Zentrum für Entwicklungsforschung (ZEF)

ENTOMOPHAGY IN MYANMAR

FACTORS INFLUENCING EDIBLE INSECT CONSUMPTION BEHAVIOR

Inaugural-Dissertation

Zur

Erlangung des Grades

Doktorin der Agrarwissenschaften

(Dr. agr.)

der

Landwirtschaftlichen Fakultät

der

Rheinischen Friedrich-Wilhelms-Universität Bonn

von

Myint Thu Thu Aung

geb. in

Sittwe, Rakhine State, Myanmar

Bonn 2023

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Tag der mündlichen Prüfung: 26. September 2023

Angefertigt mit Genehmigung der Landwirtschaftlichen Fakultät der Universität Bonn

Abstract

As the world population rapidly increases, food security and malnutrition are becoming ever more significant concerns, as well as challenges to achieving sustainable development. These global problems are exacerbated by other persistent factors, such as decreased arable land, water scarcity, and changing climatic conditions. Edible insects promise an alternative protein source with fewer land and water requirements, as well as lower greenhouse gas emissions than conventional animal husbandry. Thus, the concept of entomophagy—consuming insects as food—has become particularly important. One country with a long history of consuming insects is Myanmar, yet where the problem of chronic malnutrition also persists. The growing significance of entomophagy has drawn the attention of researchers recently. However, the paucity of existing research into the topic of entomophagy makes it difficult to understand people's behavior regarding eating edible insects as well as their motives and aversions, particularly in the local culture of Myanmar. This knowledge gap emphasizes the need for consumer studies of edible insects; thus, this dissertation examines people's behavior towards entomophagy to understand the current and future prospects, specifically in Myanmar.

Data collection was conducted through telephone interviews, acquiring 872 respondents. The conceptual framework was based on the extended Theory of Planned Behavior (TPB) and Randall and Sanjur's food consumption model. Consumer acceptance and consumption frequency of edible insects were explored using Poisson regression with sample selection analysis (Heckpoisson model). With the help of structural equation modelling analysis, consumption intention towards edible insects and reared crickets were then predicted. Moreover, the moderating effect of background factors in the relationship between the TPB constructs and the consumption intention of edible insects was also investigated using multi-group moderation analysis.

Results revealed that the majority (72%) of people in Myanmar had experienced consuming insects while 67% were already insect consumers, indicating that entomophagy is pervasive. Consumer acceptance towards edible insects as food was 67%—a moderately high percentage in Myanmar, where consumption frequency is occasional. Twenty-three (23) types of edible insects have been documented, where crickets, bamboo worms, and bees were identified as the most eaten and preferred among them. Consumer acceptance was found to be influenced by ethnicity, religion, opinion towards entomophagy, insect phobia, nutritional properties, social concerns, and discomfort. Meanwhile, consumption frequency was influenced by respondents' income, ethnicity, family size, taste, smell, and safety concerns. Negative opinions, insect phobia, safety concerns, social concerns, and discomfort were significant bottlenecks for insect consumption in Myanmar. In contrast, the nutritional properties of edible insects motivated individuals to consume them.

There was a significant positive effect of attitude, subjective norm, and perceived behavioral control on consumption intentions towards edible insects. Environmental concern, however, had a significant negative impact. Only four out of ten factors had moderating effects on consumption intention, especially the administrative division, urban or rural location, educational level, and ethnic group.

On the other hand, most respondents had a positive attitude towards reared crickets and were ready to accept them as food. Consumption intention towards reared crickets was directly influenced by consumers' attitudes, perceived behavioral control, and trust in producers. At the same time, it was indirectly influenced by consumer knowledge about the environmental friendliness of cricket farming. Subjective norm, trust in retailers, and perceived product quality did not significantly affect the intention to eat crickets.

Being the first consumer analysis in Myanmar, this research supported the appropriateness of TPB as well as Randall and Sanjur's food consumption model for analyzing insect consumption behavior. In addition, the study proved that broadening the scope of the TPB model is possible for edible insect research. The theoretical contribution of this study provides clarity for a full comprehension of the topic and lays the basic framework for future research. This study also highlighted the importance of raising public awareness of the benefits of entomophagy, creating a positive impression, and reducing social fears about insect consumption. Providing novel insect-based foods, such as flour, could boost consumption. A gradual shift from mere collection to insect farming would improve the all-year availability of edible insects and reduce the difficulties consumers face in accessing them. As trust in producers is the new key predictor, insect producers should build public trust by bringing transparency to the cricket production process, thereby achieving a more favorable attitude towards reared insects, leading to higher consumption levels. Government and non-governmental organizations are recommended to hold public fora to raise public awareness on the environmental and health benefits of consuming edible insects. Furthermore, the government should set good manufacturing practices for edible insects to ensure food safety, and the actors along the value chain should prioritize food safety by following laid-down policies.

Zusammenfassung

Durch die rapide anwachsende Weltbevölkerung werden Ernährungssicherheit und Mangelernährung sowie eine nachhaltige Entwicklung zu immer wichtigeren Herausforderungen. Diese globalen Probleme werden durch weitere Faktoren, wie z. B. abnehmende Verfügbarkeit von Ackerland, Wasserknappheit und sich ändernde klimatische Bedingungen, verschärft. Essbare Insekten stellen eine alternative Proteinquelle dar, die mit einem geringeren Flächen- und Wasserbedarf sowie geringeren Treibhausgasemissionen als die herkömmliche Tierhaltung einhergeht. Daher ist das Konzept der Entomophagie – dem Verzehr von Insekten als Nahrung – zunehmend wichtiger geworden. Ein Land mit einer langen Geschichte des Verzehrs von Insekten ist Myanmar, wo das Problem einer chronischen Unterernährung jedoch weiterhin fortbesteht. Die wachsende Bedeutung der Entomophagie hat in letzter Zeit die Aufmerksamkeit von Forschern auf sich gezogen. Der noch mangelhafte Forschungsstand zum Thema Entomophagie macht es jedoch schwierig, das Verhalten der Menschen hinsichtlich des Verzehrs von essbaren Insekten sowie ihre Motive und Abneigungen diesbezüglich zu verstehen. Dies trifft insbesondere für lokale Kulturen wie diejenige Myanmars zu. Diese Wissenslücke unterstreicht die Notwendigkeit von Verbraucherstudien zum Thema essbare Insekten. Daher untersucht diese Dissertation das Verhalten der Menschen bezüglich Entomophagie, um dadurch aktuelle und zukünftige Perspektiven des Insektenkonsums, insbesondere in Myanmar, einschätzen zu können.

Die Datenerhebung erfolgte durch Telefoninterviews mit insgesamt 872 Personen. Der konzeptionelle Rahmen basiert auf der erweiterten Theory of Planned Behavior (TPB) und dem Lebensmittelkonsummodell von Randall und Sanjur. Verbraucherakzeptanz und Verzehrhäufigkeit von essbaren Insekten wurden mittels Poisson-Regression mit Stichprobenanalyse (Heckpoisson-Modell) untersucht. Mit Hilfe von Strukturgleichungsmodellen wurde dann die Verzehrsabsicht gegenüber essbaren Insekten und gezüchteten Grillen vorhergesagt. Darüber hinaus wurde ein möglicher moderierender Effekt von Hintergrundfaktoren im TPB-Modellkonstrukt bezüglich der Verzehrsabsicht von essbaren Insekten mittels Multi-Gruppen-Moderationsanalyse untersucht.

Die Ergebnisse zeigen, dass die Mehrheit (72%) der Menschen in Myanmar schon Erfahrung mit dem Verzehr von Insekten haben, und 67% Insektenkonsumenten sind, was darauf hindeutet, dass Entomophagie im Land weit verbreitet ist. Die Verbraucherakzeptanz gegenüber essbaren Insekten lag bei 67% – ein mäßig hoher Prozentsatz, wobei in Myanmar

der Insektenverzehr nur gelegentlich erfolgt. Es wurden 23 Arten essbarer Insekten dokumentiert, von denen Grillen, Bambuswürmer und Bienen bevorzugt und auch am häufigsten gegessen werden. Es wurde festgestellt, dass die Verbraucherakzeptanz von Faktoren wie ethnischer Zugehörigkeit, Religion, Meinung über Entomophagie, Insektenphobie, Nährwert, sozialen Bedenken und Unbehagen beeinflusst wird, während die Konsumhäufigkeit durch das Einkommen, die ethnische Zugehörigkeit, die Familiengröße, den Geschmack, den Geruch und die Sicherheitsbedenken der Befragten beeinflusst wird. Vor allem eine negative Meinung, Insektenphobie, Sicherheitsbedenken, soziale Bedenken und Unbehagen bilden erhebliche Barrieren für den Insektenkonsum in Myanmar. Im Gegensatz dazu motivieren die guten ernährungsphysiologischen Eigenschaften essbarer Insekten die Menschen, diese zu konsumieren.

Es gab einen signifikanten positiven Effekt der Einstellung, der subjektiven Norm und der wahrgenommenen Verhaltenskontrolle auf die Konsumabsichten gegenüber essbaren Insekten. Umweltbedenken wirkten sich jedoch erheblich negativ aus. Nur vier von zehn Faktoren hatten moderierende Auswirkungen auf die Konsumabsicht, insbesondere die administrative Aufteilung, die städtische oder ländliche Lage, das Bildungsniveau und die ethnische Zugehörigkeit.

Andererseits hatten die meisten Befragten gegenüber gezüchteten Grillen eine positiv Einstellung und waren bereit, sie als Lebensmittel zu akzeptieren. Die Konsumabsicht gegenüber gezüchteten Grillen wurde direkt von der Einstellung der Verbraucher, der wahrgenommenen Verhaltenskontrolle und dem Vertrauen in die Produzenten beeinflusst. Gleichzeitig wurde es indirekt durch das Wissen der Verbraucher über die Umweltfreundlichkeit der Grillenzucht beeinflusst. Subjektive Norm, Vertrauen in Einzelhändler und wahrgenommene Produktqualität hatten keinen signifikanten Einfluss auf die Absicht, Grillen zu essen.

Als die erste Analyse dieser Art in Myanmar stützt die vorliegende Forschung die Angemessenheit der TPB sowie des Lebensmittelkonsummodells von Randall und Sanjur zur Analyse des Konsumverhaltens von essbaren Insekten. Darüber hinaus zeigte die Studie auf, dass eine Erweiterung des Anwendungsbereichs des TPB-Modells für die Forschung an essbaren Insekten möglich ist. Der theoretische Beitrag dieser Studie schafft daher mehr Klarheit für ein vollständigeres Verständnis des Themas und legt ein Grundgerüst für zukünftige Forschung. Diese Studie betont auch, wie wichtig es ist, das öffentliche Bewusstsein für die Vorteile der Entomophagie zu schärfen, ein positives Image zu verbreiten und soziale Ängste vor dem Verzehr von Insekten abzubauen. Neuartige Lebensmittel auf Insektenbasis wie Insektenmehl könnten den Konsum ankurbeln. Ein schrittweiser Übergang vom bloßen Sammeln zur Insektenzucht würde die ganzjährige Verfügbarkeit von essbaren Insekten verbessern und die Schwierigkeiten der Verbraucher beim Zugang zu ihnen verringern. Da Vertrauen ein Schlüsselfaktor ist, sollten die Insektenproduzenten öffentliches Vertrauen aufbauen, indem sie den Grillenproduktionsprozess transparent machen, dadurch eine positivere Einstellung gegenüber gezüchteten Insekten erreichen, welche dann wiederum zu einem höheren Konsum führen kann. Regierungs- und Nichtregierungsorganisationen wird empfohlen, öffentliche Foren zu veranstalten, um das öffentliche Bewusstsein für die ökologischen und gesundheitlichen Vorteile des Verzehrs von essbaren Insekten zu schärfen. Darüber hinaus sollte die Regierung Regeln für einwandfreie Herstellungsverfahren essbarer Insekten festlegen, um dadurch die Lebensmittelsicherheit zu gewährleisten. Schließlich sollten die Akteure der Wertschöpfungskette der Lebensmittelsicherheit hohe Priorität einräumen, indem sie solch festgelegte Richtlinien befolgen.

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List of Acronyms and Abbreviations

AB	Actual behavior
ACAPS	Assessment capacities projects
AGFI	Adjusted goodness of fit index
AIC	Akaike’s information criterion
AMOS	Analysis of a moment structures
AR	Ascribed responsibility
ATT	Attitude
AVE	Average variance extracted
BB	Behavior belief
BI	Behavioral intention
BNI	Burma News International
BV	Biospheric value
CB	Control belief
CFA	Confirmatory factor analysis
CFI	Comparative fit index
CI	Consumption intention
CK	Consumer knowledge
COVID-19	Coronavirus Disease 2019
CR	Composite reliability
DOP	Department of Population
EA	Environmental awareness
EC	Environmental concerns
EFSA	European Food Safety Authority
ETPB	Extended theory of planned behavior
EXP	Experiences
FAO	Food and Agriculture Organization
FN	Food neophobia
GDP	Gross domestic product
GEN	Gender
GFI	Goodness of fit index
GHG	Greenhouse gases
GMI	Global Market Insights

IFPRI	International Food Policy Research Institute
IFR	Insect food rejection
IOM	International Organization for Migration
IPIFF	International Platform of Insects for Food and Feed
IRR	Incidence-rate ratio
ISIF	Interaction of self-identity and familiarity
LIFT	Livelihoods and Food Security Trust Fund
MC	Motivation to comply
MIMU	Myanmar Information Management Unit
MMK	Myanmar Kyat
MPLCS	Myanmar Poverty and Living Conditions Survey
NAM	Norm Activation Model
NB	Normative belief
NFI	Normed fit index
NGO	Non-Governmental Organization
OCHA	United Nations Office for the Coordination of Humanitarian Affairs
OE	Outcome evaluation
OECD	Organization for Economic Co-operation and Development
PBC	Perceived behavioral control
PE	Perceived effectiveness
PEM	Protein-energy malnutrition
PEOU	Perceived ease of use
PI	Purchase intention
PN	Personal norms
PP	Perceived power
PPQ	Perceived product quality
PR	Perceived risk
PU	Perceived usefulness
RMSEA	Root means the square error of approximation
RUT	Random Utility Theory
SA	Sustainable attitude
SDE	Social demographic and economic
SDGs	Sustainable Development Goals

SEI	Stockholm Environment Institute
SEM	Structural equation modelling
SN	Subjective norms
SPSS	Statistical package for the Social Sciences
TLI	Tucker Lewis index
TP	Trust in producers
TPB	Theory of Planned Behavior
TR	Trust in retailers
TRA	Theory of Reasoned Action
TRT	Trust
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNHCR	United Nations High Commissioner for Refugees
UNICEF	United Nations International Children's Emergency Fund
USAID	United States Agency for International Development
USD	United States Dollar
VIF	Variance inflation factor
WFP	World Food Programme
WHO	World Health Organization

Acknowledgements

My PhD journal would not have been possible without the help, support, inspiration and guidance of the following generous persons and institutions:

I would like to first pay my sincerest gratitude to my first supervisor, Prof. Dr Christian Borgemeister for his clear, precise and accurate feedback and suggestion to enhance my dissertation's quality. My heartful thanks and deep indebtedness to my co-supervisor, Prof. Dr Jan Börner, for his constructive comments and for sharing valuable knowledge and time to improve this dissertation. I am incredibly thankful for my enthusiastic, devoted, and big-hearted Doctoral tutor, Dr Jochen Dürr; your ideas and perspectives helped shape this dissertation. I would not have achieved this doctoral degree without his extreme support, patience, guidance and help. I am grateful to Jeanette Leila Klink-Lehmann for her valuable advice and comments in designing the questionnaire and even afterwards help me with critical suggestions, kindness and understanding. I want to thank Dr Guido Luechters for being helpful and generous with his time and advice regarding statistical analysis.

This dissertation could not be written without funding from the ProciNut (Production and Processing of Edible Insects for Improved Nutrition) project. I want to express my thanks to all project members, especially former project leader Dr Sarah Nischalke and current project leader Dr Simone Kathrin Kriesemer. Thank you for keeping your doors open anytime for the discussions and being supportive. Thank you, my friend, Yauheniya Shershunovich, for reviewing the article.

No words of appreciation would be sufficient to express my feelings towards the administration of ZEF, including Dr Günther Manske, Dr Silke Tönsjost, Ms Maike Retat-Amin, and Max Voit, for their great support.

I cannot find words to express my utmost gratitude to my loving parents and brother for their affection, inspiration and constant support during all these years of my study; without their efforts and encouragement, I would not have survived and reached this stage of my career. Special thanks to my lovely sister, Daw Hla Theingi, for the kind help, encouragement, affection and inspiration throughout my study to overcome all the difficulties.

Lastly, I am eternally grateful to the Three Gems: Buddha, Dhamma, and Sanga.

ENTOMOPHAGY IN MYANMAR:

FACTORS INFLUENCING EDIBLE INSECT CONSUMPTION BEHAVIOUR

CHAPTER I

1. Introduction

1.1 Background

As the global population continues to grow at an alarming rate, food insecurity and malnutrition will become more pressing as time goes on (FAO, 2017; FAO *et al*., 2019; IFPRI, 2018). Three main factors exacerbate these problems: decreased availability of arable land, water scarcity, and changing climatic conditions (Alexandratos and Bruinsma, 2012; Ebenebe *et al*., 2017; Fitton *et al*., 2019; Gomiero, 2016; Misra, 2014; Sachs, 2009). The decrease in agricultural lands directly and negatively impacts food security (Alexandratos and Bruinsma, 2012; Gomiero, 2016). Diminishing water availability harms food production (Fitton *et al*., 2019), and concurrently, worsening global climate conditions have resulted in decreased food production (Islam and Wong, 2017; Ritchie, 2019). Food production and climate change interact, with the latter significantly impacting global warming, accounting for 26%-35% of the world's greenhouse gas (GHG) emissions (Islam and Wong, 2017; Lynch *et al*., 2021; Ritchie, 2019). Among food production activities, meat production is responsible for about 15% of total GHG emissions (Lazarus *et al*., 2021). As a result, food insecurity has emerged as a major problem (FAO, 2017). The FAO *et al*. (2019) reported that the prevalence of undernourishment has re-increased in the world since 2015 and accounted for 811.7 million of the world's total population in 2017; one in every nine people then suffered from malnutrition. In 2020, the situation had worsened— 821.6 million of the global population experienced hunger; one in three people had no chance to get enough food, and thus, about 10% of the total population encountered undernutrition problems (FAO, 2021; Szmigiera, 2021a; World Vision Canada, 2021).

In addition, the COVID-19 pandemic and global political conflicts have amplified the food security problem. In 2022, 869 million people experienced hunger, and more than 40% of them faced severe food insecurity (WFP, 2022). Moreover, malnutrition has become a problem worldwide, especially in low- and middle-income countries (IFPRI, 2018). Thus, there is a need for a suitable solution to solve the concomitant food security and malnutrition problems (Nyandiala, 2017; Van Huis, 2013).

Meanwhile, more ecological ways of meat protein production have been proposed to substantially reduce GHG emissions (UNEP, 2012) because meat protein production in traditional and industrial ways demands high land, water, and energy supplies and causes significant emissions of GHGs that lead to global climate change (Hartmann and Siegrist, 2017). Consequently, since the early 2000s, Western societies have started diversifying their protein sources (Gavelle *et al*., 2019).

In relation to different protein sources, studies have found that edible insects could be an alternative meat protein source with less land and water requirements and lower GHG emissions than conventional livestock production to fulfil sustainable food requirements as a different source of meat protein (FAO, 2017; Kinyuru *et al*., 2015; Van Huis *et al*., 2013). Edible insects are very fecund, with higher feed conversion efficiency and less resource use than conventional livestock species (Dagevos, 2021; Kinyuru *et al*., 2015; Lange and Nakamura, 2021; Tao and Li, 2018; Van Huis and Oonincx, 2017). Their nutritional content, however, varies depending on the insect species, stage of their lifecycle, habitat, and diet (Ghosh *et al*., 2017; Shah *et al*., 2022; Skotnicka *et al*., 2021). Yet generally, insects offer high contents of proteins, fats, vitamins, and minerals, comparable to those in conventional meat and consuming them as food can greatly benefit the consumers' health if the insects are appropriately handled and prepared. This will eventually lead to increased food and nutritional security (Belluco *et al*., 2013; Kinyuru *et al*., 2015; Tang *et al*., 2019). All these facts point to the advantages of consuming edible insects to meet food security and, at the same time, may potentially solve undernutrition problems (Imathiu, 2020). Therefore, the consumption of edible insects can have great potential to positively impact food security, sustainable food production, livelihoods of vulnerable populations, providing economic opportunities and protecting the environment. However, consumers' negative perception of edible insects still poses a significant obstacle to being accepted as a meat protein alternative (Van Huis *et al*., 2013).

Insect consumption is not a new idea (Van Huis *et al.*, 2013), as humans are omnivores and have eaten insects since ancient times (Robert, 2008; Van Huis *et al*., 2013; Vantomme, 2015; Yen, 2015; Yen, 2009). Due to animal husbandry and taming, the insect consumption trend declined due to the similar nutritional contents of insects and more conventional livestock species (Halloran *et al*., 2018). Even though entomophagy, the scientific term for eating insects, is common in many parts of the world, it remains a peculiar practice for other people, particularly in Western societies (Shockley and Dossey, 2014; Sogari *et al*., 2018). Still, more than 2 billion people in the world eat insects, and more than 1,900 insect species are reportedly used as food

(Van Huis *et al*., 2013). Consumption stages are different, and most insects are eaten as adults (*e.g.*, crickets, grasshoppers), some as larvae (*e.g.*, bamboo worms, palm weevils), and others as pupae (*e.g.*, silkworms), while some insects such as honeybees, can be eaten as eggs, larvae, and pupae (Alamu *et al*., 2013; Banjo *et al*., 2006; Kouřimská and Adámková, 2016). Even dried insects offer good protein and enrichment of vitamins and minerals (Banjo *et al.*, 2006), as insects are highly nutritious food that can provide a balanced diet and improve human well-being (Schabel, 2010). The Belgian entrepreneur Chris Derudder introduced "World Edible Insect Day" on the 23rd of October 2015 to raise awareness of insects as food.

With environmental sustainability, climate change, nutrition, food safety, and health becoming significant issues today, insect foods have re-emerged worldwide (Gere, 2017; Huang, 1996; Sogari *et al*., 2019). Insects are popular not only as human foods but also as a natural diet for livestock such as chicken, duck, and fish (Kelemu *et al*., 2015; Spectrum, 2016). While in most countries, insects are collected from the wild, in some countries such as Belgium, the Netherlands, Canada, the United States, the United Kingdom, Spain, Germany, South Africa, Vietnam, and Thailand, commercial production of edible insects is being established (Glover and Sexton, 2015). For example, Thailand is a leading country in cricket farming which started in 1997 (Halloran *et al*., 2016). Durable insect-based processed foods like insect pastes and spreads, insect flour, dried insects, burgers, pasta, balls, bread, biscuits, chocolates, ice cream, oil, and so on, as well as insect-based feeds for livestock and fish, are produced in those countries (Glover and Sexton, 2015). Commercial insect production for food can improve the environment, health, and livelihood of those consuming them and economically participating in this sector (Kinyuru *et al*., 2015). Consequently, many researchers pointed out that edible insects may have both direct and indirect impacts on the attainment of the Sustainable Development Goals (SDGs) such as zero hunger (SDG-2), no poverty (SDG-1), decent work and economic growth (SDG-8), good health (SDG-3), responsible consumption and production (SDG-12), and climate action (SDG-13) (Chia *et al*., 2019; Moruzzo *et al*., 2021; SEI, 2019).

Owing to the aforementioned benefits, non-traditional entomophagous Western countries have shown increasing interest in consuming edible insects in recent years (GMI, 2020; IPIFF, 2020). Consequently, the insect market is expected to explode from its USD 55 million 2019 level to a whopping USD 710 million by 2026 across the world, including the Americas, Europe and Asia (Ahuja and Mamtani, 2020). As edible insects have become increasingly popular around the world and opened up new revenue streams, numerous research have looked into the factors that influence people's decision to consume insects. In the beginning, consumer studies on edible insects were conducted mainly in Western nations where edible insects are a novel food (Amato, 2017; Capponi, 2016; Mancini *et al*., 2019; Moruzzo *et al*., 2021; Orsi *et al*., 2019; Sogari *et al*., 2019; Vartiainen *et al*., 2020; Woolf *et al*., 2019); later, studies were also conducted in insect-eating countries (Liu *et al*., 2020; Hwang and Kim, 2021; Omemo *et al*., 2021). Consumer analysis studies, in particular, are required for insect-eating countries with a high prevalence of chronic malnutrition (Ancha *et al*., 2021; Dürr and Ratompoarison, 2021).

According to Müller and Krawinkel (2016), a significant number of developing nations continue to struggle with undernourishment. Poor individuals in many developing nations can only afford cheap foods that are often of poor quality, which is the root cause of the multiple types of malnutrition (Lartey *et al*., 2018; Siddiqui *et al*., 2020). As a direct consequence of this, malnutrition accounts for almost 50% of all preventable deaths that occur in children under the age of five (Bread for the World, 2021). Subsequently, these nations can lose as much as 12% of their GDP each year due to malnutrition (Horton and Steckel, 2011). Improving nutrition is one of the most cost-effective ways to solve these problems and promote the development in these countries (Shekar *et al*., 2016).

Foods that are both cheap and nutritious are needed to meet the needs of the underprivileged in developing nations (Bhargava, 2015). Insects are regarded as affordable, high-quality, and nourishing foods for those people (Tang *et al*., 2019). Edible insects contain high-quality protein, fat, fiber, significant amounts of micronutrients (copper, iron, magnesium, manganese, phosphorous, selenium, and zinc), and vitamins (Rumpold and Schlüter, 2015). Insect-derived essential amino acids such as lysine, threonine, and methionine are deficient in cereals and beans and are especially beneficial in situations where malnutrition persists (Smith *et al*., 2021; Tajudeen, 2020). Lysine is required to create connective tissues, including bone, skin, collagen, and elastin; synthesize carnitine; convert fatty acids to energy; promote appropriate growth and development in children; and maintain normal immune function, notably antiviral activity (Anonymous, 2007). Threonine is an immunity booster; thus, a depressive state of the immune system might result from even a mild reduction in dietary threonine consumption (Braverman *et al*., 2003). Romanet *et al*. (2020) listed the functions of methionine as an antioxidant, methyl donor, and precursor of cysteine, cystine, and it also improves dry skin, hair nutrition, joint mobility, mental health, belly fat reduction, and muscular strength. Hence, insects are wholesome foods for their nutritional contents (Van Huis *et al*., 2013).

Further studies show that insects can significantly improve the nutritional value of diets in malnourished populations; thus, insect consumption may be an excellent option to enhance food security in developing nations (Roos, 2018; Tao and Li, 2018). Nadeau *et al*. (2015) postulated that malnutrition worldwide could be significantly reduced by using insects as a human food source. However, some studies revealed that insect-eating habits have decreased in traditionally entomophagous countries such as Japan and Laos (Hartmann *et al*., 2015; Mitsuhashi, 1997; Pambo *et al*., 2018; Yen, 2009). Improving living standards and changing consumer behaviors gradually led to losing traditional habits and customs (Looy *et al*., 2014). Thus, insect consumption practices have become less common in many insect-eating countries (Lehane, 2016; Lim et al., 2009; Teffo, 2006). Edible insect studies conducted by Hartmann *et al*. (2015) and Yen (2009) found that entomophagy is declining because the food options for Asian consumers have increased with the introduction of more Western or European-style dishes (Ahmad *et al*., 2020). Vantomme (2015) also pointed out that there seems to be a trend towards rejecting insect-eating practices among urban and young people in rooted entomophagous countries. Barennes *et al*. (2015) highlighted that the current downward trend of consuming insects in Laos, is affected by, among others, the non-availability and seasonality of edible insects. However, entomophagy has been well-practiced in China for more than 2,000 years (Feng *et al*., 2018). In Thailand, insect-eating is constantly growing (Durst and Hanboonsong, 2015); similarly, insect consumption is still very prevalent in Central Africa (Kelemu *et al*., 2015). Thus, the argument that entomophagy practice is declining in traditional insect-eating countries remains debatable. Not only does it vary from one country to another, but in even two provinces within one country, such as in South Africa, with insect consumption declining in KwaZulu-Natal while being stable in Limpopo (Hlongwane *et al*., 2021).

Due to the above distinct and different findings, one might wonder why, even though such entomophagous nations are struggling with food and nutrition insecurity, some of them are cutting back on insect consumption rather than increasing it to combat hunger and malnutrition. Possible causes for this phenomenon range from changes in agricultural farming techniques, unavailability of edible insects, seasonality, increasing Westernization of local diets, and loss of traditional practices, particularly eating customs, to the lack of preserving indigenous knowledge. The reasons, however, again differ from one country to another. Therefore, the underlying hindering factors have to be thoroughly examined separately for each entomophagous nation in order to identify the possible causes of the decline in insect consumption.

1.2 Entomophagy in Myanmar

In Southeast Asia, Myanmar is one of the countries where insect-eating is most common. It is popular in traditional communities as well as in big cities such as Yangon and Mandalay, where insects are consumed as fashion food (Spectrum, 2016). Regarding consumption habits, insects are not just snacks or dishes; some insects, such as weaver ants, are consumed as a blended digestive powder mixed with salt and black cumin by locals (Linn *et al*., 2016).

Myanmar is located between latitudes 9° 32' and 28° 31' and longitudes 92° 10' and 101° 11'[1]. It has a total area of 676,578 sqkm[2] and covers a broad range of agro-climatic zones. The tropical monsoon climate[3] provides a proliferation of various edible insects all over the nation (Yhoung-Aree and Viwatpanich, 2005), but popular insects differ from one region to another. Spectrum (2016) documented that a tiny traditional open insect market is developing in Myanmar. Insects are being sold in markets in cities and small towns, most notably in regions such as Yangon and Mandalay and in states such as Shan and Mon. Nowadays, wide varieties of wild and some reared insects are supplied on online markets. Some insects, such as cicadas, giant crickets, ground crickets, house crickets, and giant water bugs, are only available during specific times of the year. On the other hand, bamboo worms, silkworms, and palm weevil larvae can be found year-round (Myint Thu Thu and Dürr, 2021). Depending on the region, the available insect types and species differ. Crickets are the most popular among other types of edible insects and can be found throughout the country (Spectrum, 2020a). The total amount of crickets collected in the wild is estimated at approximately 180 tons, leading to $3.9 million as annual revenue from sales in Myanmar and about 12-20 tons of crickets exported to neighboring countries (Spectrum, 2020a). Mon and Shan states are the main border trade zones which export edible insects to Thailand and China (Spectrum, 2016). In Myanmar, insects are primarily available from the wild; thus, insect supply is generally seasonal (Spectrum, 2020d, 2020c). However, Myanmar began apiculture under British rule (Than, 2016) and modern sericulture in 1952 (Win and Hlaing, 2015). Silkworms are commercially reared for silk production in five regions of Myanmar, *i.e.*, Kachin, Kayah, Chin, Mandalay, and Shan states. About 4,500 metric tons of honey are produced annually by 893 beekeepers in the country (LIFT, 2016). However, there is no record of how much bees and silkworms are used as human food in Myanmar.

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[1] http://www.myanmar-embassy-tokyo.net/about.htm
[2] https://en.wikipedia.org/wiki/Geography_of_Myanmar
[3] https://www.go-myanmar.com/climate-and-weather

Only "a few dozen" entrepreneurs started launching insect farms in Myanmar before 2020 (Reverberi, 2020). Spectrum (2021b) described that about a hundred people have recently launched cricket farming. Farming insects for human food has a market potential of $10-15M annually. In comparison, farming insects like crickets, larvae of black solider flies and red palm weevils, and worms such as silkworms, mealworms, and super worms have the potential as animal feed to generate $200 million annually (Spectrum, 2020b). Hence, the market potential of insects as feed seems much higher than that for food. Moreover, many edible insects are imported from neighboring countries for off-season consumption as domestic insect rearing for the food industry is still in its initial phase (Nischalke *et al*., 2020).

1.3 Statement of the problem

As entomophagy has become popular globally due to its positive attributes to nutrition and the environment (Schabel, 2010; Van Huis, 2013), Spectrum (2021a) recommended incorporating edible insects as a basic food of different indigenous diets in Myanmar to increase the nutritional health of the country's citizens. Myanmar is plagued with the shortages of micronutrients and macronutrients, such as protein-energy malnutrition (PEM) as reported by Robertson *et al*. (2018). It is one of the foremost widespread problems among poor people because of their deficiency in protein, energy, and micronutrients (Ahmed *et al*., 2020). According to Robertson *et al.* (2018), PEM is one form of nutritional deficiency that affects many people in Myanmar. Three clinical types of PEM, *i.e*., underweight, stunting, and wasting, are visible among children under the age of five in Myanmar (Ministry of Health, 2014). In 2018, about 19% of children in Myanmar were underweight, 27% were short for their age, and 7% were too skinny (UNICEF and WHO, 2020). PEM was portrayed by Grover and Ee (2009) as a covert threat, analogous to the submerged portion of an iceberg, having terrible repercussions that may not be immediately apparent. Therefore, PEM needs to be addressed in order to lessen the impact of its repercussions. Combating malnutrition is critical because healthy nutrition helps with physical and intellectual development, as well as disease prevention (WFP, 2019). As Nischalke (2020) stressed, many children consider insects to be one of their favorite foods, and they never say no when eating them, so insects might be a possible option for fighting PEM in Myanmar.

One main root of PEM in Myanmar is low meat consumption. Eurocham Myanmar (2019) reported that currently meat consumption in the country is historically low. People primarily rely on eggs to provide animal protein (Eurocham Myanmar, 2019), coupled with various other plant sources such as rice, beans, and nuts providing protein in Myanmar (Robertson *et al*., 2018). Yet many of the latter are deficient in some essential amino acids (Smith *et al*., 2021). Rice is a staple diet in Myanmar that helps fill the stomach, but it lacks essential nutrients, which can result in micronutrient deficiency (OECD, 2017; Robertson *et al*., 2018). Only 38% of families in Myanmar eat the recommended daily intake of protein-rich foods such as fresh or dried fish, fresh or dried meat, eggs, and pulses (Mahrt *et al*., 2019). A survey conducted by Robertson *et al*. (2018) found that protein consumption and income have a positive relationship, with higher-income families consuming more protein food (five times per week) than low-income families (three times per week). But 37% of metropolitan low-income families in Yangon eat meat only once or twice a week, while 10% cannot afford to eat meat at all.

Apart from chronic malnutrition, the people in Myanmar suffer from economic, political, and social instability due to the triple burden of impoverishment, the COVID-19 pandemic, and the military coup (UNDP, 2021). Violent conflict can cause famine (Grebmer *et al*., 2021), and about 99 million people in 23 nations recently faced starvation due to conflict, including Myanmar (Action Against Hunger, 2021; UN, 2021). Even before the military coup, according to the UN, almost 3 million people in Myanmar faced starvation (The World, 2021). Conflict greatly limits free mobility since food, medicine, transportation, and buying were restricted around the conflict areas (ACAPS, 2021; Myanmar Now, 2021; OCHA, 2021), resulting in over 13.2 million of the total population in Myanmar facing moderate or severe food insecurity problems in 2021 (UNHCR, 2021). At the same time, crop production, unfortunately, decreased due to the 2021 floods leading to famine (OCHA, 2021). Hence, food availability, affordability, and accessibility have become very limited, and it is quite challenging to fix the country’s food crisis.

One of the Indian international online media reported that people are solving starvation problems in light of the COVID-19 pandemic by eating insects, snakes, and rats during the second lockdown period in Myanmar (Asiaville Interactive Pvt Ltd, 2020). This highlighted that edible insects might possibly help to address the food insecurity problem. Belluco *et al*. (2015) point out that consuming insects is a recently proposed idea to help alleviate food shortages and famine. Insects can help alleviate protein shortages and iron deficiency while promoting long-term food and nutritional security (Smith *et al*., 2021; Tuhumury, 2021). Regular consumption of edible insects could, thus, reduce malnutrition (Smith *et al*., 2021). Even though insects are gaining popularity as an alternative meat protein globally (Hlongwane, 2021; Kim *et al*., 2019; Rumpold and Schlüter, 2015, 2013a; Van Thielen *et al.,* 2019), people from traditional entomophagous areas of Myanmar are still suffering from protein deficiency problems. According to the Ministry of Health and Sports, one in every three prenatal children in Chin State suffer from anemia due to protein and iron deficiency during pregnancy (BNI multimedia group, 2022). Even though insects have a place in the diet of some ethnic people—mainly from mountainous areas such as Kayin, Chin, Kachin, Shan, and others (Linn *et al*., 2016)—entomophagy seems uncommon among many urban dwellers of the country's central area (Nischalke *et al*., 2020), apart from giant cricket consumption. People from some areas are familiar with insect consumption, but it is still strange to some people from other areas of Myanmar. The reasons behind those differences have not been investigated, highlighting the need for a comprehensive insect consumption analysis in Myanmar since information regarding determinants of insect consumption are crucial to evaluate its capability to fight hunger.

Indigenous traditional culture was decimated during the British colonization, eventually transforming a traditional civilization into a more westernized one (Gandhi, 2019; Targosz, 2016). In general, insect consumption in entomophagous countries has decreased, with food provision from edible insects over the years declining in Asia and Africa (Chakravorty *et al*., 2013; Manditsera *et al*., 2018; Pambo *et al*., 2018). However, the absence of detailed studies on edible insect consumption in Myanmar poses uncertainty as to whether traditional insect consumption is decreasing in the country, as in other entomophagous countries, and whether there is regular insect consumption or not. Thus, the potential role of edible insects in nutrition in Myanmar remains unknown (Nischalke *et al*., 2020). It is crucial to know whether insect consumption is still favored in traditionally insect-eating regions like before and what factors support or discourage insect consumption, as such information are important for enhancing entomophagy in Myanmar. According to Meysing *et al*. (2021), in countries with conventional insect-eating habits where chronic malnutrition is prevalent, it is necessary to examine the insect consumption behavior of the population.

Even if insect consumption can help solve food insecurity and malnutrition, there is a conundrum in developing the edible insect sector as a long-term solution. In Myanmar, insect consumption is mainly dependent on wild collections. Overharvesting wild insects, in Myanmar and beyond, may threaten insect populations, particularly crickets (Spectrum, 2020c). Wild harvesting may endanger wild species populations and severely affect the environment and society (Spectrum, 2021c). Linn *et al*. (2016) reported that cutting down the host trees and over-harvesting are the main problems in edible insect collection and they highlighted the need for some conservation methods. As Myanmar also faces complex and challenging barriers to conserving its biodiversity (Sovacool, 2012), there is an urgent need for measures to protect and maintain the survival of the wide range of wild insect populations, food supply chains, and the environment (Halloran *et al*., 2015; Linn *et al*., 2016). While insects are globally interesting as an eco-friendly source for sustainable food solutions (Iqbal, 2020), insect consumption in Myanmar may adversely affect the environment since it is mostly relying on collecting wild insects. To be a sustainable solution for all people, this sector should have characteristics of long-term availability, no harmful effects on the environment, easy accessibility, low costs and good quality (Waddle, 2009).

Nischalke *et al*. (2020) highlighted that transforming wild harvesters into small insect producers is necessary for Myanmar to incorporate insects into a sustainable food system. While commercial insect production is practiced in neighboring countries such as Thailand, generally speaking, insect rearing in Myanmar is still in its infancy and has yet to establish a foothold in the domestic food market. Although some entrepreneurs have started rearing crickets recently, market perception of reared crickets in Myanmar is weak compared to wild-harvested crickets, and the general populace continues to prefer wild-collected giant crickets due to their perceived delicacy and size (Nischalke *et al*., 2020). Mass-producing giant crickets is economically not feasible due to their extremely long lifespan (Nischalke *et al*., 2020). According to Myanmar Digital News (2020), the demand for reared crickets is lower than for wild giant crickets, but there is market demand for both of them in Thailand, opening up the potential for their export. Hence the need to explore the domestic demand for reared crickets as food in Myanmar and to assess the potential viability of local cricket farming and its ability to contribute to sustainable food and nutritional security in the country.

Little is known about the factors that could potentially promote or inhibit people from consuming edible insects as an alternative source of animal protein in Myanmar. Thus, this study's problem statement is concerned with understanding consumers' behavior towards edible insects in three main components. The first is from the perspective of food and nutritional security: which administrative divisions practice entomophagy, what percentage of the population eats insects, and how frequently do they eat insects? Understanding consumer acceptance towards edible insects as food is vital because consumer aversion is the main barrier for the insect industry (Naranjo-Guevara *et al*., 2021; Van Huis, 2013; Yen, 2009). Second, from the perspective of insect producers and harvesters, understanding whether people have a strong desire to consume edible insects and which factors affect their intentions to consume them are critical for their businesses. It can provide information on potential consumer demand, and its influencing factors can be helpful for insect producers and harvesters to boost sales of their products. The third is from a sustainability point of view, as wild insect consumption may threaten some wild insect species, and rearing insects could serve as an environmentally more friendly alternative to wild collections. The consumers' willingness to eat reared insects as food is a prerequisite for such a substitution to succeed.

