A pilot study: consumer acceptability of Polish style cooked sausages containing house cricket flour

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There is a growing interest on insects as food in Western countries. Currently, EU legislation limits the use of insects as food, however, new regulation coming to force in 2018 will clarify the situation. In the ScenoProt project funded by Strategic Research Council of Finnish Academy insects are considered as potential protein source for human consumption, and therefore, some food technological properties of insects are studied in the project. Scientific research has proven mealworm larvae and silkworm pupae originated protein fraction equal to meat protein in emulsion sausages. Generally, it is also of interest how unfractionated, chitin containing insect flour would affect the sensory properties of sausages. The objective of the present study was to investigate the consumer attitudes to Polish style sausages containing unfractionated house cricket (*Acheta domesticus*) flour. Lean and fatty meat was purchased from local supplier, and three different sets of smoked and cooked sausages were made. The basic recipe contained pork, water, house cricket flour, nitrite salt, and spices. Salt content of sausages was approx. 1.8%. In the first set 1/5, and in the second and third set approx. 1/6 of lean meat was replaced with house cricket flour. The fat content was approx. 12% in the first and 19–20% in the second and third set of sausages. The third set included ordinary Polish style sausage as a reference. Cooking loss of the sausages was acceptable, below 10%. Odor, texture and taste were evaluated by ordinary consumers (n=26) for the first, by media people (n=34) for the second, and by representatives of food industry (n=17) for the third set. Because of potential allergic reaction in shellfish sensitive people, the consumers were informed about the contents of the sausages. Consumer willingness to eat sausages again was recorded for the first and second set and free comments were collected for all the sets. The evaluation scale had five points (1=extremely negative, 5=extremely positive).Only in the first set the evaluations on odor, texture, and taste of the sausages averaged lower than 3. Even the willingness to eat sausages again was approx. 3. This may reflect the interest of the consumers towards food containing insects in general. The increased fat content in the second and third sets of sausages may be one factor responsible for increase in the valuation of the sensory parameters as Finnish consumers are used to the fat content of around 20 % in cooked sausages. In
the third set the control sausages showed slightly higher acceptance for texture than the house cricket sausages. In free comments, dryness, dark colour, floury texture, and liver flavor were most often mentioned. In conclusion, consumers may accept non-fractionated house cricket flour as a sausage ingredient but its strong flavor may limit the level of inclusion or lead towards stronger, masking, spicing in the house cricket sausages.

Key words: house cricket, sausage, taste

Introduction

There is a growing interest on insects as food in Europe. According to FAO (2009) in 2050 world's population will be over 9 billion and the food production must increase with 70% in order to meet the increased demand of food. In countries of Africa and also in Australia for example ants and beetle larvae are a regular part of diet in tribes. In East Asia thereafter, crispy-fried locusts and beetles are consumed as popular food (van Huis et al. 2013). Currently, however, in only few EU countries insects are allowed to be marketed as food. Also, to date, importing insects to Finland is allowed only from Austria, Belgium, Great Britain, Netherlands and Switzerland, and the insect species allowed as food in each country may vary (Evira 2018). According to EFSA further research on the chemical and microbiological risks from insects as food is recommended (EFSA Scientific Committee 2015) In the ScenoProt project funded by the Strategic Research Council (SRC) at the Academy of Finland insects are considered as one future protein source for human consumption, and food properties of insects are studied in the project.

Composition analysis of insect species since the 1970 's has revealed the variability in for example their crude protein and crude fat contents (Finke 2013, Kortelainen et al. 2014). The crude protein however contains nitrogen from chitin and amino acids (Finke 2013). According to (van Huis et al. 2013) chitin is largely thought to be indigestible for humans.

Fat content of for example house crickets (*Acheta domesticus*) is 230 g kg^{-1} dm^{-1} (Barker et al. 1998) and the fat contains palmitoleic acid (16:1) 2.57 %; oleic acid (18:1) 23.7 % and linoleic acid (18:2) 41.3 % of the analysed fatty acids (Grapes et al. 1989) which together comprise nearly 68 % of fatty acids. This, however, depends on the diet of the insects (van Huis et al. 2013). In pork back fat the respective fatty acids comprise 49 – 54% of the fatty acids analysed (Pascual et al. 2007). Extraction of insect based raw material enables separating the fat from protein and thereafter water-soluble and water-insoluble protein fractions (van Huis et al. 2013). Controlled addition of these fractions separately to food therefore could enable the control of the fat quality and technological properties of the foods containing insects.

Insects as a raw material for sausages have also been of interest. Kim et al. (2016) reported that in emulsion sausages the protein fraction from meal worm larvae and silkworm pupae flour the physicochemical, nutritional and texture properties were similar to control pork sausages. The inclusion of silk worm pupae flour increased the lipid oxidation measured with thiobarbituric acid reactive substances. However, research is needed on the sensory properties of sausages including insects. It is also of interest, how unfractionated insect flour would affect the sensory properties of sausages.

