Textural Quality of Peanut Butter as Influenced by Peanut Seed and Oil Contents[1]

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ABSTRACT

Oil content, peanut seed content and the interaction of both factors significantly influenced the textural quality of peanut butter. Spreadability as measured by sensory methodology as well as instrumental measures indicated better quality as percent oil increased from 40 to 50% and peanut seed content increased from 90 to 95%. The higher peanut seed content had a significant improvement on the spreadability of the butter containing 40% oil with no influence for the 50% oil sample. The reverse was true for all adhesiveness measurements. Jamaican peanut butter exhibited textural qualities similar to the butter containing 40% oil.

Key Words: Peanut, peanut butter, texture, spreadability, oil content effect, peanut content effect, Jamaican peanut butter.

Peanut butter is the food prepared by grinding shelled and roasted peanuts to which are added dextrose, salt and stabilizing ingredients such as hydrogenated vegetable oil or emulsifier which prevents oil separation. The product is manufactured using roasted peanut seed and processing techniques that allow uniformity of product and consistent high quality in terms of wholesomeness, color, flavor, and stability of the finished product (8).

Federal regulations mandate that commercial peanut butter must contain at least 90% peanuts. Fat content, including the natural oil of the peanuts, may not exceed 55%. Maximum levels permitted for various additives are 4% for stabilizer, 6% for dextrose and 1.6% for salt (2).

The objectives of the present study were: 1) to quantify the effects of varying the oil and peanut seed contents on the textural qualities of peanut butter and 2) to compare the textural qualities of commercially prepared peanut butter with experimental butters containing controlled amounts of oil and peanut seed.

Materials and Methods

Peanut Seed - Spin blanched Florunner peanut seed obtained from Florida Peanut Co, High Springs, FL were roasted in a General Electric Rotisserie oven at 177 C for 35 min and cooled quickly in a forced air stream. The temperature-time combination was selected since it resulted in roasted nuts with color similar to that of USDA No. 2 color standard for peanut butter (7). Peanut seeds with reduced oil content were obtained by pressing the roasted seeds with a hydraulic press maintained at a pressure of 31.75 x 10^3 kg for 2 h. The oil contents of the pressed and unpressed roasted seeds were determined by grinding the seed in a Waring Blender and extracting of the oil in a Soxhlet apparatus with petroleum ether as the solvent (1).

Peanut Butter Preparation - The method of preparation was generally similar to those described by Tressler and Woodroof (6) and Woodroof (8). Additives mixed with the roasted peanut seed were: 1) Emulsifier (Atmul 84 sprayed mono- and diglycerides of edible fats and oils, Atlas Chemical Industries, Inc.), 2) Salt, 3) Sugar and 4) Corn syrup solids type FRO-DEX 24D (American Maize Products Company).

The formulations containing 90 and 95% peanut seed were as follows:

1) 90% peanut seed

500g peanuts	90%
8.33g salt	1.5%
8.33g emulsifier	1.5%
27.77g corn syrup solids	5%
11.13g sucrose	2.0%

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2) 95% peanut seed

500g peanuts	95%
7.89g emulsifier	1.5%
7.89g salt	1.5%
10.52g sucrose	2.0%

Each mixture was blended in a Waring Blender for 2 min at medium speed and fed into a coffee grinder to obtain the peanut butter.

Commercial Peanut Butter - Jamaican smooth peanut butter "Jamaica Way" was obtained from Jamaica Frozen Foods Ltd., Kingston, Jamaica. Three different brands of commercial smooth peanut butter were obtained from a local supermarket in the U. S.

Textural Quality Measurements

A. Instrumental methods

1. Koehler cone penetrometer. This method is based on the principle of penetrating the test material with a cone-shaped metal probe (102.5 g) for 5 sec and measuring the depth of cone penetration. Results are expressed as distance in mm.
2. Adhesiveness

   The adhesiveness of each sample was measured using the Universal Testing Instrument (Instron Model T M) equipped with a CCB load cell (0 - 2 kg range). A stainless steel plunger, 2.5 cm in diameter, was attached to the crosshead which moved at a speed of 0.5 cm/mim. The recorder chart speed was set at 5.0 cm/min and the zero load was set at the middle of the chart. The peanut butter samples were placed in a metal ring 5.5 x 2.5 cm (Diameter x Depth) and placed atop the load cell. The crosshead was set to move downward and penetrate the peanut butter sample for a distance of 0.4 cm. At the point of maximum penetration (point A in Fig. 1) the crosshead direction of travel was automatically reversed and the plunger was withdrawn at the same speed. Point B in Fig. 1 represents the moment where the plunger surface is in contact with the top surface of the sample. At this point also, a part of the peanut butter sample is still attached to the plunger surface. With continued withdrawal of the plunger, the food column stretches till it breaks at point D. Maximum force of withdrawal of the plunger from the sample occurs at point C and the area BCD represents the work necessary to remove the food sample from the plunger surface. The distance B-D could be converted to time since both the chart and crosshead were moving at similar speeds per unit time. This measurement might include mainly cohesive forces between the sample molecules and to a lesser degree the adhesive forces between the sample and the plunger. Results are expressed as maximum force (newtons, N) of withdrawal, maximum force per cm² of the plunger surface area, work necessary to remove sample from plunger surface (joule, J) and time (sec) required to break the peanut butter column.