1.4 Research objectives and research questions

The previously identified problems highlight the importance of edible insect consumer studies in Myanmar to identify the influencing factors on consumer behavior towards edible insects. Greater understanding in this area could conceivably harness the potential of insects in combating food insecurity and malnutrition. Hence, the main objective of this dissertation is to explore the people of Myanmar behavior towards entomophagy and the factors that may attract or dissuade them from consuming insects as a substitute for conventional meat protein to help understand the current and future prospects of entomophagy in the country.

This dissertation has four main research questions to cover all three perspectives:

1. How prevalent is entomophagy in Myanmar?

By answering this research question, this dissertation tries to understand Myanmar's overall insect consumption situation. Information related to how many people practice entomophagy, which administrative divisions and the kinds of insects they eat, how many people do not practice entomophagy and what prevents them from trying edible insects were explored. These information can shed light on the potential of edible insects as alternative food sources and help to understand the prospects of entomophagy in Myanmar and how to make edible insects more widely accepted in the country.

2. What factors influence consumer acceptance towards edible insects as food and the consumption frequency of edible insects?

This dissertation intends to look at people's acceptance and actual consumption of edible insects and their drivers to understand the prospects of entomophagy in Myanmar. Acceptance of entomophagy is a prerequisite for the effective growth of the edible insect sector in Myanmar (Nischalke, 2020).

3. What factors influence the intention to consume edible insects?

This dissertation explores whether people intend to eat insects shortly and what influences them. Information on the factors affecting consumption intention will enable the development of effective marketing strategies and ways to overcome hurdles for enhancing entomophagy in Myanmar.

4. What factors influence the consumption intention towards reared crickets?

This dissertation tries to explore the potential roadblocks to reared insects as food in Myanmar as a prerequisite for promoting insect production in Myanmar. As cricket farming is now being explored in the country, reared crickets were chosen as the target species.

1.5 Expected contributions

Since edible insects are becoming popular food in many parts of the world, consumer analysis studies will help identify factors that could potentially encourage or discourage consuming edible insects as an alternative livestock protein. This research constitutes the first consumer analysis of edible insects in Myanmar. The findings and implications will provide valuable insights and suggestions to the value chain actors as well as to research and development officials to enhance the market of edible insects from the present small-scale to future large-scale production. It will provide useful information for entrepreneurs who want to start an innovative business, such as insect rearing. This study also provides information on edible insects that can be used as low-cost, high-quality, nutritious foods for local and international organizations and government agencies implementing nutritive foods and supplement provision programs for vulnerable people like pregnant women, breastfeeding mothers, children, and internally displaced persons. These organizations, in turn, will benefit from the useful insights of the research in relation to consumer behavior, which will help them create an effective nutritional initiative. Moreover, policymakers might recognize insects as a source of food and nutrition as well as a livelihood opportunity if natural resources are effectively used to contribute to the economy and to reduce food imports.

1.6 Limitations

Initially, it was planned to explore the entire edible insects value chains from producers and harvesters to final consumers through a pre-survey in Yangon and Shan states. However, the advent of the COVID-19 global pandemic and the country's dramatic political changes made it hard to travel, prompting this research to narrow its scope to the consumer perspective. Hence, this dissertation mainly focused on consumer acceptance, current consumption frequency and their underlying factors, consuming different types of insects, reasons for not consuming or not continuing entomophagy, and consumption intentions. Time and financial constraints and the unstable political situation in Myanmar made it difficult to repeat the survey with the same respondents. As a result, this study could not investigate whether the consumption intention turned into actual consumption or whether the factors that affected the intention also affected actual behavioral actions.

1.7 Outlines of the thesis

This dissertation is organized into seven chapters addressing the before mentioned four research questions. Following the introductory Chapter 1, the theoretical background and models of consumer behavior are presented in Chapter 2. Chapter 3 addresses research question 1, “How prevalent is entomophagy in Myanmar?”. Chapter 4 reports on “Factors affecting consumption of edible insects as food: entomophagy in Myanmar” (research question 2), and Chapter 5 describes “Predicting consumers’ intention towards entomophagy using an extended theory of planned behavior: evidence from Myanmar” (research question 3). Chapter 6 reports on “Behaviour intention to eat reared crickets in Myanmar: the effects of trust, knowledge, and perceived quality” (research question 4). Chapter 7 wraps up the dissertation by discussing the most important findings, drawing a general conclusion and recommendations, and suggesting directions for future study.

CHAPTER II

2. Theoretical background and models of consumer behavior

2.1 Definition, theories, and the derived models

Consumer behavior was first described by Walters (1979) as "the process whereby individuals decide whether what, when, where, how, why and from whom to purchase goods and services." Then, it was defined as a multidisciplinary perspective that entails several actions, such as selection, acquisition, consumption, evaluation, and disposal of goods, services, and ideas (Schiffman and Kanuk, 2004; Solomon *et al*., 2006). Consumer behavior explains an individual's or group's feelings, perceptions, desires, and performance (Solomon *et al*., 2006). According to Wani (2019) the term consumer behavior encompasses every mental process and physical motion an individual makes in relation to making a consumption. Commonly, consumer behavior in the context of food is accessed through consumer acceptance, intention, or actual consumption/buying (Bos *et al*., 2013; Hwang and Kim, 2021; Juaneda-Ayensa *et al*., 2016; Rani, 2014).

Scholars have developed different models and theories to understand consumer behavior (Ajzen, 1991; Bandura, 1989; Davis, 1993; Fishbein and Ajzen, 1975; Gallagher, 2012; Schwartz, 1977). The applied theories and models vary depending on what the researchers want to explore. Recent work on the consumption behavior towards edible insects as food focused on consumer acceptance, actual consumption (consumption frequency), and the intention to consume edible insects.

For consumer acceptance, MacFie (2007) noted that acceptance by people is said to be the key to enhancing a food product. Cambridge dictionary defines acceptance as "the general agreement that something is satisfactory or right" (Cambridge Dictionary, 2020). In the marketing field, acceptance is the willingness of people to use a new product or service (Adell, 2009b; Dunphy et al., 1999; Kollmann, 2004; Vaittinen et al., 2019). The absence of prevalence theory, definition, and measure of acceptance has led to various ways to explore "acceptance" (Adell, 2009a; Adell, 2009b; Schade and Schlag, 2003). Multiple indicators for consumer acceptance of foods have been proposed, including overall acceptance, attitude, willingness to pay, desire to purchase, willingness to eat, food perceptions, actual consumption, buying intention, and choice (Adámek *et al*., 2018; Baker *et al*., 2022). In this study, the consumption of edible insects refers to the consumer acceptance definition by Pilgrim (1957). As consumer acceptance is the main barrier for the insect industry (Naranjo-Guevara *et al*., 2021), exploring it is crucial (Van Huis *et al*., 2013).

In the context of food, frequency of consumption is the number of events of eating a specific food item or a food group at a specific time (Agudo, 2004). Another well-known term for this phenomenon is repetitive or repeat consumption typical in everyday life; thus, repeating occurrence is usually assessed to know the frequency (Liu *et al*., 2011; Wang *et al*., 2019). It means eating the same items repeatedly over a specific time (Balintfy and Melachrinoudis, 1982; Liu *et al*., 2019). These information are essential for understanding customer satisfaction and consumption behavior (Fernández-Alvira *et al*., 2013; O'Brien, 2021). Research focusing on the repeated consumption of edible insects can detect how consumers' attitudes change (Sogari *et al*., 2019). Since repetitive consumption reflects the achievement or success of a product showing how the consumer likes it, many researchers studied the factors affecting the frequency of food consumption. Consumption frequency, in this study, refers to how often an individual consumes insects in a year.

Intention, by a simple definition, is a person's level of effort and commitment to completing a specific behavior (Mamman *et al*., 2016). Behavioral intention is the perceived possibility that a person will carry out a particular behavior (Fishbein and Ajzen, 1975). The individual's intention is the strongest and immediate indicator of implementing the behaviors (LaMorte, 2019); thus, it helps to tell whether the individual will act in the very near future. Consumption intention, in this study, refers to an individual's willingness to consume edible insects and in particular reared crickets in the very near future.

Regarding consumption behavior, no single theory can fully capture and explain precisely how consumers behave, as it is a complex process involving multiple actions (Ramya, 2018). However, there are three most crucial methods for understanding human food consumption behavior, namely: (a) the economic models, (b) the food choice models, and (c) the Theory of Reasoned Action/ Theory of Planned Behavior (Gorton and Barjolle, 2013).

2.1.1 The economic models

2.1.1.1 Random Utility Theory (RUT)

The Random Utility Theory (RUT) considers the discrete random choice behavior of the individual from a finite set (Louviere *et al*., 2010). RUT is grounded on the idea of stochastic preferences in which individuals are considered to randomly choose a utility function on each selection event (Timmermans, 2001). It assumes that a person has a "utility" for each alternative option that is specific to the individual and has some components, such as taste preference, that are invisible to researchers (Gorton and Barjolle, 2013; Louviere *et al*., 2010). Thus, the individual utility can be broken down into deterministic and stochastic components. The deterministic component consists of the attributes of products and characteristics of decision-makers, while the stochastic component consists of all unobserved elements that influence choices, such as personal preferences, measurement mistakes, and faulty functional misspecification (Baltas and Doyle, 2001). RUT assumption can be expressed by:

$$U_{nj} = V_{nj} + \varepsilon_{nj} \qquad (1)$$

$$V_{nj} = V\,(X_{nj}, S_{nj}) \qquad (2)$$

Where,

U_{nj} is the utility of alternative j for the consumer i
V_{nj} is the deterministic component of the utility
X_{nj} is the attributes of the product
S_n is the attributes of the decision maker
ε_{nj} is the stochastic component of the utility

In the context of food consumption, RUT has been applied, for instance, to assess consumer's preferences for extra-virgin olive oil in Catalonia, Spain (Yangui *et al*., 2014), to analyze the demand for functional and non-functional dairy products in Germany (Bechtold, 2013), to examine the choices of consuming dairy products in Poland (Fu and Florkowski, 2011) and to analyze the choice decision of red sweet peppers in Taiwan (Yeh *et al*., 2020). However, Baltas and Doyle (2001) listed some drawbacks of applying RUT, such as 1) the unmanageable problem when having an excessive number of alternatives, 2) the challenge of including numerous explanatory factors when working with individual descriptors, 3) aggregation bias resulting from aggregating alternatives by considering brand as the alternatives, given that one brand may have multiple products such as different flavors, formulas, etc. (aggregating alternatives may raise aggregation bias), and 4) bias problem when excluding occasional buyers. RUT considers the selection among discrete alternatives, whereas our study did not address the alternative selection; hence, RUT was not utilized in our investigations.

2.1.2 Food choice models

Various food consumption behavior models argue that food consumption, food choice, or preference is dependent not only on product and consumer attributes but also on environmental factors (Pilgrim, 1957; Randall and Sanjur, 1981; Shepherd, 1985; Steenkamp, 1993).

2.1.2.1 Pilgrim's model

In 1957, Pilgrim established the food acceptance model to organize research in several fields, particularly in the areas of nutrition and sensorial analysis. His model supports the idea that perception plays a pivotal role in determining consumer acceptance towards food. Pilgrim admitted that the operational concept of food acceptance is consumption. As described in Figure 1, this model considers that an individual's perception of food is influenced by three main factors: 1) physiological factors of the individual, 2) sensory factors, and 3) attitude of the individual. Physiology is an internal aspect related to hunger and appetite, whereas sensation is considered a result of the combination of the food (stimulus) and the person (receptor). Personal attitude is an external component impacted by the environment and learning. It suggests that people can form attitudes depending on their previous experiences. The effects of physiology and attitudes can be either generally steady or changing over brief intervals regarding food consumption. Pilgrim (1957) expected those three main factors to interact with each other when influencing food consumption but he did not investigate their interaction effect and the possibility of the time effect.

As Pilgrim's model is one of the oldest models, it served as a starting point for many other food consumption models (Steenkamp, 1993). Sijtsema *et al*. (2002) pointed out the strengths and weaknesses of Pilgrim's model. One of its particular strengths is that it considers time-dependent factors like hunger and the impacts of learning. One of its weaknesses is that this model separated the individual variables, but in reality, the impact of physiology on attitudes cannot be disentangled. It has been argued that Pilgrim's model overemphasizes the role of sensory aspects of food such as taste and texture rather than other significant factors that influence food acceptability, such as individual difference, cultural norms, social influence, availability and accessibility of food (Meiselman, 1996; Shepherd and Raats, 2006; Sijtsema et al., 2002). Meiselman (1996) mentioned that Pilgrim's model may not work for some functional foods that are fortified or enriched with specific nutrients. This is because Pilgrim's model may help explain why people like or dislike functional foods based on their sensory qualities, but it may not fully capture the cognitive beliefs and emotional responses. For example, people may be more willing to eat functional foods if they think the ingredients are good for their health, even if they taste or feel bad. As a functional food, edible insects have become resurgent due to their nutritional richness. Hence, Pilgrim's model did not fit with our study.

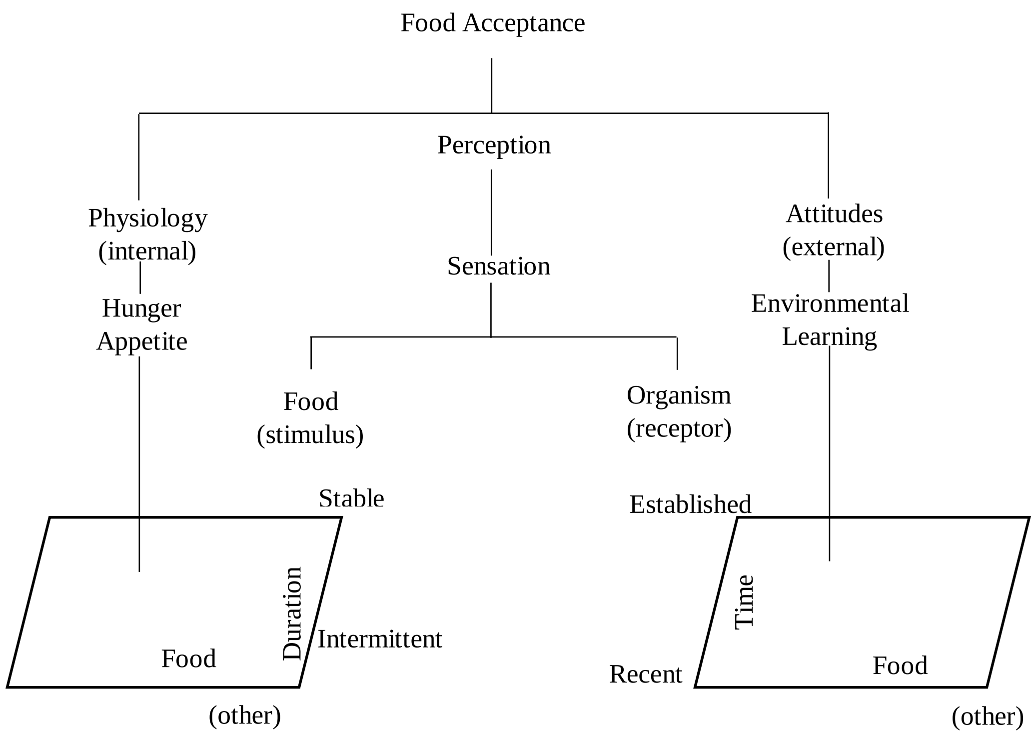

Figure 1: Pilgrim's food acceptance model (Pilgrim, 1957).

2.1.2.2 Randall and Sanjur's model

Randall and Sanjur (1981) proposed a food consumption model which supports the idea that food preferences play a vital role in determining people's food consumption. The three sets of characteristics—individual, food, and environment—are clearly separated in this model of the elements determining food preferences (Figure 2). This model was built to validate the importance of food, individual, and environmental factors in the relationship between food preference and consumption (Randall and Sanjur, 1981). The authors considered that those three main categories do not correlate with each other.

Two key considerations were made while selecting the appropriate independent variables for this model: 1) how often they had been studied separately in prior research, and/or 2) how strongly they were hypothesized to be related to food preferences (Sijtsema *et al*., 2002). Individual factors include, for example, age, gender, education, income, knowledge, skills, and attitude. Food factors include taste, appearance, texture, price, type, and food combinations, while environmental factors ranging from the season, employment, location, and family size. Sijtsema *et al*. (2002) mentioned that allocating the variables into the three categories is the first notable feature of this model. They gave just two examples: the *family stage* is categorized as an environmental factor, but it might also be an *individual trait* as culture influences the food preparation method, which is itself a feature of the environment. Second, when compared with Pilgrim's model, Randall and Sanjur's model fails to consider the time effect, but the variables in this model are anticipated to be simple to implement. In a study about food consumption, the model was applied by Mak *et al*. (2012) to explore the salient factors affecting tourists' food consumption. As our study assumed that the determinant factors of edible insect consumption are unrelated to each other and since we did not consider time-dependent factors, Randall and Sanjur's model is deemed more suitable for this study.

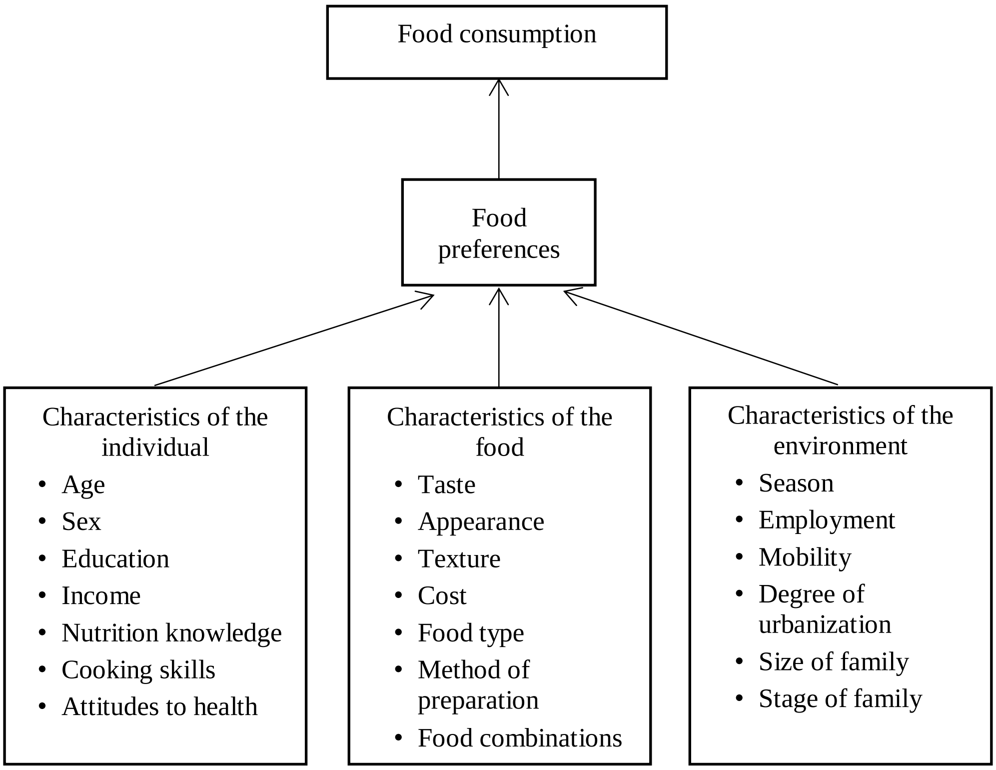

Figure 2: Randall and Sanjur's food consumption model (Randall and Sanjur, 1981).

2.1.2.3 Shepherd's model

Shepherd (1985) developed one of the food consumption models, which explains food consumption through food choice. This model considers that food choice plays a key role in determining food consumption. It is influenced by four factors, namely: food factors, personal factors, economic and social factors, and attitudes (Figure 3). Food factors include physical properties (*e.g.,* taste, texture, appearance) and chemical properties (*e.g.,* the amount of protein or carbohydrates) and nutrient content that might cause physiological effects. Individuals will perceive certain food features based on food's sensory characteristics, such as how it tastes, feels, and looks. Merely noticing these sensory qualities of a food does not mean that consumers will definitely choose to eat it; instead, it depends on how much they enjoy such traits in general (Shepherd and Raats, 1996). Perception of sensory attributes and psychological factors are categorized as *personal factors*. Psychological variations such as personality, experience, emotional state, and beliefs may also influence what people choose to eat. In the context of food choice, many other elements such as economic and social, cultural, and religious variables, may also be crucial. Meysing *et al*. (2021) applied Shepherd's food consumption model to identify the variables that account for variations in indigenous consumers' intake rates of insects in Madagascar.

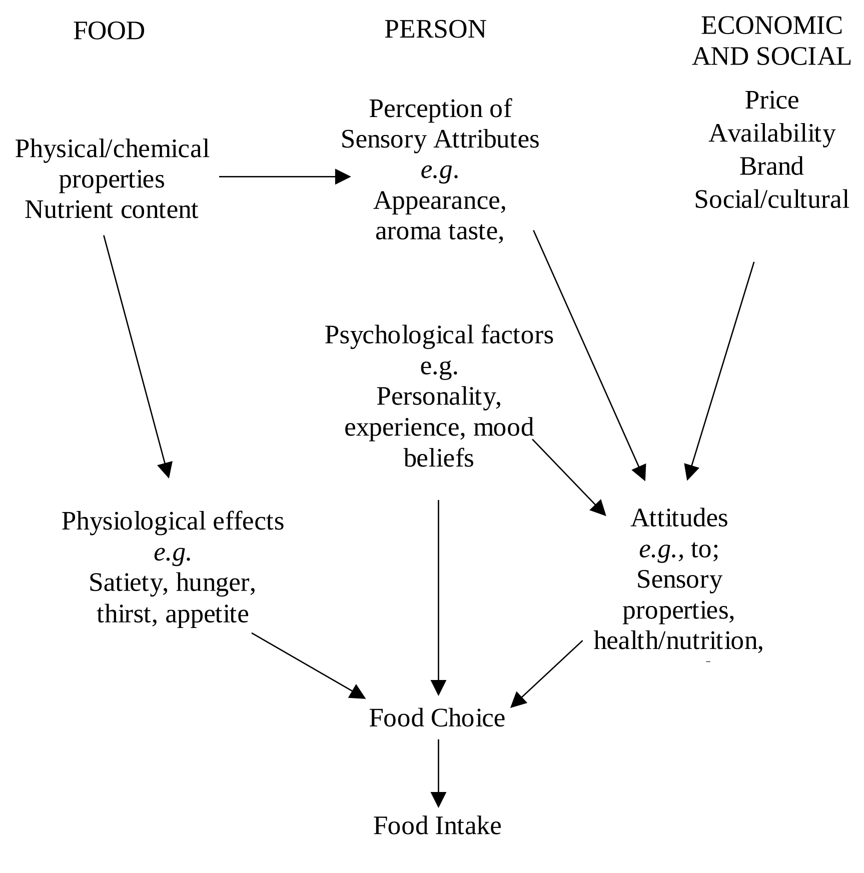

Figure 3: Shepherd's food consumption model (Shepherd, 1985).

The difference between this model and Randall and Sanjur's one is that attitude is here a separate factor influenced by personal factors itself and economic and social factors. Like Pilgrim's model, Shepherd's separated the individual variables, but the effect of physiology on attitudes cannot be negligible. The physiological consequences, such as satiety, hunger, thirst, and appetite, that individuals experience can vary over time according to a number of circumstances and reasons.

The model might not take these differences into account, which could reduce its prediction power (Baumont et al., 2000; Vermeir and Verbeke, 2006; Wansink and Van Ittersum, 2003). Thus, our study did not apply Shepherd's food consumption model.

2.1.2.4 Steenkamp's model

Steenkamp (1997) developed a food choice model to explain consumer behavior towards food. He considered that even though there are some discrepancies among the above-described three food choice models, all of them generally consider: 1) food attributes, 2) consumer characteristics, and 3) environmental factors as determinants of food consumption. Determinant classifications are different from each other. For instance, Pilgrim (1957) classified sensory perception as a separate category, but Shepherd (1985) saw sensory perception as part of the individual-related factors, while Randall and Sanjur (1981) grouped it under the food attributes (Steenkamp, 1993). Although their boundaries are ambiguous, Steenkamp believes that all those factors are important in investigating food consumption habits (Steenkamp, 1993); hence all three categories were used in his model (Figure 4).

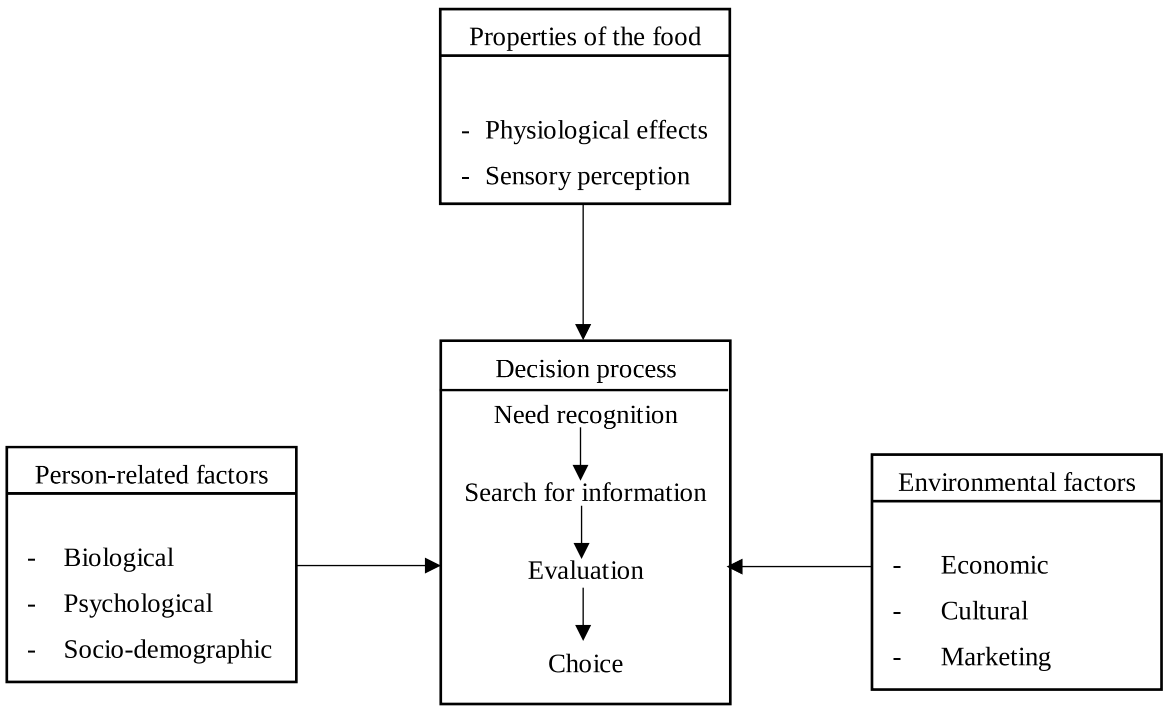

Figure 4: Steenkamp's consumer behavior towards food model (Steenkamp, 1997).

Person-related factors include biological, psychological and socio-demographic factors. Properties of food are physical, chemical, and nutrient content that influence physiological and sensory perception, while environmental factors include economic, sociocultural, and marketing factors. Steenkamp's model assumes that those factors influence the decision-making process. In his model, the decision-making process can be broken down into four stages: (1) problem identification, (2) acquiring information, (3) evaluation, and (4) choice. He considered that acceptance or rejection of certain foods is related to the expected consequences of consumption. The consequences could promptly or gradually be: 1) physiological, such as sickness or a satisfying feeling; 2) psychological, such as feeling uncomfortable; or 3) social, such as being unsuitable to their culture or social status. Furthermore, those three main factors have a mutual effect. Salazar-Ordóñez *et al.* (2018) applied Steenkamp's model with the integration of the Theory of Reasoned Action (TRA) to understand the product differentiation failure in olive oil markets in Spain. Steenkamp's model believes consumers make logical judgments based on specified criteria, but in reality, consumers may make more complicated decisions based on emotions, attitudes, and other factors (Banovic´, 2009; Paasovaara, 2011; Ravi Dhar & Klaus Wertenbroch, 2000). On the other hand, this model was established for industrialized countries, and there is no prior literature that used this model in developing countries (Banovic´, 2009; P. J. Chen & Antonelli, 2020; Gomes et al., 2017; Paasovaara, 2011; Wier et al., 2008). As our study was conducted in Myanmar, a developing country, Steenkamp's model was not chosen.

2.1.2.5 Furst et al.'s model

Furst *et al.* (1996) created a food choice process model based on grounded theory to better comprehend the multifaceted nature of food selection. This model postulates that making food selections involves more than just deliberate thought; it also involves unconscious, habitual, and automatic processes. The model has three fundamental aspects influencing food choice (Figure 5).

The first component is the life course about food consumption experiences from the past and present. Present food consumption patterns can only be understood by considering people's trajectories—the evolution of their ideas, emotions, strategies, and behaviors over time (Furst *et al.*, 1996). The second component is an influence that includes five factors, namely ideas, personal factors, resources, social factors, and contexts. Ideals set eating standards that are culturally learned from families and societies (Ito *et al.*, 2018). Each person has his/her own ideals by which she/he measures and evaluates whether his/her eating habits is "proper," "normal," "inappropriate," or "unacceptable" (Sobal and Bisogni, 2009). Personal factors relate to individual physiological and psychological traits (Ito *et al.*, 2018). There are two types of resources: tangible (such as money, machinery, vehicles, and space) and intangible (culinary knowledge, skills and time) (Gorton and Barjolle, 2013; Ito *et al*., 2018). Social factors are a person's network of ties that can either restrict or aid his/her ability to make food-related decisions (Sobal and Bisogni, 2009). Families and society are the most important set of interpersonal relationships affecting food choices (Gorton and Barjolle, 2013). Contextual factors include the social environment, *i.e*., the economy, government regulations, and the media, as well as the physical environment, which encompasses things like the climate, physical features, and other material items that either stimulate or limit the food choice decisions (Sobal and Bisogni, 2009). The third component of the paradigm - the personal food system - involves mental processes that transform food decisions in a specific situation. This includes value negotiations such as sensory perceptions, money, convenience, health/nutrition, connections, and quality and strategies that reflect the consistent pattern of behavior choices (Gorton and Barjolle, 2013). A diabetic, for example, may prioritize health over other values such as taste, cost, convenience, and relationships (Sobal and Bisogni, 2009).

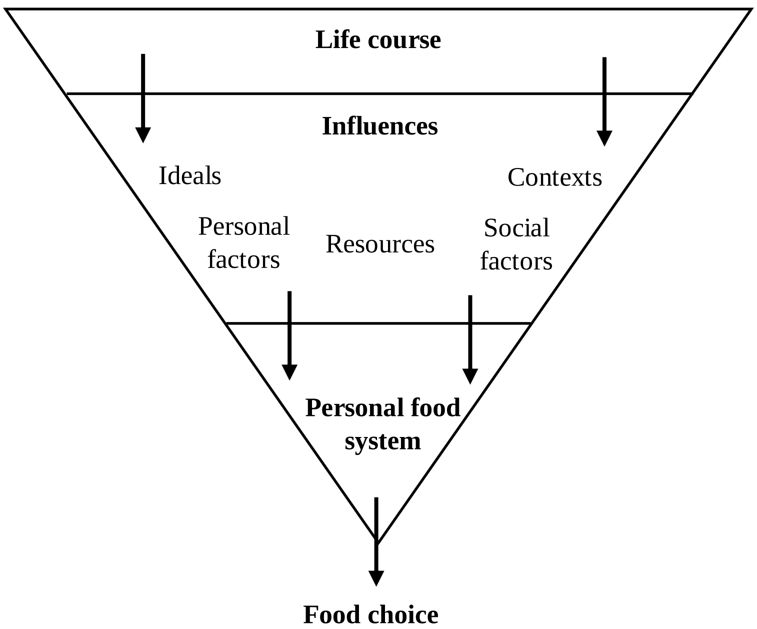

Figure 5: Furst’s food choice process model (Furst et al., 1996).

In the context of food consumption, this model has been applied, for instance, to investigate the impact of weather in the process of choosing food in Japan (Ito *et al*., 2018). The model's constructionist foundation means that it may not accurately reflect the interplay of factors such as biology, behavior, culture, and society (Sobal and Bisogni, 2009). Sobal *et al*. (2006) observed that it is challenging to determine the precise function of each subcomponent because some subcomponents overlap and interact with one another. Hence, this model was not applied in our study.

2.1.3 Theory of Reasoned Action and Theory of Planned Behavior

The Theory of Reasoned Action (TRA) is also a well-known theory developed by Fishbein and Ajzen (1975) for predicting consumer behavior (Hosseini *et al*., 2015; Hussain *et al*., 2016; Mohanty, 2020; Wilujeng *et al*., 2019). TRA was not intended explicitly to explore food choice, although it has been frequently utilized for this purpose (Gorton and Barjolle, 2013). As shown in Figure 6, the three fundamental elements of TRA, which originated in social psychology, are attitude, subjective norms, and behavioral intention (Ajzen and Fishbein, 1980; Fishbein and Ajzen, 1975).

The basic idea of TRA is to explain behavior under the complete volitional control of the consumer (Ajzen, 1991; Fishbein and Ajzen, 1975; Madden, 1992). According to this theory, the behavioral intention that determines individual behavior is a function of attitude and subjective norms, in which attitude is shaped by behavioral beliefs, and subjective norms are shaped by normative beliefs (Towler and Shepherd, 1992; Zhang, 2018). Thus, a food's nutritional value and health impacts are less influential than a person's beliefs about them in shaping their decision (Shepherd and Raats, 1996).

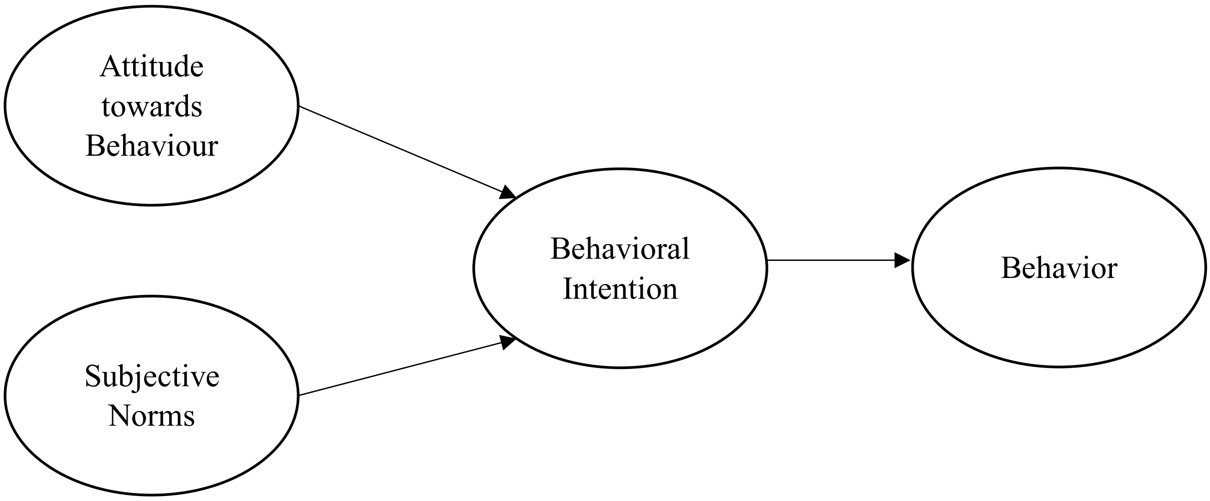

Figure 6: The Theory of Reasoned Action model (Ajzen, 2002).

According to the TRA proposed by Fishbein and Ajzen (1975), evaluation of attitudes should be made in reference to the act of engaging in the behavior itself instead of in relation to any particular items, persons, or events, *i.e*., attitudes towards entomophagy would be evaluated rather than attitudes towards edible insects. When dealing with people who cannot exercise voluntary control, the TRA encounters some obstacles. As a result, the Theory of Planned Behavior (TPB) came into place (Ajzen, 1991; Fishbein and Ajzen, 2011).

TPB, developed by Ajzen in 1985, assists in understanding behavior. It is one of the most frequently applied and tested models for predicting human behavior (McEachan *et al*., 2011) and is prominent in behavioral intention studies on edible insect consumption (Mancini *et al*., 2019; Menozzi *et al*., 2017). TPB was originally developed as an extended TRA model, modified by adding perceived behavioral control derived from self-efficacy theory to predict more accurately under incomplete volitional control (Ajzen, 1991; Madden, 1992). It is “a full-fledged social psychology theory” that can predict human behavior (Zhang, 2018, p.1). According to Ajzen (1991), TPB accurately predicts behavior intention with the help of attitude, subjective norms, and perceived behavior control (Figure 7).

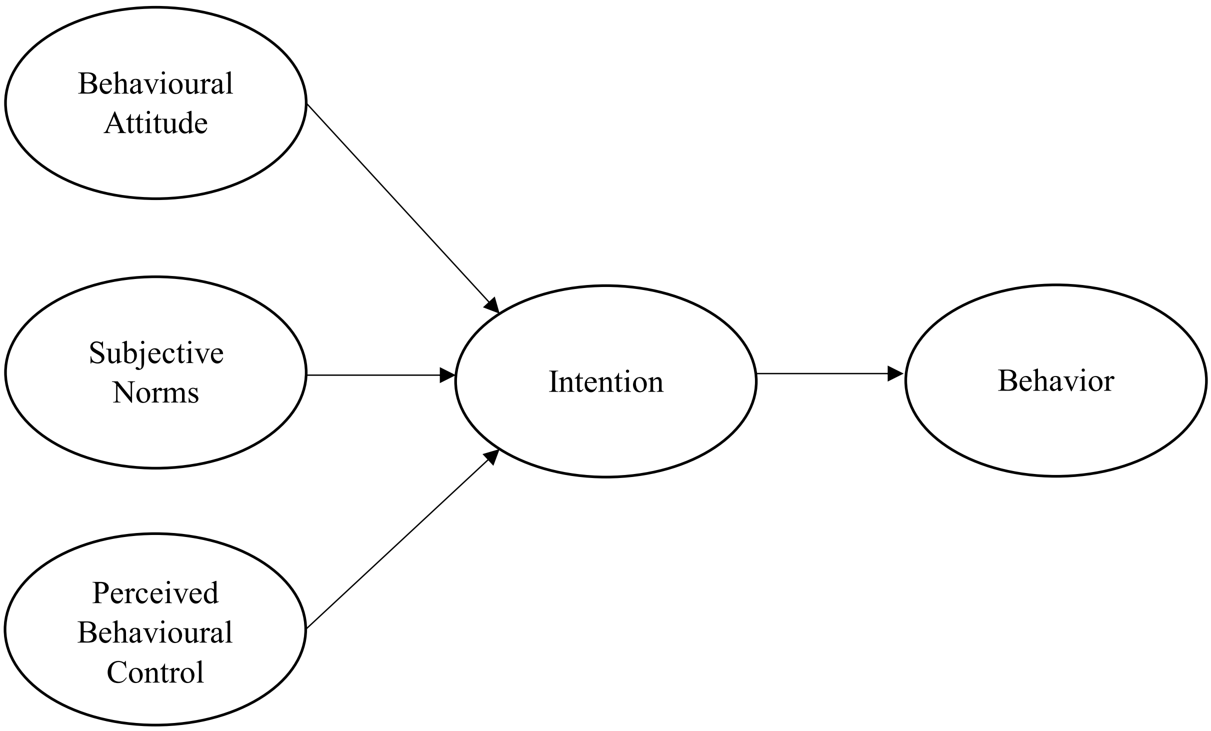

Figure 7: The Theory of Planned Behavior model (Ajzen, 2008).

Behavioral intention is an individual’s willingness to carry out the specific behavior that would typically occur before the actual behavior. Thus, it is the best indicator of the particular action that happens immediately (Ajzen, 1991). Attitude, the first component of TPB, indicates a person’s optimistic or pessimistic view of something or someone. Attitude is guided by behavior beliefs that refer to a person's belief about the effects of a particular behavior (Arafat and Mohamed Ibrahim, 2018). The second component, subjective norms, refers to people's social influence around an individual influencing them to do something. Subjective norms are characterized by normative belief, which refers to the expectation that an essential individual or group of individuals will agree and favor a specific action (Trafimow, 2007). The third component, perceived behavioral control, relates to the individual's ability to do something. Behavioral control is influenced by control beliefs, which are beliefs regarding the existence of circumstances that may facilitate or hinder the accomplishment of a behavior (Arafat and Mohamed Ibrahim, 2018).

