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ACCEPTANCE OF INSECTS AS FOOD: AN EXPLORATORY STUDY OF YOUNG CONSUMERS IN MACAU

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ABSTRACT

Substitute foods are increasingly popular to reduce our environmental footprint and promote food security. As the world population is expected to grow and food resources become scarce, insects as food have recently gained attention as a viable alternative. In the present study, a model grounded on the Theory of Planned Behavior (TPB) is proposed and analyzed through structural equation modeling software (SmartPLS) to assess consumers' intentions toward insects as food. Except for subjective norm, both attitude and perceived behavioral control were key determinants of intention and, in turn, of actual use behaviour. Despite insects being consumed in nearly 1/4 of the sample (for instance in Chinese medicine), the study found that respondents were on average relatively unwilling to use them as a dietary habit. Also, it appeared that men were more likely to consume insects as food than women. The insights of our study have important implications for practitioners and policymakers seeking to promote sustainable nutritional practices among consumers. This study is particularly relevant for Macau, as the city positions itself as a "UNESCO Creative City of Gastronomy" with the aim to develop internationally a unique and sustainable food image.

Key words: Insects as food, entomophagy, edible insects, consumer behaviour, environmental footprint, food security, theory of planned behaviour, attitude, behavioural control, dietry habit, nutritional practice

Some ideas are difficult to accept even when they bring advantages (Rogers, 2003). Ideas can take several years to become apparent, and, in practice, many of them fail to be widely accepted for several causes (Tidd, 2010). The reason for this is that consumers are often resistant to change and need time to get used to new concepts. For instance, when plant-based meat alternatives first came on the market, many consumers were initially skeptical, but over time they accepted the idea (Alcorta and Porta, 2021). As a means of reducing our environmental footprint and promoting human welfare, food substitutes have become increasingly popular. In particular, due to the anticipated increase in world population and scarce food resources, insects have recently drawn attention as an alternate source of food. According to the Food and Agricultural Organization (FAO), a viable way to address worldwide food security is through insect farming. This is because insects are everywhere and reproduce quickly, they have high growth and feed conversion rates with a minimal environmental footprint (FAO, 2013). Human diets have always included insects. Before people had the tools for hunting or farming, insects constituted an important component of the human diet (Kouřimskáa and Adámková, 2016).

Around the world, >2000 insect spices are considered edible (Mariod, 2020), and some are even part of the local cuisine. In Thailand, for example, worms and crickets are common street food (InsectGourmet, 2023), while in Mexico a specie of grasshopper served with beef and beans is considered a national dish (Mariod, 2020).

Similarly, in many areas of China, roasted larvae from worms, water beetles, or bee cocoons are consumed as gourmet foods (InsectGourmet, 2023). Eating insects in China has been an integral part of the culture since ancient times. In addition to providing nutrition, insects are the sources of active ingredients for traditional Chinese medicine (Xie et al., 2021) with a significant role in improving people's health and quality of life (Hong and Lampo, 2022). Currently, over 300 species of insects are documented as edible in China, but the number is growing (Guiné, Correia, Coelho and Costa, 2021). Although insects are becoming increasingly popular as food, there is a lack of research being conducted in Macau. An ex-Portuguese enclave where gambling is the pillar of the economy (Lampo, 2023), Macau was chosen as a "UNESCO Creative City of Gastronomy" in 2017. This international recognition,

in the government's plans, will help Macau become a diverse, truly unique, and sustainable city (The Macau Post Daily, 2017). However, while many studies have focused on consumers in Europe and the US (Liu et al., 2020) little is known about the intention toward edible insects in Macau. To fill the gap in the literature, we collected data from local consumers to assess the factors that influence their insect-related consumption decisions. Using the Theory of Planned Behavior (TPB) (Fishbein and Ajzen, 2009), a basic model to assess consumers' intentions was developed and analyzed by structural equation modeling (SmartPLS). To the best of our knowledge, this is the first quantitative study that examines consumers' intentions toward insects in Macau. This is especially relevant considering the city's plan to develop a sustainable image in the food sector. Additionally, this study's findings have implications for policymakers and practitioners who want to encourage local consumers to adopt sustainable nutritional alternatives.

