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Evaluation of individuals' perspectives and preferences for entomophagy

Bireylerin entomofajiye bakış açılarının ve tercihlerinin değerlendirilmesi

İlkay Yılmaz[1], Eren Yalçın[2*]

[1]*Baskent University, Faculty of Fine Arts, Design and Architecture, Department of Gastronomy and Culinary Arts, ANKARA, TÜRKİYE*
[2]*Selcuk University, Faculty of Tourism, Department of Gastronomy and Culinary Arts, KONYA, TÜRKİYE*
(Yazar sıralamasına göre)
***ORCID ID:** 0000-0001-5938-3112, Assist. Prof.*
***ORCID ID:** 0000-0002-9927-1972, Res. Assist.*
**Corresponding author/Yazışmalardan sorumlu yazar: yalcinerene@gmail.com*

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Abstract

Objective: Approximately 26.4% of the world population is experiencing food insecurity moderately or severely. By 2050, it is predicted that the world population will reach 9 billion and around 870 million people will experience problems related to food insecurity or insufficiency. As an alternative to nutritional problems that may arise, Food and Agriculture Organization of the United Nations (FAO) recommends entomophagy, a diet that includes insect consumption. 95% of the insects on earth have a higher caloric value than wheat, 87% of corn, 70% of fish, 63% of cow meat, and 50% of soybeans. Compared to protein values, insect proteins are claimed to be higher than meat and vegetable proteins and contain less fat. In addition, flour obtained from insects might be used to increase their nutritional content. This study aims to evaluate the perspectives and preferences of individuals towards entomophagy, considering the future of sustainable food consumption.

Materials and methods: Multiple data collection methods were used in this study. The sample size was determined as 384 at the 95% confidence interval. Variables for the identification of participants' demographic data were determined through descriptive analysis methods.

Results and conclusion: A total of 457 people participated in the research. The obtained results suggested that the disgust ($t=2.081$, $p<0.05$; ($F(3.453)=1.950$, $p>0.05$); ($F(3.453)=2.365$, $p>0.05$) and interest ($t=1.398$, $p>0.05$; ($F(3.453)=0.186$, $p>0.05$); ($F(3.453)=0.250$, $p>0.05$) dimensions of entomophagy showed significant differences by gender, but did not show significant differences by age and educational background of the participants. Similarly, the difference between the dimension of feeding animal ($t=0.989$, $p>0.05$) and age ($F(3.453)=1.645$, $p>0.05$) was not statistically significant. However, the dimension of feeding animals significantly differed by the participants' educational background ($F(3.453)=3.758$, $p<0.05$).

Keywords: entomophagy; insect consumption; edible insects; sustainable food

Öz

Amaç: Dünya nüfusunun yaklaşık %26,4'ü orta ya da şiddetli seviyede gıda güvensizliği yaşamaktadır. 2050 yılına kadar dünya nüfusunun 9 milyara ulaşacağı ve yaklaşık olarak 870 milyon insanın gıda güvensizliği ya da yetersizliği ile ilgili sorunlar yaşayabileceği öngörülmektedir. Ortaya çıkabilecek beslenme sorunlarına alternatif olarak ise Birleşmiş Milletler Gıda ve Tarım Örgütü tarafından böceklerin tüketildiği bir beslenme biçimi olan entomofaji önerilmektedir. Dünya üzerinde yer alan böceklerin %95'i buğdaydan, %87'si mısırdan, %70'i balıktan, %63'ü büyükbaş hayvan etinden ve %50'si ise soya fasulyesinden daha yüksek kalori değerine sahiptir. Protein değerleri karşılaştırıldığında böcek proteinlerinin et ve bitki proteinlerine göre daha yüksek olduğu ve daha az yağ içerdiği ifade edilmektedir. Bu çalışmada, sürdürülebilir gıda tüketiminin geleceği dikkate alınarak bireylerin entomofajiye olan bakış açılarının ve tercihlerinin değerlendirilmesi amaçlanmıştır.

