CONSUMER ACCEPTANCE OF NEW PULSE SPREADS BEFORE AND AFTER *SOUS VIDE* TREATMENT

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Abstract

Pulse spreads are an alternative to traditional animal-derived spreads, having all nutritious components of pulses: quality protein, complex carbohydrates, dietary fibre, minerals, vitamins, and antioxidant compounds. Sous vide packaging technology should be considered to extend the shelf-life of pulse spreads. The aim of this research was to develop innovative pulse spreads from different pulses growing in Europe and subject these spreads to sensory evaluation before and after sous vide treatment. Pulse spreads were made from cowpeas (Vigna unguiculata (L.) Walp.) and maple peas (Pisum sativum var. arvense L.), two spreads from each pulse: classic (control) spread and spread with spices. Hedonic evaluation by consumers (n=120) showed that sous vide treatment did not influence the overall preference of cowpea and maple pea spreads (p>0.1). Sous vide treatment could be used to extend shelf-life of new pulse spreads and maintain their sensory quality for at least 22 days.

Key words: *pulse spreads, sensory evaluation, sous vide, consumer acceptance*

1. INTRODUCTION

Around 20 leguminous species are used as dry grains in appreciable amounts for human nutrition. Among these, pea (*Pisum sativum* L. subsp. *arvense*) is highly consumed in Northern countries and cowpea (*Vigna unguiculata* (L.) Walp) in Southern countries (de Almeida Costa et al. 2006). The grains of legumes are an important source of vegetable protein in the diet of the world population, especially in countries where the consumption of animal protein is limited for economic, religious, or cultural reasons (Pereira et al. 2014). Pulses (grain legumes) are dry seeds of leguminous plants which are distinguished from leguminous oil seeds by their low fat content. Pulses yield from one to twelve seeds of variable size, shape, and colour within a pod and are mainly cultivated for human consumption (Kirse & Karklina 2014).

Pulses have long been recognised as nutritious because of their high quality protein and nutrient density. Pulses are a rich source of both soluble and insoluble dietary fibre and vegetable protein (Brummer et al. 2015). They are also relatively low in energy density (1.3 kcal g^{-1} or 5.3 kJ g^{-1}) and a good source of digestible protein (average of 7.7 g of protein per 100 g^{-1}). Pulse carbohydrates are slowly digested, which allows some of the lowest glycaemic index (GI) among carbohydrate-containing foods. Pulse GI typically range from ~29 to 48 (using glucose as the standard) compared with GI of 32–36 for dairy, 39–64 for fruit, 42–72 for grains, 49–80 for breakfast cereals, and 49–97 for root vegetables (McCrory et al. 2010). Regular consumption of low GI foods reduces serum cholesterol (Ha et al. 2014), blood pressure (Jayalath et al. 2014), and the high levels of polyphenols in pulses have good antioxidant properties (Azarpazhooh & Boye 2012).

Cowpea (*Vigna unguiculata* (L) Walp.) contains almost all the mineral and organic nutrients essential for animal and human nutrition, plus a number of unique organic phytochemicals that favour health (Garcia-Hernandez et al. 2005). Harvested dry seeds can be ground into a slurry to make cowpea cake, or deep fried into bean balls, or the seeds could be boiled, mixed with sauce or stew and consumed directly (Zia-Uk-Haq et al. 2013). Cowpeas, also black-eyed peas, are one of the most important food legume crops in the semiarid tropics. Cowpea seeds contains up to 25% protein and is low in anti-nutritional factors.

Maple pea (*Pisum sativum* L. subsp. *arvense*) is a cool season legume crop produced worldwide, mainly in the temperate regions. Approximately half of the dry pea world production is fed to livestock while the remaining half is used for human food, primarily in developing countries. Pea seed nutritional value

relies on a balanced composition: dry pea seeds contain 18–33% proteins, 35–50% starch and 4–7% fibres. No major anti-nutritional factor is present in pea (Rubiales et al. 2011). Maple peas, also Austrian winter peas, are one of the first domesticated pulses and traditional food in Latvian cuisine.

Pulse spreads are an innovative product and an alternative to traditional animal–derived spreads or pates. The concept of commercially available pulse spreads is fairly new, however, as non-dairy and reduced fat/calorie spreads are becoming popular for health conscious people, animal product alternatives have the potential to contribute to overall public health, as well as increasing consumer choice (Kirse & Karklina 2015).

