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BEEF PATTIES: THE EFFECT OF TEXTURED SOY PROTEIN AND FAT LEVELS ON QUALITY AND ACCEPTABILITY

INTRODUCTION

THE USE OF textured soy protein (TSP) products to extend, and thus reduce the cost of ground beef patties has become widespread, but the acceptance of these products has been variable. The Food and Nutrition Service (USDA) has approved the use of TSP in the school lunch program. Many manufacturers of meat patties use these extenders in school lunch patties but not in the patties sold directly to the consumer. Robinson (1972) reported that 71% of all persons questioned were prejudiced against meat analogs, but this figure was reduced to 58% after exposure to good meat analogs.

Judge et al. (1974) suggested that cook shrinkage (decrease in patty diameter) is one of the criteria of ground beef quality, and reported that soya additives substantially reduced shrinkage in samples containing 20 and 30% fat. Anderson and Lind (1974) found that retention of water and retention of fat was directly proportional to the amount of TSP in ground beef. Nollman and Pratt (1972) found that the addition of 2% TSP to meat loaves had no effect in total cooking loss or individual influence on moisture or fat retention. Wolf (1970) indicated that TSP added to meat loaves increased moisture retention.

Law et al. (1971) reported that consumers preferred ground beef with the relatively low fat content of 15–20% and that moisture content varied inversely with the fat content. As the fat content of ground beef was increased the amount of fat lost in cooking increased; however, high total weight losses consisted mainly of moisture. Kaiser et al. (1970) found that fat content had no influence on consumer acceptance of cooked ground beef. In contrast to the findings of Law et al. (1971), Cole et al. (1960) reported that laboratory and family taste panels rated ground beef with 15% fat less acceptable than ground beef with 25, 35 and 45% fat.

This study was initiated to determine if a synergistic effect existed between fat and TSP levels that would: (1) optimize the quality and acceptability of ground beef containing TSP and (2) affect the fat analysis as determined by either heat or solvent extraction.

EXPERIMENTAL

USDA CHOICE TOP ROUNDS, 7–10 days postmortem, were obtained from a commercial source along with cod and kidney fat. A 2^4 factorial design was used that consisted of four fat levels (15, 20, 25 and 30% by raw weight of patties) plus four levels (0, 15, 20 and 25% by raw weight of patties) of Archer Daniels Midland Co. Minced 180 textured soy protein (TSP). Levels of TSP added were calculated on a wet weight basis; moisture content of the hydrated form was 65% in all instances (USDA, FNS Notice 219).

The rounds were trimmed of cover fat and cut into strips about 5 cm thick. A 1.27 cm plate was used to grind the meat and fat separately. Prior to fat and TSP addition to the lean ground beef, the fat content of the lean ground beef was determined using a Hobart Fat Percent Indicator described by Bellis et al. (1967). Ground beef, textured vegetable protein and fat in the proper amounts were combined on a wt/wt basis into the 16 treatments. Each treatment (4.54 kg) was mixed for 3 min in a Hobart Mixer (Model No. H-600-T) to insure thorough blending of the ingredients. After mixing, each treatment was ground through a 0.3 cm plate. A Hollymatic Food Portioning machine (Model 54) was used to produce patties 7.6 cm in diameter, 1.27 cm thick and approximately 71g ± 0.3g in weight. The patties were wrapped in freezer-paper, frozen at −23.3°C and stored at −17.8°C until analysis.

Total cooking loss of the patties was determined by weight difference. Moisture content of raw and cooked patties was determined by placing the samples in a 70°C oven with 507 mm of vacuum for 24 hr. Fat content of the raw patties was determined by a Hobart Fat Percent Indicator, and of the raw and cooked patties by the Soxhlet extraction method.

Sensory quality evaluations were performed with a screened and trained panel of 12–14 members. Eight sessions were required, and four samples of one-third of a patty each were served at each session. In four of the sessions, one of the four fat levels was held constant and TSP varied; in the other four sessions the procedure was reversed. All test samples were evaluated on a nine-point descriptive quality rating scale ranging from 9 = Excellent, 5 = Fair and 1 = Extremely Poor. Five general attributes of quality were rated in this order: color, odor, flavor, texture and appearance. Samples were served in balanced random order. The frozen patties were grilled 5 min per side in an electric frypan calibrated to an average surface temperature of 176°C. They were held warm (about 63°C) until served. Water and unsalted crackers were used between samples to reduce flavor carryover.

For sensory acceptance evaluation, 32 consumer judges were selected at random from a roster of 500 Natick Labs staff volunteers. The nine-category Hedonic Scale was used to rate flavor and texture separately. Samples were presented one at a time to judges seated at a partitioned counter. Judges were provided with a standard instructional set describing the Hedonic method and were advised upon entering the laboratory that they were to "rate flavor and texture of grilled beef patties." Optional salt in portion-control packets was offered with each sample (one-half patty).

