

Physicochemical and Sensory Properties of Peanut Spreads Fortified with Soy Flour

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Abstract: The physicochemical and sensory properties of peanut spreads fortified with soy flour were studied. Peanut spreads were replaced by whole soybean flour and soy nut flour at 0, 5, 15, 20 and 30% (w/w). All samples were analyzed for fat, protein, sugar, moisture content, adhesiveness, cohesiveness, hardness and sensory characteristics. Replacing peanut spread with soy flour had significant effect ($p < 0.05$) on physicochemical and sensory properties of peanut soy spreads. Replacing peanut spread by soy flour at 30% resulted in the lowest fat content. Regardless of type of flour used, replacing peanut spreads by soy flour increased the protein content of spreads. As the amount of soy flour increased, the average hardness increased. All peanut soy spreads received flavor ratings similar to control, while spreads containing 20% soy nut flour (Psn20) received the highest score for flavor and even more than control.

Key words: Peanut soy spreads % Physicochemical properties % Sensory properties

INTRODUCTION

Peanut seeds are a good source of protein, lipid and fatty acids for human nutrition [1,2]. Peanut proteins are relatively rich in amino acids needed for growth of school age children, except for lysine. In addition, roasted peanut kernels are an excellent source of folate, niacin and vitamin E, but are deficient in vitamins A and C and the minerals calcium and iron. Meanwhile, a large portion of vitamin B complex is destroyed during the roasting and blanching steps associated with peanut butter processing [3]. Peanut kernels contain 47 to 50% oil and since peanut butter must contain at least 90% peanut, it is a high fat food.

Soybean has the highest protein content among cereals and legumes and also contains phospholipids, isoflavones, vitamins and minerals. Some scientists have suggested that a positive association existed between high intake of soybean products and a low risk of cancer in some organs, such as the breast and colon [4,5]. Functional foods have become a means of delivering beneficial components in the human diet. As the functional food market continues to grow, surveys indicate consumers wish soy to be incorporated into food [6]. Soybeans contain 40% protein on a dry basis and have a relatively high amount of lysine and can provide all of the essential amino acids required for children and adults.

Functional properties of soybeans, lower fat content and also lower popularity of soy butters (containing only soybeans) due to their off flavors and texture make soybean and peanut good complementary for peanut soy spreads to provide a complete protein source, low fat and functional food product for every one specially growing children [3]. Dubost *et al.* [7] analyzed the consumer acceptability, sensory and instrumental analysis of peanut soy spreads, using varying levels of isolated soy protein 8, 14 and 20%. Yeh *et al.* [3] studied overall acceptability and sensory profiles of peanut spreads fortified with protein, vitamins and minerals. The main objective of this study was to investigate the effect of soy flour added to peanut spread formulations by determining several measurable quality characteristics as instrumental and sensory analysis.

MATERIALS AND METHODS

Samples: Medium roasted peanuts containing 49% fat (dry basis), oil, fine powdered salt, molasses and sugar were obtained from local market. Whole soybean flour and soy nut flour containing approximately 22.8 and 16.2% fat (dry basis), respectively, were obtained from Soybean Inc. (Mashhad, Iran).

Preparation of Peanut Soy Spread: The method of preparation was generally similar to those described by

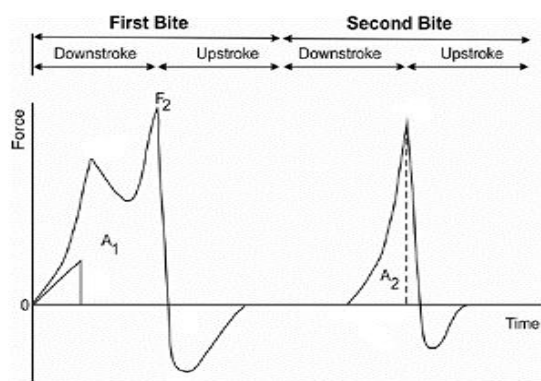


Fig. 1: A standard texture profile analysis diagram. (10)

Woodroof [8] with small modifications [1]. Medium roasted peanuts were coarsely ground in a peanut butter mill. Sugar, molasses, salt and 30% of oil were added to the ground peanut and were mixed for 7 minutes, second 30% of oil was added and mixed for 2 minutes, the rest of oil was added to the mixture and mixed for 5 minutes. The approximate composition of the formulation was peanut (90.5%), oil (1%), sugar (6%), molasses (1.5%) and salt (1%). Peanut spreads were replaced by whole soybean flour and soy nut flour at 5, 15, 20 and 30% (w/w) and 9 formulas were prepared. Each formulated peanut and peanut soy spread was filled into plastic jars and stored at -7°C until analysis.