Materyal ve yöntem: Çoklu veri toplama yönteminin kullanıldığı bu araştırmada, örneklem sayısı %95 güven aralığında 384 olarak belirlenmiştir. Katılımcıların kişisel bilgilerinin tanımlanması için değişkenler betimsel analiz yöntemleriyle tanımlanmıştır.

Bulgular ve sonuç: Araştırmaya toplamda 457 kişi katılmıştır. Elde edilen sonuçlara göre, entomofajinin tiksinti ($p<0,05$; ($F(3,453)=1,950$, $p>0,05$); ($F(3,453)=2,365$, $p>0,05$) ve ilgi boyutunun ($t=1,398$, $p>0,05$; ($F(3,453)=0,186$, $p>0,05$); ($F(3,453)=0,250$, $p>0,05$) katılımcıların cinsiyetlerine göre anlamlı bir farklılık gösterdiği fakat, yaşlarına ve eğitim durumlarına göre anlamlı bir farklılık göstermemiştir. Benzer şekilde hayvanların beslenmesi boyutunun ise cinsiyete ($t=0,989$, $p>0,05$) ve katılımcıların yaşlarına ($F(3,453)=1,645$, $p>0,05$) göre anlamlı bir farklılık göstermemiştir. Öte yandan hayvanların beslenmesi boyutunun ise katılımcıların eğitim durumlarına göre anlamlı bir farklılık gösterdiği ortaya çıkmıştır ($F(3,453)=3,758$, $p<0,05$).

Anahtar kelimeler: entomofaji; böcek tüketimi; yenilebilir böcekler; sürdürülebilir gıda

1. Introduction

As one of the main human needs, nutrition is expressed as the use of nutrients to maintain health and sustain life. Considering the physiological state of individuals, it is important to obtain the necessary energy by providing adequate and balanced nutrition in order for the body to continue its life and functioning (Baysal, 2012).

Entomophagy originated from the Greek word “entomo” meaning insect and “phagein” meaning food (Ramos-Elorduy, 1998). In 2050, it is forecast that the world's population will reach up to 9 billion people, and about 870 million people will experience food insecurity or inadequacy (Ramos-Elorduy, 1998; Sogari, 2015). The FAO recommends a diet defined as "entomophagy", "insect consumption" or "edible insect consumption" as an alternative food source to meet the nutritional needs of the growing population. (Ramos-Elorduy, 1998; Gahukar, 2011; Belluco et al., 2013).

A rapid increase in human population is also rapidly increasing the demand for food, and limited energy (fossil fuels) and resources are used to meet this demand. Insects that release less greenhouse gases into the atmosphere than many animals and can feed on organic waste might also be used as a feed component to reduce the negative effects on natural areas, forests and water quality that occur in livestock production (Ramos-Elorduy, 1998; Saruhan and Tuncer, 2010; Oonincx et al., 2010; Gahukar, 2011; Rumpold and Schlüter, 2013; Lensvelt and Steenbekkers, 2014; Sogari, 2015; Van Huis, 2010; Güneş, Sormaz and Nizamlıoğlu, 2017; La Barbera et al., 2020).

The level of commercialization is increasing over time as entomophagy can be a solution for food safety and sustainability. Production methods and various quality criteria have been commercialized by national and international companies. In fact, it is estimated that the global market of edible insects will exceed 522 million US dollars by 2023 (Pino Moreno and Reyes-Prado, 2020). 2037 different insect species are already eaten in various countries of the world and form an integral part of the diet of more than 2 billion people worldwide (Bessa et al., 2020). Due to the high acceptance of insect consumption, especially in Mexico, there are several companies that manufacture and commercialize various foodstuffs prepared from insects as feed for both humans and livestock (Pino Moreno and Reyes-Prado, 2020). The Netherlands made a start in this field by introducing its first insect-based products (mealworm burgers) to commercial stores in 2014. Countries such as Belgium in 2015 and Switzerland, which legalized the sale of insects for human food on the commercial market in 2017, followed the Netherlands (Bessa et al., 2020).

