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Exploring the Sensory Characteristics of the Soybean Spreads Enhanced with Vegetables and Spices

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Abstract: Transitioning to a plant-based diet presents a number of complex ethical, environmental, and health-related considerations. This trend is not only reshaping consumer diets, but also steering the food industry towards the development of new plant-based products. The primary aim of this study was to examine and identify the sensory similarities and differences in soybean spreads consisting of vegetable purées—specifically, beetroot, pumpkin, broccoli, and carrot—with the addition of spices such as marjoram and cumin. The sensory assessment was conducted using the Quantitative Descriptive Analysis (QDA). Twenty-three descriptors were selected and defined following the profiling procedure. The sensory properties of soy-based spreads have been significantly altered by the addition of vegetable purées and spices. Adding vegetable purées reduced the intensity of soybean odour and flavour, lowered fatty notes, and resulted in a less dense texture, while enhancing vegetable odour and flavour. This also improved the moisture content and overall sensory quality of the spreads. Although spices did not notably enhance these sensory attributes, soy-based vegetable spreads remain an attractive option for unique vegetarian finger foods and lunch dishes, catering to diverse consumer preferences. The addition of vegetable purées and spices to spreads creates opportunities for innovative and flavourful plant-based options.

Keywords: soybean spreads; vegetable purée; spices; plant-based foods; profiling

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1. Introduction

In recent years, there has been a significant shift in consumer preferences towards more sustainable and plant-based alternatives (PBAs) to animal products, particularly meat [1]. This shift is driven by consumers' concerns about health, environmental sustainability, and animal welfare [2,3]. Alternative protein sources, including pulses, algae, insects, plant-based meat substitutes, and cultured meat, are commonly regarded as healthier and more environmentally sustainable compared to conventional animal-derived proteins [4].

The global shift towards plant-based diets has catalysed a transformative wave in the food industry, with manufacturers and retailers increasingly adopting this new paradigm. Within the European context, retail sales of plant-based foods have seen a remarkable upsurge in recent years. This growth is primarily attributed to the introduction of innovative products and advanced technological innovations in the market. In 2022, the European market saw a 6% increase in plant-based food sales, marking an overall rise of 21% since 2020, and reaching a total of €5.8 billion [5].

Plant-based alternatives are predominantly linked to public benefits such as climate impact, biodiversity, and ethical choices rather than private attributes like taste and price [6].

Despite the association of plant-based products with public goods, it was discovered that private good features played a crucial role in their consumption. Healthiness and taste were revealed to be highly relevant for the acceptance of all alternative proteins, particularly in the case of pulses [7]. Additionally, the appeal of the product's texture plays a pivotal role in consumers' acceptance of plant-based products [8]. Consumer willingness to try various categories of plant-based alternatives differs, with meat substitutes typically acquiring greater interest and a higher willingness to consume (WTC) than fish substitutes [9]. Consumers also differ in terms of the frequency of consuming meat alternative products depending on their type of diet, with flexitarians being the most likely to consume both highly processed PBAs convenient products as well as legumes [10].

Another important issue related to incorporating more plant-based products into the diet is ensuring consumers have access to a variety of options, new sensory experiences, and an adequate amount of nutrients. It is observed that consumers transitioning to plant-based diets often consume an excess of grain-based proteins in comparison to vegetable-based proteins, resulting in an insufficient intake of valuable nutrients [11]. Widespread criticism has been also directed at numerous emerging plant-based food alternatives due to their high level of processing, often leading to their classification as 'ultra-processed' food products [12,13]. Adverse changes in the diet are largely associated with a lack of skills in preparing diverse, nutritious, and sensorily appealing vegetable-based dishes. Greater emphasis should be placed on the development of new products containing plant-based proteins that are not only convenient, but also contribute to a healthier, nutrient-dense plant-based diet. Incorporating high-quality convenience plant-based foods into one's diet can significantly improve overall dietary health by addressing the challenges associated with preparing vegetable-based dishes [14]. Developing new plant-based products with a lower degree of processing, utilising easily accessible raw materials that can be sourced from local providers, appears to be a sound approach. Legumes and plant-based meat substitutes are considered more sustainable sources of protein, and they appear to be the most promising approach, both in terms of environmental impact and societal acceptance [4].

Soybeans have early emerged as a versatile and popular choice for plant-based alternatives. This is because soybeans offer a rich array of nutritional benefits, including unsaturated fatty acids, essential B vitamins, dietary fibre, iron, calcium, zinc, and an array of other bioactive compounds, making them an attractive and wholesome addition to the diet [15]. The cultivation of soybeans in European conditions is becoming increasingly popular, not only for fodder purposes, but also for consumption, due to the growing demand for raw materials, especially in the production of food that substitutes for animal products [16]. Soybeans are an excellent source of high-quality plant-based protein, containing all the essential amino acids. Soy products, such as tofu, soy milk, and edamame, are popular choices for individuals following vegetarian or vegan diets [17]. These products can help meet protein requirements while providing essential nutrients and lowering the risk of cardiovascular disease [17,18]. One potential strategy to encourage consumers to increase their consumption of plant-based alternatives based on legumes is to offer products that are both convenient and flavourful. One category that has gained significant attention and popularity in this movement is vegetable spreads. These spreads, made from a combination of vegetables, herbs, and spices, open up various culinary possibilities. They can serve as spreads for sandwiches and wraps, condiments for pasta dishes, and dips when paired with fresh raw vegetables, pita bread, or crackers. This versatility makes them an attractive choice for a diverse range of consumers. The sensory properties of soybean products, such as soybean spreads, play a key role in determining their acceptability. Consumer acceptance of soybean-based foods is often influenced by the legume's flavour, particularly due to the presence of undesirable compounds known as "beany flavors" [19]. The addition of salt and spices is common in plant-based meat alternatives to mask off-flavours [20]. Therefore, adding vegetables and spices to a soybean base can alter sensory properties and increase consumer acceptance.

The main objective of this research was to ascertain both the similarities and differences in the sensory profiles of soybean spreads incorporating vegetable purée, specifically beetroot, pumpkin, broccoli, and carrot, along with the addition of spices, namely marjoram and cumin. The study provides a comprehensive understanding of how these varied ingredients influenced the overall sensory characteristics of the soybean spreads.

