EFFECT OF SALT ON THE SENSORY CHARACTERISTICS OF BEEF AND BEEF-SOY PATTIES

by

CAROL ANNE GARDZE

B.S., University of Illinois, 1976

A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

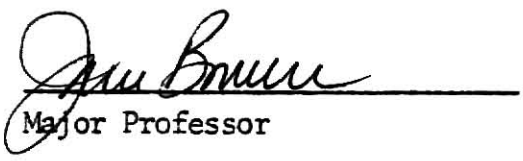
MASTER OF SCIENCE

Department of Foods and Nutrition

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1977

Approved by:



Major Professor

TABLE OF CONTENTS

INTRODUCTION

The use of soy protein to extend animal protein provides a way of using high quality vegetable protein which is relatively inexpensive. The problem of protein deficiency in the "third world" countries, along with the desire for greater amounts of protein by affluent countries, makes the use of soy important in providing for expanding protein consumption (Butz, 1974). At this time, soy is "the only consistent and abundant vegetable protein resource available for food and animal feed purposes" (Coppock, 1974). However, when world demand for meat, poultry, and fish keeps prices high and supplies limited, soy proteins will be called upon to alleviate this situation (Fisher, 1974).

The National Livestock and Meat Board in 1976, reported that sales of extender products were 60 to 70% lower in 1975 than in 1973. The decrease in the cost of meat in recent years has brought about this decrease in the use of soy extenders. The changing attitudes of consumers, including their greater acceptance of soy extenders, coupled with the expected rise in the price of beef will more than likely increase the demand for soy protein extenders in the future. Over the years, soy extenders have improved greatly in functionality and quality. Presently, main disadvantages are flavor, mouthfeel, flatus production, and low content of methionine (Rakosky, 1974).

The addition of salt to soy products has a masking effect, according to Rakosky, 1974. Jennings (1965) stated that salts are added to food to improve taste, but in addition, he found that sodium chloride increased the volatility of a dilute ester solution. Jennings cites work which found that most salts increase the volatility of benzene, carbon dioxide, nitrous oxide, ammonia, trimethylamine, aniline, acetone and various organic acids.

According to Pintauro (1971) salt is the oldest and most widely used flavor enhancer for meat. Levels at which it cannot be detected, but at the same time, are effective in bringing out natural flavor can be used. Franzen and Kinsella (1974) noted that flavor-protein interactions are dependent on many variables, among which was the presence of salts.

Since the addition of salt to foods is such a common practice, the object of this study is to determine how such an addition would affect the sensory characteristics, specifically the aroma, flavor and juiciness, of beef-soy patties.

REVIEW OF LITERATURE

This review surveys the properties of soy, beef and salt, the components of the study, and the interrelationship between them. Since the use of salt, solely, in beef-soy mixtures could not be found in the literature, a review of the research using salt in combination with other seasonings is included.

Properties of Soy as a Meat Extender

Flavor characteristics. As a meat extender, soy may be used in various forms. Since the soy used in this study was a textured soy flour (flaked type), the literature reviewed deals mainly with soy flour or defatted flakes (soybean meal).

Rackis et al. (1966) found the major flavor characteristics of soybean meal to include bitter, beany and green notes, with toasted and sweet being apparent with different amounts of steaming. They found the major flavor characteristics of defatted soybean meal to be present in both the lipid and non-lipid constituents. This was based on solubility behavior,

chemical analysis and chromatographic properties. In later work, Rackis et al. (1970) found bitter, beany type characteristics present in raw, full fat and defatted soy flakes. They believe that these characteristics may pre-exist in whole soybeans and that oxidation may produce other flavors in addition to those already present.

Various studies (Moser et al., 1967; Rackis et al., 1966; Maga, 1973;) have shown that steaming or increasing the amount of heating during processing reduces the raw beany flavor of the soy. Maga (1973) cites research stating that steaming or toasting darkens the soy's color, decreases protein dispersibility and results in the formation of carbonyl compounds. During heating, some of the carbohydrates present in the soybeans may degrade by hydrolysis, dextrinization or caramelization. This might also affect flavor (Maga, 1973). Toasted flakes may also impart an astringent, throat-catching sensation and a long lasting aftertaste (Rackis et al., 1970).

Hexane is the solvent usually used to extract the lipid components from soybeans but it does not remove the characteristic bitter, beany flavor of the soybeans. Moser et al. (1967) found the use of 80% ethanol with 20 minutes of steaming on hexane-defatted flakes gave improved flavor scores. Bechel and workers in 1948 found ethanol extraction gave improved color and flavor and served as a debittering agent for soy flakes (Maga, 1973).

Eldridge et al. (1971), working with several hexane:alcohol azeotrope mixtures, found these mixtures incompletely removed the undesirable flavors of defatted soy flakes. These mixtures decreased the intensity of the flavors but did not entirely remove them. Work by Honig et al. (1976), using the method of hexane:ethanol azeotropic extraction of flours made from defatted soy flakes plus toasting, resulted in the best flavor scores.

Using this method, they found a decrease in the intensity of grassy/beany, bitter and astringent properties. An increase in musty and cereal grain flavors was noted in the azeotropic extracted flours. Possibly, those components were formed during and/or after processing or were found in the original flour but were masked by the predominant grassy/beany, bitter components.

Economic reasons, mainly additional time and expense, are preventing major soybean processors from using some of these flavor improving treatments (Maga, 1973).

Various researchers have differing views as to the factors that may be responsible for the "problem" flavors in soy protein. The autoxidation of fat in the defatted flakes may occur during the defatting procedure, storage, or because of the physical or chemical environment. Although defatted, Fujimaki et al. (1965) found 0.5% residual fat in the defatted flakes. The volatile carbonyl compounds identified from the defatted flakes were methanal, ethanal, hexanal, 2-propanone, 2-pentanone, 2-hexanone, 2-heptenal and 2,4-decadienal.

Arai et al. (1966) found nine phenolic compounds which impart sour, bitter and astringent properties. They believe these compounds originate in the raw bean and were not removed because of their stability to heat and low solubility in hexane. Maga (1973) cites later work by Rackis and co-workers. They found that phenolic compounds in soy have little taste and do not contribute to soy flavor.

A strong bitter taste, arising from the autoxidation of unsaturated fatty acid components of soybean phosphatidylcholine was found by Sessa et al. (1974). Later work by Sessa et al. (1976) isolated three phosphatidylcholines, representing about 0.08% in defatted flakes and two of the

three had a strong bitter taste when a 0.05% suspension was tasted.

Other research reports that Japanese soybean varieties contain greater amounts of sucrose, raffinose and stachyose than American varieties. It is thought that nonenzymatic browning and/or further storage or processing may alter the flavors and cause different flavors to exist between the two varieties (Maga, 1973).

Goossens (1975) lists many of the problem flavor components by functional group. Those include alcohols, aldehydes, ketones, phenols, amines, esters, acids and sulphides. Although the components under these functional groups are not usually present at the same time, their appearance depends on the raw materials, processes used, and the variety of the soy.

Method for reducing soy flavor in extended products. A method for reducing the characteristic soy flavor, suggested by Wilding (1974) is to add spices and seasonings to the hydration water of the soy. This allows the flavor to penetrate the soy instead of the meat. Fischetti (1975) also suggests this method for use in extended meat patties. The flavoring of soy is complicated because it binds to certain functional groups and produces other chemicals upon heating. These chemicals include aliphatic aldehydes and furans along with increases in the branched chain aldehydes and sulfur compounds.

Effect of soy on cooking losses and juiciness. Soy proteins have hydrophilic properties which promote moisture retention and other properties which promote fat absorption. These properties enable soy extended meat to have decreased cooking losses, both volatile and drip (Wolf and Cowan, 1975). Researchers have shown that increasing the amounts of textured vegetable protein in ground beef mixtures, decreases total cooking losses as compared with a 100% ground beef control (Yoon et al., 1974;

Bowers and Engler, 1975; Smith et al., 1976).

Anderson and Lind (1975) found, in cooked beef patties, higher moisture retention and lower fat retention to be directly proportional to the percent of textured vegetable protein in the mixture. With this in mind, since more moisture is retained in the beef-soy formulas, these mixtures should be juicier. Bowers and Engler (1975) using 0, 15 and 30% soy and Smith et al. (1976) using 0 to 50% soy, found juiciness scores, determined through sensory evaluation, did not vary with different amounts of added soy. Cross et al. (1975) using a beef mixture containing 22% fat, found juiciness scores to be lower with 20% textured soy than with 12.5% and 0% soy. With 25% fat, the 12.5% and 20% soy mixtures were similar in juiciness scores and only slightly greater than 0% soy.

Flavor and Aroma Properties of Beef

Meat flavor is a subject that has been studied extensively and yet much is still not known. Species does have an effect on meat flavor, but its exact effects also are not known. Although related, components of beef flavor and identity can be separated into flavor precursors, volatile factors and factors contributed by fat.

