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Sensory aspects and consumer acceptance of certain legume extruded snacks

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Legumes are an important source of protein for the human diet. Still they are underutilized mainly because they have a long preparation time, even when the protein content is higher than in grains. In order to make legumes more utilized, snacks from different legume flours were made using a twin screw extrusion cooker. In this paper, extruded snacks made of three different legume bases from grey pea (*Pisum sativum* L.), cow pea (*Vigna unguiculata* (L.) Walp) and faba bean (*Vicia faba* L.) were analysed. The obtained products were divided and spice coated, and control samples without coating were made.

A questionnaire was carried out in order to ascertain consumers' opinion about extruded snacks. In order to determine which snacks would be most likable, sensory analyses were carried out. Consumers from different European countries were asked to determine likeness using a 5-point hedonic scale. Best results were obtained for sweet snacks with almond taste, based of grey pea (*Pisum sativum* L.) and salty snacks with onion taste, both of grey pea (*Pisum sativum* L.) extrudates and cow pea (*Vigna unguiculata* (L.) Walp.) extrudates. Unfortunately, participants didn't have a consensus about the quantity of spiciness. Such differences can be explained by different tastes.

Key words: extruded products, legume snacks

Introduction

Legumes are an important food source and play a significant role in traditional diets in many regions of the world. Among the legume seeds, some are used as vegetables and others as supplementary sources of proteins in diets [1].

There is an increased interest in utilizing peas (*Pisum sativum* L.) as an alternative for soy which has a dominating advantage in the market. Pea is one of the valued crops in the world market [2, 3]; like other legume seeds, pea seeds are characteristically rich in proteins (18–30 %) with a well-balanced amino acid profile, especially a high content of lysine [4]. In addition to providing amino acid nutrition, the ultimate success of utilizing peas as a promising food ingredient and an alternative to soy depends largely on its functional properties, including solubility, viscosity, water- and oil binding property, gelation, foaming and emulsifying properties. To date, pea products are very limited in food applications. One of the major limitations is that the functionality of pea products as a food ingredient is relatively weak and, as compared with soy [5, 6] and peas, have a long preparation time [7].

Faba beans (*Vicia faba* L.), too, are used by humans and domestic animals as an important source of protein, especially in countries with a shortage of high quality protein sources. Some beans are used as staple foods in many countries and are receiving increasing attention as preventive products against coronary heart disease [8]. Faba beans are a rich source of carbohydrate, protein content varies from 26 % to 38 %, they contain fibre, vitamins and minerals [9]; however, their contents include certain antinutritional factors, such as protease inhibitors, lectins, raffinose-series oligosaccharides, tannins and phytic acid [10–12], though they can be eliminated with heat.

Cow peas (*Vigna unguiculata* (L.) Walp.) are used worldwide as food, primarily in tropical regions. They have also been widely researched [13, 14], particularly as part of recent efforts to investigate under-exploited legume species as potential energy and food sources in response to their nutritional value [15]. Cowpea is a relatively inexpensive legume with high protein (19–40 %) and carbohydrate (50–65 %) contents, though starch is its main component (30–50 %). This starch contains 50 % amylose, giving it a low starch digestibility that can be increased *in vitro* through baking or germination, thus facilitating *in vivo* carbohydrate digestibility [16].

The extrusion processing technology offers opportunities for the processing of legumes into products that are safe and shelf-stable. Food extrusion is a high-temperature short-time (HTST) processing technology that can transform a variety of ingredients into intermediate or ready-to-eat finished products such as precooked flours, expanded snacks, breakfast cereals, pastas and texturized protein. Exposure of food ingredients to heat during extrusion also improves digestibility by eliminating or reducing the content of antinutritional factors such as phytic acid, lectins, oligosaccharides, and trypsin inhibitors [17, 18]. Extrusion cooking has been employed to produce meat analogues using common starches and proteins as raw materials [19]. Extrusion technology has led to the production of a wide variety of cereal-based foods,

including snacks and ready-to-eat breakfast cereals [20]. In extrusion cooking, starches are gelatinised, proteins are denatured, and extrudates are texturally and histologically restructured [21]. The proteins are plasticized and texturized in a long cooling die by varying the moisture, temperature, pressure and shear, respectively [22]. The combination of these process parameters results in molecular transformation and the chemical reaction of the protein molecules which contribute to the stabilization of the three- dimensional network formed after the extrusion step [23–25].