2. Materials and Methods

2.1. Materials

The materials used in the study were the soybean spreads with a different addition of vegetable purées and spices. The choice of ingredients for our study was driven by the idea to develop spreads using soy, a familiar base ingredient, complemented by commonly grown vegetables that could be sourced locally. This approach could lead to more cost-effective pricing, while also aligning with sustainability. Additionally, the outcome of our study was intended to support small-scale vegetable processors, especially those involved in shorter supply chain operations. Furthermore, the proposed spreads were intentionally developed to have a "clean label", a concept that resonates with health-conscious consumers seeking minimally processed PBAs. The soybeans were obtained from a commercial food company, Sante, located in Poland. The frozen vegetables used for preparing the purées were sourced from Hortex, one of the leading producers of frozen foods in Poland (Warsaw). The spices, including marjoram and cumin, were sourced from the same producer, Primat in Poland. The cumin was provided in powdered form. A standard procedure for preparing the spreads was developed in preliminary research. The soybean spreads under examination featured varying ingredient proportions. A control sample consisted of 100% soybean paste. In another variant, 70% of the spread was soybean paste, and the remaining 30% comprised a mixture of pumpkin, carrot, broccoli, and beetroot purée. All samples were uniformly salted with 0.8% salt content. These samples differed primarily in terms of the spices utilised: (a) the control contained no additional spices (0.0% marjoram and cumin), (b) the second variant featured 0.4% marjoram as the sole spice, (c) the third variant included 0.1% cumin as the sole spice, and (d) the fourth variant contained a combination of 0.4% marjoram and 0.1% cumin. In addition, 27% water and 2% oil were added to each sample of soybean spread. The experimental design is shown in Figure 1.

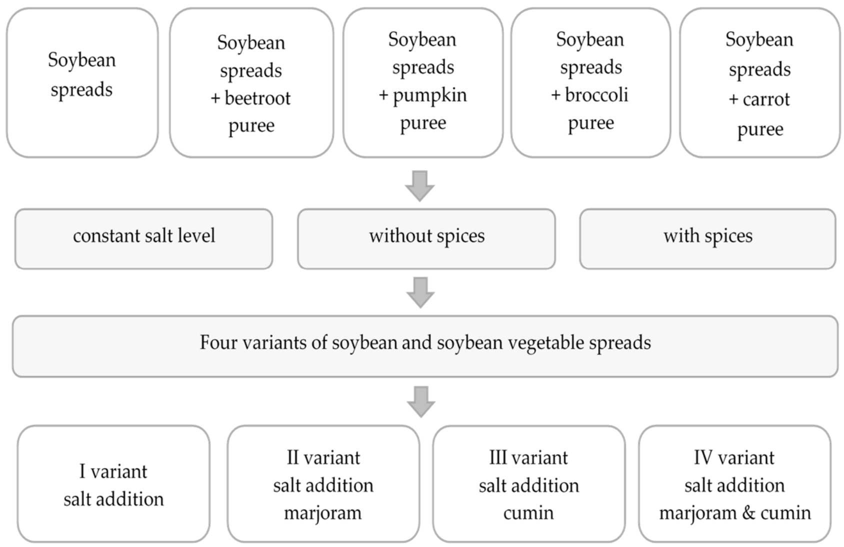


Figure 1. The experimental design.

The soybean spreads with vegetable purée and spices were prepared for sensory research according to the following procedure: (1) Washed soybeans were placed in a pot and then covered with boiling water, where they were left to soak for 3 h. Afterward, the beans were drained and rinsed under running tap water (during the soaking process, the soybeans more than doubled their weight). (2) The beans were then covered with fresh tap water at a ratio of 1 part soybeans to 2 parts water and brought to a boil using the maximum power of a Whirlpool glass-ceramic induction hob—ACM 918/BA (Whirlpool, Tulsa, OK, USA). (3) For the initial 15 min, the soybeans were boiled uncovered without reducing the power, allowing any foam to be removed. The cooking process then continued for an additional 1 h and 15 min, covered, at power levels 2–3, without interruptions. (4) Following this, the cooking water was drained, and the cooked soybeans were set aside to cool completely. (5) Subsequently, the frozen vegetables were prepared, with pumpkin and diced carrots, as well as broccoli florets, blanched for 2.5 and 5 min, respectively, and then drained. Beetroot purée was thawed in a water bath. (6) Precise amounts of selected spices were measured using small weighing vessels with an accuracy of 0.001 g, and they were then covered with pre-boiled, warm water. (7) Soybeans and selected vegetables were weighed with an accuracy of 0.01 g into large containers, and (8) the spice solution was poured into the large containers, oil was added, and the ingredients were blended using an immersion blender, specifically the robot coupe® Mini MP (Robot Coupe, Vincennes, France) 160 V.V set to level 9, until all the components were thoroughly mixed. Photos of the ingredients for preparing various spreads and ready-made soybean spreads are shown in Figure 2.

(**a**) (**b**)

Figure 2. Photos of the ingredients for preparing various soybean spreads: (**a**) the first photo in the middle shows the cooked soybeans, from left to right are the weighed ingredients: salt, marjoram, cumin, marjoram, and cumin; the next photos show the weighed ingredients as above and blanched vegetables (beetroot, pumpkin, broccoli, and carrot), and (**b**) ready-made soybean spreads with spices and vegetables from left to right: soybean samples without vegetable purée, soybean samples with broccoli purée, soybean samples with pumpkin purée, soybean samples with carrot purée, and soybean samples with beetroot purée.

2.2. Methods

The sensory assessment was conducted using the Quantitative Descriptive Analysis (QDA) [21,22]. Two preliminary sessions were conducted with the soybean spread samples by expert sensory assessors to establish a list of attributes. Subsequently, twenty-three descriptors were finally selected and defined, following the profiling procedure. The intensity of attributes was measured on a linear scale ranging from 0 to 10 cm, anchored between "none" and "very strong" for odour (soybean, vegetable, marjoram, cumin, fatty, sweet, sharp, overall intensity), flavour (soybean, vegetable, fatty, bouillon), taste (salty, sweet, bitter), pungency impression, and from "low" to "high" for texture traits such as density, moisture, coating, and particle sensibility.

The overall sensory quality of the samples was defined as the impression of the harmony of all descriptors, with either no or only a slight intensity of negative features.

2.3. Sample Presentation

Individual samples (15 g portions) of each type of soybean spread, in accordance with the experimental design, were randomly presented to the panellists at room temperature (21 ± 2 °C) in plastic beakers coded with 3-digit random numbers and covered with lids. Mineral water served as a neutraliser between the examined products. The samples were presented using a sequential monadic test.