Flavor precursors. Early work by Crocker, as reported by Doty et al. (1961), found the typical meaty flavor present in the meat fibers rather than in the expressible fluid of cooked meat. Later work by Crocker (1948) and other authors (Kramlich and Pearson, 1958; Hornstein et al., 1960) agree that the flavor precursors of beef are water soluble.

Doty et al. (1961) reported work done at the American Meat Institute Foundation where some flavor precursors from raw ground meat were isolated and identified. Using chemical separations and tests, a basic meat flavor precursor was found to contain a substance resembling a glycoprotein, with

a high phosphorus content. Further work broke the glycoprotein into glucose plus the following: proline, isoleucine, α-alanine, valine, serine, β-alanine, glycine and glutamic acid in small amounts, and two unidentified amino acids. The researchers found that a mixture of the glycoprotein plus inosine and inorganic phosphate and glucose, when heated in fat, produced an odor similar to broiled steak. This odor, however, is relative to the proportions of the components. The final flavor ingredients could not be determined since the breakdown products, developed when the precursors were heated with fat, were not studied.

Pintauro (1971) reported other work that has been done with this precursor. When the precursor is dissolved in water, without heating, it has no detectable odor and a mildly salty taste. When heated to 280° to 320° F, cooked beef flavor is developed and when heated to 320° F with beef fat, a broiled steak odor is produced.

A summary of studies on lean meat flavor precursors, as reported by Hornstein (1967), resulted in the following conclusions. Meat flavor precursors are only low-molecular weight, water soluble materials. High molecular weight proteins are thought not to contribute to the precursors. Similarities in the odor of lean pork, beef and lamb are related to their similar conposition of amino acids and carbohydrates. As mentioned earlier, parts of beef flavor may result from a specific glycoprotein plus inosinic acid. Finally, a browning type reaction may not be the only cause of lean meaty flavors. They also have been produced from a mixture of polypeptides, amino acids and hypoxanthine.

Volatile components. Volatilization of the water soluble fractions and identification, mainly by gas chromatography, has lead to many components of heated beef. MacLeod and Coppock (1976) report listings of more than

300 volatile constituents of heated beef which include members of at least 18 different chemical classes.

Identification of the volatile compounds of beef has been studied for the last 20 years, yet the compounds identified to date have not represented the characteristic cooked beef aroma (Min et al., 1977). In 1960, Hornstein et al. identified the following compounds from the volatile fraction of raw ground beef, heated in a vacuum. They included acetone, acetaldehyde, formaldehyde, hydrogen sulfide, ammonia and methylamine. Kramlich and Pearson (1960) reported the presence of carbon dioxide, acetone, acetaldehyde, methyl mercaptan and possibly methyl sulfide from cooked beef. Tonsbeek et al. (1968) found two furanones with characteristic odors, one similar to caramel and the other to roasted chicory root. Other components which were found included acetone, acetic acid, propionic acid, isobutyric acid, butyric acid, valeric acid, isocaproic acid, lauryl alcohol and lactic acid.

Hornstein (1967) reports that a large part of meat flavor is due to the amino acids and sugars in raw meat. Maillard browning or the Strecker degradation are responsible for most of those compounds.

Research conducted by Chang and Peterson (1977), led them to believe the following classes of compounds may not be primary contributors to meat flavor. Included are aliphatic hydrocarbons, aromatic hydrocarbons, saturated alcohols, carboxylic acids, esters, ethers and carbonyl compounds (aldehydes and ketones). Instead, they believe 1) lactones, found in roast beef drippings and boiled beef, 2) acyclic sulfur containing compounds (e.g. mercaptans, sulfides), 3) nonaromatic heterocyclic compounds containing S, N, O (e.g. hydrofuranoids), and 4) aromatic heterocyclic compounds containing S, N, O (e.g. pyrazines, thiophenes) were important.

The isolation of 102 volatile compounds was achieved by MacLeod and Coppock (1976) in their study to determine the composition of boiled beef aroma. Although not all of the compounds could be identified, some of the compounds eluted aromas described as: dull, cardboard; pleasant, sweet; strong, sour, harsh, burnt, unpleasant; grassy, solvent-like; strong; grassy, onions, rancid; animal-like; rancid, rotting vegetables; medicinal; and background smell, sweet, green peppers, rubber.

Although gas chromatography is a very useful instrument in isolating the volatile components of meat, Chang and Peterson (1977) believe that some compounds are never eluted from the column, for various reasons, and thus are lost. They propose that high pressure liquid column chromatography be used to determine the components of the less volatile fraction and that gas chromatography be used for the more volatile components.

Contribution of fat. Fat found in beef also contributes to flavor and aroma. In studies by Hornstein and Crowe (1960) beef fat was rendered under nitrogen and heated at 100° C in nitrogen, a vacuum, and in air. The fat heated in nitrogen produced a non-meaty aroma, while the fat in the vacuum was sweet and apple-like. The fat heated in air produced a fried fat aroma, usually associated with beef. Fat oxidation in the presence of air, increases the carbonyl compounds which are responsible for both desirable and undesirable flavors.

As mentioned earlier, Chang and Peterson (1977) do not believe that carbonyl compounds are very important in meat flavor. However, certain carbonyl compounds are powerful and do contribute to total meat flavor. Most are decomposition products (autoxidation or oxidative) of lipids. In their studies, they found no odor or flavor, similar to meat, in the decomposition products of animal fats and oils. They reported work that

found volatiles in boiled beef flavor contained a limited number of carbonyl compounds, none of which had meaty notes.

Min et al. (1977) identified a homologous series of n-alkylbenzenes and other alkyl substituted benzenes from the neutral volatile fraction in roast beef. They believe these compounds may be important in the odor of cooked beef fat. Those researchers believe alkylbenzenes may be produced through some of the following methods: 1) pyrolysis of D-glucose at 300° C; 2) pyrolysis of free phenylalanine or tyrosine; 3) oxidation of trans-2-trans-4-decadienal, a thermal oxidation product of fat; or 4) formed from long chain unsaturated hydrocarbons.

Sensory method for determining flavor and aroma. The flavor profile method is a sensory method of determining the major aroma, flavor and aftertaste characteristics of a food. Caul (1957a) applied this method to broiled beef loin steaks. The aroma included an animal note (similar to liver) along with brothy (including caramelized and bouillon-type notes), nosefilling (due to brothiness and broiled fat), and sweet (associated with nuts).

The flavor characteristics include serum (mixture of blood salts and salivation), brothy (including cooked serum and factors of pyrolysis), animal (liver), mouthfilling (derived from salivation), salivation, and bouquet (full flavor perceived when meat is chewed). The aftertaste included the notes: nosefilling, salivating, and mouth satisfaction.

The effects of aging meat and different grades were noted also through the profile method. Aroma characteristics present in some of the various steaks included sour, fatty, and bloody. Other flavor notes included sweet, sour, metallic, astringent, nosefilling, fatty-soapy, and fishy (Caul, 1957a).

Properties of Salt as a Seasoning

General properties. Salt, according to Pintauro (1971), is the oldest and most widely used flavor enhancer for meat. It can be used at levels at which it cannot be detected, but is effective in bringing out natural flavor. According to Crocker (1945), unless a fair proportion of salt is present, nearly all starchy and protein foods are uninteresting. Salt becomes noticeable when its proportion is between 1/2 and 1%, and in most foods, this proportion must not be exceeded.

Researchers have shown sodium chloride to reduce the sourness of acid and to increase the sweetness of sugar. Sugar reduces the saltiness of sodium chloride while acids (except hydrochloric acid) increase the saltiness (Johnson and Peterson, 1974).

Other properties of salt include its acceleration of the onset of rancidity in frozen meat (Levie, 1963). When used in soy products, the addition of salt has a masking effect (Rakosky, 1974). No comments were made in the article as to the amounts of salt needed or the effect received from such an addition. Franzen and Kinsella (1974) noted that flavor protein interactions are dependent on many variables, among which was the presence of salts.

Jennings (1965) mentions, in addition to the use of salt in foods to improve taste, that sodium chloride increases the volatility of a dilute ester solution. Other work, cited by Jennings, showed that most salts increase the volatility of benzene, carbon dioxide, nitrous oxide, ammonia, trimethylamine, aniline, acetone and various organic acids.

Use of salt in beef-soy mixtures. In various studies, salt has been incorporated with other seasonings into beef-soy patties and loaves. In some of these studies, (Terrell and Staniec, 1975; Shafer and Zabik, 1975)

sensory evaluation was not the primary objective so data were not available. No reports, however, were found in the literature of the effects of adding only salt to beef-soy mixtures.