One of the main advantages of TPB is that it is flexible enough to incorporate additional constructs into the model; some researchers developed their research models by combining relevant factors adopted from different contexts pertinent to their situation to enhance and improve the predictive ability of the specific models. Some researchers use all three TPB constructs (attitude, subjective norms, and perceived behavior control) when exploring behavior intention. Some add extra constructs from behavioral theory to TPB and exclude some constructs depending on their research needs. For example, some edible insect studies added new constructs, such as ascribed responsibility (Choe et al. 2020), phobia (Bae and Choi 2020), the interaction of self-identity and familiarity (Pambo et al. 2018), environmental concerns (Chang et al. 2019), and safety (Vartiainen et al. 2020). For including additional elements to the theory, there are some criteria such as: (1) added variables should be behavior-specific, (2) should be the determinants of intention and behavior, (3) should be independent of the existing three factors, (4) should apply to a variety of behaviors, and (5) to be part of the theory, they should help increase the estimation of intention or behavior (Fishbein and Ajzen, 2011). Last but not least, the TPB research results can be easily used to make interventions (Dunn, 2008; Pambo, 2018).

The unique idea behind the TRA and TPB was that other elements, such as socio-demographic characteristics, should influence behavior through the components of TRA and TPB, such as attitudes, subjective norms, perceived behavioral control and intention. In other words, those factors should have indirect rather than direct effects on behavior (Shepherd and Raats, 1996). Ajzen and Albarracin (2007) mentioned that TPB emphasizes particular behaviors without ignoring broader dispositions, demographics, or other elements commonly studied in social psychology and relevant fields. According to them, dispositions comprise individual characteristics such as global attitudes, personality traits, self-esteem, emotions, and intelligence. Demographics include age, gender, ethnicity, income, education, and religion. Experience, knowledge, and media exposure can be considered as other factors. Ajzen and Albarracin (2007) refer to all those factors as background factors and acknowledge the indirect effect of those factors on behavior via behavioral beliefs (attitude), normative beliefs (subjective norms), and control beliefs (perceived behavioral control).

Various behavior intention studies regarding edible insect consumption were primarily based on TPB (Bae and Choi, 2020; Mancini *et al*., 2019; Menozzi *et al*., 2017). Those studies examined the influential factors on consumer intention, purchase intention, and actual behavior towards insect foods. These studies verified how suitable the TPB is for consumption intention towards edible insects. As this research is not restricted to examining behaviors only under complete volitional control, TPB seemed to be more appropriate than TRA.

2.1.4 Selection of adaptable theory and model for the current study

As stated previously, the present study looked into consumer behavior towards edible insects as food, encompassing consumer acceptance towards edible insects, the consumption intention towards edible insects, and the consumption frequency of edible insects. Randall and Sanjur's (1981) model was applied to explore the direct effects of individual, product and environmental factors on consumer acceptance and consumption frequency. At the same time, TPB was selected to predict consumer intention to consume edible insects from a psychological point of view because TPB is flexible to add extra components based on previous literature and considered the effect of background factors. The indirect effects of individual and environmental (in our study, we use the term household-level) factors on consumption intention through TPB’s components were also explored. Hence, the theoretical framework of this dissertation was based on TPB and Randall and Sanjur's (1981) model to understand insect consumption behavior in Myanmar.

CHAPTER III

3. How prevalent is entomophagy in Myanmar?

3.1 Abstract

Insect consumption as food for humans is necessary from a food security perspective. The growing significance of this practice has drawn the attention of many researchers studying edible insects from several different perspectives. Still, a significant gap in the literature remains, as many studies have focused on consumer analysis in non-entomophagous western countries. There is also a need for consumer study in entomophagous countries with a prevalence of malnutrition, where the trend of entomophagy practices has instead been downward. This study examines the overall insect consumption situation in Myanmar, an entomophagous country. Telephone interviews with 872 citizens were conducted from March to June 2021 in Myanmar. The data were analyzed through descriptive statistics. The study revealed that about three-quarters of respondents in Myanmar had consumed insects. Most still practice entomophagy, which is prevalent in both states and regions. However, the average consumption frequency was only five times a year. The available insect varieties differed from region to region, ranging from 6 to 19. Some species, such as crickets, were known in every administrative division, while others were found in only one or two areas. Crickets are the most consumed and favorite edible species in Myanmar, followed by bees and bamboo worms. The main reasons mentioned by non-consumers for not eating insects are phobia, distastefulness, never having tried insects, and assuming entomophagy to be a bad habit. Meanwhile, unavailability, expensiveness, childhood habits, dislike, and health problems were the five main reasons for not continuing the entomophagy practice. Governments and organizations should encourage entrepreneurs and business owners to invest in the insect sector, and wild insect harvesters should transform them into miniature livestock farmers by offering them with training in insect-rearing and the necessary facilities to ensure a steady supply of edible insects.

3.2 Introduction

Human beings are omnivores and eat plants and animals to obtain energy and nutrients. Even ancient people had an "insect-eating habit" (Robert, 2008; Van Huis, 2013; Yen, 2009). "Entomophagy," also known as "insectivory," is the technical term for the insect-eating habit (Meyer-Rochow, 2010). The Cambridge Dictionary defines "entomophagy" as "the practice of humans eating insects as food" (Cambridge Dictionary, 2020). Therefore, entomophagy is not a novel concept (Van Huis, 2013). Three hundred indigenous societies practice entomophagy in 113 nations across the globe (MacEvilly, 2000). This habit depends mainly on the culture and religion of the community (Jansson and Berggren, 2015). Jongema (2017) listed 2,403 species of edible insects worldwide. Among these, 717 species are from the order Coleoptera. Other orders include Lepidoptera, Hymenoptera, Orthoptera, and Hemiptera. Consumed species vary widely based on the different ecosystems and climatic conditions. Popular edible insect species are butterflies and moths, beetles, ants, bees, wasps, grasshoppers, crickets, cockroaches, termites, dragonflies, bugs, and cicadas (Van Huis *et al*., 2013).

Since the food sector faces challenges driven by the increasing global human population, decreasing cultivable land, water scarcity, and climate change (Ebenebe *et al.*, 2017; Fitton *et al.*, 2019; Misra, 2014; Sachs, 2009), edible insects have reemerged as an alternative option for animal protein (Belluco *et al*., 2013; Gere, 2017; Kinyuru *et al*., 2015; Sogari *et al*., 2019; Tang *et al*., 2019). Insects usually have a relatively high protein content, followed by fat, vitamins, and minerals (Rumpold and Schlüter, 2013b; Van Huis and Oonincx, 2017). The average protein content ranges from 35% to 61%. All essential amino acids, comparable to conventional meats, such as beef and pork, and two familiar plant-based protein sources, such as cereal and pulses, are provided by insects (Bukkens, 1997; Rumpold and Schlüter, 2015). The amino acid composition of about 100 edible insect species ranges from 10% to 30%, including 35%–50% of all amino acids. This amino acid content is in line with the standards of the World Health Organization (WHO) and the Food and Agriculture Organization of the United Nations (FAO) (Xiaoming *et al*., 2010). Many edible insects have 10%–50% fat. The especially fat content of the larvae and pupae stages is higher than that of the adult stage. Fatty acids of edible insects differ from animal fat in that it contains a high concentration of fatty acids required by the human body. Lipid components, such as phosphatide, found in edible insects are beneficial for human health (Xiaoming *et al*., 2010). Vitamins A and B1, thiamin, B2, riboflavin, B3, niacin, B6, D, E, K, C, and carotenes are some of the essential vitamins rich in edible insects (Payne *et al*., 2016; Xiaoming *et al*., 2010). Minerals (e.g., calcium, zinc, and iron) are frequent in edible insects.

Additionally, iodine, sodium, potassium, copper, manganese, and phosphorus are also available in edible insects (Xiaoming *et al*., 2010). Payne *et al*. (2016) noted that micronutrients are often deficient in regions with high food scarcity. Still, these nutrients are notably abundant in insects. Therefore, it can be helpful to people in food-insecure areas if they are encouraged to eat insects.

Apart from their nutritional value, edible insects have vital features, such as a high food conversion capacity when compared to traditional animals, more effective use of organic waste than conventional agriculture, and production capacity with low inputs or without additional inputs, such as land, water, or chemical inputs (DeFoliart, 1989). Thus, edible insects may be viable for developing countries with rooted entomophagy, where malnutrition persists. Nonetheless, some studies have revealed that entomophagy habits have decreased in entomophagous countries (Hartmann *et al.*, 2015; Pambo *et al.*, 2018; Yen, 2009).

Myanmar is a traditional entomophagous country where malnutrition is prevalent. Three clinical types of protein–energy malnutrition— underweight, stunting, and wasting— are visible among children under 5 years of age (Health in Myanmar, 2014). About 19% of children were underweight, 27% were stunted, 7% were wasted (acute weight loss) in 2018 (UNICEF and WHO, 2020), and 45% of deaths under five years of age are caused by various malnutrition types (UNICEF, 2014). On the other hand, people from Myanmar suffer from economic, political, and social instability due to the COVID-19 pandemic and the military coup in 2021 (UNDP, 2021). Therefore, over 13.2 million people in Myanmar face moderate or severe food insecurity problems (UNHCR, 2021). Since insects are both nutritious and free food, insect consumption has recently been recommended for solving world hunger and malnutrition (Belluco *et al.*, 2015). Thus, knowing if entomophagy can relieve current problems is necessary. Given this context, this study explores the overall insect consumption situation in Myanmar by examining which administrative divisions extensively practice entomophagy and which administrative divisions do not practice it at all. We tried to identify insect consumers, consuming insect varieties, preferably insect varieties, and barriers to insect consumption. The findings may help policymakers comprehend edible insects as a source of income and food security solutions and implement insect-based nutrition initiatives to alleviate malnutrition in Myanmar.

3.3 Method

There are 15 administrative areas in Myanmar—seven states, seven regions, and one union territory (MIMU, 2015). Regions are generally densely populated, and states are sparsely populated. Therefore, the adequate representation that covers the whole country is needed. The entire Myanmar country was considered the research area in this study, including all administrative divisions. This study applied quota sampling to obtain enough samples for sparsely populated areas. Quota sampling is often used to obtain enough samples for a small group in a community (Iliyasu and Etikan, 2021). Moreover, it helps to accurately reflect the whole population (Iliyasu and Etikan, 2021). Thus, quota sampling was suitable to represent all areas in Myanmar. A semi-structured questionnaire was used to obtain information about insect consumption. Telephone interviews with the citizens were performed from March to June 2021 in Myanmar. After dialing 18,694 cell phone numbers, only 15% of the respondents gave their consent. Data from 872 respondents were collected, with 427 males and 445 females comprising our sampling universe. Descriptive statistics were used to analyze the data.

3.4 Results

3.4.1 Identifying edible insect consumers

The collected data cover all regions of Myanmar, representing the entire country, as shown in Table 1. Respondents were classified into three types when it came to insect consumption. Type I people have consumed insects in the past and present. Thus, they can be considered insect consumers. In other words, they accept edible insects as food. Type II people have consumed insects in the past but have not practiced insect consumption habits in recent years. Types I and II people have insect consumption experiences. Type III people have never tried consuming insects; thus, they are regarded as non-insect consumers or individuals with no insect consumption experiences.

Type I accounted for 67% of the total respondents in the whole country, followed by Type III, with 28%, and a minority (5%) was under Type II. The number of insect consumers (Type I) was higher than the other two types in almost all areas except the Mon and Magway regions. The highest percentage of insect consumers was observed for the Kayah state, with 88% of respondents, followed by Rakhine with 87% and Kachin with 84%. The consumer percentage of all administrative divisions formed more than half of all respondents, ranging from 56% to 88%, except for the Mon and Magway regions. The consumer percentage in the Mon and Magway administrative divisions was the lowest, at 32% and 42%, respectively. Type II respondents were primarily found in Naypyitaw (16%), but none were from the Kayah, Shan, and Tanintharyi regions. Consequently, Type III was mainly found in Mon, Magway, and Chin states.

Table 1: Three types of respondents by administrative division regarding edible insect consumption.

Sr.	States and regions	Total respondents	Type I		Type II		Type III	
			Frequency	%	Frequency	%	Frequency	%
A	**States**	**256**	**178**	**69**	**10**	**4**	**68**	**27**
1	Kachin	25	21	84	2	8	2	8
2	Kayah	25	22	88	-	0	3	12
3	Kayin	24	18	75	1	4	5	21
4	Chin	25	14	56	1	4	10	40
5	Mon	28	9	32	2	7	17	61
6	Rakhine	46	40	87	4	9	2	4
7	Shan	83	54	65	-	0	29	35
B	**Regions**	**616**	**409**	**66**	**33**	**6**	**174**	**28**
8	Ayeyarwady	87	65	75	1	1	21	24
9	Bago	70	49	70	3	4	18	26
10	Magway	48	20	42	5	10	23	48
11	Mandalay	137	89	65	8	6	40	29
12	Naypyitaw (Union territory)	25	16	64	4	16	5	20
13	Sagaing	76	48	63	5	7	23	30
14	Tanintharyi	24	17	71	-	0	7	29
15	Yangon	149	105	70	7	5	37	25
	Total	**872**	**587**	**67**	**43**	**5**	**242**	**28**

Out of all the states, 73% of the respondents had insect consumption experiences. Among them, 69% were still practicing entomophagy. The rest (27%) did not have insect consumption experience. In the regions, 72% had insect consumption experiences. Among them, 66% still practised entomophagy. In contrast, 28% did not experience insect consumption. Thus, the distribution of all respondents in states and regions was not very different. The consumer rate was moderate in the central part of Myanmar (Sagaing, Magway, Mandalay, and Naypyitaw), except in Magway. On average, 6 in 10 people are insect consumers in the central regions. Hence, entomophagy is widespread in the central region of Myanmar. In the whole country, 72% of the respondents had had an insect consumption experience, while 67% were insect consumers.

3.4.2 Distribution of insect consumption frequency by administrative divisions

The distribution of insect consumption frequency was different from one area to another, as shown in Figure 1. The maximum consumption frequency was 55 times a year in Yangon, which might be related to the ready availability of edible insects in Yangon, and Kachin followed with 53 times. The minimum insect consumption frequency was once a year throughout the country, except in Sagaing and Shan, where it was twice a year.

The administrative divisions can be classified into five groups according to the average insect consumption frequency. Group 1 includes the states of Yangon, Kachin, Rakhine, and Shan, shown in green, with the highest average insect consumption frequency of seven times per year. Group 2 includes the Chin and Sagaing regions in red, with the second-highest average insect consumption frequency of five times per year. This is followed by Group 3, with four times the average consumption frequency consisting of regions of Bago and Mandalay, represented by the gray color. Group 4, in yellow, with an average consumption frequency of three times a year, included the Kayin, Ayeyarwady, Magway, and Naypyitaw regions. Finally, Group 5 on the map is shaded in blue, representing three administrative divisions, namely Kayah, Mon, and Tanintharyi, where the average consumption frequency of edible insects was only twice a year. Thus, the average insect consumption frequency across the administrative divisions ranged from twice to seven times per year.

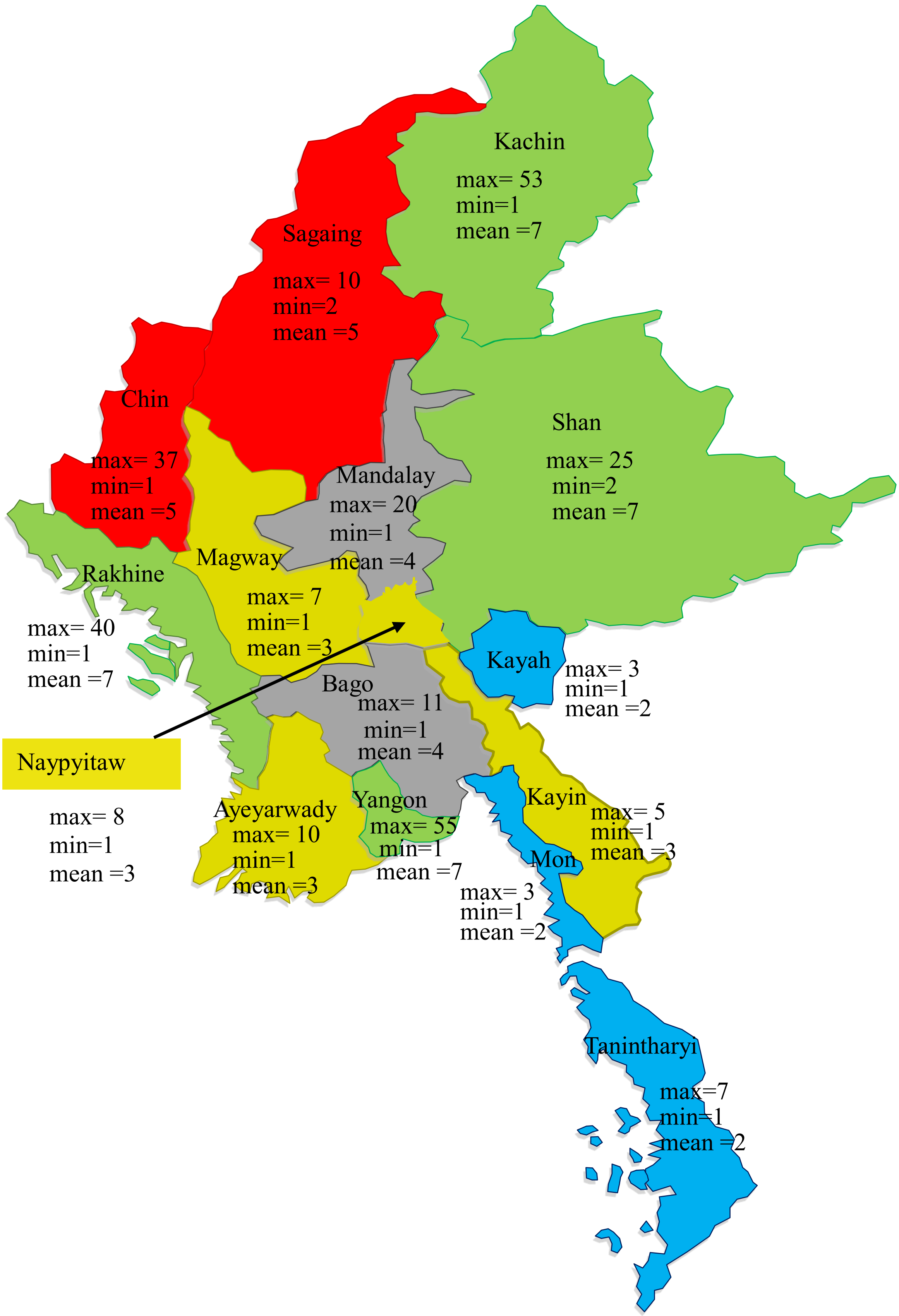

Figure 8: The annual insect consumption frequency in Myanmar.

3.4.3 Available and consumed edible insect varieties in each administrative division

The types of insects available were not identical from one administrative division to another, and the types of insects currently eaten differed from one area to another (Table 2). Respondents said that the number of available insect species in the Magway region was the smallest (only six varieties). In contrast, the highest number was found in the Yangon and Mandalay regions, with 19 species each. As wide varieties of edible insects were available in Yangon and Mandalay, the number of edible insect varieties currently consumed was also the highest, with 17 and 16 species, respectively. At least eight edible insects were found in Kayah, Kayin, and Mon. Still, the number of insect species consumed by the respondents during this period was surprisingly low. Twelve insect species were available in Kayah, but they only ate crickets. Similarly, eight species of edible insects were available in Kayin, but only crickets and termites were consumed. Furthermore, although ten species of insects were available in the state of Mon, only three insect species—crickets, termites, and wood borers—were eaten. Cricket consumption was found in all 15 administrative divisions in Myanmar.

Some insects, such as crickets and bees, were available in every state and region. At the same time, some species, namely back swimmers, banana skippers, dinorid bugs, dragonflies, longhorn beetles, predaceous diving beetles and water beetles, were more region-specific. For example, dinorid bugs were found in Kachin and Mandalay, whereas common emigrants were consumed only in the Shan and Yangon areas. The same was true for banana skippers, as they were exclusively found in the Mandalay region, while back swimmers were consumed solely in Rakhine. Only in the administrative divisions of Rakhine and Yangon were water beetles found and consumed. Respondents from the states of Kayah and Kayin acknowledged eating insects like dragonflies but did not directly say that they did so recently. Similarly, only people from the Mon, Rakhine, Ayeyarwady, and Mandalay regions mentioned eating longhorn beetles, although they did not report eating such insects recently. People from the Rakhine and Yangon administrative divisions mentioned the existence of predatory diving beetles, but they did not say that they had eaten them in recent years.

Table 2: List of available and consumed edible insect species in each administrative division[4].

States and regions	Name of available edible insect varieties	Name of consumed edible insect varieties in recent years
Kachin	Bamboo worms, Bees, Cicadas, Crickets, Dinorid bugs, Dung beetles, Grasshoppers, Hornets, Palm weevil larvae, Rhinoceros beetles, Silkworms, Termites, White grubs, Wood borers	Bamboo worms, Bees, Crickets, Cicadas, Dinorid bugs, Grasshoppers, Hornets, Rhinoceros beetles, Silkworms, White grubs
Kayah	Bees, Cicadas, Crickets, Dragonflies, Dung Beetles, Giant water bugs, Grasshoppers, Weaver ants, Termites, Water scavenger beetles, White grubs, Wood borers	Crickets
Kayin	Bees, Crickets, Dragonflies, Dung beetles, Grasshoppers, Palm weevil larvae, Silkworms, Termites	Crickets, Termites
Chin	Bamboo worms, Bees, Cicadas, Crickets, Dung beetles, Grasshoppers, Hornets, Silkworms, Termites	Bamboo worms, Bees, Cicadas, Crickets, Hornets, Silkworms
Mon	Bamboo worms, Bees, Crickets, Dung beetles, Longhorn beetles, Palm weevil larvae, Rhinoceros beetles, Silkworms, Termites, Wood borers	Crickets, Termites, Wood borers
Rakhine	Back swimmers, Bees, Cicadas, Crickets, Dung beetles, Giant water bugs, Grasshoppers, Longhorn beetles, Palm weevil larvae, Predaceous diving beetles, Weaver ants, Water beetles, Water scavenger beetles	Bamboo worms, Bees, Back swimmers, Crickets, Dung beetles, Giant water bugs, Grasshoppers, Palm weevil larvae, Water beetles, Water scavenger beetles, White grubs

[4] Some respondents were unable to accurately answer the variety of insect and only answered beetle, bug, local name etc., and could not clearly describe the type and shape. The interviewer named possible types of insects to get the real name of insect varieties, but their answers do not match. Thus, their answers were left out.

States and regions	Name of available edible insect varieties	Name of consumed edible insect varieties in recent years
Shan	Bamboo worms, Bees, Cicadas, Common emigrants, Crickets, Dung beetles, Hornets, Palm weevil larvae, Rhinoceros beetles, Silkworms, Water scavenger beetles, White grubs	Bamboo worms, Bees, Crickets, Cicadas, Common emigrants, Dung beetles, Hornets, Water scavenger beetles
Ayeyarwady	Bamboo worms, Bees, Crickets, Dung beetles, Diving beetles, Giant water bugs, Grasshoppers, Longhorn beetles, Hornets, Palm weevil larvae, Weaver ants, Rhinoceros beetles, Silkworms, Wood borers	Bamboo worms, Bees, Crickets, Diving beetles, Giant water bugs, Grasshoppers, Hornets, Palm weevil larvae, Weaver ants, Rhinoceros beetles, Wood borers
Bago	Bamboo worms, Bees, Crickets, Dung beetles, Giant water bugs, Palm weevil larvae, Rhinoceros beetles, Silkworms, Water scavenger beetles	Bees, Crickets, Dung beetles, Giant water bugs, Rhinoceros beetles, Water scavenger beetles
Magway	Bamboo worms, Bees, Crickets, Palm weevil larvae, Weaver ants, Silkworms	Bamboo worms, Crickets, Palm weevil larvae, Weaver ants, Silkworms
Mandalay	Banana skippers, Bamboo worms, Bees, Cicadas, Crickets, Dung beetles, Dinorid bugs, Diving beetles, Giant water bugs, Grasshoppers, Hornets, Longhorn beetles, Palm weevil larvae, Weaver ants, Rhinoceros beetles, Silkworms, Termites, Wood borers, White grubs	Banana skippers, Bamboo worms, Bees, Cicadas, Crickets, Dung beetles, Dinorid bugs, Diving beetles, Grasshoppers, Hornets, Palm weevil larvae, Weaver ants, Rhinoceros beetles, Silkworms, Wood borers
Naypyitaw	Bamboo worms, Bees, Crickets, Dung beetles, Diving beetles, Palm weevil larvae, Weaver ants, Rhinoceros beetles, Silkworms, Termites, Water scorpions, Water scavenger beetles	Bees, Crickets, Diving beetles, Palm weevil larvae, Weaver ants, Rhinoceros beetles, Silkworms, Termites, Water scavenger beetles

States and regions	Name of available edible insect varieties	Name of consumed edible insect varieties in recent years
Sagaing	Bamboo worms, Bees, Crickets, Cicadas, Diving beetles, Giant water bugs, Palm weevil larvae, Silkworms, White grubs	Bamboo worms, Bees, Crickets, Diving beetles, Giant water bugs, White grubs
Tanintharyi	Bees, Crickets, Diving beetles, Durm stick borers, Hornets, Palm weevil larvae, Rhinoceros beetles, Termites	Bees, Crickets, Diving beetles, Durm stick borers, Hornets, Palm weevil larvae, Rhinoceros beetles, Termites
Yangon	Bamboo worms, Bees, Cicadas, Common emigrants, Crickets, Diving beetles, Dung beetles, Giant water bugs, Grasshoppers, Hornets, Palm weevil larvae, Predaceous diving beetles, Weaver ants, Rhinoceros beetles, Silkworms, Termites, Water beetles, Water scavenger beetles, Wood borers	Bamboo worms, Bees, Cicadas, Common emigrants, Crickets, Diving beetles, Dung beetles, Giant water bugs, Grasshoppers, Palm weevil larvae, Weaver ants, Rhinoceros beetles, Silkworms, Termites, Water beetles, Water scavenger beetles, Wood borers

The varieties of insects consumed differed by area, but crickets were consumed countrywide. On average, one to three different kinds of insects were eaten (Table 3). The highest average number of edible insect varieties consumed was in Kachin, with three insect varieties. At the very least, every individual consumer in each administrative division consumed one kind of insect. In Kachin, Mandalay, and Yangon, people ingested up to six different types of insects. One hundred percent of the respondents in Kayah state consumed only one kind of insect, cricket. The state of Kayin came in second, with 94% of the respondents eating cricket only. The percentage of respondents who said they exclusively consumed one kind of insect varied widely among administrative divisions, with the lowest percentage found in Kachin state (19%). Next were the regions of Naypyitaw (38%), Shan (39%), Rakhine (43%), Tanintharyi (44%), and Yangon (46%). Therefore, almost half of the respondents in those six administrative divisions consumed at least two types of edible insects, while most insect consumers in the other nine administrative divisions consumed just one variety.

Table 3: Number of edible insect varieties consumed and percentage of consumers who consumed only one variety of edible insects in each administrative division.

States and regions	Number of consumed edible insect varieties in the last year			Consumers who consumed only cricket (%)	Consumers who consumed only one edible insect variety (including cricket) (%)
	Minimum	Maximum	Average		
Kachin	1	6	3	5	19
Kayah	1	1	1	100	100
Kayin	1	2	1	94	94
Chin	1	5	1	71	79
Mon	1	3	1	78	89
Rakhine	1	4	2	30	43
Shan	1	4	2	11	39
Ayeyarwady	1	4	1	43	72
Bago	1	3	2	46	50
Magway	1	2	1	65	65
Mandalay	1	6	2	49	66
Naypyitaw	1	3	2	38	38
Sagaing	1	3	1	75	75
Tanintharyi	1	5	2	25	44
Yangon	1	6	2	41	46

3.4.4 Consumer-preferred varieties of edible insects

When identifying the consumer-preferred edible insect species, participants were found to be currently eating insects (587 respondents). They said crickets are often the most popular choice (Figure 2). Cricks were voted favorite by 50% of the respondents. Bees came in second place (14%), followed by bamboo worms (8%) and dung beetles (5%). Palm weevil larvae, water scavenger beetles, diving beetles, and giant water bugs were also mentioned, accounting for 3% of the preferred varieties. Other varieties include cicadas, dinorid bugs, drumstick borers, grasshoppers, hornets, red ants, rhinoceros beetles, silkworms, termites, white grubs, and wood borers were also preferred by the respondents. Still, only less than 3% of the respondents preferred each variety. Therefore, all these varieties were combined and labeled as others.

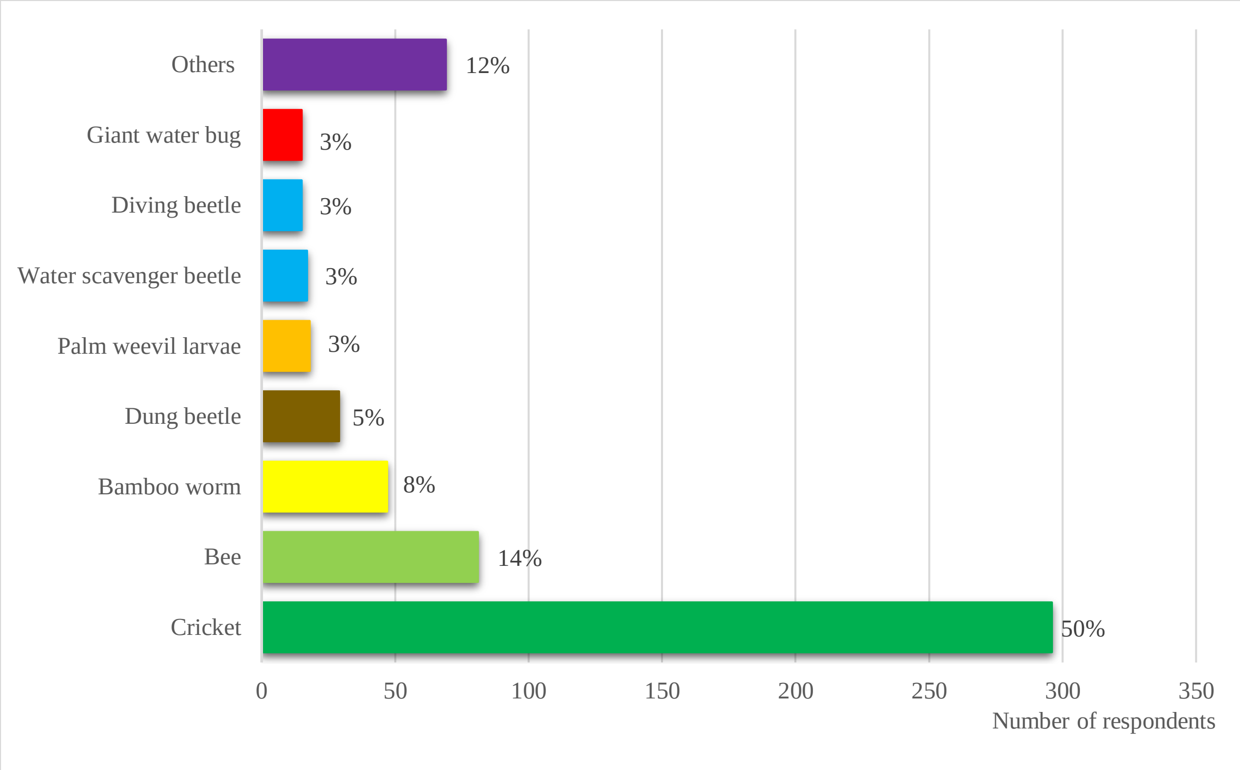

Figure 2: Consumer-preferred varieties of edible insects in Myanmar.

3.4.5 Reasons for not consuming insects

When non-consumers were asked why they had never tried edible insects, they mentioned 14 reasons for not consuming them, as shown in Table 4. Each respondent revealed at least one to a maximum of four reasons. In detail, 32% of the non-consumers feared insects, and 18% were disgusted. Another 18% said they had never tried eating edible insects or had no entomophagy habits, while 16% said they disliked entomophagy or believed it was distasteful. Unavailability and inaccessibility were factors mentioned by 7% of the respondents. Another 7% of the respondents thought insects were dirty food, and 3% feared eating insects would cause health-related problems. In some cases, other considerations, such as being expensive (3%), being forbidden by their religion (2%), and disliking eating them (2%), were stated. About 2% did not want to eat beneficial insects, and another 1% were uncomfortable eating insects. Strangely, 1% of the respondents did not know about the practice of entomophagy, while 0.4% were vegetarians.

Table 4: Reasons to avoid eating insects.

Sr.	Reasons	No. of cases	% of the respondents
1	Afraid	77	32
2	Disgusted	44	18
3	Not a habit/ Never tried	43	18
4	Dislike of insect-eating habit/ Not a good habit	39	16
5	Unavailable/ Cannot access easily	16	7
6	Insects are dirty foods	16	7
7	Afraid of allergic problems/ Health problems	8	3
8	Expensive	7	3
9	Religion	6	2
10	Dislike	4	2
11	Do not want to eat beneficial insects	4	2
12	Uncomfortable to eat	3	1
13	Never heard about entomophagy	3	1
14	Vegetarian	1	0.4

3.4.6 Reasons for not continuing the practice of entomophagy

Five percent of the respondents had consumed insects in the past but had not practised this habit in recent years. The respondents raised 1–3 reasons for not eating insects in recent years. There were nine main reasons for not continuing the practice of entomophagy, as listed in Table 4. Unavailability was the main barrier (20%), followed by its high cost (17%). Another reason mentioned by 14% of the respondents was that they used to eat insects in their childhood, as their families practised entomophagy. However, they stopped this habit when they were adults and had control over whether to eat insects. This was because they embraced the belief that people must have compassion for animals and that eating insects was unacceptable. Dislike and health problems were two more reasons cited by 12% and 11% of the respondents, respectively. Another 8% revealed that they had eaten many insects during childhood. They used to buy or search for insects and eat them, even though they knew killing insects was a bad habit. As they were becoming old and trying to follow the teachings of their religion, they did not want to kill/eat such creatures, even if eating insects differs from the mass killing of insects. Among the respondents, 7% had already stopped eating insects due to unsanitary issues. Some mentioned that they feared using chemicals (6%) and were disgusted by insects (5%).

Table 5: Reasons for not continuing the practice of entomophagy.

Sr.	Reasons	No. of cases	% of the respondents
1	Unavailable/ Unavailable in the current location/ Cannot access easily/ Cannot afford to buy	17	20
2	Expensive	14	17
3	Entomophagy is just a childhood habit, as it is not an acceptable practice	12	14
4	Dislike	10	12
5	Health problems (allergy, high blood pressure, headache)	9	11
6	Getting older and do not want to eat/kill insects or other live creatures	7	8
7	Afraid of unsanitary practices	6	7
8	Afraid of using chemicals	5	6
9	Afraid and disgusted	4	5

3.5 Discussion

Most respondents in Myanmar experienced the consumption of insects, and almost all (67%) were active insect consumers. Hence, it can be noted that entomophagy is almost equally widespread in both states and regions. According to Barennes *et al*. (2015), 97% of people in Laos are insect consumers, and thus, the percentage of insect consumers in Myanmar is relatively low. Nevertheless, entomophagy is widespread throughout the nation, and the population in central Myanmar also practices this habit. The result conflicts with the study of Nischalke *et al*. (2019), saying that Burmese people from central Myanmar seldom eat insects.

The typical insect consumption frequency is minimal since the average consumption frequency is only five times a year. The available insect varieties differed by region, ranging from 6 to 19. Crickets were available everywhere, while some insect species were restricted to specific regions. As a result, crickets stand first place not only as the most common but also as the most preferred insect variety. These findings are in agreement with those of Spectrum (2016). Following closely behind the most popular choice is bees, followed by bamboo worms in third place. Those three edible insects are the most sought-after types in Southeast Asian nations (Raheem *et al*., 2019).

The number of insect species consumed varied according to the administrative division, with a minimum number consumed of one to six. More than half (54%) of consumers only ate one kind of insect, particularly crickets, whereas the remaining (46%) ate two to six types of insect species. From this, it can be concluded that a wide variety of insects are consumed in Myanmar as food. It was also found that the consumption frequency of edible insects in areas where people eat many kinds of insects was higher than in areas where people eat only a few insect types. For those who eat a wide variety of edible insects, consumption frequency is higher because seasonality is less constraining for them. Since different insect species appear at different times of the year, those who eat a wide variety of insects rather than just one kind can extend their insect consumption period. The majority eat one variety of insects, which might be one possible reason for the low frequency of consumption of edible insects in Myanmar. Thus, Barennes *et al*. (2015) mentioned that the seasonal occurrence of edible insects makes it challenging to obtain them during the off-season.

Although there was a considerable frequency of consumption in places that consumed many insect species compared to areas that only consumed one, this did not imply a greater consumption frequency in locations where more insect species were available. This is because the term “availability” in this context does not solely refer to market availability, and it could apply to insect proliferation, market availability, or both. Not everyone can consume insects, even though they are proliferous nearby and are available to everyone once on the market. Thus, Pambo *et al*. (2016) stated that non-availability appears to be an obstacle to accepting and consuming edible insects in Kenya.

The main justifications given by non-consumers for not eating insects are fear, disgust, a lack of experience with them, and the belief that entomophagy is a harmful habit. These findings are confirmed by various insect consumption studies conducted in entomophagous countries. Insect consumption is influenced negatively by insect phobia and disgust, consistent with other studies conducted in both traditional insect-eating nations, China and Thailand, and nontraditional insect-eating countries, Italy and Australia (Cicatiello *et al.*, 2016; Hartmann *et al.*, 2015; Phonthanukitithaworn *et al.*, 2021; Sogari *et al.*, 2019). It can be interpreted that people usually fear edible insects due to the appearance of insects being different from other food products concerning unfamiliar forms. Insects are considered disgusting to eat due to the nature of the insects' habitats, contamination, and disease (Hartmann and Siegrist, 2018; Jensen *et al.*, 2019; Barbera *et al.*, 2018). For instance, dung beetles grow in animal faeces, and people tend to feel disgusted and reluctant to eat them. In Zimbabwe, the Apostolic Church sects assumed that certain insects were dirty and should not be consumed (Manditsera *et al.*, 2018). People had the preconceived notion that insects are unclean, unsanitary, and dirty; hence, they avoided eating them (Ancha *et al*., 2021). Thus, insect phobia and disgust are the main burdens on insect consumption in non-entomophagous and entomophagous countries.

The five primary reasons for not continuing the practice of entomophagy were: (1) unavailability, (2) costs, (3) only a childhood habit, (4) distaste, and (5) health issues. The findings regarding the availability of edible insects align with studies conducted in entomophagous and non-entomophagous countries (Hlongwane *et al*., 2021; Shelomi, 2015; Tan *et al*., 2015). Non-availability is an obstacle to the widespread acceptance and consumption of edible insects in Kenya and Laos, two nations with long histories of insect consumption (Barennes *et al*., 2015; Pambo *et al*., 2016). There have been reports of health problems regarding insect consumption, such as sickness, vomiting, diarrhea, headache, dizziness, breathing problems, allergic reactions, and itchy rash (Belluco *et al*., 2015; Chomchai and Chomchai, 2018; Ribeiro *et al*., 2021).

3.6 Conclusions

The current study aimed to fill a gap in the literature by conducting a consumer study of edible insects in entomophagous countries like Myanmar. This article adds to the existing literature by examining the population of insect consumers, consuming insect species, and preferring varieties to forecast the possibility of edible insects addressing food poverty and inadequate nutrition in Myanmar. As entomophagy is widespread in both states and regions, edible insects could be an alternate source of meat protein in Myanmar's battle against food insecurity and malnutrition problems. Moreover, the reasons for not consuming insects and stopping entomophagy were also explored to determine the bottleneck of enhancing edible insects as food in Myanmar. The study highlights the main barriers to entomophagy, such as phobia, disgust, and non-availability. There may be a way to alleviate the fear and disgust of insects by introducing novel goods based on insects or by providing them in an unrecognized form, like flour. Disseminating information about producing or harvesting edible insects through mass media can help diminish disgust. One possible solution for non-availability would be rearing edible insects. Insect farming is not yet thriving in Myanmar. Insect consumption frequency can be increased by providing a steady supply of the three most preferred insect species, crickets, bees, and bamboo worms, which might help the food and nutrition situation of Myanmar. This information could also be helpful for entrepreneurs to launch insect-rearing businesses and for existing and new value chain actors to make effective marketing plans. On the other hand, it is essential to increase public awareness of the health and environmental benefits of eating insects to change the minds of those who have never eaten insects and may have negative preconceptions about entomophagy. However, this study failed to inquire about the motivation factors of insect consumers, which are crucial for efficient marketing strategies.