Methods

Chemical Analysis: The fat content of spreads was determined by Soxhlet extraction with diethyl ether, protein was measured by microkjeldal. Sugar, ash and moisture content were also measured according to Iranian standard number 5690 [9].

Texture Profile Analysis (TPA): Texture measurements were carried out using the Universal Texture Analyser (CNS Farnell, UK) connected to a computer programmed with Texture Pro™ texture analysis software. A flat rod probe (25 mm in diameter) was attached to a 2 Kg compression load, while the target value was set at 10 mm with the speed of 0.5 cm/min. Samples (50 g) were placed into glass petri dishes, (13 cm dia x 1.5 cm deep). Probe was set to penetrate the samples to a depth of 0.4 cm. Texture profile analysis resulted in the calculation of instrumental hardness (the peak force measured during the first compression cycle, F_2), instrumental adhesiveness (the negative force area for first bite, representing the work necessary to pull the compression probe away from the sample, based A_3), instrumental cohesiveness (the ratio of the positive force area during

the second compression to that during the first compression, A_2/A_1) [10] (Fig. 1).

Sensory Analysis: Texture is a property difficult to evaluate with the use of a machine because it can only quantify the textural parameters in terms of a few specific characteristics, as it is a multi parameter characteristic, detected by several senses and derived from the food structure, texture is evaluated well by individuals who can perceive and describe all attributes of a product's texture [11]. Fifteen panelists (consisted of 8 female and 7 male, aged between 22 and 45 years) were selected from thirty volunteers of sensory analysis from students of Ferdowsi University (according to their accomplishment of a general sensory aptitude test). as proposed by Szczesniak [12,13]. Panelists were trained to determine the textural characteristics in two hour sessions prior to evaluation to be familiar with attributes and scaling procedure. Hardness, cohesiveness, adhesiveness intensity and flavor, color, aroma preferences were judged. Hardness was evaluated by each panel member by placing a sample in the mouth, between the molar teeth and biting down evenly, evaluating the maximum force required to compress the food. Cohesiveness was evaluated by placing a sample between the molar teeth and estimating the amount of deformation before rupture. Adhesiveness was measured by the panel by pressing each sample to the palate with the tongue. The force required to subsequently move the sample with the tongue was evaluated. A nine-point hedonic scale sensory test was used. (9 like extremely/ high intensity, 1 dislike extremely/low intensity).

All samples were coded with three-digit random numbers and presented to panelists on a tray in individual booths. Orders of servings were completely randomized. Panelists were provided with 50g samples in Petri dishes and were asked to rinse their mouths with water between samples. Samples were evaluated at ambient temperature.

Experimental Design and Statistical Analysis: Peanut spreads were replaced by two types of soy flour at 4 levels (w/w). 1) Whole soybean flour at 5 (Psw5), 15(Psw15), 20(Psw20) and 30% (Psw30). 2) Soy nut flour at 5 (Psn5), 15(Psn15), 20(Psn20) and 30%(Psn30). Control consisted of peanut spread without soybean flour (ps0) and 9 formulations were prepared. Physicochemical and sensory properties of samples were measured, each in three replicates at ambient temperature and after one night storage in -7°C .

Statistical analysis of data was performed by two factor randomized complete design using MSTATC

Ver.2.0 software. Factors were two flour types at five levels. The mean differences were analyzed using Duncan's test at $\alpha=0.05$ [12]. Pearson's Correlations between measurements were made using Minitab Ver.13.0 software.

RESULTS AND DISCUSSION

Chemical Analysis: The percentage of fat, protein, sugar, ash and moisture in spreads are presented in Table 1. As expected Ps0 had the highest fat content. Replacing peanut spread by soy flour at 30% resulted in the lowest fat content with about 10% decrease in comparison to control. Results show that psw30 and psn30 had the highest protein content. Spreads containing 5% soy flour had protein content similar to control, followed by spreads containing 15% soy nut flour. Regardless of type of flour used, replacing peanut spread by soy flour increased the protein content of spread about 3.5%. Yeh *et al.* [3] reported that peanut spreads fortified with roasted soybean at a 40.5% total fat content had the highest protein content. There is significant difference ($P<0.05$) between sugar content of all samples. Psn30 and ps0 had the highest and lowest ash, respectively. There was no significant difference ($P>0.05$) between moisture content of psn5 and psn15 and control. Replacing peanut spread by whole soybean flour increased the moisture

content, but replacing it with soy nut flour decreased the moisture content significantly ($P<0.05$).

