Peanut Science (1981) 8, 31-35

Quality of Cooked Ground Beef Extended with Defatted Peanut Meal[1]

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ABSTRACT

Beef chuck and plate cuts obtained from U.S.D.A. utility grade carcass were mixed and ground through a 0.318 cm plate. The ground meat was extended with extruded and non-extruded defatted peanut meal. Hydrated defatted peanut meal was added at the rate of 20 and 30 parts to 80 and 70 parts of the ground meat, respectively. All treatments were formulated to contain 20% fat in the final patty and loaf products. Extruded and non-extruded meat products were stored at -18 C for periods up to 6 weeks. All quality evaluations were conducted on cooked meat products.

Ground meat patties and loaves extended with non-extruded peanut meal exhibited similar cooking losses to those either extended with extruded peanut meal or 100% beef products. Control meat products stored for 4 weeks or longer required larger forces to shear than the non-stored patties. Freezing storage of the extended meat products did not result in a change of shearing forces. These forces were similar to the shearing force exhibited by freshly prepared products. Trained sensory panelists indicated that extended meat patties were more tender and less cohesive than non-extended patties. However, sensory acceptability tests indicated similar acceptability ratings for the extended and non-extended meat patties and loaves.

Key Words: Peanut meal, Extended ground meat, Sensory quality, Peanut:ground meat mixtures.

The use of plant proteins as extenders to comminuted meat products has been increasing steadily due to the relatively high cost of animal protein and to the approval by the Food and Nutrition Service of the U.S. Department of Agriculture for their inclusion in the School Lunch Program (16). Butz (2) reported that about 2 million kg of rehydrated plant protein were used in the School Lunch Program in 1972-1973. The major plant protein used was soybean protein. The 1985 market projections for total edible textured soybean protein, on a dry weight basis, are 95.2 million kg for the School Lunch Program, 958 million kg as extruded products and 1080 million kg as spun fibers (17). The average projected price is $0.88/kg for the extruded protein and $1.98/kg for the spun fibers (7). Peanut protein was used to extend meat products without adverse effects (4, 11, 12) and thus it could have a role in sharing the projected markets of soybean protein.

Considerable interest in determining the nutritional values of ground meat:soy protein mixtures was developed. Addition of textured soy protein to ground meat, at a 30% level, resulted in a mixture exceeding the nutritional value of casein (17). Rat feeding studies using cooked extended ground beef patties of loaves (80 meat:20 soy protein) showed a protein efficiency ratio (PER) of 3.1 at 10% protein level in the diet. Increasing the soy protein amount to 30% resulted in a PER value of 3.0. Percentages of adult requirements of essential amino acids found in 45 g protein from beef or beef:soy mixture (70:30) far exceeded the U.S. recommended daily allowance for adults and were similar for these two types of food systems (17).

The most important factor affecting the addition of soybean or plant protein is consumer acceptance of the animal protein:plant protein mixtures. Consumer acceptance and palatability of these mixtures are dependent on the amount of plant protein added and its effect on the appearance of the uncooked product and on the texture and flavor of the cooked product. Meat patties containing 25 to 50% textured soybean protein (TSP) received low appearance scores due to the color of the soy:meat mixture; light tan mixed with red meat color (13). Appearance scores decreased as the amount of TSP increased. Addition of soybean protein resulted in increased tenderness of the beef patties (6,8,11,12,13,15). Soybean products impart an off-flavor to other food systems, described mainly as "beany" or "cereal-like". Beef patties containing 0 to 50% TSP received lower sensory flavor scores as the amount of TSP was increased (13). The addition of food ingredients or spices strong enough to mask this off-flavor might result in consumer acceptance of TSP:meat food mixtures.

Limited work has been conducted on the effects of peanut protein addition to comminuted meats. McWatters (11) and McWatters and Heaton (12) used defatted and moist heated peanut and soybean meals to extend ground beef patties. These authors found that the extended patties were less cohesive and required less force to compress and shear than the nonextended beef patties. Similar sensory qualities of appearance, color, texture and flavor were obtained for the peanut and the soybean meal extended patties. Peanut-extended patties exhibited better aroma than the soybean-extended patties (11). The aroma and flavor of ground beef patties extended with 5% moist-heated peanut or soybean meal were similar to 100% ground beef patties (12). The addition of these meals at concentrations greater than 5% caused adverse changes in sensory quality of the extended ground beef patties (11,12). However, Kotula et al. (9) and Twigg et al. (15) found that ground beef patties extended with 20 and 30% TSP received similar sensory quality ratings to those of 100% beef patties.