Thus, the aim of this study was to develop new legume-based products from peas (*Pisum sativum* L.), faba beans (*Vicia faba* L.), cow peas (*Vigna unguiculata* L.) Walp.) and to estimate consumers' assessment of such products.

Materials and methods

In experiments were used peas (*Pisum sativum* L.) of the variety 'Bruno' from the State Priekuli Plant Breeding Institute (Latvia), faba beans (*Vicia faba* L.) of variety 'Barteks' from the joint-stock Pure Horticultural Research Centre (Latvia), and cow peas (*Vigna unguiculata* (L.) Walp) from the University of Trás-os-Montes e Alto Douro (Portugal). Legume samples (peas, faba beans and cow pea) were milled with the A400 MSA mill. Various recipes (Table 1) were used in order to obtain samples with a different structure. All samples were extruded with a twin screw extrusion-cooker SLG65-III at temperatures 50/150/170 and frequency 22 Hz. After extrusion, samples were dried for 15 min on a belt-type dryer at 80 °C.

To obtain a variety of flavours, the snack base was supplemented with different flavours – salty or sweet (Table 1). No spices were used for faba beans, and only salty tastes were used for cow peas in order to preserve their specific taste, as well not to cause the tiredness of evaluators, thus causing inappropriate results. After coating with spices, samples were dried at 80 °C, for salty samples for 20 min and for sweet samples for 60 min.

Table 1. Numbers and description of developed snacks

Number of bases	Developed snack bases	Added additives (spices)	Sample code in this study
1	Pea flour (91 %), water, salt	Control sample without added taste	1
		Grill spice (3 %)	1-C
		Fried, grinded onion spice (5 %)	1-F
2	Pea flour (44 %), wheat flour, water, powdered sugar, salt	Almond flour (10 %)	2-A
3	Pea flour (71 %), wheat flour, water, oath, powdered sugar, cocoa, salt	Chocolate powder (10–20 %), golden syrup	3-B
4	Cow pea flour (91 %), water, salt	Control sample without added taste	4
		Grill spice (3 %)	4-C
		Fried, grinded onion spice (5 %)	4-F
5	Faba bean flour (91 %), water, salt	Sample without added taste	5
6	Faba bean flour (45 %), wheat flour, water, salt	Sample without added taste	6

Sensory evaluation was realized to find out consumers' opinions about the legume snacks and to determine which samples were best for the further experiments. Consumers' attitudes about the extruded legume snacks from gray peas, cowpea, and faba beans was evaluated by 41 panelists, of which 54 % were male and 46 % female of the age between 26 and 58, average 44. Samples were labeled with numbers (abbreviations). Each panelist had served with 10 samples (8 – salty taste, 2 – sweet taste) in a fixed serving sequence: first – a control sample without added taste, after then – a sample with spices. Experimental extruded legume snacks were offered to consumers for sensory evaluation using a five-point hedonic scale to determine the consumer degree of liking of each kind of samples, i. e. 5 – like very much, 4 – like a little, 3 – am not sure, 2 – dislike a little, and 1 – dislike very much. Additionally, questions about consumers' daily intake of legumes and extruded snacks were asked, as well as questions what they liked in given products and what they disliked.

The obtained data processing was performed using mathematical and statistical methods with statistical software Microsoft Office Excel 14.0 and SPSS 20.0 for Windows; differences among the results were analyzed using one-way analysis of variance and Tukey's test. The results were expressed as a mean ± standard deviation. For the interpretation of the results, it was assumed that $\alpha = 0.05$ with a 95 % confidence and differences among

the results were considered significant if the *p*-value was $< \alpha = 0.05$.

Results and discussion

Overall, 61 % of respondents have said that they consume legume-based meals at least once a week, but 24 % answered that they consumed legume-based meals one to two times per month, and only 15 % of respondents said that they consumed legume-based products less than once a month.

The obtained results show that the viewpoints of respondents differ (Fig. 1) when asked how often they consume legume-based meals. The majority of evaluators have noted that they consume legume-basted meals at least once a week (totally 61 % of the evaluators). It should be noted that male evaluators note to consume legume-based meals more often (84 % cases) than female evaluators (39 % cases).

