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Original article

Consumer perception of insect-based foods in the community of Zhejiang University

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Abstract

Insect foods are nutritious and available for human consumption. This study was aimed to determine the factors of motivational preference, satisfaction, and food safety knowledge on insect foods consumption among Zhejiang University community. The study adopted the structured online questionnaire designed by the investigator for this convenience sample survey. Data were collected from Zhejiang University, China. A total of 873 respondents, (students, teachers, and staff) ranging in age from 18 to 85 years (503 men and 370 women) completed the survey. Factor analysis was used to determine the variables of interest. The analysis revealed three factors; respondents' motivation for consuming insect food showed that taste (40.4%) is the major reason for consuming insect foods followed by nutritional value (27.3%) and affordability (13.9%). A little above half of the population studied were satisfied with the price of insect foods (51.7%). The survey also revealed that respondents had no food safety concerns about the potential toxicity of insects (47.2%), while 33% were concerned, and 19.8% did not believe there were safety concerns. The study revealed that males between 18-28 years prefer insect food to females in the same age group. Although some insect foods may be toxic, many respondents enjoyed consuming and they were not opposed to eating them. This study shows the current trend in consumer perceptions of insect-based foods in the university-based place.

Keywords:insects, insect food, consumption, Zhejiang university

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Introduction

Insects are nutritious and suitable food for human consumption (Lensevelt et al., 2014). The nutritional importance of insects deserves as much attention as the meat consumed. Noting the growth of the world population and the increasing demand for traditional beef, pork, and chicken production, the consumption of insects should be valued as a source of animal protein (Defoliart, 1992). Nowadays, there is a great understanding of how insects can supplement nutrition (Huis, 2016; Huis et al., 2013). Edible insects are showing signs of being a widely accepted option for meat consumption for human consumption (FAO, 2018). Human nutrition should not be limited to biological sciences, but should be expanded to include dietary behavior and its associated factors (Ma 2015).

In China, the extent of insect consumption is acknowledged to some extent. Several studies on edible insects have been completed. Currently, 324 insect species from eleven orders are documented as edible or or related to insect consumption in China (Feng et al., 2018). In different regions of China, there are many ethnic tribes that retain the tradition of insect consumption, although conditions are rapidly improving (DeFoliart, 1992). In Hunan Province, edible insects are prevalent, with more than 44 species of edible insects (Zhu, 2003). In Jiangu Province, 122 species belonging to 48 families and 10 orders have been recorded as edible insects (Lu, 2005). The identification of local insects has spread to major cities throughout Yunnan. It is clear that the insect food market will be huge in the coming years (Chuanhui et al., 2010). The nutritional significance for 174 species is available in China, including edible species (Feng et al., 2018).

Direct teaching activities about the advantages of insect consumption in various gatherings will play a great role in promoting the consumption of insect-based foods (Hamerman, 2016). University subjects related to gastronomy and food science should be considered as opportunities to taste edible insects, since these students will have the opportunity to understand and know the future trends of insect cuisine (Sogari et al., 2017). Understanding the opportunity to give consumers the chance to try whole insects or insect-based products is expected to be the most successful marketing strategy to motivate insect food consumption (Wilkinson et al., 2018). Strategies targeting insect food consumption groups can lead to awareness to overcome aversions to insect food reactions. Training workshops on insect food can be organized to improve knowledge and expertise related to unique insect food preparation (Myers et al., 2018).

There is scientific evidence that uncooked insects have many microbial populations and therefore consumption of raw uncooked insects may lead to difficulties such as stomach pain (Ssepuuya et al., 2016). The incidence of allergic reactions following the consumption of silkworm pupae, cicadas and crickets has been reported in China (Chen and Li, 1996). Although research on insect food is limited, statistics on insect food safety suggest that insects are safe as food (Feng et

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al., 2018). The level of food safety associated with insects can be determined by insect toxicity, pathogen contamination, allergies, and spoilage during preservation (Van huis, 2016). The "Codex Alimentarius Commission" has developed clear international food standards; intended to protect the health of consumers; and when developing foods from edible insects and insects, potential safety issues regarding consumer health should be identified and mitigated.