RESULTS & DISCUSSION

TABLE 1 indicates that as the amount of fat was reduced, total cooking losses were also reduced; as the amount of TSP was increased total cooking losses decreased. A significant increase in cooking loss due to fat content was found, and the largest reduction (2.5g) occurred between 25 and 20% fat. Another significant reduction (1.7g) occurred between 20 and 15% fat.

Table 1—Total cooking loss in grams for ground beef patties (71g ea) with added increments of textured vegetable protein and fat[a]

Amount of fat (%)	Amount of TSP (%)				$\bar{X}$ for effect of fat
	0	15	20	25	
30	20.95	19.32	18.43	13.36	18.01a
25	21.16	16.40	16.97	14.97	17.28a
20	17.00	14.66	14.50	12.97	14.78b
15	16.57	11.66	11.80	12.12	13.04c
$\bar{X}$ for effect of TSP	18.92a	15.51b	15.42b	13.26c	

[a] Values followed by the same letter in columns or rows did not differ significantly from each other at $P > 0.95$.

As the amount of TSP was increased, total cooking loss was significantly reduced. Patties containing no TSP had a total mean cooking loss of 18.92g and this figure was significantly reduced by the addition of 15% TSP. Increasing the level of TSP to 25% resulted in further significant reduction in total cooking losses.

As shown in Table 2, the amount of TSP incorporated into ground beef had no effect on fat losses. As the amount of TSP increased from 0 to 25% no binding effect of TSP on fat content was observed. The amount of fat lost during cooking depended upon the level of fat originally incorporated into the raw ground beef patties before cooking.

As the amount of fat in ground beef was increased from 15 to 30%, an increase in fat losses occurred during cooking, but the only significant change in fat loss was between the 15% and 30% fat levels.

Moisture losses during cooking of ground beef containing selected levels of fat and TSP are presented in Table 3. The initial amount of fat in raw ground beef patties had no significant influence on the final moisture content of the cooked product. The presence of TSP, however, had a significant influence on the amount of moisture retained in the cooked product. Cooked ground beef patties containing 15, 20 and 25% TSP lost equivalent amounts of moisture during cooking, and significantly less than patties containing no added TSP.

Raw ground beef patties containing TSP had significantly higher amounts of moisture than patties containing no TSP. Some of the increased moisture in the cooked patties containing TSP, was possibly due to water used to rehydrate the TSP. However, the moisture loss was equivalent at all levels of TSP studied and significantly less than patties with no TSP; thus it can be concluded that TSP did bind moisture during cooking.

Ground beef is purchased by the military on the basis of fat content, and the Hobart Fat Percent Indicator is used by the Military to determine the amount of fat present. In a study using 20% fat in the ground beef, Bellis et al. (1967) determined that fat content could be determined by either the Hobart Method or the Soxhlet Method with equal accuracy. However, the question arose whether or not these two methods would compare favorably when the ground beef contains increments of TSP with certain levels of fat.

There was no evident statistical interaction between fat and TSP content. Both methods of fat determination produced results that were comparable regardless of TSP content. At all calculated fat levels both the Hobart and Soxhlet methods produced comparable results that were within ± 1%. The amount of fat and TSP present in the raw patties had no effect on either Hobart or Soxhlet method of fat extraction. The Hobart Method for fat determination indicated a variation of 1.75% between ground beef with 0% and 25% TSP. The Soxhlet method of fat determination indicated a variation of 2.5% between samples with 0 and 25% TSP. At the four levels of TSP the differences between the two methods were 0.07, 1.02, 0.78 and 0.78, respectively. All differences in analyzed fat content were small and either method would produce accurate and comparable results regardless of TSP or fat content found in ground beef within the range of fat and TSP evaluated.

Results of quality and acceptance evaluations of cooked patties are exhibited in Tables 4, 5 and 6. Table 4 indicates, that of the five general attributes evaluated by the trained panel, the effects on color and texture were not significant for fat and TSP levels investigated and there were no significant interactions. The effect of TSP on odor scores was significant. However, the Newman-Keuls Test, computed when significant F ratios are found, revealed this was primarily due to scores at the 15% fat level wherein the 0% TSP patty was rated significantly higher than those containing any level of TSP. Although F ratios suggested that fat and TSP levels had a significant effect on appearance scores, the direction of the differences followed no consistent pattern with respect to level of either ingredient, and average ratings were within a narrow range of quality (less than 0.5 scalepoint).

Table 2—Grams fat lost during cooking of beef patties (71g ea) with selected amounts of textured vegetable protein and fat[a]

Amount of fat (%)	Amount of TSP (%) 0	15	20	25	$\bar{X}$ for effect of fat
30	6.33	8.33	6.78	4.91	6.58a
25	4.30	4.27	4.52	3.25	4.08ab
20	1.70	1.44	1.02	3.00	2.54ab
15	0.36	0.61	1.47	1.03	0.86b
$\bar{X}$ for effect of TSP	3.17a	3.66a	3.39a	3.04a	

[a] Values followed by the same letter in columns or rows did not differ significantly from each other at P > 0.95.

