FORMED, FROZEN STEAKS FROM BONELESS LAMB AND MUTTON

by

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TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

Chapter I

INTRODUCTION

The sheep industry fails to maximize returns in the salvage of its culled breeding stock. In 1972, of 12.1 million breeding sheep in the United States, about 2.5 million were culled and available for meat use.

A ewe weighing 100 pounds would yield about 30 to 35 pounds of boneless, lean meat. Yet ewes usually have sold for $5 to $15 per head, even though a world-wide scarcity of protein exists, reflected by higher beef, pork, and lamb prices.

Mutton is discriminated against for two alleged reasons. It has a stronger flavor than lamb, and it is less tender. Practically all mutton is sold as processing meat or as inedible.

Thin cuts of lamb, such as the breast and foreshank, have a small amount of lean in relation to fat and bone and are of low value. Frequently the breast is not processed at all, but discarded and sold as inedible. The shoulder is undesirable for roast meat unless large deposits of external and seam fat and some connective tissue are removed. Additional use and marketing alternatives would be advantageous and might result in more profit and more efficient utilization of animal protein.

The objective of this project was to develop a highly acceptable fabricated lamb-mutton product from less demanded cuts.

Chapter II

REVIEW OF LITERATURE

Palatability of Lamb and Mutton and Its Relation to Fat

Palatability of food is largely affected by flavor, which consists of three factors: taste, aroma, and tactile characteristics. Taste is stimulated by chemical phenomena involving taste buds and their receptor cells mainly present on the tongue. Aroma has been described as the most important component of flavor. The human has millions of odor receptors and also can recognize greater variety of odors than tastes (Beidler, 1958). Tactile properties or mouthfeel affects salivation and also affects aftertaste of meats (Bratzler, 1971).

Much basic research on the flavor of lamb and mutton has been done. Howe and Barbella (1937) noted that flavors characteristic of a species are present in fat, not lean. Hornstein and Crowe (1963) found that heated lamb aroma originates from fat. A major portion of the odor was contributed by carbonyl compounds. After these were removed, heating the remaining fat did not produce a lamb aroma. Lean meat portions contributed a basic, meaty aroma upon heating.

Hofstrand and Jacobson (1960) prepared separate broths with varying amounts of lamb fat and mutton fat. The amount or absence of fat did not significantly affect broth taste, but fat contributed to aroma.

Wasserman and Talley (1968) studied taste panel identification of beef, veal, lamb and pork as affected by fat. Veal, which is bland in flavor, was used as the lean portion for blends containing 10%

(by weight) of raw beef, pork, or lamb fat. Lamb fat significantly increased the identification of veal as lamb. Adding solvent extracted fat to veal caused no significant increase in the correct identification of beef and pork, but did with lamb. The authors concluded that lamb aroma is fat soluble while pork aroma may be water soluble.

Hornstein (1971) noted that heating pork or beef fat in vacuum or in nitrogen produced nonmeaty aromas, while heating either in air produced characteristic specie aromas. However, lamb fat produced typical lamb aroma under all conditions of heating. Analysis of the three fats showed that free fatty acid concentration in pork and beef fat respectively was 14 and 7 times as great as in lamb fat. Pork and beef fat also had a substantially greater proportion of fatty acids having two or more double bonds. These are easily oxidized to carbonyl compounds. This difference is reflected by a greater amount of carbonyl compounds recovered from heated beef and pork fat than from lamb fat. Thus the stronger flavor associated with lamb may be related to a lower concentration of carbonyl compounds. However, beef, pork and lamb flavor are affected by compounds other than fatty acids and carbonyls. Hirai et al. (1973) found 54 compounds to be involved in the characteristic aroma of boiled beef, including carbonyl compounds, hydrocarbons, acids, and sulfides.

Few researchers have compared lamb and mutton flavor. Earlier work by Weber and Loeffel (1932) compared leg roasts from lamb and mutton. The mutton had more pronounced aroma and less desirable flavor, but the greatest difference was in tenderness. Several workers found that palatability of lamb was not related to chronological age at slaughter (Weller, 1962; Jeremiah et al., 1971). Batcher (1969) evaluated flavors of lamb and yearling mutton and found no difference for slices of roasted, broiled or braised meat due to age. Wenham et al. (1973) stated that mutton is usually frozen after slaughter and prior to rigor mortis which could significantly toughen the muscles. When Wenham conditioned mutton carcasses for 24 hours at 15^{o}C before freezing, roasts were only slightly less tender than lamb treated similarly. He concluded that simple processing improvements could make mutton acceptable for roasting. Hankins et al. (1951) studied the effect of fatness on palatability of cuts from Karakul sheep. As fatness increased, desirability of flavor and tenderness increased; this agrees with earlier work by Cline and Eckblad (1937). Cuts from fat ewes gave greater total cooking losses and were superior in tenderness, juiciness and desirability of flavor.

Today most edible mutton is sold as processing meat (Wenham et al. 1973). Baliga and Medaiah (1970, 1971) reported that 43 to 45% mutton added to sausages provides optimal texture and firmness in sausages with a combination of non meat fillers and spices. The mutton flavor was also masked by these ingredients. Williams (1962) reported that injection of monosodium glutamate solution into mutton carcasses immediately after slaughter along with holding at elevated temperatures was effective in masking mutton flavor.