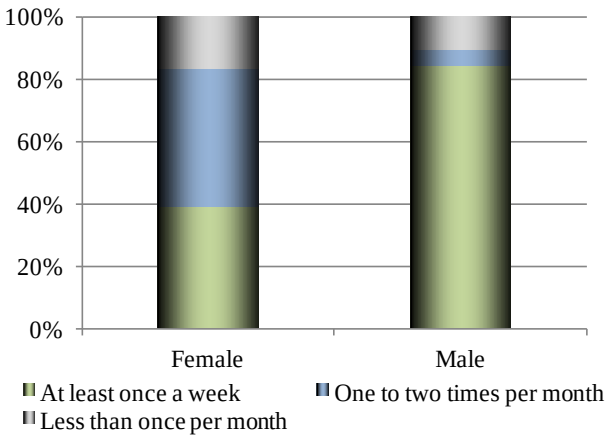

Fig. 1. Consumption of legumes and their products

Only 14 % of all evaluators have noted that they consume legume-based meals less than once per month.

Respondents have been asked how often in their daily diet they include snacks. 78 % of evaluators have reported that they consume extruded snacks less than once a week, 12 % of respondents have said they consume extruded snacks at least once a week, but 7 % said they consume them several times a week. Only 3 % said they consume them daily.

For new products, sensory evaluation is very important. For obtained extruded legume snacks, a 5 point hedonic scale was used for the determination of consumers' likeness of products (Fig. 2, Fig. 3). The best ones of salty products (Fig. 2) were determined to be with onion taste both of pea (*Pisum sativum* L.) and cow pea (*Vigna unguiculata* (L.) Wasp.) extrudates. Although faba bean (*Vicia faba* L.)-based products were liked less, the sample with wheat flour was evaluated slightly better. The differences were not significant, $p = 0.5$ ($\alpha = 0.05$).

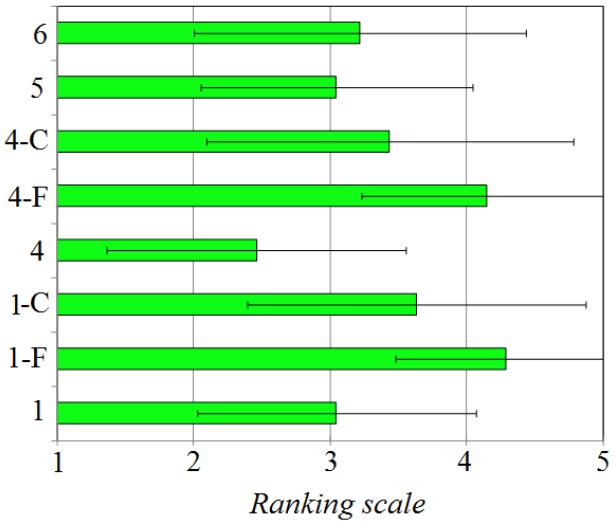

Fig. 2. The consumer degree of likeness of different salty extruded legume products (1 – I dislike very much; 2 – I dislike a little; 3 – I am not sure; 4 – I like a little; 5 – I like very much)

For sweet products, pea-based extruded snacks were coated with almond and chocolate. Extruded pea (*Pisum sativum* L.) based products with almond and chocolate taste were evaluated equally by participants and given averagely 4.2 points of 5. But salty products obtained from cowpea (*Vigna unguiculata* (L.) Walp.) and grey pea (*Pisum sativum* L.) were more liked with the onion taste. They were evaluated with 4.2 points and 4.3 points of 5, respectively. Grey pea (*Pisum sativum* L.) based snacks with Grill taste obtained 3.6 points from 5, and they were evaluated as the third best salty products. Results gathered in Fig. 3 show that these products were evaluated better than salty products, as none of them was evaluated with 1 (I dislike very much). But the samples were evaluated rather similarly, and no significant differences ($p = 0.3$; $\alpha = 0.05$) were found in consumer likeness for these samples.

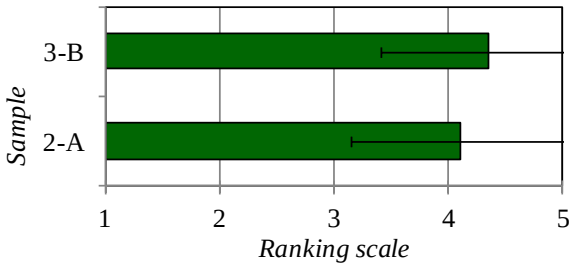

Fig. 3. The consumer degree of likeness of different sweet extruded legume products (1 – I dislike very much; 2 – I dislike a little; 3 – I am not sure; 4 – I like a little; 5 – I like very much)

Although asked to estimate what they liked in such products and what they disliked, respondents gave similar answers (Fig. 4, *a*) to both questions, first liking the taste in 37 % and the texture in 24 % of cases (Fig. 4, *b*) and disliking it in 20 % and 24 % of cases (Fig. 4, *b*). These results can be explained by the fact that samples obtained from different legumes had a different texture and

hardness. For example, samples from grey peas and faba beans were less hard than samples obtained using cow peas.