CHAPTER IV

4. Factors affecting consumption of edible insects as food: entomophagy in Myanmar

This chapter has been published as Thu Thu Aung *et al*. (2022) Journal of Insects as Food and Feed

http://dx.doi.org/10.3920/JIFF2022.0151

4.1 Abstract

With the world's population rapidly increasing, food security and malnutrition have emerged as critical issues. Edible insects offer an alternative protein source that requires less land and water than conventional livestock production and emits lower levels of greenhouse gases. Myanmar has a long history of consuming insects such as crickets, grasshoppers, palm weevil larvae, giant water beetles, stink bugs, honeybees, cicadas, and ants. Although insect consumption is common in Myanmar, very little is known about the factors that could potentially encourage or discourage people from consuming edible insects as an alternative meat protein. This study analyzes data from 872 respondents to investigate consumer acceptance of entomophagy and the factors influencing edible insect consumption in Myanmar using descriptive statistics and Poisson regression model with sample-selection analysis. Results show that consumer acceptance towards edible insects as food is 67%—moderately high in Myanmar, but consumption frequency is occasional. Edible insect consumption is influenced by ethnicity, religion, opinion towards entomophagy, insect phobia, nutritional properties, social concerns, and discomfort. Meanwhile, consumption frequency is influenced by income, ethnicity, family size, taste, smell, and safety concerns. We find that negative opinions, insect phobia, safety concerns, social concerns, and discomfort are significant bottlenecks for insect consumption in Myanmar. In contrast, the nutritional properties of edible insects motivate individuals to consume them. This highlights the importance of increasing public awareness of the benefits of entomophagy, creating a favourable impression, and reducing social fears about insect consumption. Providing novel insect-based foods, such as flour, could boost consumption. The government should implement, monitor and communicate good manufacturing practices to ensure actual and perceived food safety.

4.2 Introduction

With the world population rising rapidly, food security and malnutrition are becoming ever more critical challenges for sustainable development (FAO, 2017; FAO *et al.*, 2019; IFPRI, 2018). These problems are exacerbated by decreased arable land, water scarcity, and changing climatic conditions (Alexandratos and Bruinsma, 2012; Ebenebe *et al.*, 2017; Fitton *et al.*, 2019; Gomiero, 2016; Misra, 2014; Nam *et al.*, 2022; Sachs, 2009). Edible insects promise an alternative protein source with less land and water requirements and lower GHG emissions than conventional livestock production (FAO, 2017; Kinyuru *et al.*, 2015; Van Huis *et al.*, 2013). Nutritional content varies depending on the insect species, but generally, insects offer higher contents of proteins, fats, vitamins, and minerals than meat (Banjo *et al.*, 2006; Orkusz, 2021). Hence, edible insects may contribute to solving the undernutrition problems (Imathiu, 2020). Consumption of edible insects can positively impact food security, sustainable food production, vulnerable populations' livelihoods, economic opportunities, and the environment. However, consumers' negative perception of edible insects still poses a significant obstacle for them to becoming a meat protein alternative (Van Huis *et al.*, 2013).

Even though entomophagy is common in many parts of the world, it remains a peculiar practice for many consumers, particularly in Western societies (Shockley and Dossey, 2014; Sogari *et al.*, 2019b). Consumer studies on edible insects have primarily been conducted in Western (i.e. nonentomophagy) countries. Only a few studies focus on insecteating countries (Hwang and Kim, 2021; Liu *et al.*, 2020; Omemo *et al.*, 2021). Given that insect consumption in many entomophagous countries may have already decreased due to westernisation (Chakravorty *et al.*, 2013; Manditsera *et al.*, 2018; Pambo *et al.*, 2018), more consumer studies for traditional insect-consuming countries where malnutrition is chronic are needed to understand the associated driving forces (Meysing *et al.* , 2021). Investigating consumer acceptance is important for such countries, as people from traditional insect-eating areas may also reject insect consumption for various reasons (Ghosh *et al.*, 2019). Changes in farming techniques, westernisation, loss of traditional practises, particular eating habits, and a lack of indigenous knowledge transmission are all possible causes of this phenomenon (Ancha *et al.*, 2021; Bae and Choi, 2020; Ghosh *et al.*, 2019; Pambo *et al.*, 2016). For Southeast Asia, a traditional insect-eating region, previous research focused primarily on edible insect species, production and markets, but not on consumers (Sogari *et al.*, 2019a). Hence, Liu *et al.* (2020) stressed the need for analysing consumer acceptance towards insects as a protein source in less developed Asian nations.

Myanmar has been a diverse ethnic country with an 'insect-eating habit' for centuries. In eight out of fifteen regions, the Burmese form the country's largest ethnic group, while in the remaining seven regions other ethnic groups such as Kachin, Kayah, Kayin, Chin, Mon, Rakhine, and Shan are the majority (Myanmar embassy (Tokyo), 2003). Insects play an important role in the diet of some ethnic groups, primarily those from mountainous regions, such as the Kayin, Chins, Kachins, and Shans (Linn *et al.*, 2016). In contrast, entomophagy is not as common in the central part of Myanmar, where the Burmese people rarely consume insects (Nischalke *et al.*, 2020). Although insect consumption is not widespread everywhere in Myanmar, various edible insects are naturally abundant throughout the country (Yhoung-Aree and Viwatpanich, 2005). The well-known insects in Myanmar are crickets, grasshoppers, palm weevil larvae, giant water beetles, stink bugs, honey bees, cicadas, and ants (Spectrum, 2016). The annual value of wild-harvested insect value chains is approximately USD 5 million (Spectrum, 2020b).

About 30% of children under five in Myanmar face chronic malnutrition (USAID, 2020), and maybe surprisingly, many people from traditional entomophagous areas of Myanmar suffer from malnutrition, including due to the high poverty level in these parts of the country. Moreover, the COVID-19 pandemic and the recent military coup aggravated this situation even further (UNDP, 2021; UNHCR, 2021). Consuming insects is a recently proposed idea to help alleviate food shortages and famine (Belluco *et al.*, 2015). Because of their high protein content, insects are a good food source for countries like Myanmar, where meat protein consumption is traditionally low (Eurocham Myanmar, 2019; Smith *et al.*, 2021; Tuhumury, 2021).

Owing to a dearth of research, it is difficult to understand edible insect consumption as another source of protein in fighting food insecurity and malnutrition in Myanmar. Especially, data regarding the proportion of insect consumers, how much or how frequently they consume insects, and what factors influence their consumption is lacking. This research gap highlights the importance of edible insect consumer studies in Myanmar to identify the factors that may potentially promote or inhibit consumers from consuming edible insects as an alternative meat protein. Researching consumer acceptance could aid in exploring the business potential of edible insects (Van Huis *et al.*, 2013). By investigating consumer acceptance of edible insects and its main influencing factors, this study aims to better understand edible insect consumption as another source of protein in fighting food insecurity and malnutrition in Myanmar and beyond. This will provide valuable insights into promoting edible insect consumption and related market activities.

4.3 Factors affecting consumer acceptance and consumption frequencies

4.3.1 Consumer acceptance

Consumer acceptance is a complex phenomenon, and a single theory cannot adequately explain why individuals accept or reject a product (Lensvelt and Steenbekkers, 2014). Consequently, numerous indicators of consumer acceptance of foods have been proposed, including overall acceptance, attitude, willingness to pay/eat, buying intention, and actual consumption (Adámek *et al.*, 2018; Baker *et al.*, 2022). The definition of consumer acceptance and the results of studies on edible insects varied widely from country to country. Ancha *et al.* (2021) defined consumer acceptance as insect consumption and found that most respondents in Nigeria (82%) consume insects. Meanwhile, consumer acceptance in Korea, as measured by the willingness to buy and consume edible insects, is 64% (Bae and Choi, 2020). Interestingly, 63% of these consumers do not want to eat insects unless necessary. Ghosh *et al.* (2019) analysed consumer acceptance regarding individuals' attitudes towards using insects as food and feed in Korea and Ethiopia. Insect-containing meals are less acceptable to Ethiopians (11%) than they are to Koreans (46%), and male participants in both societies were more accepting than their female counterparts. Pambo *et al.* (2016) explored consumer acceptance, defined as eating insects as a regular part of people's diets, and found that this applied to 73% of respondents. Even though consumer acceptance is generally high according to these studies, in certain regions, for example, in Ethiopia, where malnutrition is prevalent, most consumers do not accept edible insects as food. Based on the definition of Pilgrim (1957), consumer acceptance in this research refers to the consumption of edible insects.

4.3.2 Frequency of edible insect consumption

As regular consumption of edible insects could reduce malnutrition problems in Myanmar, it is essential to know the consumption frequency and its driving factors. Only a few studies have explored the frequency of edible insect consumption in entomophagous countries. For instance, Barennes *et al.* (2015) conducted a national survey in Laos with 1,059 adult respondents from 30 different ethnic groups. They showed that nearly 97% were insect consumers, and consumption frequency varied by ethnicity, region, and season. About 13% of respondents consumed insects weekly or daily, 31% occasionally, and 56% very infrequently during a year. Manditsera *et al.* (2018) explored insect consumption frequency in Zimbabwe. The results showed that 80% of urban and 90% of rural residents were consumers, with rural residents consuming more frequently than urban ones.

4.3.3 Factors affecting the consumption of edible insects

Several factors that may influence the consumption of edible insects and the frequency of consumption have been proposed as one of them. Most of these factors are based on the models of Randall and Sanjur (1981) and Shepherd and Raats (1996). According to both models, individual, product-related, and environmental factors are the three main determinant groups. Individual factors include gender, age, education, income, and knowledge (Assegaff, 2017; Randall and Sanjur, 1981). Men engage in entomophagy more than women in Ghana and Kenya (Anankware *et al.*, 2017; Omemo *et al.*, 2021). However, why men are more willing to accept edible insects as food than women remain unclear. Women consume more edible insects than men in Liberia and China. Women, especially pregnant women, consume more insects because they are thought to be beneficial to their health (Castro and Chambers, 2019; Coley *et al.*, 2020). In China, age correlates positively with the consumption frequency of edible insects because older people are more familiar with them (Liu *et al.*, 2020). Young people in developing countries are increasingly turning away from insect-eating practises (Vantomme, 2015) by adopting Western food and abandoning their cultural habits (Hlongwane *et al.*, 2021). However, some younger generation members in Myanmar see edible insects as trendy food and are willing to try them (Nischalke, 2020). In South Africa, education is the strongest predictor of edible insect consumption, with people with less education consuming more insects (Egan, 2013). However, Anankware *et al.* (2017) detected positive relationships between education and insect consumption in Ghana and explained this by stating that well-educated people are more likely to travel and be open to new experiences. Furthermore, more educated people may be more aware of the nutritional benefits of edible insects and thus consume them more frequently (Liu *et al.*, 2020). Carolyne (2018) and Manditsera *et al.* (2018) revealed a negative relationship between income and edible insect consumption in Kenya and Zimbabwe; they explained that as income rises, people have more options for purchasing other animal proteins. Lower-income people in South Africa consume more edible insects, most likely because they save money on food when insects are readily available (Egan, 2013). Similarly, Dürr and Ratompoarison (2021) found no significant differences in insect consumption between poorer and wealthier families in Madagascar highlands because insects are not purchased but instead collected in the wild. Meanwhile, in China and Kenya, income does not affect the frequency of consumption of edible insects (Liu *et al.*, 2020; Carolyne, 2018).

Due to the inconsistency of the effect of individual characteristics, additional emotional factors, such as disgust, neophobia, familiarity, and opinions, may interfere with and influence acceptance

(Hartmann *et al.*, 2015; Orsi *et al.*, 2019; Pambo *et al.*, 2016; Sogari *et al.*, 2019c). Disgust harms the acceptance of insects as food (Cicatiello *et al.*, 2016; Neves, 2015; Orsi *et al.*, 2019). About one-fourth of Nigerian respondents do not accept edible insects as food due to disgust, as insects are perceived as unclean and unsanitary (Ancha *et al.*, 2021). Similarly, insect phobia is the main barrier to consumer acceptance in non-entomophagous countries (Junges *et al.*, 2021; Moruzzo *et al.*, 2021; Sogari *et al.*, 2019c) and in traditional insect-eating countries like China (Hartmann *et al.*, 2015). Hartmann *et al.* (2015) showed that familiarity plays a crucial role in consumer acceptance. People familiar with edible insects indicate higher acceptance of edible insects in Kenya (Pambo *et al.*, 2016). Similarly, familiarity significantly affects insect consumption in Uganda (Olum *et al.*, 2020). Familiarity with a certain food type reduces fear and doubts about it (Aldridge *et al.*, 2009). For example, people who are familiar with edible insects regard them as food (Schardong *et al.*, 2019). Food preferences can also be predicted by considering the individual's attitude towards the food item (Steenkamp, 1993). In Western societies, an opinion as a way of verbally expressing one's attitude (Sundararaj and Rejeesh, 2021) towards entomophagy is often negative (Sogari, 2015; Videbæk and Grunert, 2020). Moreover, in South Africa, younger people have negative attitudes towards entomophagy, possibly as a result of globalisation (Egan, 2013). Besides, Shepherd and Raats (1996) mentioned negative effects on consumption behaviour caused by anticipated worry, concern, or regret. Some unpleasant feelings associated with insect consumption, including nausea, vomiting, diarrhoea, headaches, dizziness, difficulty breathing, allergic reactions, and an itchy rash, have been reported (Belluco *et al.*, 2015; Chomchai and Chomchai, 2018; Ribeiro *et al.*, 2021).

When selecting foods, customers must consider productrelated factors, such as nutritional values, taste and smell, and safety (Adámek *et al.*, 2018). The nutritional value of edible insects influences their consumption in Madagascar (Meysing *et al.*, 2021). Moreover, food safety concerns harm the frequency with which Chinese consumers consume edible insects (Liu *et al.*, 2020). Insects may be contaminated by pesticides, toxic elements, and heavy metals in their habitats in Laos (Barennes *et al.*, 2015). Similarly, respondents in a pre-survey conducted in Yangon, Myanmar, cited food safety concerns about chemical contaminations as the primary reason for decreasing and discontinuing insect consumption (Myint Thu Thu and Dürr, 2019). Finally, edible insect availability is critical for entomophagy (Hlongwane, 2021; Shelomi, 2015; Tan *et al.*, 2015). Non-availability appears to be a barrier to insect consumption in Laos and Kenya (Barennes *et al.*, 2015; Pambo *et al.*, 2016). According to Egan (2013), populations of edible insects in South Africa have declined due to overharvesting and climate change. In

Myanmar, insect farming is still in its early stages, and the availability of edible insects is primarily dependent on seasonal wild collection (Nischalke *et al.*, 2020).

Household-level factors such as location, family size, ethnicity, and religion have also influenced individuals' particular actions (Yakut, 2019). In Ghana, consumption of insects is more common in rural than in urban areas (Anankware *et al.*, 2017). Also, Manditsera *et al.* (2018) discovered that in Zimbabwe, insect consumption frequency is higher in rural areas where insects are collected in the wild than in urban areas where most people have to buy them. According to Liu *et al.* (2020), family size does not affect the frequency of consumption of edible insects. Yet, Meysing *et al.* (2021) discovered that larger households in Madagascar have lower per capita insect consumption because more members share total amounts. In contrast, larger families in Kenya are more likely to adopt entomophagy (Omemo *et al.*, 2021), maybe because more family members increase the available time for insect collection in the wild, thereby expanding the insect harvest (Dürr and Ratompoarison, 2021). On the other hand, edible insect consumption frequency in Laos varies depending on ethnic differences (Barennes *et al.*, 2015). Finally, Dube *et al.* (2013) highlighted that religion significantly impacts the eating of insects because entomophagy is not practised by people whose religion forbids the consumption of foods derived from animals (Abdullahi *et al.*, 2021). As Myanmar is a multi-religious and ethnically diverse country, these factors may be crucial.

4.4 Material and methods

4.4.1 Questionnaire design

In this study, consumer acceptance is based on the actual consumption of edible insects. Insect consumers are individuals who have consumed insects in the past and continue to do so today. According to Agudo (2004), insect consumption frequency refers to the individual insect consumption times within a year. Based on the current literature, this study included individual factors such as gender, age, education, and income, emotional factors such as disgust, insect phobia, familiarity, opinions, and discomfort, product-related factors such as nutrition, taste, smell, availability and safety and household factors such as location, family size, ethnicity and religion as explanatory factors. Besides, willingness to eat naturalness was considered as one extra factor as people in Myanmar are often hesitant to eat farmed insects and prefer wild collection (Nischalke *et al.* , 2020). Furthermore, the availability of substitutes, such as fish and meat, is critical in understanding insect consumption behaviour (Van Huis, 2015), and it was counted as an additional factor. Finally, social concerns were incorporated in this study as Van Huis *et al.*

(2022) and Egan (2013) mentioned that people today prefer to eat more meat than insects, and insects as a traditional food have been abandoned because insect consumption is seen as a symbol of poverty or illiteracy.

The analysis consisted of two stages: for the first stage, we explored the drivers of insect consumption and tested the following ten variables: gender, ethnicity, religion, opinion, disgust, insect phobia, familiarity, nutrition, discomfort, and social concerns. As the dependent variable is binary, '1' denotes 'consume insects in recent year' and '0' signifies 'do not consume insects in recent year.' For the second stage, we analysed the effects of 14 variables on the consumption frequency of edible insects per year (measured as count numbers). The variables were: gender, age, education, income, location, ethnicity, family size, naturalness, taste, smell, nutrition, food safety, availability of edible insects, and availability of fish and meat. As the data collection period coincided with the military coup in Myanmar, many individuals feared political unrest, and respondents were hesitant to provide precise information regarding age, income, and family size. Therefore, open-ended questions were replaced with multiple-choice questions to determine which groups respondents belonged to. Besides, this study used 'yes or no' and 5-point Likert scale questions. Afterward, all 5-point Likert scale variables were re-arranged into three groups: negative perception (strongly disagree + disagree), neutral and positive perception (agree + strongly agree). The description of each variable are described in the following Table 1.

Table 1: Description of all independent variables to predict consumer acceptance and consumption frequency of edible insects.

Variables	Description	Expected sign	
		Consumption (Consumer acceptance)	Consumption frequency
Gender	Sex of respondents (Male =1, Female = 0)	+/-	+/-
Age	Chronological age [Young (≤ 30 years) =1, Middle age (31–45) =2, Old age (>45) =3]		+
Education	Education level (Middle school =1, High school =2, Undergraduate =3, ≥ Bachelor =4)		+

Variables	Description	Expected sign	
		Consumption (Consumer acceptance)	Consumption frequency
Income	Monthly income [Low (<$200) =1, Others (≥$200) = 0]		+
Location	Geographic entity (Urban =1, Rural =0)		+/-
Ethnicity	Belonging to a particular ethnic group (Burmese =1, Kachin =2, Kayah =3, Kayin =4, Chin =5, Mon = 6, Rakhine =7, Shan =8)		+/-
Religion	Practicing Buddhism =1, Others =0		+/-
Family size	Total number of household members [Small (≤3) =1, Medium (4–6) =2, Large (>6) =3]		+
Opinion	Insect consumption is a good habit. (Positive =1, Negative =0)	+	
Insect phobia	I am afraid of edible insects. (No =1, Neutral =2, Yes =3)	-	
Disgust	I feel disgusted with edible insects. (No =1, Neutral =2, Yes =3)	-	
Familiarity	I heard about edible insects. (Yes =1, No =0)	+	
Discomfort	The thought of eating insects makes me feel uncomfortable. (Disagree =1, Neutral =2, Agree =3)	-	
Social concerns	Insect consumption is a symbol of lower status. (Disagree =1, Neutral =2, Agree =3)	-	
Nutritious	Edible insects are nutritious foods. (Disagree =1, Neutral =2, Agree =3)	+	+
Taste	Taste of the insects generally_ not for specific insect. (Normal =1, Good =2, Very good =3)		+

Variables	Description	Expected sign	
		Consumption (Consumer acceptance)	Consumption frequency
Smell	Smell of the insects generally_ not for specific insect. (Disagree =1, Neutral =2, Agree =3)		+
Naturalness	Willingness to eat wild edible insects. (Eat only wild insects=1, Otherwise =0)		+
Safety concerns	Afraid of chemical contamination of edible insects (Disagree =1, Neutral =2, Agree =3)		-
Availability of edible insects	Edible insects are available in my area. (Yes =1, No =0)		+
Availability of fish and meat	Fish and meat are readily available in my town/village. (Disagree =1, Neutral =2, Agree =3)		+

4.4.2 Survey and sampling

Between March 2021 and June 2021, telephone surveys were used to gather the data. Participants were chosen at random from all areas of Myanmar. The minimum required number of respondents for each category was calculated according to Cochran (1963) as follows:

$$N = \frac{Z^2 \times p(1-p)}{e^2} \qquad (3)$$

Where:

N = required minimum sample size

Z = Z score

p = expected consumer proportion

q = 1 − p;

e = margin of error

We used consumer proportion (p) = 0.5 at a 90% confidence level with a 3% margin of error since the proportion of the entire population was unknown. Hence, the required minimum sample size for this study was 752 participants.

Since no databases in Myanmar contain mobile phone numbers, a total of 18,694 numbers were generated randomly and then called. Of these numbers, 68% were unavailable or out of service. For the numbers that were dialled (5,981), 40% of persons did not answer the call, 45% declined to participate, and 15% (897) agreed. Despite some variation, the collected data represent the actual population of the 2014 census data (DOP, 2015) in terms of regions, gender, age, education, income, ethnicity, religion, and family size but do not represent the rural-urban population. Nevertheless, it must be considered as a convenience sample. After cleaning data and eliminating outliers, the number of valid respondents was reduced to 872.

4.4.3 Statistical analysis

4.4.3.1 Poisson regression with sample-selection analysis

When an individual never consumes insects, the consumption frequency is zero. Without knowing the exact reason for zero consumption frequencies, we must assume that our dependent variable is truncated. For truncated data, samples are taken from a subset of a larger sample of interest (Ao, 2009; Ilyas *et al.*, 2020). In this study we are only interested in people who eat insects. The bias resulting from this sample selection is referred to as sample selection bias (Heckman, 2010). The use of ordinary least squares regression analysis in the presence of such data is expected to be biased, inconsistent, and inefficient (Greene, 2012). Heckman (1977) claimed that estimation on the selected subsamples leads to sample-selection bias because of the study's partially observable outcome of interest.

When normality and homoskedasticity assumptions were violated, the presence of discreteness and heteroskedasticity in count data motivate using a Poisson rather than a linear specification. The Heckpoisson model fits the dependent variable better with count data and corrects sample selection bias (Kingsuwankul *et al.*, 2021; Waruingi *et al.*, 2021). Hence, we used Poisson regression with sample selection (Heckpoisson model). It is divided into two stages: (1) a binary regression that shows whether respondents consume edible insects or not, with values of 0 or 1, and (2) a Poisson regression with count data for the frequency of edible insect consumption, which can be written as follows (Stata, 2021):

For the first step (selection model):

$$C_i = \beta_i X_i' + \varepsilon_1 \qquad (1)$$

$$\varepsilon_1 \sim N\ (0,1)$$

$$C_i = 1 \; if \; \beta_i X_i' + \varepsilon_1 > 0, and \; 0 \; for \; otherwise.$$

For the second step (Poisson model):

$$E(CF_i / X_j', \varepsilon_2) = \exp(\beta_i X_j' + \varepsilon_2) \quad (2)$$

$$\varepsilon_2 \sim N\ (0, \delta)$$

CF_i is only observed if $C_i = 1$

$\rho = corr\ (\varepsilon_1, \varepsilon_2)$

Where:

C_i	is the binary dependent variable show whether consume edible insects or not
CF_i	is the insect consumption frequency per year
X'_i and X'_j	are the explanatory variables hypothesised to affect the dependent variables
β_i	is the vectors of parameters to be estimated
ε_1 and ε_2	are the error terms with a mean of zero
δ	is the standard deviation
ρ	is the correlation between ε_1 and ε_2

4.4.3.2 Diagnostic tests

Before starting the analysis, the basic assumptions of the econometric model were checked with various tests. Following Şanlı (2019) and Uzun *et al.* (2017), we first conducted Pearson correlation tests of the explanatory variables, resulting in generally weak relationships (r-values less than 0.5), except for disgust with a moderate correlation (r=0.54) with insect phobia (Supplementary Table S1 and S2). Thus, disgust was excluded from the model. According to descriptive statistics, familiarity, availability of edible insects, and availability of fish and meat occurred in more than 90% of cases; therefore, these three variables were omitted in the subsequent analysis.

Multicollinearity was checked using the variance inflation factor (VIF). Individual VIF values ranging from 1.02 to 1.36 do not indicate multicollinearity issues, given that they are smaller than the critical VIF value 10 (Hair Jr *et al.*, 2014) (Supplementary Table S3). The Breusch-Pagan/CookWeisberg test was used to examine heteroskedasticity under the null hypothesis that the variances of the error terms are constant. As both the consumption and consumption frequency chi-square values were large and significant at 0.001, heteroskedasticity issues exist (Supplementary Table S4). To resolve this issue, we performed a robust estimate of the

Heckpoisson methods. The Wald test of the independent equation yielded a significant correlation estimate (ρ) of (-0.50) at (P=0.001), leading to a rejection of the null hypothesis of no sample-selection bias. Therefore, the error terms were associated, confirming the appropriateness of using the Heckpoisson model. The findings of the Heckpoisson model are robust against using a separate probit or logit for consumer acceptance, followed by a standard Poisson for consumption frequency.

4.5 Results

4.5.1 Descriptive analysis

Most respondents (72%) had consumed insects (Figure 1). People with insect consumption experience can be divided into two groups: (1) those who consumed insects only in the past (5%); and (2) those who consumed insects both in the past and present (67%). In this article, we referred to the second group as insect consumers. In terms of the frequency of insect consumption among those insect consumers, 25% of respondents consumed insects 1-2 times annually; 30%, 3-6 times annually; and 9%, 7-12 times annually. Only 3% of those surveyed reported eating insects on average at least once a month (>12 times per year). On average, general consumption frequency was around three per year and five times per year for consumers.

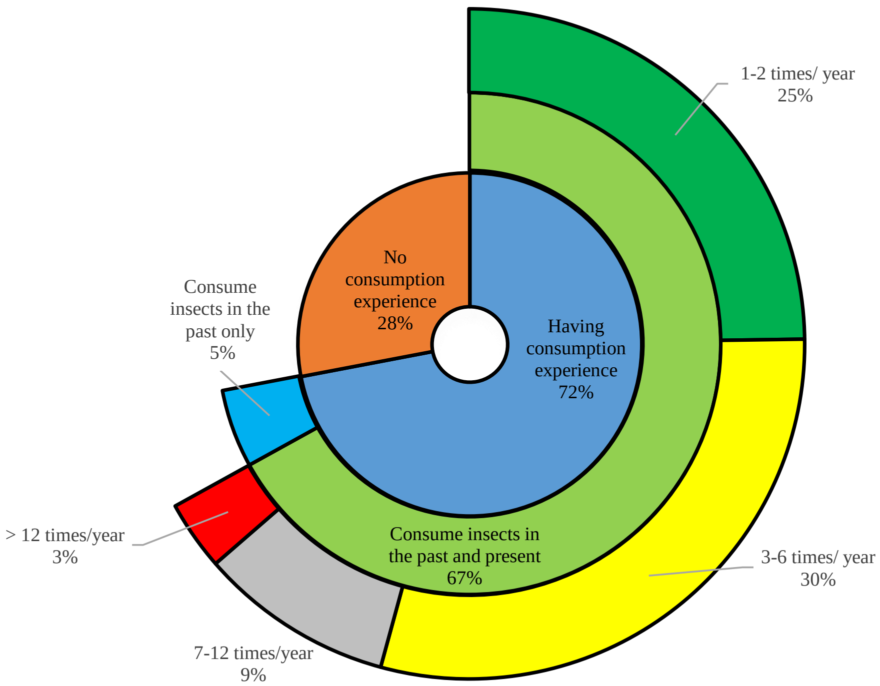

Figure 1. Consumption of edible insects in Myanmar.

In terms of the individual characteristics of the respondents, which were then used as independent variables in the Heckpoisson models, the female/male ratio in the sample turned out to be nearly equal, and approximately half of the respondents were under the age of 30 (Table 2). The respondents' educational level was high, with roughly half of the respondents having bachelor's degrees. Approximately 85% of respondents earn < \$200 per month, whereas 15% earn more > \$200 per month. According to the Pearson chi-square test, except for gender, no significant differences in the number of insect consumers between individual factor groups were found. The percentage of consumers did not differ significantly by age, education, or income, though the frequency of consumption varied significantly between the two income groups.

Table 2: Distribution of insect consumers and their consumption frequency regarding the individual characteristics of the respondents.

Individual characteristics		Total %	Insect consumers %	Pearson Chi-square value	Average consump-tion time a year	Pearson Chi-square value
Gender	Female	51.03	59.33	26.37***	5	38.46
	Male	48.97	75.64		5	
Age	Young (≤ 30)	48.97	66.28	5.45	5	62.77
	Middle age (31– 45)	35.21	71.66		5	
	Old age (> 45)	15.82	60.87		5	
Education	Middle school	12.16	67.92	4.13	4	83.20
	High school	19.95	73.56		5	
	Undergraduate	19.38	65.68		4	
	≥ Bachelor	48.51	65.25		5	
Income	Low (< \$200)	84.75	66.98	0.25	4	62.08***
	Others (≥ \$200)	15.25	69.17		6	

Note: *** = p-value < 0.001; ** = p-value < 0.01; * = p-value < 0.05.

Regarding emotional factors, only 40% of respondents held a favourable view of entomophagy (Table 3). About 20% of respondents have insect phobias, and 16% are disgusted by them. Just < 1% are unfamiliar with edible insects or have never heard of them, while 30% feel uncomfortable when consuming insects. About 32% of respondents do not believe that eating insects indicate a lower social status. In contrast to individual factors, the Pearson correlation test showed that all emotional factors influence consumer acceptance significantly, while consumption frequency was influenced by opinion, phobia, and discomfort.

Table 3: Distribution of insect consumers and their consumption frequency regarding the emotional characteristics of the respondents.

Emotional characteristics		Total %	Insect consumers %	Pearson Chi-square value	Average consump-tion time a year	Pearson Chi-square value
Opinion	Negative	60.09	52.10	138.20***	4	64.49***
	Positive	39.91	90.23		6	
Insect phobia	No	61.58	83.05	199.82***	5	77.43*
	Neutral	18.01	59.87		4	
	Yes	20.41	26.40		4	
Disgust	No	58.49	83.53	253.41***	5	51.98
	Neutral	25.57	64.57		4	
	Yes	15.94	12.23		4	
Familiarity	No	0.80	0.00	14.53***	0	-
	Yes	99.20	67.86		5	
Discomfort (thought of eating insects makes me feel uncomfortable)	Disagree	52.52	82.97	145.70***	5	96.02**
	Neutral	17.55	68.63		4	
	Agree	29.93	39.08		5	
Social concerns (insect consumption is a symbol of lower status)	Disagree	32.00	61.29	7.32*	5	55.01
	Neutral	41.05	68.99		5	
	Agree	26.95	71.91		5	

Note: *** = p-value < 0.001; ** = p-value < 0.01; * = p-value < 0.05.

Regarding the product-related factors, less than half of respondents (45%) thought edible insects were wholesome foods, and 33% of the individuals who recently consumed insects believed insects had good taste, with 13% rating the taste as excellent (Table 4). Approximately 88% of people believed that edible insects have a pleasant smell, but 83% of people said they would eat only wild insects, and 61% of the respondents expressed concerns about contamination by pollutants. With 93 and 96%, the vast majority of the respondents were sure of insects and meat and fish availability in their areas, respectively. The Pearson correlation test revealed that all product-related factors, except for safety issues, significantly varied across groups regarding insect consumers. There is a noticeable variation in consumption frequency regarding taste, smell, and safety issues.

Table 4: Distribution of insect consumers and their consumption frequency regarding product-related factors.

<table>
<tr><th colspan="2">Product characteristics</th><th>Total %</th><th>Insect consumers %</th><th>Pearson Chi-square value</th><th>Average consump-tion time a year</th><th>Pearson Chi-square value</th></tr>
<tr><td rowspan="3">Nutritious food</td><td>Disagree</td><td>18.35</td><td>47.50</td><td rowspan="3">91.15***</td><td>5</td><td rowspan="3">62.26</td></tr>
<tr><td>Neutral</td><td>36.70</td><td>57.19</td><td>4</td></tr>
<tr><td>Agree</td><td>44.95</td><td>83.67</td><td>5</td></tr>
<tr><td rowspan="3">Taste</td><td>Normal</td><td>53.66</td><td>100.00</td><td rowspan="8">Data are only for those who have eaten insects recently (587 respondents)</td><td>3</td><td rowspan="3">170.42***</td></tr>
<tr><td>Good</td><td>33.05</td><td>100.00</td><td>7</td></tr>
<tr><td>Very good</td><td>13.29</td><td>100.00</td><td>7</td></tr>
<tr><td rowspan="3">Smell</td><td>Disagree</td><td>3.07</td><td>100.00</td><td>3</td><td rowspan="3">58.16</td></tr>
<tr><td>Neutral</td><td>8.52</td><td>100.00</td><td>6</td></tr>
<tr><td>Agree</td><td>88.42</td><td>100.00</td><td>5</td></tr>
<tr><td rowspan="2">Naturalness</td><td>Eat only wild insects</td><td>82.96</td><td>100.00</td><td>5</td><td rowspan="2">46.53*</td></tr>
<tr><td>Otherwise</td><td>17.04</td><td>100.00</td><td>6</td></tr>
<tr><td rowspan="3">Safety (afraid of chemical contamination of edible insects)</td><td>Disagree</td><td>16.86</td><td>70.75</td><td rowspan="3">1.61</td><td>6</td><td rowspan="3">80.73*</td></tr>
<tr><td>Neutral</td><td>22.48</td><td>64.29</td><td>4</td></tr>
<tr><td>Agree</td><td>60.66</td><td>67.49</td><td>4</td></tr>
<tr><td rowspan="2">Availability of edible insects</td><td>No</td><td>7.00</td><td>18.03</td><td rowspan="2">72.41***</td><td>3</td><td rowspan="2">26.15</td></tr>
<tr><td>Yes</td><td>93.00</td><td>71.02</td><td>5</td></tr>
<tr><td rowspan="3">Availability of fish and meat</td><td>No</td><td>1.49</td><td>53.85</td><td rowspan="3">16.34***</td><td>3</td><td rowspan="3">24.42</td></tr>
<tr><td>Neutral (Not sure)</td><td>1.95</td><td>23.53</td><td>5</td></tr>
<tr><td>Yes</td><td>96.56</td><td>68.41</td><td>5</td></tr>
</table>

Note: *** = p-value < 0.001; ** = p-value < 0.01; * = p-value < 0.05.

Concerning the household-level factors, the rural-to-urban ratio in this study turned out to 30:70, as opposed to the 70:30 ratio in the 2014 census data (DOP, 2015) (Table 5). In terms of ethnicity, the majority of the samples were Burmese (68%), and 88% were Buddhists, with the remaining 12% practising other religions. Most people live in mediumsized families, with 26% belonging to small families and 14% to large families. Pearson correlation test revealed that consumer percentage and frequency differ significantly by ethnicity but not by location, religion, or family size.

Table 5: Distribution of insect consumers and their consumption frequency regarding the household-level factors.

Household-level characteristics		Total %	Insect consumers %	Pearson Chi-square value	Average consumption time a year	Pearson Chi-square value
Location	Rural	33.26	69.66	1.08	4	35. 51
	Urban	66.74	66.15		5	
Ethnicity	Burmese	67.66	64.07	30.21***	4	311.18***
	Kachin	3.67	87.50		8	
	Kayah	2.41	95.24		2	
	Kayin	5.05	72.73		4	
	Chin	3.21	67.86		5	
	Mon	2.98	46.15		3	
	Rakhine	7.22	84.13		8	
	Shan	7.80	66.18		7	
Religion	Buddhism	88.30	67.79	0.68	5	42.06
	Others	11.70	63.73		6	
Family size	Small (≤ 3)	26.49	64.94	0.81	4	76.23
	Medium (4–6)	59.52	68.21		5	
	Large (> 6)	13.99	68.03		6	

Note: *** = p-value < 0.001; ** = p-value < 0.01; * = p-value < 0.05.

4.5.2 Varieties of edible insects in Myanmar

Twenty-three edible insect varieties could be identified (Table 6). Around 54% of the people tried only one type of edible insects in a year, while the rest, 46%, tried two to six different species. Cricket consumers accounted for 80% of the total population, and 43% of respondents only tried crickets, but no other insects. Half of the respondents regarded crickets as their favourite. This was followed by bees (14%), bamboo worms (8%) and dung beetles (5%).

Table 6: Lists of the common eating edible insects in Myanmar.

Sr.	English Name	Scientific Name	Burmese Name
1	Backswimmer	*Notonecta gluca*	Nga Poe
2	Bamboo Worm	*Omphisa fuscidentalis*	Wah Poe
3	Banana leaf roller/ skipper	*Erionota thrax*	Ngapyaw Poe
4	Bee	*Apis sp. Linneaus*	Pyar
5	Cicada	*Tibicen purinosus*	Puzin Yin kwe
6	Common emigrant pupa	*Catopsilia pomona*	Mezali Poe
7	Cricket	*Brachytrupes portentosus/ Gryllus assimilis/ Acheta domesticus*	Pa Yit
8	Dinorid bug	*Coridius singhalanus*	Kyauk Poe
9	Diving Beetle	*Eretes sticticus*	Twin Poe
10	Dung Beetle	*Helicopris bucephalus*	Ecode
11	Giant water bug	*Lethocerus indicus*	Be-lar/ Palima
12	Grasshopper	*Oxya hyla*	Hnan Kaung
13	Hornet	*Vespa sp.*	Padu
14	Long horn beetle	*Batocera rufomaculata*	D n d lwan Poe/ Thit Poe
15	Predaceous diving beetle	*Dytiscus verticalis*	Yae Kyar
16	Red palm weevils	*Rhynchophorus sp.*	Thin Paung Poe
17	Rhinoceros beetle	*Oryctes rhinoceros*	Ohn Poe
18	Silkworm	*Bombyx mori*	Poe Zar
19	Termite	*Maacrotermesdarwiniensis*	Palu
20	Water beetle	*Aciliussulcatus*	Yae Poe
21	Water scavenger beetle	*Hydrophilus triangularis*	Ngape Poe
22	Weaver ant	*Oecophylla smaragdina*	Kha Gyin
23	White grub	*Phyllophaga spp.*	Thae Poe

4.5.3 Result of the Heckpoisson model

4.5.3.1 Factors affecting insect consumption

The results of the first step (selection) of the Heckpoisson model, i.e. the binary regression model that determines whether or not respondents consume insects, are summarised in Table 7. Belonging to a particular ethnic and religious group but not gender influenced insect consumption significantly. Fear of insects, social concerns, and discomfort turned out to be the primary obstacles to consuming edible insects. Regarding ethnicity, the incidence-rate ratio (IRR) for Kachin, Kayah, and Rakhine are >1, indicating that these three ethnic groups are more likely to consume insects than Burmese, with likelihoods of 420, 312 and 76%, respectively. The likelihood of Mon ethnicity to consume edible insects was 52% less than that of Burmese ethnicity. Buddhists are 58% more likely to consume insects than adherents of other religions. The IRR of 2.33 for opinion indicates that insect consumption is 133% more likely for respondents with a positive compared to a negative attitude towards entomophagy. The likelihood of consuming edible insects is 73% lower for respondents with than without insect phobia, and individuals who believe edible insects are nutritious are 79% more likely to consume them. People who believe insect consumption indicates a lower social status are 34% less likely to consume edible insects, and those who are uncomfortable with insect consumption are 58% less likely to consume insects.

Table 7: Results of Heckpoisson analysis of the factors influencing the consumption and consumption frequency of edible insects.