The objective of the present study was to investigate the consumer reactions to Polish type sausages containing a large quantity of unfractionated house cricket (*Acheta domesticus*) powder.

Material and methods

Manufacturing the sausages

The recipes of sausages are described in Table 1. Lean and fatty pork meat was purchased from local supplier. Unfractionated house cricket powder was purchased from EntoCube (Espoo, Finland, importer; originally from Canada, packed by Mophagy, UK). Spices were purchased from local grocery store and salt was from own stock. Spicing in general was kept moderate compared to typical Polish sausage. In the first set 20% and in the second and third set 15% of lean meat was replaced with a mixture containing house crickets flour and water 1:1 (w/w). The chemical composition of the sausage ingredients given by the suppliers and Fineli (2018) are presented in Table 2.

Table 1. Ingredients of the house cricket flour containing experimental sausages.

	First set	Second set	Third set control	Third set crickets
Ingredients, g kg^{-1}				
Lean meat	562	284	380	284
Fatty meat	122	442	470	442
House crickets meal	85	64		64
Water	214	195	130	195
Salt	16	16	16	16
Spices	5	5	4	5

Table 2. Supplier given chemical compositions of the ingredients of the sausages (*Fineli 2018).

Chemical composition	Lean meat, g kg^{-1}	Fatty meat, g kg^{-1}	House cricket meal, g kg^{-1}
Energy, MJ	6.55	12.9	19.95
Dry matter			980
Protein	180	150	590
Fat	100	350	240
-of which saturates	23*	105*	85
-monounsaturates	28*	140*	51
-polyunsaturates	7.0*	42*	91
Carbohydrates	-	-	84
-of which sugars	-	-	5.0
Fibre	-	-	60
Salt	1.2*	1.5*	9.0
Potassium	2.8*	1.9*	11
Omega 3	<1*	5.0*	28
Omega 6	6.0*	36*	63
Calcium	74 mg*	80 mg*	1100 mg
Iron	10 mg*	6.0 mg*	25 mg

Lean and fatty meat were cured with salt for 2 d at 4 ˚C. Fatty meat was ground through a 4.5 mm screen and lean meat through a 8 mm screen. Ingredients were mixed by hand and stuffed to a natural casing with diameter 18-20 mm. Sausages were left resting for 3 h at 9 ˚C. Then sausages were smoked for 1.5 hours with natural smoke from wood (alder) chips and cooked for 30 minutes in a hot water bath at 80 ˚C, after which the sausages were cooled at 4–5 ˚C and kept in cold until warmed for consumer sensory panel.

Proximate composition of sausages was analysed in Luke (Table 3). Moisture content was determined by drying at 105 ˚C for 20 h and measuring the weight difference of the fresh and dry sample. Crude fat was measured according to Anon. (1971) after hydrolysis with 3M HCl. The equipment used was Foss Soxtec/Hydrotec 8000™ System for total fat analysis, consisting of Soxtec™ 8000 extraction unit and Hydrotec™ hydrolysis unit, (FOSS Analytical, Denmark). Protein content was analysed by measuring nitrogen content by accredited In-house method Luke-v1-Method 2001, Kjeldahl nitrogen, based on method AOAC 984.13 (Association of Official Analytical Chemists, USA) using Cu as a digestion catalyst and using Foss Kjeltec 2400 Analyzer Unit (Foss Tecator AB, Höganäs, Sweden). The protein content was achieved by multiplying the nitrogen content by a factor 6.25. Sodium content was analysed with Evira8143 In-house method based on SFS-EN 15621 (confirmed 2012-08-13, Animal feeding stuffs. Determination of calcium, sodium, phosphorus, magnesium, potassium, sulphur, iron, zink, copper, manganese and cobalt after pressure digestion by ICP-AES). Salt content (Table 3) was achieved by multiplying the total sodium content of the sausages by a factor 2.548.

Cooking loss (Table 3) of the sausages was calculated from the weight difference of stuffed and cooked sausages and expressed as a percentage from the stuffed sausage weight.

Table 3. Analysed proximate composition and cooking loss of house cricket flour containing sausages.

Analysed composition	First set	Second set	Third set control	Third set crickets
Moisture, g kg^{-1}	628	591	590	562
Protein g $kg^{-1}d.m^{-1}$	546	420	400	439
Crude fat g $kg^{-1}d.m^{-1}$	331	481	480	425
Salt g kg^{-1}	16	19	17	19
Cooking loss, %	9,0	9,0	9,0	9,0

Sensory evaluation of the sausages

In the first set the time of cold storage was three days and for nine people the sausages were kept in freezer until the consumer panel took place. In the second and third set the time of cold storage at 4 – 5 ˚C before sensory evaluation was one day.

