Peanut Butter Quality as Affected by Inclusion of Non-Fat Dry Milk Components

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ABSTRACT

Peanut butter is deficient in lysine, methionine, and threonine. Addition of 7.5% non-fat dry milk (NFDM) increases these amino acids 24.5, 15.0 and 11.0% respectively with a commercial peanut butter as a reference. Addition of hydrolyzed non-fat dry milk (HNFDM) resulted in similar increases for lysine and threonine but only a slight increase for methionine. The experimental peanut butter spreads had intensities for flavor characteristics similar to a commercial butter as a reference. The dry milk components lowered the textural properties. While the dry milk mixtures had acceptable textural properties, the commercial peanut butter was significantly higher in both adhesiveness and spreadability parameters.

Key Words: Peanut butter, peanut spread, non-fat dry milk, hydrolyzed non-fat dry milk, flavor, texture.

Peanut butter is a very popular food in the U. S. and is among the products distributed by the Department of Agriculture for school lunches. Peanut butter in the U. S. accounted for 323.5 million kg of peanuts in 1986 (15).

In the U.S., federal regulations require peanut butter to have a minimum of 90% peanuts and have a maximum permissible oil content of 55% (6). Stabilizers such as hydrogenated vegetable oils or mono and diglycerides from vegetable oils which are permitted in peanut butter are used to prevent oil separation during storage. The objectives of this investigation were: (a) to determine the effects of the inclusion of non-fat dry milk (NFDM) and hydrolyzed non-fat dry milk (HNFDM) on the quality of peanut butter, (b) to increase the quantity of several essential amino acids in which peanuts are deficient (3) and (c) to compare the quality of these experimental mixtures with commercial butter. Use of dry milk products in peanut butter would help reduce the large supply of NFDM that is produced in the U.S. This addition would also provide added nutrition to peanut butterlike products used in school lunches. Even though the peanut mixtures being reported (6) contained 90% or more of peanuts, addition of NFDM or HNFDM would make them spreads. HNFDM can be used in foods for people who are adversely affected by lactose, a sugar in milk products. Lactose in milk supplements requires lactase, an enzyme produced in the small intestines, to reduce it to a usable form of sugar, such as glucose. With a deficiency of lactase, milk may cause digestive tract distress such as cramps, flatulence and/or diarrhea (10).

Materials and Methods

The following materials were used for preparing peanut butter spreads (a) commercial Jumbo Runner peanuts (b) commercially prepared non-fat dry milk (NFDM) containing 49% lactose (c) commercially prepared hydrolyzed non-fat dry milk (HNFDM), 70+% hydrolyzed lactose (d) emulsifier (Durkee 07 partially hydrogenated cotton seed oil, Durkee Industrial Foods SCM Corp.) and (e) salt. A commercial peanut butter obtained within code date was used in these tests for comparison purposes.

Analytical Methods

Lipids in the peanut butters and spreads were determined by AOCS (1984) methods (5) and moisture by AOAC (1984) methods. Lipids in NFDM and HNFDM were determined by ADMI (1971) methods and moisture by drying 2-3g for 5 hours at 75 C under vacuum. Amino acids were determined by AOAC (1984) methods (4) by a commercial laboratory using a HPLC method (9).

Roasting Peanuts

Jumbo Runner peanuts were roasted in a Surface Combustion Dryer (11). Peanut lots weighting 2.27 kg were roasted with hot air at 65.2 meters/min at 162.8C for 13.5 minutes. In this procedure, the peanut lot was spread over a 929 cm^2 area, hot air was sent up through the peanuts for 6.75 min and the air direction then reversed down through the peanuts for 6.75 min. The peanuts were cooled with forced air and then passed through a split nut blancher to remove the skins and hearts.

Peanut Butter and Peanut Spread Preparation

A Cuisinart DLC-7 Superpro food processor equipped with the standard blade was used to grind the ingredients into peanut butter and peanut spreads (13). First the additives (non-fat dry milk, emulsifier and salt) were ground for 90 sec to produce particles which would disperse more unifromly. Then, the peanuts were ground for 5 sec, after which the additives were incorporated with the peanuts. The mixture of peanuts and additives (500 g) was ground for 8 min. The grinding was stopped at 30 sec intervals so that the peanut butter or spread cake could be broken up and the mixture formed on the perimeter of the food processor's grinding section could be moved toward the center to maintain uniformity of grinding. The mixtures after grinding reached a temperature of 43.3C. The mixture was then heated to 87.8 C in a water bath, poured into 0.237 liter (1/2 pint Mason) jars to a depth of 4.03 cm to yield a mixture having a color between 2 and 3, using USDA Color Guides for peanut butter (16). The 500 g mixture provided material for 4 jars. Four 500 g replicates were made for each mixture.