<u>Formed Meat Products</u>

Karmas (1970) noted that larger cuts of meat which are free of connective tissue sell at higher prices than do smaller "chunks" even though both are equally nutritious and flavorful. Thus a method to utilize meat trim by forming it into "integral cuts" was needed.

Maas (1963) found "chunks" of cured meat weighing about one-half to three pounds could be mechanically worked and bonded together to form a "solid, integral body of meat" which has "texture the same as, or similar to, a primal cut." Maas also showed that a natural binder was released by the meat when it was mechanically worked and that addition of salt and/or a polyphosphate during mechanical working hastened formation of exudate in fresh beef, pork or mutton.

Mainhardt and Biehl (1964) developed a process utilizing fresh ground meat and binder to form higher grade cuts. Ground meat was extruded through openings of 0.05 inch diameter; heated collagen was brushed on the extruded fibers. The product was pressed, chilled and sliced into steaks. Other compounds which were used included gums such as carboxymethylcellulose, gelatin, algin, and acetylated mono-glycerides.

Formed meat products have become increasingly popular in the poultry industry. Maesso <u>et al</u>. (1970b) reported over 25% of turkey was sold in the United States as loaves or rolls. Hansen <u>et al</u>. (1961) first found that pieces of poultry meat could be held together using salt soluble proteins as binding agents. Froning (1965, 1966) showed binding of loaves could be enhanced by addition of polyphosphate.

Cooking losses were also reduced. Froning (1966) also observed that polyphosphate, dried milk solids and gelatin significantly increased tear strength of ground and formed chicken meat, while wheat gluten did not.

Maesso et al. (1970) studied the effect of salt and polyphosphates upon binding of cubed chicken meat. Both additives increased binding and decreased cooking loss. Acton (1972) compared effects of different particle sizes, ranging from muscle "strips" weighing about eight grams to material ground through a fine plate (4 mm), upon cooking loss and binding strength in chicken loaves. As particle size decreased, cooking loss decreased and binding strength increased. A higher degree of surface contact was observed between meat particles with reduction in size.

Use of Phosphate and Salt in Meat Products

Polyphosphates have been used in the meat and poultry industries for many years. Three functions of phosphates apply to the meat industry. Phosphates may inhibit undesirable color changes and reduce shrinkage in cured products (Brotsky and Everson, 1973). Phosphates can also inhibit development of "warmed over" flavors in reheated meats (Tims and Watts, 1958).

Brostsky and Everson (1973) list four polyphosphates which are most widely used, namely trisodium orthophosphate, tetrasodium pyrophosphate, sodium tripolyphosphate and sodium metaphosphate. Sodium tripolyphosphate is most widely used since it exhibits a desirable combination of properties. Hamm (1971) reported that polyphosphates affect meat hydration in three ways: (1) by raising pH; (2) by increasing ionic strength; and (3) by causing polyphosphate-protein interactions. Each may increase water binding capacity of meat.

Morse (1955) attributed the effect of phosphates on water-binding capacity to raising of pH. However, when Bendall (1954) adjusted the pH of rabbit lean without phosphate to the pH of lean with added phosphates, cooking loss was lower for phosphate-treated samples. Bendall concluded that ionic strength was more important than pH.

Monk et al. (1964) studied the effect of phosphates upon moisture losses and nitrogen levels in poultry meat. Phosphates reduced cooking losses while protein nitrogen levels were lower for phosphate treated samples. Monk concluded this was due to partial breakdown of protein by phosphates, previously reported by Bendall (1954) and Swift and Ellis (1956).

Maesso (1970) reported addition of 0.5% phosphate to turkey loaves increased binding capability. He also found that adding phosphates during mechanical beating of turkey meat caused a significant increase in binding. Shults and Wierbicki (1973) compared shrinkage of ground chicken muscle with 10% added water and different levels of phosphate ranging from 0 to 1%. The optimum level was 0.5% with little added reduction in shrinkage at higher phosphate levels. Mahon and Schneider (1964) found that dipping fish fillets in polyphosphate solution prior to freezing reduced the amount of thawing drip. Johnson (1973) injected turkey breasts with a 5% solution of Kena (a mixture of sodium polyphosphate salts) at the rate of 10% by weight. Phosphate treated breasts had a lower percentage cooking loss and more total moisture after cooking than untreated samples. However, soapy tastes resulted from phosphate addition. Swift and Ellis (1956) reported greatest moisture retention when phosphate was added to meat at temperatures below 40°F.

Sodium chloride has been used as a major constituent for meat cures. It lowers water activity of meat, retards microbial growth, and enhances flavor, but promotes fat rancidity (Kramlich, 1971 and Urbain, 1971). These authors showed that salt acts much like phosphate by interacting with or solubilizing protein which binds moisture and fat.

Shults and Wierbicki (1973) studied the effect of 0 to 10% salt on shrinkage of chicken muscle. The optimum level for reduced shrinkage was 3 to 5% salt. Salt also had a synergistic effect with phosphates. Maesso et al. (1970) showed that salt alone reduced shrinkage in turkey loaves, but a phosphate-salt combination resulted in a synergistic effect.

Mahon (1961) studied synergism of phosphates and salt as related to cured meat volume. He concluded that as salt concentration decreases, phosphate concentration must increase proportionally if meat volume is to be maintained.