In order to extend shelf-life of pulse spreads, preservation methods must be considered as consumers increasingly demand high quality foods, as much similar as possible to fresh produce, following quality and safety standards and without the addition of preservatives (Allende et al. 2006; Rastogi et al. 2007). *Sous vide* cooking is characterised by packaging food in vacuum, in heat-stable, food-grade plastic pouches and cooking food using precisely controlled heating. *Sous vide* technology allows to obtain products with an extended shelf-life and a quality similar to that of fresh food (Baldwin 2012).

Food quality is a multidimensional concept defined as a set of safety, nutritional and organoleptic characteristics of a product (Bianchia et al. 2016). Sensory analysis and consumer research are the most important tools that enable informed decision making. Sensory evaluation is one of the last steps in product development and aims to characterize and measure sensory attributes of the product and/or to determine differences among products (Guiné et al. 2012).

The aim of this research was to develop innovative pulse spreads from different pulses growing in Europe and subject these spreads to sensory evaluation before and after *sous vide* treatment.

2. MATERIALS AND METHODS

2.1. Preparation of pulse spreads

New spreads were prepared from two different pulses:

- ✧ cowpeas ‘Fradel’ (*Vigna unguiculata* (L.) Walp.), harvested in 2014 at The University of Trás-os-Montes and Alto Douro, Vila Real, Portugal;
- ✧ maple peas ‘Bruno’ (*Pisum sativum* var. *arvense* L.), harvested in 2014 at Institute of Agricultural Resources and Economics, Priekuli, Latvia.

Pulse spreads were prepared with additional ingredients: ‘Extra virgin’ canola oil (Iecavnieks Ltd., Latvia), citric acid (Spilva Ltd., Latvia), Himalayan salt (Pakistan) and herb (sun-dried tomato, garlic and basil) spice ‘Bruschetta’ (P.P.H. fleisch mannschaft®-Polska Sp. z o.o., Poland).

Spreads were prepared at the laboratory of Faculty of Food Technology (Latvia University of Agriculture) according to Kirse & Karklina (2015). Maple peas (or cowpeas) were soaked in water (with added $NaHCO_3$, 21.5 g kg^{-1}) at 20 ± 2ºC for 15 h, then rinsed and boiled in a pressure cooker (KMZ, USSR) until tender (about 35 ± 5 min plus 15 min for natural pressure release). Warm cooked pulses were then grinded in a food processor (Philips HR 7761/00, Philips, The Netherlands) together with salt and citric acid, spices were added to the pulse paste (if needed); oil was added at the end of mixing in the food processor.

Pulse spread with bruschetta spice was made of ground re-hydrated cooked maple peas or cowpeas (93%), to which salt (0.3%), citric acid (0.2%), oil (5.9%) and herb spice (1%) were added. Control samples (classic spreads) were made of identical constituents but without addition of herb spice. A total of four different spreads were investigated in this research: classic cowpea spread, cowpea spread with bruschetta spice, classic maple pea spread and maple pea spread with bruschetta spice.

2.2. Packaging and sous vide treatment of pulse spreads

Spreads were vacuum packaged (Fig. 1) in two-layer transparent laminate polyamide/polyethylene film pouches (45 mm x 170 mm, film thickness 45 μm) with barrier properties and hermetically sealed by chamber type machine *Multivac C300*, each sample was 50±1 g (Kirse et al. 2015).



Figure 1. Maple pea spread in vacuum packaging.

Sous vide treatment of pulse spread was carried out in *Clifton Food Range* water bath. Samples were pasteurized for 15 min at +80.0±0.5 °C temperature, which corresponds to the core temperature of the packaged pulse spreads +76.0±1.0 °C. After heat treatment, packages were immediately chilled to sample temperature +4.0±0.5 °C in +2±1 °C cold ice-water. This heat treatment regimen was chosen based on previous experiments as the optimal *sous vide* regimen for pulse spreads.

Sous vide samples were stored in a commercial cooler ELCOLD at +4.0±0.5 °C (temperature recorded by Greisinger MINILog) for 22 days under fluorescent light (OSRAM Lumilux De Luxe) with radiant fix at 100–800 lux (measured by Light meter LX-107).

Chosen *sous vide* treatment regimen and sequential storage for 22 days is able to maintain microbial contamination well below the admissible levels (Kirse et al. 2015), therefore the product is microbiologically safe for consumption.