The term "Entomophagy" is used to describe the eating of insects as food (Collins, 2023), a common practice in many countries around the world but predominantly in parts of Asia, Africa, and Latin America (FAO, 2013). Insects account for 80% of the world's species and are the most diverse group of organisms (Chantawannakul, 2020). From a nutritional standpoint, insects have significant protein content that varies from 20 to 76% of dry matter depending on the type and development stage of the insect (Kouřimskáa and Adámková, 2016). Insects are also rich in amino acids, fatty acids, and various minerals such as copper, iron, magnesium, manganese, phosphorous, selenium, and zinc as well as the vitamins riboflavin, biotin, and, in some cases, folic acid (Chantawannakul, 2020). Despite the benefits, consumer aversion is the largest barrier to adopting insects as viable sources of nutrients (FAO, 2013). When associated with food, insects are viewed as pests and a sign of filth due to food neophobia, which is the fear of eating unfamiliar foods Field (Bao and Song, 2022), however, many would be pleasantly surprised by their taste (Sjøgren, 2017). It is argued that the shape and appearance of insects play a significant role in consumers' responses (Liu et al., 2020). Research shows that curiosity drives people to try edible insects, while disgust and negative opinions from family and friends prevent them from doing so (Sogari, 2015). An additional barrier to consumption is the possibility that some insects produce or contain toxic compounds, or may contain residues of pesticides (Kouřimskáa and Adámková, 2016). While the West has been reluctant to adopt edible insects as food because insects are typically associated with uncleanliness (Bao and Song, 2022), studies suggest that Chinese consumers are more accepting of consuming insects due to their familiarity with the idea (Liu et al., 2020). However, China has only a limited amount of scientific research available. Past studies on entomophagy have demonstrated the environmental benefits of substituting meat protein with edible insects (Bao and Song, 2022). Livestock production accounts for around 15% of global greenhouse gas emissions and pollutes both the land and surrounding water (Sjøgren, 2017). Due to lower greenhouse gas emissions, water pollution, and land use, breeding insects appears to be more environmentally friendly than raising livestock (Lange and Nakamura, 2023). Therefore, it appears as insect-based foods could contribute to the achievement of sustainable development goals and help solve the looming issue of global food insecurity. Next, we examine the research model for assessing our sample's behavioral intentions toward edible insects.

MATERIALS AND METHODS

To assess the intention of Macau residents of consuming edible insects, exploratory study was conducted based on the Theory of Planned Behaviour (TPB) (Fishbein and Ajzen, Predicting and changing behaviour: The reasoned action approach, 2009). Developed upon the theory of reasoned action (TRA) (Fishbein and Ajzen, 1975) which is regarded as one of the most fundamental theories of human behaviour (Momani and Jamous, 2017). The TPB has been used in a variety of domains and represents an effort to predict and explain virtually any human behaviour (Lampo, 2022). At its core, the theory poses that the performance of a behaviour (for example using edible insects as food) is the consequence of the behavioural intention to perform that behaviour. The intention is in turn influenced by three predictors: i.e., attitude, subjective norm, and perceived behavioural control concerning the behaviour in question. As described in Lampo (2022), a person's attitude refers to positive or negative feelings about performing a behaviour. The subjective norm describes the perceived expectation of relevant others (e.g., family members, friends, etc.) as to whether an individual should perform a specific behaviour. Lastly, perceived behavioural control represents the perceived ease or difficulty of performing a specific behaviour. The TPB suggests that when the perceived behavioural control closely reflects an actual control, it may directly predict the behaviour (Fishbein and Ajzen, 2009),

thus behavioural control and behavioural intention can directly predict the actual behaviour. As a general rule, the stronger the attitude, the perceived norm, and the perceived behavioural control towards a specific behaviour, the higher an individual's intention to perform the behaviour in question. However, the relative importance of these three determinants is expected to vary depending on the behaviour and population under consideration (Fishbein and Ajzen, 2009). Figure 1 illustrates the conceptual model, while the associated hypotheses are subsequently reported in Table 1.

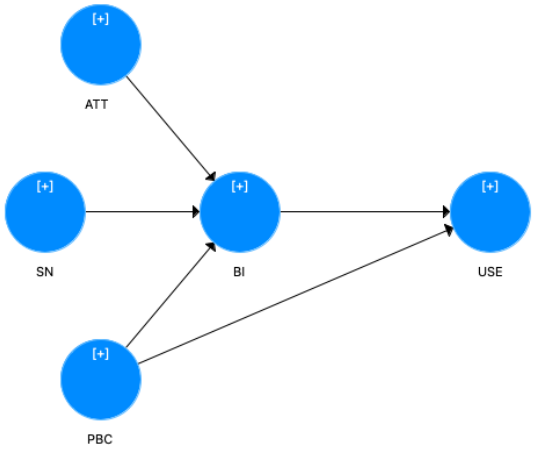

Fig. 1. Analytical framework (Smart PLS output)