All insect foods distributed in community supermarkets should be inspected for standards to measure the color texture and taste of the product. Nutrition labeling is important for consumers to receive measurements of nutrients such as proteins, fats, minerals, vitamins, phytochemicals, and antinutrients. Storage and inspection of products suitable for consumption is also necessary when preparing insect food for human safety (House, 2016). If properly prepared, insects could add to the worldwide food supply chain especially in the future (Sun-Waterhouse et al., 2016). The purpose of this study was to establish motivations for choice, preferences, perspectives on insect food consumption, common insect food consumption, food safety, and knowledge of insect food toxicity in the Zhejiang University community.

Methods

Research design and sampling procedures

A convenience sample of students, faculty, and staff at Zhejiang University's Zijingang, Yuquan, Xixi, and Huajiachi campuses was taken using online survey. The online questionnaire was designed by the research investigators for this survey. The survey was conducted from November 2019 to January 2020. A total of 873 respondents of 18-85 years (503 men and 370 women) completed the online self-reported questionnaire through *WeChat,* a social media app.

Research instruments

The researchers designed a structured questionnaire online and then administered it to students, faculty and staff. The questionnaire was written in English and Chinese. Informed consent was obtained from all respondents of this study. The questionnaire was divided into: socio-demographics, motivational choices of insect food, common insect food products of respondents, how they obtain and prefer to consume insect food, attitudes towards packaging, price and delivery conditions of insect food, food safety, knowledge of toxicity, confidence and reasons for consuming insect food. After obtaining permission from the Institute of Insect Science of Zhejiang University and the ethics committee, the researchers conducted the survey. In this study, we developed the conceptual framework shown in Figure 1 to discuss the three main factors that influence respondents' motivational choices, satisfaction with service quality, safety, and toxicity knowledge regarding insect food consumption.

Data collection

The data collected from the questionnaires were categorized into various variables. These data were then analyzed to determine the relationship between the variables. Survey questions included (1. do you prefer whole or insect food), (2. how long have you consumed insect food), (3. where do you obtain insect food), (4. how often do you consume insect food), (5. how do you cook insect food), and (6. do you have any allergic reactions after consuming insect food). What motivates you to choose to consume insect food? Are you satisfied with the preparation, packaging, price, and delivery of insect food, and knowledge (are you concerned about the potential toxicity of insect food). What do you think is the value of knowing about insect food consumption?. The results of the survey were tabulated in excel sheets and imported into the statistical package for the social sciences SPSS version 20. Factor analysis was used to identify socio-demographic differences in food safety knowledge, satisfaction and motivation on insect foods consumption. Descriptive and percentages statistics were used to summarize the variables and presented in graphs and tables. The difference with $p < 0.05$ (*) was considered statistically significance. The highly significant difference was $p < 0.01$ (**).

Results

Socio-demographic characteristics of respondents

A total of 873 respondents aged 18-85 years completed the survey, including 503 men (57.6%) and 370 women (42.4%). Over 46 % of the respondents were between the ages of 18-28 and a few were between the ages of 56-85. The majority of respondents (up to 70%) were Asian, followed by African (14.8%), European (7.2%), American (4.6%), British (2.4%) and Australian (0.8%). More than 67% of respondents were not married; 23% said they were married. The remaining 9.5% fell into the other options. About 6.2% of respondents were Christian, 2.5% were Muslim, 2.4% were Buddhist and 1.6% were Hindu. The majority, 87.3 percent, indicated other. A whopping 34.4 % of respondents were from the College of Agriculture, Life and Environment, followed by the College of Science at 15.8%. A small percentage, 2.6 %, came from the College of Social Sciences. More than 52% of the respondents were undergraduate students, followed by diploma at 22.9% and master's at 15.2%. A lower percentage of PhD students and other students, at 5.1% and 4.7% respectively. The majority of respondents were students (60.5%), followed by teachers at 13.8%. Staff followed with 13.6% and the remaining 11.8% were other; employees of the university (e.g., security staff, grounds staff, cafeteria staff). The detail composition of the survey participant is shown in Table 1.

Table 1: Socio-demographic characteristics of respondents (**n = 873**).