In a study by Nielsen and Carlin (1974) salt was one of the components of their beef-soy loaves with soy being substituted at the 30% level. Their study was involved with freezer storage of the loaves. They found neither the beef or soy was significantly affected by freezer storage up to six months. Their panel members found the soy flavor, for all of the treatments, to be pronounced. The researchers stated, however, that no attempt was made to mask the soy flavor with tomatoes or spices. Juiciness scores were found to be significantly lower in the 30% soy substituted loaves than in the all beef loaves. Williams and Zabik (1975) conducted a sensory evaluation of 0 and 30% textured soy substituted ground beef and found lower flavor and juiciness scores with the beef-soy loaves.

The effect of condiments and freezer storage was studied by Kotula et al. (1976). Their beef patties were substituted with 20 and 30% textured soy protein and concentrates. The patties included monosodium glutamate, salt and pepper, and were served on a bun with pickles, mustard, and catsup, along with cola and potato chips. They found the condiments significantly improved scores for flavor, aroma and overall acceptability as judged by a 13 member panel. Juiciness scores were lower for the patties with the condiments, probably because the buns absorbed some of the juices.

Drake et al. (1975) utilized consumer and trained panels to rate flavor and texture in beef-soy patties containing 0, 15, 20, and 25% soy and four different fat levels (15, 20, 25 and 30%). The consumer panel was given optional, portion controlled salt packets. There was no mention of this given to the trained panel rating the same product. Both groups

found the soy to have a significant effect on odor and flavor. Since the salt was optional for the consumer panel, its use and effects could not be determined.

Effect of salt on cooking losses. Moore et al. (1976) working with beef rolls, and Schwartz and Mandigo (1976) using restructured pork, found cooking losses to be reduced significantly by using various percentages of salt (Moore et al. used 1, 2 and 3% while Schwartz and Mandigo employed 0, 0.75, 1.50 and 2.25%). Sherman (1961) noted that fluid retention, as affected by sodium chloride, a neutral salt, depended on the degree of ion absorption by meat proteins. The anions tend to be retained preferentially. Upon heating to 100° C, anions and cations are released but the anions still are retained preferentially from the neutral salts. Hamm (1960) relates that the nature of the binding of salt to protein is mainly electrostatic because salt ions are attracted by positively or negatively charged groups of the protein. Ground meat has a greater swelling and water holding capacity than a more structured piece of meat because of its increase in surface area while maintaining the insolubility of the muscle proteins.

EXPERIMENTAL

Materials and Preparation

Fifty pounds of ground beef, approximately 75 per cent lean, was procured from the Department of Animal Science and Industry of Kansas State University. The meat was packaged in amounts needed for each evaluation period and held frozen until used. For each evaluation period, ground beef was thawed 39 hr. at 5° C, then mixed with salt and/or soy and made into 200 gram patties. Textured vegetable protein (VMR III-1895

coarse flake, Nabisco, Randolph, N.J.) was rehydrated with cold tap water (2 parts water: 1 part soy by weight) for ten minutes and added to the ground beef in the following percentages: 0, 2, 6 and 10. For each level of soy, salt was added at levels of 0, 0.4, 0.8 and 1.2 grams per 200 gram patty. The salt was added to the hydration water of the soy or was sprinkled over the ground beef.

The ingredients were mixed for 1 minute at speed 1 in a Hobart mixer (Model N-50), then reground through a 3/16 in plate and molded into a patty. Patties were placed on a wire rack 7 cm high, in a shallow pan and a thermometer inserted. They were cooked in a rotary-hearth electric oven at 350° F (177° C) to an internal temperature of 75° C. The percentage total losses were calculated based on the weight of the uncooked patty. Cooking time also was recorded.

Measurements

Sensory evaluation by rating. Prior to the first evaluation, the eight panelists were given a flavor recognition test to determine whether or not they could perceive the salty and other primary tastes. The solutions, made with reagent grade chemicals and distilled water, included: 1) sour--citric acid (monohydrate), 0.70 g/1000 ml; 2) bitter--caffeine, 0.70 g/1000 ml; 3) sweet--sucrose, 20.0 g/1000 ml; (Caul, 1957b), and 4) salty--sodium chloride, 3.0 g/1000 ml (Caul, 1977). A duplicate of citric acid and a sample of water were included giving the panelists six samples to evaluate. All of the panel members were able to identify the salty sample as well as the other primary tastes.

Each patty was cut into eight wedges and each wedge placed with the outer, browned side up in a pre-warmed 50 ml beaker and covered with a 50 mm watch glass. Two beakers were placed in a pre-warmed covered, ceramic

casserole dish, placed on a hot tray and presented to an eight member panel. Each panel member received two casserole dishes with a total of four samples per session. Crackers with unsalted surfaces and water were used by the panelists to alleviate flavor carry-over between the samples. The panelists evaluated their samples in individual booths. Scoring of the patties included aroma and flavor for both cereal and beef (1, absent, to 7, very intense), juiciness (1, very dry, to 7, very juicy), saltiness (1, absent, to 7, very intense) and a separate scoring for personal preference (1, dislike extremely, to 7, like extremely). The scorecard may be found on p. 41 of the Appendix.

Statistical design. A 4 X 4 balanced lattice design was used for the evaluation (Cochran and Cox, 1966). The effective error mean square was used to determine significant treatment effects. Thereafter, Fisher's LSD technique was employed. The sources of variation considered in the study were the following:

Source of Variation	d.f.
Replications	4
Treatments	15
Blocks (adj.)	15
Intra-block error	45
Total	79

Sensory Evaluation by Flavor Profile Analysis

Flavor profiles of the textured soy flakes, ground beef, and the beef-salt and beef-soy-salt patty combinations were done twice to provide additional information on the aroma, flavor and aftertaste of the patties. The six member panel was composed of students from various fields, who had training in this method of analysis the previous semester while enrolled

in a food flavor analysis course at Kansas State University. The author of this study served as the panel leader. Usually, two evaluation sessions were held each week with two samples evaluated at each session. Each panel member was seated at a desk in a circular arrangement. This was to facilitate discussion of the samples after individual evaluations were made. Crackers with unsalted surfaces and water were available for the panel members. This analysis was begun 3 1/2 weeks before the sensory analysis that was explained previously and was held concurrently for 4 1/2 weeks. Most of the flavor profile panelists were also members of the other sensory analysis panel. On days that both panels were held, the sensory analysis panel was held first, followed after a five to ten minute rest period, by the flavor profile panel.

Sample preparation. The textured soy flakes were prepared for the panel by heating in a double boiler, 10 grams of the soy with 80 grams of water to 75° C, the temperature to which the meat patties were cooked. The mixture was divided into six pre-warmed 50 ml beakers, covered with a 50 mm watch glass and kept warm on a hot tray set at the medium heat. The beakers were each placed in a 1 5/8 in deep custard cup which was half filled with hot distilled water, to keep the samples warm during the evaluation time. These were then given to the panelists. They were instructed to sample the amount of flakes that would cover the tip of a stainless steel teaspoon. This amounted to approximately 1/4 teaspoon.

The ground beef, beef-soy and beef-soy-salt combinations were mixed and prepared for sampling according to the method described previously for the sensory analysis by rating. The samples were placed in the beakers in the same manner as for rating, but the beakers were placed in a custard cup, half filled with hot water, as was done for the flavor profiles of the

soy flakes.

Each sample was evaluated for aroma, flavor and aftertaste. Panelists recorded the aroma, flavor and aftertaste characteristics in the order in which they were perceived. Intensities of each were scored:)(, just recognizable; 1, slight; 2, moderate; and 3, strong. Overall intensities for the aroma and flavor also were noted. Discussion followed of each of the components that the members perceived. The notes that all of the members agreed upon then were indicated as being part of the flavor profile. Components that were not found by all of the members were listed in the "other" category. Each sample was profiled once on each of two different days. The results of the second profile are reported in the Appendix, pp. 52 - 56.

RESULTS AND DISCUSSION

Adjusted mean values of the sensory evaluation by rating were computed following the analysis of variance shown in Table 6, Appendix. The appropriate LSD's and significant differences between means are indicated in Table 1.

Sensory Evaluation by Rating Panel

Meaty aroma. In most instances, the salt level did not influence the meaty aroma of the beef-soy patties. However, the meaty aroma in the 6% soy patties was greater with 1.2 g than with 0.8 g of salt and gave the highest meaty aroma of the samples. The same salt addition (1.2 g) to the 10% soy mixtures gave the lowest meaty scores of the samples. Salt works to round out or pull together character notes (Caul, 1957a). Oversalting would break this blend, causing the notes to "stick out" or be dominated by the salt. The greater meaty aroma in the 6% soy patty with

Table 1. Adjusted means of sensory evaluations of cooked beef-soy-salt patties with LSD values.