Use of Soy Protein Extenders in Meat Products

Soy products are an economical source of protein and have been used in meat products, especially for hotel, restaurant, and institutional markets. Thulin and Kuramoto (1967) described soy products as economical, but they also "offer greater stability, uniformity, nutritional control, and organoleptic variety." Soy flour is useful as an extender in sausage product because it can hold meat juices (Rakosky, 1970). Sair (1972) demonstrated that soy protein concentrate decreased cooking loss in ground beef patties. Carlin and Nielson (1974) found that hydrated soy protein reduced cooking loss when added in meat loaves. It did not influence percent of lipid or water present in drip cooking loss. Sair (1972) agreed with this finding.

Karmas (1969) stated that the objectionable flavor of soy has limited its acceptability as a food. Rakosky (1970) noted that soy protein concentrate has a more bland flavor than soy flour, and thus its use is being increased. Carlin and Nielson (1974) compared control meat loaves (no soy) versus loaves containing 10%, 20% and 30% hydrated soy (60-65% moisture). Triangular test results revealed that the number of correct discriminations was highly significant at all three levels. In loaves with 30% hydrated soy, beef flavor was described as weak while soy flavor was pronounced.

Rakosky (1970) proposed that soy protein could be useful as a fat binder in meat as well as a water binder. Huffman and Powell (1970) compared all combinations of three levels of fat (15, 25 and 30%) and 0% and 2% soy (Soyabits). Tenderness was greater for 2% soy but was not affected by fat, according to taste panel results.

Gum Tragacanth in Food Products

Gum tragacanth has been used by the food industry as a stabilizer in products such as salad dressings, ice cream, and sherbets. Furia (1968) described the product as having the ability to form thick, viscous solutions when added to water. Gum tragacanth forms a fairly stable colloidal solution over a wide pH range and has been used in foods where stable viscosities are critical.

Other gums, namely gum karaya and locust bean gum, have been reported as suitable stabilizers and emulsifiers for sausages. Gum tragacanth has been used experimentally as an agent to reduce shrinkage in beef carcasses according to R. T. Earl (personal communication), but no research on its use in fabricated meat products is available.

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Chapter III.

FORMED, FROZEN STEAKS FROM BONELESS LAMB AND MUTTON

Trial I. The Effect of Fat Level and Lamb/Mutton Lean Ratio on Cooking Loss and Palatability of Formed, Frozen Steaks.

Preliminary work has shown that patties with a steak-like texture could be fabricated from lower priced cuts of beef or lamb and mutton, utilizing a silent cutter along with the Bettcher Press and Cleaver system. The objective of Trial I was to compare different levels of lamb fat and lamb/mutton lean ratios as they related to cooking loss and taste panel acceptance of formed steaks.

Treatments. A 2 x 3 factorial design was used with all combinations of two ratios of lamb lean to mutton lean (50% lamb, 50% mutton and 25% lamb, 75% mutton) and three levels of added fat (10, 15, and 20%). All added fat was lamb fat obtained from the breast, shoulders, and kidney knobs.

Product Fabrication. Chilled, whole ewe carcasses and lamb breasts, foreshanks, and shoulders were obtained through the meats Laboratory, boned, and fat and coarse connective tissue were separated from the lean. Lean was coarsely chopped for two revolutions in a silent cutter, while fat and connective tissue were ground through a 1/8" plate of a conventional meat grinder. Kidney fat was added to the ground material as needed to provide three different fat levels in the finished steaks. The chopped and ground material was then mixed together at a ratio of approximately 3:1. Water, salt and tripolyphosphate were added to the meat during mixing at the rate of 3%, 0.5% and 0.25%, respectively. The product was stuffed into fibrous sausage casings and tempered overnight to 26°F (-3.3°C). When this internal temperature was reached, logs were formed using a Bettcher Press and then sliced into 3/4" thick steaks with a power cleaver. Steaks were skin-tight packaged in Dupont film (Iolon), frozen and stored at 20°F (-28.9°C) for 10 days until evaluation.

Evaluation. Prior to evaluation, steaks were cooked from the frozen state by modified broiling in a rotary oven preheated to 350°F (177°C). Steaks were cooked to an internal temperature of 160°F (71°C), which required approximately 25 minutes. A consumer taste panel using five housewives as members was employed. Panelists were not told what the product was. Each member judged the steaks for intensity of meat flavor, juiciness, texture, and overall acceptability on an eight point scale (Figure 1). Each member sampled and judged each steak four times, thus the total number of observations was 20.

Flavor profile analysis was also used with a two member panel of trained flavor analysts with treatment not revealed at the time of analysis. Both members agreed upon possible terms at the beginning of the trial. Flavor notes were reported from threshold to three (strong).

Percent total cooking loss was determined by the difference in weights before and after cooking to the nearest one-eighth ounce. Each treatment was sampled four times for cooking loss.

Figure 1. TASTE PANEL EVALUATION SCALES FOR TRIALS I AND II.

Intensity of Meat Flavor

8 None
7 Weak
6 Slight
5 Moderate to slight
4 Moderate
3 Strong to moderate
2 Strong
1 Very strong

Juiciness

8 Extremely juicy
7 Juicy
6 Moderately juicy
5 Slightly juicy
4 Slightly dry
3 Moderately dry
2 Dry
1 Extremely dry

Texture

8 Extremely firm
7 Firm
6 Moderately firm
5 Slightly firm
4 Slightly crumbly
3 Moderately crumbly
2 Crumbly
1 Extremely crumbly

Overall Acceptability

8 Extremely desirable
7 Desirable
6 Moderately desirable
5 Slightly desirable
4 Slightly undesirable
3 Moderately undesirable
2 Undesirable
1 Extremely undesirable

Statistical Analysis. Taste panel and cooking loss data were statistically analyzed using analysis of variance and least significant difference (Snedecor and Cochran, 1971).