In experiments, it was noted that, in order to make more likable products, their appearance, colour and size should be improved (Fig. 4, *b*).

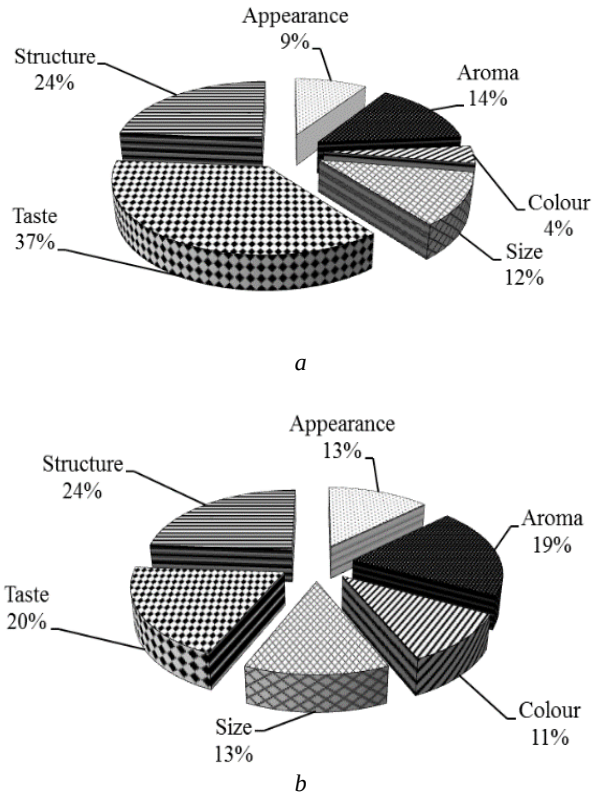

Fig. 4. Evaluators liked (a) and disliked (b) traits of the new extruded legume products

Evaluators have indicated that they like the taste, given 36 % of all likable votes, and structure, given 23 % of all likable votes, of the extruded legume snacks (Fig. 4). The third one to be likable was aroma (14 %), but colour was not noted so often, only in 4 % of total likeable votes.

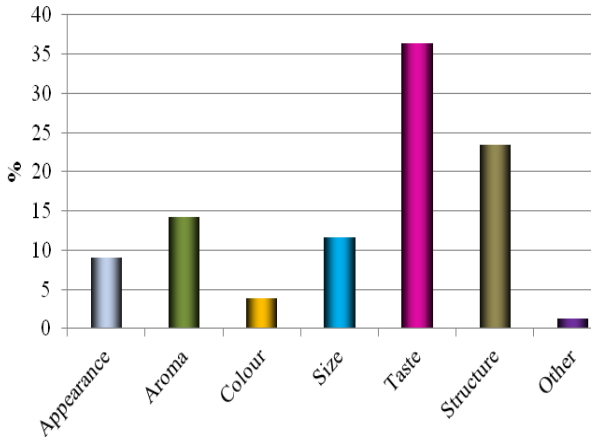

Fig. 5. Evaluators liked traits in the new extruded legume depending of country

Even thought evaluators have indicated that they like the structure (Fig.5) of the extruded legume snacks, in 23% of votes it was noted as most dislikeable (Fig. 6). The same principle applies to taste given 21 % of total dislike, and aroma – 19 % of total dislike; 13 % of total dislike votes were given to appearance, as later suggestions were given to make products glossier or add some additional colour.

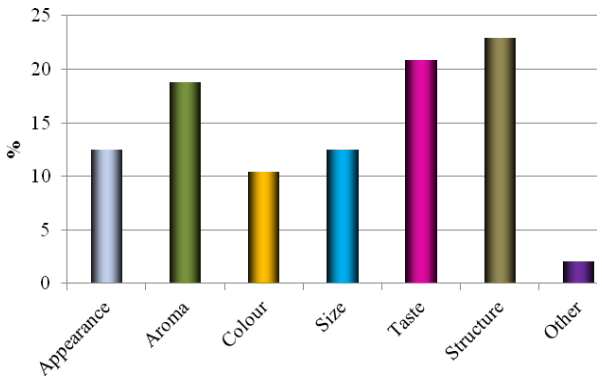

Fig. 6. Evaluators disliked traits in the new extruded legume products depending on country

It should be noted that some evaluators have found the taste too strong, whereas others for the same products have noted that in their opinion taste is too weak. Also, it should be noted that evaluators rated cow-pea-based products very differentlly as part of them noted the aftertaste as likable and others noted it as dislikeable.