2.4. Subjects and Testing Conditions

A trained panel of nine individuals selected for their expertise in sensory analysis following the recommendation of Meilgaard et al. [23] participated in the evaluation of the samples. The expert assessors had 15 to 25 years of theoretical and practical knowledge of sensory procedures and the assessment of food products using different methods (also QDA). The panel participates in evaluation regularly and the results are statistically verified (ability to differentiate samples, repeatability in sessions). To ensure a thorough and reliable assessment, each panel member took part in two separate sessions. The profiling of the samples was conducted during the morning and early afternoon hours, with two sessions per day for each set of soybean spreads (one set × four samples × nine assessors × two sessions). All profiling sessions took place in the sensory laboratory, adhering to the general requirements of the ISO standard (ISO8589:2010 [24]). The ten individual testing booths were equipped with the ANALSENS computerized system for data acquisition. The results of the profile assessment of the samples were automatically converted into numerical values (0–10 conventional units—c.u.) using sensory software version 7.5.

2.5. Statistical Analysis

Eighteen individual results were employed for each sample in the statistical analysis and data interpretation. All analyses were carried out using the XLSTATS version 2021 software developed by Addinsoft (Paris, France). The profiling data underwent a two-way analysis of variance (ANOVA), with consideration given to the products, assessors, and their interactions as fixed variables. Mean comparisons were conducted using Fisher's LSD significant test (at a 5% probability level). To discern the similarities and differences in the sensory characteristics of the evaluated samples, a Principal Components Analysis (PCA) was performed.

3. Results

3.1. Sensory Properties of Soybean Spreads with Vegetable Purée and Spices

The results of the profiling of the various soybean spreads with vegetable purée and spices are presented in Tables S1–S5 (Supplementary Materials). The significance of differences in the attribute intensity between samples was verified at the $p < 0.05$ level.

Statistically significant differences in the intensity of the attributes between soybean samples were found for 11 attributes, including marjoram odour (<0.0001), cumin odour (0.000), sweet odour (0.004), sharp odour (0.005), overall odour intensity (0.011), soybean flavour (0.000), fatty flavour (0.021), marjoram flavour (<0.0001), cumin flavour (0.000), sweet taste (0.000), and pungency sensation (0.007), between soybean spreads with and without spices (Table S1).

The samples of soybean spreads with marjoram were characterised by a significantly greater intensity of marjoram odour and flavour. The addition of cumin significantly increased the noticeability of cumin odour and flavour, though their intensity remained rather low. The soybean spread with marjoram and cumin had a significantly sharper odour compared to the sample with the addition of only cumin. The overall odour intensity remained at a significantly higher level in the sample with marjoram and cumin, and variant with marjoram, compared to the soybean spread with cumin, which had a sweeter odour and taste. The addition of both spices (marjoram and cumin) significantly reduced the soybean flavour. Fatty flavour was most pronounced in the soybean sample without spices. Pungency sensation was higher in samples with marjoram and with marjoram and cumin compared to the plain soybean spread (Table S1).

The mean results from the sensory profiling of the soybean spreads with beetroot purée and spices are presented in Table S2. The examined samples exhibited significant differences in the intensity of 10 descriptors: soybean odour (0.013), marjoram odour (<0.0001), sweet odour (0.047), sharp odour (0.003), vegetable flavour (0.012), marjoram flavour (<0.0001), cumin flavour (0.001), salty taste (0.010), bitter taste (0.002), and overall sensory quality (<0.0001).

The highest intensity of soybean odour was recorded in the soybean spread with beetroot purée and the variant with the addition of cumin, while the lowest intensity was found in the sample with marjoram and cumin. Marjoram odour and flavour were most noticeable in samples with the addition of marjoram. The soybean spreads with beetroot purée and both spices had the lowest intensity of sweet odour and the highest levels of sharp odour and bitter taste. The intensity of vegetable flavour was most perceptible in the soybean spreads with beetroot purée, differing statistically from samples with marjoram as well as marjoram and cumin. Cumin flavour was most intense in the sample with the addition of cumin. The soybean spreads with beetroot purée exhibited the highest intensity of salty taste. The overall sensory quality was at the highest level in the soybean spreads with beetroot purée (Table S2).

The intensity of the attributes for the soybean spreads with pumpkin purée and spices is shown in Table S3. Significant differences between the samples were detected for 11 attributes: marjoram odour (<0.0001), cumin odour (0.001), sharp odour (0.014), overall odour intensity (<0.0001), soybean flavour (0.003), marjoram flavour (<0.0001), cumin flavour (0.001), salty taste (0.048), sweet taste (0.000), bitter taste (0.005), and overall sensory quality (0.002).

The addition of spices to the samples significantly influenced the perception of marjoram and cumin odour and flavour, as well as sharp odour, when compared to the soybean spread with pumpkin purée. The overall odour intensity of the soybean spread with pumpkin purée and marjoram as well as the variant with marjoram and cumin was significantly higher compared to the other examined spreads. The most intense soybean flavour was found in the soybean spread with pumpkin purée without spices. However, the sample with the addition of marjoram and cumin was the least salty and the most bitter in taste. The soybean spread containing pumpkin purée received significantly higher overall sensory evaluations compared to the other samples, with the exception of the cumin variant (Table S3).

The mean value of the attributes for the soybean spreads with broccoli purée without and with spices is given in Table S4. Significant differences between the samples were found for 13 descriptors: soybean odour (0.009), vegetable odour (0.010), marjoram odour (<0.0001), cumin odour (0.016), fatty odour (0.027), soybean flavour (0.011), vegetable flavour (0.003), fatty flavour (0.007), marjoram flavour (<0.0001), cumin flavour (0.001), bitter taste (0.015), pungency (0.006), and overall sensory quality (0.016).

Soybean odour was significantly more noticeable in the sample with broccoli and the variant with cumin compared to the marjoram sample. It was found that the sample with both spices had the least vegetable odour and the highest level of marjoram and cumin odour as well as flavour. Differences in fatty odour intensity were detected between the spread with broccoli purée, broccoli purée with cumin (higher intensity), and the sample with the addition of marjoram and cumin (lower intensity). The perception of fatty flavour was also significantly lower in the sample with marjoram. It was stated that the soybean flavour remained at the highest level in the soybean spread with broccoli purée, which was at the same time less bitter, and its pungency was comparable to the variant with both spices. The overall sensory quality was at a significantly higher level in the sample without spices than in the variants with marjoram and marjoram/cumin (Table S4).