Trial II. The Effect of Fat and Hydrated Soy Protein on Cooking Loss and Palatability of Formed, Frozen Steaks.

Increased use of non-animal protein in ground meat products is likely in the future. The objective of Trial II was to compare different levels of fat and hydrated soy protein as they related to palatability and cooking loss of lamb - mutton formed steaks.

Treatments. A 2 x 4 factorial design was used with all combinations of two levels of added lamb fat (15 or 20%) and four levels of hydrated soy (0, 7½, 15 and 30%). A lean ratio of 25% lamb and 75% mutton was used.

Product Fabrication. Steaks were fabricated as in Trial I except lean meat was chopped three rounds in the silent cutter instead of two to provide more uniformity in the product. Treatments without soy had 3% added water, 0.5% salt and 0.25% tripolyphosphate, while those with soy had no phosphate. Salt at 0.5% of meat weight was added to soy-containing treatments. Hydrated soy protein was prepared by soaking textured vegetable protein (Far-Mar-Co soy chiplets, ½" x ½" x 1/8", caramel colored) in water at 1:2 weight ratio for 30 minutes. The hydrated soy was then ground through a 1/8" plate with lamb fat and mixed at appropriate levels with the chopped lean.

Steaks were packaged in Iolon Film, blast frozen and stored one week at $-20^{o}F$ ($-28.9^{o}C$) before evaluation.

Evaluation. Eight steaks per treatment were cooked using the same cooking and weighing procedure as in Trial I to determine percent total cooking loss. A taste panel of 18 members was divided into four groups:

1. Trained, unaware of product type
2. Untrained, unaware of product type
3. Trained, aware of product type
4. Untrained, aware of product type

Both groups which were aware of the product type were told that steaks consisted of lamb and different levels of soy, but individual treatments were coded. Each panelist sampled each treatment once, resulting in 18 observations per treatment.

Flavor profile analysis was done as in Trial I, but with only one analyst.

Statistical Analysis. Taste panel, cooking loss and group data were analyzed using analysis of variance and least significant difference (Snedecor and Cochran, 1971).

Trial III. The Effect of Salt, Phosphate, and Gum Tragacanth on Cooking Loss and Palatability of Formed, Frozen Steaks.

Phosphate, salt, and gum tragacanth have been used as water binders and emulsifying agents in various foods. The objective of Trial III was to compare the effects of these substances on cooking loss and palatability of lamb-mutton steaks.

Treatments. A 2 x 2 x 2 factorial design was used with all possible combinations of 2 salt levels (0.5% and 1.0%), with or without 0.25% tripolyphosphate and with or without 0.5% gum tragacanth.

Product Fabrication. Steaks were fabricated as in Trial I except the lean was chopped three rounds in the silent cutter. The lean consisted of 75% mutton and 25% lamb, while fat was added at approximately 15%. Tripolyphosphate was added to the lean in solution with 3% added water. Salt was sprinkled over the lean during chopping while gum tragacanth was added dry during mixing of lean and fat. Steaks were packaged in freezer paper, frozen and stored at -20°F (-28.9°C) for one month prior to evaluation.

Evaluation. A seventeen member panel of experienced taste panelists scored desirability of flavor, juiciness, texture, and overall acceptability on an eight point scale (Figure 2). Each member sampled each treatment one time.

Percent total cooking loss was measured as in Trial I with eight samples per treatment.

Statistical Analysis. Analysis of variance and least significant differences were used to test main and interaction effects.

RESULTS AND DISCUSSION

Trial I

The effect of fat level and lamb/mutton lean ratio on cooking loss and taste panel evaluation is given in Table 1. No significant interaction ($P < .05$) was calculated in Trial I. Therefore, discussion will be largely centered around main treatment effects.

Cooking loss. The percent total cooking loss was not affected by ratio of mutton lean to lamb lean. The lowest fat level resulted in

Figure 2. TASTE PANEL EVALUATION SCALES FOR TRIAL III

Desirability of Flavor

8 Extremely desirable
7 Desirable
6 Moderately desirable
5 Slightly desirable
4 Slightly undesirable
3 Moderately undesirable
2 Undesirable
1 Extremely undesirable

Juiciness

8 Extremely juicy
7 Juicy
6 Moderately juicy
5 Slightly juicy
4 Slightly dry
3 Moderately dry
2 Dry
1 Extremely dry

Texture

8 Extremely firm
7 Firm
6 Moderately firm
5 Slightly firm
4 Slightly crumbly
3 Moderately crumbly
2 Crumbly
1 Extremely crumbly

Overall Acceptability

8 Extremely desirable
7 Desirable
6 Moderately desirable
5 Slightly desirable
4 Slightly undesirable
3 Moderately undesirable
2 Undesirable
1 Extremely undesirable

TABLE 1. EFFECT OF FAT LEVELS AND LAMB/MUTTON LEAN RATIOS IN FORMED, FROZEN STEAKS ON COOKING LOSS AND TASTE PANEL SCORES.[a]

