ARGUMENTS SUPPORTING THE INTRODUCTION OF EDIBLE INSECTS IN EUROPEAN FOOD CONSUMPTION

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Abstract

Entomophagy (the consumption of insects) has been part of the human diet since the dawn of humanity, being influenced by cultural and religious practices. But despite its long tradition among at least half of the world's peoples, in most Western countries entomophagy is viewed with disgust and associated with primitive behavior. One reason could be that after Europe became agrarian and adopted a sedentary lifestyles, insects were seen as destroyers of crops rather than a source of food. In the scientific literature, the edible insects are described as the food of the future. And this not only because of their nutritional value, but also for their sustainability. Edible insects are an excellent alternative to the traditional meat production, especially because their breeding has little impact on the environment. Even though the subject of entomophagy has started to capture the public attention in developed countries, the comsumption of edible insects in Europe is just at the beginning. The main aim of our paper is to demonstrate, through a secondary data research and through a calculation of nutritional value, that edible insects are really an alternative source for some foods of animal origin. Our paper do not advocate the inclusion of edible insects in the daily shopping list of the European consumers. By giving numerous arguments on the high nutritional value and sustainability of edible insects, our goal is to arouse the consumers' interests for the subject of entomophagy.

Key-words: entomophagy, edible insects, novel food, nutritional value, sustainability

JEL Classification: I12, O13, Z10

Introduction

Entomophagy (the consumption of insects) has been part of the human diet since the dawn of humanity, being influenced by cultural and religious practices. The use of insects as a source of food are mentioned in the Bible (Leviticus 11:21: "but from all winged insects that walk on four legs, eat only those that have longer hind legs…") (Meyer-Rochow, 2010).

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Also from Antiquity comes many historical references about the relationship between insects and human civilization. For example, in Antic Rome and Greece, people loved to eat cicadas and beetle larvaes (Johnson, 2010).
Nowadays, as FAO reports, about 1900 species of insects are commonly consumed as a food source in many regions of the world. More than 2 billion people across the world are eating insects, as parts of numerous traditional dishes, especially in Africa, South-East Asia and South-America.
The edible insect industry was founded on the harvesting of wild species from forest areas around villages. Nowadays, edible insect species are obtained from both wild harvesting and the farming of a few species.
Edible insects provide a wide range of important nutrients: highly digestible proteins, fiber, unsaturated fatty acids, vitamins and minerals. But, edible insects are considered the food of the future not only because of their nutritional value, but also for their sustainability (their breeding has little impact on the environment).
But despite its valence of highly nutritious and sustainable source of food and its long tradition among at least half of the world's peoples, in most Western countries entomophagy was viewed with disgust and even associated with primitive behavior (Huis et al., 2013). One reason could be that after Europe became agrarian and adopted a sedentary lifestyles, insects were seen as destroyers of crops rather than a source of food.
Moreover, Western attitudes toward food can be characterized by the rejection of certain food sources for psychological reason rather than the logical one (Belluco et al., 2013).
Even though the subject of entomophagy has started to capture the public attention in developed countries, the comsumption of edible insects in Europe is just at the beginning.
Lately, on the European market, snacks, snack bars and protein powders are the top application areas of interest for edible insects. Also the insects' powder are used in burgers, sausages, shakes etc.
Starting with 2015, in European Union, edible insects are considered novel foods and their status is regulated by the new Regulation 2015/2283 on novel foods, which have entered into force through its publication in the Official Journal of the EU and and will be applicable two years later.
The paper, structured into many sections for a better understanding of the subject, starts with a literature review in order to identify the most relevant aspects regarding the nutritional benefits and farming efficiency of edible insects. In the second section are presented some evidence on the use and the perception of edible insects as "novel food" sources on the EU market. Next section of the paper presents the research objectives and specific methodology, followed by a comparative analyses of the nutritional value of two menus, one which includes only traditional ingredients (meat, cheese and vegetables) and the other one where the ingredients of animal origin have been replaced by edible insects. In the final part, we highlight the conclusions and implications of the research results.