Texture Profile Analysis (TPA): Effect of soy flour on textural properties as instrumental adhesiveness, cohesiveness and hardness is presented in Table 2. As shown in the Table, replacing peanut spread by soy flour increases the adhesiveness significantly ($P<0.05$). Psn30 and Psw30 scored the highest adhesiveness among samples. Totally, cohesiveness decreased with incorporation of soy flour in peanut spreads. No significant difference was observed between Psn15, Psn20 and Psn30 ($P>0.05$). Cohesiveness is defined as the strength of the internal bonds within the body of the product suggesting that the internal bonds of the peanut spreads were stronger than peanut soy spreads. Similarly, Dubost *et al.* [7] observed a significant decrease in cohesiveness as isolated soy protein was incorporated in peanut butter. As the amount of soy flour increased, the average hardness increased (Table 2). It appears that the amount of soy protein present in the spread significantly affected the level of hardness ($r= 0.87$) (Table 3). Dubost [15] reported that the spreads containing higher amounts of isolated soy protein were expected to be harder and more adhesive. Totally whole soybean flour and soy nut flour showed similar behaviors in textural properties.

Table 1: The percentage of fat, protein, sugar, ash and moisture content in spreads

Flour type	Sample code	Fat (%)	Protein (%)	Sugar (%)	Ash (%)	Moisture content (%)
Control	Ps0	46.25 ^{af}	25.47 ^c	23.55 ⁱ	3.25 ^d	1.49 ^c
1	Psw5	45 ^b	26.05 ^e	23.22 ^h	3.74 ^{cd}	1.99 ^b
1	Psw15	42.51 ^d	27.19 ^{cd}	24.06 ^g	4.07 ^{abc}	2.16 ^{ab}
1	Psw20	41.28 ^f	27.79 ^{bc}	24.44 ^f	4.26 ^{abc}	2.22 ^{ab}
1	Psw30	38.78 ^b	28.95 ^a	25.36 ^e	4.47 ^a	2.42 ^a
2	Psn5	44.75 ^c	25.94 ^e	24.01 ^d	3.8 ^{bcd}	1.49 ^c
2	Psn15	41.75 ^e	26.9 ^d	25.82 ^c	4.45 ^{ab}	1.47 ^c
2	Psn20	40.26 ^g	27.39 ^{cd}	26.99 ^b	4.26 ^{abc}	1.1 ^{cd}
2	Psn30	37.35 ⁱ	28.35 ^b	28.99 ^a	4.36 ^{abc}	0.96 ^{df}

Data with different letters in a column are statistically different at $P < 0.05$

Table 2: Effect of soy flour replacement on instrumental adhesiveness, cohesiveness and hardness

Flour	Sample	Adhesiveness	Cohesiveness	Hardness
Control	Ps0	6.16 ^d	0.95 ^a	3.8 ^c
1	Psw5	23.97 ^d	0.85 ^{ab}	5.2 ^c
1	Psw15	55.03 ^d	0.73 ^b	5.55 ^c
1	Psw20	164.1 ^b	0.465 ^c	39.2 ^b
1	Psw30	267.6 ^a	0.33 ^d	64.5 ^a
2	Psn5	26.94 ^d	0.74 ^b	6.3 ^c
2	Psn15	66.79 ^{cd}	0.44 ^{cd}	8.5 ^c
2	Psn20	149 ^{bc}	0.41 ^{cd}	13.1 ^c
2	Psn30	257.1 ^a	0.37 ^{cd}	38.2 ^{b*}

Data with different letters in a column are statistically different at $P < 0.05$

Table 3: Effect of soy flour on sensory attributes of spreads

Flour type	Sample code	Adhesiveness intensity	Cohesiveness intensity	Hardness intensity	Flavor	Color	Aroma
Control	Ps0	5.685d	4.875e	7.935a	6.56ab	6.625a	6.245abc
1	Psw5	7.31c	5.31de	7.435ab	6.37ab	6.37a	5.935bc
1	Psw15	7.5c	6 bc	7.435ab	6.435ab	6.685a	6.495abc
1	Psw20	8.31ab	7.12a	7.75e	6.435ab	6.625a	6.81ab
1	Psw30	8.81a	7.56a	5.25de	6.12b	6.31a	5.81c
2	Psn5	7.75bc	5.75cd	7.12bc	6.62ab	6.56a	6.495abc
2	Psn15	7.75bc	6.375b	6.56c	6.625ab	6.625a	6.37abc
2	Psn20	8.185ab	7.06a	5.81d	7.0a	6.45a	6.935a
2	Psn30	8.37ab	7.31a	5.06e	6.435ab	6.0a	6.56abc*