B. Sensory spreadability Evaluation

A subjective evaluation of the case of spreadability of each peanut butter sample was determined by 20 panelist. Panelists spread peanut butter (20g) onto saltine crackers and used a scale of 1 (most difficult to spread) to 10 (easiest to spread) to evaluate spreadability. There were three replications and results are expressed as the average of 60 determinations.

Experimental Design - A 2 x 2 factorial design was used with two levels of peanut seed content (90%, 95%) and two levels of oil content (40% and 50%). Four replicates of each formulation and the commercially prepared peanut butters were made and responses to instrumental tests were duplicated. Statistical analyses included analysis of variance and student "t" (4). Each treatment combination value of the instrumental measurements represents the average of 8 determinations.

Results and Discussion

Oil contents of Florunner seed, pressed Florunner seed and Jamaican peanut butter were 50.1±0.3%, 39.9±0.2% and 40.3±0.4%, respectively. Oil content as well as peanut seed content of the peanut butter influenced the textural properties of the butter. The main effects, % oil and % peanut seed in peanut butter, as well as the interaction between the two main effects were significant at the 5% level of probability. Texture evaluation of peanut butter by the sensory spreadability method and the instrumental cone penetration test revealed a significant difference due to peanut seed content at the 40% oil content while no difference was found at the 50% oil content (Table 1). Increasing oil content from 40 to 50% resulted in significantly higher values for these methods of texture evaluation at each content of peanut seeds.

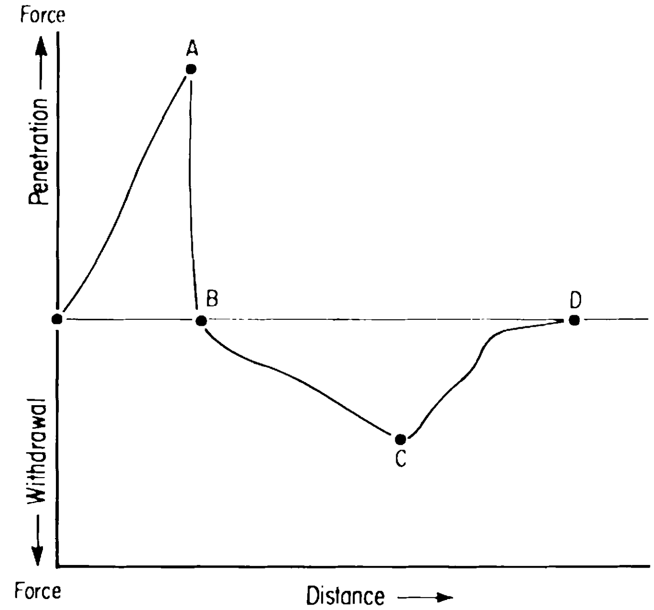

Fig. 1. Force-distance curve of peanut butter during plunger penetration and withdrawal cycles.

Table 1. Effect of oil and peanut seed contents (%) in peanut butter on the spreadability rating¹ and distance of travel by the cone penetrometer.

% Oil	% Peanut		
	Spreadability rating		
	90	95	Difference
40	1.55	3.30	1.75*
50	8.85	9.10	0.25 NS
Difference	7.30*	5.80*	
	Penetration distance (mm)		
40	19.5	24.4	4.9*
50	30.7	32.0	1.3 NS
Difference	11.2*	7.6*	

¹Rating: 1 = most difficult to spread, 10 = easiest to spread.