Table 3—Grams moisture lost during cooking of beef patties (71g ea) with selected amounts of textured vegetable protein and fat[a]

Amount of fat (%)	Amount of TSP (%) 0	15	20	25	$\bar{X}$ for effect of fat
30	14.19	10.81	11.46	7.78	11.06a
25	16.89	11.73	10.86	11.66	12.78a
20	14.30	12.97	13.17	9.99	12.60a
15	16.01	10.78	9.49	10.87	11.78a
$\bar{X}$ for effect of TSP	15.34a	11.57b	11.24b	10.07b	

[a] Values followed by the same letter in columns or rows did not differ significantly from each other at P > 0.99.

Table 4—F-ratios sensory quality evaluation of beef patties containing four levels of fat and TSP (trained panel)

Source of variation	Color	Odor	Flavor	Texture	Appearance
TSP	0.46^{NS}	5.44**	79.51**	1.83^{NS}	4.17**
FAT	1.66^{NS}	1.69^{NS}	0.76^{NS}	0.86^{NS}	2.75*
TSP & FAT	0.10^{NS}	0.40^{NS}	1.19^{NS}	0.40^{NS}	0.11^{NS}

** P > 0.99
* P > 0.95

Table 5—Mean sensory ratings of cooked patties for odor, flavor and appearance as affected by textural soy protein content (trained panel)[a]

Characteristic	Percent TSP 0	15	20	25
Odor	6.83a	6.59b	6.50b	6.41b
Appearance	6.99a	6.68b	6.79b	6.92a
Flavor	6.83a	5.27b	5.08b	4.72c

[a] Values followed by the same letter in rows did not differ significantly from each other at P > 0.99.

Table 6—Acceptance ratings for flavor and texture (consumer panel)[a]

Number of judgments	Percent		Attribute	
	Fat	TSP	Flavor	Texture
Acceptance Test 1				
32	30	0	7.2a	7.1a
32	15	0	6.9a	6.5a
32	30	25	5.8b	6.6a
32	15	25	5.5b	6.7a
Acceptance Test 2				
32	20 & 25	0	7.2a	6.9a
32	20 & 25	15	6.5b	7.0a
32	20 & 25	20	5.9b	6.7a
32	20 & 25	25	6.0b	6.7a

[a] Values followed by the same letter in columns did not differ significantly from each other at $P > 0.99$.

Table 4 shows that TSP level had a highly significant effect on flavor and fat level had no effect. Table 5 displays the ratings for the TSP levels averaged across the four fat levels. Patties at 0% TSP were rated significantly higher than patties containing 15 and 20% TSP. Increasing the TSP level to 25% resulted in a further significant decrease in flavor ratings.

Since objective data suggested that the extremes of fat and TSP levels could produce the largest differences in fat and moisture retention (Table 5), the four out of 16 combinations representing these levels were selected for an initial preference evaluation. They were: 30% fat, 0% TSP; 30, 25; 15, 0; and 15, 25. As this experiment demonstrated that TSP, but not fat level had a significant effect on preference, a follow-up experiment was run wherein the two intermediate fat levels were combined and all four levels of TSP were presented.

In acceptance test 1, Table 6, patties with 0% TSP were significantly preferred for flavor at both initial raw-basis fat levels over those containing the highest level studied. Results from acceptance test 2 agreed with test 1: the panel significantly preferred the 0% TSP patty over all those containing TSP, and no preferences occurred between levels. In both tests, voluntary panel comments were few and did not provide clear reasons for acceptance expressed via the Hedonic scale. At 20 and 25% TSP levels, 25% or more of the panelists expressed some degree of dislike which could also be inferred from the relatively high standard deviations among their ratings. Texture ratings in both preference tests were, for practical purposes, identical, and there was little evidence from panel comments or authors' observations of any notable differences.

CONCLUSIONS

TOTAL COOKING LOSS can be reduced with the addition of TSP to the ground beef patties. TSP did not have a binding effect on the fat present in the product, but the addition of TSP to ground beef patties resulted in a product higher in moisture, both before and after cooking. The amount of fat lost during cooking was directly related to the original level of fat in patties and not to the level of TSP.

In the determination of the amount of fat incorporated into the beef patties, both the Hobart Fat Percent Indicator and the Soxhlet methods produced equally reliable results regardless of fat and TSP contents over the ranges investigated. Either method of fat determination was considered to be acceptable.

Sensory data indicated that: (1) TSP level had no effect on the quality attributes of appearance and color, and a limited effect on odor; (2) within TSP levels studied, neither trained nor consumer judges perceived differences in texture; (3) both trained and consumer judges found TSP addition to have a highly significant effect on flavor; (4) the various levels of fat had no effect on color, odor, flavor, texture or acceptance; (5) there was no interacting effect found between the TSP and fat levels and any addition of TSP resulted in lower quality and acceptance ratings regardless of fat content.

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