The soybean spreads with carrot purée without and with spices varied significantly in the intensity of 13 attributes (Table S5). There were differences found in the intensity of the vegetable odour (0.023), marjoram odour (<0.0001), cumin odour (0.006), fatty odour

(0.007), sweet odour (<0.0001), overall odour intensity (0.015), soybean flavour (0.011), vegetable flavour (<0.0001), marjoram flavour (<0.0001), cumin flavour (0.002), sweet taste (<0.0001), bitter taste (0.010), and pungency (0.000).

The sample with carrot purée without spices had the highest intensity of vegetable odour and flavour. The spices significantly influenced changes in the intensity of the odour and flavour of marjoram and cumin. Additionally, the samples with the addition of marjoram and marjoram/cumin were less fatty in odour than the variant with cumin. The combined addition of two spices significantly reduced the perception of sweet odour and, at the same time, caused an increase in the overall odour intensity. It was found that the intensity of soybean flavour and sweet taste was lower, whereas bitter taste was higher in the samples with marjoram and with the addition of marjoram and cumin compared to the other samples. Pungency sensation was the lowest in the soybean spreads with carrot purée. Significant differences in the intensity of the attributes between the samples did not influence changes in their overall sensory quality (Table S5).

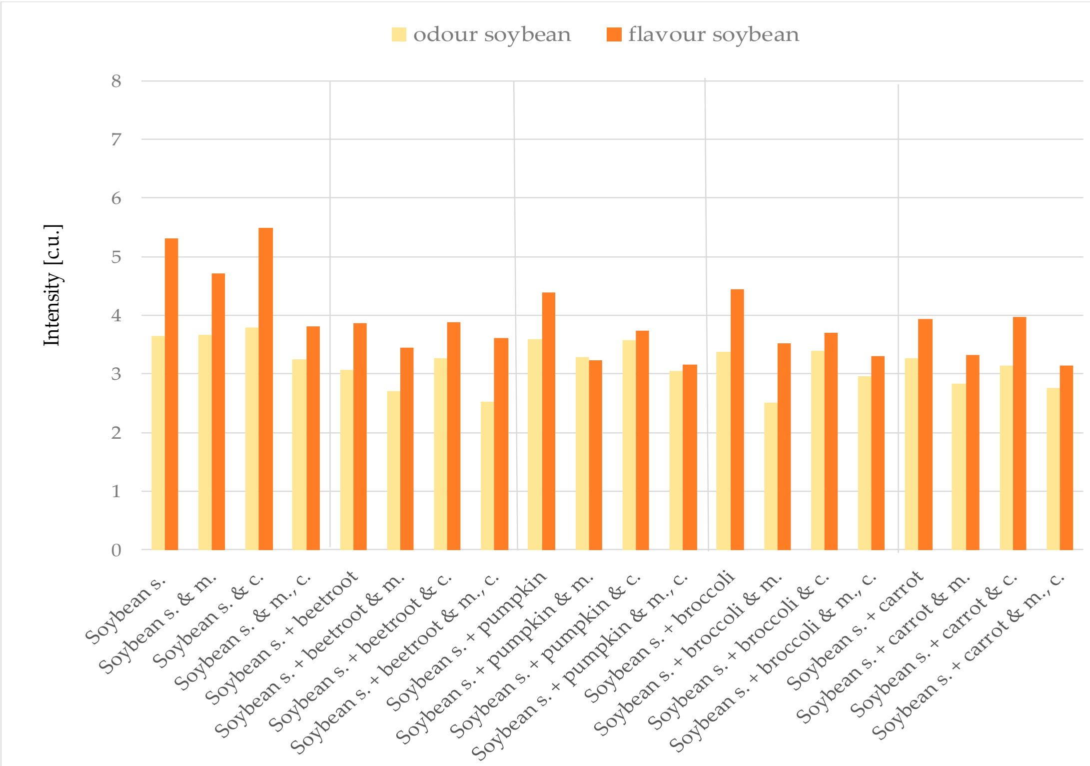
A comparison of the changes in the intensity of some attributes (soybean odour and flavour, vegetable odour and flavour) as well as in the overall sensory quality between the examined soybean spreads with various vegetable purées and spices is shown in Figure 3a–d. There was a greater reduction in the intensity of soybean flavour than in soybean odour in the vegetable purée samples in relation to soybean spreads (Figure 3a). Changes in the perception of soybean odour and flavour were similar in samples regardless of the type of vegetable purées and spices.

The intensity of vegetable odour and flavour remained at a relatively higher level in beetroot and broccoli vegetable soybean spreads compared to the pumpkin and carrot spreads (Figure 3b). The spices used had a slight effect on the perception of vegetable odour and flavour in beetroot spreads. However, a decrease in their intensity due to the addition of marjoram and cumin was observed in broccoli and carrot soybean spreads. There were large differences between the samples in the impression of density and moisture (Figure 3c). The soybean spreads represented the highest level of density and the lowest moisture level compared to the other samples. Among the vegetable spreads, it was found that beetroot and pumpkin spreads represented a higher impression of density and lower moisture than broccoli and carrot soybean spreads. The addition of spices did not affect the density and moisture of the examined samples. It was shown that in some cases, the overall sensory quality increased in samples (e.g., soybean spreads with beetroot, pumpkin, and broccoli) compared to the soybean spreads (Figure 3d). Slightly lower mean values of the overall sensory quality were recorded for the pumpkin, beetroot, and broccoli samples with marjoram and the combined addition of marjoram and caraway.