*Significance at $P \leq 0.05$

NS = not significant at $P \leq 0.05$

Adhesiveness measurements were selected according to the definition established by the General Foods Corporation Texture Profile (3,5). This definition defines adhesiveness as the force required to remove material that adheres to the mouth (generally the palate) during the masticatory process. The plunger used represented the palate (3) and the force required to remove the material from the plunger complies with this definition of adhesiveness. Since different investigators might use plungers with different surface areas, the displayed forces would be partially dependent on the plunger surface area used in addition to the physical property of the tested material. To obviate such a source of artifact, the maximum force was expressed also as maximum force (N) per unit area (1.0 cm^2) of the plunger surface. Peanut butters containing 50% oil exhibited lower maximum force and maximum force per cm^2 and higher values for work and time at both the 90 and 95% peanut seed content than those butters containing 40% oil (Table 2). These effects were more pronounced at the 95% level of peanut seed content than at the 90% level. However, variation in peanut seed content at the 40% oil content did not result in statistical differences for these instrumental measures of adhesiveness. The reverse was true for the butters containing the 50% oil. These results indicate that oil content of the peanut seeds influenced to larger extents the adhesiveness of peanut butter than peanut seed contents.

Table 2. Effect of oil and peanut seed content (%) on peanut butter textural quality.

% Oil	% Peanut		
	90	95	Difference
	Max Force[1] (N)		
40	0.747	0.852	0.105 NS
50	0.397	0.102	0.295*
Difference	0.350*	0.750*	
	Max Force (N/cm^2)		
40	0.153	0.174	0.021 NS
50	0.081	0.021	0.060*
Difference	0.072*	0.153*	
	Work (J)[2]		
40	54.1	56.3	2.2 NS
50	90.3	126.6	36.3*
	36.2*	70.3*	
	Time (sec)		
40	3.65	4.52	0.87 NS
50	6.58	7.59	1.01 *
Difference	2.93*	3.07*	

NS = not significant at $P \leq 0.05$

* = significant at $P \leq 0.05$

[1]plunger surface area = 4.89 cm^2

[2]joules x 10^{-5}

Data in Table 3 show that butter commercially prepared in the USA exhibited ease of spreadability values close to the experimental butter samples containing 50% oil (F_3 and F_4). Jamaica peanut butter spreadability value approximated that of the butter containing 40% oil (F_1 and F_2). Higher distance of travel of the cone penetrometer indicates softer test material. Peanut butter containing 50% oil (F_3 and F_4 and USA commercial samples A and C showed higher penetration values for the cone than commercial sample B and experimental butters containing 40% oil (F_1 and F_2. Unfortunately, due to lack of adequate supply of Jamaican peanut buter, this test was not conducted. Higher values for maximum force and maximum force per unit area of the plunger surface and lower values for spreadability, work and time required for butter column separation were reflected by Jamaican peanut butter and butter samples containing 40% oil in comparison to samples containing 50% oil and the USA commercial samples.

Table 3. Textural qualities of peanut butter prepared with different oil and peanut seed contents (%) and commercial peanut butters.

Factorial treatment[1]					Commercial			
					Jamaica	USA		
F_1	F_2	F_3	F_4			A	B	C
				Spreadability[2]				
1.55^{c}	3.30^{c}	8.85^{a}	9.10^{a}		2.09^{c}	8.90^{a}	7.82^{b}	8.18^{b}
				Cone Penetration distance (mm)				
19.5^{c}	24.4^{b}	30.7^{a}	32.0^{a}		IS	31.0^{a}	28.0^{b}	31.0^{a}
				Max Force (N)				
0.847^{a}	0.852^{a}	0.397^{b}	0.102^{c}		0.874^{a}	0.341^{b}	0.403^{b}	0.385^{b}
				Max Force (N/cm^2)				
0.153^{a}	0.174^{a}	0.081^{b}	0.021^{c}		0.179^{a}	0.070^{b}	0.082^{b}	0.079^{b}
				Work (J)[3]				
54.1^{d}	5.74^{d}	9.21^{b}	12.91^{a}		53.9^{d}	98.3^{b}	77.4^{c}	79.5^{c}
				Time (sec)				
3.65^{c}	4.52^{c}	6.58^{b}	7.59^{a}		3.46^{c}	6.67^{b}	6.33^{b}	5.83^{b}

[1]Oil/peanut %: F_1 = 40/90, F_2 = 40/95, F_3 = 50/90, F_4 = 50/95

[2]Rating scale: 1 = most difficult to spread
10 = easiest to spread

[3]joules x 10^{-5}

IS = Insufficient sample size to conduct this test

Means, within each row, followed by the same letter are not statistically different at $P \leq 0.05$

Conclusions

The textural quality of peanut butter was influenced by oil and peanut seed content. Undesirable textural qualities are due to low oil content. A possible improvement in the textural quality of Jamaican peanut butter could be accomplished either adding about 10% oil to the peanut seed mix prior to grinding or use peanut seed that contain 50% oil.

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