There are about 2000 insect species that can be used in human diet today (Yhoung-Aree, Puwastien and Attig, 1997; Ramos-Elorduy, 1998; Raubenheimer and Rothman, 2013; Mankan, 2017; Güneş, Sormaz and Nizamlıoğlu, 2017; Kaymaz and Ulema, 2020). In addition to their ecological advantages, edible insects are also rich in nutritional values, especially carbohydrates, proteins, fats, vitamins and minerals (DeFoliart, 1992; Bukkens 1997; Ramos-Elorduy, 1998; Gahukar, 2011; Belluco et al., 2013; Rumpold and Schlüter 2013; Makkar et al., 2014; Sogari, 2015; Mitsuhashi, 2016; Özkan, 2019; Tuccillo, Marino and Torri, 2020). Furthermore, insect proteins require less resource use than animal proteins. It is therefore assumed that insects can be beneficial to the ecosystem and be a nutritious food for human (Katayama et al., 2008). 95% of the insects on earth have a higher caloric value than wheat, 87% of corn, 70% of fish, 63% of cow meat, and 50% of soybeans (Ramos, 1997; Özkan, 2019). It is stated that insect proteins, in comparison to meat and

vegetable proteins, have higher nutritional value and contain less fat (Ramos-Elorduy, 1998; Anankware et al., 2015; Muslu, 2020). Additionally, insects are viewed as healthy and nutritious alternatives to foods such as chicken, fish and red meat (Ramos-Elorduy, 1998). Furthermore, entomophagy is common in ethnic groups in South America, Mexico, Africa, and Asia, where insect flour is consumed in various forms (raw/processed) to enrich its nutritional content (Gahukar, 2011; La Barbera et al., 2020).

The examination of consumption perception towards edible insects indicates variations among communities (Beşirli, 2010; Özkan, 2019). The global food industry has contributed greatly to the expansion of the edible insect market. Between 2012 and 2015, about 20 food companies producing edible insect foods were established in America. 3,750,000 protein energy bars corresponding to about 60 tons of 150 million crickets were sold in 2014 (Hoffman, 2014, Ryu et al., 2017). The barriers to insect consumption are considered to be cultural and religious (Gahukar, 2011; Costa-Neto, 2014; Özkan, 2019) or neophobic (relating to the fear of consuming new foods) (Looy, Dunkel and Wood, 2014; La Barbera et al., 2020).

This study aims to evaluate individuals' perspectives and preferences towards entomophagy to maintain sustainable food consumption. The Entomophagy Attitude Questionnaire (EAQ) comprising of 23 questions which was developed by La Barbera et al. (2020), was applied to 457 individuals.

2. Material and methods

Within the scope of this study, an empirical research model was created using a survey model from quantitative research methods to evaluate individuals' perspectives and preferences for entomophagy. The measure evaluates individuals' disgust (Factor 1) or repulsion to entomophagy as negative and their interest (Factor 2) in new foods as positive. The third factor is the attitude towards the use of insects in feeding animals raised for human consumption. This study utilized multiple data collection methods. Multiple data collection models are models serving to reveal all the characteristics of the subject being investigated. Such models allow both in-depth descriptions and numerical data to be collected from relevant people (Chmiliar, 2010). The survey took place in Ankara and Istanbul and age between 18-75 induviduals'. Convenience sampling method was used to select participants. The Ethics Committee approval required to collect the data to be used in this research was obtained from Selcuk University, Board of Social and Humanities, Scientific Research and Publication Ethics with decision number 25338 dated 12/02/2021.

2.1. Data collection

In addition to three demographic questions, a questionnaire including 23 items developed by La Barbera et al. (2020) was used as the data collection instrument. A total of 26 questions were asked to be responded to volunteer participants in the study.