Heckpoisson model	1st step (selection model)			2nd step (Poisson model)		
Variables	Coefficient		Incidence rate ratio (IRR)	Coefficient		Incidence rate ratio (IRR)
Gender (Male)	0.115	(0.11)	1.121	0.082	(0.06)	1.085
Age (31–45)				0.038	(0.07)	1.039
Age (>45)				−0.16	(0.11)	0.852
Education (High school)				0.001	(0.10)	1.001
Education(undergraduate)				−0.062	(0.10)	0.939
Education (≥ Bachelor)				0.001	(0.10)	1.001
Income (≥$200)				0.315**	(0.10)	1.370

Heckpoisson model	1st step (selection model)			2nd step (Poisson model)		
Variables	Coefficient		Incidence rate ratio (IRR)	Coefficient		Incidence rate ratio (IRR)
Location (Urban)				−0.011	(0.07)	0.989
Family size (4–6)				0.123	(0.07)	1.131
Family size (>6)				0.192*	(0.09)	1.212
Ethnicity (Kachin)	1.648***	(0.43)	5.196	0.343*	(0.14)	1.410
Ethnicity (Kayah)	1.416**	(0.50)	4.122	−0.566***	(0.13)	0.568
Ethnicity (Kayin)	−0.092	(0.25)	0.912	0.134	(0.10)	1.144
Ethnicity (Chin)	0.485	(0.42)	1.624	−0.037	(0.27)	0.964
Ethnicity (Mon)	−0.725*	(0.30)	0.484	−0.288	(0.20)	0.75
Ethnicity (Rakhine)	0.568*	(0.25)	1.764	0.362**	(0.12)	1.437
Ethnicity (Shan)	−0.032	(0.19)	0.968	0.435***	(0.09)	1.546
Religion (Buddhism)	0.458*	(0.20)	1.581			
Opinion	0.846***	(0.14)	2.330			
Insect phobia (Neutral)	−0.592***	(0.14)	0.553			
Insect phobia (Yes)	−1.316***	(0.14)	0.268			
Nutritious food (Neutral)	0.083	(0.14)	1.087			
Nutritious food (Agree)	0.580***	(0.16)	1.785			
Social concerns (Neutral)	−0.018	(0.13)	0.982			
Social concerns (Agree)	−0.420**	(0.15)	0.657			
Discomfort (Neutral)	−0.253	(0.15)	0.776			
Discomfort (Agree)	−0.868***	(0.13)	0.420			
Naturalness (Wild)				−0.143	(0.08)	0.867
Taste (Good)				0.519***	(0.07)	1.680
Taste (Very good)				0.454***	(0.09)	1.574
Attractive smell (Neutral)				0.525**	(0.20)	1.69
Attractive smell (Agree)				0.31	(0.17)	1.364
Nutritious food (Neutral)				−0.159	(0.11)	0.853
Nutritious food (Agree)				−0.137	(0.11)	0.872

Heckpoisson model	1st step (selection model)			2nd step (Poisson model)		
Variables	Coefficient		Incidence rate ratio (IRR)	Coefficient		Incidence rate ratio (IRR)
Safety concerns (Neutral)				−0.171	(0.10)	0.842
Safety concerns (Agree)				−0.206*	(0.09)	0.814
Constant	0.249	(0.26)		0.998***	(0.23)	2.714
/athrho	−0.505***	(0.14)	0.603			
/lnsigma	−0.606***	(0.05)	0.546			
rho	−0.466	(0.11)				
sigma	0.546	(0.03)				

Note: *** = p-value < 0.001; ** = p-value < 0.01; * = p-value < 0.05.

Robust standard errors are described in the parenthesis.

4.5.3.2 Factors affecting consumption frequency

In the second stage (frequency) of the Heckpoisson model, 12 elements were used to predict variables influencing the frequency of insect consumption (count data), as shown in Table 7. Income, race, family size, taste, odour, and safety concerns greatly impacted how frequently people consume edible insects. Respondents with higher incomes (≥$200) experience a 37% greater number of consumption events than those with lower incomes (<$200). Compared to other ethnic groups, Burmese people consume insects less frequently. Kayah ethnics consume them 43% less often, whereas Kachin, Rakhine, and Shan are predicted to consume 41%, 44%, and 55% more frequently than the Burmese. The annual insect consumption frequency increases by 21% when families grow from small to large, with family size significantly impacting the consumption frequency. Respondents who believe edible insects to be tasty foods are more likely to consume more edible insects than those who do not. A 68% increase in consumption frequency is found if the taste of edible insects improves from ‘normal’ to ‘good,’ while a 57% increase in consumption frequency with the decent from ‘normal’ to ‘very good.’ The frequency of insect consumption rises by 69% when the smell perception changes from ‘disagree’ to ‘neutral,’ the latter pointing at am alluring scent. Concerns about food safety also play a significant role. One scale increase in doubts about the safety of edible insects is associated with a 19% decrease in the number of insects consumed during a year.

4.6 Discussion

4.6.1 Current situation of Entomophagy

Entomophagy is common in Myanmar, with 67% of respondents eating insects. However, the proportion is quite low compared to Laos, where 97% of the population is said to be insect consumers (Barennes *et al.*, 2015). It appears that most consumers in Myanmar eat insects only occasionally rather than daily or weekly. Twenty-three varieties of edible insects were documented; among them, crickets ranked first as the preferable insect species, consistent with the findings of Spectrum (2016), while bees and bamboo worms were the second and third most popular insect species. These edible insects have also been listed as the preferred insect varieties in neighbouring countries such as Laos, Thailand, and Vietnam (Raheem *et al.*, 2019). A continuous supply of the preferred insect varieties could help increase consumption frequency.

4.6.2 Reasons for low insect consumption

Despite insect consumption is widespread in Myanmar, the question is why the consumption rates are relatively low. One reason could be the price of edible insects. Although they are not prohibitively expensive, the overall low wages and the current economic crisis may limit consumption for many people in Myanmar. Spectrum (2016) reported that insects are often considered luxury foods in Myanmar, with the price of insects having increased considerably in recent years. However, the latter does not apply to households that harvest insects in the wild for their own consumption, and one would expect low-income households to be more active in gathering nature's 'free lunch' (Dürr and Ratompoarison, 2021). Children are primarily wild insect harvesters, so the opportunity costs for those households are meagre.

Another reason for the observed low frequency of insect consumption could be seasonal availability. Barennes *et al.* (2015) mentioned the seasonal nature of edible insects makes it difficult to obtain them during the offseason. Although insects are available in almost all areas of Myanmar, they are not always available in markets or shops. Seasonality affects availability and accessibility as prices rise in the off-season. What aggravates the problem is that important insect species, such as crickets, are declining in Myanmar, partly due to over-collection and partly due to pesticide use in agriculture (Spectrum, 2020b). As a result, commercial insect harvesters must move from one location to another in search of insects, and people who used to collect insects for home consumption can no longer easily find them in their surroundings. Furthermore, we found that more than half of the people eat only one type/ species of edible insects, mostly crickets, while the rest consume two to six species. People who eat different types/ species of insects can consume insects for longer because the seasonal occurrence varies between species, while those who eat only one type/ species may not be able to eat them all year round. One potential solution would be to raise edible insects; however, insect farming is still in its infancy in Myanmar (Nischalke *et al.*, 2020).

4.6.3 Individual and household-level factors and insect consumption

Gender, age, education, and location appear to not affect the frequency of insect consumption, possibly because entomophagy is a family tradition that is often passed down from generation to generation (Nischalke, 2020). Most people eat insects in their social environment, regardless of gender, age, educational level, rural or urban location, in a society where entomophagy is widespread and is considered a normal habit. Furthermore, approximately 20% of Myanmar's total population has migrated partly due to the current political crisis (UNESCO, IOM, UNDP, 2018), implying that a possible locational effect may have become less pronounced. However, because people in rural areas typically harvest insects for their own consumption, whereas people in urban areas typically buy them, differences in insect consumption between rural and urban would be expected. Nonetheless, more research is needed to identify potential differences between rural and urban areas because of the rural-urban population's unrepresentative data. Regarding the representation of the rural-urban population, gender, age, and education level may also differ, and thus need to explore their potential causes. Although previous studies show that those factors often do not significantly affect insect consumption (Hartmann *et al.*, 2015; Manditsera *et al.*, 2018; Orsi *et al.*, 2019; Verbeke, 2015), there is no clear explanation or conclusion for those factors. The appearance of insects strongly influences men and women in Western society, with women generally showing a stronger aversion to insects than men when the insects are visible; however, this difference disappears when the insects are invisible (Lammers *et al.*, 2019; Orsi *et al.*, 2019). In our study, 74% of women were insect phobic compared to only 26% of men. Such attitudes towards entomophagy are highly important for accepting or rejecting edible insects, underlining the importance of attitude in consumer behaviour (Ajzen, 2008). People with a favourable attitude towards edible insects are more likely to eat edible insects. This is hardly surprising. However, two startling facts merit further investigation: In our sample, 60% of respondents are opposed to entomophagy, and still, half of them consume insects. Even though 82% of the Kachin consumers oppose entomophagy, both consumer percentage and consumption frequency for Kachin turned out to be higher than the national average. The observed discrepancy between negative attitudes and consumption of edible insects might be due to the growing exposure to Western societal beliefs and related aversion against entomophagy and, at the same time, widespread poverty in Myanmar where insects collected in the wild can be a cheap source of food. Negative opinions may also be related to Buddhism, where killing of insects is considered a bad habit. Yet, in Myanmar living insects are often perceived more delicious than dead ones, thus people prepare and eat live insects despite knowing their actions are considered wrong by their religion.

The fact that insects have been eaten by some ethnic groups, such as the Kachin, Kayah, and Rakhine, since the time of their ancestors, but not by the Burmese, explains the significant difference in insect consumption and frequency observed in this study as well as in others (Nischalke, 2020; Tun, 2016). In contrast, Mon ethnic is less likely to consume insects, which may be due to the fact that 32% of Mon respondents who practiced Islam said they had never tried edible insects, which might be a combination of ethnic and religious factors here. Another element could be the location of ethnic groups. People who live in border areas consume insects more frequently than Burmese people (Nischalke *et al.*, 2020), possibly because of the greater abundance of wild edible insects in these areas and the more common harvesting practises. Thus, ethnicity plays a role in insect-eating, and intake levels vary from one ethnicity to the next, but more research is needed to determine the underlying reasons for this.

Our selection model revealed a significant positive association between Buddhism and entomophagy, possibly because eating foods that others have slain is not forbidden in Buddhism (Hays, 2008), whereas in Islam, entomophagy is not entirely forbidden, but is not a traditional habit (Rahim, 2018; Tajudeen, 2020). Eating insects has generally been considered acceptable by all faiths, including Christianity, Judaism, and Islam (Terrell, 2000). We found no differences between Buddhist versus non-Buddhist insect consumers (68 vs 64%), though Muslims in Myanmar clearly consume much less insects.

The consumption frequency of edible insects is positively and significantly influenced by family size. This means that people from larger families consume insects more frequently than others due to per capita consumption. It might also be related to poverty, as poorer households often have more family members (Kyaw, 2009; MPLCS, 2017) and are more vulnerable to food insecurity. Hence, such households use insects as food more frequently. In addition, larger families may be able to collect more insects than smaller households (Dürr and Ratompoarison, 2021). However, per capita consumption might be lower as the number of consumers in the family increases.

4.6.4 Emotional factors and insect consumption

We found that insect phobia negatively affects consumption, which is consistent with findings from other studies from entomophagous and non-entomophagous countries (Cicatiello *et al.*, 2016; Hartmann *et al.*, 2015; Phonthanukitithaworn *et al.*, in press; Sogariet al., 2019a). Insect phobia is frequently associated with cultural issues and the perceived risk of such unfamiliar, novel, and unusual food (La Barbera *et al.*, 2018; Nyberg *et al.*, 2021; Sogari *et al.*, 2019b; Yen, 2009). This cultural phenomenon is more prevalent in non-entomophagous countries (Hartmann *et al.*, 2015; Moruzzo *et al.*, 2021; Sogari *et al.*, 2019a). However, in an insect-consuming country like Myanmar, at least 20% of the respondents in our study expressed insect phobia, and most were no longer insect consumers. One reason for this could be the different appearance of insects compared to other food products.

Furthermore, 'social concerns' can harm consumer acceptance of edible insects. In our study, 27% of people believe that eating insects denotes a lower social status and thus consume less. Similarly, Van Huis *et al.* (2022) in Niger observed that insects were regarded as poor men's food when living standards improved and consequently phased out of local diets. Whether this trend also exists in Myanmar is unclear; if so, promoting edible insects as healthy, nutritious, and fashionable food would be necessary to possibly counteract such a trend.

The consumption of edible insects can be associated with discomfort. On the one hand, 17% of the respondents in our study said they were hesitant to eat insects because they were concerned about them being unsanitary and containing unhealthy ingredients such as oil. Likewise, discomfort and fear reduced insect consumption frequencies by 36% in South Africa (Hlongwane *et al.*, 2021). On the other hand, 30% of people reported feeling discomfort after eating insects. Some people experience high blood pressure and/or headaches. These people generally avoid or reduce their consumption of insects. Studies in entomophagous countries such as Thailand, China, and Laos reported allergies, health problems, and other intolerance after insect consumption (Barennes *et al.*, 2015; Chomchai and Chomchai, 2018; Ji *et al.*, 2009; Taylor and Wang, 2018). However, those studies did not specify whether or not people who experienced such health issues continued to practise entomophagy.

4.6.5 Product-related factors and insect consumption

When people believe insects taste good or excellent, they are more likely to consume them. Hence, consumer preferences play an important role in the frequency of consumption in an entomophagous country like Myanmar. One of the primary motivations for consumers is the taste of insects (Barennes *et al.*, 2015; Dürr and Ratompoarison, 2021; Van Huis *et al.*, 2013). Deroy *et al.* (2015) argued that insects are not eaten out of necessity in Western countries but because they are considered delicious. Studies from Zimbabwe and the Netherlands came to the same conclusion that taste is a vital factor in determining the consumption frequency of foods (House, 2016; Manditsera *et al.*, 2018). Aside from taste, the frequency with which edible insects are consumed is influenced by smell, which, according to cricket traders, is the most convenient method of determining the freshness of insects (Spectrum, 2020b). The less smelly the insects are, the fresher they are. As a result, when people find insects to have no smell, they consume them more frequently.

We also found regarding food safety that persons concerned about chemical contaminations are more inclined to avoid higher consumption than those who are not. Consumers in Myanmar are becoming more aware of food safety, but this concept is still relatively new in the edible insect sector (Spectrum, 2021b). Nonetheless, when people believe edible insects are safe to eat, they consume more of them, underlining the importance of food safety also for entomophagy as exemplified by a study from Zimbabwe where awareness of food safety issues turned out to be one of the most vital characteristics of insect consumers (Manditsera *et al.*, 2018).

In terms of nutritional value, those who believe insects are nutritious foods are more likely to consume them. A study conducted in Zimbabwe found that three-quarters of the urban population consumed insects due to their nutritional value (Manditsera *et al.*, 2018). Yet, only 45% of our respondents regarded insects as nutritious food; there appears to be a lack of consumer knowledge in Myanmar about the nutritional benefits edible insects can have.

In our analysis 'naturalness' had no significant impact on the frequency of consumption of edible insects, although a large majority of insect consumers prefer eating wild-harvested compared to (mass-) reared insects. Wild-harvested insects currently dominate the market, and insect rearing for human consumption is still in its infancy in Myanmar (Nischalke *et al.*, 2020). Some reared insect species, such as crickets, are imported into Myanmar from neighbouring countries, though the quantities are so far rather small (Nischalke, 2020). Hence, markets generally supply, and consumers typically consume wild insects. More research is needed to better understand consumer preferences in Myanmar vis-à-vis wild-harvested and (mass-) reared insects.

4.7 Conclusions

Before concluding, we note some research limitations to better evaluate the results. First, this study did not consider the effect of price on insect consumption frequency. Second, it did not explore how people consume insects (e.g. as snacks or as part of a meal) and how they acquire them (by purchase or harvest), which might be important to better understand entomophagy in Myanmar. Third, there may be reporting bias. The proportion of Muslims and Hindus in the survey is small and most respondents are from urban areas, although in reality 70% of the population resides in rural areas. Results may differ if the sample is representative of the actual rural-urban population.

As one of Myanmar's first edible insect consumer studies, this article explored factors influencing consumer acceptance and consumption frequencies. Entomophagy is pervasive among all ethnic groups, including both urban and rural residents, and consumer acceptance of edible insects as food is moderately high. However, insects are rarely consumed, and the potential of edible insects to combat food insecurity and malnutrition remains challenging. Myanmar is rooted in malnutrition and food insecurity; regular consumption of edible insects could significantly improve the nutritional value of diets in malnourished populations. National nutrition programmes based on insects would be beneficial for promoting more frequent consumption in Myanmar. One of the key findings of this study is that social concerns, which are mentioned by Egan (2013) and Van Huis *et al.* (2022) but not investigated in any earlier studies, are crucial factors in determining insect consumption. Moreover, emotional factors, such as negative opinions, insect phobia, safety concerns, and discomfort, are major barriers to insect consumption. Providing new insect-based products or an invisible form, such as flour or a food additive, could help reduce insect phobia and discomfort. In contrast, the nutritional properties of edible insects motivate people to consume them. This emphasizes the need to educate the public about the benefits of consuming edible insects, forming a favourable opinion and reducing social concerns about insect consumption. Thus, governments and non-governmental organisations should hold public forum to raise public awareness of the environmental benefits and health benefits of consuming edible insects. In addition, the government should set good manufacturing practices for edible insect food to ensure food safety and the value chain actors should priority food safety by following laid down policies.

CHAPTER V

5. Predicting consumers' intention towards entomophagy using an extended theory of planned behavior: evidence from Myanmar

This chapter has been published as Thu Thu Aung *et al*. (2023) International Journal of Tropical Insect Science

https://doi.org/10.1007/s42690-023-01016-4

5.1 Abstract

The concept of entomophagy—consuming insects as food—has become particularly important from the perspective of food security. Myanmar is an entomophagous country, but where chronic malnutrition problems persist. A lack of research into the topic of entomophagy in Myanmar makes it difficult to understand people's behavior regarding edible insects as food, as well as their motives and aversions. As this knowledge gap emphasizes the need for consumer studies of edible insects in Myanmar, this study examines the factors affecting consumers' intention to eat insects. The model used is based on the theory of planned behavior, extended by the variable environmental concern. Data collection was conducted through telephone interviews, acquiring 872 respondents. Structural equation modelling analysis was performed to predict the influence factors on consumption intention towards edible insects. Results revealed that participants' consumption intention was low and primarily influenced by attitude, subjective norm, perceived behavioral control, and environmental concern. Only four out of ten factors had moderating effects on consumption intention, mainly the administrative division, urban or rural location, educational level and ethnic groups. These results are useful for further developing the insect sector in Myanmar, and especially for creating more public awareness of the benefits of eating insects as well as promoting a more positive attitude and possibly leading to an increase in consumption intention. A gradual shift from mere collection to insect farming would improve all year availability of edible insects and reduce the difficulties of consumers accessing edible insects. Consequently, edible insects can assist in achieving the nutrition policy's objective of reducing all types of malnutrition by making it easier for all people, at all times of the year, to acquire nutritious food at an affordable price.

5.2 Introduction

Entomophagy that is, consuming insects as food (Chakravorty *et al*. 2011; Moruzzo *et al*. 2021), has become an increasingly popular topic globally due to its potentially positive effects on food security, nutrition, and the environment (Woolf *et al*. 2019). As edible insects are rich in protein, unsaturated fats, vitamins, minerals, and dietary fiber, consuming them as food can greatly benefit the health of consumers if they are appropriately handled and eaten and thereby contribute to improved food and nutritional security (Belluco *et al*. 2013; Kinyuru *et al*. 2015; Tang *et al.* 2019). The nutritional composition of edible insects varies greatly depending on the species, life stage, habitat, and diet of the insects (Ghosh *et al*. 2017; Shah *et al.* 2022; Skotnicka *et al*. 2021; Tuhumury 2021). Compared to conventional livestock, edible insects have more benefits from an environmental perspective, as they require less water and soil and emit lower greenhouse gases and ammonia while producing a higher percentage of edible mass (Dagevos 2021; Lange and Nakamura 2021; Van Huis and Oonincx 2017).

Due to the abovementioned benefits, there is a growing demand for edible insects in developed countries that are not traditionally entomophagous (GMI 2020; IPIFF 2020). The value of the insect market has risen substantially from 33 million USD in 2015 to 55 million USD in 2019 in ten countries, including the United States, Brazil, and Mexico from the Americas; the United Kingdom, Netherlands, France, and Belgium in Europe; and China, Thailand, and Vietnam in Asia, and the market size is projected to further increase dramatically to 710 billion USD in 2026 (Ahuja and Mamtani 2020). As edible insects are popular on the world market and have created new income activities, numerous studies have examined their consumption and its determinants in recent years (Liu *et al*. 2020; Hwang and Kim 2021; Mancini *et al*. 2019; Moruzzo *et al.* 2021; Omemo *et al*. 2021; Orsi *et al*. 2019; Vartiainen *et al.* 2020; Woolf *et al*. 2019). However, the majority of this research was undertaken in developed nations where edible insects are considered a novel food, and only a few studies were conducted in traditional entomophagous countries where malnutrition is often chronic, such as for example Nigeria and Madagascar (Ancha *et al*. 2021; Dürr and Ratompoarison 2021; Meysing *et al*. 2021).

Malnutrition is still a significant problem for people in the developing world (Müller and Krawinkel 2016). In 2019, approximately 687.8 million people worldwide suffered from malnourishment (Szmigiera 2021). About half of all avoidable deaths in children under five are caused by malnutrition (Bread for the world 2021). In developing countries, most people are poor and can only afford low-quality diets that contribute to all forms of malnutrition (Lartey *et al*. 2018; Siddiqui *et al*. 2020). Consequently, these countries suffer the greatest productivity losses due to malnutrition, causing a significant negative impact on their economies. Yet, nutrition is one of the most cost-effective ways to solve malnutrition and its consequences problems (Shekar *et al*. 2016). To address the nutritional requirements of poor people in developing countries, affordable, high-quality foods are needed (Bhargava 2015). Insects are a low-cost, high-quality, and nutritious food (Tang *et al*. 2019). Thus, edible insects may be a viable solution for traditional entomophagous countries where malnutrition persists. Meysing *et al*. (2021) pointed out that in countries with conventional insect-eating habits where chronic malnutrition is prevalent, the people's insect consumption behavior needs to be urgently examined.

Myanmar is one of such entomophagous countries where about 30% of children under five encounter chronic malnutrition problems (USAID 2018). About 45% of deaths below five years of age are caused by various types of malnutrition (UNICEF 2014). According to Robertson *et al*. (2018), Myanmar suffers from both micronutrient and macronutrient deficiencies, such as protein–energy malnutrition (PEM). According to the United Nations Children's Fund (UNICEF) definition, PEM is a hidden danger, similar to the tip of an iceberg, with dreadful ramifications that can go unnoticed (Grover and Ee 2009). Thus, PEM must be addressed to mitigate its consequences. According to the Myanmar Non-Governmental-Organization (NGO) Spectrum (2021a), edible insects are nutritious food and have the potential to substantially contribute to reducing malnutrition in the country. However, even though insects have a place in the diet of some ethnicities — mainly from mountainous areas, such as Kayin, Chin, Kachin, Shan, and others (Linn *et al*. 2016) — entomophagy is uncommon among urban dwellers of Myanmar's central area (Nischalke *et al*. 2020). Moreover, the indigenous insect-eating culture has vanished from a number of traditionally entomophagous countries (Barennes *et al*. 2015; Mitsuhashi 1997; Pambo *et al*. 2018). Despite entomophagy has a long history in the country, still, there are no laws or restrictions on eating or collecting insects. The general lack of information on insect consumption in Myanmar poses uncertainty as to whether traditional insect consumption is disappearing in the country, emphasizing the need for consumer studies of edible insects in Myanmar. Thus, we intended to explore people's behavior towards entomophagy and the factors that may attract or dissuade them from consuming insects as a substitute for conventional livestock and to understand the prospects of entomophagy in Myanmar by addressing the following research questions:

1. What is the current status of entomophagy in Myanmar?
2. What is the consumption intention towards edible insects, and its influencing factors?

5.3 Theoretical framework and derivation of hypotheses—Literature insights

5.3.1 Theory of planned behavior as a theoretical framework

Various scholars have developed different models and theories to understand food consumption behavior. Among the vast array of theories and models found in the field of consumer behavior studies regarding food consumption, the Theory of Reasoned Action (TRA), Theory of Planned Behavior (TPB), and Norm Activation Model (NAM) are common. However, NAM is developed to predict pro-social or pro-environmental behavior (Zhu *et al.* 2022), and current research is mainly interested in consumption intentions, not pro-environmental behavior. Thus, TRA and TPB are better options than NAM for this study. However, the basic idea of TRA is to explain behavior under the complete volitional control of the consumer and when dealing with persons who cannot exercise volitional control, the theory of reasoned action encounters some obstacles (Ajzen 1991; Fishbein and Ajzen 1990; Madden 1992). As this research is not restricted to examining behaviors only under complete volitional control, the TPB seemed to be the most appropriate model. Additionally, the results of the TPB research can be easily used to make interventions (Dunn 2008; Pambo 2018). Because of these considerations, TPB was selected as the study's primary theoretical foundation.

The TPB, developed by Ajzen in 1985 (Ajzen 1985), is one of the most frequently applied and tested models in predicting human behavior (McEachan *et al*. 2011) and is prominent in the behavioral intention studies on edible insect consumption (Mancini *et al*. 2019; Menozzi *et al.* 2017). It was originally an extended model of the TRA but modified by adding perceived behavioral control derived from self-efficacy theory to predict behavior more accurately under incomplete volitional control (Ajzen 1991; Madden 1992). It is "a full-fledged social psychology theory" that can predict human behavior (Zhang, 2018, p. 1). According to Ajzen (1991), the TPB accurately predicts behavior intention with the help of attitude (ATT), subjective norm (SN), and perceived behavioral control (PBC). ATT, the first component of the TPB, indicates a person's optimistic or pessimistic view of something or someone. The second component, SN, refers to the social influence of the surrounding people on an individual in doing something. The third component, PBC, relates to an individual's ability to do something. In this theory, ATT is guided by behavior beliefs that refer to a person's belief about the effects of a particular behavior (Arafat and Mohamed Ibrahim 2018). One of the main advantages of TPB is that it is flexible enough to incorporate additional constructs into the model; some researchers developed their research models by combining relevant factors adopted from different contexts pertinent to their situation to enhance and improve the predictive ability of the specific models (Bae and Choi, 2020; Hwang and Kim, 2021; Vartiainen *et al*., 2019). One of the limitations is that it is impossible to investigate the direct influence of other factors such as socio-demographic, on behavior in the absence of TPB constructs because the unique idea behind the TPB was that other elements, such as socio-demographic characteristics, should influence behavior through the components of TRA and TPB, such as attitudes, subjective norms, perceived behavioral control and intention. In other words, those factors should have indirect rather than direct effects on behavior (Shepherd and Raats, 1996).

5.3.2 Application of the TPB to consumption intention of edible insects

The growing importance of entomophagy has drawn the attention of many researchers, who have studied its potential as food from several different perspectives (Chomchai and Chomchai 2018; Egan 2013; Pambo *et al*. 2016; Sogari *et al*. 2018; Videbæk and Grunert 2020). Edible insect studies applied the TPB when predicting either consumer intention or actual behavior in entomophagous and non-entomophagous countries (Brekelmans 2016; Hwang and Kim 2021; Lucchese-Cheung *et al*. 2020; Pambo *et al*. 2016). Thus, a literature overview containing a summary of research papers on entomophagy using the TPB was performed to refine our hypothesis. Table 1 lists the previous studies of edible insect consumer behavior that used TPB worldwide. It includes the countries, sample sizes, measured constructs, the focus of the study, and the significant predictors of each study.

The majority of the studies were conducted in Western societies, non-entomophagous countries (Brekelmans 2016; Lucchese-Cheung *et al*. 2020; Mancini *et al*. 2019; Menozzi *et al*. 2017; Navarré 2017; Vartiainen *et al*. 2020); with a small number of studies conducted in traditionally entomophagous countries (Bae and Choi 2020; Chang *et al.* 2019; Hwang and Kim 2021; Pambo *et al.* 2018). However, to the best of our knowledge, no consumer study focuses on Myanmar. While some of the studies only included the original constructs of the TPB—namely ATT, SN, and PBC (Brekelmans 2016; Menozzi *et al*. 2017; Navarré 2017)—other studies added new constructs, such as ascribed responsibility (Choe *et al*. 2020), phobia (Bae and Choi 2020), the interaction of self-identity and familiarity (Pambo *et al*. 2018), environmental concern (Chang et al. 2019), and safety (Vartiainen et al. 2020).

All these studies proved the applicability of TPB in the context of edible insect research. Moreover, the openness of adding factors to TPB components inspired us to use an extended version of the TPB. Thus, applying the TPB to the case of entomophagy in Myanmar led to the hypotheses outlined below.

Table 1: Summary of the worldwide studies of edible insects using the TPB.

Authors	Country	Sample size	Measured constructs	Depend. Variables	Significant predictors	Main findings
Hwang and Kim (2021)	South Korea	440	BB, OE, NB, MC, CB, PP, SA, SN, PBC, BI, PK (as moderator)	BI	BB, OE, NB, MC, CB, PP, SA, SN, PBC	BI was significantly influenced by SA, SN, and PBC. BB and OE have effects on SA, NB and MC have effects on SN while CB and PP have effects on PBC. PK moderated the relationship of SN and BI.
Diaz *et al.* (2021)	Colombia	100	ATT, SN, PBC, PU, PEOU, BI	BI	SN	Only SN had a significant effect on BI.
Bae and Choi (2020)	South Korea	390	ATT, SN, PBC, FN, EXP, BI	BI	ATT, SN	BI was significantly influenced by ATT and SN.
Choe *et al*. (2020)	South Korea	439	ATT, SN, PBC, PN, EA, AR, BV, EC, PE, BI	ATT, PN, BI	ATT, SN, PBC, PN, EA, AR, BV, EC, PE	SN plays a role in shaping ATT. EA, AR, BV, EC, and PE positively impacted PN. ATT, SN, PBC, and PN were all found to shape BI.

Authors	Country	Sample size	Measured constructs	Depend. Variables	Significant predictors	Main findings
Lucchese-Cheung *et al*. (2020)	Brazil	404	ATT, SN, PBC, TRT, PR, SDE, CI	CI	SN, PBC	SN had a negative impact on CI, while PBC had a positive impact on CI.
Vartiainen *et al*. (2020)	Finland	564	ATT, SN, PBC, GEN, CI	CI	ATT, SN, PBC	ATT showed the significantly largest influence on CI, followed by SN and PBC.
Chang *et al*. (2019)	Taiwan	316	ATT, SN, PBC, FN, EC, PI	PI	ATT, PBC, FN	ATT, PBC, and FN significantly influenced PI.
Mancini *et al*. (2019)	Italy	165	FN, IFR, PBC, CI	CI	FN, PBC, IFR	PBC was the most critical factor in determining CI, followed by FN and IFR.
Pambo *et al*. (2018)	Kenya	432	ATT, SN, PBC, ISIF, CI	CI	ATT, SN, PBC, ISIF	CI was significantly influenced by all constructs — ATT, SN, PBC and ISIF.
Menozzi *et al*. (2017)	Italy	231	ATT, AB, SN, PBC, CI	AB, CI	ATT, PBC, CI	CI was significantly influenced by ATT and PBC, whereas AB was influenced by CI and PBC.
Navarré (2017)	Spain	300	ATT, SN, PBC, CI (FN as moderator)	CI	ATT, SN, PBC, FN	CI was affected by ATT, SN, and PBC. FN moderated the link between SN and CI.

Authors	Country	Sample size	Measured constructs	Depend. Variables	Significant predictors	Main findings
Brekelmans (2016)	Netherlands	151	ATT, SN, PBC, CI	CI	ATT, SN, PBC	All constructs — ATT, SN, and PBC, had a significant effect on CI.

Note: ATT = Attitude, AB = Actual behavior, AR = Ascribed responsibility, BB = Behavior belief, BI = Behavioral intention, BV = Biospheric value, CB = Control belief , CI = Consumption intention, EA = Environmental awareness, EC = Environmental concern, EXP = Experiences, FN = Food neophobia, GEN = Gender, IFR = Insect food rejection, ISIF = Interaction of self-identity and familiarity, MC = Motivation to comply, NB = Normative belief, OE = Outcome evaluation, PBC = Perceived behavioral control, PE = Perceived effectiveness, PEOU = Perceived ease of use, PI = Purchase intention, PK = Product knowledge, PN = Personal norms, PP = Perceived power, PR = Perceived risk, PU = Perceived usefulness, SA = Sustainable attitude, SDE = Social demographic and economic, SN = Subjective norm, TRT = Trust.

5.3.2.1 Consumption Intention

Consumption intention (CI) is an individual's willingness to carry out the specific behavior that would typically occur before the actual behavior and, thus, is the best indicator of the particular action that happens (Ajzen 1991). Based on these definitions, consumption intention in this study refers to an individual's willingness to consume edible insects in the future.

5.3.2.2 Attitude

An attitude (ATT) can be defined as a relatively static opinion of a person towards something or somebody (Solomon 2009). According to Ajzen (1991), it is one of the main indicators of behavioral intention. Attitude in this study refers to an individual's general positive or negative opinion towards edible insects. The effect of ATT on intention was tested in various edible insect studies (Chang *et al*. 2019; Menozzi *et al*. 2017; Navarré 2017; Pambo *et al.* 2018; Vartiainen *et al*. 2020). These studies proved that ATT towards insect-based food significantly influences CI. Hence, we postulated the following hypothesis:

H_1: Positive ATT towards entomophagy positively affect the CI for edible insects.

5.3.2.3 Subjective norm

Subjective norm (SN) can be defined as the perceived social pressure or influence on an individual's particular action from the people who have a close relationship with them (Ajzen 1991); one's attitudes are influenced by people like friends and family (Singh and Verma 2017). In the field of edible insects, researchers examined the effect of SN on behavior intention. Navarré (2017) demonstrated that SN positively affects consumption intention towards insect-based foods, which was further corroborated by Bae and Choi (2020), who additionally revealed that SN significantly influences behavioral intention towards edible insect food. Chang (2013) proved a significant causal relationship between SN and ATT. Moreover, a study of consumers' ATT towards functional yoghurts in Vietnam verified that SN could influence consumers' ATTs (Nguyen et al. 2020). Hence in our study, we tested for both a direct and indirect effect through an ATT of SN on CI with the following hypotheses:

H_2: Positive SN regarding entomophagy positively affect the CI for edible insects.

H_3: Positive SN regarding entomophagy positively affect the CI for edible insects via ATT.

5.3.2.4 Perceived behavioral control

There are circumstances in which individuals may not have complete voluntary control over their actions; consequently, perceived behavioral control (PBC) becomes an essential factor of intention as per the TPB (Ajzen 2002). It refers to individual control over performing the behavior (Ajzen 1991) and combines perceived difficulty and controllability. The former refers to a person's perception of how easy or difficult it is to carry out a specific behavior. In contrast, the latter refers to the degree to which individuals can control their performance (Ajzen 1985, 2002, 2008, 2011). Edible insect researchers studying the importance of PBC in predicting intention all proved that it significantly impacts consumption intention towards edible insect foods (Brekelmans 2016; Hwang and Kim 2021; Lucchese-Cheung *et al*. 2020; Mancini *et al*. 2019; Menozzi *et al*. 2017; Navarré 2017; Pambo *et al.* 2018; Vartiainen *et al.* 2020). This led us to the following hypothesis:

H_4: A high PBC regarding entomophagy positively affects the CI for edible insects.

Although TPB is broadly applied, some researchers suggested adding more constructs to it due to its low predictive ability with the above-discussed three original constructs (Karimy *et al*. 2015; Wang *et al*. 2016). There are some criteria for including additional elements in theory. The added variables should (1) be behavior-specific, (2) be the determinants of intention and behavior, (3) be independent of the existing three factors, (4) apply to a variety of behaviors, and (5) be part of the theory, and help to increase the estimation of intention or behavior (Fishbein and Ajzen 2011).

One relevant factor determining consumers' intention to consume edible insects in studies conducted in Asia by Choe *et al*. (2020) and Chang *et al*. (2019) included environmental concern. Unlike in developed countries, in Myanmar, edible insects are mainly harvested from nature, raising environmental concerns. According to Choe *et al*. (2020), a person with a greater degree of environmental concern might believe that humans are gravely abusing the environment in many ways. One of the main reasons for entomophagy's global re-emergence is that it is generally believed to cause little to no harm to the environment (Guiné *et al*. 2021; Imathiu 2020). However, according to Spectrum (2021b), wild harvesting of edible insects may endanger wild populations and severely affect the environment and society in Myanmar. Thus, environmental concern is assumed to be an important factor, but it is unclear in which direction they influence the CI. Hence, the TPB was modified by additionally integrating environmental concerns.

5.3.2.5 Environmental concern

Having environmental concern (EC) means realizing the harmful impacts of human actions on the environment (Kollmuss and Agyeman 2002), and was used in food studies as an additional construct to the TPB model (Basha *et al*. 2015; Fleseriu *et al*. 2020). For instance, a study on eco-friendly packaged products in India revealed that EC significantly affects buying intention (Prakash and Pathak 2017). Yet, a survey in Romania with consumers of organic products EC significantly impacted attitude, not the intention (Fleseriu *et al*. 2020). Although EC has become a pressing issue worldwide, edible insect studies that used the TPB as a basic model paid little attention to this factor. Chang *et al*. (2019) used EC as additional TPB constructs but found no impact of them on buying intention of edible insects in Taiwan. Similar studies from developing countries have not addressed the effect of EC on the CI of edible insects. As insect consumption in Myanmar is largely dependent on wild collections, we tested the effect of EC with the following two hypotheses:

H_5: High EC has a negative direct effect on the CI for edible insects.

H_6: High EC has a negative indirect effect on the CI for edible insects via ATT.

5.3.2.6 Background factors (moderators)

According to Wassmann *et al*. (2021), most edible insect studies neglected to test the moderating effects of factors such as age and education. Although organic food studies and other studies usually tested the moderating effect of different factors in the relationship between TPB constructs and intention (Asif *et al.* 2018; Saleki *et al*. 2021; Tandon *et al.* 2020; Tarhini 2013; Wang *et al*. 2019), only a few edible insect studies have considered moderating variables (Hwang and Kim 2021; Navarré 2017). Hwang and Kim (2021) tested the moderating effect of product knowledge in the relationship of all TPB constructs on behavioral intention to use edible insects in restaurants. Product knowledge moderated the relation of subjective norms and behavioral intentions but not the other constructs.

A moderating variable, or moderator, is a factor that moderates the influence of an independent variable on a dependent one, which is termed the moderator effect (Edwards and Lambert 2007; Hair Jr *et al.* 2015; Preacher *et al.* 2007). According to Memon *et al*. (2019), a compelling reason for a moderation analysis can be the contradictory effects of independent variables on a dependent one. The effects of individual factors in edible insect studies have revealed inconsistent findings. For instance, Vartiainen *et al*. (2020) found that individuals from a Western society with higher education were more likely to consume edible insects, contradicting findings from studies in other Western countries (Hartmann *et al*. 2015; Tan *et al*. 2017). Although in Western countries, men are more likely to consume edible insects than women (Castro and Chambers 2019; Menozzi *et al*. 2017), in some entomophagous countries such as China, women consume more insects (Castro and Chambers 2019), though in others like Korea or Ethiopia not (Ghosh *et al*. 2020). Similarly, other sociodemographic factors, such as age, caused differing results on insect consumption even within the same country (Hlongwane *et al*. 2021). These contrasting findings stress the need for moderating analyses of sociodemographic factors. Thus, we tested the effect of background factors such as gender, age, education, income, location, administrative division, ethnicity, religion, family size, and experience with insect consumption on intention to consume edible insects using the following hypotheses:

- H_{7a}: Background factors moderate the relationship between ATT and CI for edible insects.
- H_{7b}: Background factors moderate the relationship between SN and CI for edible insects.

H_{7c}: Background factors moderate the relationship between PBC and CI for edible insects.

Figure 1 shows the conceptual framework of the study.