The objective of this study was to determine the quality attributes of ground beef extended with 20 or 30% additions of hydrated defatted peanut meal and extruded peanut meal.

Materials and Methods

Materials

Defatted peanut meal (PM) was donated by Goldkist Research Center, Lithonia, GA. 'Binasol' starch was donated by A. D. Staley Manu-

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facturing Company, Decatur, IL. The ground beef meat was obtained from the Meats Laboratory, Animal Science Department, University of Florida, Gainesville, FL. Other food ingredients were purchased from local supermarkets in Gainesville, FL.

Extrusion

Distilled water and soybean oil were added to PM to obtain final contents of 30% moisture and 4% oil. The modified PM was extruded using the Wenger X-5 extruder, Wenger Manufacturing Company, Sabetha, KS. The extruder's screw and feed speeds and air pressure were controlled to produce two different stages of extrusion; a well extruded (WE) and a poorly extruded (PE) product. Conditions for the WE product were screw and feed speeds of 600 and 40 rpm, respectively, and air pressure of 689 KPa. Corresponding values for the PE product were 540 and 15 rpm and 345 KPa. Temperature of the peanut meal just prior to extrusion were 149 and 132 C for the WE and PE materials, respectively. The extruded materials were dried at 80 C for 6 hours. The physical dimensions for the extruded materials and for the defatted PM are shown in Table 1. The WE product has about twice the diameter and less than one-half the density of the PE product. The PM is characterized by small size particles and is much denser than the extruded material.

Table 1. Physical dimensions of peanut products.

Product	Diameter (mm)	Density (g/ml)
PM	0.39-1.27	0.789
WE	8.69	0.073
PE	4.87	0.175

Product Formulation

PM and the extruded materials were hydrated prior to mixing with the ground beef. PM and water at the ratio of 1:2 (w/w) were steamed at 35 KPa for 30 minutes. WE and PE material were cut into pieces about 1.0 cm long and covered with water (24 C) to hydrate for 15 minutes. The moisture contents of the hydrated PM, WE and PE were 70.0, 64.3 and 60.0% while that of the ground meat was 61%. Beef chuck (lean) and plate (fat) cuts, both obtained from a USDA Utility grade carcass, were ground through a 1.3 mc plate using a Hobart Mixer-Grinder model GMC 150. The hydrated peanut material was added, mixed with the ground beef by hand for one minute, then reground through a 0.318 cm plate. Hydrated peanut products were added in amounts ranging from 20 to 30% w/w. Fat content of the meat blocks was determined by the modified Babcock procedure. All treatments were formulated to contain 20% fat in the final ground meat:peanut product mixtures. The mixture was shaped either into 9.5 cm in diameter patties weighing 85 g using the Hollymatic 200 patty machine, or into a loaf weighing about 450 g. Binasol starch (12.3 g), egg whites (23.2 g); Lipton onion soup mix (42.6 g), Monosodium glutamate (3.6 g) and non-fat dry milk solids (50.8 g) were added prior to shaping into a loaf. Each patty or loaf was packaged in a freezer wrap and stored at -18 C for periods up to 6 weeks. The patty mixture was composed of 80% ground meat:20% hydrated peanut product while the loaves contained either 20% or 30% hydrated peanut product to 80% or 70% of the ground meat.

The patties were subjected to quality evaluations immediately after preparations and after 4 weeks of freezer storage. The loaf product was evaluated at 0, 2, 4 and 6 weeks of frozen storage.

Cooking Method

Frozen patties were thawed at 4 C for one hour and cooked on an electric Farberware broiler, model 450 A, for 7½ minutes on one side and 6½ minutes on the other side. Frozen loaves were thawed at 4 C overnight and cooked at 188 C for 75 minutes in a conventional household electric oven.