Fresh pulse spread samples were packed in 200±5 g polypropylene cups and stored in a commercial cooler ELCOLD at +4.0±0.5 °C for 12 h prior to sensory evaluation.

2.3. Sensory evaluation of cowpea and maple pea spreads

Sensory evaluation of new products was completed in two stages.

Stage I included sensory evaluation of new spreads by trained panellists at the Laboratory of Sensory evaluation, Faculty of Food Technology. 38 trained panellists (47% women, 53% men, average age 38 years) were asked to determine the overall preference of new pulse spread samples using 5-point hedonic scale (5 – like very much and 1 – dislike very much). Panellists also reported strengths and weaknesses of the products in order to improve sensory attributes before pulse spread development was completed.

Trained panellists were from different countries: Latvia (n=11), Spain (n=6), Portugal (n=7), Sweden (n=2), Germany (n=1), Czech Republic (n=2), Estonia (n=2), Austria (n=1), Greece (n=3), Norway (n=2) and China (n=1). A total of four spreads were evaluated.

Stage II was carried out during the international Baltics food industry fair 'Riga Food 2015' (120

panellists; 65% women and 35% men, average age 35 years) where consumers were asked to evaluate fresh and *sous vide* pulse spreads using 5-point hedonic scale. Consumers were also asked to describe likes and dislikes about pulse spreads and the likeliness to purchase these products at a grocery store and consume them on a daily basis.

Consumer respondents were from all regions of Latvia: Kurzeme (16%), Zemgale (30%), Vidzeme (15%), Latgale (10%) and Riga (29%). A total of eight spreads were evaluated: four fresh spreads and four *sous vide* spreads.

2.4. Data processing

The obtained data processing was performed with statistical software '*R 3.0.2*' and 'Microsoft Office Excel 14.0'; differences among results were analysed using one-way analysis of variance and Tukey's test. Differences among results were considered significant if p-value $<\alpha_{0.05}$.

3. RESULTS AND DISCUSSION

The results of hedonic evaluation of fresh pulse spreads by trained panellists (Fig. 2) showed that the average overall preference of cowpea spreads was between 'not sure' to 'like a little' (3.4-3.9) and maple pea spreads- 'like a little' to 'like very much' (4.0-4.3). Classic cowpea spread had a significantly lower average hedonic score than other spreads (p=0.032). Latvian panellists gave higher scores to all pulse spreads compared to other panellists (p=0.023). The number of panellists from different countries is too low to give a reliable comparison and prediction of pulse spread preference to represent the people of selected countries.