Variables	Factors	Frequency (%)
Gender	Male	503 (57.6)
	Female	370 (42.4)
Age group	18-20	402 (46.1)
	21-39	257 (29.4)
	40-45	121 (13.9)
	46-55	54 (6.2)
	56-85	39 (4.5)
Race	Asian	613 (70.2)
	African	129 (14.8)
	American	40 (4.6)
	European	63 (7.2)
	British	21 (2.4)
	Australian	7 (0.8)
Marital status	Single	589 (67.5)
	Married	201 (23)
	Others	83 (9.5)
Level of education	Others	41 (4.7)
	Diploma	200 (22.9)
	Bachelor	455 (52.1)
	Master	133 (15.2)
	PhD	44 (5)
Occupation	Student	528 (60.5)
	Teacher	122 (14)
	Staff	120 (13.8)
	Others	103 (11.8)
Faculty	Faculty of medicine & Pharmaceutical	52 (6)
	Faculty of Agriculture, life and Environment	300 (34.4)
	Faculty of Information and Technology	33 (3.8)
	Faculty of Engineering	43 (4.9)
	Faculty of Science	138 (15.8)
	Faculty of Social Sciences	23 (2.6)
	Faculty of Arts and Humanities	144 (16.5)
	Others	140 (16)
Religion	Christian	54 (6.2)
	Muslim	22 (2.5)
	Buddhist	21 (2.4)
	Hindu	14 (1.6)
	Others	762 (87.3)

Common insect foods consumed in China and insect foods consumed by respondents

The most commonly consumed insect foods by Chinese are shown in Table 2. While insect foods consumed by respondents are shown in (Table 3). Up to 31.3% of the respondents consumed grasshoppers, 17.1% consumed cicadas, followed by termites with 10.2%. Cockroaches, water bugs and bed bugs had the lowest percentage of 2% each. More than 44% of the respondents preferred fried insect food, fried (21.7%), and baked (15.5%). Pan-fried, stewed and boiled insect foods were the least preferred methods of preparation. It was observed that 21% of the respondents consumed insect food once a month, 20.9% 5-6 times a week, and 20.1% once a month. It was also reported that 13.8% of the respondents consumed insect food once a year and 6.7% consumed it after a year. A small number of respondents consumed insect food once a week (6.1%) and daily (0.3%). Some of the insect foods consumed by the respondents have been reported in the previous study (Table 2).

Table 2. Some insect foods consumed in China

Food items	Consumed	Cooking methods	Intake	Publications
Ants	Guangxi Zhuang minority	Roasted Deep-Fried, Pan	Not specified	Chen and Li, 1996
Ants, Cockroaches and *Omphisa fuscidentalis* Hampson	Yunnan Jinuo minority	Roasted Depp-Fried, Pan	Not Specified	Chen and Li, 1996
Eggs of ants	Dai minority	Roasted Depp-Fried, Pan	Not Specified	Chen and Li, 1996
Predaceous diving beetle, the sheath of egg of ground beetle, larvae of	Fujian and Guangdong minority	Roasted Depp-Fried, Pan	Not Specified	Chen and Li, 1996

	Jiangsu, Zhejiang, North-eastern provinces of Chongqing	Roasted Depp-Fried, Pan	Not Specified	Chen and Li, 1996
Aspongopus chinensis Dallas, Locusts, Cicadidae	Zhejiang provinces	Roasted Depp-Fried, Pan	Not Specified	Chen and Li, 1996
Clanis bilineata tsingtaucia Mell		Roasted Depp-Fried, Pan	Not Specified	Chen and Li, 1996

Factor analysis on respondents' motivation, satisfaction and food safety knowledge on insect foods

Factor analysis was used to determine respondents' motivation, satisfaction, and knowledge factors. Based on these three factors, 12 variables related to insect food consumption factors were developed. To determine the factors that motivated respondents to select the most important ones from the large number of variables, principal component analysis (PCA) was used, using Varimax rotation. Variables with factor loadings above 0.50 had higher importance among all other variables and had a greater impact on consumer preferences for insect food consumption. Therefore, variables with factor loadings above 0.50 were identified and categorized as composite factors, motivation, satisfaction, and knowledge. The eigenvalues of motivation, satisfaction, and knowledge were 1.406, 1.325, and 1.431, respectively. since the eigenvalues of these three factors were greater than 1, these factors were the most important factors influencing respondents' motivation, satisfaction, and attention to consume insect food. It was observed that the three combined factors accounted for 52.78% of the total variance. Thus, as shown in Table 4, motivation and satisfaction with price were the most important factors in determining respondents' consumption of insect food, followed by respondents' lack of concern about the toxicity of insect food.

Table 3: Insect foods consumed by respondents (**n = 873**).