Sample mixtures prepared in jars were kept at 21.1 C for at least 3 days. Sample mixtures for adhesiveness tests were then evaluated on the Instron Texture Tester; then all sample mixtures were stored at -23.3 C until evaluated for flavor, spreadability and chemical analyses. Tests for texture, were made directly on mixtures in the Mason jar (5.87 cm diameter at the surface by 4.03 cm depth). Tests were conducted in this manner because removing a peanut butter or spread from a jar and placing it into a mold for tests changes its physical characteristics. For the same reason, tests on the commercial peanut butter were also made directly on peanut butter in the 0.514 kg (18 oz) jar in which it was packaged (6.60 cm diameter at surface).

Formulations of peanut butter with additives are shown in Table 1. A commercial peanut butter was used for comparative purposes. All peanut butters and spreads that were mixed contained 1.5% emulsifier and 1% salt. The basic butter had no added milk product. Exact composition of the commercial butter was not available. However it contained dextorse, salt and partially hydrogenated vegetable oil.

Table 1. Formulations of Peanut Butters and Spreads[1].

Component	Mixtures 1	2	3	4	Basic
Peanut,%	90.00	93.75	90.00	93.75	97.50
NFDM,%	7.50	3.75			
HNFDM,%			7.50	3.75	

[1] All butters and spreads contained 1.5% emulsifier and 1.0% salt.

Adhesiveness

Adhesiveness is defined as the force required to remove material that adheres to the mouth (palate) during mastication (2). An Instron machine

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was used to determine adhesiveness. With this machine the palate is represented by the plunger and instrumental adhesiveness is defined as the force required to remove the material from the plunger (2). Sensory adhesiveness on first compression is not affected by particle size, which is imitated by the instrumental method being reported (7, 8).

The adhesiveness values were determined by the method of Ahmed, and Ali with minor modifications (2). The Instron used was a Model TM equipped with a CBC Load Cell (0-2 kg range) as a texturometer. Ths cell used in conjunction with a cylindrical stainless steel probe (1.270 cm dia.) was found to be appropriate for taking the measurements. The probe was attached to the crosshead which moved 5 mm/min. The recorder chart was set for 20 mm/min with the zero load at the middle of the chart. The peanut butters and spread samples in half-pint jars were placed beneath the load cell. The probe was set to move downward and was stopped just before it touched the surface. The settings were checked and the probe was then allowed to penetrate the surface. The moment the recorder pen started to move upward the machine was reset so the the measurement of force began with the penetration of the sample. The probe was allowed to penetrate the sample for 4mm at 5mm/min and then automatically reversed at the same speed. Recording was stopped when the zero line of the recording chart was reached for the second time. Point A in Fig. 1, represents the point of maximum penetration - 4 mm from the surface of the mixture. Point B represents the instant that the probe surface is at the same level as the top surface of the sample. Point C represents the point where maximum force of withdrawal of mixture from the probe occurs. Point D represents the point at which the column of peanut butter or spread which clings both to the probe and to the mixture surface breaks. It is to be noted that at point B there is still some mixture clinging to the probe. As the probe is further withdrawn from the mixture surface, this clinging mixture forms a column which stretches until it breaks at point D. Area BCD represents the work of adhesiveness necessary to remove the mixture from the surface of the probe.

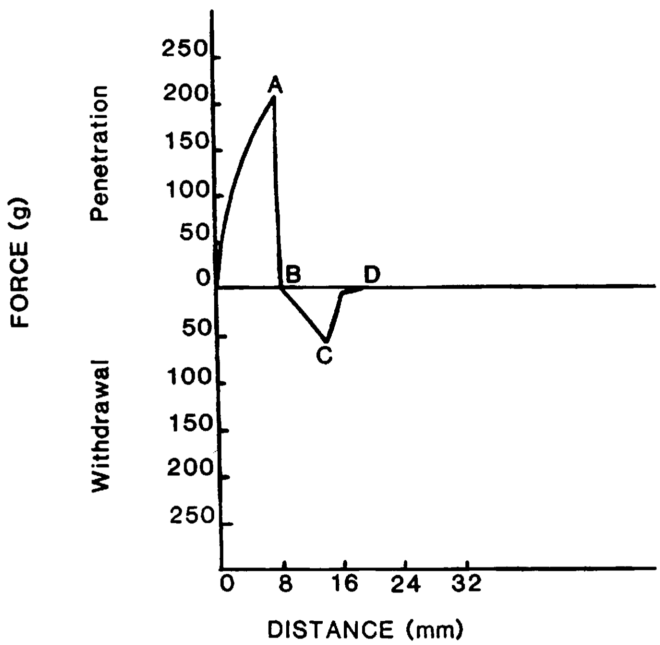

Fig. 1. Force distance curve for plunger penetration and withdrawal from peanut butter or spread.

