Insect Based Foods a Nutritional Point of View

Article · December 2017

DOI: 10.19080/NFSIJ.2017.04.555638

4 authors, including:

Attila Gere
Szent István University, Godollo
49 PUBLICATIONS **141** CITATIONS
SEE PROFILE

Ryan Zemel
4 PUBLICATIONS **0** CITATIONS
SEE PROFILE

Dalma Radványi
Hungarian Academy of Sciences
11 PUBLICATIONS **14** CITATIONS
SEE PROFILE

Nutrition & Food Science
International Journal
ISSN 2474-767X

Juniper Publishers
key to the Researchers

Mini Review
Volume 4 Issue 2 – December 2017
DOI: 10.19080/NFSIJ.2017.04.555638

Nutri Food Sci Int J

Insect Based Foods a Nutritional Point of View

Attila Gere[1]*, Ryan Zemel[2], Dalma Radványi[3] and Howard Moskowitz[4]

[1]*Faculty of Food Science, Szent István University, Hungary*

[2]*Independent Researcher, Downers Grove, USA*

[3]*Centre for Agricultural Research, Hungarian Academy of Sciences, Plant Protection Institute, Hungary*

[4]*Mind Genomics Advisors, USA*

Submission: October 18, 2017; **Published:** December 18, 2017

***Corresponding author:** Attila Gere, Szent István University, Villányiút 29-43, H-1118 Budapest, Hungary, Email: gere.attila@etk.szie.hu

Abstract

An insect as food, consuming insects, is gaining popularity in the Western cultures in the past few years. There are undoubtedly positive advantages to consuming insects in the place of consuming traditional meats such as beef, chicken or pork. Economics and health, supply and demand, cost and the need for adequate nutrition, are in play here. The ever-increasing world population will face serious issues in the not so distant future. Providing affordable, good quality and nutritious food for every human being is a problem of today. Using insects, as food products (or ingredients) may afford somewhat of a solution to these serious problems. To complement already-published reviews dealing with environment and product, we focus here on a review of the nutrition-related issues addressable by introducing insects into the diet. There is an emerging body of knowledge about the nutritional advantages of insects. This mini-review provides an analysis about the most recent state of the topic, the nutritional characteristics of edible insects, coupled with the twin issue in Western cultures of the response of consumers to the notion of insects.

Keywords: Entomophagy; Insect-based food; Nutrition

Introduction

Insects have been part of the human diet from early ages [1]. There are clear archeological evidences showing that early humans regularly consumed insects [2]. Insects as food are still a fact in the majority of countries all around the world. More than 1900 species have been recorded as consumed regularly [3]. It is estimated that around 2 billion people regularly consume insects [4] in Africa, Asia, and Latin America.

Insects are eaten not only because of their nutritive value but also because of their taste [5]. In Western countries, however, insects disappeared from the plates in the past few centuries. This short period, just a few centuries, sufficed for people to forget almost completely insect eating. Emotions followed, as westerners began to consider entomophagy (insect eating) as an interesting (or disgusting) habit practiced in Eastern countries.

A typical belief is that insects are consumed in many countries only because they are part of their traditional diet. The rich nutrition possible is, therefore, overlooked, a gift of the combination of abandoning or forgetting tradition, and in place allowing an emotional reaction to take its place. The result is counter-productive to society and to the individual within the society. The reality is that one of most important practical reasons of insect-eating is the nutritional value they have. In places where nutritious and quality food is less available, insect present a real solution to get the necessary nutrients.

There is another trend at work, demand for meet which will meet with limiting factors in the not too distant future. Predicted meat demand of the world will rise by 163% until 2050 [6]. It has been accepted that traditional livestock farming will be unable to produce the required amount of meat; hence to feed the world. In the past decade, fueled by an extremely successful FAO report on entomophagy [3], research interest has focused on insects as possible food products or food materials.

Insect as food bring to play many factors, from history to nutrition to consumer attitudes. At the same time, environment and ecology play a role as well. Researchers have focused on ecological factors [7], use of animal feed [8,9] agricultural sustainability [10], food safety [11,12], biological hazards [13] and the development of rearing and processing technologies [14].