Treatment						
Fat level	Lamb-Mutton Ratio[b]	Percent Total Cooking Loss	Intensity of Meat Flavor[c]	Juiciness[d]	Texture[e]	Overall Acceptability[f]
10%	50:50	25.10	3.75	5.10	4.85	4.55
10%	25:75	25.10	4.50	4.55	4.70	5.10
15%	50:50	32.59	4.45	5.05	4.65	5.35
15%	25:75	35.00	4.40	4.45	5.05	5.60
20%	50:50	36.37	4.30	5.30	4.55	5.20
20%	25:75	29.76	4.60	5.70	5.30	5.85
Main Effects						
Fat level						
10%		25.10^{g}	4.12	4.82^{g}	4.77	4.82^{g}
15%		33.80^{h}	4.43	4.75^{g}	4.85	5.47^{h}
20%		33.06^{h}	4.45	5.50^{h}	4.92	5.52^{h}
Lamb-Mutton Ratio						
50:50		31.35	4.17	5.15	4.68	5.03^{g}
25:75		29.95	4.50	4.90	5.02	5.52^{h}

[a]Main effect means within a column sharing the same or no superscript letter are not significantly different ($P<.05$).

[b]Ratio of lamb lean to mutton lean.

[c]1 = very strong, 8 = none.

[d]1 = extremely dry, 8 = extremely juicy.

[e]1 = extremely crumbly, 8 = extremely firm.

[f]1 = extremely undesirable, 8 = extremely desirable.

lowest cooking loss, while no difference was noted between the 15 and 20% fat levels.

Taste Panel Evaluation

Intensity of meat flavor. Intensity of meat flavor (Table 1) was not significantly ($P<.05$) affected by ratio of lamb lean to mutton lean. This finding is in agreement with Batcher (1969) who compared flavor of lamb and yearling mutton. It is possible that the process of chopping and grinding along with the addition of salt and phosphates masked any flavor differences which were initially present.

Intensity of meat flavor was not significantly affected by level of fat, although previous research has shown that fat is responsible for the characteristic specie flavor (Hornstein and Crowe, 1963; Wasserman and Talley, 1968).

Juiciness. Juiciness was not affected by ratio of lamb lean to mutton lean. Steaks containing 20% fat were significantly more juicy than steaks having either 10% or 15% fat. This agrees with results by Carlin and Nielson (1974), who examined the role of fat in ground beef loaves.

Texture. Texture was not affected by either fat level or the lamb to mutton ratio. Obviously neither mutton nor lamb lean was superior in its ability to hold moisture or promote cohesiveness in the steaks. Also, any tenderness problem with mutton was removed by chopping.

Overall acceptability. Steaks with 10% fat were significantly less desirable than those with either 15% or 20% fat. This difference cannot be totally explained by any one of the previously considered taste panel factors, but was probably due to a combination of the three. The lower ratio of lamb to mutton was scored significantly more desirable than the higher one, partially due to a more bland, less intense flavor. Wenham *et al*. (1973) suggested that mutton could be made more desirable if better processing methods were developed. Further tests would be necessary with a larger number of panelists to determine consumer acceptability although most scores ranged from slightly to moderately desirable.

Flavor Analysis

Flavor. The main flavor notes for all samples were those of sourness and mature animal flavors, although most were at low intensities. Both evaluators found these flavors more intense with a higher level of mutton, thus differing from taste panel results. Flavor analysts also found that higher levels of fat made flavor more mild and uniform. Patties with 10% fat were described as having the most intense flavor. This agrees with observation by Hansen (1951) and Cline and Eckblad (1937). Both analysts found that texture and flavor were not uniform throughout the patty, and extra chopping may be needed (refer to Figure 3). This non-uniformity could explain some variation in taste panel results.

Texture and juiciness. Flavor analysts judged these two traits together. Both were enhanced by greater levels of fat, but were not affected by the ratio of lamb lean to mutton lean. This tends to agree with taste panel results.

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Figure 3. COMPARISON OF 10, 15 and 20% FAT LEVELS IN FORMED, FROZEN STEAKS WITH A 50:50 LAMB/MUTTON LEAN RATIO.

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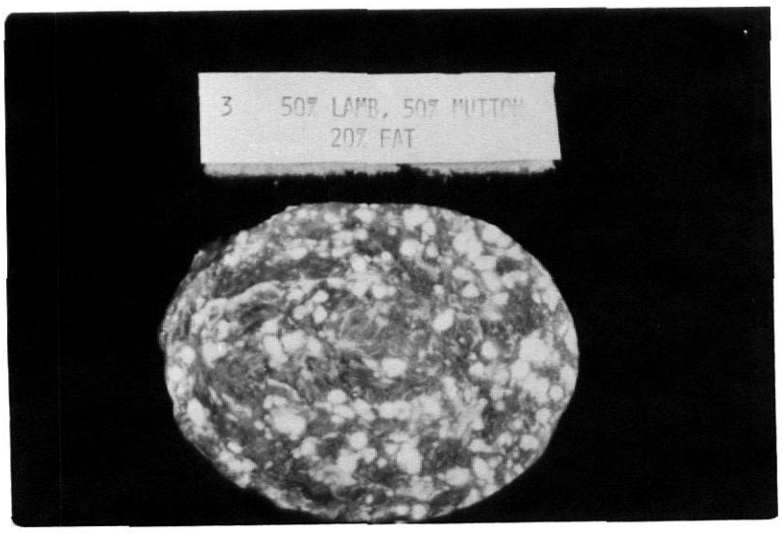
1 50% LAMB, 50% MUTTON
10% FAT


2 50% LAMB, 50% MUTTON
15% FAT


3 50% LAMB, 50% MUTTON
20% FAT

Trial II

The effect of fat and hydrated soy levels on cooking loss and taste panel evaluation is given in Table 2. No significant interaction ($P<.05$) was calculated for Trial II. Also no significant difference ($P<.05$) was found for any taste panel evaluation due to panelists being trained or untrained or aware or unaware of product type. Therefore, data from the entire panel were combined for further analysis.