Treatment	Aroma		Flavor			
	Meaty	Cereal-like	Meaty	Cereal-like	Saltiness	Hedonic
0% Soy						
0.0 g. salt	4.5	2.4	4.7	2.5	1.5	3.9
0.4 g.	4.3	2.5	4.7	2.5	2.3	4.6
0.8 g.	4.5	2.3	5.0	2.0	3.3	5.2
1.2 g.	4.2	2.3	5.0	2.1	4.4	5.8
2% Soy						
0.0 g.	4.5	2.6	4.3	2.8	1.5	3.8
0.4 g.	4.6	2.1	5.1	2.2	2.6	4.8
0.8 g.	4.5	2.8	5.1	2.2	3.6	5.7
1.2 g.	4.6	2.5	5.0	2.5	4.1	5.7
6% Soy						
0.0 g.	4.4	2.9	4.2	3.5	1.4	3.9
0.4 g.	4.3	2.8	4.3	3.3	2.2	4.3
0.8 g.	4.2	2.8	4.5	2.8	3.2	5.1
1.2 g.	4.7	2.8	4.7	2.7	3.8	5.3
10% Soy						
0.0 g.	4.0	3.6	3.1	4.8	1.3	3.2
0.4 g.	4.2	3.2	3.7	4.0	2.0	4.2
0.8 g.	4.1	3.7	3.8	4.5	3.0	4.8
1.2 g.	3.7	4.0	3.8	4.2	3.9	4.4
LSD + = .05 < P ≤ .10	+ = 0.4	+ = 0.5	+ = 0.4	+ = 0.5	+ = 0.4	+ = 0.5
* = .01 < P ≤ .05	* = 0.5		* = 0.5	* = 0.6	* = 0.5	* = 0.6
** = P ≤ .01			** = 0.6	** = 0.8	** = 0.7	** = 0.7

1.2 g salt could have resulted from an enhancing of the meaty note or masking of the soy. The decreased value in the 10% soy patty with 1.2 g salt could have been caused by too much or too little salt for the soy level used.

Generally, increasing the soy level decreased meaty aroma. Differences were significant between the 6 to 10% soy substitutions for patties containing the 0 and 1.2 g salt additions.

Cereal-like aroma. Generally, salt levels had few effects on cereal aroma. Cereal-like aroma decreased with the addition of 0.4 g salt to the 2% soy patty, but increased with the addition of 0.8 g salt to the same soy level. An increase in cereal aroma occurred between the 0.4 and 0.8 g salt additions in the 10% soy substituted patties.

Increases in soy level generally increased cereal-like aroma. Differences occurred between the 6 and 10% soy substitutions in all patties but those containing 0.4 g salt. For the patties containing 0.4 g salt, cereal aroma was greater in those with 6% soy than those with 2%. For patties with 0.8 g those with 2% soy had more cereal aroma than those with no soy. Increases in cereal-like aroma occurred at lower soy levels with 0.4 and 0.8 g salt than the samples with 0 or 1.2 g salt where changes only occurred between the 6 and 10% soy addition. At the 0.4 and 0.8 g levels, salt may enhance cereal-like aroma while at the 0 and 1.2 g levels, it may mask or dominate part of the aroma.

Meaty flavor. Generally meaty flavor increased with added salt. Differences were significant ($P \leq .01$) for patties with soy substituted at 2 and 10% levels and with salt added at levels between 0 and 0.4 g. Perhaps this occurred because salt enhances the natural flavor of foods (Pintauro, 1971).

Increasing soy generally decreased meaty flavor. Significant decreases occurred with both the 0.4 and 0.8 g salt additions between the 2 and 6% soy levels. Meaty flavor was decreased significantly ($P \leq .01$) between the 6 and 10% soy levels for all salt additions. Bowers and Engler (1975) found freshly cooked beef patties containing 15% soy to be significantly lower in meaty flavor as compared to all beef patties. Fifteen percent soy was the lowest soy level used in their study.

Cereal-like flavor. In some cases, cereal-like flavor decreased when 0.4 or 0.8 g of salt was added to the beef-soy patties. Significant decreases were noted between the 0 and 0.4 g salt additions to patties containing 2 and 10% soy. A decrease was also noted with salt added between 0.4 and 0.8 g for the patties with no soy. Some masking or decrease in cereal flavor may have occurred here.

Increasing soy levels, for the most part, increased cereal-like flavor. For patties with 0, 0.4 and 0.8 g salt, differences were significant between 2 and 6% and between 6 and 10% soy, and for those with 1.2 g salt between 6 and 10% soy.

Saltiness. An increase in saltiness was perceived with each salt addition to each soy level. Within each salt level, increased soy did decrease the saltiness, but differences were significant ($P \leq .05$) only between the 0 and 6% soy, and 0 and 10% soy substitutions with 1.2 g salt.

Juiciness. No discernible effect on the juiciness scores was shown by changing the salt or soy levels. Research by Bowers and Engler (1975) and Smith et al. (1976) found no variation in juiciness in ground beef patties substituted with soy at 15 and 30%, and 20 through 50% levels, respectively.

Hedonic. A separate hedonic scoring was done because some people

like saltier food than others. Significant increases in degree of "likeness" occurred with salt between 0 and 0.4 g and between 0.4 and 0.8 g for all soy levels except the 6% level. No significance was noted between the 0 and 0.4 g salt levels for the 6% soy. Increases between 0.8 and 1.2 g salt occurred only with 0% soy. Improved acceptability occurred with some salt additions, but after a certain amount, no further improvement was made.

Increasing soy decreased scores only in a few instances. Differences occurred for patties containing 0 and 1.2 g salt levels between the 6 and 10% soy substitutions and for the patty with 0.4 g salt between the 2 and 6% soy substitutions. The decrease in degree of "likeness" between the 2 and 6% soy with 0.8 g salt followed an increase at the same salt level between 0 and 2% soy.

Physical Measurements

Table 2 presents the adjusted mean values and the significant differences between treatments for the physical measurements. The analyses of variance are found in Tables 6 and 7 in the Appendix.

Cooking loss. Cooking losses generally increased with increased salt level. For patties containing 0, 6 and 10% soy, cooking losses were greater for the 1.2 g salt addition than for the 0.8 g. Since salt levels used in this study were 0.2, 0.4 and 0.6% of the mixtures, these may have been too low to give the decrease in cooking losses as found by Moore et al. (1976) who used 1, 2 and 3% salt in beef rolls, and Schwartz and Mandigo (1976) who employed 0, 0.75, 1.5 and 2.25% salt in restructured pork.

Some decreases in cooking losses were noted with increases in soy level. Significant differences were noted between the 2 and 6% soy levels with 0, 0.4 and 1.2 g salt additions, and between the 6 and 10% soy levels

Table 2. Adjusted means of physical measurements of cooked beef-soy-salt patties with LSD values.

Treatment	Cooking Loss	Cooking Time
0% Soy		
0.0 g. salt	36.73	45.2
0.4 g.	37.45	45.6
0.8 g.	37.24	46.6
1.2 g.	38.90	47.7
2% Soy		
0.0 g.	36.57	45.8
0.4 g.	36.72	48.0
0.8 g.	36.68	47.2
1.2 g.	38.22	46.0
6% Soy		
0.0 g.	34.79	46.8
0.4 g.	35.43	45.2
0.8 g.	36.05	45.0
1.2 g.	35.38	45.8
10% Soy		
0.0 g.	33.37	45.2
0.4 g.	34.72	44.9
0.8 g.	33.74	43.7
1.2 g.	34.83	42.8

LSD + = .05 < P ≤ .10 + = 0.9 + = 3.0
* = .01 < P ≤ .05 * = 1.1 * = 3.6
** = P ≤ .01 ** = 1.4

with 0 and 0.8 g salt. This general trend of decreased cooking losses is supported by Wolf and Cowan (1975) who found that soy proteins promoted moisture and fat retention. Work by Yoon et al. (1974), Bowers and Engler (1975) and Smith et al. (1976) also has shown that textured vegetable protein in ground beef mixtures decreases total cooking losses as compared to 100% ground beef.

Cooking time. Level of salt did not affect cooking time.

Increasing soy, in some cases, decreased cooking time. Increasing soy from 6 to 10% for patties with 1.2 g salt decreased cooking time, as did increasing soy from 2 to 10% for patties with 0.4 and 0.8 g salt. Work by Nielsen and Carlin (1974), however, found no significant effect on cooking time with their beef-soy loaves, while Shafer and Zabik (1975) found cooking time to be inversely related to fat content.

Flavor Profile Analysis

Aroma of the samples consisted of combinations of some of the following character notes: browned beef and fat, cereal, sweet and salty. The flavor may have also included a springy, chewy or mealy mouthfeel and possibly a BSM (bloody, salty, metallic) character. Basically, the aftertaste was comprised of an oily mouthcoating, and/or salty, BSM and cereal notes. Discussion of the profiles (Appendix, p. 52) will be divided into the effect of increased soy within each salt level and increased salt within each soy level on aroma, flavor and aftertaste. An explanation of the flavor terms used in the profiles is found in the Appendix, p. 48.