1. Literature review regarding the nutritional benefits and farming efficiency of edible insects

Globally, the most commonly consumed species of insects are beetles (31%), caterpillars (18%). These two species are followed by bees, wasps and ants (14%), grasshoppers, locusts and crickets (13%), cicadas, leafhoppers, planthoppers, scale insects and true bugs (10%). With a smaller share in global consumption are termites (3%), dragonflies (3%), flies (2%) and others (5%) (Harrison – Dunn, 2015a).

Because edible insects have great nutritional values, they are considered by FAO a credible food alternative.

Edible insects are an *excellent source of highly digestible proteins* (35 % to over 60%), containing all the amino acids necessary for the body, that can completely replace meat consumption (Rumpold and Schluter, 2013).

Insects represent *a source of fiber*, because of their high content of chitin, a carbohydrate found in invertebrate exoskeletons (about 10% of the whole dried insect) (Belluco et al., 2013).

Most of insects' fatty acids are unsaturated, generally comparable to those of poultry and fish. They are also *low in saturated fats* (Harrison – Dunn, 2015a).

Edible insects also have *high content of vitamins* (especially from B group) and *provide many minerals* (iron, magnesium, zinc, phosphorous, selenium, copper). It was demonstrated that the content of vitamins and minerals in edible insects can be controlled through the feed (Pennino, Dierenfeld and Behler, 1991; Rumpold and Schluter, 2013).

Thus, insects can be compared to other foods of animal origin, such as crustaceans, fish, and meat, which form the Western diet (Belluco et al., 2013).

Edible insects can be cooked for all kinds of dishes, from appetizers to desserts. Insects are also processed into powder, granular or paste forms, which can be used to make pastries, shakes etc. Before processing, insects pass through a dehydration process which makes them clean and hygienic and also keeps intact most of their nutritional value.

As for taste, most of them don't have a weird taste. Some taste like almonds or nuts (crickets), other more like bacon (silkworms) or smoked bacon (beetles), other like grilled corn (bamboo worms) or baked potatoes (grasshoppers).

Apart from the numerous attributes listed above, that make them an attractive sources of highly nutritious food, edible insects are equally a sustainable source of food, especially because their breeding has little impact on the environment.

The most important *advantages of edible insects breeding* are as follows:

- The insects cost less and also pollute less than traditional breeding, as they uses very little space and require fewer resources (insects use much less water than farm animals, as they hydrate directly from the food); moreover, unlike cattle, insects don't produce gases causing global warming (Dossey, 2013);
- The insects' growth rates are high, they are very prolific (they reproduce at a much faster rate than farmed animals: for example, crickets are twice as efficient to rear as chickens, 4 times more efficient than pigs and 12 times more than cattle) (Watson, 2015);
- The insects are much more efficient in converting biomass to protein; compared to cattle production, insect farming is much more efficient: 100 kilograms of feed produces 10 kilograms of beef, while the same amount of feed produces 45 kilograms of cricket (National Geographic News, 2010);
- The edible insects are easy to process and they work well in may kind of food products (pasta, baked goods, snack bars, protein shakes, hamburgers etc.).

For all these benefits, is predicted that the edible insect industry has much potential for providing protein sources in the future and for income generation.

In European Union, edible insects are analysed not only through their benefits – a highly nutritious and sustainable source of food – but also by their risks in household consumption.