To test our hypotheses about respondents' behaviour regarding the consumption of insects as food, a cross-sectional approach was adopted. To collect data, we used a self-administered survey based on the TPB framework. Each item was assessed using a 5-point Likert scale with anchors ranging from 1 (Disagree) to 5 (Agree). For better understanding, items were developed in English and then translated into traditional Chinese using the back-translation technique (Son, 2018). To gather insights quickly, convenience sampling and snowball (Flick, 2009) methods were used to recruit participants. The survey design included a pilot test with 10 respondents to identify problematic items and further improve the flow of the survey. Participants were provided with a link to a survey hosted in Google form, and their responses were downloaded at the end of the fieldwork. Regarding the minimum sample, we used the application G*Power (Erdfelder, Faul and Buchner, 1996). The software (settings: .15 effect size, .05 probability error, .80 power, and three predictors in the model) returned 77 cases as the minimum sample size.

The online survey-based data collection resulted in 137 responses. We had to discard 9 responses because of straight-lining (Shmueli, et al., 2019). In total, 128 valid and usable responses were obtained from fieldwork and deemed sufficient for an exploratory study. The contribution was voluntary and respondents were not remunerated for their participation. Besides guaranteeing anonymity, respondents were informed about the purpose of the research and that the findings would be published in aggregated form.

RESULTS AND DISCUSSION

The respondents were evenly divided between females (50.00%) and males (50.00%). The large majority of participants were below 34 of age (78.12%) while the remaining were under 44 (21.88). A majority of respondents reported having a bachelor's degree (31.25%) or a master's degree (31.25%). In 22% of the sample, it was found that insects were already consumed in some form (e.g., in Chinese medicine). SmartPLS version 3 (Ringle, Wende and Becker, 2022) was used to analyze the data. Before running the PLS algorithm, several factors were examined, including missing data, outliers, non-normality, and multicollinearity; and there was no cause for concern. It was initially found that the model explained 63.8% ($R^2 = 0.638$) of BI's variance and 31.9% ($R^2 = 0.319$) of USE's variance. A weak path was also observed in the relationship SN-BI ($\beta = 0.025$). However, to interpret these findings properly a 2-step process was necessary (Hair et al., 2021). Hence, the first step consisted in testing our data for reliability, internal consistency, convergent validity, and discriminant validity to determine whether the indicators of each

Table 1. Summary of hypothesis

H1	There is a positive and significant relationship between attitude (ATT) and behavioral intention (BI).
H2	There is a positive and significant relationship between subjective norm (SN) and behavioral intention (BI).
H3	There is a positive and significant relationship between perceived behavioral control (PBC) and behavioral intention (BI).
H5	There is a positive and significant relationship between perceived behavioral control (PBC) and use behavior (USE).
H4	There is a positive and significant relationship between behavioral intention (BI) and use behavior (USE).

Authors' table.

construct measured the same underlying concept and were different from other constructs in our model. In the evaluation of the measurement model, a common rule is that the standardized outer loading should be 0.708 or higher (Hair et al., 2021). In our case, the analysis reported a lower loading for the items PBC1 (0.460) with an adverse impact on the variance explained. By removing this item, BI's variance increased by 0.8%, thus bringing the explanatory power of the model to 64.6%. (R^2 = 0.646). There were no changes in USE as a result of the removal of the item. Then, because all of the outer model's measurements fell within the recommended thresholds (Shmueli et al., 2019). More precisely, all the loadings exceeded the critical value of 0.708, all the construct reliabilities (i.e., Cronbach's alpha, rho_A, and the composite reliability) had values above 0.70, and the average variance extracted (AVE) was higher than the threshold value of 0.50. Table 2 presents the reliability and validity of the construct in our model.

According to the literature, the heterotrait-monotrait (HTMT) criterion is the preferred method in PLS-SEM for evaluating the discriminant validity (Hair, Hult, Ringle and Sarstedt, 2021), testing that a construct does not relate to other variables in the model. All the values were below the conservative threshold of 0.85. As a result, the constructs in our model were significantly different and measured what they were supposed to measure. Table 3 reports the HTMT results. As all of the measurements fell within the suggested values (Garson, 2016; Hair, Hult, Ringle and Sarstedt, 2021), the outer model was successfully evaluated.