Due to Covid-19, data was collected using the electronic form created in Google Documents. Sample size determination table was used to determine the sample size of the study from a given population. For the population size of ten thousand and above, the sample size was determined to be 384 at a 95% confidence interval (Bal, 2001; Ural and Kılıç, 2006). The measure was applied to a total of 457 people. The items in the questionnaire were evaluated with a 5-point Likert scale, whereby 1: strongly disagree, 2: disagree, 3: undecided, 4: agree and 5: strongly agree. Data was collected between February and March 2021.

2.2. Data analysis

The data was analyzed through SPSS 20.0 statistical package program. Using frequency analysis method, variables for the identification of participants' demographic information were determined by descriptive analysis methods. At this stage, the minimum-maximum mean and standard deviation (SD) values were also calculated.

The reliability of the variables in the measure was tested via the Cronbach's alpha coefficient, and the skewness and kurtosis values were analyzed for normality analysis. The evaluation criteria of the reliability coefficient are considered to be reliable in the range of $0.00<\alpha<0.40$, low reliable in the range of $0.40<\alpha<0.60$, very reliable in the range $0.60<\alpha<0.80$, and highly reliable in the range of $0.80<\alpha<1.00$ (Özdamar, 1999). The skewness and kurtosis values between +1.5 and -1.5 indicate the acceptance of normality assumption (Tabachnick and Fidell, 2013).

A one-way analysis of variance (ANOVA) as well as an independent samples t-test were performed to analyze the relationships between demographic data and research variables. Bonferroni Post-hoc test was conducted for between-group differences in case of a meaningful result in ANOVA.

3. Results

The gender, age and educational background of the participants are shown in Table 1. As can be seen, the measure applied within the scope of the study was responded to a total of 457 participants, including 151 females and 306 males.

Table 1. Results of descriptive analysis concerning demographic data

		Frequency	Percentage
Gender	Female	306	67.0
	Male	151	33.0
Age	20 and below	132	28.9
	21-30	198	43.3
	31-40	63	13.8
	41-50	45	9.8
	51 and above	19	4.2
Educational Background	Primary	2	0.4
	Secondary	2	0.4
	High School	27	5.9
	Associate	125	27.4
	Undergraduate	237	51.9
	Master	58	12.7
	PhD	6	1.3
Total		457	100

In the study, 67% of the participants (n=306) were females, 33% (n=151) were males. 28.9% of the participants (n=132) were aged 20 or below, 43.3 % (n=198) were between 21-30, 13.8% (n=63) were between 31-40, 9.8% (n=45) were between 41-50, and 4.2 % (n=19) were aged 51 and above. In addition, 51.9% of the participants (n=237) held an undergraduate, 27.4% (n=125) had an associate degree, and 12.7% (n=58) were graduates of a master's degree.

The examination of the mean scores obtained by the participants with regard to the dimensions of entomophagy (disgust, interest, and feeding animals) high rated in Table 2.

Table 2. Results of descriptive analysis concerning entomophagy dimensions

	n	Min.	Max.	M	SD
Disgust	457	1.00	5.00	3.69	1.31
Interest	457	1.00	5.00	2.70	1.44
Feeding Animals	457	1.00	5.00	3.09	1.14

n: Number of samples, M: Mean, SD: Standard deviation

It can be observed that the dimension with the highest participant score was the dimension of disgust, with a mean score of 3.69±1.31. In addition, the participant score was 2.70±1.44 for the dimension of interest and 3.09±1.14 for the dimension of feeding animal.

The levels of reliability and normality of the variables to be used in the study are provided in Table 3.

Table 3. Results of reliability and normality analyses concerning research variables

	Skewness	Kurtosis	α
Disgust	-0.703	-0.796	0.950
Interest	0.328	-1.270	0.905
Feeding Animals	-0.025	-0.674	0.651

As shown in Table 3, the reliability coefficient was 0.950 for the disgust variable; 0.905 for the interest variable; and 0.651 for the feeding animal variable. These values suggested high reliability for the

variables disgust, interest and feeding animals.It is seen that the skewness and kurtosis values in Table 3 were between +1.5 and -1.5 (Tabachnick and Fidell, 2013), indicating normal distribution thus the use of parametric analysis methods.