Data with different letters in a column are statistically different at P <0.05

Table 4: Pearson's correlation coefficients between measured variables

	Adhesiveness inten.	Cohesiveness inten.	Hardness inten.	Flavor	Color	Aroma	Adhesiveness	Cohesiveness	Hardness	Fat (%)	Protein	Suger (%)	Ash (%)
Cohesiveness inten.	0.905***												
Hardness inten.	-0.687*	-0.756*											
Flavor	-0.180ns	-0.121ns	0.052ns										
Color	-0.450ns	-0.475ns	0.774*	0.262ns									
Aroma	0.164ns	0.270ns	0.040ns	0.719*	0.184ns								
Adhesiveness	0.787*	0.931***	-0.809**	-0.316ns	-0.683*	0.060ns							
Cohesiveness	-0.872**	-0.966***	0.791*	0.021ns	0.444ns	-0.256ns	-0.865**						
Hardness	0.703*	0.812**	-0.604ns	-0.582ns	-0.521ns	-0.190ns	0.911***	-0.721*					
Fat(%)	-0.824**	-0.948***	0.855**	0.147ns	0.635ns	-0.206ns	-0.940***	0.930***	-0.751*				
Protein(%)	0.844**	0.948***	-0.739*	-0.370ns	-0.517ns	0.056ns	0.950***	-0.883**	0.876**	-0.945**			
Sugar(%)	0.551ns	0.715*	-0.845**	0.227ns	-0.695*	0.381ns	0.725*	-0.767*	0.406*	-0.849**	0.634ns		
Ash(%)	0.898***	0.898***	-0.693*	-0.103ns	-0.330ns	0.195ns	0.745*	-0.941***	0.612ns	-0.874**	0.856**	0.648ns	
Moisture	0.141ns	0.026ns	0.330ns	-0.703*	0.341ns	-0.475ns	0.020ns	0.090ns	0.344ns	0.121ns	0.201ns	-0.623ns	0.062ns

\$Not that : (ns: p>0.05), (*:p<0.05), (**:p<0.01), (***:p<0.001)

Sensory Analysis: Sensory attributes evaluated are presented in Table 3. Panelists scored the control, the least adhesive. Psw30 was the most adhesive among the products. Totally adding soy flour increased the cohesiveness and decreased hardness significantly (P<0.05). All peanut soy spreads received flavor ratings similar to the control, while Psn20 received the highest score for flavor. Panelists did not observe any significant difference between color of different samples (P<0.05). Aroma perception were also not different from one another and from the control (P<0.05).

Correlation between Measurements: Table 4, presents the Pearson's correlation coefficients between measurements. This specific correlation considers each attribute separately with no other attribute affecting the results.

As shown in the Table, there is significant correlation between instrumental and sensory adhesiveness, cohesiveness and hardness. Dubost *et al*, [7] observed a significantly positive correlation

between TPA adhesiveness and sensory adhesiveness (r=0.89, P = 0.054) and a significantly negative correlation between TPA cohesiveness and sensory cohesiveness (r = -0.89, P = 0.045).

Szczesniak [16] stated that making correlations between sensory and instrumental methods is important for several reasons. In quality control, correlations between sensory and analytical methods are helpful because they allow for the use of faster instrumental tests to determine if products are texturally consistent. Extensive work must be done on a commodity to evaluate which parameters contribute to consumer acceptance and the relationship between these and empirical measurements. This data can potentially be used to predict consumer satisfaction. Linking sensory attributes and specific forces is very important to understanding what is sensed in the mouth when texture is being perceived. A strong relationship between sensory and analytical techniques will also help to advance the optimization of instruments to better simulate human perception [17].

Some parameters correlate better to sensory data better than others. Empirical Tests for hardness have consistently correlated well with sensory studies [18,16]. In Cheddar cheese, TPA and compression tests were used successfully to predict sensory attributes [19].

CONCLUSION

Whole soybean flour and soy nut flour were used to replace the peanut spread. Peanut spread without any soy flour was used as control. Physicochemical and sensory properties of products were measured. Instrumental texture profile and sensory analysis helped as an effective technique to select formulations in an acceptable range of important characteristics. Totally whole soybean flour and soy nut flour showed the same behavior in texture properties. All peanut soy spreads were accepted by panelists in their flavor and aroma, even higher than all peanut samples (psn20). Regarding soybean as an important functional food and low fat content of peanut soy spreads, peanut soy spreads can strongly provide an excellent vehicle, acceptable by panelists, to deliver soy to consumers.

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