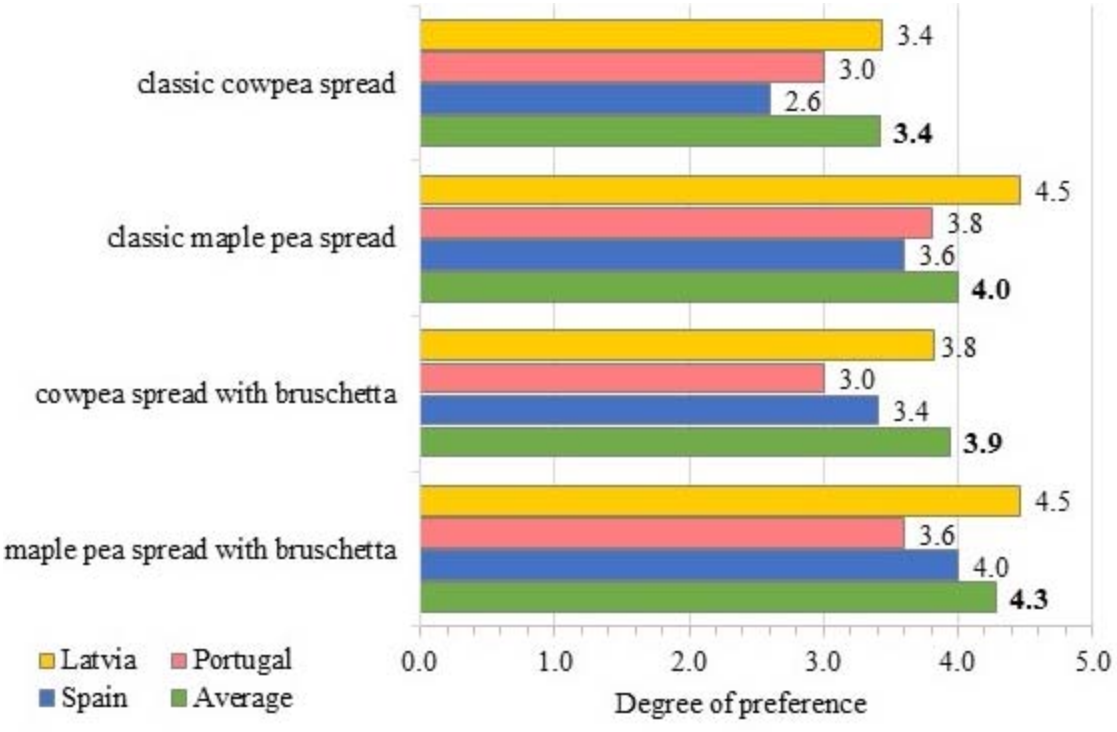


Figure 2. Hedonic evaluation results of pulse spreads by trained panellists.

Panellists were divided into two groups to compare the preference of pulse spreads by geographic location of panellists (Fig. 3). The preference of classic maple pea spread and cowpea spread with

bruschetta spice between northern and southern panellists had no differences of significance ($p>0.05$). Among four spreads, southern panellists preferred classic cowpea spread less ($p=0.019$) than other spreads, however, northern panellists preferred maple pea spread with bruschetta spice more ($p=0.027$) than other spreads. Northern panellists liked classic cowpea spread better than southern panellists, however, only at borderline significance ($p=0.100$).

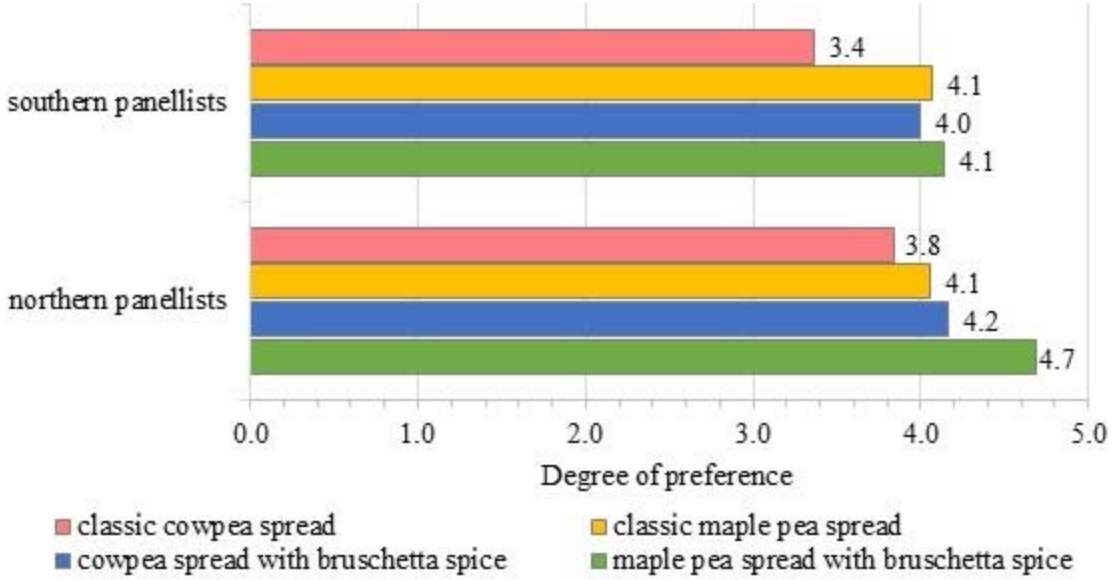


Figure 3. Overall preference comparison between norther and southern panellists.

The preference of classic cowpea spread, cowpea spread with bruschetta spice and maple pea spread with bruschetta spice was without significant differences ($p>0.05$) between female and male panellists (Fig. 4). Women liked classic maple pea spread more than men ($p=0.009$). Overall women preferred spread from maple peas significantly more than from cowpeas ($p<0.05$), but men liked spreads with spices over classic samples.