We focus here on the nutritional values of different insect species, almost the 'micro-economics' of insects as food, rather than the 'macro-economics.' We focus on the person doing the eating. As it has been introduced, the term 'insects' is too general since it covers several hundred species and their different development stage [15], hence the comparison of

nutritional values of insects cannot be done globally. Based on these, the authors compare the nutritional values of different species to beef, chicken, and pork, the three most widely bred livestock.

Nutritional Comparison of Insects to Conventional Meat Products

Nutritional composition of edible insects is a topic in itself, due to the large number of species which could serve as food. One number per insect may not suffice. Insects develop, and as they develop their nutritional profile changes. These changes will vary by species, and must be mapped out to produce a nutritional profile of each insect by each development phase. Such understanding is important, given the short life of an insect, and the potentially large variation in nutritional profile across that short life [16,17]. Variation also comes from the way the insects are killed, this time a variation in sensory quality. The method of killing insects influences the sensory qualities and physiochemical properties of crickets prepared in broth. For example, umami, sweet and salty taste showed significantly higher values when the broth was mead of live crickets compared to the ones from frozen [18]. Furthermore, preparation has a significant effect on their nutritional profile [3].

The energy content of insect species show similar or higher values compared to conventional meat products (Table 1), but it depends on their fat content [19]. Insects have a high-quality protein content due to the presence of all the essential amino acids in the recommended ratios [20,21]. Amino acid composition is also favorable. Insects contain higher amounts amount of amino acids compared to common meat types. The phenylalanine and tyrosine levels are exceptionally high, leading to the suggestion that consuming insects may allow for the necessary amino acid intake [22].

Table 1 compares fifteen aspects of nutritional importance within three meats and six insect families based on data from the published literature. The particular meats and insects are those conventionally encountered in the diet. The three meats are common to the regular diet and the six insect families are used in insect food products. The insects are classified to the taxonomic family and their stage in development is listed. Only portions of the organisms deemed edible are analyzed.

Table 1 shows clear that there exists wide range in nutritional content amongst the sources protein sources. Keep in mind that these are estimates, and need further validation as insects become more popular as a food. Nonetheless, Table 1 shows that the variation generates distinct advantages and disadvantages for each insect and meat, respectively. For example, Gryllidae has an advantage when high protein and low-calorie content is desired, namely 20.1g of protein per 153Kcal. However, Gryllidae has a disadvantage when low sodium is desired, since Gryllidaae contains 152mg/per 100g of edible portion. Curculionidae enjoys an advantage regarding low sodium, but it is at a disadvantage when it comes to protein content, only having 9.96g protein per 479Kcal. This variation in content, coupled with appropriate communications, enables the consumer to identify the insect that meets their nutritional requirements. Meats such as beef, pork, and chicken do not provide this advantage in nutritional choice because they have similar nutritional contents (Table 1).

Table 1: Median values for nutrients in 100g of commonly used meats and insects [15,23-28].

	Gryllidae-Cricket (adult)	Apidae-Honeybee (Brood)	Bombycidae-Silkworm (Pupae)	Saturniidae-Mopane Caterpilla (Final Instar)	Curculionidae-Palm weevil (Larvae)	Tenebrionidae-Mealworm (Larvae)	Beef	Chicken	Pork
Energy (Kcal) per 100g edible portion	153	499	128	409	479	247	169	152	186
Protein (g) per 100g edible portion	20.1	15.2	14.8	35.2	9.96	19.4	20.6	19.9	20.1
Fat (g) per 100g edible portion	5.06	3.64	8.26	15.2	25.3	12.3	9.3	7.2	12.4
Saturated fat (g) per 100g edible portion	2.28	2.75	3.45	5.74	9.84	2.93	3.8	1.81	3.5

How to cite this article: Attila G, Ryan Z, Dalma R, Howard M. Insect Based Foods a Nutritional Point of View. Nutri Food Sci Int J. 2017; 4(3): 555638. DOI: 10.19080/NFSIJ.2017.04.555638.