Regarding the possible risks, the views are different. Having as argument the great diversity of edible insects (FAO estimates that there are more than 1900 species currently consumed by people), one consider them being more safe than vertebrate animals such as cattle, chickens or fish, which are increasingly susceptible to many disease (Dossey, 2013).
Other scientists consider that toxic, allergenic or antinutrient substances, which are considered intrinsic factors of risk, could be incorporated in insects. For example, American scientists (University of Nebraska-Lincoln) have proved that the insects protein could cause allergy (especially to those who are also allergic to seafood), they suggest to producers to label their foods containing insect protein as being not suitable for shellfish allergics (Watson, 2015).
But, the extrinsic factors must be considered as well. Rumpold and Schluter (2013) noted that it was reported many cases of botulism, parasitoses and food poisoning caused by aflatoxins contamination of edible insects. In addition, some species of edible insects can synthesize toxins via feed, as a chemical defense mechanism against predators (insectivores). Their consumption can lead to digestive or visual disorders.
It was also reported that insects harvested in the wild could contain pesticides if they have fed in pesticide-treated areas. From this point of view, it is preferable to consume farm insects, whose controlled feeding eliminates the risk of pesticide contamination (Schabel, 2010).
Starting with 2015, in European Union, edible insects are considered novel foods and their status is regulated by the new Regulation 2015/2283 on novel foods, which have entered into force through its publication in the Official Journal of the EU and and will be applicable two years later.
According to the Article 3 (Definitions) of this Regulation, through the “novel food” we have to understand any food that has not been consumed to a significant degree by humans in the EU prior to 1997 (when the first Regulation on novel food came into force). In the Novel Foods class are included newly developed foods, innovative foods (foods produced using new technologies and production processes) and also the traditionally foods eaten outside of the EU (European Commission, 2016).
The regulation confirms that insects are unauthorised Novel Food sources in Europe if they were not consumed before 1997. It also states that the producers of insects for human consumption that intend to sell their products on the EU market shall obtain an authorisation from the European Commission. This gives to companies that already sell edible insects on the EU market two years to submit a dossier for authorisation (Harrison-Dunn, 2015b).
In order to help the edible insect industry prosper in Europe and worldwide, it was created The International Platform of Insects for Food and Feed (IPIFF), a non-profit organization, located in Brussels. The IPIFF vision is that the European insect industry to be composed of a collaborative network of local partner companies that will share sustainability as a common value and promote insect industry as an eco-industry (International Platform of Insects for Food and Feed, 2014).
Representing the interests of the insect sector, IPIFF is advocating the potential of insects for human food towards the European Commission and the European Food Safety Authority (EFSA). Simultaneously, IPIFF guides and advices its members on how to authorise their products.

2. Obiectives and research methodology

The main aim of our paper is to demonstrate, through a secondary data research and through a calculation of nutritional value, that edible insects are really an alternative for some foods of animal origin. In this respect, we have chosen two menus for calculating the nutritional value, one which includes only traditional ingredients (meat, cheese and vegetables) and the other one where the ingredients of animal origin have been replaced by edible insects.
By giving numerous arguments on the high nutritional value and sustainability of edible insects, another aim of our paper is to arouse the interests of European consumers for this subject; we do not advocate the inclusion of edible insects in the daily shopping list, we only want that European consumers have an open mind about entomophagy.
The calculation of the caloric intake and the degrees of covering the recommended daily energy and nutrients are based on the following formulae (Dima et al., 2006):

$Q = 4,1xP + 4,1*Gl + 9,3xL$	where: Q – energy value of the product (kcal); P, Gl, L – amounts of proteins, carbohydrates, lipids (g).
$G = Q/N \times 100$	where: G – degree of coverage of recommended daily energy intake (%); Q - energy value (kcal); N - the recommended daily energy intake (kcal).
$G_P = P/N_P \times 100$ $G_{Gl} = Gl/N_{Gl} \times 100$ $G_L = L/N_L \times 100$	where: G_P, G_{Gl}, G_L – degrees of coverage of the recommended daily intake of proteins, carbohydrates, lipids (%);P, Gl, L – amounts of protein, carbohydrates, lipids (g); N_P, N_{Gl}, N_L – daily recommended intake of proteins, carbohydrates and lipids (g).

The calculation of the covering degrees was based on the daily intakes of calories and nutrients recommended in the dietary guidelines of Romania for females with the age between 20-45 years old, who undertake a physical activity of weak intensity (2500 kcal, 90 g proteins, 340 g carbohydrates, 80 g lipids).

3. Results and discussions

Table 1 and Table 2 show the results obtained following the application of “Covering degree method”.

Table 1. The traditional menu – chemical composition and covering degrees

Ingredients		Quanti-ties	Chemical composition and covering degrees					
			P (g)	Gl (g)	L (g)	Q (kcal)	Ca (mg)	Fe (mg)
Salad	Lettuce	250 g	4.75	7.25	0.75	56.18	62.50	2.50
	Cucumber	50 g	0.65	1.45	0.10	9.54	11.50	0.50
	Onion	20 g	0.20	0.70	0.04	4.06	27.00	0.20
	Cheese	40 g	7.76	0.40	8.16	109.34	198.40	0.00
	Olive oil	15 g			15.00	139.50		
Grilled Turkey with rice and vegetables	Turkey meat	200 g	39.20		13.60	287.20	17.00	5.27
	Rice	100 g	7.29	67.95	1.08	318.53	27.00	1.17
	Peas	20 g	1.44	2.52	0.09	17.07	4.68	0.27
	Bell pepper	20 g	0.23	1.38	0.07	7.25	0.00	0.14
TOTAL			61.52	81.65	38.89	948.67	348.08	10.05
Recommended intake			47.50	180	45	1350	400	9
Covering degree of recommended intake (%)			**129.52**	**45.36**	**86.42**	**70.27**	**87.02**	**111.67**