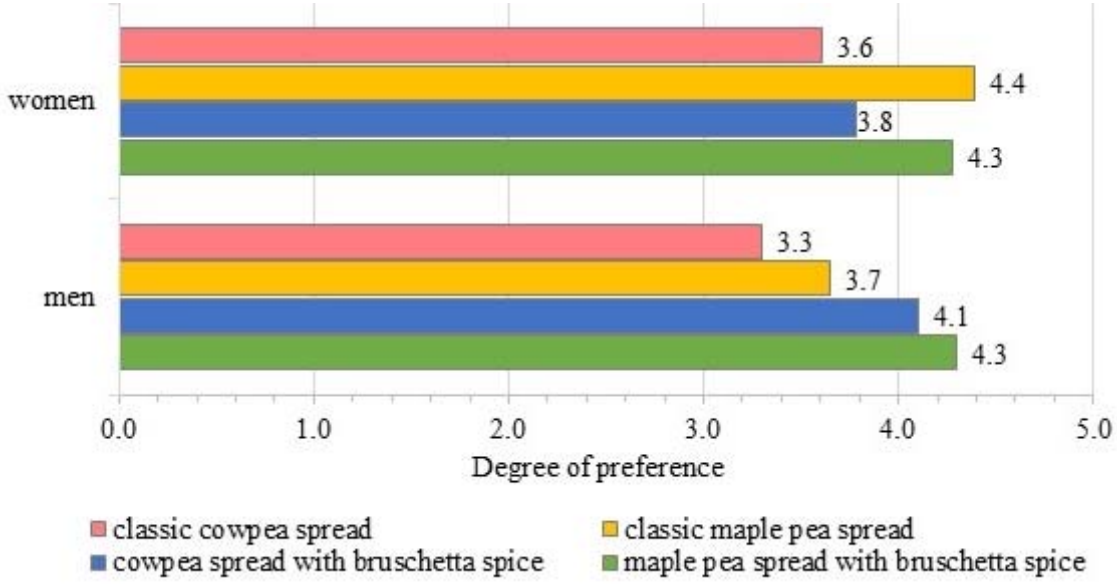


Figure 4. Overall preference comparison between female and male panellists.

The majority of the panellists (58%) reported pleasant flavour as a positive aspect of pulse spreads (Table 1). Mouthfeel was also reported as satisfactory. Some noted that spreads with spices had a savoury flavour and nice aroma. Female panellists pointed out that they liked the consistency of pulse spreads a lot – the fact that it was not homogenous (pulse spreads are made from whole pulses, without the removal of seed coats).

Colour of pulse spreads was one of the dislikes and a suggestion was made to improve the appearance, as the colour of grinded pulses is between light grey and dark brown. Some panellists did not like that the flavour of pulses was too pronounced.

One the main concerns of panellists was salt content in spreads. The added salt amount in pulse spreads was 0.3 g per 100 g, and respondents reported this amount to be too low. Salt amount in spreads was increased following guidelines from Regulation No 172/2012 (the Cabinet of Ministers of the Republic of Latvia) which describes the added amount of salt in the finished product for kindergarten students and pupils. In order for pulse spreads to be an option in the diet of pupils, the added salt amount must not exceed 0.4 g per 100 g of product.

Likes	**Dislikes**	**Suggestions and notes**
✓ flavour (n=22) ✓ consistency (n=9) ✓ aroma (n=5) ✓ easy to eat (n=3) ✓ freshness (n=4) ✓ mouthfeel (n=12)	✓ colour (n=10) ✓ flavour (n=4) ✓ appearance (n=3) ✓ too little salt (n=10) ✓ flavour of pulses is too pronounced (n=2)	✓ add more spices (n=3) ✓ add more salt (n=5) ✓ improve appearance (n=2) ✓ I would like to purchase these products (n=13)

Table 1. Characterisation of pulse spread sensory attributes by panellists.

One third of panellists were satisfied with the new product and said that they would like to purchase these products at a grocery store.

The results of hedonic evaluation of cowpea pulse spreads by consumers (Fig. 5) showed that overall preference of classic cowpea spreads was between ‘not sure’ to ‘like a little’ (3.7-3.9) and cowpea spread with bruschetta spice- ‘like a little’ to ‘like very much’ (4.3-4.5).