The second step consisted in examining the structural (or inner) model. To ensure that collinearity issues didn't affect the regression results, the constructs' VIF values were examined. In our case, VIF values reached a maximum of 2.906 and, therefore, below the recommended value of 3.3 (Garson, 2016). As mentioned, the revised model explained 64.6%. (R^2 = 0.646), of the dependent variable BI; this is regarded as a substantial explanatory power (Hair et al., 2021). On the other hand, the model explained 31.9% (R^2 = 0.316) of USE's variance; a result that is regarded as more than satisfactory as USE is solely dependent on the variable BI. A closer examination of the structural paths indicated that ATT (β= 0.608) had the strongest effect on BI, followed by PBC (β= 0.284). It was also

Table 3. Constructs discriminant validity

	ATT	BI	PBC	SN	USE
ATT	-				
BI	0.820				
PBC	0.836	0.816			
SN	0.764	0.594	0.697		
USE	0.459	0.589	0.504	0.363	-

Evaluating criterion: HTMT <0.85

Table 2. Constructs reliability and validity

Construct	Items	Loadings	Cronbach's Alpha	rho_A	C.R.	AVE
Behaviour intention (BI)	BI1	0.911	0.906	0.911	0.941	0.842
	BI2	0.943				
	BI3	0.898				
Attitude (ATT)	ATT1	0.830	0.896	0.916	0.917	0.766
	ATT2	0.806				
	ATT3	0.734				
	ATT4	0.910				
	ATT5	0.878				
	ATT6	0.812				
Subjective norm (SN)	SN1	0.898	0.886	0.891	0.929	0.735
	SN2	0.901				
	SN3	0.875				
Perceived behavioural Control (PBC)	PBC2	0.989	0.711	0.791	0.809	0.714
	PBC3	0.888				
Use behaviour (USE)	USE1	1.000	1.000	1.000	1.000	1.000

Evaluation criteria: Loadings >0.708; Cronbach's Alpha: >0.70; Rho_A: >0.70; Composite Reliability: >0.70; AVE: >0.50.

observed that BI had a strong impact on USE (β= 0.510). The bootstrap routine validated that these results were significant at the 5% level. The relationship SN→BI (β= -0.025) was negatively correlated and, together with the relationship PBC→USE (β= 0.079) was found not significant. The structural results are reported in Fig. 2.

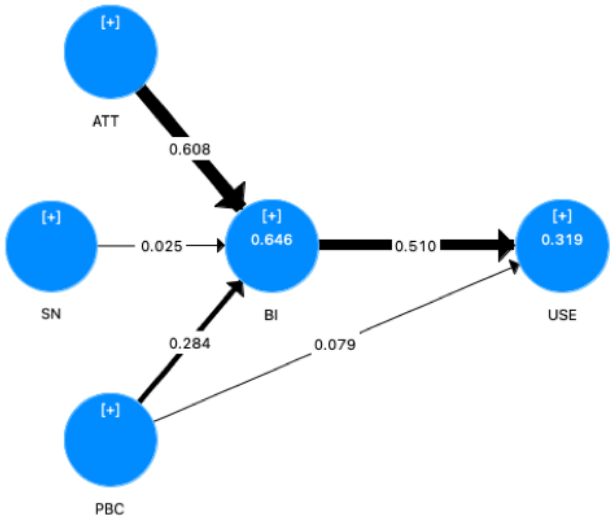

Fig. 2. PLS-SEM structural results

Additionally, the f^2 effect sizes were calculated to determine whether an omitted construct had a fundamental influence on intention and, in turn, on use behaviour. An effect size of approximately 0.02, 0.15, and 0.35 is considered small, medium, and large, respectively (Hair et al., 2021). The analysis reported a large effect in the case of removing ATT (0.435) and a small to medium effect in removing PBC (0.125) from the model. On the other hand, SN (0.001)) could be dropped from the model as it does not significantly impact the dependent variable BI. The structural analysis concluded with the assessment of the approximate model fit. Despite reservations about using this metric (Hair et al., 2021), this test in SmartPLS is measured by the standardized root mean square residual (SRMR). The SRMR value of 0.078 was lower than the suggested threshold of 0.80 (Garson, 2016), indicating that the model fits the data well.

The structural analysis indicated the importance of attitude (ATT) as a predictor of behaviour, however, the mean (M=2.64, SD=0.89) suggested an unclear attitude concerning the intention to use insects as food. Subjective norm (SN) did not contribute to the intention of consuming edible insects. The construct values (M=2.70, SD=1.13) also indicated that respondents tend to neither agree nor disagree about the impact of society on their behavioural intentions. About the construct of perceived behavioural control (PBC) (M=2.75, SD=0.92) the analysis showed that respondents perceived having some degree of control of the situation. As for behavioural intention (BI), the strong structural path suggested that respondents with higher intentions were more likely to use edible insects. As a matter of fact, it was found that insects were already consumed in some form in 22% of the sample, for example as an ingredient of Chinese medicine (Hong and Lampo, 2022). However, the values of the construct (M=2.15, SD=1.05) indicated that respondents, on average, were somehow resistant to the idea of consuming edible insects as part of their diet soon. Additionally, in the sample, men (M=2.29, SD=1.02) tend to score higher than female (M-1.99, SD=1.08) concerning intention, however, an independent t-Test showed that this difference was not significant (p>.05). For the survey items in BI, the detailed results are shown in Table 4.