Spreadability

Spreadability is the ease at which the sample (approximately 1/2 teaspoon is spread over the smooth side of a cracker (saltine) with one stroke of a knife or wooden spatula. Spreadability was determined on a continuous 1 to 14 (easiest to spread) point scale, 4 replicates and 5 panelists evaluating. Results were expressed as an average of 20 deteminations.

Flavor

The peanut butters and spreads were evaluated by a panel of 10 persons using the following descriptors: roasted peanutty, raw/beany/green, dark roasted, sweet aromatic, woody/hulls/skins, cardboardy, painty, sweet, sour, bitter, salty, astringent, and fermented/fruity (11, 13). A Universal Food Scale of 0 to 15 or higher was used for intensity evaluations of each descriptor (12). Four replications were made and results were expressed as average of 40 determinations.

Experimental Design

An analysis of variance was performed using a completely randomized design and fixed effects (14). In addition, four linear contrasts were performed: 1) commercial sample vs. all other levels, 2) basic vs the experimental levels (NFDM comprising 3.75 and 7.50%, of the mixture and HNFDM comprising 3.75% and 7.50% of the mixture), 3) hydrolyzed vs. non-hydrolyzed levels, and 4) 3.75% vs. 7.5% of levels.

Results and Discussion

Moisture and lipids contents of the peanut butters and spreads and NFDM and HNFDM are shown in Table 2. Addition of NFDM and HNFDM to the basic peanut butter resulted in lower lipid content.

Table 2. Analyses of Peanut Butter and Spread Products.

Description	Moisture (%)	Lipids (%)
NFDM	2.6	0.79
HNFDM	2.0	0.55
Commercial P/N Butter	1.2	51.58
Basic P/N Butter	1.3	51.55
P/N Spread, 7.5% HNFDM	1.6	47.54
P/N Spread, 7.5% NFDM	1.4	48.57
P/N Spread, 3.75% HNFDM	1.4	50.48
P/N Spread, 3.75% NFDM	1.2	50.05

Flavor

The peanut spreads with HNFDM were slightly sweeter but the difference was not found significant. All experimental peanut butters and spreads had intensities for flavor characteristics similar to the commercial peanut butter as a reference.

As shown in Table 3 the formulated peanut spreads were not significantly different. in al attributes except roasted peanutty ($p \geq .05$), painty ($p \geq .01$), and fermented/fruity ($p \geq .05$), the commercial product was not significantly different from the basic butter and formulated spreads. In these attributes the roasted peanutty was higher and the painty was lower in the basic and formulated spreads than in the commercial butter. Fermented/fruity was highest in the commercial and lowest in the basic and the 3.75% HNFDM; the 3.75% and 7.5% NFDM and 7.5% HNFDM were not significantly different from the others.

Grouping the hydrolyzed spreads together and the unhydrolyzed spreads together and comparing the two groups resulted in no significant differences between the two groups (this did not include the commercial). Grouping the 7.5%

Table 3. Mean Flavor Properties of Peanut Butter and Spreads[1].

Descriptors	Means					
			NFDM		HNFDM	
	Commercial	Basic	7.5%	3.75%	7.5%	3.75%
Roasted peanutty	4.11^{b}	4.78^{a}	4.55^{a}	4.72^{a}	4.62^{a}	4.77^{a}
Raw/beany/green	1.83	1.79	1.92	1.81	1.77	1.78
Dark roasted	2.19	2.39	2.30	2.50	2.45	2.35
Sweet aromatic	2.88	2.76	2.74	2.75	2.77	2.93
Woody/hulls/skins	1.84	2.15	2.11	2.15	2.04	1.94
Cardboardy	0.53	0.48	0.46	0.36	0.30	0.27
Painty	0.58^{a}	0.14^{b}	0.07^{b}	0.07^{b}	0.16^{b}	0.10^{b}
Sweet	2.47	2.27	2.30	2.33	2.48	2.44
Sour	1.23	1.13	1.16	1.12	1.17	1.17
Bitter	1.80	1.65	1.75	1.71	1.67	1.66
Salty	2.53	2.66	2.94	2.91	3.04	2.85
Astringent	2.15	2.18	2.34	2.35	2.20	2.17
Fermented/fruity	0.53^{a}	0.15^{b}	0.29^{ab}	0.29^{ab}	0.36^{ab}	0.18^{b}

[1/] Means within each row followed by the same letter (a, b) are not statistically different.