Effect of increased soy. Many of the components of aroma, flavor and aftertaste of the soy are lost when combined with the beef.

Aroma. The browned beef and fat note was prominent for all but the 10% soy patties, at which level it was decreased slightly in intensity and

was dominated by the cereal aroma (Figure 1). The salty character, usually found as an "other" note, was dominant only in the 0% soy patty with 1.2 g salt. The sweet note, intermittently appearing, could be a component of the beef (Caul, 1957a) or the soy (Rackis et al., 1966). The sweet note was a major one in the following patties: 0 soy with 0 salt; 6% soy with 0 salt; and 10% soy with 0.4 g salt. The panelists believed the soy contributed the sweet note in the 10% soy patty with 0.4 g salt.

For the overall intensity, the 6% soy patty with 0.4 g salt had the greatest aroma intensity of the samples and was rated 1+ to 2. At the 10% soy level, the cereal aroma became dominant when 0 and 1.2 g salt were added. Otherwise, the aroma intensities were similar and ranged from 1- to 1+.

Flavor. The order of the perception of the flavor notes for the lower salt levels was beef, cereal and salty, while for the higher salt levels it was salty, beef and cereal.

For the first group, browned beef and fat was predominant in the 0, 2 and 6% soy patties containing 0 and 0.4 g salt (Figure 2). Blending of the beef and cereal occurred in the 6% soy patty with 0 salt while beef was blended with a salty note in the 6% soy patty with 0.4 g salt. Cereal was the dominant note in the 10% soy patties with 0 and 0.4 g salt and was followed by the beef character. Although dominant only in the 10% soy samples, cereal was noted in all of the 0 and 0.4 g salt samples, including those with no soy added. The salty character was a major note in the 6% soy patties with 0 and 0.4 g salt and also in the 0 and 2% soy patties with 0.4 g salt added. Several "other" salty notes also were perceived. Several panelists perceived the browned exterior of the samples to be saltier than the interior and noted this with the 6% soy 0.4 g salt

FIGURE 1 BEEF & CEREAL AROMAS REPORTED FROM FLAVOR PROFILES

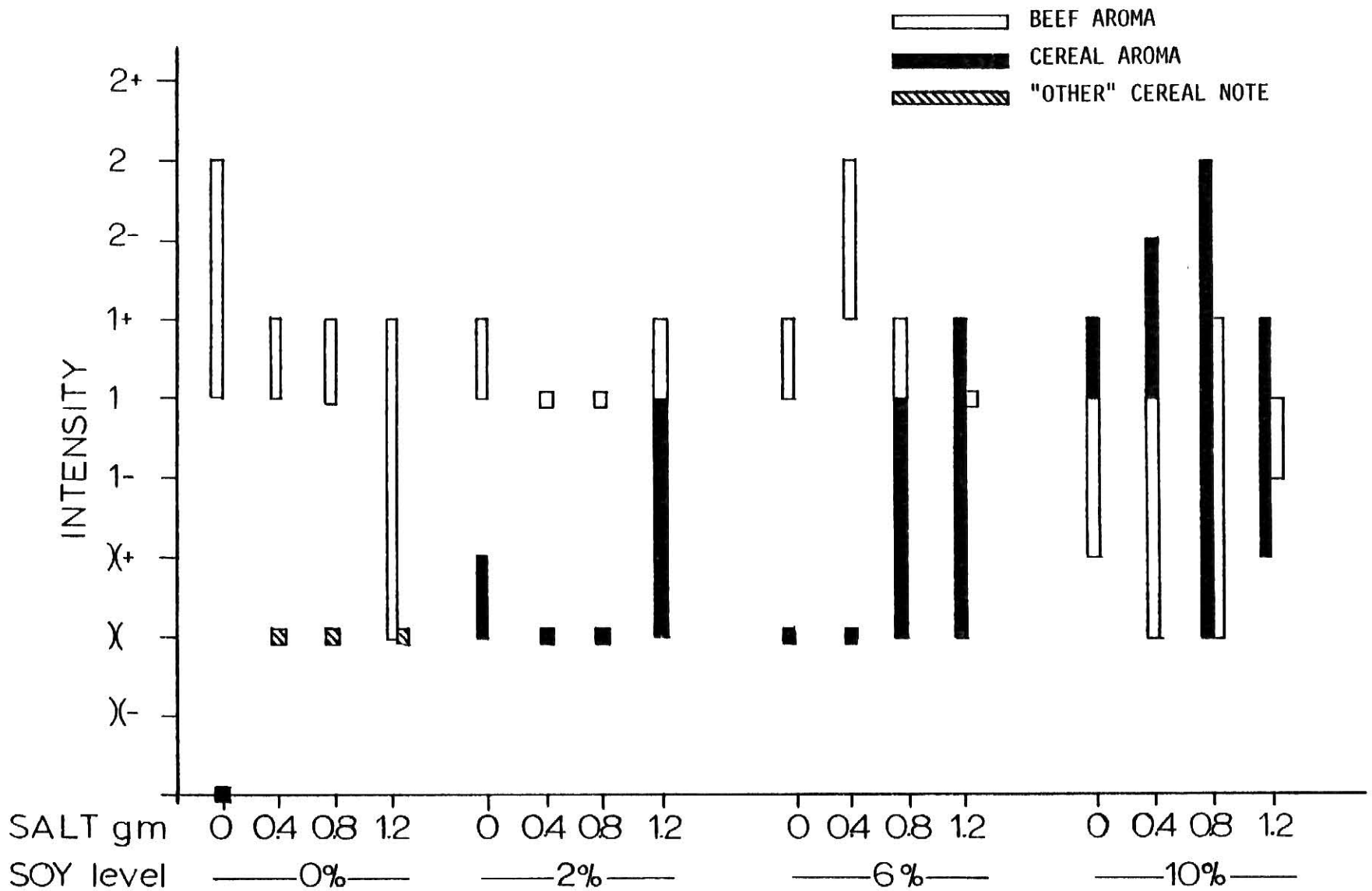
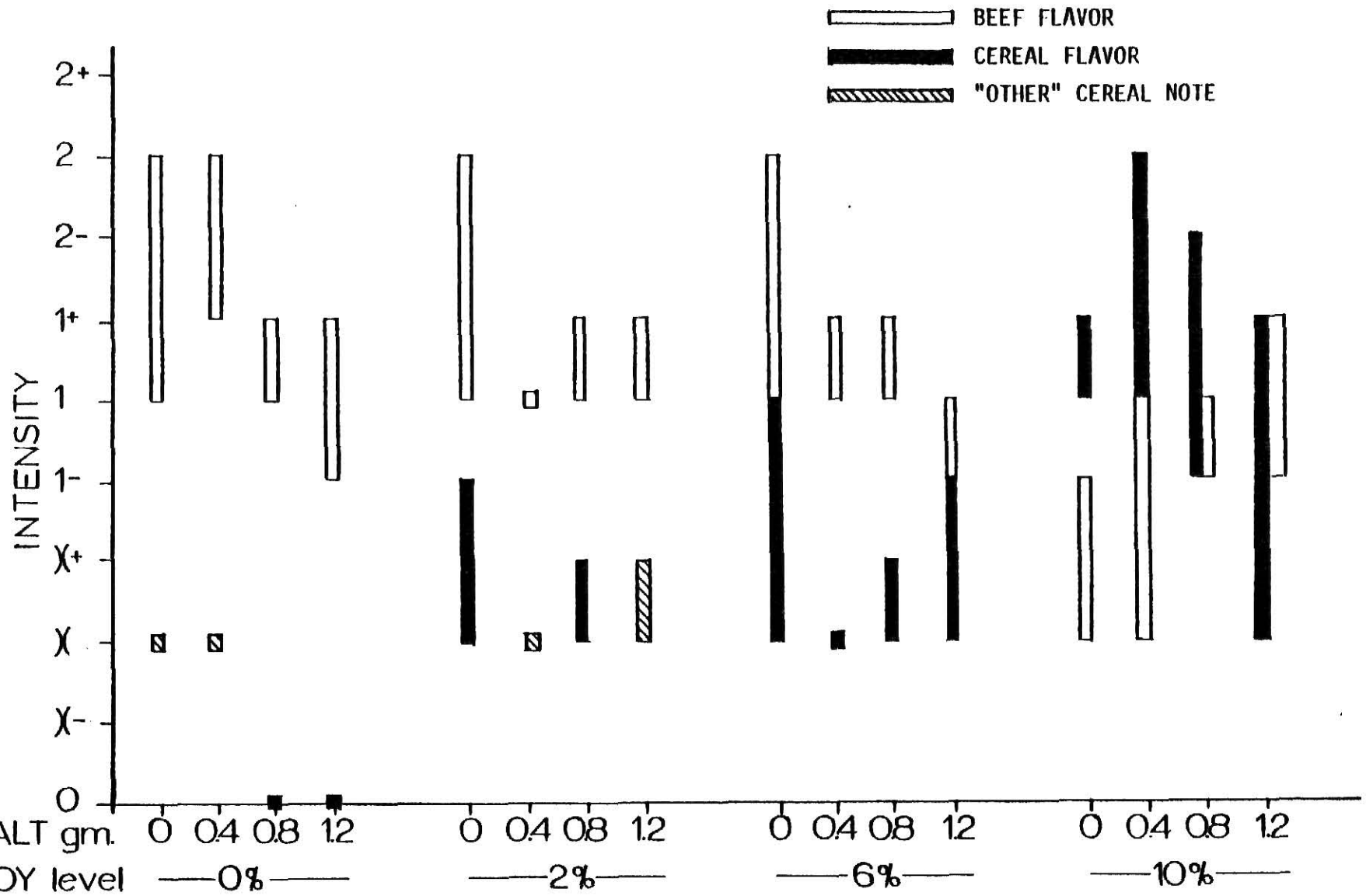


FIGURE 2 BEEF & CEREAL FLAVORS REPORTED FROM FLAVOR PROFILES



patty. The saltier taste could occur from concentration differences, since the outside of the patty is drier than the interior.