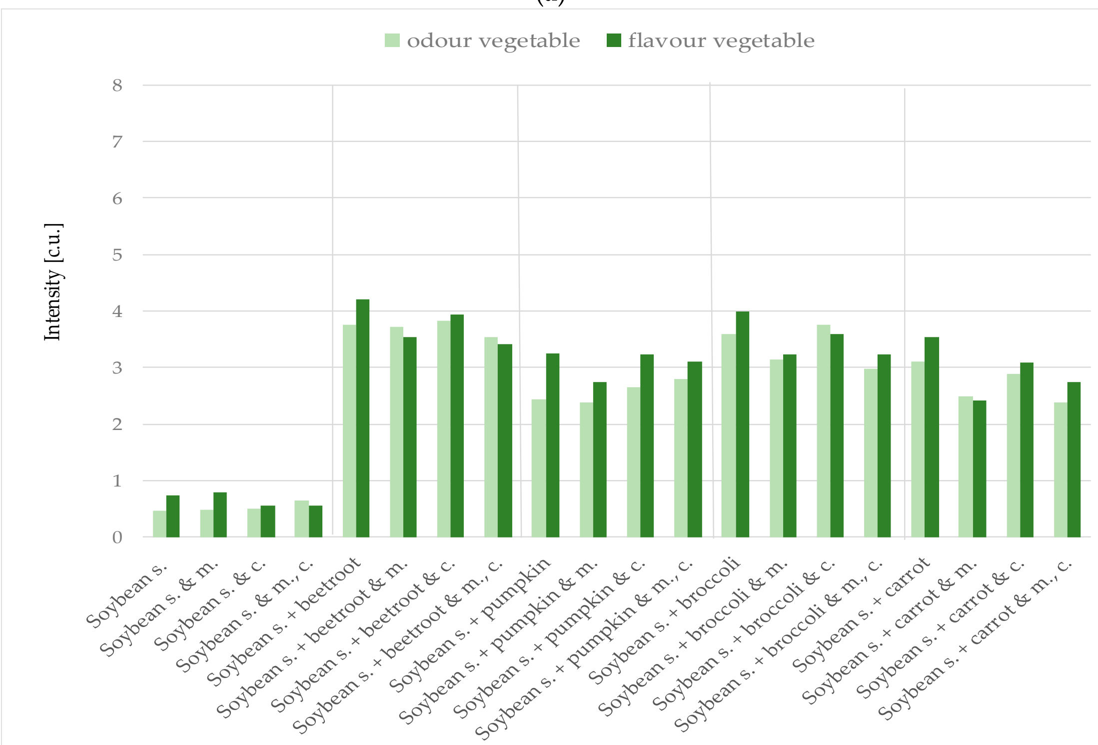
3.2. Effect of the Type of Vegetable Purée and Spices on the Sensory Profile of Soybean Spreads

The influence of the type of vegetable purées and spices on changes in the sensory profile of the soybean spreads can be observed on the PCA plot (Figure 4a–d).

In the case of soybean spread and a soybean spread with various vegetable purée, it was found that the variability of the samples was related to the greatest extent to the first principal component (81.62%), while the second component was assigned to a smaller share of variability (8.73%) (Figure 4a). The overall sensory quality of the soybean spread with broccoli and beetroot remained positively related to the overall odour intensity, the perception of the salty taste, and vegetable odour and flavour. On the opposite side from these samples was the soybean spread without the added vegetable purée. It was perceived as dense, with a distinct soybean and fatty odour and flavour, compared to all the other assessed samples.

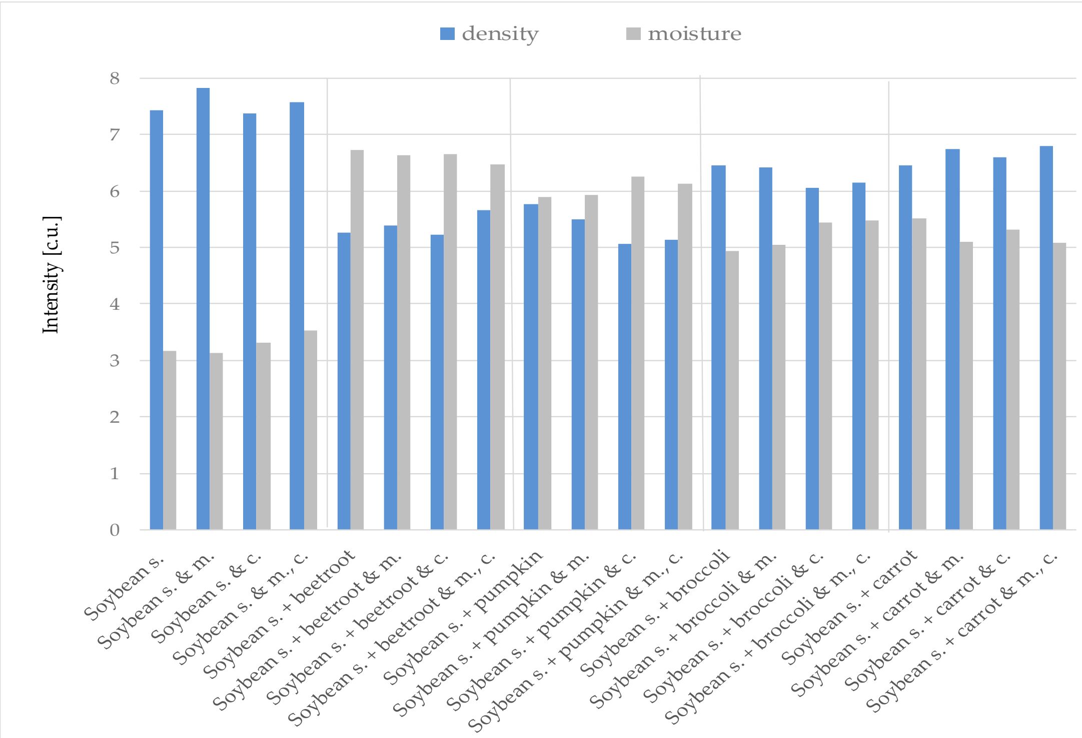


(a)



(b)