The first set of sausages was taken to room temperature about 0.5 h before the sensory panel (n=17) of house cricket sausages. The sausages were heated in hot water bath for three minutes before serving to research people. For nine research people sausages were served after freezing, the sausages were put to hot water bath for approximately 7 minutes and then served. Second set of sausages were served at room temperature to media people (n=34). The third set including control sausages without house crickets flour and those containing the crickets flour were heated in commercial oven to serving temperature to representatives of Finnish food industry (n=17).

The consumers evaluated sausages using a questionnaire asking the smell, texture, taste and willingness to eat the product again on a scale 1 – 5 with 1 being extremely negative and 5 being extremely positive evaluation. At the end of the questionnaire the consumers could write freely their experience on the house cricket sausages.

Results

The analyzed moisture, fat, protein and salt content of the cooked sausages are shown in Table 3. The first set of sausages was designed to contain more house cricket flour and less fat than the second and third set. Salt content was designed to be similar in all sausages but some variation existed. Cooking loss of the sausages was 9.0%.

Opinions of research people (set 1), media people (set 2) and food business people (set 3) on the sausages containing house cricket flour are shown in Figure 1. Smell in the freshly provided set 1 sausages seemed to be considered poorer than in the other sets. Most frequent grade given for smell, texture, taste and willingness to eat sausage again was 4, above the middle 3.

Most abundant free comments concerning taste or smell of the house cricket flour containing sausages were: floury (16 of 77), dry (12 of 77), livery (5 of 77). Other free comments about taste or smell of the sausages included dogfood, cow-shed, and feed like, tasty, and stuffy.

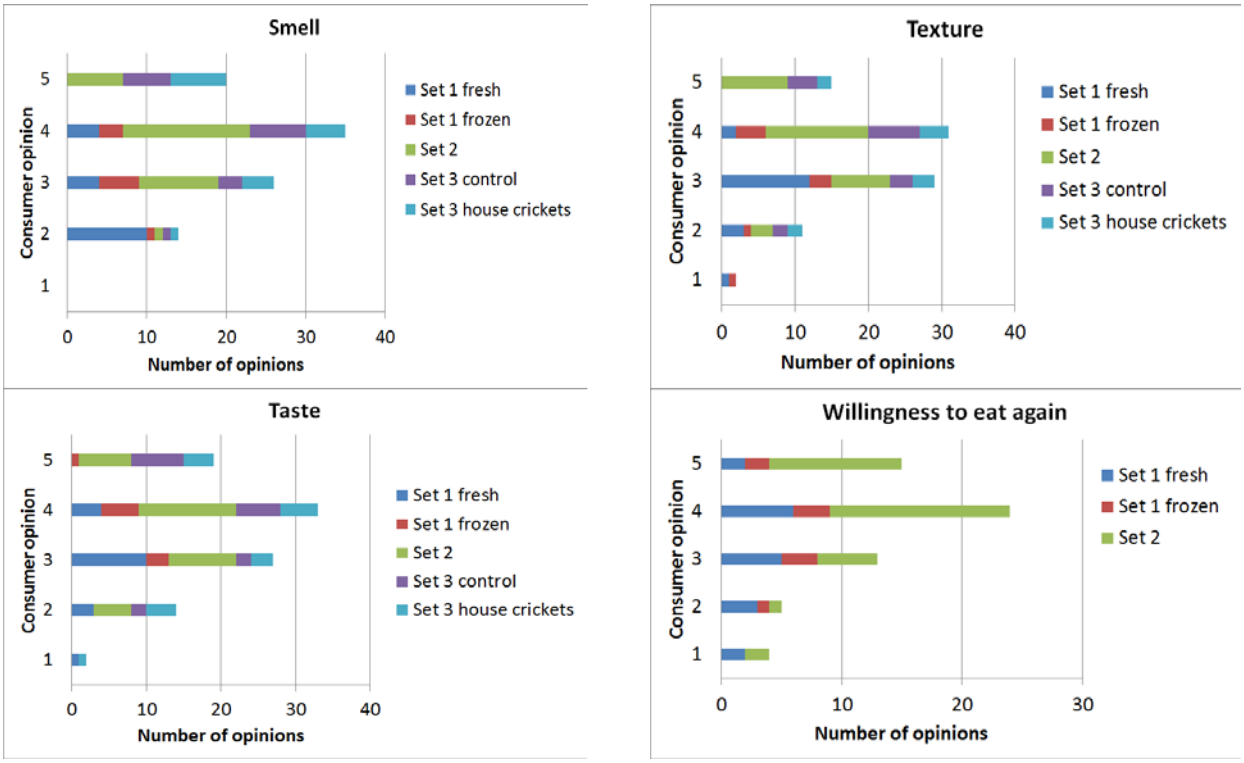

Fig. 1. Consumer opinions (n=77) about house crickets containing sausages on a five point scale about the smell, texture, taste and willingness to eat again, when 1=extremely negative and 5=extremely positive opinion. Fresh=fresh reheated sausages, frozen=frozen stored reheated sausages, control=no house cricket flour in sausages