In this part of the study, the differentiation of the dimensions of disgust, interest and feeding animals of entomophagy according to demographic data such as gender, age and educational background was examined.

Some groups were combined and used in the analyses to increase the homogeneity of group variances and eliminate the possible negative effect of groups with low number of participants on the analysis results. In the age variable, a new group of "41 and over" was formed by combining the groups "41-50" and "51 and over". In the educational background variable, primary education, secondary education, and high school groups were combined under a new group called "High school and before". Also, Master and PhD groups were combined under “Postgraduate” group for the same variable.

Table 4. Independent samples t-test and one-way ANOVA results concerning the relationship between demographic data and entomophagy's disgust dimension

Disgust		n	M	SD	F&t	p
Gender	Female	151	3.50	1.43	2.081	0.038
	Male	306	3.79	1.25		
Age	20 and below	132	3.75	1.15	1.950	0.121
	21-30	198	3.59	1.35		
	31-40	63	4.02	1.23		
	41 and above	64	3.59	1.53		
Educational Background	High school and before	31	3.14	1.45	2.365	0.070
	Associate	125	3.78	1.37		
	Undergraduate	237	3.75	1.22		
	Postgraduate	64	3.58	1.42		

n: Number of samples, M: Mean, SD: Standard deviation, F: one-way ANOVA coefficient, t : independent samples t-test coefficient, p: statistical significance

Independent samples t-test (Table 4) showed that the disgust dimension of entomophagy differed significantly according to the gender of the participants t=2.081, p<0.05. Similarly, one-way ANOVA results indicated no statistical significance between the disgust dimension of entomophagy and age (F(3.453) =1.950, p>0.05) and educational background (F(3.453)=2.365, p>0.05) of the participants.

Table 5. Independent samples t-test and one-way ANOVA results concerning the relationship between demographic data and entomophagy's interest dimension

Interest		n	M	SD	F&t	p
Gender	Female	151	2.84	1.50	1.398	0.163
	Male	306	2.64	1.41		
Age	20 and below	132	2.65	1.42	0.186	0.906
	21-30	198	2.73	1.43		
	31-40	63	2.64	1.43		
	41 and above	64	2.79	1.56		
Educational Background	High school and before	31	2.68	1.35	0.250	0.861
	Associate	125	2.66	1.47		
	Undergraduate	237	2.69	1.43		
	Postgraduate	64	2.84	1.51		

n: Number of samples, M: Mean, SD: Standard deviation, F: one-way ANOVA coefficient, t : independent samples t-test coefficient, p: statistical significance

As illustrated in Table 5, independent samples t-test results revealed no significant difference between entomophagy and gender t=1.398, p>0.05. Similarly, one-way ANOVA results showed that the interest dimension of entomophagy did not differ significantly according to age (F(3.453)=0.186, p>0.05) and educational

background (F(3.453)=0.250, p>0.05) of the participants.

Table 6. Independent Samples t-test and one-way ANOVA results concerning the relationship between demographic data and entomophagy's feeding animals dimension

Feeding Animals		n	M	SD	F&t	p
Gender	Female	151	3.17	1.23	0.989	0.324
	Male	306	3.06	1.10		
Age	20 and below	132	3.01	1.04	1.645	0.178
	21-30	198	3.10	1.17		
	31-40	63	3.37	1.05		
	41 and above	64	2.98	1.32		
Educational Background	High school and before	31	2.73	1.27	3.758	0.011
	Associate	125	2.92	1.29		
	Undergraduate	237	3.15	1.06		
	Postgraduate	64	3.39	1.00		

n: Number of samples, M: Mean, SD: Standard deviation, F: one-way ANOVA coefficient, t : independent samples t-test coefficient, p: statistical significance

As indicated in Table 6, independent samples t-test results revealed no significant difference between feeding animals' dimension of entomophagy and gender t=0.989, p>0.05. In addition, one-way ANOVA test showed that feeding animals dimension of entomophagy did not differ significantly according to participants' age (F(3.453)=1.645, p>0.05).