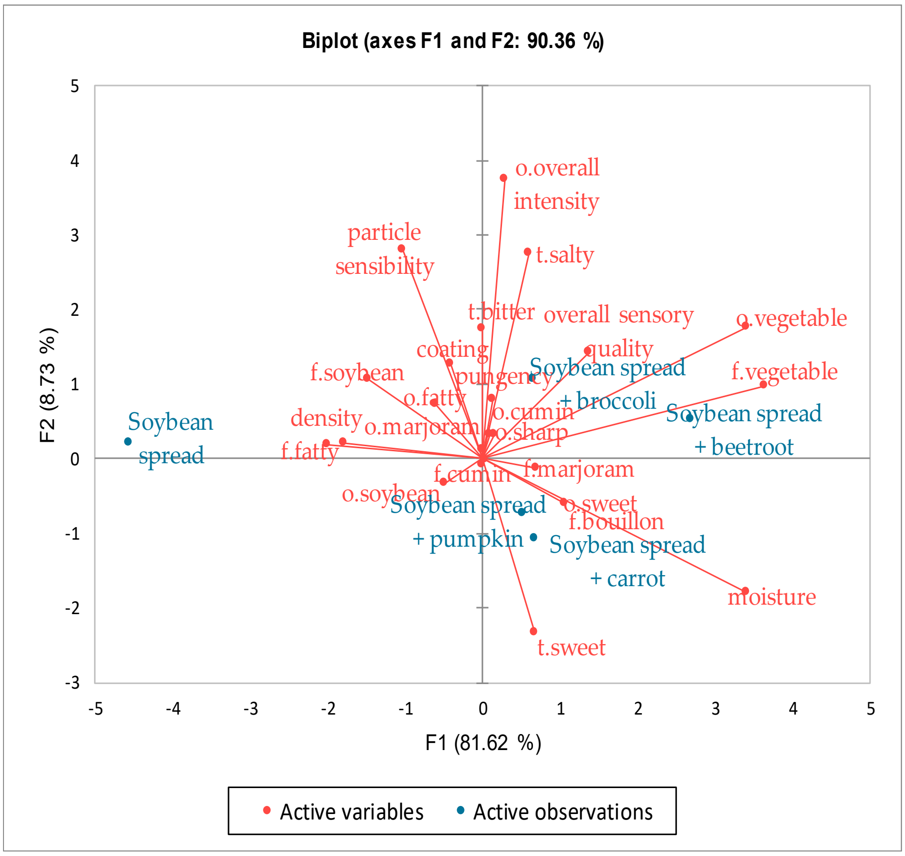
Figure 3. *Cont.*



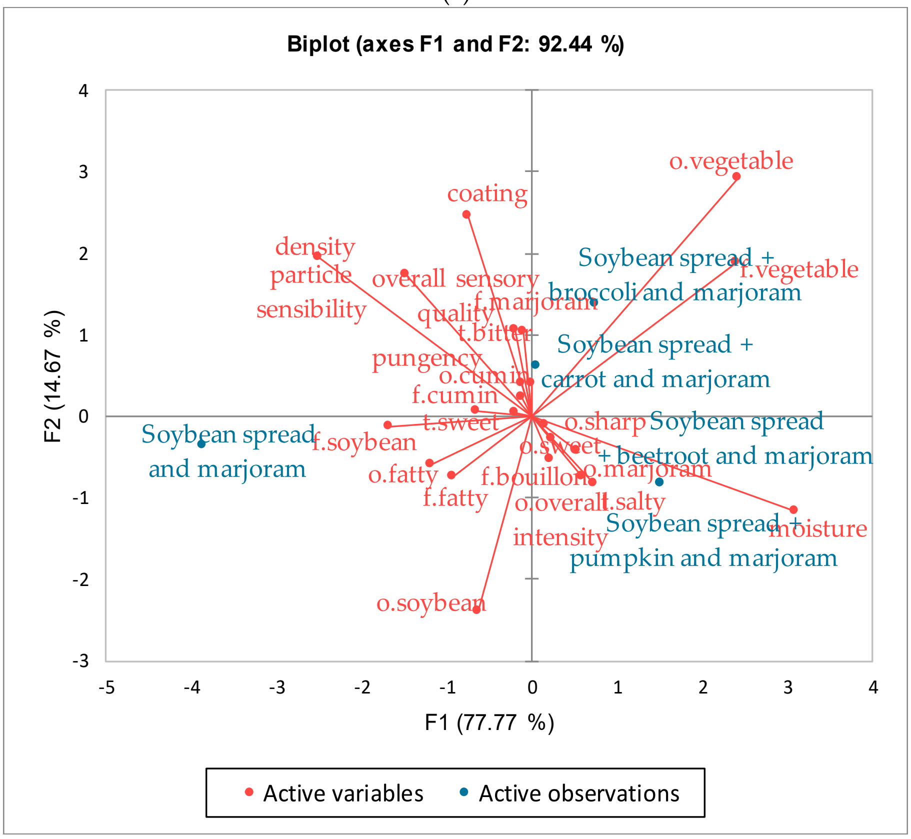
(**c**)

(**d**)

Figure 3. Intensity of (**a**) soybean odour and flavour, (**b**) vegetable odour and flavour, (**c**) density and moisture, and (**d**) impression of overall sensory quality in various soybean spreads (s.—spreads, m.—marjoram, c.—cumin). The explanation of different colours in subfigure (**d**): blue for soybean samples without vegetable purée; pink for soybean samples with beetroot purée; yellow for soybean samples with pumpkin purée; green for soybean samples with broccoli purée; beige for soybean samples with carrot purée.

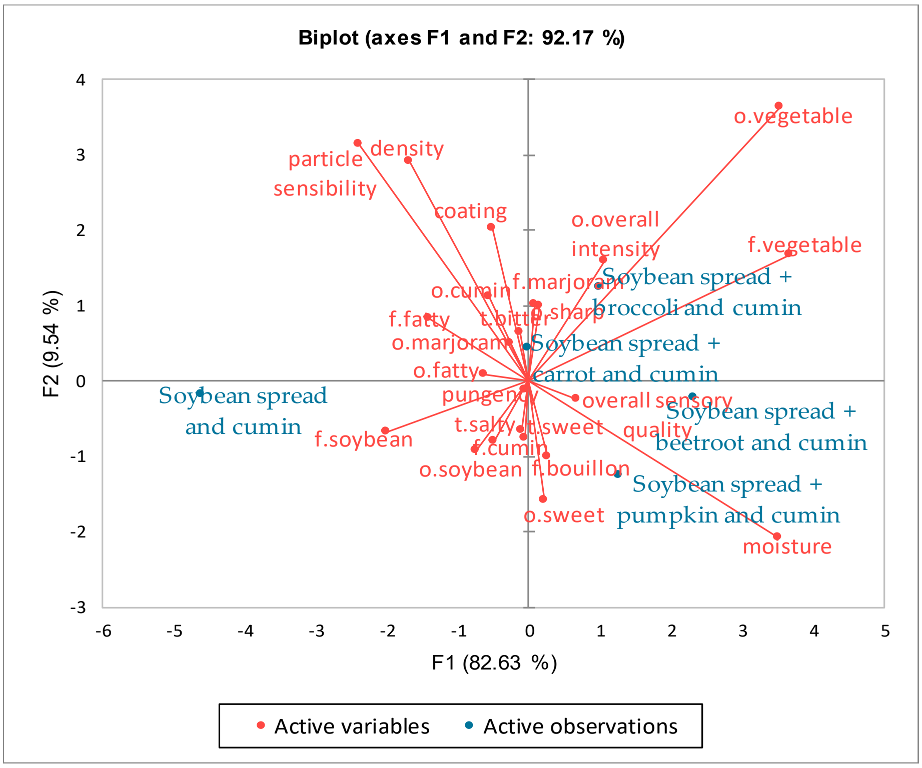


(**a**)