Cooking loss. The higher level of fat caused a significant increase in percent total cooking loss ($P<.05$) as expected. Cooking loss was also affected by soy level ($P<.05$), although the trend was not linear. Cooking loss was lowest for treatments containing 7.5% soy, while the greatest loss was with treatments containing no soy. This agrees somewhat with previous research showing that soy protein decreases cooking loss by increasing the bind of water and fat (Carlin and Nielson, 1974).

In general, cooking loss was lower for Trial II than Trial I. A reasonable explanation for this is that the lean was chopped slightly more in Trial II, thus allowing for more lean surface area and better binding of fat and water. This agrees with findings of Acton (1972) who related meat particle size in poultry loaves to binding ability.

Taste Panel Evaluation

Intensity of meat flavor. Level of hydrated soy did not significantly affect mean scores for this factor. Carlin and Nielson (1974) have found that soy products produce a bland flavor in meat products.

TABLE 2. EFFECT OF FAT AND HYDRATED SOY LEVELS IN FORMED, FROZEN STEAKS ON COOKING LOSS AND TASTE PANEL SCORES.[a]

Treatment Fat Level	Hydrated Soy Level[b]	Percent Total Cooking Loss	Intensity of Meat Flavor[c]	Juiciness[d]	Texture[e]	Overall Acceptability[f]
15%	0%	22.92	4.50	5.89	5.67	6.50
15%	7.5%	14.85	4.56	6.28	4.67	6.22
15%	15%	20.21	4.11	5.83	4.44	5.28
15%	30%	18.61	4.22	5.33	4.50	4.89
20%	0%	28.98	3.61	6.11	5.67	5.72
20%	7.5%	27.25	3.17	5.94	4.56	5.11
20%	15%	27.71	3.33	6.22	5.39	5.11
20%	30%	24.87	3.44	5.22	4.72	4.61
Main Effects						
Fat Level						
15%		19.15^{h}	4.35^{h}	5.83	4.82	5.72^{h}
20%		27.21^{g}	3.39^{g}	5.88	5.08	5.14^{g}
Soy Level						
0%		25.95^{g}	4.06	6.00^{h}	5.67^{h}	6.11^{i}
7.5%		21.05^{i}	3.86	6.11^{h}	4.61^{g}	5.67^{hi}
15%		23.96^{gh}	3.72	6.03^{h}	4.92^{g}	5.19^{hg}
30%		21.74^{hi}	3.83	5.28^{g}	4.61^{g}	4.75^{g}

[a] Main effect means within a column sharing the same or no superscript letter are not significantly different ($P<.05$).

[b] Hydrated at rate of 2 parts water to 1 part soy.

[c] 1 = very strong, 8 = none.

[d] 1 = extremely dry, 8 = extremely juicy.

[e] 1 = extremely crumbly, 8 = extremely firm.

[f] 1 = extremely undesirable, 8 = extremely desirable.

Either different terminology was needed to describe flavor, or lamb-mutton flavor was too strong to be masked by soy products.

Steaks with the higher level of fat had significantly ($P<.05$) stronger flavor.

Juiciness. No difference was found in mean scores for juiciness due to the level of fat.

Juiciness was affected by level of hydrated soy, with treatments containing 30% scoring significantly less juicy than treatments containing less soy ($P<.05$). Work by Sair (1972) and Carlin and Nielson (1974) showed that hydrated soy reduced moisture loss and fat loss in cooked ground beef. Hydrated soy may have formed such a strong bind with water that not enough free water was present in the samples, and they were described as dry.

Texture. Fat level did not affect mean scores for texture. However, texture was affected by the presence of soy. Mean scores for treatments without soy were significantly higher than those with soy ($P<.05$), indicating that soy decreased firmness and increased crumbliness of the steaks. This disagrees with other authors who have found that soy protein improves texture in meat products (Huffman and Powell, 1970; and Rakosky, 1970). *It is important to* note that the hydrated soy was finely ground with the fat, thus a lesser percentage of the soy containing steaks consisted of coarsely chopped lean. This may explain why the soy containing steaks appeared more crumbly. Texture in this study was defined as either firm or crumbly, while many other studies actually measured tenderness.

Overall acceptability. Overall acceptability was significantly higher for 15% fat steaks than those containing 20% fat ($P<.05$). Since juiciness and texture were not affected by fat level, it is assumed that more intense meat flavors for 20% fat steaks reduced acceptance. These results disagree with Ockerman (1972) who found that general acceptability was highest for ground beef with 25% fat compared to other levels ranging from 15% to 35%.

Overall acceptability scores tended to be inversely related to the level of hydrated soy with 0% soy levels scoring highest and 30% scoring lowest. Previous research has not indicated that soy protein improves overall acceptance of either beef, pork or lamb patties, although other factors such as tenderness have been enhanced.