Discussion

In this study three sets of sausages containing insect flour as an ingredient was prepared and tested for consumer attitudes. Insects were allowed to be sold as food in Finland in November 2017. The first products are on the market and food industry is developing new concepts. Consumer attitudes for insects vary from strongly negative to eagerness to try (Videbæk and Grunert 2017).

Fat content was 120 g kg^{-1} (fresh weight) for the first set and 190–200 g kg^{-1} (fresh weight) for the second and third set, respectively. Fat content in the first set sausages was lower than that in typical Polish and Finnish sausages (180–300 g kg^{-1} fresh weight, Fineli 2018, HealthGrove 2018). Also the texture of all experimental sausages was coarser than that of typical Finnish sausage. The fatty acid composition of the sausages could be improved towards healthier by modifying the feed of the insects.

According to Fineli (2018) the average moisture content in bratwurst type sausages in Finland is 607 g kg^{-1}. In the study of Ruusunen et al. (2003) moisture content of Bologna type sausages was 650–685 g kg^{-1}. Moisture content of the sausages in the present study was 562 (set 3) – 628 (set 1) g kg^{-1}. Also the amount of added water varied (13–21.4%) in the sausages of present study, mainly because the third set control sausages were prepared without the mixture of house cricket flour and water (1:1 w/w). Polish type homemade sausages are made of coarse ground meat whereas typical emulsion sausage in Finland is made of fine ground meat and other ingredients with 20–30% added water depending on the recipe. Six of the 12 consumer comments mentioning ‘dry’ in this study were from the set 1 and six from the set 3. As according to Ruusunen et al. (2003) and Keeton (1994) low-fat products may be considered dry, and the moisture content and percentage of added water in recipe of sausages in the sets 2 and 3 were at lower level than the general levels in Finnish cooked sausages, the consumer comments on dryness in the present study was in accordance with earlier studies.

Cooking loss of all the sausages in the present study were below 10 % which was acceptable. For example Yang et al. (2007) observed cooking losses of 4.2–10.9% from sausages with phosphate to increase water holding capacity and stuffed into synthetic cellulose casings (diameter 30 mm). In the present study phosphate was not used and natural casing was used (diameter approx. 20 mm). Kim et al. (2016) reported cooking losses of 4. –6.9% from sausages containing protein fraction of mealworm larvae or silkworm pupae, stuffed into edible clear collagen casing, 21 mm in diameter and with added phosphate in the sausage dough.

Generally, the sausages were evaluated surprisingly positively. However, the comments associated to animal feed or stuffiness of the taste or smell of the unfractionated house cricket flour containing sausages indicate possible need of masking the insect flavor by strong spicing if marked portions of the insect flour will be added to sausages in the future. For example Kim et al. (2016) used only protein fraction of the mealworm larvae and silkworm pupae and only 10% of meat was replaced with insect powder and water (1:1 w/w). In the present study 20% of lean meat in the first set and 15% in the second and third set was replaced with the mixture of house cricket flour and water (1:1 w/w). According to a Danish study, (Videbæk and Grunert, 2017) young people and especially men in Copenhagen area would be most interested in tasting insects as food. The eagerness of tasting is higher if consumer has tasted insects already earlier. Insects were preferred as processed rather than as whole food (Videbæk and Grunert, 2017). According to Neville et al. (2017) partial replacement of meat with soybean or mycoprotein based product is possible without adverse effects to sensory properties of beef burger steaks if the moisture and fat content of the products correspond to those of a whole meat product. However, to the authors' knowledge, a comprehensive study on acceptability of insects as ingredients of meat products does not exist.

Currently, one Finnish manufacturer provides house crickets containing sausages and minced vegetable steaks. They contain 4.6 or 5.6% house crickets flour which is less than the house crickets flour content of the sausages in the present study. Also the commercial sausages contain less meat and have higher fat content and are smoother in structure than the sausages in the present study. Results of the present study however, encourage in conducting more research with different unfractionated and fractionated insect flour types containing sausages.

Conclusions

Considering that sausages included quite high amount of house crickets flour, the consumer response was surprisingly positive although the smell of sausages was rated quite low. Consumer acceptance for the sausages might be increased by increasing fat, added water content and spicing in the sausages.

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