Quality Objective Measurements

All quality measurements were determined on cooked products. Thaw and cooking losses were determined by weighing samples before and after thawing or cooking. Color of the top side of the cooked patties was evaluated by reflectance colorimetry using the Hunter Color Difference Meter model 25 D-2 with an "M" optical sensor and a white standard with color parameters of L = 92.2, a = -1.1, b = +0.4. Hue angle (0) and saturation index (S.I.) were calculated from Hunter Color values (L, a, b) according to the method outlined by Little (1975).

Texture was determined using the Instron model TM equipped with a single blade shear attachment (5). A 3 x 3 x 0.7 cm sample was prepared from each patty or loaf, cooled to room temperature, and was sheared by the single blade. Maximum force of shearing the sample was considered the shearing force. Instron measurements are expressed in g or kg and are the average of 3 replications. Each replication was comprised of 10 observations.

Quality Sensory Assessment

Trained Panel. An eight member trained sensory panel (1,3) evaluated samples from each formulation at each of three sessions. The parameters evaluated were: flavor (4 = no off-flavor, 1 = extreme off-flavor); juiciness (8 = extremely juicy, 1 = extremely dry); tenderness (8 = extremely tender, 1 = extremely tough); connective tissue amount (8 = none, 1 = abundant) and cohesiveness (8 = extremely cohesive, 1 = extremely uncohesive).

Acceptance Panel. Patty and loaf samples were presented to a small size untrained panel. Panelists represented both sexes and ranged in age from 20 to 60 years. Samples were presented as commonly consumed, i.e. patties were presented in a bun with the choice of ketchup, mustard, onion, lettuce and a pickle, and loaf samples were presented as a sandwich, using a firm rye bread and ketchup. Panelists were requested to score their acceptance on a scale ranging from 1 for extrememly unacceptable to 9 for extremely acceptable. There were 2 replications with 20 and 13 individual judgments per replicate for the patty and loaf type products, respectively. Results are expressed as the mean of all judgments within any one treatment.

Statistical Analysis. Appropriate statistical techniques were employed to determine if the differences among treatment means were significant (14).

Results and Discussion

The use of defatted plant proteins as extenders to ground meat results in lowering the fat content of the uncooked mixture. However, this does not occur in the cooked product since plant proteins are capable of retaining fat and moisture. Thus cooking losses are expected to be lower for the ground meat:plant protein mixture than for 100% ground meat. This was found to be true for 30% soy substituted ground beef, but not for pork and turkey meat loaves (18). However, in the present study, addition of peanut meal or extruded peanut meal to ground beef patties did not result in reducing thaw losses or cooking losses (Table 2). This is in accordance with the conclusion

Table 2. Cooking and thaw losses (%) of fresh and stored patties at -18 C[1].

Treatment[2]	0 wk	4 wks	
	Cooking	Thaw	Cooking
Control	32.7a	5.9a	30.9a
PM	29.4a	3.4a	28.4a
WE	31.1a	6.5a	30.1a
PE	28.1a	6.3a	29.0a

[1]Means within each column followed by the same letter are not statistically different at the 95% level of probability.

[2]Control = 100% ground beef, PM = peanut meal (20%), WE = well extruded peanut meal (20%), PE = poorly extruded peanut meal (20%).

that cooked ground meat patties extended with 5% heated peanut meal contained as much moisture and fat as the all-beef controls (12).

Color

Most noticeable changes in color of the cooked patties were reflected in L (lightness), b (yellowness) and hue angle. Extended patties were lighter in color, had more yellow coloration and the hue angle was shifted more toward yellow than the 100% ground beef patties (Table 3). The relatively low values of the saturation index indicate the absence of chromatic colors of the cooked patties. Differences in color were limited to degree of lightness of the cooked products.

Table 3. Color[1] of top surface of patties cooked after storage at -18 C for 4 weeks.

Treatment[2]	Color Parameter (±s.d.)				
	L	a	b	Θ	S.I.
Control	33.7c	5.2a	7.7b	54.4b	8.9b
PM	37.6b	4.8a	10.2a	64.5a	11.3a
WE	35.9b	5.3a	9.7a	62.0a	11.0a
PE	40.1a	4.3b	10.3a	67.0a	11.0a

[1]Means within each column followed by the same letter are not statistically different at the 95% level of probability.