Sodium (mg) per 100g edible portion	152	19.4	14	14	11	53.7	60	80	62
Protein (Crude Measured as N × 6.25)	66.6	60	53.8	16	25.8	49.1	17.37	17.44	15.41
Fat (% Crude at)	22.1	10.6	8.1	NA	38.5	35	17.07	8.1	17.18
Fiber (a, acid detergent fiber; b, crude fiber)	10.2	NA	6.4	11.4	NA	6.6	0	0	0
Ash	3.6	17.4	6.4	7.6	2.1	2.4	0.86	1.17	0.79
Na	NA	NA	47.5	1032	NA	53.7	57	60	58
K	NA	NA	316	1024	NA	341	246	522	297
Ca	75	NA	15	174	NA	16.9	7	6	14
P	NA	NA	641	543	NA	285	122	178	181
Fe	54	NA	3.1	31	NA	2.06	1.69	0.82	0.91
Mg	NA	NA	49.8	160	NA	80.1	17	21	20

Consumer Acceptance

As it has been shown, insects have great nutritional values supported by relevant data from the literature. However, in Western countries, consumption of edible insects is prohibited by psychological factors. One of the most important factors is food neophobia, the fear from new food products. The negative effect on acceptance has been found in Belgium, Germany, Hungary, Italy, and USA also, just to name a few [29-33].

There is no evidence of an innate aversion for insects [34]. Many psychological and biological factors govern food preferences and aversions. Children are taught at a young age what not to eat, and at the same time also learn to like specific foods through mere exposure and social learning [35]. Whereas, there are certain predispositions, food likes and dislikes are mostly acquired through experience. It has been shown that sensory liking increased after tasting insect-based burgers [36].

\Individuals vary in their sensitivity to disgust. This sensitivity extends to three dimensions of disgust: core, animal reminder, and contamination, respectively. The origin is presumed to be biological. Core disgust is rooted in the threat that stems from oral consumption of offensive items, animal reminder disgust is based on reminding people of their own animal nature, and contamination disgust is a reaction to the perceived threat of disease transmission from other people [37]. Insect-based food, especially processed insects whose form has been changed into a power, may move beyond the typical drivers of the disgust response, especially those rooted in the aforementioned causes, namely physiology.

When the "yuk" factor of the whole insect is removed and familiar looking is presented, the transformation may allow people to relax. This effect of transformation manifests itself in the finding that the likelihood of acceptance generally decreases with the degree of visibility of the whole insect [32,38]. We need look no further than raw fish. It took many years for raw fish to defeat its western bafflement. Today, world-wide, Japanese-origin sushi and sashimi are seen to be 'normal' foods. It is advised to hide the insects, as usually happens with the other land animals. Meat is almost always disguised in a way that the animal is not recognizable.

The insect sector is rapidly emerging due to the high number of experimenters, who are less neophobic, and who are sufficient curious and adventurous to try insect-based food products [39]. People may consume insect food more easily when insect protein (extract), unrecognizable as to its original source, is incorporated in food. Such a strategy is simple, and overcomes the issues involved with consumer acceptance of whole insects as foodstuffs [30,40]. Indeed, it is the processed insect as a food ingredient, which may pave the way for the acceptance of insects in the daily diet in industrialized countries [41,42]. The key task, then for entomophagy, is to convince consumers about the positives of insects as food and as food ingredients.

How to cite this article: Attila G, Ryan Z, Dalma R, Howard M. Insect Based Foods a Nutritional Point of View. Nutri Food Sci Int J. 2017; 4(3): 555638. DOI: 10.19080/NFSIJ.2017.04.555638.