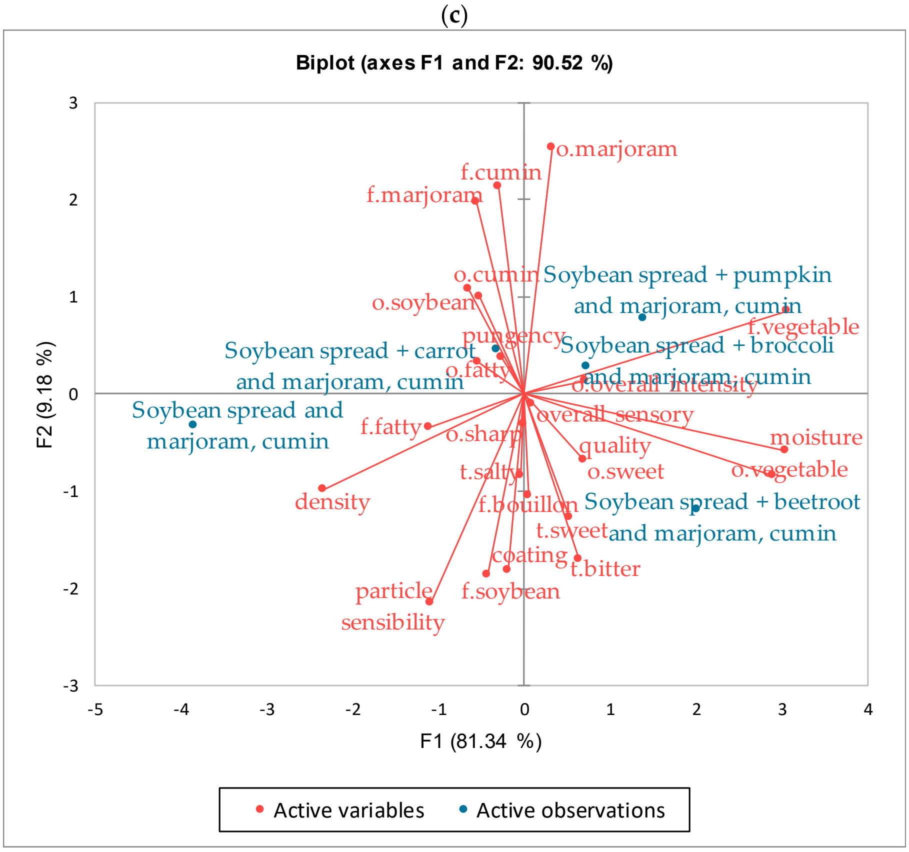


(**b**)

Figure 4. *Cont.*



(**c**)



(**d**)

Figure 4. Similarities and differences in sensory characteristics of the examined spreads: soybean pasta with different vegetable purée (**a**), soybean pasta with different vegetable purée and marjoram (**b**), soybean pasta with different vegetable purée and cumin (**c**), and soybean pasta with different vegetable purée, marjoram, and cumin (**d**).

The similarities and differences in the sensory characteristics of different soybean spreads with vegetable purées and marjoram are presented as a PCA biplot in Figure 4b (92.44% of the total variability). The overall sensory quality was positively related to some texture attributes, e.g., density and particle sensibility, and did not depend on the intensity of the vegetable odour and flavour. The samples with vegetable purées remained at a distance from the plain soybean spread.

The results of the descriptive analysis of different samples with cumin are displayed in Figure 4c (PCA plot—92.17% of total variability). The soybean spreads with vegetable purée had a relatively similar overall sensory quality. Vegetable odour and flavour were positively associated with each other and correlated with the overall odour intensity. Soybean spread with cumin represented different sensory characteristics compared to soybean-vegetable spreads with cumin.

The profiling characteristics of soybean spreads with vegetables and spices (marjoram + cumin) are presented as a PCA plot in Figure 4d (90.52% of total variability). Three types of spreads with marjoram and cumin (pumpkin soybean, broccoli soybean, and beetroot soybean) had similar sensory properties and were located close to each other in terms of attributes like vegetable odour and flavour and the overall sensory quality. It was found that the overall sensory quality was negatively related to the cumin odour and flavour, soybean odour, and marjoram odour and flavour. Similar to previous versions of the soybean spreads (as shown in Figure 4a–c), the sample without the addition of vegetable purées exhibited a distinctly different sensory profile.

4. Discussion

The proposed new types of vegetable spreads, featuring soy as the main ingredient along with the addition of vegetables and spices, constitute a promising alternative in the development of versatile culinary sandwich spreads. Our study contributes to the development of low processed PBAs by exploring the combination of soy with various locally sourced vegetables. This is particularly relevant in the growing market for plant-based foods, offering new and diverse options to consumers. Through sensory evaluation, the study provides valuable insights into consumer perception of plant-based products. It enhances understanding of how different vegetable combinations affect taste, texture, and the overall quality of soy-based spreads. Our research contributes also to the health and nutrition field. To align with health-conscious food choices, our approach emphasises the development of spreads that undergo minimal processing and can be perceived as products with “clean labels”. By incorporating soy, a protein-rich base, and enhancing it with commonly grown and potentially locally sourced vegetables and spices, these spreads also contribute to the ongoing trend of promoting sustainable and plant-centric diets. The vegetable spreads based on legumes have the potential to cater to a wide array of culinary preferences, accommodating both health-conscious individuals and those seeking new taste experiences in plant-based products [25].

To our knowledge, there are no data in the available literature on the detailed sensory characteristics of products such as soybean spreads (pasta) with the addition of vegetable purée and spices.