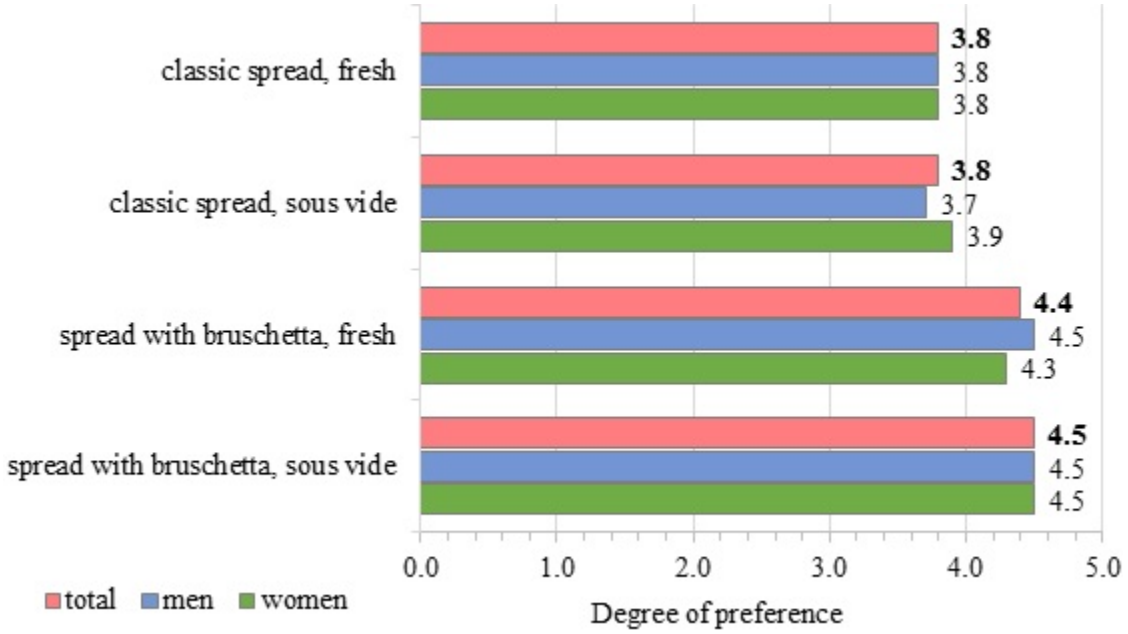


Figure 5. Hedonic evaluation results of cowpea spreads before and after *sous vide* treatment by consumers.

Consumers liked cowpea spread with bruschetta spice better ($p<0.05$) compared to classic cowpea spread. Significant differences were not found between the preference of women and men ($p>0.05$). *Sous vide* treatment did not influence the overall preference of cowpea spreads ($p>0.1$).

Overall preference of pulse spreads made from maple peas (Fig. 6) was between 'like a little' to 'like very much' (4.4-4.9). Results showed that classic maple pea spread and maple pea spread with bruschetta spice did not have relevant differences in preference ($p>0.05$). Significant differences were not found between the preference of women and men ($p>0.05$). *Sous vide* treatment did not influence the overall preference of maple pea spreads ($p>0.1$).

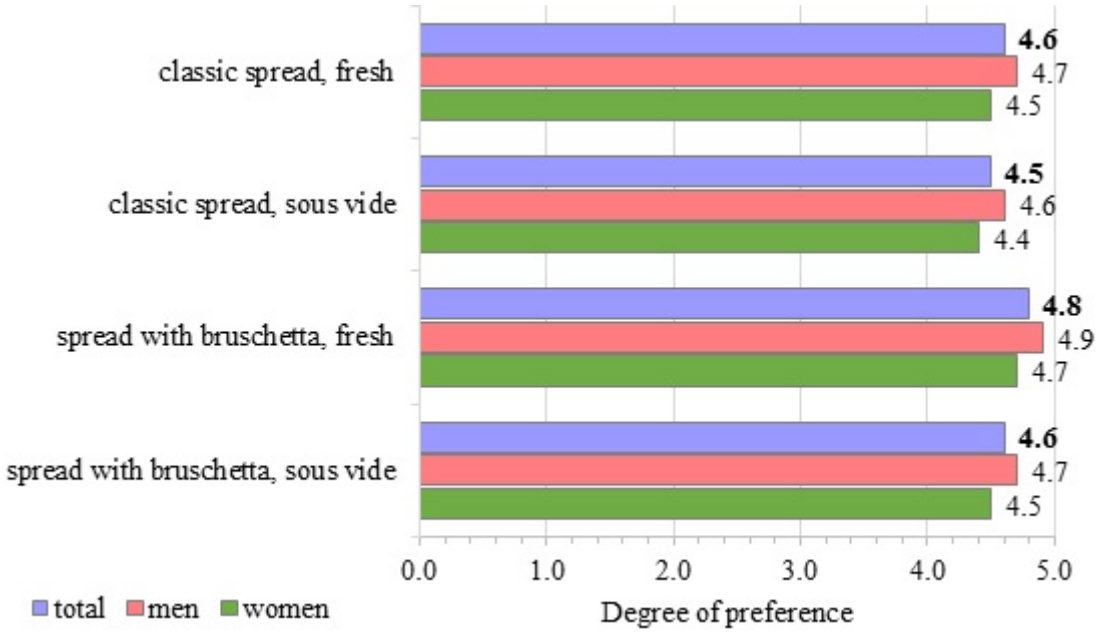


Figure 6. Hedonic evaluation results of maple pea spreads before and after *sous vide* treatment by consumers.