Flavor Analysis

Analysis by one member only showed that hydrated soy masked lamb-mutton flavor by providing a browned or cereal-like flavor, especially at higher levels. This is in contrast to taste panel results which may have composited intensity of mutton and soy flavor. No difference for flavor or texture was found due to fat level. All samples were described as tender, juicy and compact.

Trial III

The effects of salt level, phosphate and gum tragacanth in formed, frozen steaks on cooking loss and taste panel evaluation are shown in Table 3. Some significant two way and three way interactions were calculated and will be discussed along with the appropriate main effects.

TABLE 3. EFFECT OF SALT LEVELS AND ADDITION OF PHOSPHATE AND GUM TRAGACANTH IN FORMED, FROZEN STEAKS ON COOKING LOSS AND TASTE PANEL SCORES.

Treatment[a] Salt level	0.25% Phosphate	0.5% Gum Tragacanth	Percent Total Cooking Loss	Desirability of Flavor[b]	Juiciness[c]	Texture[d]	Overall Acceptability[b]
0.5%	0	0	33.04^{e}	5.94	4.71	5.00	5.62^{efg}
0.5%	0	+	24.24^{fg}	5.88	6.12	3.29	5.29^{ef}
0.5%	+	0	28.14^{f}	6.00	5.74	5.15	6.00^{fg}
0.5%	+	+	27.55^{f}	5.94	5.94	3.24	5.26^{ef}
1.0%	0	0	33.77^{e}	6.18	5.56	5.53	6.26^{g}
1.0%	0	+	22.75^{g}	5.68	6.12	3.59	4.97^{e}
1.0%	+	0	20.72^{g}	5.94	6.09	6.24	5.76^{fg}
1.0%	+	+	25.00^{fg}	6.24	6.21	4.03	5.85^{fg}
Main Effects[h]							
Salt Level	0.5%		28.24	5.94	5.63^{e}	4.17^{e}	5.54
	1.0%		25.56	6.01	5.99^{f}	4.85^{f}	5.71
Phosphate	0		28.45	5.92	5.63	4.35	5.54
	+		25.35	6.03	5.99	4.66	5.72
Gum Tragacanth	0		28.91	6.01	5.52	5.48^{f}	5.91
	+		24.88	5.93	6.10	3.54^{e}	5.35
Interaction[i]							
Salt x Phosphate	0.5%,	0	28.64	5.91	5.41	4.15	5.46
	0.5%,	+	27.84	5.97	5.84	4.19	5.63
	1.0%,	0	28.26	5.93	5.84	4.56	5.62
	1.0%,	+	22.86	6.09	6.15	5.13	5.81
Salt x Gum Tragacanth	0.5%,	0	30.59	5.97	5.22	5.07	5.81
	0.5%,	+	25.89	5.91	6.03	3.26	5.28
	1.0%,	0	27.24	6.06	5.82	5.88	6.01
	1.0%,	+	23.87	5.96	6.16	3.81	5.41

TABLE 3. CONTINUED.

			Percent Total Cooking Loss	Desirability of Flavor[b]	Juiciness[c]	Texture[d]	Overall Acceptability[b]
Phosphate x Gum Tragacanth	0,	0	33.40	6.06	5.13[e]	5.26	5.94
	0,	+	23.49	5.78	6.12[f]	3.44	5.13
	+,	0	24.43	5.97	5.91[f]	5.69	5.88
	+,	+	26.28	6.09	6.07[f]	3.63	5.56

[a]Treatment means within a column with same or no superscript letters do not differ significantly (P<.05).

[b]1 = extremely undesirable, 8 = extremely desirable.

[c]1 = extremely dry, 8 = extremely juicy.

[d]1 = extremely crumbly, 8 = extremely firm.

[h]Main effect means within a column with same or no superscript letters do not differ significantly (P<.05).

[i]Means for a specific interaction within a column with same or no superscript letters do not differ significantly (P<.05).

Cooking loss. A significant three way interaction (P<.05) was present for percent total cooking loss. Steaks containing 1.0% salt and either tripolyphosphate or gum tragacanth had the lowest cooking loss, although these were not significantly different than two other treatments, both containing gum tragacanth.

Treatments containing salt at 0.5% and 1.0% with no tripolyphosphate or gum tragacanth addition were significantly highest for cooking loss. An additive effect was observed between salt and either phosphate or gum tragacanth. Use of either seems important in reducing cooking loss of this product. Maesso et al. (1970), Shults and Wierbicki (1973), and Mahon (1961) found that salt and phosphate act synergistically to bind water in lean meat, but no previous work was available regarding use of gum tragacanth.

Taste panel evaluation

Desirability of flavor. Flavor score was not affected by either the level of salt, or presence of phosphate or gum tragacanth, or their interactions (P<.05). Phosphate has been reported to cause "soapy" flavors in poultry when added at the rate of 0.5% (Johnson, 1973). Preliminary work before this trial revealed soapy flavors could be detected in lamb steaks with phosphate levels of 0.5% but not at 0.25%. Salt has been used as a flavor enhancer in cured products but at higher levels. Perhaps a greater difference or a higher level of salt is needed to affect lamb flavor.

Juiciness. Salt level significantly affected juiciness scores with the 1.0% level scoring more juicy. Salt has been shown to be effective in reducing cooking loss and increasing water binding (Hamm, 1971; and Bendall, 1954). Therefore, higher juiciness scores might be expected when salt level is increased.