[2]Same as in Table 2.

Texture

Texture of meat and comminuted meat products is the prime quality factor affecting their acceptance by the consumer, with the preference being for tender products. Cross et al. (5) developed a single-blade shear attachment to the Instron to measure the degree of tenderness or toughness of ground beef. The maximum shear force, using this attachment, correlated with the subjective panel evaluation of amount of connective tissue (-0.92) and tenderness (-.88) of ground beef patties. The use of such an attachment to evaluate the texture of ground beef patties and loaves in the present study showed no differences in textural quality of the freshly prepared and the stored meat products (Tables 4, 5). However, patties and loaves formulated from 100% ground meat showed higher shear forces than the extended patties. Statistical analyses indicated that treatment x storage duration at -18 C interactions were significant at the 95% level of probability for both patties and loaves (Tables 4, 5). This was due to the different trends in changes in shearing forces upon storage of meat products (Tables 4, 5). Patties and loaves formulated with 100% ground meat required larger forces to shear while those for the extended products did not show any changes or required slightly smaller forces to shear. Method of extrusion of peanut meal did not influence the textural quality of the extended patties and loaves upon storage. Resistance to shearing forces were similar for the WE, PE and PM meat products (Tables 4, 5).

Table 4. Mean maximum shear force (g) of stored and non-stored patties[1].

Treatment[2]	Wks at -18 C		
	0	4	mean
Control	3965	5964	4965
PM	3320	2519	2920
WE	3460	3564	3512
PE	3780	3357	3568
Mean	3631	3851	

[1]Treatment x storage duration interaction was statistically significant at the 95% level of probability.

[2]Same as in Table 2.

Table 5. Mean maximum shear force (g) of stored an non-stored meat loaves[1].

Treatment[2]	Wks at -18 C				
	0	2	4	6	mean
Control	536.7	708.3	1375.0	1466.7	845.8
20% WE	453.3	550.0	416.7	326.7	436.7
30% WE	375.0	466.7	333.3	316.7	372.9
20% PM	400.0	396.7	383.3	400.0	395.0
30% PM	450.0	316.7	433.3	375.0	393.7
Mean	435.7	487.7	588.3	577.0	

[1]Treatment x storage duration interaction was statistically significant at the 95% level of probability.

[2]Control = 100% ground meat, WE = well extruded peanut meal, PM = non extruded peanut meal.

Sensory Quality Assessment

No differences were found in the sensory quality attributes, as judged by the trained panel, for the freshly prepared and cooked all beef or beef:peanut mixtures (Table 6). All products received good ratings for tenderness, but borderline in juiciness and cohesiveness. However, following frozen storage for 4 weeks, the trained sensory panel detected a greater amount of "off-flavor" in patties containing PM and PE than the control patties (Table 6). This "off-flavor" was described as a "nutty" flavor. Patties containing PM and PE were less juicy than all-beef patties. The inclusion of extruded or non-extruded peanut products in the formulation of beef patties resulted in patties that were more tender, more cohesive and had less detectable connective tissue than the 100% ground beef patties (Table 6). Since this increased toughness was detected by both the panel and by instrumental shear measurement, control patties appeared to have undergone a change during frozen storage that increased the bind of particles, thereby increasing particle cohesion and reducing tenderness. Numerous investigators have indicated that addition of plant proteins increased the tenderness of ground beef (4,5,8,9,11,12,15). It was assumed that the change in tenderness resulting from addition of plant proteins was caused by the dilution of myofibrillar and stromal proteins. However, the results of the present study suggest that patties with peanut protein added (extruded on non-extruded) do not undergo the toughening during frozen storage that was evident for the 100% beef patties

Table 6. Trained sensory panel scores[1] for patties cooked after storage at -18 C for 0 and 4 weeks.