References

1. Rothman JM, Raubenheimer D, Bryer MA, Takahashi M, Gilbert CC (2014) "Nutritional Contributions of Insects to Primate Diets: Implications for Primate Evolution." J Hum Evol 71: 59-69.
2. Van Huis A (2017) "Did Early Humans Consume Insects?" Journal of Insects as Food and Feed 3(3): 161-163.
3. Van Huis, Van Itterbeeck J, Klunder H, Mertens E, Halloran A, et al. (2013) "Edible Insects. Future Prospects for Food and Feed Security."
4. Schouteten, Joachim J, Hans De S, Sara De P, Sofie L, et al. (2016) "Emotional and Sensory Profiling of Insect-, Plant- and Meat-Based Burgers under Blind, Expected and Informed Conditions." Food Quality and Preference 52: 27-31.
5. Nonaka K (2009) "Feasting on Insects." Entomological Research 39(5): 304-312.
6. Mark RW, Tokgoz S, Prapti B (2013) "The New Normal? A Tighter Global Agricultural Supply and Demand Relation and Its Implications for Food Security." American Journal of Agricultural Economics 95(2): 303-309.
7. Lundy Mark E, Michael PP (2015) "Crickets Are Not a Free Lunch: Protein Capture from Scalable Organic Side-Streams via High-Density Populations of Acheta Domesticus." PloS One 10(4): e0118785.
8. Alexandre T, Rivera JL, Wilfart A, Maillard F, Hassouna M, et al. (2017) "Mealworm Meal for Animal Feed: Environmental Assessment and Sensitivity Analysis to Guide Future Prospects." Journal of Cleaner Production 170.
9. Sergiy S, Larki NA, Pernutz C, Franke K, Bindrich U, et al. (2017) "Structure Design of Insect-Based Meat Analogs with High-Moisture Extrusion." Journal of Food Engineering.
10. Alexander, Peter, Calum B, Almut A, Clare D, et al. (2017) "Could Consumption of Insects, Cultured Meat or Imitation Meat Reduce Global Agricultural Land Use?" Global Food Security, in press pp. 1-11.
11. Grabowski, Nils Th, Günter Klein (2017) "Bacteria Encountered in Raw Insect, Spider, Scorpion, and Centipede Taxa Including Edible Species, and Their Significance from the Food Hygiene Point of View." Trends in Food Science and Technology 63: 80-90.
12. Maciel-Vergara G, Ros VID (2017) "Viruses of Insects Reared for Food and Feed." J Invertebr Pathol 147: 60-75.
13. Finke MD, S Rojo, N Roos, A Van Huis, AL Yen (2015) "The European Food Safety Authority Scientific Opinion on a Risk Profile Related to Production and Consumption of Insects as Food and Feed." Journal of Insects as Food and Feed 1(4): 245-247.
14. Rumpold BA, Schlüter OK (2013) "Nutritional Composition and Safety Aspects of Edible Insects." Mol Nutr Food Res 57(5): 802-823.
15. Payne CL, Scarborough P, Rayner M, Nonaka K (2016) "Are Edible Insects More or Less 'healthy' than Commonly Consumed Meats? A Comparison Using Two Nutrient Profiling Models Developed to Combat over- and Undernutrition." Eur J Clin Nutr 70(3): 285-291.
16. Paoli PP, Donley D, Stabler D, Saseendranath A, Nicolson SW, et al. (2014) "Nutritional Balance of Essential Amino Acids and Carbohydrates of the Adult Worker Honeybee Depends on Age." Amino Acids 46(6): 1449-1458.
17. Finke MD, Dennis O (2014) "Chapter 17 - Insects as Food for Insectivores." In Mass Production of Beneficial Organisms, edited by Juan A Morales-Ramos, et al. (Eds.), 583-616. San Diego: Academic Press, USA.
18. Farina Michael F (2017) "How Method of Killing Crickets Impact the Sensory Qualities and Physiochemical Properties When Prepared in a Broth." International Journal of Gastronomy and Food Science 8: 19-23.
19. Kouřimská L, A Adámková (2016) "Nutritional and Sensory Quality of Edible Insects." NFS Journal 4: 22–26.
20. Simone B, CarmenZ L, Michela M, Cristiana CA, Maurizio GP, et al. (2013) "Edible Insects in a Food Safety and Nutritional Perspective: A Critical Review." Comprehensive Reviews in Food Science and Food Safety 12(3): 296-313.
21. Collavo A, Glew RH, Yunk-Sheng H, Lu-Te C, Bosse R, et al. (2005) "Housekricket Smallscale Farming." In Ecological Implications of Minilivestock: Potential of Insects, Rodents, Frogs and Snails, edited by MG Paoletti, (1st edn), 519-544. Enfield NH, USA.
22. Sogbesan AO, AAA Ugwumba (2008) "Nutritional Evaluation of Termite (Macrotermes Subhyalinus) Meal as Animal Protein Supplements in the Diets of Heterobranchus Longifilis (Valenciennes, 1840) Fingerlings." Turkish Journal of Fisheries and Aquatic Sciences 8(1): 149-157.
23. Williams JP, Williams JR, Kirabo A, Chester D, M Peterson (2016) "Chapter 3 - Nutrient Content and Health Benefits of Insects." In: Insects as Sustainable Food Ingredients, In: Aaron T Dossey, et al. (Eds.), 61-84. San Diego: Academic Press, USA.
24. Melo-Ruiz V, Sandoval-Trujillo H, Quirino-Barreda T, Sánchez-Herrera T, Díaz-García R, et al. (2015) "Chemical Composition and Amino Acids Content of Five Species of Edible Grasshoppers from Mexico." Emirates Journal of Food and Agriculture 27(8): 654-658.
25. Sandra GFB (1997) "The Nutritional Value of Edible Insects." Ecology of Food and Nutrition 36(2-4): 287–319.
26. Bodenheimer FS (1951) Insects as Human Food (1stedn) Huage: Springer Netherlands.
27. Finke MD (2007) "Estimate of Chitin in Raw Whole Insects." Zoo Biology 26(2): 105-115.
28. Finke MD (2013) "Complete Nutrient Content of Four Species of Feeder Insects." Zoo Biology 32(1): 27-36.
29. Gere A, Géza S, Sándor K, Zoltán K, László S (2017) "Readiness to Adopt Insects in Hungary: A Case Study." Food Quality and Preference 59: 81-86.
30. Hartmann C, Jing S, Alice G, Michael S (2015) "The Psychology of Eating Insects: A Cross-Cultural Comparison between Germany and China." Food Quality and Preference 44: 148-156.
31. Hartmann C, Michael S (2016) "Becoming an Insectivore: Results of an Experiment." Food Quality and Preference 51: 118-122.
32. House J (2016) "Consumer Acceptance of Insect-Based Foods in the Netherlands: Academic and Commercial Implications." Appetite 107: 47-58.
33. Olatunji BO, Jonathan H, Dean McKay, Bieke D (2008) "Core, Animal Reminder, and Contamination Disgust: Three Kinds of Disgust with Distinct Personality, Behavioral, Physiological, and Clinical Correlates." Journal of Research in Personality 42(5): 1243-1259.
34. Ramos-Elorduy J, Piano JM, Escamillia EP, Perez JO, Lagunez JO, et al. (1997) "Nutritional Value of Edible Insects from the State of Oaxaca, Mexico." Journal of Food Composition and Analysis 10: 142-157.
35. Rozin P, and TA Vollmecke (1986) "Food Likes and Dislikes." Annual Review of Nutrition 6: 433-456.
36. Ruby MB, Rozin p, Chan C (2015) "Determinants of Willingness to Eat Insects in the USA and India." Journal of Insects as Food and Feed 1(3): 215-225.
37. Schösler H, de Boer J, Boersema JJ (2012) "Can We Cut out the Meat of the Dish? Constructing Consumer-Oriented Pathways towards Meat Substitution." Appetite 58(1): 39-47.