Insect foods	Frequency	%
Ant	21	2.41%
Silkworm	58	6.64%
Cockroach	2	0.23%
Diving beetle	14	1.60%
Caterpillar	52	5.96%
Grasshopper	273	31.27%
Cicada	149	17.07%
Locust	4	0.46%
Dragonfly	33	3.78%
Termite	89	10.19%
Grubs	3	0.34%
Cricket	45	5.15%
Water bug	2	0.23%
Moth	4	0.46%
Stinkbug	2	0.23%
Honeybee	59	6.76%
Wasp	4	0.46%
Palm weevil	12	1.37%
Praying mantid	18	2.06%
Sago worm	12	1.37%
Other	17	1.95%
Total	873	100.00%

Table 4: Factor analysis on respondent's motivation, satisfaction and food safety knowledge on insect foods consumption.

Items	Factors	Variables	Factor	Eigen	Variance %	Cumulative %
Factor 1	Motivation	Medical/health	.759			
		Affordability	.873			
		Religion	.689			
		Taste	.926			
		Nutritional value	.915			
		No specific reason	.847	1.406	14.048	30.267
Factor 2	Satisfaction	Preparation	.676			
		Packaging	.647			
		Price	.785			
		Delivery	.526	1.325	13.757	40.896
Factor 3	Knowledge	Food safety	.726	1.431	12.982	52.778

Insect foods motivation choice and consumption period

About 73.3% of the respondents consumed insect food and 21.7% did not eat insect food. The analysis of the period of insect food consumption showed that 42.7% of the respondents consumed insect food for 0-5 years, 32.8% for 6-10 years, 19.6% for 11-15 years, and 4.9% for more than 15 years. The analysis of the motivation for choosing insect food (Fig. 1) showed that the main reasons for choosing insect food for 40.4% were taste, nutritional value (27.3%), affordability (13.9%), no specific reason (10%), medical or health reasons (4.8%), and religion was the lowest (3.7%), with young Asian and African males aged 18-30 years preferring insect food. This may be due to the adventure, convenience, affordability and taste of the different kinds of insects behind the diet.

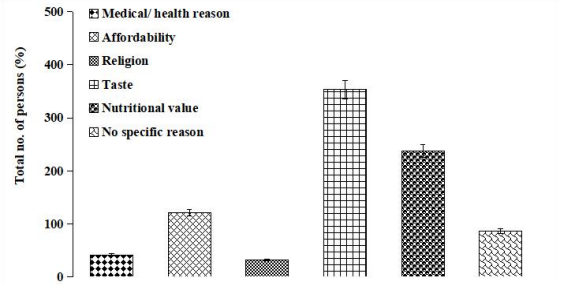

Figure 1. What motivates your choice of insect foods consumption?

The majority of respondents 74.2% prefer whole insect foods and 25.8% prefer insect food products. The survey revealed that most respondents buy insect food online (56%) and as many as 18.6% obtain insect food from street food vendors. About 13.3% of respondents buy insect food from local supermarkets, and 9.3% prefer to eat insect food in restaurants. A small number of respondents (2.1%) hunted insect food from different places, and 0.8% raised their own insect food. Some respondents in this survey prefer insect food, such as cookies, protein bars, because eating whole bugs is not attractive to them. Respondents mainly use insect food as a supplemental food and rarely have the opportunity to use it as a main dish. Some respondents indicated that insect food is sometimes limited to minority tribes or entire provinces in their respective countries.

Satisfaction on the packaging, price and delivery condition of insect foods

Of all respondents, 51.7% were satisfied with the pricing of insect food, 22. 7% were satisfied with the packaging, 13.9% were satisfied with the method of preparation of insect food in different places of purchase, and 11. 8% were satisfied with the delivery conditions of insect food (Fig. 2). These included delivery from supermarkets, restaurants or online purchase services from street food vendors. Some respondents preferred to cook their own insect food after obtaining it from various sources.

Knowledge on insect foods consumption safety

About 47% of the respondents said they were not concerned about the potential toxicity of insect food, while 33% were concerned about the safety of insect food consumption and 19.8% said they never thought about the safety and toxicity of insect food. To be exact, 89.4% of the respondents did not have any allergic reactions after consuming insect food. However, 10.7% of the respondents had allergic reactions after consuming insect food. Due to the high percentage of respondents consuming insect food, the respondents' perceptions of the value of understanding insect food were consistent with expectations. Up to 63% of the respondents indicated that it was valuable to know about insect food, followed by not sure (17.4%), very valuable (15%), and finally, no value at 4.6% (Fig. 3).