Consumers described pulse spreads as having pleasant acidity, nice consistency, however, classic spreads (control) were more plain compared to spreads with spices. Consumers reported cowpea spread with bruschetta spice as similar to pâté with a rich flavour, and maple pea spread with bruschetta spice as having flavours similar to Middle Eastern cuisine, a rich taste, pleasant spiciness and garlic flavour.

Majority of consumer respondents reported positive aspects of pulse spreads (Table 2). Pulse spreads were characterised by a pleasant mild taste, satisfactory consistency and mouthfeel. Women noted that spreads are an alternative to meat pate and suitable to vegetarians, but men liked that spreads are a good source of plant proteins.

Likes	**Dislikes**
✓ protein source (n=26)	✓ not savoury enough (n=29)
✓ pleasant, mild taste (n=68)	✓ needs more seasoning (n=31)
✓ the idea of the product (n=53)	✓ needs more salt (n=23)
✓ consistency and mouthfeel (n=86)	✓ taste is too strong (n=15)
✓ products do not contain preservatives (n=50)	
✓ an alternative to meat pate (n=72)	
✓ products are vegetarian (n=87)	

Table 2. Likes and dislikes of new pulse spreads.

Contrary to panellists, none of the consumers reported colour as a dislike. Some respondents still wanted the products to be saltier and spicier, while others said that the taste of products was too strong.

Salt taste preferences in humans are learned by previous oral sensory exposure to saltiness. Our diet is comprised of many processed foods and we may have adapted to the levels of saltiness of these foods. Processed foods provide approximately 80% of our dietary sodium intake, whereas only 10% is under discretionary control (i.e., table and cooking salt) (Brown et al. 2009; Bolhuis et al. 2015). Therefore, if the individual salt intensity sensitivity is lower, consumers prefer saltier foods. In order to conform to the Regulation No 172/2012, it was decided not to increase the added salt amount in pulse spreads, as consumers can add extra salt on their own if the need arises.

Consumers were asked about the likeliness to purchase these products at a grocery store (Fig. 7). The majority of respondents (75%) would like to purchase these spreads. Women are more likely to buy them compared to men. The percentage of respondents who would not like to purchase these products is low.

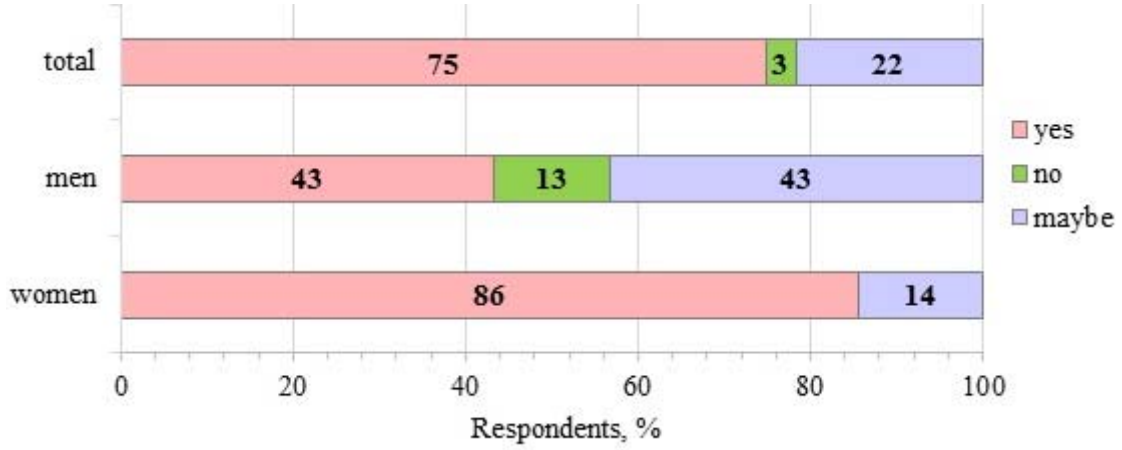


Figure 7. Would you like to purchase these products in a store?