Treatment[2]	Sensory Parameter				
	Off-flavor	Juiciness	Tenderness	Connective Tissue	Cohesiveness
			0 week storage		
Control	3.8a	5.0b	6.4c	5.8d	5.0e
PM	3.6a	4.8b	6.7c	5.9d	4.5e
WE	3.5a	4.8b	6.7c	5.8d	4.5e
PE	3.6a	4.9b	6.4d	5.8d	5.1e
			4 weeks storage		
Control	3.9f	5.4h	5.6j	5.01	6.3n
PM	3.6g	4.6i	6.7k	6.1m	5.5o
WE	3.7fg	4.8hi	6.8k	6.2m	5.3o
PE	3.5g	4.6i	6.8k	6.2m	5.1o

[1]Means, within each column of each storage period, followed by the same letter are not statistically different at the 95% probability level. Sensory rating scales: Off-flavor; 1 = extremely off-flavor, 4 = no off-flavor; Juiciness; 1 = extremely dry, 8 = extremely juicy; Tenderness; 1 = extremely tough, 8 = extremely tender; Connective tissue; 1 = abundant, 8 = none; Cohesiveness; 1 = extremely uncohesive, 8 = extremely cohesive.

[2]Same as in Table 2.

(Tables 4, 5).

Patties presented to the trained panelists were plain, without any condiments. The panelists detected the off-flavor contributed by the peanut products and differences in tenderness (Table 6). However, presentation of the patties with condiments and in a manner that is commonly consumed may mask this off-flavor and differences in tenderness. Acceptability ratings by the non-trained panelists showed no differences among the all ground beef and the peanut- extended patties (Table 7) or loaves (Table 8). Several quality parameters are involved in a panelist's decision for an acceptability rating: flavor, absence of off-flavor, tenderness, juiciness, amount of connective tissue present and cohesion. The rather small differences detected by the trained panelists (Table 6) were not evident to the acceptability panelists due to the use of condiments. Similar results were found for beef patties extended with TSP. Kotula et al. (9) found that condiments improved the sensory ratings of TSP-extended beef patties for the parameters of flavor, aroma, tenderness and overall acceptability over the ratings of the same patties served without condiments. Twigg et al. (15) used family-type consumer testing (where families cook and serve patties with condiments as commonly used at home) to evaluate the sensory quality of TSP-extended beef patties. Families could not discern any differences between the 100% ground beef patties and the 20-30% TSP extended patties in flavor, appearance, aroma and overall acceptability.

The use of moist heat in hydrating the peanut meal or in extruding the peanut meal for extending the ground meat may have contributed to the high sensory acceptability scores obtained in the present study. This is substantiated by the findings that panelists consistently rated ground beef patties containing moist-heated peanut meal as similar in aroma and flavor to the all-beef controls (12).

Table 7. Sensory acceptance ratings[1] of patties cooked after storage at -18 C for 0 and 4 weeks.

Treatment[2]	Wks storage	
	0	4
Control	7.4	7.6
PM	7.2	7.5
WE	7.1	7.1
PE	7.0	7.2

[1]Rating scale: 9 = extremely acceptable, 1 = extremely unacceptable.

[2]Same as in Table 2.

Table 8. Sensory acceptance ratings[1] of loaves cooked after storage at -18 C for 0, 2, 4, and 6 weeks.

Treatment[2]	Wks storage			
	0	2	4	6
Control	7.7	7.8	7.5	7.8
20% PM	7.5	7.2	7.2	7.2
30% PM	6.9	7.1	6.8	7.3
20% WE	7.1	7.5	7.4	7.1
30% WE	6.7	7.2	7.3	7.1

[1]Rating scale: 9 = extremely acceptable and 1 = extremely unacceptable.

[2]Control = 100% ground beef, PM = peanut meal, WE = well extruded peanut meal.

The results of the present study indicate that moist heated peanut meal or extruded peanut meal could be used to extend 20% fat ground beef at the 20 and 30% levels without any adverse effects on sensory quality or acceptability. Since no differences were found between the extruded and non-extruded peanut meal, it seems that it would be more economical to use the moist heated peanut meal to extend ground beef. The limiting factor in using peanut meal is the color of the uncooked peanut meal:ground meat mixture; it does not possess the common red color of ground meat. The color of the cooked product is slightly lighter than the 100% ground beef product. These differences in color of the raw and cooked products could be overcome by consumer education, advertising and lower prices for the extended products.

Acknowledgements

The financial assistance of the Florida Peanut Growers Association is greatly appreciated. The technical help of Mrs. Mary R. Heisler is appreciated.

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Accepted February 19, 1981