For the patties with 0.8 and 1.2 g salt, the salty note was dominant for all but the 2% soy sample with 0.8 g salt, where the beef note prevailed. The beef note, perceived next, was blended with the salty note in the 6% soy patty with 0.8 g salt and blended with the salty and cereal notes in the 10% soy sample with 0.8 g salt. Cereal was a major note for all of the soy substituted samples with 0.8 and 1.2 g salt, except the 2% soy patty containing 1.2 g salt where it was an "other" note. A slight increase in cereal flavor was noted in the 10% soy sample with 0.8 g salt.

Generally the oily mouthcoating decreased with increased soy additions. Since soy promotes fat absorption (Wolf and Cowan, 1975) this could explain why the oily mouthcoating was decreased or eliminated with increased soy.

The BSM character usually decreased with added soy. Although perceived as a major note in the 0% soy patties with 0, 0.4 and 0.8 g salt, it was noted as an "other" in almost all of the other samples.

The mouthfeel of the samples changed from springy to mealy with the addition of soy. The squeaky character, found in the ground beef, could be associated with the springy mouthfeel. Between the 2 and 6% levels, the springy mouthfeel changed to springy mealy with no salt and to chewy and mealy with the higher salt levels. All of the 10% soy samples were mealy while the sample with 0.4 g salt also was slightly chewy. Salt, in a high enough concentration, can alter the feel of food (Sjostrom, 1972). This, coupled with the mealy mouthfeel of the plain soy, could be responsible for the changes in the mouthfeel of the samples.

The sweet note was dominant only in the meat patties with 6% soy and no salt. It was in the remaining 6% soy samples and the 0 and 10% soy

patties with no salt as an "other" flavor note. The absence of this note could be caused by the domination of the salt or lack of enough salt to enhance the sweetness in the samples.

The overall flavor intensity for all of the samples was similar and ranged from 1 to 1+. The patties with 10% soy and no salt were predominantly cereal in flavor, while the patties with 1.2 g salt were scored slightly higher in intensity, possibly because of the predominance of salt.

Aftertaste. Soy slightly shortened the duration of the aftertaste for patties with 0 and 0.4 g salt. For the patties with 0.8 and 1.2 g salt, increasing the soy from 6 to 10% increased the duration of the aftertaste.

An oily mouthcoating was present for all samples but was decreased slightly for the 6% soy patties with all salt additions, and the 2 and 10% soy patties with 0.4 g salt. Generally, the BSM note decreased with increased soy. A cereal note became apparent for the 10% soy patties with 0 and 0.4 g salt added. Astringency was related to the cereal note in the 10% soy sample with 0.4 g salt. "Other" cereal notes were found in the remaining 10% soy patties and all the patties with 1.2 g salt except the 2% soy patty. The salty character was a major note in all patties with 1.2 g salt and the 6% soy patty with 0.8 g salt, but was an "other" note for the remaining 0.8 g salt patties.

Effect of increased salt. This section will deal with the effect of increased salt on the aroma, flavor and aftertaste of the samples in each of the soy levels.

Aroma. Browned beef and fat was predominant in all samples but those with 10% soy where cereal was dominant. Increasing salt in the 0

and 6% soy samples gave a slight decrease in beef aroma intensity. The salty note was found as an "other" note in many of the samples. Increasing salt levels slightly increased the cereal note in the 2 and 6% soy samples, but decreased cereal slightly in the 10% soy samples. Sweet was perceived only as a major note in patties with no salt containing 2 and 6% soy and in the 0.4 g salt patty with 10% soy. The sweet in the 0.4 g salt, 10% soy sample was thought to be related to the soy.

Overall, the aroma decreased very slightly with increased salt. Cereal was the predominant aroma only in the 10% soy samples with 0 and 1.2 g salt.

Flavor. Generally as salt was increased, the browned beef and fat note decreased. The beef note was the dominant note in the 0% soy with 0 and 0.4 g salt and for the 2% soy with the 0, 0.4 and 0.8 g salt. The salty note was dominant in the 0.8 and 1.2 g salt additions for 0, 6 and 10% soy and the 2% soy with 1.2 g salt sample. The cereal note dominated the 10% soy, 0 and 0.4 g salt samples. The browned beef and salty characters were blended in the 6% soy patties with 0, 0.4 and 0.8 g salt. With 1.2 g salt, the blend broke, possibly a result of too much salt.

Some salt additions seemed to mask some of the cereal flavor. The 0.8 and 1.2 g salt levels removed the "other" cereal flavor in the 0% soy sample. With 2% soy, the added salt caused the cereal to fluctuate between a major and minor note, meaning that some masking may be occurring. Decreases in cereal flavor also were noted in the 6% soy samples with 0.4 and 0.8 g salt and in the 10% soy, 1.2 g salt sample.

The mouthfeel of the samples was springy for the 0 and 2% soy levels with all salt additions. At the 6% soy level, increasing salt additions changed the mouthfeel from mealy and springy to chewy and mealy. For patties with 10% soy, increasing salt levels changed the mealy to chewy

and mealy and then back to only mealy.

Salt removed the oily mouthcoating from the samples with no soy and 0.8 and 1.2 g salt removed it from patties with 2% soy. Although the oily mouthcoating was found as "other" notes in several of the 6% soy samples, the 1.2 g salt addition removed this note.

The BSM character generally decreased with increasing salt. The salt removed this note completely in the 6% soy samples but it was present again in the 10% soy samples.

The sweet character, found in the 0 soy, 0 salt patty and lost when salt was added, was probably overpowered by the salt. At the 6% soy level, the salt additions somewhat overpowered the sweet note, and moved it into the "other" category, while the 0.4 g salt addition to the 10% soy patty enhanced the sweetness and enabled it to become a major note.

Overall, the intensities of the samples increased slightly with increased salt, because of the dominance of the salt.

Aftertaste. Generally, with increased salt, the duration of the aftertaste decreased, as did the BSM character. An oily mouthcoating, however, was present in all samples. Therefore, the decrease in BSM may be a factor that shortens the duration of the aftertaste. A salty character of major or "other" importance was noted for all soy levels with the 0.8 or 1.2 g salt additions. The cereal appeared occasionally as an "other" note in the 0 and 6% samples. In the 10% samples, the cereal flavor was a major note until the 0.8 and 1.2 g salt additions when it became an "other" note. Apparently, the salt had some masking effect in these last two samples.

Rating panel and profile panel comparisons. Findings of the two panels were similar for both the cereal-like and meaty aroma notes. The

rating panel found an increase in the meaty aroma of the 1.2 g salt, 6% soy sample over the 0.8 g salt, 6% soy patty which was not seen in the profiles. The increase in cereal-like aroma between the 6 and 10% soy patties with 1.2 g salt was indicated by the rating panel but only slightly perceived by the profile panel.

The rating panel and profile panel both indicated decreases in meaty flavor with increased soy. Those decreases occurred between the 6 and 10% soy levels except for the patties with 1.2 g salt where no decrease occurred. Decreases noted in the rating panel between 2 and 6% soy for both the 0.4 and 0.8 g salt additions were not apparent in the profile panels. For cereal-like flavor, the profiles followed the trends for all but the decrease in cereal flavor between 0 salt and 0.4 g salt in the 10% soy patty. This decrease by the rating panel was noted as a slight increase by the profile panel.

The salty character was evaluated similarly by both panels.

The patties with the most meaty and least cereal intensity were noted from results of both panels. For the ground beef sample (0% soy), both patties containing the 0.4 and 0.8 g salt were evaluated by the flavor profile as having a good beef intensity. The patty with 0.4 g salt was predominantly beefy in taste, unlike the 0.8 g salt sample where salt was predominant. Cereal, however, was found as an "other" note in the flavor of this sample. Of this group, the hedonic score from the rating panel evaluated the sample with 1.2 g salt the best liked.