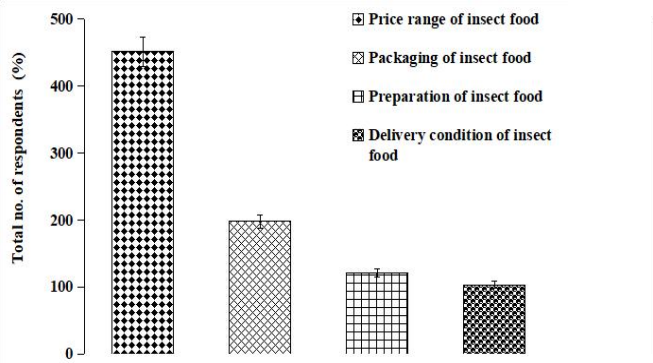

Figure 2. Satisfaction with price, preparation, packaging and delivery condition.

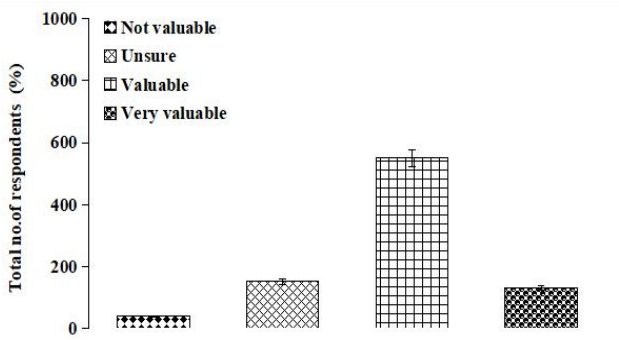

Figure 3. How valuable do you think it is to know about insect foods consumption?

Discussion

The results of this study indicate that insect food consumption is popular among the ZJU community, which suggests a promising trend in insect food consumption. Supplementation, fortification, and dietary intake of insect foods are recommended to increase the consumption of animal protein. In this study, a higher percentage of males than females in all age groups consumed insect food. Respondents consumed insect foods for many reasons, including unique taste, nutritional value, affordability, and health reasons, among others. Both male and female respondents preferred deep-frying, and stewed and boiled insect food was the least preferred cooking method by all respondents. Since respondents' motivation for consuming insect food is primarily taste and nutritional value, chefs need to improve their cooking skills to meet these expectations. Respondents were satisfied with the preparation, packaging, presentation, and overall price of insect food. Therefore, companies should maintain, and even more so, raise these standards. This will encourage consumers to make healthy insect food choices. Respondents mainly prefer to eat grasshoppers and cicadas, followed by termites. This information will enable insect food suppliers to develop healthy insect food products and interesting insect menus.

Most respondents indicated that knowledge of insect food was valuable, while on the other hand, they were not concerned about the safety of insect food. The university sample limited the generalizability of the findings to the broader population. It is recommended that insect food safety education be included in university subjects related to entomology, food science, human nutrition, culinary arts, and gastronomy. Food safety management training and education should always be conducted in food service establishments, including education of street food vendor operators and empowerment of commercial food operators. When properly handled and maintained, products obtained from insects are harmless and can provide an adequate source of nutrition for human consumption. With proper food safety safeguards, insect food can be successfully introduced into the daily diet as a healthy, reasonably priced food product. The global trend in insect food consumption is encouraging as it appears to be accepted by most countries in the world, in terms of the ethnically

diverse populations we studied in the Zhejiang University community.

The results of this survey will bring to awareness why, how consumers enjoy insect food, and how to improve and encourage insect food consumption. The results are relevant to public health, policy makers, food safety, food business operators, food scientists, and food technologists; for chefs to understand how to enhance insect food dishes for consumers and ensure compliance with food safety measures; in order to produce, prepare, or process and market safe foods. Insect food operators should use innovative production practices to ensure that safe products are provided to consumers. Future human trial studies should be conducted to understand the possible effects of long-term insect food consumption on cardio-metabolic risk factors in the general population. It is also recommended that the benefits of insect foods be scientifically demonstrated and that clinical trials be conducted to study in detail whether insects are consumed as a whole or as part of a composition.

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