How to cite this article: Attila G, Ryan Z, Dalma R, Howard M. Insect Based Foods a Nutritional Point of View. Nutri Food Sci Int J. 2017; 4(3): 555638. DOI: 10.19080/NFSIJ.2017.04.555638.

38. Giovanni S, Davide M, Cristina M (2016) "Exploring Young Foodies, Knowledge and Attitude Regarding Entomophagy: A Qualitative Study in Italy." International Journal of Gastronomy and Food Science 7: 16-19.

39. Tan Hui SG, Fischer ARH, Trijp HCM van, Stieger M (2016) "Tasty but Nasty? Exploring the Role of Sensory-Liking and Food Appropriateness in the Willingness to Eat Unusual Novel Foods like Insects." Food Quality and Preference 48 Elsevier Ltd: 293-302.

40. Valle FRD, Mena MH, Bourges H (1982) "An Investigation into Insect Protein." Journal of Food Processing and Preservation, Blackwell Publishing Ltd 6(2): 99-110.

41. Verbeke W (2015) "Profiling Consumers Who Are Ready to Adopt Insects as a Meat Substitute in a Western Society." Food Quality and Preference, Elsevier Ltd 39: 147-155.

DOI: 10.19080/NFSIJ.2017.04.555638

How to cite this article: Attila G, Ryan Z, Dalma R, Howard M. Insect Based Foods a Nutritional Point of View. Nutri Food Sci Int J. 2017; 4(3): 555638. DOI: 10.19080/NFSIJ.2017.04.555638.