For the 2% soy samples, the addition of 0.4 g salt made the cereal note an "other" and kept the beef as a major flavor. The hedonic panel liked the slightly saltier sample and gave the 0.8 g addition the highest rating.

The aftertaste from the 0.8 g salt, 6% soy patty was shorter than the 0.4 g salt, 6% soy patty and also had the BSM character as an "other". The hedonic panel rated the patty with 1.2 g salt the highest but significantly preferred the 0.8 g addition over the 0.4 g salt addition.

Patties with 10% soy and 1.2 g salt had the lowest cereal flavor, a slightly higher beef note, and a fairly short aftertaste, but were predominantly salty. Of the patties with 10% soy, those with 0.8 g salt were liked most. When looking at the top scores given by the hedonic panel and comparing them with the profile panels, the lowest scoring cereal samples are not always the most well liked.

The profile panels show that salt does have an effect on the cereal character but more work is needed to be done to determine the salt levels which would be most helpful without dominating the product.

SUMMARY

Sensory characteristics of beef patties containing four levels of soy and four levels of salt were evaluated by a rating and a flavor profile panel. Cooking time was decreased only by the highest levels of salt and soy. Cooking losses increased with added salt, but decreased with added soy.

As scored by the rating panel, meaty aroma was not affected by salt level, but increasing soy levels generally decreased meaty aroma. Salt caused little change in cereal-like aroma but increasing soy levels increased this aroma. Meaty flavor generally decreased with increased soy, while the lowest salt level increased meaty flavor. Cereal-like flavor increased with added soy but decreased with some salt levels.

Saltiness increased with each increase in salt, but decreased with

added soy only for the samples containing 1.2 g salt. Changing the salt and soy levels had no effect on the juiciness scores. Generally, the 0.4 and 0.8 g salt additions to each soy level were scored higher in the hedonic rating.

The flavor profiles showed trends similar to the rating panel. Many of the components of aroma, flavor and aftertaste of the soy were lost when it was combined with the beef. The addition of salt affected the flavor of the samples by masking the cereal note in some cases and enhancing it in others. Salt dominated some samples and broke their flavor blends, increased the sweet character in some patties, decreased oily mouthcoating and the BSM note, and altered the mouthfeel of various samples. Soy additions decreased oily mouthcoating and changed the mouthfeel of the samples from springy to mealy.

Soy additions slightly shortened the aftertaste duration of the samples, while added salt shortened the aftertaste duration and BSM notes.

ACKNOWLEDGMENTS

I would like to thank Dr. Jane Bowers, Major Professor, for her guidance, patience and time throughout this study. Also, I want to thank Dr. Holly Fryer, committee member from the Department of Statistics for his help in the statistical analysis and interpretation of the data, and Dr. Carole Setser, committee member from the Department of Foods and Nutrition for her encouragement.

Also, I appreciate the help of Dr. Don Kropf from the Department of Animal Science and Industry in obtaining the meat for the study. I especially want to thank Dr. Jean Caul from the Department of Foods and Nutrition for her ideas and suggestions about the flavor profile analysis.

Special thanks is extended to the members of my taste panels, for without their help and cooperation, this study would not have been possible.

Finally, I would like to thank my friends who encouraged and supported me in this endeavor.

REFERENCES

Anderson, R.H. and Lind, K.D. 1975. Retention of water and fat in cooked patties of beef and of beef extended with textured vegetable protein. Food Technol. 29:44.

Arai, S., Suzuki, H., Fujimaki, M. and Sakurai, Y. 1966. Studies on flavor components in soybean. Part II. Phenolic acids in defatted soybean flour. Agr. Biol. Chem. 30(4):364.

Bowers, J.A. and Engler, P.P. 1975. Freshly cooked and cooked, frozen reheated beef and beef-soy patties. J. Food Sci. 40:624.

Butz, E. 1974. World protein markets--a supplier's view. J. Am. Oil Chem. Soc. 51:57A.

Caul, J. 1957a. Study on development of beef flavor in U.S. choice and U.S. commercial cuts of sirloin. Chem. of Natural Food Flavors Symposium. Sponsored by NAS/NRC for Quartermaster Food and Container Inst. and Pioneering Research Division. ed. by J.H. Mitchell, Jr., N.J. Leinen, E.M. Mrak and S.D. Bailey. Wash., D.C.

Caul, J.F. 1957b. The profile method of flavor analysis. Adv. Food Res. 7:1.

Caul, J.F. 1977. Private communication. Kansas State University, Manhattan, Kansas.

Chang, S.S. and Peterson, R.J. 1977. Symposium: The basis of quality in muscle foods. Recent developments in the flavor of meat. J. Food Sci. 42(2):298.

Cochran, W.G. and Cox, G.M. 1966. "Experimental Designs." 2nd. ed., Plan 10.1, p. 396. John Wiley and Sons, Inc., New York.

Coppock, J. 1974. Soy proteins in foods--retrospect and prospect. J. Am. Oil Chem. Soc. 51:59A.

Crocker, E.C. 1945. "Flavor." p. 55. McGraw-Hill Book Co., Inc.

Crocker, E.C. 1948. Flavor of meat. Food Research 13:179.

Cross, H.R., Stanfield, M.S., Green, E.C., Heinmeyer, J.M. and Hollick, A.B. 1975. Effect of fat and textured soy protein content on consumer acceptance of ground beef. J. Food Sci. 40:1331.

Doty, D.M., Batzer, O.F., Landman, W.A. and Santoro, A.T. 1961. Meat flavor. In "Proc. Flavor Chem. Symp." Campbell Soup Co., Camden, N.J.

Drake, S.R., Hinnergardt, L.C., Kluter, R.A. and Prell, P.A. 1975. Beef patties: the effect of textured soy protein and fat levels on quality and acceptability. J. Food Sci. 40:1065.

Eldridge, A.C., Kalbrenner, J.E., Moser, H.A., Honig, D.H., Rackis, J.J. and Wolf, W.J. 1971. Laboratory evaluation of hexane:alcohol azeotrope-extracted soybean flakes as a source for bland protein isolates. Cereal Chem. 48:640.

Fischetti, F. 1975. Flavoring textured soy proteins. Food Prod. Dev. 9(6):64.

Fisher, R.W. 1974. Future of soy protein foods in the marketplace. J. Am. Oil Chem. Soc. 51:178A.

Franzen, K. and Kinsella, J. 1974. Parameters affecting the binding of volatile flavor compounds in model food systems. J. Agr. Food Chem. 22(4):675.

Fujimaki, M., Arai, S., Kirigaya, N. and Sakurai, Y. 1965. Studies on flavor components in soybean. Part I. Aliphatic carbonyl compounds. Agr. Biol. Chem. 29(9):855.

Goossens, A.E. 1975. Protein flavour problems. Food Process. Ind. 44(528):29.

Hamm, R. 1960. Biochemistry of meat hydration. Adv. Food Res. 10:355.

Honig, D.H., Warner, K. and Rackis, J.J. 1976. Toasting and hexane:ethanol extraction of defatted soy flakes. Flavor of flours, concentrates and isolates. J. Food Sci. 41(3):642.

Hornstein, I. 1967. Flavor of red meats. In "Symposium on Foods: Chemistry and Physiology of Flavors." by H.W. Schultz, E.A. Day, and L.M. Libbey. p. 228. AVI Publishing Co., Inc., Westport, Conn.

Hornstein, I. and Crowe, P.F. 1960. Flavor studies on beef and pork. J. Agr. Food Chem. 8(6):494.

Hornstein, I., Crowe, P.F. and Sulzbacher, W.L. 1960. Constituents of meat flavor: beef. J. Agr. Food Chem. 8(1):65.

Jennings, W. 1965. Influence of temperature and salt addends on vapor equilibration of headspace. J. Food Sci. 30:445.

Johnson, A. and Peterson, M. 1974. "Encyclopedia of Food Technology." p. 778. AVI Publishing Co., Inc., Westport, Conn.

Kotula, A.W., Twigg, G.G. and Young, E.P. 1976. Evaluation of beef patties containing soy protein, during 12-month frozen storage. J. Food Sci. 41:1142.

Kramlich, W.E. and Pearson, A.M. 1958. Some preliminary studies on meat flavor. Food Research 23:567.

Kramlich, W.E. and Pearson, A.M. 1960. Separation and identification of cooked beef flavor components. Food Research 25(6):712.

Levie, A. 1963. "The Meat Handbook." p. 55. AVI Publishing Co., Inc., Westport, Conn.

MacLeod, G. and Coppock, B.M. 1976. Volatile flavor components of beef boiled conventionally and by microwave radiation. J. Agr. Food Chem. 24(4):835.