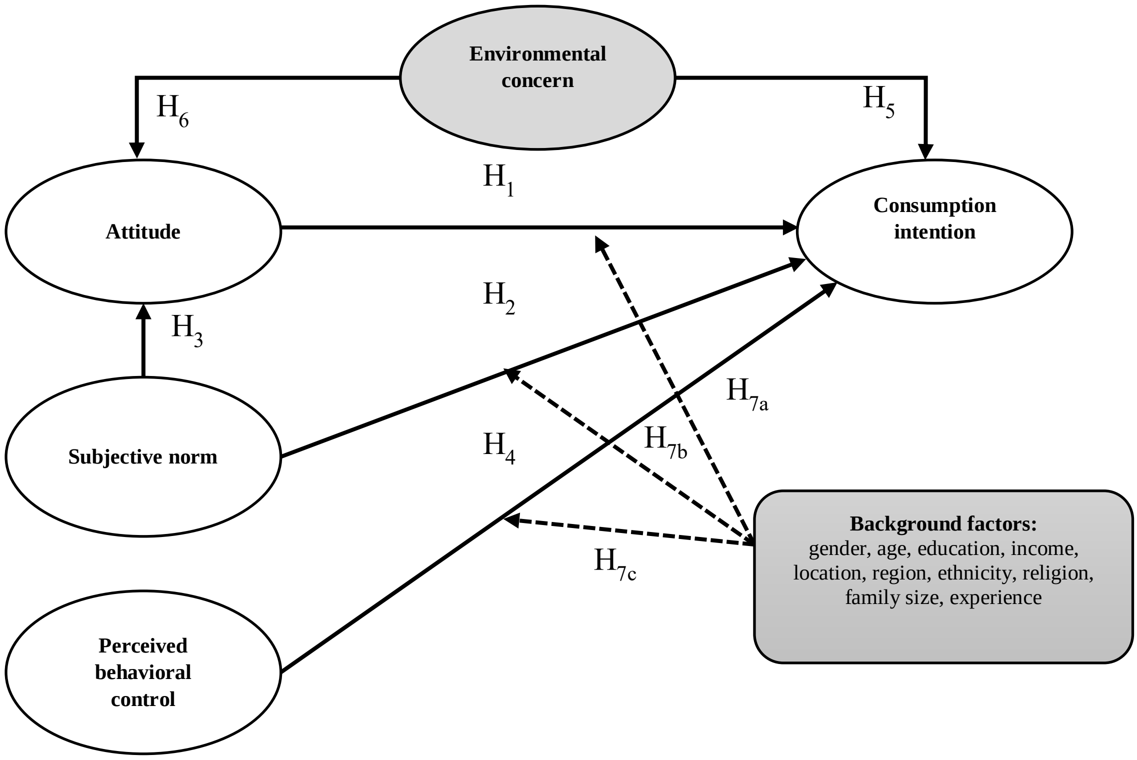

Figure 1: Conceptual framework for testing hypotheses (modified after Ajzen (2002)).

5.4 Material and measures

5.4.1 Measures

In order to test the hypothesized model presented in figure 1, we used a Structural Equation Modelling (SEM) approach. Each of the five latent constructs (ATT, SN, PBC, EC, and CI) was reflectively measured with three indicators, utilizing a 5-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree). The indicators for the constructs were adapted from scales used in previous research and slightly adjusted to the context of our study (Table 2). The items to measure the constructs ATT and PBC were adapted from Wang *et al*. (2019), referring to the studies of Ajzen (2002) and Asif *et al*. (2018). Chang *et al*. (2019) cited the study of Dunlap and Van Liere (1978) as the source for the items used to measure CI and EC. An adapted scale from Vartiainen *et al*. (2020) was used to measure SN.

Table 2: Description of questionnaire structure and supporting literature.

Latent variable	Indicators
Consumption intention (CI)	CI-1: I plan to eat edible insects in the next three months. CI-2: I intend to consume edible insects in the next three months. CI-3: I am willing to recommend others to consume edible insects.
Attitude (ATT)	ATT-1: I am interested in eating edible insects. ATT-2: I think that consuming edible insects is a good idea. ATT-3: I think that consuming edible insects is beneficial.
Subjective Norm (SN)	SN-1: People I respect would consume edible insects. SN-2: People close to me probably find edible insects as food enjoyable. SN-3: People important to me wouldn't mind if I consumed edible insects.
Perceived Behavioral Control (PBC)	PBC-1: Whether or not I consume edible insects within the next months is completely up to me. PBC-2: I am confident that if I wanted, I could consume edible insects within the next months. PBC-3: For me, to consume edible insects within the next months is easy.
Environmental concern (EC)	EC-1: Mankind is severely abusing the environment. EC-2: Humans must live in harmony with nature in order to survive. EC-3: When humans interfere with nature, it often produces disastrous consequences.

5.4.2 Survey design and data collection

The items and questions used in the survey were translated from English into Burmese and back-translated into English with the help of a translator to check whether the concept and linguistics were identical. The questionnaire included two parts: part one was related to background factors, and the other was for measuring TPB constructs.

Data were collected by telephone surveys between March 2021 and June 2021 with citizens of Myanmar. As there are no official lists of cell phone numbers in Myanmar, a random sample of cell phone numbers were generated for conducting the telephone survey. The cell phone numbers in Myanmar usually have eleven digits: the first two digits, "09," are a prefix for all cell phones, the third digit is the cell operator code, and the following three are used to identify the region. The remaining five digits were added randomly. In total, 18,694 cell phone numbers were dialed.

Of the contact numbers, 68% were invalid, unavailable, or not yet installed; 14% of the contacted were unwilling to participate in the interview, 13% did not answer the phone call, and only 5% agreed to participate. Among these 949 volunteers, 53 respondents refused to answer more than half of the questions. Thus, finally, collected data from 897 respondents were entered into an SPSS worksheet.

5.4.3 Data analysis methods

The characteristics of the respondents and the main measures were described through descriptive statistics and SEM using SPSS 25 and AMOS 24. Structural Equation Modelling is a multivariate tool incorporating confirmatory factor analysis (CFA) and path analysis into a single framework for testing hypotheses about the interactions between factors (Altikriti and Anderson 2020; Hasman 2015). Confirmatory factor analysis was conducted to validate that the SEM met the requirements of validity and reliability (Awang 2014). After assessing the measurement model's validity, reliability, and model fitness, the model fitness of the SEM was tested, and causal effects were analyzed using path analysis. Path analysis determines the structural relationships between observed and unobserved factors (Altikriti and Anderson 2020).

After that, the moderating effects of background factors on the SEM were examined using multi-group moderation analysis because Ajzen and Albarracin (2007) acknowledged the indirect effect of background factors on behavior via attitude, subjective norm, and perceived behavioral control. Moderating analysis determines whether or not two constructs have the same relationship across different groups (Memon *et al*. 2019). Thus, in this analysis, each background factor was divided into two groups; after that, the identical model was evaluated for each group to explore the significant differences between the two groups by performing pairwise comparisons across the models.

5.5 Results

5.5.1 Sample description and descriptive results

The number of participants in the final dataset was reduced from 897 to 872 after inaccurate or incomplete data were removed. This data covers Myanmar's all areas and represent the whole country (OSF Appendix 1 and 2).

In Myanmar, there are 15 administrative divisions; the areas where the country’s largest ethnic group, the Burmese, reside are referred to as regions. On the other hand, the areas inhabited by other ethnic groups—namely the Kachin, Kayah, Kayin, Chin, Mon, Rakhine, and Shan—are referred to as states. Briefly, in regions, the Burmese are a majority, while other ethnicities are minorities; in states, it is the reverse. Hence, the collected data included all ethnic groups.

As presented in table 3, the majority (71%) of respondents lived in regions, whereas the rest lived in states. One-third of them were rural residents, and two-thirds were urbanites. The sample comprised an almost equal ratio of males to females and of age groups (the latter in terms of under 30 and over 30 years old). About 85% of respondents earned less than 200 USD per month, while 15% earned more than this. The respondents' education level was high, with 68% having a university education. The majority (68%) were Burmese, whilst 32% belonged to other ethnic groups. In terms of religion, about 88% were Buddhist, and the remaining 12% were composed of Christians (9%), Hindus (1%), and Muslims (2%). Concerning family size, most (74%) of the population came from a family of four or more members.

Except for gender and consumption experience, there is no variance in the mean values of CI indicators among groups of each background factor. Consumption intention slightly varied by gender and strongly by consumption experience, with women having lower response rates than men. People who had eaten insects in the past had a mean CI-1 and CI-2 score of 3.5, indicating that they intend to eat insects again within the next three months. However, given that their responses had a mean CI-3 value of 3.0, they were unsure if they would advise others to eat insects. While those who had not eaten insects gave answers in the range of 2.1–2.2, indicating that, on average, there was no intention to eat insects nor to suggest them to others. For all other background factors, the means of CI-1 ranged from 3.1 to 3.3, whereas those of CI-2 and CI-3 ranged from 3.0 to 3.2 and 2.5 to 2.9, respectively. As the mean response level leaned towards neutral, overall, there was uncertainty about whether to eat insects in the next three months or to recommend this.

Table 3: Responses to consumption intention indicators by participants' background factors.

Background factors		Total respondents		Mean		
		Frequency	%	CI-1	CI-2	CI-3
Administrative division	States	256	29%	3.1	3.1	2.8
	Regions	616	71%	3.1	3.1	2.7
Location	Rural	290	33%	3.2	3.1	2.8
	Urban	582	67%	3.1	3.1	2.7

Gender	Female	445	51%	3.0	2.9	2.7
	Male	427	49%	3.3	3.8	2.8
Age	Young ≤ 30	427	49%	3.1	3.1	2.7
	Others > 30	445	51%	3.2	3.1	2.8
Income	Low (< 200 USD)	739	85%	3.1	3.1	2.7
	Others (≥ 200 USD)	133	15%	3.2	3.1	2.8
Education	≤ High school	280	32%	3.2	3.1	2.9
	University level	592	68%	3.1	3.1	2.7
Ethnicity	Burmese	590	68%	3.1	3.0	2.7
	Others	282	32%	3.3	3.2	2.9
Religion	Buddhism	770	88%	3.1	3.1	2.8
	Others	102	12%	3.2	3.0	2.5
Family size	Small (≤ 3 members)	231	26%	3.1	3.1	2.7
	Others (> 3 members)	641	74%	3.2	3.1	2.8
Consumption experience	Yes	630	72%	3.5	3.5	3.0
	No	242	28%	2.2	2.1	2.2

Note: 1= Strongly disagree, 2 = Disagree, 3 = Neutral, 4 = Agree and 5= Strongly agree.

5.5.2 Distribution percentages of Likert scale responses for all indicators

Even if more than 70% of respondents had tried edible insects, their CI was not high, with the means of items ranging from 2.7 to 3.1 (Table 4). As respondents tended to the neutral answer, they were either uncertain or undecided in their statements. The same held true for AAT, SN, and PBC. The mean values of all indicators ranged from 3.1 to 3.4, but participants' responses to the indicators of EC leaned towards the agreement, with the means of items ranging from 4.1 to 4.3.

Table 4: Distribution percentages of Likert scale responses for all indicators.

Indicators	Mean	Standard Deviation	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly agree (5)
ATT-1	3.3	0.98	3%	25%	15%	54%	4%
ATT-2	3.1	0.91	2%	28%	32%	35%	2%
ATT-3	3.2	0.88	2%	23%	32%	41%	2%
SN-1	3.4	0.84	2%	14%	30%	51%	2%
SN-2	3.4	0.85	2%	12%	30%	50%	5%
SN-3	3.1	0.83	3%	18%	47%	29%	2%
PBC-1	3.3	0.94	4%	16%	26%	50%	4%
PBC-2	3.1	0.92	4%	24%	30%	41%	2%
PBC-3	3.1	0.88	3%	22%	36%	37%	2%
EC-1	4.1	0.64	0%	3%	8%	68%	21%
EC-2	4.3	0.51	0%	0%	2%	65%	33%
EC-3	4.3	0.57	0%	0%	6%	60%	34%
CI-1	3.1	1.05	6%	26%	22%	42%	5%
CI-2	3.1	1.06	7%	25%	25%	37%	6%
CI-3	2.7	0.93	7%	37%	33%	22%	2%

5.5.3 Confirmatory factor analysis

As a first step, a CFA was conducted to validate that the model met the requirements. As shown in Table 5, the factor loadings of each indicator were > 0.5, after eliminating SN-3. Cronbach's alpha and composite reliability (CR) results were between 0.74 to 0.89; thus, all constructs in this study had good internal consistency. Moreover, the average variances extracted (AVE) result ranged from 0.51 to 0.74, meaning the model achieved convergent validity. And also √ AVE was greater than the correlation for each pairwise construct (off-diagonal), so discriminant validity was given.

Table 5: Analysis results of confirmatory factor analysis.

Factors	Items	Factor loadings	Reliability		Convergent validity	Discriminant validity				
			Cronbach's α	CR	AVE	ATT	SN	PBC	EC	CI
Attitude (ATT)	ATT-1	0.83	0.82	0.82	0.61	**0.78***				
	ATT-2	0.80								
	ATT-3	0.70								
Subjective norms (SN)	SN-1	0.83	0.88	0.80	0.67	0.44	**0.82***			
	SN-2	0.81								
Perceived behavioral control (PBC)	PBC-1	0.83	0.86	0.86	0.67	0.15	0.20	**0.82***		
	PBC-2	0.80								
	PBC-3	0.82								
Environmental concern (EC)	EC-1	0.58	0.74	0.76	0.51	0.05	0.01	-0.04	**0.72***	
	EC-2	0.83								
	EC-3	0.73								
Consumption intention (CI)	CI-1	0.95	0.80	0.89	0.74	0.67	0.40	0.20	-0.06	**0.86***
	CI-2	0.98								
	CI-3	0.62								

Note: *Diagonal cell in bold is √ AVE;

thresholds: factor loadings > 0.50, Cronbach's alpha and CR > 0.70 and AVE > 0.50.

The fit indices for the model, including all indicators, showed that x^2/df was 3.58, thus above the acceptable value of 3. The model with the exclusion of SN-3 resulted in an acceptable range for good model fit based on Kline (2016), as shown in Table 6. In sum, the CFA findings indicate that the measurement models were valid for processing the path analysis (structural model).

Table 6: Fit indices of the measurement model.

Model Fit Indices	Including all items	After deleting SN3	Thresholds [a]
Chi-square; p-value	286.452; < 0.001	191.77; < 0.001	> 0.05
Goodness of fit index (GFI)	0.96	0.97	> 0.90
Root means square error of approximation (RMSEA)	0.05	0.05	< 0.08
Minimum discrepancy per degree of freedom (x^2/df)	3.58	2.86	< 3.00
Adjusted Goodness of fit index (AGFI)	0.94	0.95	> 0.80
Comparative fit index (CFI)	0.97	0.98	> 0.90
Normed fit index (NFI)	0.96	0.97	> 0.90
Tucker Lewis index (TLI)	0.96	0.97	> 0.90

Note: [a] acceptable values are based on Kline (2016).

5.5.4 Structural equation model

The results of the overall goodness-of-fit of the hypothesized structural model showed acceptable to good results, with χ^2 = 194.13, df = 68, p < 0.001, χ^2/df = 2.86, RMSEA = 0.05, AGFI = 0.95, CFI = 0.98, NFI = 0.97 and TLI = 0.97.

Five out of six hypotheses were not rejected, as shown in Figure 2. The unstandardized coefficient is shown with the standardized coefficient in parenthesis. Significant standardized coefficients below 0.1 are classified as small (S), between 0.1 and 0.2 as medium (M), and above 0.2 as large (L) (Mehmetoglu and Jakobsen 2017). ATT towards eating edible insects had a significant positive influence on the CI of edible insects (*b* = 0.75, p < 0.001) and was the highest predictor for the CI. It also mediated the relationship between SN and CI. There were significant moderate positive effects of SN (*b* = 0.15, p < 0.01) and PBC (*b* = 0.13, p < 0.01). EC had a negative effect on CI (*b* = -0.23, $p < 0.01$), but the effect was small. Briefly, CI was significantly influenced by all four constructs, with a $R^2 = 0.469$; TPB constructs—namely ATT, SN, PBC, and the additionally included construct EC —explained 47% of the variation in CI to eat edible insects, which according to Chin and Newsted (1998) reflects a model with moderate explanatory power.

5.5.5 Multi-group moderation analysis

The moderating effects of ten background factors were examined using multi-group moderation analysis to analyze the variations between the same model for diverse groups. Each background factor was divided into two groups. Each factor was added to the model one at a time and tested separately in order to test the increasing or decreasing effects of the dependent variable on an independent variable. According to Hair Jr *et al.* (2020), a model has to be well-fitted for a correct interpretation of the results. All models of the tested categories except for income and religion showed an acceptable model fit (OSF Appendix 3). Some indices of higher income and other religious groups were not satisfactory because the sample size for these groups was lower than recommended (200). The normal fit index (NFI) of the higher income group was 0.894; still, the interpretation was meaningful, as the other seven indices were satisfactory. Also, the goodness of fit (GFI), NFI, and the root means square error of approximation (RMSEA) of other religious groups were not satisfactory. However, the interpretation for this group was meaningful because at least one index of absolute fit, parsimonious fit, and incremental fit was in the acceptable range. A two-tailed z-test's z-score was used to determine the significance between groups. The absolute value of the z-score >1.96 is considered significant at the 0.05 level, >2.57 at the 0.01 level, and >3.28 at the 0.001 level (Afthanorhan *et al.* 2014; Goss-Sampson 2018; Weston and Gore 2006).

Table 7 shows that the administrative division moderated the effects of ATT and PBC on CI, with a z-score >1.96. Although ATT→CI was significant for both state and region, the effect was more visible among respondents from regions while the PBC effect on CI was stronger for states. Regarding location, SN had a significantly stronger positive effect on CI for urbanites but not rural people. Education amplified the impact of ATT on CI for respondents with a university education more than those with only a high school diploma or less. Ethnicity moderated the PBC→CI relationship, with a stronger impact on the other ethnic groups, meaning ethnicity had a more intense moderating effect on non-Burmese people. Gender, age, income, religion, family size, and consumption experience had no significant moderating effect on any relationships since all z-scores <1.96. Since, R^2 values for each group of all factors were ranging from 0.36 to 0.63, each model has moderate explanatory power.

Table 7: Results of moderating analysis.

Moderators		ATT→CI	SN→CI	PBC→CI	EC→CI	R^2
Administrative division	Estimate of group 1 (States)	0.552***	0.247*	0.337***	-0.278	0.39
	Estimate of group 2 (Regions)	0.839***	0.153**	0.021	-0.188*	0.55
	z score	-2.647**	0.706	3.398***	-0.48	
Location	Estimate of group 1 (Rural)	0.834***	-0.08	0.044	0.051	0.46
	Estimate of group 2 (Urban)	0.709***	0.331***	0.131**	-0.33***	0.52
	z score	-1.178	3.836***	0.943	1.795	
Gender	Estimate of group 1 (Male)	0.725***	0.103	0.186**	-0.07	0.46
	Estimate of group 2 (Female)	0.754***	0.191**	0.081	-0.330**	0.46
	z score	-0.306	-0.808	1.275	1.485	
Age	Estimate of group 1 (≤ 30 age)	0.738***	0.158*	0.185**	-0.300**	0.47
	Estimate of group 2 (> 30 age)	0.762***	0.150*	0.087	-0.15	0.47
	z score	0.231	-0.074	-1.181	0.84	
Income	Estimate of group 1 (< 200 USD)	0.723***	0.121*	0.136**	0.220*	0.45
	Estimate of group 2 (≥ 200 USD)	0.932***	0.340*	0.049	-0.28	0.63
	z score	1.472	1.489	-0.676	-0.259	
Education	Estimate of group 1 (≤ High school)	0.606***	0.032	0.217**	-0.03	0.36
	Estimate of group 2 (University level)	0.814***	0.233***	0.065	-0.340**	0.53
	z score	2.023*	1.72	-1.707	-1.884	

Moderators		ATT→CI	SN→CI	PBC→CI	EC→CI	R^2
Ethnicity	Estimate of group 1 (Burmese)	0.813***	0.195**	0.029	-0.240*	0.52
	Estimate of group 2 (Other ethnicities)	0.626***	0.071	0.292***	-0.12	0.42
	z score	-1.876	-1.043	3.165**	0.642	
Religion	Estimate of group 1 (Buddhists)	0.786***	0.183**	0.104*	-0.250**	0.49
	Estimate of group 2 (Other religions)	0.533***	0.073	0.271*	0.053	0.37
	z score	-1.723	-0.685	1.414	1.071	
Family size	Estimate of group 1 (Small_≤3 members)	0.805***	0.042	0.126	-0.450*	0.52
	Estimate of group 2 (Others_>3 members)	0.732***	0.183**	0.138**	-0.18	0.46
	z score	-0.7	1.279	0.112	1.19	
Consumption experience	Estimate of group 1 (Have experience)	0.636***	0.078	0.155***	-0.18	0.52
	Estimate of group 2 (No experience)	0.462***	0.124	0.085	-0.22	0.46
	z score	-1.503	0.501	-0.826	-0.756	

Note: *** = p-value < 0.001; ** = p-value < 0.01; * = p-value < 0.05.

5.6 Discussion

Only less than half of the respondents in our study in Myanmar exposed their intention to eat insects. On average, participants' responses to ATT, SN, and PBC towards entomophagy leaned towards neutral answers. Only EC and consumption experience showed considerable variation in CI. Expectedly, people with prior insect consumption experience have a higher CI than those without. Pambo (2018) showed that intentions to consume insects are affected by a lack of consumption experience, and behavior is associated with past experiences and the inclination of an individual to act (Haddock and Maio 2007).

A significant positive effect of ATT on CI is in line with previous entomophagy studies (Chang *et al*. 2019; Pambo *et al*. 2018). As edible insects are often perceived as a gift of nature in rural areas, people who cannot always afford to buy other foods are more accustomed to eating insects collected in the wild. Additionally, although insects can be expensive at markets, people buy them due to their traditional habits. Some people might also realize the nutritional benefits of edible insects, thus exhibiting a positive attitude towards entomophagy. As Çoker and van der Linden (2022) mention, if ATTs towards edible insects are more optimistic, CI will be higher.

The positive effect of SN on CI indicated that either close or important persons influenced the respondents' insect CI. If people who were important to respondents consumed insects enjoyably, they were more likely to eat insects themselves, reflecting the social influence emanating from the people around them. The positive effect of SN on CI towards edible insects is aligned with previous entomophagy studies (Hwang and Kim 2021; Piha *et al*. 2018; Verneau *et al*. 2016). SN had a direct and an indirect effect on CI through ATT, corroborating earlier results from other studies in Asia (Bae and Choi 2020) and may be explained by the fact that people around can greatly influence individuals' behavior, meaning social pressure is essential in shaping a person's ATT (Riemer *et al*. 2014).

We found a significantly positive effect of PBC on CI, similar to an earlier study in Kenya (Pambo *et al.* 2018). According to our descriptive statistics results, only half of the respondents might have the ability to decide to consume insects independently; the other half did not have enough time and money to search for, buy, and eat insects and might be uncertain about the perceived difficulties of doing so. The lack of respondents' own decision-making, confidence in their ability, and perceived difficulties become significant hurdles in the CI for edible insects. Among these three items, perceived difficulty may be the main barrier. Although offline and online insect markets are well-developed in some big cities in Myanmar, such as Yangon, Mandalay, and Bago, edible insects are unavailable all the time and at all locations. The seasonal availability of edible insects may make it challenging to obtain them in the off-season (Barennes *et al*. 2015). Consequently, people who consider that searching (either collecting or buying) for insects is not a burden are more likely to eat them.

Confirming one of our initial hypotheses, EC leads to a lower CI for edible insects. As more than 90% of respondents showed serious EC, they might have realized the adverse effects that consuming insects can have, such as the extinction of species due to overharvesting and other harms to the ecosystem (Spectrum 2020b). According to Linn *et al*. (2016), ecological problems might arise due to over-harvesting and cutting down of host trees in search for edible insects, contrasting the often-cited notion that edible insects are an environmentally friendly food. Yet, because of the rather small effect that EC had in our study on the CI for edible insects, there may be some other factors which were not covered here such as food insecurity and usual habits that govern the behavior of consumers.

Only four out of the ten investigated background factors had a significant moderating effect on CI. Administrative divisional differences had a moderating impact on the relationship of ATT and PBC on CI, with stronger effects on respondents from regions than states of Myanmar. Entomophagy is not such a common practice in the country's regions, so the CI might mainly depend on the ATT. On the other hand, the effect of PBC on CI was 16 times stronger for respondents from states than those from regions. As insects are proliferous throughout Myanmar, they can be collected relatively easily in rural areas, whereas urbanites have primarily the option to buy. As edible insect markets (traditional and online) are more developed in the regions such as Yangon and Mandalay (Spectrum 2020a, 2020c) than in the states, it is easier to buy insects there. Moreover, as most Burmese live in the regions, whereas other ethnicities live in the states (Myanmar embassy (Tokyo) 2003), administrative divisional effects are amplified by ethnic differences. Consequently, the effect of PBC on CI was ten times stronger for non-Burmese ethnicities, meaning that for non-Burmese respondents living in the states, the perceived difficulties are more crucial for their CI for edible insects.

An urban location enhanced the effects of SN on CI. Because of the greater food options in urban areas, insects are a less important food item than in rural areas. Thus, in rural areas where entomophagy is common and food security a major issue, the CI depends less on socio-psychological factors, whereas, in urban areas, the SN play a more prominent role.

Education amplified the effect of ATT on CI. Education seems critical in fostering a wider acceptance of entomophagy, as it can change people's ATT (Petersen *et al.* 2020). A better knowledge of the nutritional benefits of insects is significantly related to higher education (Cicatiello *et al*. 2016; Reverberi 2021); this might lead to positive ATTs and higher CI.

Gender, age, income, education, religion, family size, and consumption experience had no moderating effect on any relations. However, differences were found in each association for each group. For example, path coefficients for SN and EC for females significantly differed from zero. Thus, significant relationships were found in SN → CI and EC → CI for females but not for males. At the same time, the path coefficient for PBC for males was significantly different from zero. Thus, significant relationships were found in PBC → CI for only males. Though gender did not moderate the effects of the TPB's factors on CI, both groups could not be considered homogenous. It is the same for other background factors, thus, our results stressed the importance of moderating analysis for this study. Notably, no background factors moderated the relationship between EC and CI. This might be because most respondents, regardless of their background, showed high EC vis-à-vis the consumption of insects.

Our SEM's moderate explanatory power proved that TPB is a suitable framework for this research. Various edible insect studies have shown that the TPB explained 17-80% of the variations in CI towards edible insects (Brekelmans 2016; Hwang and Kim 2021; Mancini *et al.* 2019; Menozzi *et al*. 2017; Pambo *et al.* 2016; Pambo 2018; Sogari *et al*. 2019; Vartiainen *et al.* 2020). As the TPB explanatory power in our models with or without moderators are well in the range of the just cited other studies, we can confirm that the TPB is an appropriate framework for identifying factors that influence the CI to consume edible insects in Myanmar and beyond. Moreover, in this study, the addition of a new variable (environmental concern) to the TPB model fulfilled the criteria stated by Fishbein and Ajzen (2011). These criteria included: (1) the new variable must determine intention, (2) it should be independent of the existing three factors, (3) it should apply to a range of behaviors, and (4) its inclusion, in theory, should enhance the estimation of intention.

Our study is not without limitations. The first limitation refers to the data collection method. Although telephone interviews are cost-effective, they did not well represent the rural-urban population, with disproportionally more respondents from towns than the countryside. Additionally, most respondents were Buddhist, with Hindus and Muslims being underrepresented in our study. Thus, future research should ascertain more representation from rural parts of the country and religious minorities. Another constraint is that our study focused on the intention to consume edible insects in the following three months and failed to explore whether a future CI turns into actual consumption and whether the factors that affected the intention also affected the real actions. Insect consumption in Myanmar mainly relies on wild insects, and most insects are seasonal—usually only available once a year for a short period of time. Thus, CI for different times of the year should be explored. Moreover, future studies should conduct a deeper analysis of consumers' behavior towards each specific species, form, and type of edible insect. As Norberg *et al*. (2007) stated, the intention is not always followed by real performance; hence, an investigation of actual behavior needs to be carried out to validate our findings.

5.7 Conclusions

As the first consumer analysis of edible insects in Myanmar, this study supported the appropriateness of the theory of planned behavior for analyzing CI for edible insects in the country. In addition, we could show the influence of environmental concern on behavior intention and thus add a new dimension to the TPB. Therefore, broadening the scope of the TPB model is possible for future edible insect research. Our findings on the negative effects of EC can be valuable information for entrepreneurs considering entering the insects for the food market and those already in the business. As this negative impact is primarily determined by the fact that insect consumption in Myanmar mainly depends on the collection of wild insects, this highlights that transforming wild harvesters into insect farmers is urgently needed in Myanmar to incorporate insects into a more sustainable food system. This should go along with rising awareness that insect farming can reduce the environmental consequences of overharvesting wild insects. Market players should take advantage of consumers' EC by, for example, stressing how their consumption affects the environment. This will increase consumer awareness of the consequences of collecting wild insects vis-à-vis reared insects.

The significant effect of ATT on the intention to eat edible insects highlights the need to better inform consumers of the many benefits of entomophagy, for instance, by means of media, public forums, or the distribution of brochures. One of our key findings is that SN is positively related to both ATT and intention, which can be used to promote insect consumption in Myanmar, for instance, on social media. As administrative division and education level moderate the relationship between ATT and CI, forming a positive ATT by providing information on the nutritional benefits of insects is especially important for individuals from regions and with higher education. As administrative division and ethnicity are moderators of PBC and CI, insect farming should be accelerated, especially for non-Burmese ethnicities who live in states, to improve access to edible insects beyond wild harvesting and throughout the year. The urbanites also need promotional efforts to strengthen a positive relationship between SN and CI.

Although insects are available throughout the country, insect availability is still limited due to seasonality and the underdevelopment of insect farming in Myanmar. Thus, the perceived difficulty of consuming insects by many might be reduced by rearing insects to create a constant supply. Accelerating insect rearing can also provide a greater supply during the off-season, thereby increasing insect consumption. Not only the availability of edible insects but also their accessibility in many markets throughout the year with affordable prices might increase the frequency of insect consumption. So, edible insects can help to reach the nutrition policy's broad goal of reducing malnutrition in all its forms by making it easier for all people, at all times of the year, to get nutritious food at an affordable price. In this way, edible insects may have both direct and indirect effects on achieving the Sustainable Development Goals (SDGs) like ending hunger (SDG-2), ending poverty (SDG-1), having decent work and economic growth (SDG-8), having good health (SDG-3), being responsible consumption and production (SDG-12), and taking action on climate change (SDG-13).

CHAPTER VI

6. Behaviour intention to eat reared crickets in Myanmar: the effects of trust, knowledge, and perceived quality

This chapter has been published as Myint Thu Thu *et al*. (2023) Journal of Insects as Food and Feed

https://brill.com/view/journals/jiff/aop/article-10.1163-23524588-20230017/article-10.1163-23524588-20230017.xml

6.1 Abstract

Edible insects are a good source of proteins, fats, and micronutrients for human consumption. Crickets are one of the most widely reared insects worldwide. They require less capital spending and less space and water consumption while offering more food, employment, and income possibilities than conventional animal farming. Additionally, raising crickets may aid in achieving various sustainable development objectives. Although crickets are Myanmar's most popular edible insects, a few farmers are presently rearing them. The farming business is not thriving as in other countries mainly because consumers primarily eat crickets collected from the wild. Using the extended theory of planned behaviour, this study identifies factors possibly impacting the intention to eat reared crickets in Myanmar, alongside perceived product quality, consumer knowledge, and trust in value chain actors. Data were collected through telephone interviews, resulting in a valid data set of 212 respondents from Yangon and Mandalay who recently ate crickets collected from the wild. The result of the structural equation modelling revealed that participants are ready to accept reared crickets as a food source. Consumption intention towards reared crickets is directly influenced by consumers' attitudes, perceived behavioural control, and trust in producers. Concurrently, it is indirectly influenced by consumer knowledge of the environmental friendliness of cricket farming. Subjective norms, trust in retailers, and perceived product quality do not significantly affect the intention to eat crickets. As trust in producers is the new main predictive factor, cricket farmers should build public trust by giving transparency in the production process, thereby achieving a more favourable attitude towards reared insects, possibly leading to higher consumption levels.

6.2 Introduction

Along with the international community's growing interest in edible insects as a potential source of animal protein, crickets have become popular (Magara *et al*., 2021; Reverberi, 2020; Van Huis *et al*., 2013). Among the different species of edible insects, several cricket species can be reared and need lesser investment than traditional livestock production systems because of the low land and water requirement while providing food, job, and income opportunities (Van Huis *et al*., 2013). Therefore, cricket rearing can enhance the development and mainstreaming of bioeconomy, thereby helping societies to reach certain Sustainable Development Goals (SDGs), such as SDGs 2, 6, 9, etc. (Chia *et al*., 2019; Moruzzo *et al*., 2021; SEI, 2019).

According to Jongema's report (2017), 44 species of true crickets of the *Gryllidae* family are listed in the worldwide catalogue of edible insects. Since crickets are high in protein content (55–73%) and minerals, more attention is given because they could possibly solve present and future food insecurity and malnutrition problems while helping conserve our planet (EFSA Scientific Committee, 2015; Magara *et al*., 2021; Phesatcha *et al*., 2022). Moreover, they contribute to the economy and livelihoods in several countries and can provide certain medicinal and social advantages (Magara *et al*., 2021). Meanwhile, some cricket species are threatened by extinction as their populations have dramatically decreased in many countries and non-entomophagous regions due to wild harvesting, overexploitation, increasing demand, farming system, deforestation, and climate change (Dirzo *et al*., 2014; Gondo *et al*., 2010; Miantsia *et al*., 2018; Van Huis *et al*., 2013; Worrell & Appleby, 2000). Yet, according to Van Huis and Vantomme (2014), semicultivation and rearing insects are the most feasible and sustainable solutions in wild insect conservation.

Globally, 1,000–1,200 billion insects, such as crickets, mealworms, black soldier flies, and others, are reared annually. The most popular countries for insect farming are Thailand, France, South Africa, China, Canada, and the United States (Rowe, 2020). Even though insect farming is widespread worldwide, Myanmar is an entomophagous country where insect farming is still in its early stages of development (Nischalke *et al*., 2020). It traditionally uses various insect species as ingredients in food and traditional medicine (Linn *et al*., 2016), with crickets being the most widely consumed insects in Myanmar (Spectrum, 2016). The most popular cricket species in Myanmar are brown or giant crickets (*Tarbinskiellus portentosus* Lichtenstein), house crickets (*Acheta domesticus* [L.]), and black crickets (*Gryllus assimilis* [Fab.]) (Khin, 2016; Linn *et al*., 2016; Tun, 2016). According to Tun (2016), brown crickets can be found all year round in the wild but are available on markets only from September to October. In contrast, house and black crickets are available on markets from October to February (Khin, 2016). Apart from these three species, several field cricket species, such as *Gryllus texensis and Anaxipha sp.,* can be found during the monsoon period in rice fields (Oo *et al*., 2020).

According to Spectrum (2020a), approximately 180 tonnes of crickets collected in the wild worth $3.9 million are sold annually in Myanmar, of which approximately 12–20 tonnes of crickets (3–5 million crickets) are exported to neighbouring countries. Wild harvesting, growing demand for crickets, and the absence of regulations or governance in this sector may harm cricket populations and threaten the well-being of the people (Spectrum, 2020c). While insects are increasingly seen globally as eco-friendly and sustainable food (Iqbal, 2020), insect consumption in Myanmar may adversely affect the environment due to over reliance on wild insect collections. According to Nischalke *et al*. (2020), wild harvesters must be transformed into "mini livestock" producers to integrate insects into a more sustainable food system. Yet, the same authors noted that market perception of reared crickets is weaker than wild-harvested crickets in Myanmar, even though reared ground and house crickets are often imported from Thailand (Dürr and Nischalke, 2021). In recent years, approximately 100 cricket farms have been operating in Myanmar (Spectrum, 2021), with the reared insects, including crickets, mainly used for feed (Spectrum, 2020b). Although giant cricket farming is economically not feasible due to the extreme length of the lifespan of this species, giant crickets are preferred by Myanmar's general populace due to its delicacy and size (Nischalke *et al*., 2020). Moreover, since reared crickets are small species, their demand is lower than those of wild giant crickets; nonetheless, there is a market demand for reared crickets in Thailand, opening up the potential for their export (Myanmar Digital News, 2020). Hence, the domestic demand for reared crickets' as food in Myanmar needs to be explored to assess their potential role in contributing to more sustainable food and nutritional security in the country. In Kenya, a traditional entomophagous country, Pambo (2018) investigated the attitudes and desire of the populace to eat insect-based food, as cricket farming and producing insect-based foods were nascent. Similarly, Van Huis *et al.* (2013) suggested that consumer studies are necessary to explore the commercial possibilities of edible insects and information on consumers' attitudes and willingness to eat them. Consumers' attitudes are crucial when innovations are incorporated into products, particularly insect-based foods (Rabadán, 2021). Crickets are not a new food item, but cricket farming is a novel challenge in producing crickets in Myanmar. Consumer intent and its influencing factors could help producers boost their product sales. Without these information, expanding the business, making effective profit-generating marketing strategies, and increasing the market share and competitiveness in the existing market are difficult

(Wong and Mo, 2013). Considering these points, a comprehensive consumer analysis study can offer a potential approach to overcome and improve crickets' productivity.

Because of the limited knowledge on reared cricket consumption in Myanmar, this study aims to evaluate insights into consumers' attitudes and their readiness to accept reared crickets as food and explore their intentions to eat reared crickets and its influencing factors.

6.3 Theoretical framework and literature overview

The theoretical framework of this study is primarily based on the theory of planned behaviour (TPB) developed by Ajzen (1985). Among the vast array of theories and models found in the field of consumer behaviour studies, TPB is commonly used to predict and understand individual behaviour intention following edible insects (Chang *et al*., 2019; Choe *et al*., 2020; Hwang and Kim, 2021; Navarré, 2017; Pambo *et al.*, 2018). Such studies have been conducted in both entomophagous and non-entomophagous countries and proved the appropriateness of TPB in insect consumption research. Moreover, the results of TPB research can be easily used to plan interventions (Pambo, 2018). TPB clarifies an individual's purpose in implementing the behaviours (Bae and Choi, 2020; Irianto, 2015; Mancini *et al*., 2019; Menozzi *et al*., 2017). An individual's willingness to perform any behaviour is the behavioural intention, assuming it will typically occur before the actual behaviour (Setiawan *et al.*, 2022; Wahyudin *et al.*, 2021). It is the best indicator of the particular action that happens (Kan & Fabrigar, 2017; Worthington, 2021). Additionally, the theory stipulates three factors affecting behaviour intention: attitude (ATT), subjective norms (SN), and perceived behavioural control (PBC).

Applying the TPB to reared crickets, consumption leads to the hypotheses formulated in the following.

6.3.1 Attitude towards reared cricket consumption

Attitude is a psychological way of evaluating a product (Eagly and Chaiken, 2007). It is a person's general perception of something remaining unchanged over a relatively long period (Solomon, 2009). It plays a crucial role as it influences our worldviews and actions and primarily shapes behavioural intentions (Haddock and Maio, 2007; Ajzen, 1991). Attitude comprises affective, cognitive, and behavioural components. Affective refers to the feelings towards something; cognitive refers to the belief related to the object. The behavioural component is associated with past experiences and the inclination of an individual to act (Haddock and Maio, 2007). Studies on attitude towards insect-based food have shown a significant positive effect on consumption intention (Chang *et al*., 2019; Choe *et al*., 2020; Pambo *et al*., 2018; Vartiainen *et al*., 2020). Due to these aspects, this study tested the following hypothesis:

H_1: Attitude towards reared crickets has a significant positive relationship with the consumption intention towards reared crickets.

6.3.2 Subjective norm in reared cricket consumption

Another prominent indicator of consumption intention is the subjective norm. It refers to the pressure from the surroundings whether to perform or not a behaviour (Ajzen and Albarracin, 2007). It concerns an individual's beliefs regarding whether important, close, or respectable people approve and support the specific action (Ham *et al*., 2015). It combines descriptive and social norms. The term "descriptive norms" pertains to the actual performance of other people, whereas "social norms" relate to the opinions of others about the behaviour of an individual (Ham *et al*., 2015). Navarré (2017) and Bae and Choi (2020) confirmed that subjective norm has a significant positive effect on consumption intention towards insect-based foods, and Nguyen *et al*. (2020) suggested its effect on attitude in their study in Vietnam. Hence, we tested the effect of subjective norm on consumption intention with the following hypotheses:

H_2: Subjective norm in reared cricket consumption has a significant positive relationship with the consumption intention towards reared crickets.

H_3: Subjective norm in reared cricket consumption has a significant positive indirect relationship with the consumption intention towards reared crickets through attitude.