The obtained results indicate that the addition of vegetable purée, and particularly beetroot, enhanced the overall sensory quality. Incorporating beetroot into vegetable spreads not only improves sensory characteristics but also aligns with the growing interest in functional foods that offer health benefits related to the antioxidant-rich composition that beetroot brings to these spreads [26]. Adding vegetables and spices improves the nutritional value of the dishes and products with legumes and enhances the taste [27]. Incorporating herbs and spices like cumin into legumes can help to reduce salt content without sacrificing the hedonic liking of low-salt legume-based mezzes [28].

Currently, some fermented soy products have been proposed into the functional food market (e.g., soy cheese, soy yoghurt, soy sauce, doenjang, douchi, tempeh, miso) taking into account their certain health-promoting effects [29]. It is emphasised that the unsatisfactory sensory properties of traditional soy products are an important factor limiting their consumption and acceptability among consumers. For example, products made from soybeans, such as soy-juice beverages, soymilk, and many of their analogues may have a noticeable beany flavour, which is often described as an earthy, grassy, or musty odour by consumers [30]. According to some researchers, fermentation has been considered to possess the unique advantage of improving the taste, flavour, and texture of soy products by removing the undesirable beany flavour and contributing positively to sensory characteristics (odour, mouthfeel, and stable structure) [31,32].

In our research, the detailed quantitative-qualitative (cognitive) characteristics made it possible to determine the sensory image of different versions of soybean spreads (also with vegetable purée and spices). The literature emphasises the important role of qualitative matching (consonance) in the perception of sensory impressions and creating an integrated effect, which is the comprehensive flavour or, more broadly, the sensory quality of the product. The importance of sensory consonance concerns both the cognitive aspect of impressions (quality and intensity) and the affective (hedonic) dimension [33]. All vegetable purées added to soybean spreads had a positive effect on the sensory experience. It was shown that the intensity of the vegetable odour and flavour increased, and the intensity of the soybean flavour and odour decreased. In some cases, the addition of spices (especially both) affected the sensory dissonance (e.g., caused the lower intensity of vegetable attributes) in soybean spreads, such as those with broccoli purée and carrot purée. It was observed that changes in the density and moisture of soybean pastes with vegetable purée resulted in a decrease (suppression) in the intensity of key features. For example, the soybean carrot spreads were more dense and less moist, which resulted in a lower intensity of the vegetable odour and flavour compared to the soybean beetroot spreads.

The sensory quality of the soybean spreads could also depend on the interactions between the purée ingredients and spices and affected the perception. Numerous scientists have conducted research on identifying volatile compounds in spices, as well as in both raw and cooked vegetables. According to Amin [34], cumin is classified as a strong aromatic spice with a sweet aroma, a slightly bitter taste, and a pungent sensation. The characteristic odour of cumin is primarily due to the presence of aldehydes in the seeds, specifically cuminaldehyde, p-menth-3-en-7-al, and p-menth-1,3-dien-7-al [35]. Kesen et al. [36] determined a total of 32 volatile compounds consisting of different chemical classes in the seed extract of black cumin. Olfactometric analysis data revealed that the characteristic odour of black cumin seed extracts is predominantly buttery, cheesy, balsamic, citrusy, fatty, and spicy. These findings align with the sensory analysis descriptions of the seed (sample) and its aromatic extract [36]. Raghavan, Rao, Singh, and Abraham [37] investigated the impact of different drying methods on the flavour quality of marjoram. The main components contributing to the herb's typical flavour were identified as cis-sabinene hydrate, trans-sabinene hydrate, and terpinen-4-ol. More specifically, cis-sabinene hydrate is noted for its tropical-fruity flavour, characteristic marjoram flavour, and sweet taste, while terpinen-4-ol is characterised by a potato-like and herbaceous flavour. This could partially explain the variations in the intensity of certain attributes in the evaluated samples (e.g., the odour and flavour intensity of cumin and marjoram, and the bitter and sweet tastes). Differences in sensory characteristics might also be attributed to the presence and concentration of various odour-active volatile and taste-active non-volatile compounds (e.g., those responsible for sweet and bitter tastes) in various soybean spreads. For instance, Kallio, Raimoaho, and Virtalainen [38] identified 14 major volatiles in the headspace of cooked broccoli, including glucosinolate degradation products containing sulfur or nitrogen heteroatoms. In the research of Zhao et al. [39], 19 volatile compounds were identified that stand as differential volatile metabolites in traditional fermented soybean pastes from Northeast China and Korea. These substances appear to have a crucial role in creating the unique flavours that distinguish these two varieties of soybean paste. In another study, it was reported that the degradation of carotenoids is the most probable origin of the terpenes isolated in pumpkin purée, which are significant for aroma formation [40]. Understanding the role of sensory active compounds is a very important issue to consider to improve the appreciation of the existing complexities of the chemicals involved in flavour perception.

In products like soybean spreads and soybean spreads with vegetable purées, it is important to consider the mutual proportions of ingredients, the level of spices, and the use of other spices in future studies. Additionally, conducting consumer tests could provide significant insights into product expectations and acceptance. According to Forde and de Graaf [41], future research is needed to understand whether sensory properties can support sustained changes in eating behaviour and promote healthier dietary patterns in the longer term. Our study also has certain limitations. The analysis did not cover the content of volatile compounds and their relation to the sensory profile of the spreads. In future research, a gas chromatography analysis, such as headspace, would be recommended.

5. Conclusions

The sensory characteristics of soy-based spreads were found to be influenced by the specific combination of vegetables and spices used in their formulation. The addition of vegetable purée positively influenced the overall sensory quality as a result of harmonising the intensity of the attributes.

Our results revealed that the inclusion of spices did not yield a substantial improvement in the sensory attributes of the tested samples when compared to their non-spiced counterparts. Despite this finding, soy-based vegetable spreads present themselves as a compelling and intriguing alternative for crafting diverse vegetarian finger foods and lunch dishes, catering to the preferences of discerning consumers. The careful balance of vegetable purées and spices opens up opportunities for creating innovative and flavourful plant-based options, meeting the expectations of consumers who are in search of varied and appealing vegetarian options.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/app14031096/s1, Table S1: Sensory profiling of the soybean spreads with spices; Table S2: Sensory profiling of the soybean spreads with beetroot purée and spices; Table S3: Sensory profiling of the soybean spreads with pumpkin purée and spices; Table S4: Sensory profiling of the soybean spreads with broccoli purée and spices; Table S5: Sensory profiling of the soybean spreads with carrot purée and spices.

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