Assessing the prospects for a new product, the respondents were asked if they would be willing to purchase such products. The answers of more than 50 % of responses were affirmative (Fig. 7).

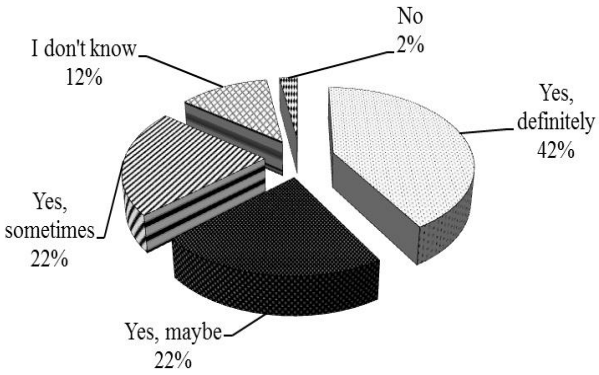

Fig. 7. Respondents' desire to purchase such products

Recommendations such as to improve the appearance and colour, to increase product size, decrease hardness, enrich some samples with plant and herb material, make them more spicy or improve salt balance were given by respondents. Such new products could have great prospects to capture consumers' hearts, and they could be included in their diet as one of the sources of protein and serve as an alternative to other snacks.

Conclusions

The obtained results show that 39 % of respondents consume legume-based meals one to two times per month or less.

Extruded pea (*Pisum sativum* L.) based products with almond and chocolate tastes were evaluated by averagely 4.2 points out of 5, but salty products obtained from cowpea (*Vigna unguiculata* (L.) Walp.) and pea (*Pisum sativum* L.) were more liked with the onion taste with 4.2 points and 4.3 points out of 5. The third best liked products were with Grill taste, evaluated by 3.6 points out of 5.

In experiments, it was established that, in order to make more likable products, their appearance, colour and size should be improved.

Some participants noted that they would like such products to be spicier, others noted that these were too spicy, and so there was no united point of view in this aspect.

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EKSTRUDUOTŲ ANKŠTINIŲ JAVŲ GRŪDŲ UŽKANDŽIŲ JUTIMO ASPEKTAI IR PRODUKTŲ PRIIMTINUMAS VARTOTOJUI

S a n t r a u k a

Ankštinių javų grūdai yra svarbus žmogaus mityboje baltymų šaltinis. Iki šiol dėl ilgo pasiruošimo laiko jie naudojami neefektyviai, netgi jei juose esantis baltymų kiekis yra didesnis nei grūdinių javų grūduose. Siekiant padidinti ankštinių javų grūdų panaudojimo galimybes, iš įvairių ankštinių javų grūdų miltų gaminti užkandžiai naudojant dviejų sraigtų ekstruderį. Šiame darbe analizuoti ekstruduoti užkandžiai, paruošti iš trijų skirtingų ankštinių javų (*grey pea – Pisum sativum* L., *cow pea – Vigna unguiculata* (L.) Walp) ir *faba bean – Vicia faba* L.) grūdų miltų. Gauti produktai suskirstyti į grupes ir apibarstyti prieskoniniais, o kontroliniai mėginiai ruošti be prieskonių.

Siekiant išsiaiškinti vartotojų nuomonę apie ekstruduotus užkandžius, sudarytas produktų priimtinumo klausimynas. Siekiant nustatyti, kuris produktas yra labiausiai priimtinas vartotojui, vartotojai, naudodamiesi klausimynu, atliko ekstruduotų užkandžių juslinį įvertinimą. Vartotojus sudarė atstovai iš įvairių Europos šalių, vertinę produktus *5-point* hedonine skale. Geriausi rezultatai gauti degustuojant saldžius migdolų skonio užkandžius ir sūrius svogūnų skonio užkandžius. Deja, dalyvių nuomonės apie prieskonių kiekius nesutapo. Tokius skirtumus galima būtų paaiškinti atskirų tautybių atstovų skonio įpročių ypatumais.

Reikšminiai žodžiai: ekstruduoti produktai, ankštinių javų grūdų užkandžiai.