6.3.3 Perceived behavioural control in reared cricket consumption

The concept of perceived behavioural control refers to an individual's subjective assessment of the ease or difficulty associated with executing a specific behaviour (Li et al., 2023; Murphy, 2009). As an essential intention construct, as per TPB, several studies proved that perceived behavioural control is the main contributor to behavioural intention (Chang *et al*., 2019; Chen, 2020). For instance, Menozzi *et al*. (2017) found that perceived behavioural control positively affected the consumption intention of flour-based insect foods, and Brekelmans (2016) asserted that PBC remarkably positively influences the consumption intention towards insect burgers. Based on the above evidence, the following hypothesis was formulated:

H4: Perceived behavioural control in reared cricket consumption has a significant positive relationship with the consumption intention towards reared crickets.

When using TPB in edible insect research, extra constructs, such as food phobia, product knowledge, and environmental awareness, have been incorporated. Ajzen (1991) noted the openness of TPB to adding predictors of intention and behaviour. An extension of the model is useful when important additional determinants influence the behaviour under investigation. For example, Navarré (2017) used all three TPB constructs to study the intention of eating insect-based products, whereas Bae and Choi (2020) introduced two constructs, i.e., food neophobia and experience, to measure consumer acceptance of edible insects. Therefore, in the present study, four additional constructs were added to the TPB: (1) perceived product quality (PPQ), (2) consumer knowledge (CK), (3) trust in producers (TP), and (4) trust in retailers (TR). The hypotheses are formulated in the following.

6.3.4 Perceived product quality of reared crickets

Perceived product quality is distinct from real product quality since it is based on the assessment of the customer on the product's visible and invisible features (Vantamay, 2007). Perceived quality also estimates a customer’s overall evaluation of a good or service (Vantamay, 2007). Product quality following nutritional value is important in food consumption (Imtiyaz *et al.*, 2021) because it drives peoples’ eating preferences and purchasing decisions (McMahon, 2018). The nutritional and health-beneficial values are one of the main reasons for using edible insects as food interest (Vartiainen *et al*., 2019). Even though people traditionally eat insects in Myanmar, they are unaware of the nutritional benefit of edible insects (Nischalke *et al*., 2020). Food safety is another important product quality for food consumption (Imtiyaz *et al*., 2021). According to Spectrum (2020c), wild insect gathering poses a safety and chemical hazard issue and has a higher risk of chemical contamination than rearing insects. Chemical contamination of food causes substantial health problems (Rather *et al*., 2017). Inadequate food safety knowledge and practices are the major obstacles to enhancing Myanmar’s food and nutritional security (FAO, 2019). It has become the main reason affecting product purchases, following the country’s population increased awareness of food safety (FAO, 2019; Vagneron *et al*., 2018). In our study, nutrition, food safety, and chemical contamination were collectively considered as the construct PPQ that was used to predict CI to eat insects. The impact of perceived product quality on consumption intention proved to be a significant predictor of the intention to pay for organic foods (Krystallis and Chryssochoidis, 2005). Ali and Ali (2020) and Ueasangkomsate and Santiteerakul (2016) found product quality to be a significant predictor for the purchase intention of healthy and organic foods. Hence, in our study, we tested the effect of perceived quality of reared crickets on the consumption intention towards reared crickets using the following hypothesis.

H_5: Perceived quality of reared crickets has a significant positive relationship with the consumption intention towards reared crickets.

6.3.5 Consumer knowledge of the environmental friendliness of cricket farming

Consumer knowledge refers to a consumer's perception of numerous product facts (Sumarwan [2003] in Soliha *et al*., 2019; Zainuddin and Madjid, 2018). According to Ateke and James (2018), it is one of the main drivers of intention. Although wild crickets are a traditional food for Myanmar people, reared crickets offers an alternative food source. Thus, consumers are often unwilling to eat reared insects (Nischalke *et al*., 2020). Liu *et al*. (2020) reported that limited knowledge about edible insects appeared to be the primary issue preventing consumers in China from consuming insects as food, despite the long history of entomophagy in the country. Chen *et al.* (2017) found that product knowledge was vital for an unfamiliar product among societies. Environmental friendliness of insect production, such as consuming less energy and water than conventional livestock, emitting fewer greenhouse gases, and supporting a healthy ecosystem (Kinyuru *et al*., 2015; Oonincx and de Boer, 2012; Tao and Li, 2018), is one of the main motivating factors for consumers in Western societies to eat insects, where insect consumption rarely exists (Hartmann and Siegrist, 2016; Kornher *et al*., 2019; Sogari, 2015; Verbeke, 2015; Woolf *et al*., 2019). Ueasangkomsate and Santiteerakul (2016) and Wijaya and Sukidjo (2017) demonstrated the importance of the environmental friendliness of organic food production in predicting consumption intention. As these facts proved to be powerful enough to convince even people unfamiliar with insect-eating, we tried to explore the effect of the consumer knowledge regarding the environmental friendliness of cricket production on the consumption intention towards reared crickets in Myanmar, where insect-eating is a traditional habit. It had been previously incorporated as an additional construct of the TPB in organic food studies. Darsono *et al*. (2018) tested the effect of consumer knowledge on attitude and consumption intention towards organic foods, showing the positive impact of consumer knowledge on attitude and consumption intention towards organic foods. Piha *et al.* (2018) proved that consumer knowledge significantly affected the willingness to buy edible insects in northern European consumers but not those from Central Europe. The differences in the strength and degree of establishment of novel food cultures might explain these regional differences as food culture in Northern Europe has seen considerable alterations in recent times, while that in Central Europe has remained more stable. Thus, people from a more conservative food culture are unwilling to try new foods, whereas those from more innovative food cultures could be more open to educational advertising of edible insect-based products. Since all previous studies underlined the importance of consumer knowledge on the products for food consumption, we developed the following hypotheses:

H_6: Consumer knowledge of the environmental friendliness of cricket farming has a significant positive relationship with the consumption intention towards reared crickets.

H_7: Consumer knowledge of the environmental friendliness of cricket farming has a significant positive indirect relationship with the consumption intention towards reared crickets through attitude.

6.3.6 Trust in producers regarding food safety

Trust is another crucial construct widely applied in the food sector (FAO, 2003). Taylor *et al*. (2012 p1) noted that trust is on the causal pathway for "behaviour change and knowledge, and ATT concerning aspects associated with safety and quality of food is also important." The basic idea of the trust definition is having confidence in the trustworthiness and integrity of one party towards another (Aljazzaf et al., 2010; Robbins, 2016). Trust in the food industry is essential because consumers expect safe food from food manufacturers and also from retailers to take care of food safety during the multiple processing stages (Klimczuk and Klimczuk-Kochańska, 2018). Developing consumer trust in a commodity, trademark, or enterprise is critical to establish a successful seller-buyer relationship (Bachnik and Nowacki, 2018). When forecasting consumption intention towards edible insects, so far, very few studies have paid attention to trust issues. Vagneron *et al*. (2018) observed that a lack of trust is the main barrier to organic food consumption in Myanmar. Trust, or the lack thereof, could be a construct in determining the consumption intention of reared crickets, especially since reared cricket is a new product with limited information in Myanmar. Thus, the risk is uncertain; in that situation, trust is essential (Swan and Nolan, 1985, as cited in Ba and Pavlou, 2002). According to Nuttavuthisit and Thøgersen (2017), the trust could be categorised as a personal trust related to producers and retailers, while system trust is related to governmental or certifying institutions. However, since the edible insect sector has received little to no institutional attention, we focused on personal trust, namely trust in producers and trust in retailers. Here, the concept of trust was described as consumers' belief in the ability of edible insect producers and retailers regarding food safety. Recent organic food studies used trust as an additional construct to predict consumption intention (Canova *et al.*, 2020; Carfora *et al*., 2019; Carfora *et al*., 2021). Carfora *et al*. (2019) studied consumer behaviour towards organic milk using trust in TPB and showed that trusting farmers is a salient indicator of CI. Carfora *et al.* (2021) explored the direct and indirect effects of trust in value chain actors on intention through attitude and found that trust, directly and indirectly, impacted purchase intention towards natural food. Hence, we tested the effect of trust in the intention to eat reared crickets using the following hypotheses:

H_8: Trust in producers regarding food safety has a significant positive relationship with the consumption intention towards reared crickets.

H_9: Trust in producers regarding food safety has a significant positive indirect relationship with the consumption intention towards reared crickets through attitude.

H_{10}: Trust in retailers regarding food safety has a significant positive relationship with the consumption intention towards reared crickets.

H_{11}: Trust in retailers regarding food safety has a significant positive indirect relationship with the consumption intention towards reared crickets through attitude.

The above-derived hypotheses are summarised in the conceptual framework depicted in Figure 1.

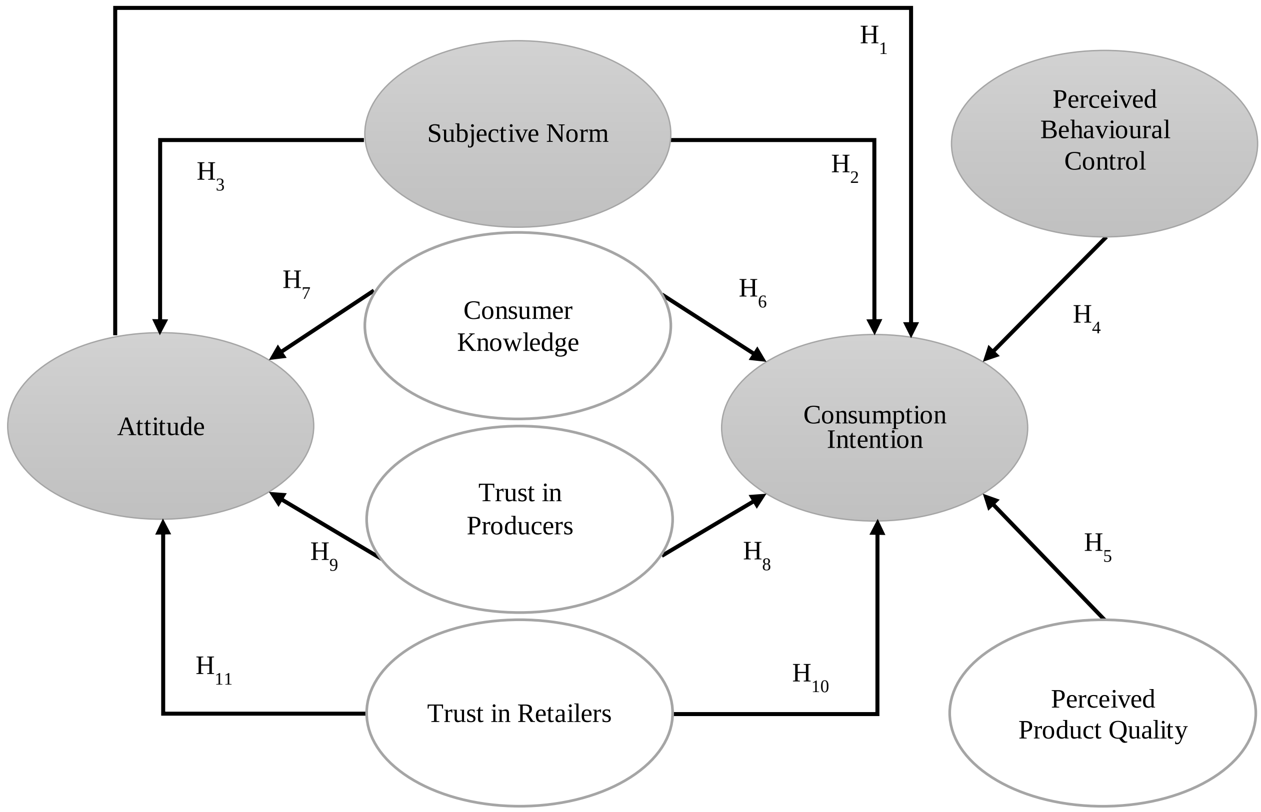

Figure 1: Conceptual framework of the study (adapted with modification from Ajzen [2002]).

6.4 Materials and methods

6.4.1 Sampling and study area

Data was collected through telephone interviews between 1st March and 31st May 2021. In total, 3,716 cellphone numbers from Yangon and Mandalay were randomly dialled, yet only 8% (311) participated in the interviews. We used data from 224 of 311 respondents with previous experience in consuming crickets. Yangon is one of the famous lower Myanmar areas where various edible insects are sold. People in Yangon are the main insect buyers in Myanmar due to their high population. Mandalay, one of the famous upper Myanmar areas, is the cricket buying area for regional consumption and serves as a transit to distribute to other cricket-deficit or identified consumption areas, such as Yangon. In addition to the sheer number of potential consumers in the two regions, the prominence of online retail of insects there informed us to use these two regions as survey areas for this study.

6.4.2 Interview structure

The questionnaire was divided into two parts: the first portion focused on the sociodemographic characteristics, while the second was on the TPB constructs. The existing 24 indicators relating to eight constructs were adapted and modified to fit the intended research. Attitude and perceived behaviour control constructs were adapted from Wang *et al*. (2019), referring to the studies of Ajzen (2002) and Asif *et al*. (2018). subjective norm items were developed following the guidelines of Ajzen (2006), as cited in Horne *et al*. (2020). To measure perceived product quality and consumer knowledge on the environmental friendliness of cricket production, adapted scales from Ueasangkomsate and Santiteerakul (2016), referring to the research by Roitner-Schobesberger *et al*. (2008) and Sangkumchaliang and Huang (2012), were used. Trust constructs were adapted from Carfora *et al*. (2019), based on the research of de Jonge *et al*. (2008). The items to measure consumption intention in this study are based on Kaushal and Kumar (2016), referenced in Zerbini *et al*. (2019). All indicators used a 5-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). The questions were formulated in English, translated into Myanmar, and then retranslated into English by a translator to ensure that the concepts and linguistics were matched.

Table 1. Description of questionnaire structure.

Code	Measurement Items
Attitude-ATT	
ATT-1	I am interested in eating reared crickets.
ATT-2	I think that consuming reared crickets is a good idea.
ATT-3	I think that consuming reared crickets is beneficial.
Subjective Norm-SN	
SN-1	People I respect would consume reared crickets.
SN-2	My family member would consume reared crickets.
SN-3	People important to me won't mind if I consume reared crickets.
Perceived Behaviour Control-PBC	
PBC-1	Whether or not I consume reared crickets is completely up to me.
PBC-2	If I wanted to, I could consume reared crickets instead of wild ones.
PBC-3	I think it is easy for me to consume reared crickets.
Perceived Product Quality-PPQ	
PPQ-1	Reared crickets are safe to eat.
PPQ-2	Reared crickets are nutritious food.
PPQ-3	Reared crickets do not contain chemicals.
Consumer Knowledge-CK	
CK-1	Reared crickets need less energy and water compared to livestock.
CK-2	Eating reared crickets is good for the environment.
CK-3	Consuming reared crickets can reduce greenhouse gas emissions.
Trust in Producers-TP	
TP-1	Cricket producers take good care of the safety of our food.
TP-2	Cricket producers have the competence to control the safety of food.
TP-3	Cricket producers have sufficient knowledge to guarantee the safety of products.

Code	Measurement Items
Trust in Retailers-TR	
TR-1	Retailers take good care of the safety of our food.
TR-2	Retailers are sufficiently open regarding the safety of food.
TR-3	Retailers are honest about the safety of food.
Consumption Intention-CI	
CI-1	I plan to eat reared crickets in the next three months.
CI-2	I intend to consume reared crickets in the next three months.
CI-3	I am willing to recommend others to consume reared crickets.

6.5 Statistical analysis

Structural equation modelling (SEM) predicted the influencing factors for the intention to consume RC. This technique integrates factor analysis and multiple regression analysis (Hasman, 2015). Measurement and structural models are initially assessed for their fit; after achieving compatibility, individual pathways can be examined (Hodapp *et al.*, 2013, p.147). The models' validity was tested using confirmatory factor analysis (CFA) (Awang, 2014). After models met all the requirements, individual pathways were tested through path analysis using IBM SPSS AMOS 24.

The basic requirements of SEM are a large sample size, normality, and lack of outliers (Jenatabadi, 2015). After outliers (value of ±3) were removed using *z*-scores, the remaining 212 respondents exceeded the recommended 200 sample size (Kline, 2016). Consequently, the final data fell within the accepted range of ±1.96 at 0.05 confidence level for Kurtosis and Skewness and were thus suitable for SEM analysis.

6.6 Results

6.6.1 Readiness to accept reared crickets as food

The readiness to consume reared crickets as food for each demographic characteristic is presented in Table 2. The samples from an equal ratio of Yangon and Mandalay were significantly different in readiness to eat reared crickets of 88% and 77%, respectively, between two cities. Urban areas were the predominant geographic location of respondents. The rural (89%) and the urban (80%) dwellers showed their readiness to eat reared crickets. Most respondents were men (59%), and women comprised 41%, with a slight variation in readiness to eat between men and women (82% and 84%, respectively). Most young adults (65 %) were more open to accepting reared crickets as food than middle-aged and older adults. Respondents with low education and low-income levels comprised 55%, while those with university education and moderate-income groups comprised 45%. People with a low level of schooling demonstrated significantly higher readiness (89%) than those with a high level of education (75%). Low-income (80%) and moderate-income (85%) respondents indicated their readiness to eat reared crickets as food. For the whole sample, 83% of the respondents were ready to accept reared crickets as food; however, the remaining 17% were not. Readiness to eat significantly differed across regions ($p < 0.05$) and education groups ($p < 0.01$), employing the Pearson chi-square test. More educated people are less likely to accept than less ones, as seen by the residents of Yangon, who are more ready to accept than those of Mandalay.

Table 2. Distribution of the readiness to accept reared crickets as food.

Characteristics		Total Respondents	Readiness to accept		Pearson's χ^2 Value
			Yes	No	
Total		**100%**	**83%**	**17%**	
Region	Yangon	50.0%	88%	12%	3.962*
	Mandalay	50.0%	77%	23%	
Location	Rural	30.7 %	89%	11%	2.907
	Urban	69.3 %	80%	20%	
Gender	Male	59.4 %	82%	18%	0.138
	Female	40.6 %	84%	16%	
Age	Young adult (≤ 30)	64.6 %	86%	14%	3.453
	Middle and old adults (> 30)	35.4 %	76%	24%	
Education	Low (≤ high school)	54.7 %	89%	11%	6.937**
	High (≥ university level)	45.3 %	75%	25%	
Income/ month	Low (< 200 USD)	55.2 %	80%	20%	0.881
	Moderate (≥200 USD)	44.8 %	85%	15%	

Note: *** = p-value < 0.001; ** = p-value < 0.01; * = p-value < 0.05.

6.6.2 Distribution of Likert scale responses for all TPB's statements

Table 3 shows that the attitude indicator responses lean towards agreement of attitude statements. Hence, most people had a positive attitude towards reared crickets. However, SN-1 and SN-2 leaned towards disagreement; thus, their respective persons or family had no consumption experience regarding reared crickets. In contrast, SN-3 leaned towards agreement, respecting persons or families would accept reared cricket consumption. The responses for PBC-1 and PBC-2 were inclined towards the agreement scale, indicating they have enough control and ability to eat reared crickets. However, the responses for PBC-3 were tilted towards the scale of disagreement, as they think finding reared crickets in the market would be difficult. As the responses for all perceived product quality indicators inclined towards agreement, it could be said that people think that reared cricket is safe, nutritious, and chemical-free. The highest percentage of "agree" was found for consumer knowledge indicators. Thus, respondents had sufficient knowledge regarding the environmental friendliness of cricket production. According to TP-1 indicators, people agree that cricket producers contribute the food safety. While TP-2 and TP-3 indicators showed that they were unsure about producers' competency and knowledge regarding food safety. For TR-1 and TR-2, people were unsure whether retailers took care and were transparent regarding food safety. TR-3 is weighted towards agreeing; thus, they believed retailers were honest regarding food safety. In general, consumption intention to eat reared crickets was high, but they were hesitant to recommend or encourage them to others.

Table 3: Distribution Percentages of Likert scale responses for all TPB constructs.

Measurement items	Mean ± SD	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
Attitude-ATT						
ATT-1	3.8 ± 0.7	0%	9%	14%	69%	8%
ATT-2	3.5 ± 0.8	1%	14%	28%	52%	5%
ATT-3	3.2 ± 0.9	2%	18%	38%	39%	3%
Subjective Norm-SN						
SN-1	2.3 ± 0.9	21%	36%	38%	5%	0%
SN-2	2.1 ± 0.8	20%	52%	23%	5%	0%
SN-3	3.7 ± 0.9	1%	7%	32%	42%	18%

Measurement items	Mean ± SD	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
Perceived Behaviour Control-PBC						
PBC-1	3.6 ± 0.9	2%	11%	25%	54%	8%
PBC-2	3.6 ± 0.9	1%	12%	19%	60%	8%
PBC-3	2.8 ± 1.0	8%	32%	37%	19%	4%
Perceived Product Quality-PPQ						
PPQ-1	3.4 ± 1.0	6%	14%	20%	55%	5%
PPQ-2	3.2 ± 1.0	5%	21%	24%	47%	3%
PPQ-3	3.3 ± 0.9	4%	19%	28%	46%	3%
Consumer Knowledge-CK						
CK-1	4.2 ± 0.5	0%	0%	5%	71%	24%
CK-2	4.4 ± 0.5	0%	0%	2%	57%	41%
CK-3	4.5 ± 0.6	0%	0%	2%	48%	50%
Trust in Producers-TP						
TP-1	3.2 ± 0.9	5%	17%	27%	50%	1%
TP-2	3.1 ± 0.8	2%	21%	40%	37%	0%
TP-3	3.1 ± 0.8	3%	17%	52%	27%	1%
Trust in Retailers-TR						
TR-1	3.1 ± 0.9	4%	25%	36%	31%	4%
TR-2	3.5 ± 0.6	0%	1%	53%	42%	4%
TR-3	3.5 ± 0.6	0%	6%	42%	51%	1%
Consumption Intention-CI						
CI-1	3.6 ± 0.9	2%	12%	20%	59%	7%
CI-2	3.5 ± 0.9	2%	11%	25%	54%	8%
CI-3	2.9 ± 1.0	7%	32%	32%	25%	4%

6.6.3 Structural equation modelling

The performance of the proposed model was assessed through CFA using the maximum likelihood estimation method.

6.6.3.1 Models' assessment

The CFA analysis demonstrated that the measurement model was not satisfied due to average variances extracted (AVE) of ATT <0.5 and normed fit index (NFI) of <0.9. After deleting the item ATT-1, the AVE ranged from 0.518 to 0.726, exceeding the 0.5 threshold. The composite reliability value and Cronbach's alpha also exceeded the threshold of 0.60. Concurrently, the discriminant validity reached an acceptable level, as the √AVE was greater than the pairwise correlation of the respective constructs (Table 4).

Table 4. Results of the measurement model.

Constructs	AVE[a]	CR[b]	Cronbach's alpha[c]	Discriminant validity							
				ATT	SN	PBC	PPQ	CK	TP	TR	CI
ATT	0.52	0.62	0.68	**0.72***							
SN	0.65	0.84	0.80	-0.08	**0.81***						
PBC	0.67	0.85	0.82	0.11	-0.07	**0.82***					
PPQ	0.73	0.89	0.89	0.07	-0.09	-0.08	**0.85***				
CK	0.54	0.78	0.77	0.18	0.14	0.00	-0.04	**0.74***			
TP	0.64	0.84	0.83	0.20	-0.06	0.11	-0.05	-0.25	**0.80***		
TR	0.66	0.85	0.83	0.20	-0.03	-0.01	-0.03	0.14	0.18	**0.81***	
CI	0.70	0.87	0.84	0.51	-0.01	0.19	0.10	0.01	0.32	0.14	**0.83***

Note: [a] threshold is based on Hair Jr *et al.* (2017).

[b,c] thresholds are based on Ab Hamid *et al*. (2017).

* Numbers in bold are √AVE.

Moreover, model fit indices of both measurement and structural models were well fitted, as presented in Table 5. In summary, all the results of the CFA analysis permitted to continue with the path analysis.

Table 5: Fit Indices of the tested models.

Model Fit Indices	Measurement model		Structural model	Thresholds[a]
	Including all items	After deleting ATT-1		
Goodness of fit index (GFI)	0.903	0.912	0.903	>0.90
Root means the square error of approximation (RMSEA)	0.036	0.033	0.033	<0.08
Minimum discrepancy per degree of freedom (x^2/f)	1.267	1.234	1.233	<3.00
Adjusted Goodness of Fit Index (AGFI)	0.871	0.879	0.879	>0.80
Comparative fit index (CFI)	0.975	0.979	0.979	>0.90
Normed fit index (NFI)	0.893	0.903	0.902	>0.90
Tucker Lewis index (TLI)	0.969	0.974	0.974	>0.90

Note: [a] acceptable values are based on Kline (2016).

6.6.3.2 Path analysis

Intention to consume farmed crickets was tested with path analysis, and the results supported five out of eleven hypotheses, as shown in Figure 2. Only direct causal effects were highlighted in the figure to make the illustration clearer. Attitude towards eating reared crickets significantly influenced consumption intention (b = 0.45, $p < 0.001$) and was the highest predictor for consumption intention of reared crickets. Perceived behavioural control had a significant effect on consumption intention (b = 0.14, $p < 0.05$). Consumer knowledge on environmental friendliness of cricket production had a strongly significant effect on attitude (b = 0.24, $p < 0.05$). In addition, trust in producers had a significant impact on attitude (b = 0.23, $p < 0.05$) and consumption intention (b = 0.22, $p < 0.01$).

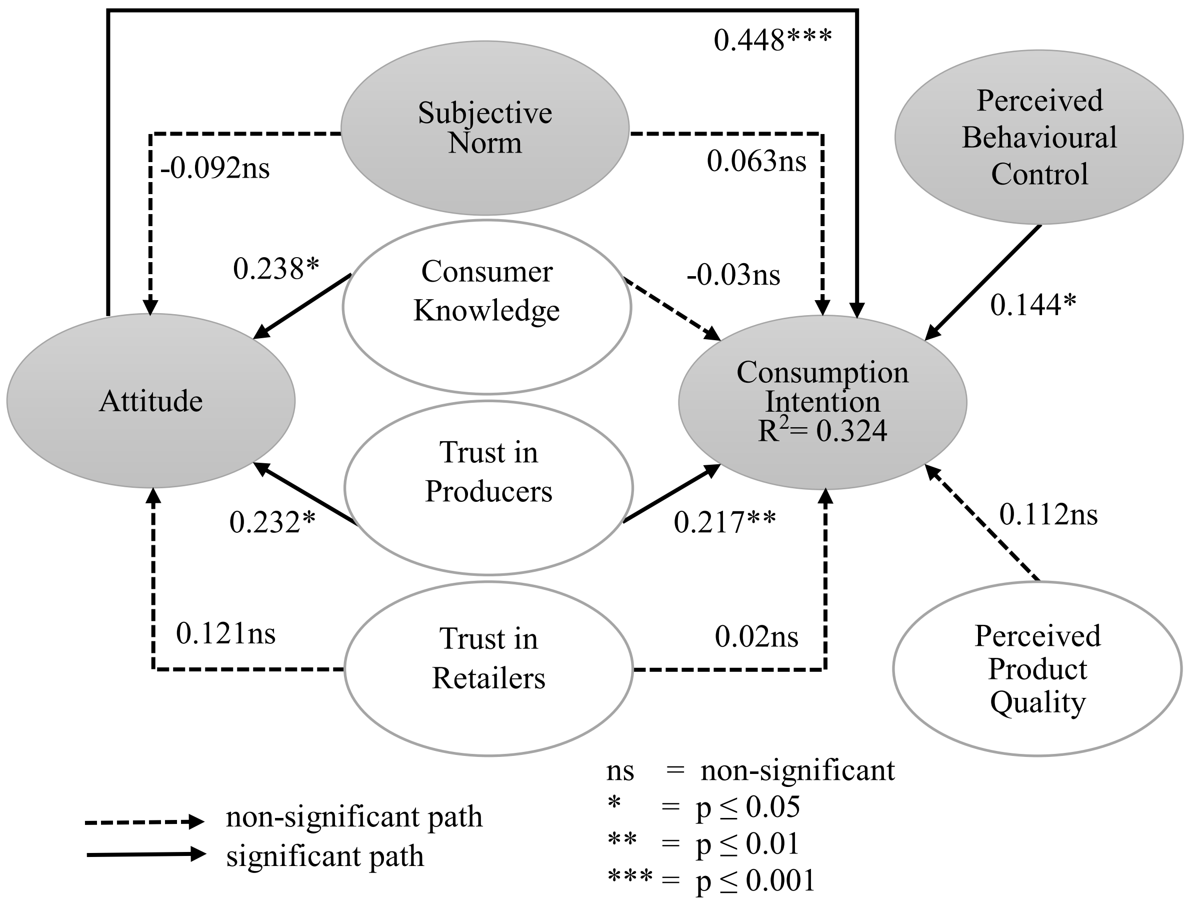

Figure 2: Results of path analysis.

The complete analysis results of SEM, including direct, indirect, and total effects, are shown in Table 6. Only one effect was tested for attitude, perceived behavioural control, and perceived quality of reared crickets; thus, the direct and total effects are the same. The magnitude of the significant total effect ranges from 0.144 to 0.448. According to Mehmetoglu and Jakobsen (2017), the standardised coefficient <0.1 was considered as Small (S), from 0.1 to 0.2 as Medium (M), and >0.2 as Large (L). Perceived behavioural control had a moderate positive direct effect. In contrast, the knowledge of consumers about the environmental friendliness of cricket farming has no direct effect but has a positive and large indirect effect on the consumption intention. Thus, its total effect on consumption intention was small. Trust in producers had a large and positive direct effect and a large and moderate indirect effect on consumption intention towards reared crickets. Hence, its total effect on consumption intention towards reared crickets was large. Attitude had a large and positive direct effect on the consumption intention towards reared crickets. Thus, three out of seven constructs, namely attitude, perceived behavioural control, and trust in producers, significantly influenced the consumption intention towards reared crickets, whereas the knowledge of consumers about the environmental friendliness of cricket farming indirectly influenced consumption intention towards reared crickets with R^2 = 0.324. Those TPB's constructs jointly explained 32% of the variation in behavioural intention to consume farming crickets. According to Chin and Newsted (1998), an R^2 of 0.67 was substantial, 0.33 moderate, and 0.19 weak. Thus, our model's explanatory power is moderate.

Table 6: Complete analysis of the theoretical model.

Variables			Effect	Exogenous	Endogenous
				Mediating	Dependent
				Attitude (ATT) (R^2 = 0.121)	Consumption intention (R^2 = 0.324)
Exogenous	Independent	Subjective norm (SN)	Direct	-0.092ns	0.063 ns
			Indirect	-	-0.041 ns
			Total	-0.092ns	0.022 ns
		Perceived behavioural control (PBC)	Direct	-	0.144* (M)
		Perceived product quality (PPQ)	Direct	-	0.112 ns
		Consumer knowledge (CK)	Direct	0.238* (L)	-0.03 ns
			Indirect	-	0.107* (M)
			Total	0.238* (L)	0.077* (S)
		Trust in producers (TP)	Direct	0.232* (L)	0.217** (L)
			Indirect	-	0.104* (M)
			Total	0.232* (L)	0.321* (L)
		Trust in retailers (TR)	Direct	0.121 ns	0.02 ns
			Indirect	-	0.054 ns
			Total	0.121 ns	0.074 ns
	Mediating	Attitude (ATT)	Direct	-	0.448 *** (L)

Note: *** = *p*-value < 0.001; ** = *p*-value < 0.01; * = *p*-value < 0.05, ns = non-significant.

6.7 Discussion

This study analyses how the intention to consume reared crickets is determined in two of the most important regions of Myanmar, Yangon and Mandalay. Generally, most respondents showed a positive attitude towards reared crickets and were ready to accept them as food, possibly because of prior experience of eating different wild cricket types. However, a minority of less than 20% were reluctant to accept reared crickets despite such previous experiences. They seemed to eat only giant crickets, the preferred cricket type in Myanmar (Nischalke *et al*., 2020) and did not want to try the smaller reared crickets.

Attitude is a personal conclusion of behavioural beliefs based on evaluating the likely consequences of insect consumption (Çoker & van der Linden, 2022). The significant positive effect of attitude on consumption intention indicated that people who believed eating reared crickets was a good idea and beneficial tended to have a higher consumption intention. Attitude, positively affecting consumption intention, was consistent with previous insect research conducted in traditionally entomophagous and non-entomophagous countries (Bae & Choi, 2020; Chang *et al*., 2019; Menozzi *et al*., 2017; Pambo, 2018). Thus, a positive attitude encouraged the consumption intention towards reared crickets.

The positive effect of perceived behavioural control on consumption intention corroborated earlier research findings on edible insects from Kenya (Pambo *et al*., 2018). To accomplish specific behaviour, such as purchasing foods, external and internal factors influence perceived behavioural control (Pomsanam *et al*., 2014). According to our descriptive results, most respondents showed enough controllability (internal factors) to facilitate reared crickets consumption behaviour, meaning they had time to search for and money to buy them. Still, situational factors, such as the availability of reared crickets, might pose problems because most respondents were unsure whether consuming reared crickets is easy or difficult. People considering reared cricket consumption did not pose an issue are more likely to eat them.

Consumer knowledge of the environmental friendliness of cricket farming indirectly affected consumption intention via attitude but not directly. Few studies, such as that of Piha *et al*. (2018), have investigated the consumer knowledge of the environmental friendliness of edible insects, where consumer knowledge remarkably affected the willingness to buy insect foods in northern but not central Europe. However, a study by Gundala and Singh (2021) on organic food supports our findings, as they also found that attitude mediates the impact of consumer knowledge on consumption intention. Purboyo *et al*. (2022) found that environmental attributes of green products significantly impact attitude but not the intention. In their study, respondents knew that environmental friendly products are good for the society; thus, they had a positive attitude towards those products, although not all people intended to buy them. This means that even having acquired enough knowledge to form a positive attitude towards a specific action does not necessarily stimulate the intention to act. Despite cricket farming being known to be good for the environment, most of Myanmar's consumers are still not familiar with cricket farming due to the lack of a well-developed cricket-rearing industry in the country. Even though respondents may know theoretically that cricket farming is environmentally friendly, the lack of knowledge on how crickets are reared in Myanmar makes consumers uncertain if reared crickets actually benefit the environment. Moreover, environmental concerns as such might not be strong enough, so the (theoretical) knowledge on the environmental friendliness of reared crickets impacts attitude but does not directly influence consumption intention.

Although trust in producers affects the consumption intention towards reared crickets, trust in retailers does not. There is no supporting research on how specific trust in producers and retailers impacts the consumption intention of reared crickets. Onwezen *et al.* (2021) found general trust as the primary driver of insect consumption, and similar results have been reported from organic food studies, such as milk (Carfora *et al.*, 2019). In Yangon and Mandalay, retailers, such as street and market vendors, usually sell wild and farmed insects. The latter often being silkworms. Clients purchasing insects are familiar with those retailers and their behaviour, despite not buying reared crickets from them. Consequently, consumers anticipate retailers to behave similarly regardless of the type of insects, reared or collected in the wild, and therefore, trust in retailers appears to be an insignificant construct in the consumption intention of reared crickets. In contrast, consumers are unfamiliar with cricket producers and their farming process. Especially, since it is a new business in Myanmar, there are still no rules or regulations for the rearing sector related to food safety. Hence, currently, trust in producers is more important for consumption intention towards reared crickets than trust in retailers. When individuals have more trust in producers concerning food safety, more positive attitude and consumption intention have been developed (Nuttavuthisit and Thøgersen, 2017).

Ajzen (1991) already mentioned that personal factors, namely attitude and perceived behavioural control, often play a bigger role than subjective norm in determining the individual intention to do something. Armitage and Conner (2010) also stated that subjective norm was a weak predictor for intention. Similarly, our results revealed that subjective norm did not affect consumption intention. Hence, social pressure from the surrounding people is expected to not stimulate consumption intention towards reared crickets, as close people probably have no consumption experience of reared crickets. Thus, they have no reason to exercise any social pressure towards eating them. This result is congruent with findings of earlier edible insect studies by Chang *et al*. (2019) and Menozzi *et al.* (2017).

Moreover, the perceived product quality of reared crickets neither impacts attitude nor consumption intention. First, as most customers have only consumed wild crickets, this perception might not be particularly pronounced. Second, wild-harvested insects pose greater threats to consumers than reared ones as they can be exposed to pesticides (DeFoliart, 1999; Belluco *et al*., 2013). Hence, consumers' perceptions favour reared crickets. Third, quality may not be the first priority when people eat crickets as part of their tradition (Barennes *et al*., 2015; Deroy *et al*., 2015; Dürr and Ratompoarison, 2021; Hlongwane *et al*., 2021: Van Huis *et al.*, 2013), leading to insignificant effects of perceived product quality on consumption intention. However, as we have not found any other edible insect study that examined the impact of perceived product quality; we can only speculate. Results from food studies conducted by Krystallis and Chryssochoidis (2005) and Ali and Ali (2020) show that perceived product quality influences consumers' willingness to pay for organic and healthy food products. Conversely, Fleseriu *et al*. (2020) demonstrate an impact of quality only on consumer attitude, not on purchase intention towards organic food.

Regarding the model explanatory power in several studies of edible insects, the TPB accounted between 17% and 80% of the variation in consumption intention (Brekelmans 2016; Hwang and Kim 2021; Mancini *et al*. 2019; Menozzi *et al*. 2017; Pambo *et al*. 2016; Pambo 2018; Sogari *et al.* 2019; Vartiainen *et al*. 2020). With 32%, this study's explanatory power falls in the lower part of the range of previous studies. Even if the extended TPB model appears to be an appropriate framework for investigating consumption intention towards reared crickets in Myanmar, it has some shortcomings in its explanatory power. Further research needs to better explain consumption intention of farmed insects, whether using TPB or alternative models. For example, accessibility and availability of reared crickets are not explicitly taken into account in TPB, but might be decisive for consumption intention.

This study also has limitations as it included only two main cities (Yangon and Mandalay) of Myanmar, and thus, further investigation is also crucial to represent the whole country. Due to the small sample size, determining whether the factors influencing consumption intention in Yangon and Mandalay are similar was impossible. Moreover, this study only focused on reared crickets and did not represent other types of reared insects. Finally, only insect consumers were included in this study, excluding people who had never tried insects.

6.8 Conclusions

Even though the Theory of Planned Behaviour has been broadly used to assess consumption intention towards different food types, such as edible insects, it has never been employed to determine insect consumption in Myanmar. This study partially supported from a theoretical standpoint Ajzen's argument that attitude and perceived behavioural control strongly predict intention. A positive attitude and consumers' readiness to accept reared crickets as food strongly highlight the possibility of reared crickets as an alternative food source in Myanmar. Consumer knowledge on the environmental friendliness of crickets farming provides valuable information to further develop the cricket production sector in Myanmar. Wild insect harvesters should try to diversify their business into insect rearing. Cricket producers should gain the public's trust to further promote their industry. Public trust can be achieved by being transparent throughout the whole cricket production process to demonstrate product safety. The power of public media should be used to raise public knowledge of the environmental benefits of eating reared crickets, emphasising their health benefits and as an alternative supply of proteins, the latter being of global importance. This can result in more favourable public attitude towards cricket farming, thus raising the consumption intention. Ultimately, developing cricket-rearing farms combined with a good market strategy should assure all year-round supply of crickets, thereby contributing to reduced malnutrition and improved food security in Myanmar.

CHAPTER VII

7. Summary, overall discussion and conclusions

7.1 Summary of findings and overall discussion

This dissertation delves into the fascinating topic of entomophagy in Myanmar, seeking to gain insights into the attitudes and behaviors of the local populace towards consuming insects as food. Through a thorough investigation of assent, behavioral intention, and actual behavior, the study sheds light on the factors that drive this practice and its potential future prospects. This section highlights and discusses the most significant findings that emerged from this research endeavor.

The first research question of this dissertation set out to investigate the current state of entomophagy in Myanmar. The study uncovered that a vast majority of Myanmar citizens are, in fact, insect consumers, indicating the widespread prevalence of this practice across the country. However, the research also identified several critical barriers hindering people from partaking in insect consumption. Fear, disgust, lack of insect consumption habits, and dislike of insect-eating habits/ believing entomophagy is a negative habit were among the primary reasons cited by those who abstain from this practice. There were five main reasons given why entomophagy practice is not maintained: (i) unavailability of edible insects, (ii) high price, (iii) just a childhood habit that is not carried on to adulthood, (iv) distaste, and lastly, (v) health risks. These factors highlight the complex nature of entomophagy and the challenges associated with promoting it as a wholesome and sustainable food source. Edible insects, for instance, may be out of reach for some people due to their price and the limited supply links to wild harvesting (Spectrum, 2020c, 2021a). Given their high price and limited supply, there may be a need to scale up insect production, and distribution would be required to meet consumer demand at a fair price (Spectrum, 2021a). Some people consider eating insects to be only a childhood habit that does not last into adulthood, raising the possibility that social stigma may be at work to discourage eating insects. Therefore, there is a pressing need to promote awareness of the benefits of entomophagy as a nutritious and eco-friendly food source. Additionally, the reasons linked to distaste and health concerns underscore the need for more education and research to dispel misconceptions and to develop safe and tasty ways of preparing edible insects.