A similar study on the acceptance of new bean spreads showed that the majority (75% men and 58% women) of the respondents (n=90) would buy bean spread with sun-dried tomatoes as soon as it was available in a store (Kirse & Karklina 2014). Men were more likely to purchase vegetarian bean spread than women.

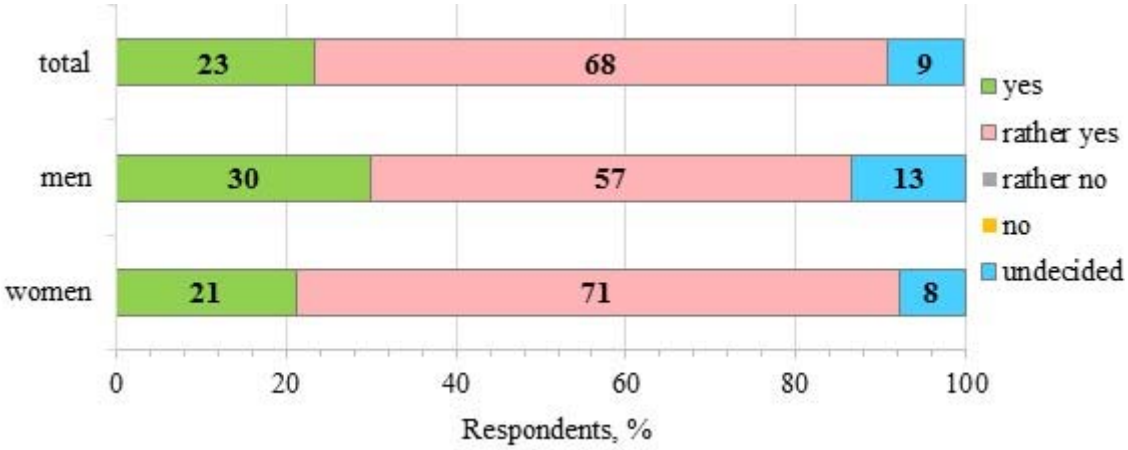


Figure 8. Would you like to consume these products on a daily basis?

The majority of respondents would like consume these products on a daily basis (Fig. 8). Kirse & Karklina (2014) previously reported that one of the main reasons for low pulse consumption among Latvians (n=780) was long cooking time and the planning ahead as dry pulses need soaking before cooking, otherwise consumers would like to consume pulses more frequently, also in the form of pulse spreads.

CONCLUSIONS

Hedonic evaluation by trained panellists showed lower overall preference of classic cowpea spread ($p=0.032$) compared to other three spreads. The preference of classic maple pea spread, cowpea spread with bruschetta spice and maple pea spread with bruschetta spice had no differences of significance ($p>0.05$); women liked classic maple pea spread more than men ($p=0.009$). The majority of the panellists (58%) reported pleasant flavour as a positive aspect of pulse spreads. Colour of pulse spreads was one of the dislikes and a suggestion was made to improve the appearance. One third of panellists were

satisfied with the new product and said that they would like to purchase these products at a grocery store.

Hedonic evaluation by consumers showed higher overall preference of cowpea spread with bruschetta spice ($p<0.05$) compared to classic cowpea spread. Classic maple pea spread and maple pea spread with bruschetta spice were equally well-liked ($p>0.05$). Significant differences among the preference of fresh spreads and *sous vide* spreads were not found between the preference of women and men ($p>0.05$). *Sous vide* treatment did not influence the overall preference of cowpea and maple pea spreads ($p>0.1$). Consumers described pulse spreads as having pleasant mild taste and acidity, satisfactory consistency and mouthfeel. Women noted that spreads are an alternative to meat pate and suitable to vegetarians, but men liked that spreads are a good source of plant proteins.

The majority of respondents would like to purchase these spreads at a grocery store and would like to consume pulse spreads on a daily basis.

The results of sensory evaluation of fresh and *sous vide* pulse spread samples indicate that this thermal treatment method could be used to extend shelf-life of new pulse spreads and maintain their sensory quality for at least 22 days.

ACKNOWLEDGMENTS

The research was supported by the FP7 Research Project Nº 61378 "Eurolegume – Enhancing of legumes growing in Europe through sustainable cropping for protein supply for food and feed".

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