Table 4. Items of behavioural intention

Items		Mean	SD
BI1	I intend to eat insects one day	2.27	1.24
BI2	In the future, I predict I will eat insects	2.33	1.28
BI3	I plan to eat insects soon	1.86	1.05

Items measured on a 5-point Likert scale, and adapted from literature (Fishbein and Ajzen, 2009).

Assessment done by the study found that three of the five proposed hypotheses were supported; their path relationships were significant at the 0.05 level and had signs in the expected directions with beta coefficients ranging from 0.282 to 0.609. On the other hand, subjective norm (SN) and perceived behavioural control (PBC) displayed a non-significant correlation with Bi, and the associated hypothesis H2 and H4 were rejected. The following Table 5 summarizes these results.

This work explored the intention and use behaviour of a sample of young consumers in Macau regarding edible insects. Present model explained 64.6% of behavioural intention and 31.9% of use behaviour, and three of the five proposed hypotheses were accepted. Taking into account that the construct of subjective norm did not contribute to the model, present results are considered to be satisfactory and provide valuable insights. There is a possibility that the construct of subjective norm was not significant and negatively correlated to intention because most people haven't tried eating insects yet. Therefore, the majority of consumers were not able to persuade family members and friends to use edible insects. It is assumed that the impact of

Table 5. Assessment of hypotheses

Hypothesis	Path	Coefficient	t-Value	*p*-Value	Supported
H1	ATT→BI	0.608	6.900	0.000	YES
H2	SN→BI	-0.025	0.309	0.757	**NO**
H3	PBC→BI	0.284	3.405	0.001	YES
H4	PBC→USE	0.079	0.646	0.519	**NO**
H5	BI→USE	0.510	7.516	0.000	YES

Hypotheses evaluation criteria: t-value>1.96; p-value<0.05

the social norm may become increasingly relevant over time as individuals become familiar with the idea of consuming insects as food; this is because social factors typically play important roles in the decision to adopt new ideas (Lampo, Silva and Duarte, 2022). Different from the mainstream theory (Fishbein and Ajzen, 1975), perceived behavioural control did not perform as a direct predictor of the actual behaviour. It is possible that consumers' perceptions may not reflect an actual control since they did not know where to find insect-based food products in Macau or that insects were not compatible with their dining habits, thus precluding an actual behaviour. On the other hand, attitude and perceived behavioural control were key determinants of intention in the prsent model and, indirectly, of actual use.

The detailed analysis of the construct of behavioural intention showed that respondents in Macau, on average, were relatively unwilling to consume insects as food at the time of the survey, even though the practice of using insects (for example in the case of traditional Chinese medicine) is well established in the region. In particular, present sample hints that men tend to be more inclined to consume insects than women, but a larger sample should be used for this conclusion. To conclude, the findings are relevant as an exploratory study, taking into account Macau's plan to promote internationally a unique and sustainable image in the food sector.

Throughout the literature, it is apparent that entomophagy has the potential for benefiting society on different levels, including social (reducing hunger), environmental (reducing the footprint of meat consumption), and health (nutritious food). Yet, consumers on average are hesitant about insects as food. However, history has shown that food habits can change. For instance, the rapid acceptance of eating raw fish in the form of sushi is a good example (ScienceDirect, 2023). Similarly, the culture of entomophagy should be disseminated where it is not widespread yet, such as in Macau. The food industry should play a significant role in raising the status of insects as food, through the creation of original recipes, gourmet dining, or events. It is also suggested that to increase the acceptance of insects as food, research and practice should focus on optimizing the experience for early adopters rather than trying to convince reluctant consumers, so as to enhance the effects of social norms and promote diffusion. Ultimately, consumers decide whether insects will become a common food source in society.

The present findings provide insights into consumers' intentions toward eating insects in Macau, but some limitations exist. For instance, the design opted for convenience sampling techniques assuming that the participants were similar to the overall target population, and based the analysis on a relatively limited sample. Most importantly, the research examined the intentions of consumers at a single point in time and used a specific theoretical framework. Therefore, future research should draw from a larger sample to take advantage of more statistical tests, make use of different theoretical frameworks, and include new constructs that may help to shed light on the individual peculiarities when it comes to considering insects as food.

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AUTHOR CONTRIBUTION STATEMENT

All authors have contributed equally to the manuscript.

CONFLICT OF INTEREST

No conflict of interest.

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