Second, this dissertation looked at whether consumer acceptance in Myanmar is a major issue for insect eating. Consequently, this dissertation identified the factors affecting consumer acceptance and consumption frequency of edible insects using Randall and Sanjur's model. Consumer acceptance is not a problem in insect consumption. Notably, ethnicity and religion were found to be strong predictors of consumer acceptance. These findings are consistent with similar studies conducted in other entomophagous nations, including Colombia, India, Laos, and Zimbabwe (Abdullahi et al., 2021; Barennes et al., 2015; Dube et al., 2013; Gasca-Álvarez and Costa-Neto, 2022; Ruby et al., 2015). In many cultures and religions, specific dietary restrictions and taboos prohibit consuming certain animals, including insects. For example, some Christian communities in Zimbabwe consider insects to be impure and thus forbid their consumption (Manditsera *et al.*, 2018). The influence of cultural and religious factors on consumption patterns highlights the need for a nuanced understanding of these factors to promote the acceptance of insects as a food source in diverse communities. The study also uncovered a range of barriers to consumer acceptance of edible insects, including negative opinions, insect phobia, social concerns, and discomfort. These findings are aligned with previous edible insect studies performed in South Africa, Niger and China (Egan, 2013; Hartmann et al., 2015; Zabentungwa T. Hlongwane et al., 2021; Van Huis et al., 2022). However, the nutritional value of edible insects provides a compelling reason to embrace them as a source of sustenance, as seen in previous studies conducted in Madagascar and South Africa (Meysing et al., 2021; Niassy et al., 2016; Vorster, 2010). Therefore, educating the public about the benefits of edible insects and creating new insect-derived food items or incorporating insects into existing products in less detectable forms, such as flour (Megido et al., 2016) could help reduce negative opinions, fear and social concerns regarding insect consumption, and persuade people with no prior insect consumption habits.

The typical insect consumption frequency in Myanmar is minimal, with an average of only five times a year. It would be interesting to know why insect consumption is low despite insect eating being a common practice nationwide. One reason might be the cost of edible insects since people with lower income consume edible insects less frequently than those from higher income segments. However, the consumption frequency for the higher-income group (six times per year) is also relatively low. As most people have low earnings, but this might inhibit their consumption of edible insects. Another possible reason is that the seasonal availability of insects due to wild harvesting poses a challenge for their regular supply, resulting in rising costs during the off-season. Barennes *et al*. (2015) mentioned that the seasonal occurrence of edible insects makes it challenging to get them in the off-season. Although insects are available in almost all areas of Myanmar, they are not available in markets or shops all the time. Seasonality, thus, affects accessibility as well as availability, with costs rising during the off-season. What aggravates the problem is that insect populations such as that of giant crickets are decreasing nowadays in Myanmar, partly because of excessive collection and partly because of heavy pesticide use in agriculture (Spectrum, 2020c). As a result, commercial insect harvesters have to shift from one place to another in search of them. People who used to collect insects for home consumption cannot find them easily anymore in their surrounding areas (Spectrum, 2020c). Accelerating insect rearing and ensuring a steady supply of the most popular insect types, including crickets, bees, and bamboo worms, could provide them at affordable prices. Moreover, not only the availability of edible insects but also accessibility in many markets throughout the year might increase the frequency of insect consumption and help improve food and nutritional security in Myanmar. This information could also be useful for entrepreneurs looking to launch insect-rearing businesses and existing value chain actors looking to develop effective marketing plans. However, the giant cricket, as the most preferred edible insect species according to Nischalke et al. (2020), is difficult to mass rear due to its long life span (Miantsia et al., 2018). On the other hand, the possibility of sustainable domestication of giant crickets is constrained by their cannibalistic nature, as described by Cloutier (2015), as cited in Miantsia et al. (2018). Thus, more research is needed for giant cricket mass production.

In addition to the previously discussed factors, several other aspects influence the consumption frequency of edible insects in Myanmar, including ethnicity, family size, taste, smell, and safety concerns. These findings support earlier research conducted in countries such as China, Kenya, and Madagascar (Barennes et al., 2015; Dürr and Ratompoarison, 2021; Liu et al., 2020; Meysing et al., 2021; Omemo et al., 2021). Family size may influence the consumption frequency of edible insects due to the availability, accessibility and affordability of insect-based foods. It is possible that a larger family may have more resources and time to collect edible insects. For example, if a family lives in an area where edible insects are abundant, a larger family may be able to collect a larger quantity of insects in a shorter amount of time than a smaller family. Additionally, if the collection process requires manual labor, a larger family may have more people available to participate in the collection effort. Encouraging the use of insects as nature’s free protein source could, therefore, be an effective way to increase insect consumption in those families. Some people reported that they did not like the taste of insects, and the smell of insects was perceived as unpleasant, which deterred them from consuming insects. The taste and smell of insects can vary depending on the species, preparation method, and the recipe used. Promoting the use of different insect species with more desirable taste profiles or developing methods for cooking insects that enhance their flavor could be ways to increase their consumption. Similarly, developing methods for processing insects that reduce their odor or incorporating insects into dishes in ways that mask their smell could be ways to address this concern. Some people may be hesitant to consume insects due to concerns about food safety, including the risk of foodborne illness or contamination. Wild insects may be exposed to chemicals such as agricultural pesticides in their natural habitats (Barennes et al., 2015; Spectrum, 2020c, 2021c). These safety concerns can be mitigated when insects are reared and processed under safe and hygienic conditions.

Consequently, this dissertation attempted to investigate the consumer intention to eat edible insects using the extended Theory of Planned Behavior. The study found that attitudes, subjective norm, perceived behavioral control, and environmental concern all play a crucial role in shaping consumption intentions towards insects, aligning with previous research on entomophagy (Chang et al., 2019; Hwang & Kim, 2021; Pambo et al., 2018; Piha et al., 2018; Verneau et al., 2016). Interestingly, certain background factors such as administrative division, geographic location, education, and ethnicity were found to moderate consumption intentions. These results offer valuable insights for developing targeted marketing and consumer education strategies aimed at promoting insect consumption. As administrative division and level of education moderate the relationship between attitude and consumption intention, forming a positive attitude by providing information on the nutritional benefits of insects is especially important for individuals from regions and those with higher education. As administrative division and ethnicity serve as moderators of perceived behavioral control and consumption intention, increasing the availability of edible insects through accelerated insect farming could benefit non-Burmese ethnicities living in states and expand the availability of insect-based foods beyond wild harvesting throughout the year. Additionally, the study indicated that urban dwellers require promotional efforts, such as posting, rating, or reviewing promoted products on social media accounts of influencers or food bloggers, which are needed to strengthen a positive relationship between subjective norms and consumption intention. By targeting urban consumers with marketing and awareness campaigns, stakeholders may be able to increase their intention to consume edible insects and contribute to a more sustainable food system.

Lastly, this dissertation investigated consumer readiness to accept reared crickets as well as the factors affecting consumption intention towards reared crickets. The majority of respondents showed a favorable attitude towards reared crickets and were willing to consume them as food. Consumption intention towards reared crickets was directly influenced by attitude, perceived behavioral control, and trust in producers. Except for trust in producers, all results align with previous edible insect research findings (Bae & Choi, 2020; Chang et al., 2019; Menozzi et al., 2017; Pambo et al., 2018; Pambo, 2018). Additionally, subjective norm and consumer knowledge were found to indirectly affect consumption intention towards reared crickets via attitude.

Attitude stands out as the most prominent factor of intention to eat edible insects and reared crickets; thus, it is required to realize people's attitudes towards them. A positive attitude towards edible insects and reared crickets is a good starting point to motivate people to consume insects. Effective marketing campaigns can play a vital role in shaping consumer attitudes. These campaigns should highlight the nutritional benefits of insects. This involves disseminating information on the benefits of consuming edible insects through mass and social media, public forums, or the distribution of brochures or leaflets. Additionally, targeting consumers who are open to trying new foods and may be more receptive to edible insects can help shift public perceptions and attitudes.

The influence of subjective norms on attitude and consumption intention towards edible insects was found to be positive, whereas reared crickets did not yield significant results. This suggests that social media and influencer marketing can be leveraged to increase insect consumption in Myanmar. Subjective norm did not significantly impact reared cricket consumption, as respondents' important and respectful persons or opinion leaders have no experience in reared cricket consumption. However, entomophagy can still be promoted by featuring insect consumption alongside reared crickets in social media content posted and shared by popular figures and influencers, including chefs, athletes, and nutritionists. Platforms such as Facebook, Twitter, and TikTok offer powerful tools for spreading awareness and influencing consumer behavior in favor of entomophagy.

As perceived behavioral control influences consumption intention, there may be perceived difficulties in insect consumption. Minimizing any perceived obstacles that consumers may encounter and boosting consumers' confidence in their ability to consume insects can be valuable strategies for promoting insect consumption. Marketers can use this information to determine what barriers prevent consumers from consuming insects. Although insects are available throughout the country, their accessibility is limited due to seasonal availability and the underdeveloped insect farming sector in Myanmar. On the other hand, in Western countries where insect consumption is not yet widespread, insects are available in specific supermarkets. In contrast, insects are presently unavailable in supermarkets or minimarts in Myanmar. Instead, edible insects are mainly sold at kiosks, mobile stalls, vendors, and hawkers, which may not be available all the time. Although online shopping for edible insects is gaining popularity in major cities such as Yangon and Mandalay, it is not yet accessible outside urban areas. Hence, promoting the availability of insect-based products in grocery stores and restaurants is an important strategy to enhance insect consumption. By providing education, guidance, access to edible insects, and skills such as cooking methods, stakeholders may be able to increase consumers' perceived behavioral control and confidence in their ability to consume insects.

Environmental concern is another crucial factor in shaping consumers' intention to consume edible insects, indicating that consumers are becoming increasingly aware of the impact of wild insect harvesting on the environment. Thus, promoting the environmental benefits of insect foods may be an effective strategy for increasing insect consumption in Myanmar. Highlighting a low carbon footprint, efficient use of resources, and potential to contribute to sustainable food systems of edible insects can promote their environmental benefits. This is particularly relevant for entrepreneurs in the insect-rearing industry, who could benefit from transitioning from wild harvesters to farmers in order to mitigate the negative environmental impact of wild collections. Raising awareness about insect farming can help reduce the environmental consequences of overharvesting wild insects. Developing insect-rearing farms in conjunction with an effective marketing strategy could provide edible insects all year round and reduce malnutrition and food insecurity in some instances. Market players should take advantage of consumers' environmental concerns by, for example, realizing how their consumption affects the environment. This will increase consumer awareness of the consequences of eating both wild and reared insects and the overall demand for edible insects. In addition, it may be useful to target consumers who are already environmentally conscious or who are interested in sustainable food choices. By tailoring messaging and marketing efforts to these groups, stakeholders may be able to increase their intention to try edible insects and contribute to a more sustainable food system.

One of the main findings of this study was that consumers' trust in producers is essential in shaping individual favorable attitudes and consumption intention towards reared crickets. This information allows stakeholders to implement more sophisticated and powerful marketing strategies for reared crickets. Cricket producers can establish public trust by implementing ethical and transparent production practices, providing product quality and safety information, and engaging with consumers through education and outreach efforts. Public trust can also be gained by following Good Manufacturing Practice guidelines, mandatory for food processing issued by the national Food and Drug Administration, along with the whole cricket production process. Although Myanmar has not yet developed any regulations for insect farming, in 2020, FAO developed standards for cricket farmers to adhere to and developed a defined inspection methodology to maintain food safety and prevent contamination (Hanboonsong and Durst, 2020). It can be applied to ensure the safety and sustainability of edible insect foods in Myanmar. Partnering with reputable third-party organizations or certification programs can also build consumer confidence and credibility in cricket products. By building trust and transparency in their operations, cricket producers could attract more consumers interested in trying edible insects and ultimately increase the demand for this sustainable food source.

Our results on consumer knowledge of the environmental friendliness of crickets farming can be valuable for developing the cricket rearing business. Increasing consumer knowledge and awareness of farming insects is necessary for promoting the acceptance and consumption intention of reared crickets as foods. This may involve educating, awareness initiatives, and informing consumers about the benefits of insect farming. Educating consumers about the health and sustainability advantages of farmed insects can lead to increased acceptance and adoption of this alternative protein source. The power of mass media could be used to raise public awareness of the environmental and health benefits of eating reared crickets, as well as the growing trend of crickets farming as an alternative supply to the increasing protein demand of the world. In addition, offering tastings, workshops, and other educational experiences can help familiarize consumers with insect farming and increase their comfort level with consuming insects. As the public becomes more aware of the positive impact of cricket farming, their attitude towards it becomes more favorable, leading to an increase in consumption intention. By using these strategies, stakeholders can promote the development of a sustainable and thriving cricket rearing industry.

7.2 General conclusions

The results of our study indicate that entomophagy is a well-established practice in Myanmar, with the majority of respondents reporting previous experience and current engagement in consuming insects. Consequently, entomophagy is wholly prevalent among all ethnic groups in all states and regions of the country, encompassing both urban and rural populations throughout Myanmar, suggesting that there is no inherent consumer acceptance problem in Myanmar. As such, edible insects have the potential to serve as an alternative source of animal protein to combat food insecurity and malnutrition issues in the country. This could help policymakers and non-governmental organizations to understand edible insects as a viable alternative to conventional meat protein. However, while there is moderate acceptance, insect consumption remains occasional due to significant barriers that hinder regular consumption. Thus, the possibility of edible insects alleviating food and nutrition insecurity remains challenging without a well-planned strategy. This will require a multifaceted approach that addresses each of these factors strategically and comprehensively. This involves the implementation of nationwide nutrition plans that incorporate edible insects. Such plans could be instrumental in promoting insect-based protein as a viable alternative to conventional meat protein, particularly in regions with high consumer acceptance. Launching insect-based nutrition programs in some ethnicities with high consumer acceptance is possible.

Indeed, promoting the consumption of edible insects and reared crickets in Myanmar is a complex task that requires a multi-faceted approach that needs to consider various factors. These factors include price and availability of edible insects, cultural and religious taboos, negative opinions, fear, social concerns, discomfort, attitude, subjective norms, perceived behavioral control, environmental concerns, trust in cricket producers, consumer knowledge, education level, administrative division, ethnicity, and urbanization. In order to consume edible insects regularly, it is crucial to address the issues of price and availability of edible insects, which can be achieved by boosting insect rearing to provide a greater and more steady supply across the entire country, even during the off-season, and ultimately increasing insect consumption. Disseminating knowledge about the production and collection of insects through mainstream and social media could also help reduce the stigma associated with insect consumption. Safety concerns related to chemical contamination can be addressed through transparency in the insect processing stages, from production/ harvesting to retail sales. Adherence to food safety guidelines set by the national Food and Drug Administrations can help control food safety concerns. To increase the consumption of insects, it is crucial to provide information on how to prepare and cook them in delicious and appealing ways. Moreover, promoting the consumption of edible insects in Myanmar requires targeted efforts that take into account factors such as education level, administrative division, ethnicity, and urbanization.

Efforts to increase knowledge and awareness of the nutritional benefits of insects and the sustainability of insect farming can help shape a positive attitude towards insect consumption. Furthermore, increasing the availability of edible insects can enhance consumers' perceived behavioral control and increase their intention to consume insects. To effectively promote insect consumption, stakeholders should leverage effective marketing campaigns, target open-minded consumers, and work with influential individuals and groups. Additionally, it is essential to boost consumers' confidence in their ability to consume insects. Environmental concerns should be emphasized to promote the benefits of insect-based foods in sustainable food systems. Trust in cricket producers is essential; transparent production processes and credible safety measures can help establish consumer confidence. Increasing consumer knowledge and awareness of insect farming is necessary for promoting acceptance and consumption intention of reared crickets as food. By focusing on these strategies, stakeholders can help to shift public perceptions and attitudes towards edible insects and ultimately promote insect consumption as a nutritious and eco-friendly food source in Myanmar. Overall, a multifaceted approach that combines education, marketing, and increased availability is necessary to promote insect consumption in Myanmar and contribute to a more sustainable food system.

7.3 Theoretical implications

There are barely any consumer studies on edible insects in entomophagous countries like Myanmar; the current study tried to close this gap. Being the first consumer analysis in Myanmar, this research adds to the existing literature on edible insects by examining consumer behavior towards edible insects and reared crickets as foods to understand the prospects of entomophagy in Myanmar. This research supported the appropriateness of the Theory of Planned Behavior in analyzing consumer intention towards edible insects in Myanmar. In addition, the study proved that broadening the scope of the TPB model is possible for edible insect research. On the other hand, the results of the Heckpoisson regression are supported by various literature, and the validity of the results was supported by a robustness check. Hence it can be concluded that Randall and Sanjur's (1981) model is also an appropriate model for understanding insect consumption behavior in Myanmar. While Randall and Sanjur's model effectively explained the direct effects of individual, product and environmental factors on consumption behavior, the TPB model explains consumption behavior using social psychology. According to its assumptions, only TPB constructs have a direct effect on consumer behavior; however, the TPB model does not ignore the effects of background characteristics; hence, the indirect impacts of these effects also explain consumption behavior through TPB constructs. Using these two models helps to understand the direct effect, moderating effect and psychological effect; thus, the theoretical contribution of this study provides clarity for a full comprehension of the topic and lays the foundation for future research.

Not only the predictors but also the measured variables and tested effects in each model are different. Thus, the results from those models are not comparable. Only some factors, such as gender, age, education, income, location, ethnicity, family size and religion, were applied in both models. In the TPB model, the indirect effects of those factors on consumption intention using components of TPB were tested. Instead, the direct effects of those factors on consumer acceptance and consumption frequency of edible insects were tested in Randall and Sanjur's model. For example, income, family size, and religion directly affect consumption behavior in

Randall and Sanjur's model but did not show any indirect effects in the TPB model. Similarly, education level and location showed indirect effects on consumption behavior in the TPB model but did not have any direct effect in Randall and Sanjur's model. In other words, some background factors have direct effects on consumer behavior, but they do not moderate psychological factors such as attitudes, subjective norm, and perceived behavioral control. In contrast, some background factors moderate attitudes, subjective norm, and perceived behavioral control to perform the behavior, but they do not directly affect consumption behavior. From this, we can conclude that the results of the TPB model cannot directly translate to the results of Randall and Sanjur's model due to the time differences in our study. This study used TPB to predict very near future consumption intentions, whereas Randall and Sanjur's model was used to explain the previous insect consumption. This indicates that both models should be utilized to predict for the same period, such as future consumption should be predicted by Randall and Sanjur's model and future intent should be predicted by the TPB model.

7.4 Recommendations

Despite widespread insect consumption in Myanmar, the consumption rate is relatively low. Based on the findings of this dissertation, recommendations for the enhancement of insect consumption are as follows:

<u>For policymakers and non-governmental organizations</u>

- Governments and organizations should encourage entrepreneurs to invest in the insect sector as well as wild insects to turn them into mini-livestock farmers by providing insect-rearing training and required facilities.
- Public awareness campaigns to prevent wild insect extinction and public fora on farming insects for consumption should be held to raise public awareness of the environmental and health benefits of eating farmed insects.
- Data and information regarding wild insect populations should be collected to know which edible insect species are endangered or decreasing in population. Wild harvesting should be prohibited for endangered species, while for the sake of preserving other wild insects, restrictive harvesting periods and harvesting amounts should be specified in law-and-order directives for every edible insect species. Such directives should be publicized and executed.

- More importantly, the government should set rules and regulations regarding insect production, food safety, and hygiene and monitor whether food value chain actors follow the laid-down rules and regulations.

For stakeholders

- Wild insect harvesters should try to expand their business by making initiatives on insects that can either be reared or semi-cultivated.

- Everyone who engages in insect harvesting, production, trading, processing, or selling should prioritize food safety. Although there is no specific guideline for insects, they must practice and follow the Good Manufacturing Practice guidelines for food products issued by the national Food and Drug Administration throughout the process, including preparation and handling, to provide safe food.

- It is impossible to prevent the extinction of all wild insect species; however, if consumers have the option of purchasing reared insects instead of wild insects, they should make an effort to support reared insects as much as possible to prevent the extinction of any species.

Various stakeholders such as cricket farmers, the government, local authorities, and local and international organizations working on environmental protection and food security are responsible for implementing these activities to avoid overexploitation of wild insects, prevent ecosystem degradation, improve food security, and enhance the insect-rearing industry in countries like Thailand, a neighboring country of Myanmar.

7.5 Limitations of this study and future research

Despite the fact that this dissertation met its objectives, certain limitations were identified. The first limitation is associated with the data collection method itself. Although a telephone interview is not costly, it could not represent the rural-urban population. Most respondents in this survey were from metropolitan areas, whereas in reality, 70% of the population of Myanmar resides in rural areas. Even if the proportion of insect consumers in rural and urban areas appears comparable, results may vary if the sample is more representative, as insect consumption habits may differ. Additionally, most respondents were Buddhists, and only a few Hindu (1%) and Muslim (2%) respondents represent the actual population; thus, it is not easy to reflect the perception of respondents from each religion. The results could have differed if more Muslims and Hindus had expressed different perspectives. Thus, it would have been prudent to conduct the study with more respondents from those beliefs to obtain more reliable and accurate results in terms of religion. Future research could attempt to describe them and find out whether the findings of this study can be replicated. Another limitation was that as the survey was conducted during the February 2021 military coup, where many individuals were anxious, and thus, it might have a reporting bias effect on the consumption frequency of edible insects.

Likewise, this study did not consider the effect of price on the consumption frequency of edible insects. There was no direct price effect for those who harvest edible insects by themselves for home consumption, but there might be a price effect for those who buy edible insects. As the current study neglects price, there is no way of finding out whether the price of edible insects is higher than that of substitute food products such as meat and fish. According to the law of demand, the consumption frequency of edible insects for those who purchase them might rise or fall depending on the relative prices of available options. Moreover, this research failed to explore consumption habits (for example, insects as a snack or as part of a meal), how much they eat (amount of consumption per capita), and how they get them (bought or harvested or a gift). By collecting such data, important information, for instance, whether freely available insects lead to higher consumption levels in rural areas, can be known to better understand the current situation of eating insects as a possible solution to food security. Future researchers should broaden their scope and cover those not explored in the current study.

Another constraint was that this study focused on the intention to consume edible insects in the three consecutive months. Insect consumption in Myanmar mainly relies on wild insects, and most insects are seasonal—they are usually only available once a year for a short period of time. Thus, consumption intention for different times of the year should be explored. Research on consumer intention towards reared crickets is required to fill in the gaps left by the current study, which only explored two major regions of Myanmar (Yangon and Mandalay). Further research that covers the entire nation is needed. The growth of insect farming in Myanmar requires research into the intention to consume reared crickets and the desire to consume other types of reared insects.

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Appendices

Appendix A: A questionnaire survey.

Date: ____ /___ /2021 Time:____:____

Respondent's Number: ☐☐☐ Cell Phone Number: __________________

The survey is part of my PhD study. The study aims to contribute to a better understanding of attitudes towards nutrition and food issues. Therefore, I will ask you some questions about your consumption of edible insects. The interview will take about 15 minutes. All data will be used exclusively for scientific purposes. The analysis of the data will be anonymous.

SECTION A: CONSUMPTION (CONSUMER ACCEPTANCE)

1. Have you ever heard about edible insects?

   ☐1. Yes ☐2. No

2. Edible insects are nutritious food.

   ☐1. Strongly disagree ☐2. Disagree ☐3. Neutral, ☐4. Agree ☐5. Strongly agree

3. Are edible insects generally available in your town/ village?

   ☐1. Yes ☐2. No

4. If yes, please provide the name of the edible insects……………………………………

   ………………………………………………………………………………………….

5. Are meat and fish readily available in your town/village?

   ☐ 1. Yes ☐ 2. No ☐ 3. Neutral

6. Do you think the practice of consuming edible insects as food is a good habit?

   ☐ 1. Yes ☐ 2. No

7. Are you afraid of edible insects?

   ☐ 1. Yes ☐ 2. No ☐ 3. Neutral

8. Do you feel disgusted with edible insects?

   ☐ 1. Yes ☐ 2. No ☐ 3. Neutral

9. Have you ever consumed edible insects as a meal or snack?

   ☐ 1. Yes ☐ 2. No

   If not, why not? ……………………………………………………………………

10. If yes, have you recently eaten insects (recently means current consumption and last month consumption/last season consumption/ last year consumption)?

☐ 1. Yes ☐ 2. No

If not, why not? ……………………………………………………………………….

11. Consuming edible insects is a symbol of lower status.

☐1. Strongly disagree ☐2. Disagree ☐3. Neutral, ☐4. Agree ☐5. Strongly agree

12. The thought of consuming insects makes me feel uncomfortable.

☐1. Strongly disagree ☐2. Disagree ☐3. Neutral, ☐4. Agree ☐5. Strongly agree

SECTION B: EXPERIENCE WITH CONSUMING EDIBLE INSECTS

This section relates to the people who say **"YES"** in question no. 10. People who say **"NO,"** skip those questions and directly go to **"SECTION C."**

<table>
<tr><th colspan="2">Questions</th><th colspan="6">Variety of Edible Insects</th></tr>
<tr><td>13.</td><td>What kind of insect did you eat (species)?</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>14.</td><td>Please describe the preferable one</td><td colspan="6"></td></tr>
<tr><td rowspan="2">15.</td><td rowspan="2">How would you rate the taste of edible insects (each species)?</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="6">Very bad =1, bad =2, Neutral=3, Good =4, Very good =5</td></tr>
<tr><td rowspan="2">16.</td><td rowspan="2">How much do you like them?</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="6">Dislike very much =1, Dislike=2, Neither like nor dislike=3, Like=4, Like very much =5</td></tr>
<tr><td rowspan="2">17.</td><td rowspan="2">The smell of edible insects looks attractive to me.</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="6">Strongly disagree=1, Disagree=2, Neutral=3, Agree=4, Strongly agree=5</td></tr>
<tr><td>18.</td><td>Consumption Frequency: times per year</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Questions		Variety of Edible Insects					
19.	Would you like to eat both wild and reared edible insects?						
		No, only wild =1, No, only reared = 2, Yes, both = 3					
20.	I am afraid that insects are contaminated with insecticides or pesticides.						
		Strongly disagree=1, Disagree=2, Neutral=3, Agree=4, Strongly agree=5					

SECTION C: TPB CONSTRUCTS FOR EDIBLE INSECTS

This section has no right or wrong answers for the following statements about edible insects. Edible insects are insect species such as crickets, silkworms, bamboo worms, beetles, bees, palm weevils, etc., used for consumption in the form of either raw, cooked, fried, or boiled. Please indicate to which degree you agree or disagree with the statements. Choose the answer that is most applicable to you. Your opinion is important to me.

Sr.	Statements	Strongly disagree (1)	Disagree (2)	Neither / Nor (3)	Agree (4)	Strongly Agree (5)
A.	**Attitudes**					
21.	I am interested in eating edible insects.					
22.	I think that consuming edible insects is a good idea.					
23.	I think that consuming edible insects is beneficial.					
B	**Subjective norms**					
24.	People I respect would consume edible insects.					
25.	People close to me probably find edible insects as food enjoyable.					

Sr.	Statements	Strongly disagree (1)	Disagree (2)	Neither / Nor (3)	Agree (4)	Strongly Agree (5)
26.	People important to me won't mind if I consume edible insects.					
C.	**Perceived behavioral control**					
27.	Whether or not I consume edible insects is completely up to me.					
28.	I am confident that I could consume edible insects if I wanted.					
29.	For me, consuming edible insects is easy.					
D.	**Environmental concerns**					
30.	Humanity is severely abusing the environment.					
31.	Humans must live in harmony with nature in order to survive.					
32.	When humans interfere with nature, it often produces disastrous consequences.					
E.	**Consumption intention**					
33.	I plan to eat edible insects in the next three months.					
34.	I intend to consume edible insects in the next three months.					
35.	I am willing to recommend others to consume edible insects.					

SECTION D: SOCIO-DEMOGRAPHICS

36. Area (State/Region): ____________________

37. Location ☐ 1. Rural ☐2. Urban

38. Gender ☐ 1. Male ☐ 2. Female

39. Age range ☐ 1. Child (≤ 16) ☐2. Young adult (17-30) ☐ 3. Middle-aged adult (31-45) ☐ 4. Old-aged adult (over 45)

40. Education ☐1. ≤ Middle school ☐ 2. High school ☐ 3. Undergraduate ☐ 4. ≥ Bachelor's degree

41. Income/month in MMK ☐1. Lowest (≤ 300,000) ☐ 2. Low (300,001-600,000) ☐ 3. Medium (600,001-900,000) ☐ 4. High (> 900,000)

42. Ethnicity ___________________________

43. Religion ___________________________

44. Family size ☐1. Small (up to 3) ☐2. Medium (4 to 6) ☐ 3. Large (≥ 7)

SECTION E: TPB CONSTRUCTS FOR REARED CRICKETS

This section is only for people from Yangon and Mandalay who have experienced eating crickets.

Sr.	Statements	Strongly disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
A.	**Attitude**					
45.	I am interested in eating reared crickets.					
46.	I think that consuming reared crickets is a good idea.					
47.	I think that consuming reared crickets is beneficial.					
B.	**Subjective norms**					
48.	People I respect would consume reared crickets.					
49.	My family member would consume reared crickets.					
50.	People important to me won't mind if I consume reared crickets.					

Sr.	Statements	Strongly disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
C.	**Perceived Behavioral Control**					
51.	Whether or not I consume reared crickets is completely up to me.					
52.	I could consume reared crickets instead of wild ones if I wanted to.					
53.	I think it is easy for me to consume reared crickets.					
D.	**Perceived Product Quality**					
54.	Reared crickets are safe to eat.					
55.	Reared crickets are nutritious food.					
56.	Reared crickets do not contain chemicals.					
E.	**Consumer Knowledge**					
57.	Reared crickets need less energy and water compared to livestock.					
58.	Eating reared crickets is good for the environment.					
59.	Consuming reared crickets can reduce greenhouse gas emissions.					
F.	**Trust in Producer**					
60.	Cricket producers take good care of the safety of our food.					
61.	Cricket producers have the competence to control the safety of food.					

Sr.	Statements	Strongly disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
62.	Cricket producers have sufficient knowledge to guarantee the safety of food products.					
G.	**Trust in Retailer**					
63.	Retailers take good care of the safety of our food.					
64.	Retailers are sufficiently open regarding the safety of food.					
65.	Retailers are honest about the safety of food.					
H.	**Consumption Intention**					
66.	I plan to eat reared crickets in the next three months.					
67.	I intend to consume reared crickets in the next three months.					
68.	I am willing to recommend others to consume reared crickets.					

"Thank you for your participation."

Appendix B

Supplementary material for chapter IV:

'Factors affecting consumption of edible insects as food: Entomophagy in Myanmar'

Table S1: Pearson correlation test result of the variables of consumption (consumer acceptance).

Factors	consume	gender	ethnicity	religion	opinion	disgust	phobia	nutritious	social concerns	discomfort
consume	1									
gender	0.17	1								
ethnicity	0.06	0.05	1							
religion	0.03	−0.04	−0.14	1						
opinion	0.40	0.11	0.10	0.07	1					
disgust	−0.52	−0.14	−0.01	0.03	−0.35	1				
phobia	−0.48	−0.27	0.00	0.03	−0.31	0.54	1			
nutritious	0.31	0.14	0.16	0.02	0.35	−0.19	−0.13	1		
social concerns	0.09	0.00	−0.03	0.06	0.25	−0.14	−0.15	0.14	1	
discomfort	−0.40	−0.11	−0.04	−0.11	−0.36	0.40	0.33	−0.23	−0.24	1

Table S2: Pearson correlation test result of the variables of consumption frequency.

Factors	frequ-ency	gender	age	edu-cation	income	Loca-tion	ethni city	family size	natural -ness	taste	nutri-tious	safety	smell
frequency	1.00												
gender	0.08	1.00											
age	−0.01	−0.01	1.00										
education	0.04	−0.16	0.00	1.00									
income	0.10	0.07	0.25	0.22	1.00								
location	0.03	−0.09	0.15	0.29	0.18	1.00							
ethnicity	0.16	0.05	−0.07	0.05	−0.10	0.04	1.00						
family size	0.07	−0.06	−0.02	−0.01	0.06	0.02	0.05	1					
naturalness	0.26	0.16	−0.04	−0.07	−0.05	−0.12	0.05	0.01	1				
taste	0.52	0.14	0.01	0.01	0.07	0.01	0.14	0.03	0.49	1			
nutritious	0.16	0.14	0.03	0.00	0.01	−0.01	0.16	0.03	0.20	0.30	1		
safety	−0.09	−0.02	−0.09	−0.03	−0.03	0.03	−0.01	0.02	−0.07	−0.07	0.00	1	
smell	0.43	0.19	0.00	−0.05	0.00	−0.05	0.07	0.02	0.67	0.77	0.33	0.01	1

Table S3: Multicollinearity tests.

Consumption (Consumer acceptance)			Consumption frequency		
Variables	VIF	1/VIF	Variables	VIF	1/VIF
Opinion	1.36	0.74	Attractive smell	3.65	0.27
Discomfort	1.28	0.78	Taste	2.62	0.38
Insect phobia	1.26	0.79	Naturalness	1.88	0.53
Nutritious	1.19	0.84	Income	1.19	0.84
Social concern	1.11	0.9	Education	1.18	0.85
Gender	1.09	0.91	Nutritious	1.16	0.86
Ethnicity	1.06	0.94	Location	1.15	0.87
Religion	1.05	0.95	Age	1.11	0.9
Mean VIF	1.17		Gender	1.10	0.91
			Ethnicity	1.08	0.93
			Food safety	1.04	0.96
			Family size	1.02	0.98
			Mean VIF	1.51	

Table S4: Breusch–Pagan / Cook–Weisberg test for heteroskedasticity.

Model	Results	
Consumption (Consumer acceptance)	chi2(1) = 40.76	Prob > chi2 = 0.0000
Consumption frequency	chi2(1) = 801.26	Prob > chi2 = 0.0000

Appendix C

Supplementary material for chapter V:

'Predicting consumers' intention towards entomophagy using an extended theory of planned behavior: evidence from Myanmar'

Supplementary Table 1: Population and participants in a telephone interview by administrative division and gender.

Sr.	States and regions	Total Population (2014 Census data)[5]			Collected Number of respondents		
		Male	Female	Total	Male	Female	Total
A	**States**	**7,450,973**	**7,645,607**	**15,096,580**	**122**	**134**	**256**
1	Kachin	878,384	811,057	1,689,441	12	13	25
2	Kayah	143,213	143,414	286,627	11	14	25
3	Kayin	775,268	798,811	1,574,079	10	14	24
4	Chin	229,604	249,197	478,801	12	13	25
5	Mon	987,392	1,067,001	2,054,393	13	15	28
6	Rakhine	1,526,402	1,662,405	3,188,807	22	24	46
7	Shan	2,910,710	2,913,722	5,824,432	42	41	83
B	**Regions**	**17,373,613**	**19,016,060**	**36,389,673**	**305**	**311**	**616**
8	Ayeyarwady	3,009,808	3,175,021	6,184,829	43	44	87
9	Bago	2,322,338	2,545,035	4,867,373	35	35	70
10	Magway	1,813,974	2,103,081	3,917,055	21	27	48
11	Mandalay	2,928,367	3,237,356	6,165,723	67	70	137
12	Naypyitaw (Union territory)	565,155	595,087	1,160,242	11	14	25
13	Sagaing	2,516,949	2,808,398	5,325,347	34	42	76
14	Tanintharyi	700,619	707,782	1,408,401	12	12	24
15	Yangon	3,516,403	3,844,300	7,360,703	82	67	149
	Total	**24,824,586**	**26,661,667**	**51,486,253**	**427**	**445**	**872**

[5] This data is from 2014 census data ((DOP), 2015).

Supplementary Table 2: Descriptive statistics of the TPB constructs and background factors.

Factors	Statistic					Skewness		Kurtosis	
	Number	Min	Max	Mean	Std. Deviation	Statistic	Std. Error	Statistic	Std. Error
Administrative division	872	0	1	0.29	0.456	0.908	0.083	-1.178	0.165
Location	872	0	1	0.67	0.471	-0.712	0.083	-1.497	0.165
Gender	872	0	1	0.49	0.500	0.041	0.083	-2.003	0.165
Age	872	1	3	1.67	0.734	0.609	0.083	-0.928	0.165
Education	872	1	4	3.04	1.082	-0.662	0.083	-0.980	0.165
Income	872	0	1	0.85	0.360	-1.936	0.083	1.753	0.165
Ethnicity	872	1	8	5.70	1.488	-1.549	0.083	2.715	0.165
Religion	872	0	1	0.88	0.322	-2.388	0.083	3.710	0.165
Family size	872	1	3	1.88	0.624	0.094	0.083	-0.490	0.165
Consumption	872	0	1	0.72	0.448	-0.995	0.083	-1.011	0.165
ATT1	872	1	5	3.31	0.977	-0.580	0.083	-0.843	0.165
ATT2	872	1	5	3.07	0.906	-0.134	0.083	-0.906	0.165
ATT3	872	1	5	3.19	0.877	-0.333	0.083	-0.816	0.165
SN1	872	1	5	3.37	0.842	-0.792	0.083	0.031	0.165
SN2	872	1	5	3.44	0.849	-0.698	0.083	0.179	0.165
SN3	872	1	5	3.10	0.832	-0.264	0.083	-0.077	0.165
PBC1	872	1	5	3.33	0.937	-0.732	0.083	-0.153	0.165
PBC2	872	1	5	3.12	0.924	-0.403	0.083	-0.789	0.165
PBC3	872	1	5	3.12	0.881	-0.385	0.083	-0.579	0.165
EC1	872	2	5	4.06	0.641	-0.765	0.083	1.933	0.165
EC2	872	3	5	4.31	0.509	0.302	0.083	-0.775	0.165
EC3	872	3	5	4.28	0.573	-0.091	0.083	-0.518	0.165
CI1	872	1	5	3.13	1.048	-0.347	0.083	-0.897	0.165
CI2	872	1	5	3.09	1.057	-0.250	0.083	-0.850	0.165
CI3	872	1	5	2.74	0.929	0.141	0.083	-0.667	0.165

Supplementary Table 3: The model fit indices of the models of the moderating factors.

Moderators		Absolute fit			Parsi-monious fit	Incremental fit			
		Chi-square	GFI	RMSEA	x2/f	AGFI	CFI	NFI	TLI
Administrative division	Regions	160.53	0.96	0.05	2.36	0.94	0.98	0.96	0.97
	States	121.29	0.94	0.06	1.78	0.90	0.97	0.94	0.97
Location	Rural	141.71	0.94	0.06	2.08	0.90	0.96	0.93	0.95
	Urban	151.32	0.96	0.05	2.23	0.94	0.98	0.97	0.97
Gender	Male	131.83	0.96	0.05	1.94	0.94	0.98	0.95	0.97
	Female	139.13	0.96	0.05	2.05	0.93	0.98	0.96	0.97
Age	≤ 30	131.60	0.96	0.05	1.94	0.94	0.98	0.96	0.97
	> 30	143.25	0.96	0.05	2.11	0.93	0.98	0.96	0.97
Education	≤ High school	100.45	0.95	0.04	1.48	0.92	0.98	0.95	0.98
	≥ University level	166.28	0.96	0.05	2.45	0.94	0.98	0.96	0.97
Income	< 200 USD	189.09	0.96	0.05	2.78	0.94	0.98	0.96	0.97
	≥ 200 USD	108.79	0.91	0.07	1.60	0.86	0.96	0.89	0.94
Ethnicity	Burmeses	155.01	0.96	0.05	2.28	0.94	0.98	0.96	0.97
	Others	141.31	0.93	0.06	2.08	0.90	0.97	0.94	0.96
Religion	Buddhists	182.18	0.97	0.05	2.68	0.95	0.98	0.97	0.97
	Others	112.96	0.87	0.08	1.66	0.81	0.94	0.87	0.92
Family size	Small (≤ 3)	135.58	0.93	0.07	1.99	0.89	0.96	0.93	0.95
	Others (> 3)	143.16	0.97	0.04	2.11	0.95	0.98	0.97	0.98
Consumption experience	Yes	144.02	0.97	0.04	2.12	0.95	0.98	0.96	0.97
	No	121.84	0.93	0.06	1.79	0.90	0.96	0.92	0.95
Acceptable range		> 0.05 (p<0.001)	>0.90	<0.08	< 3.0	< 3.0	>0.90	>0.90	>0.90