A significant interaction was calculated between phosphate and gum tragacanth (P<.05). Mean juiciness score was lower for the treatment containing no phosphate or gum tragacanth than for the other three combinations of these additives. Probably either is effective in promoting moisture retention during cooking with no additive effect.

Texture. Texture was not affected by the presence of phosphate, but differences were apparent due to either salt or gum tragacanth. Panelists found steaks containing a higher level of salt to have more firmness. This agrees with work by Maesso *et al*. (1970) who reported that salt enhances firmness and cohesiveness in poultry loaves. Salt apparently increases the extractability of myosin, thus allowing for more binding between particles.

Firmness in the steaks was reduced by the addition of gum tragacanth. Those without gum tragacanth scored 5.48 compared with 3.54 for those with this substance. Panelists frequently commented that the samples were slippery in mouthfeel and did not hold together.

Previous studies have shown that phosphates added at the rate of 0.5% in most instances increased binding in poultry loaves (Maesso *et al*. 1970). This higher level might have been effective in lamb steaks also.

Overall acceptability. A significant three-way interaction (P<.05) was calculated for overall acceptability (Table 3). Treatments containing gum tragacanth scored lower in some cases. Where phosphate and 1.0% salt were present along with gum tragacanth, acceptability score was intermediate and not reduced with gum tragacanth addition. The lower overall acceptability scores for some steaks containing gum tragacanth appear to be related to texture scores, since its use did not affect flavor and enhanced juiciness.

The highest scoring treatment contained 1.0% salt, no phosphate and no gum tragacanth, although it was not significantly different from four other treatments ($P<.05$). Phosphate treated steaks were intermediate with means ranging from 5.26 to 6.00.

SUMMARY

A three trial study was used to compare the effects of various ingredients on the cooking loss and sensory properties of formed, frozen steaks. The first trial compared three fat levels (10%, 15% and 20%) with two lamb to mutton lean ratios (50:50 and 25:75). Trial II compared two fat levels (15% and 20%) and four levels of hydrated soy protein (0%, 7.5%, 15% and 30%). Salt level (0.5% and 1.0%) and phosphate and gum tragacanth additions in formed steaks were tested in Trial III.

Results revealed that 15% and 20% fat levels were superior to 10% fat levels in acceptability, probably due to lower juiciness scores and more intense flavors for 10% fat level. Cooking loss was significantly lower for 10% fat, but was not affected by lamb to mutton ratio. Consumer panelists preferred patties with 75% mutton, although flavor analysts found these treatments to be stronger in flavor and less desirable.

Higher levels of soy resulted in lower overall acceptability scores due to dryness and more crumbly texture in soy containing steaks. Cooking loss was lowest for 7.5% soy steaks, but greatest for those containing no soy. Fifteen percent fat level steaks were more mild in flavor and more desirable overall than those with 20% fat, while no differences were observed for texture or juiciness. Cooking loss was greater for 20% fat steaks.

Use of salt at 0.5% or 1.0% with or without tripolyphosphate (0.25%) and/or gum tragacanth (0.5%) all did not affect flavor, but enhanced juiciness. One percent salt was superior to 0.5% salt for texture. Phosphate presence did not affect texture while gum tragacanth reduced firmness, thus lowering overall acceptability scores. The highest scoring treatment for overall acceptability contained 1.0% salt, no phosphate and no gum tragacanth, although this was not significantly different than four other treatments. Increasing the level of salt did not reduce cooking loss, but an additive effect was observed with either phosphate or gum tragacanth.

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FORMED, FROZEN STEAKS FROM BONELESS
LAMB AND MUTTON

by

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AN ABSTRACT OF A MASTER'S THESIS

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A formed, frozen steak was produced from boneless lamb and mutton. A three-trial study was used to determine the effect of various ingredients on cooking loss and sensory evaluation as measured by consumer taste panels and flavor analysis. Trial I compared three levels of fat (10%, 15%, and 20%) with two ratios of lamb to mutton lean (50:50 and 25:75). Trial II compared the effects of two levels of fat (15% and 20%) and four levels of hydrated soy protein (0%, 7.5%, 15% and 20%). In Trial III steaks were tested with two levels of salt, with and without 0.25% phosphate and 0.5% gum tragacanth.

Results from Trial I showed that steaks containing 10% fat scored significantly lowest in acceptability, which was probably due to lower juiciness scores and more intense flavors. Cooking loss was lowest for 10% fat, but not affected by the ratio of lamb to mutton. Consumer panelists preferred steaks with 75% mutton lean, although flavor analysts found these treatments to be stronger in flavor and less desirable.

As soy level increased, overall acceptability decreased due to an observed dryness and more crumbly texture in soy containing steaks. Cooking loss was lowest for 7.5% soy steaks, but greatest for those containing no soy. Fifteen percent fat level steaks were milder in flavor and more desirable overall than those with 20% fat, while no differences were observed for texture and juiciness. Cooking loss was greater with steaks 20% fat.

Use of salt at 0.5% or 1.0% with or without tripolyphosphate (0.25) and/or gum tragacanth (0.5%) all did not affect flavor, but enhanced juiciness. One percent salt was superior to 0.5% salt for texture. Phosphate presence did not affect texture while gum tragacanth reduced firmness, thus lowering overall acceptability scores. The highest scoring treatment for overall acceptability contained 1.0% salt, no phosphate and no gum tragacanth, although this was not significantly different than four other treatments. Increasing the level of salt did not reduce cooking loss, but an additive effect was observed with either phosphate or gum tragacanth.