Table 2. The edible insects menu – chemical composition and covering degrees

Ingredients		Quanti -ties	Chemical composition and covering degrees					
			P (g)	Gl (g)	L (g)	Q (kcal)	Ca (mg)	Fe (mg)
Salad	Lettuce	250 g	4.75	7.25	0.75	56.17	62.5	2.5
	Cucumber	50 g	0.65	1.45	0.1	9.54	11.5	0.5
	Onion	20 g	0.2	0.7	0.04	4.06	27	0.2
	Mealworms	20 g	11.08	3.08	3.82	93.64	0.16	0.01
	Olive oil	15 g			15	139.5		
Crickets with rice and vegetables	Crickets	100 g	58.51	8.4	24	497.53	1.1	0.025
	Rice	100 g	7.29	67.95	1.08	318.53	27	1.17
	Peas	20 g	1.44	2.52	0.09	17.073	4.68	0.27
	Bell pepper	20 g	0.23	1.38	0.07	7.252	0	0.14
TOTAL			84.16	92.73	44.96	1143.31	133.94	4.82
Recommended intake			47.50	180	45	1350	400	9
Covering degree of recommended intake (%)			**177.17**	**51.52**	**99.90**	**84.69**	**33.49**	**53.50**

Comparing the results presented in Table 1 and Table 2 it can be observed that the covering degrees of recommended daily intakes of macronutrients and energy calculated for a lunch meal are higher in case of the alternative menu based on edible insects. This was possible even in the conditions that the quantities of edible insects included in the alternative menu represented a half of the quantity of ingredients of animal origin from traditional menu. So, the statement regarding the high nutritional value of edible insects has been demonstrated.

But, if the high nutritional value and the sustainability are sufficient to pique consumer interest in insects, this is not enough to ensure that the insect will become a daily consumed item.
As the pieces of research of Michail (2015a and 2015b) and Tan et al. (2015) have been showing, the acceptance of insects as food source in Europe requires from the food manufacturers to develop appropriate products that will taste good and will align ethical motivations with sensory expectations of consumers.

Conclusions

Between the most frequently motives cited in the scientific literature to sustain entomophagy are included: nutritional benefits, poverty reduction through food security, the potential for income generation, pesticide avoidance and conservation of biodiversity and cultural traditions (Meyer-Rochow, 2010).
The strongest argument in favour of edible insects as food, also emphasized by our paper, is their nutritional value that support a balanced diet for improving health.
Edible insects are a new food for the European diet. Although challenging, the introduction of new food items to the human diet is not without precedence.
Insects are important elements of other food culture and as a proof of the respect for these foreign culture, enthomophagy should not be regarded with disgust and considered a barbarian or a primitive eating habit. Otherwise there is a risk that the human who make such judgments become a barbarian himself. The negative impressions and the disgust associated with edible insects can be overcome through an effort of changing the ethnocentric mentality, which is possible through consumer education.
We consider that our paper could be a valuable instrument for consumer education on the subject of entomophagy.
We also want to emphasize the need to make known the nutritional profile of edible insects among the public. A widespread promotion of this new sector would be beneficial to create demand and raise interest among consumers. Although edible insects are consumed by many people in their origin countries, their market is still relatively small.
As Hanboonsong and al. (2013) have showed, there is great potential to increase consumption demand not only in the origin countries of edible inssects, but all over the world, through marketing campaigns. Some processing methods of edible insects and product development are obviously needed in the near future, but if undertaken along with clever advertising, this could attract young consumers and middle class consumers.
There is also a need to raise awareness of the growth potential of this industry sector amongst policy-makers from the countries of origin of edible insects so that they promote and guide future development and funding into key areas of the research, such as: best management practices, food safety issues, promotion and international trade.

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