NFDM and 7.5% HNFDM and the 3.75% NFDM and 3.75% HNFDM also resulted in the two groups not being significantly different.

Texture

The results for force of adhesiveness and work of adhesiveness were essentially identical. Therefore statistical discussion is limited to work of adhesiveness and spreadability. For work of adhesiveness and spreadability the means of the various treatment levels are shown in Table 4.

Table 4. Mean Textural Properties of Peanut Butter and Spreads[1,2].

Component	Spreadability	Adhesiveness			
		Force[3] Max (N)[4]	Force Max (N/cm²)	Work (J)[5]x10⁶	Time (sec)
Commercial	11.05 a	0.943 a	0.743	761 a	53
Basic	9.45 b	0.364 c,d	0.286	443 c,d	81
7.5%NFDM	7.65 d,e	0.466 b,c	0.367	544 b	77
3.75%NFDM	8.50 c	0.430 b,c,d	0.338	493 b,c,d	76
7.5%HNFDM	7.30 d,e	0.533 b	0.420	525 b,c	83
3.75%HNFDM	8.05 c,d	0.339 d	0.267	424 d	85

[1] Average of 4 replicates
[2] Means within each column followed by the same letter (a, b, c, d) are not statistically different at $p \leq 0.05$
[3] Plunger surface area = 1.270cm²
[4] Newtons
[5] Joules

The commercial peanut butter was significantly higher in both work of adhesiveness and spreadability than that of all the other treatment levels. The Basic peanut butter was lower in work of adhesiveness (except for 3.75% HNFDM) and higher in spredability than the other experimental levels. Contrast indicated NFDM did not differ from HNFDM for either dependent variable. However, the 3.75% level was significantly lower than the 7.50% level in work of adhesiveness (458.6 vs 534.2) and higher than the 7.5% level in spreadability (8.27 vs 7.48). Some peanut butters were low (Basic 443) in work of adhesiveness and high in spreadability (Basic 9.45) and others high (Commerical 761) in work of adhesiveness and high (Commercial 11.05) in spreadability. Additional investigation needs to be done in this area including the use of sensory adhesiveness. Mouth feel of the peanut butters and spread mixtures showed no grittiness.

Table 5. Amino Acid Analyses.

Description	Threonine mg/g	Methionine mg/g	Lysine mg/g
NFDM	16.30	8.19	30.30
HNFDM	15.90	8.68	24.00
Commercial Peanut Butter	7.42	2.65	8.94
Basic Peanut Butter	7.73	2.70	9.24
Peanut Spread, 7.5% NFDM	8.24	3.31	10.30
Peanut Spread, 7.5% HNFDM	8.67	2.79	10.50

Amino Acids

Peanuts are low in lysine, methionine and threonine (3). Table 5 shows typical analyses of these amino acids, the two milk products, and for peanut spread mixtures containing 7.5% non-fat dry milk. Data show that addition of the dry milk products increased the contents of lysine, threonine and merthionine as compared to the commercial peanut butter. For mixtures containing 7.5% NFDM, increases for methionine, lysine and threonine were 24.5, 15.0 and 11.0% respectively. The addition of HNFDM resulted in similar increases for lysine and threonine but only a slight increase for methionine.

Calculations were made to show what the increases in amino acids would be if the 7.5% NFDM peanut spread mixture were compared to a peanut butter containing suffucient Basic peanut butter that has 90% peanuts instead of 97.5%. The additional 10% would be sugars, oil, salt, etc. as in commercial peanut butters. The increases would be 32.9, 21.8 and 15.6% for methionine, lysine and threonine respectively.

Conclusion

Peanut spreads prepared with NFDM or HNFDM had flavor properties that were comparable to commercial peanut butter. Textural properties were acceptable, however work of adhesiveness and spreadibility were significantly lower in spreads with added NFDM or HNFDM than the commercial peanut butter. For NFDM and HNFDM when the amounts in the spreads increased from 3.75 to 7.5% the spreadibility decreased and the work of adhesiveness increased. Addition of non-fat dry milk products increased the amounts of amino acids - methionine, lysine and threonine.

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