However, it was found that there was a statistically significant difference between the feeding animals' dimension of entomophagy and educational background of the participants (F(3.453)=3.758, p<0.05). According to the Bonferroni Post-hoc test, the participants in the "Postgraduate" group scored significantly higher in the feeding animals' dimension of entomophagy than the participants in the "High school and before" and "Associate" groups.

4. Discussion and conclusions

In our study, the dimension with the highest participant score was the dimension of disgust, which was also confirmed in other studies that the most common reason for refusing to taste an insect-based product was the disgust factor (Van Huis, 2015; Sogari, 2015). According to Caparros et al. (2014), the dimension with the highest participant score was the dimension of disgust. A study to assess Belgian individuals' perceptions of entomophagy found that although neophobia was determined among the participants, the evaluation of insect preparations was accepted. In relation to this, various insect formulations (edible worms and crickets) were prepared, and it was determined that familiar flavors and crispy insects were preferred. After the test of blind tasting, it seemed that people were willing to consume and cook insects in the near future. In the study, it was stated that entomophagy was positively associated with the eating habits of the Western European population. The integration of edible insects into human foods is a potential solution to replace other sources of animal protein. Insect consumption is a source for animal proteins in the future.

The acquired findings revealed that the measure had an acceptable level of reliability and was also applicable in Türkiye. It is therefore envisaged that the measure might be an important resource for researchers working in the field of gastronomy and nutrition. Given the current state of knowledge, this study might contribute to better acceptance of entomophagy in Türkiye and also help reduce the general public's bias, fear and negative attitude towards the consumption of edible insects.

According to our study, the participants in the "Postgraduate" group scored significantly higher than the participants in the "High school and before" and "Associate" groups. A study by Sogari et al. (2017) conducted on gastronomy science and food science students in Italy stated that students tasted almost all insect products and wanted to experience other edible insects. 109 students (53% females and 47% males) who participated in the study comprised young people between the ages of 18 and 25. Students were informed about entomophagy, and whether insects might be cooked with different culinary techniques or served as processed food. 65.0% of the participants stated

that the taste of edible insects was closely related to other substances.

According to the Bonferroni Post-hoc test, the participants in the "Postgraduate" group had higher scores for the use of entomophagy in feeding animals. A study conducted in Türkiye emphasized the need for further studies on issues such as feed value, digestibility, functional advantages, negative effects of insect flours, insect breeding systems, productivity in cultivation, and optimization in production, as well as the use of protein sources of insect origin as poultry feed within the framework of regulations to be established in the light of scientific data (Özek, 2016). That the participants in the "Postgraduate" group scored significantly higher than the participants in the "High School and Before" and "Associate" groups showing that as the level of education increased, the awareness of insects' inclusion in foods increased. There is a growing curiosity for entomophagy as well as a desire to consume products containing edible insects. Tasting sessions led by experts at food fairs, schools, museums and other special events might greatly facilitate the integration of entomophagy (Yen, 2009; Lensvelt and Steenbekkers, 2014; Balzan et al., 2016; Sogari et al., 2017).

As a result, research into entomophagy might be important in increasing the general acceptance of insects as food among different consumer groups and in commercial development. With this study, steps were taken to understand the main drives and barriers to accepting food with ingredients derived from insects (La Barbera et al., 2020). It is also assumed that people's consumption of edible insects and their use in gastronomy might occur depending on the training to be given.

The authors are aware that consumers have high levels of disgust in relation to eating insects. Insects might imperceptibly be processed as ingredients in gastronomy. It therefore seems plausible to assert that invisible insects inside insect-containing processed foods could receive more positive acceptance. Research and formulations should continue. The inclusion of insect products in gastronomy depends on culinary trends, marketing strategies and training. In particular, university courses on gastronomy and food science should be considered as opportunities for public participation to explain and taste edible insects because insects are one of food sources rich in proteins and other nutrients. Creating this positive perception of their healthy characteristics can be a powerful incentive for people who are more interested in their diet.

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