Maga, J.A. 1973. A review of flavor investigations associated with the soy products raw soybeans, defatted flakes and flours, and isolates. J. Agr. Food Chem. 21(5):864.

Min, D.B.S., Ina, K., Peterson, R.J. and Chang, S.S. 1977. The alkylbenzenes in roast beef. J. Food Sci. 42(2):503.

Moore, S.L., Theno, D.M., Anderson, C.R. and Schmidt, G.R. 1976. Effect of salt, phosphate and some nonmeat proteins on binding strength and cook yield of a beef roll. J. Food Sci. 41(2):424.

Moser, H.A., Evans, C.D., Campbell, R.E., Smith, A.K. and Cowan, J.C. 1967. Sensory evaluation of soy flour. Cereal Sci. Today 12(7):296.

National Livestock and Meat Board. Dec. 13, 1976. Meat Board Reports. 9(22):

Nielsen, L.M. and Carlin, A.F. 1974. Frozen, precooked beef and beef-soy loaves. J. Am. Dietet. Assoc. 65(1):35.

Pintauro, N. 1971. "Flavor Technology." pp. 130-132; 155. Noyes Data Corp., Park Ridge, N.J.

Rackis, J.J., Honig, D.H., Sessa, D.J. and Steggerda, F.R. 1970. Flavor and flatulence factors in soybean protein products. J. Agr. Food Chem. 18(6):977.

Rackis, J.J., Sessa, D.J. and Honig, D.H. Oct. 1966. Isolation and characterization of flavor and flatulence factors in soybean meal. In "Proc. Int. Conf. Soybean Prot. Foods." Peoria, Ill.

Rakosky, J. 1974. Soy grits, flour, concentrates, and isolates in meat products. J. Am. Oil Chem. Soc. 51:123A.

Schwartz, W.C. and Mandigo, R.W. 1976. Effect of salt, sodium tripolyphosphate and storage on restructured pork. J. Food Sci. 41:1266.

Sessa, D.J., Warner, K. and Honig, D.H. 1974. Soybean phosphatidylcholine develops bitter taste on autoxidation. J. Food Sci. 39(1):69.

Sessa, D.J., Warner, K. and Rackis, J.J. 1976. Oxidized phosphatidylcholines from defatted soybean flakes taste bitter. J. Agr. Food Chem. 24(1):16.

Shafer, M.A.M. and Zabik, M.E. 1975. Dieldren, fat and moisture loss during the cooking of beef loaves containing texturized soy protein. J. Food Sci. 40:1068.

Sherman, P. 1961. The water binding capacity of fresh pork. I. The influences of sodium chloride, pyrophosphate, and polyphosphate on water absorption. Food Technol. 15:79.

Sjostrom, L.B. 1972. Flavor potentiators. In "CRC Handbook of Food Additives." ed. Thomas Furia. p. 513. CRC Press, Cleveland, Ohio.

Smith, G.C., Marshall, W.H., Carpenter, Z.L., Branson, R.E. and Meinke, W.W. 1976. Textured soy proteins for use in blended ground beef patties. J. Food Sci. 41:1148.

Terrell, R.N. and Staniec, W.P. 1975. Comparative functionality of soy proteins used in commercial meat food products. J. Am. Oil Chem. Soc. 52(4):263A.

Tonsbeek, C.H.T., Plancken, A.J. and Weerdhof, T. v.d. 1968. Components contributing to beef flavor. Isolation of 4-hydroxy-5-methyl-3(2H)-furanone and its 2,5-dimethyl homolog from beef broth. J. Agr. Food Chem. 16(6):1016.

Wilding, M.D. 1974. Textured proteins in meat and meat-like products. J. Am. Oil Chem. Soc. 51:128A.

Williams, C.W. and Zabik, M.E. 1975. Quality characteristics of soy-substituted ground beef, pork and turkey meat loaves. J. Food Sci. 40:502.

Wolf, W.J. and Cowan, J.C. 1975. "Soybeans as a Food Source." pp. 43-45. CRC Press, Inc., Cleveland, Ohio.

Yoon, S., Perry, A.K. and Van Duyne, F.O. 1974. Textured vegetable protein palatable in meat loaves. Ill. Res. 16(2):10. U. of Ill. Agric. Exper. Station.

APPENDIX

Table 3. Experimental design showing treatment combinations.

Replication 1

Day 1	4-3	2-4	2-2	3-3
Day 2	3-2	4-2	2-3	1-2
Day 3	3-4	1-4	3-1	1-1
Day 4	1-3	4-4	2-1	4-1

Replication 2

Day 5	4-3	3-2	3-4	1-3
Day 6	2-4	4-2	1-4	4-4
Day 7	2-2	2-3	3-1	2-1
Day 8	3-3	1-2	1-1	4-1

Replication 3

Day 9	4-3	4-2	3-1	4-1
Day 10	3-2	2-4	2-1	1-1
Day 11	3-4	4-4	2-2	1-2
Day 12	1-3	1-4	2-3	3-3

Replication 4

Day 13	4-3	4-4	2-3	1-1
Day 14	1-3	2-4	3-1	1-2
Day 15	3-2	1-4	2-2	4-1
Day 16	3-4	4-2	2-1	3-3

Replication 5

Day 17	4-3	1-4	2-1	1-2
Day 18	3-4	2-4	2-3	4-1
Day 19	1-3	4-2	2-2	1-1
Day 20	3-2	4-4	3-1	3-3

Explanation of treatment combinations.

1-1	0 salt, 0 soy
1-2	0 salt, 2% soy
1-3	0 salt, 6% soy
1-4	0 salt, 10% soy
2-1	0.40 g. salt, 0 soy
2-2	0.40 g. salt, 2% soy
2-3	0.40 g. salt, 6% soy
2-4	0.40 g. salt, 10% soy
3-1	0.80 g. salt, 0 soy
3-2	0.80 g. salt, 2% soy
3-3	0.80 g. salt, 6% soy
3-4	0.80 g. salt, 10% soy
4-1	1.20 g. salt, 0 soy
4-2	1.20 g. salt, 2% soy
4-3	1.20 g. salt, 6% soy
4-4	1.20 g. salt, 10% soy

Form 1. Scorecard for rating beef-soy samples.

Name_____

Date_____

SCORECARD FOR BEEF-SOY PATTIES

Sample	Aroma		Flavor		Juiciness	Saltiness
	Meaty	Cereal-like	Meaty	Cereal-like		

Scale for:	Aroma and Flavor	Juiciness	Saltiness
	7 Very Intense	7 Very Juicy	7 Very Intense
	6	6	6
	5	5	5
	4 Moderate	4 Neither Juicy nor Dry	4 Moderate
	3	3	3
	2	2	2
	1 Absent	1 Very Dry	1 Absent

Rate each of the samples on the following personal preference scale.

Sample	Score

7 like extremely
6 like moderately
5 like slightly
4 neither like nor dislike
3 dislike slightly
2 dislike moderately
1 dislike extremely

Table 4. Sensory evaluations of the cooked beef-soy-salt patties; range 1-7.

	1-1	1-2	1-3	1-4	2-1	2-2	2-3	2-4	3-1	3-2	3-3	3-4	4-1	4-2	4-3	4-4
Aroma--Meaty																
	4.2	3.9	4.5	4.1	4.2	4.4	3.6	4.2	4.0	4.6	3.9	4.4	4.2	4.1	4.8	3.6
	4.9	4.1	4.1	3.0	4.1	4.7	4.4	4.3	4.1	4.4	4.6	3.0	4.0	5.0	4.4	3.2
	4.8	4.7	4.6	4.8	4.1	4.1	4.5	3.6	4.4	5.1	4.6	4.4	3.9	4.6	5.0	4.7
	4.2	4.5	4.5	3.8	4.7	4.2	4.1	4.4	5.0	4.1	3.8	4.7	4.0	4.8	4.8	3.6
	4.3	5.1	4.3	4.1	4.6	5.4	4.8	4.3	4.8	4.5	3.9	4.1	5.0	4.7	4.5	3.2
Mean	4.5	4.5	4.4	4.0	4.3	4.6	4.3	4.2	4.5	4.5	4.2	4.1	4.2	4.6	4.7	3.7
Aroma--Cereal-like																
	2.1	2.6	2.9	3.0	2.4	2.4	3.0	2.8	2.2	2.8	2.9	3.0	1.9	3.0	2.5	3.9
	2.4	3.4	3.4	4.5	3.1	2.3	3.6	3.2	2.7	3.7	2.9	3.8	2.4	2.3	3.6	4.3
	1.9	1.7	2.4	3.2	2.8	2.1	2.6	3.4	3.2	1.9	2.1	3.3	3.2	2.6	2.6	2.8
	2.6	3.0	2.8	4.0	1.7	2.6	2.9	3.5	1.8	3.2	2.7	3.8	2.5	2.2	3.0	4.1
	3.0	2.1	3.0	3.0	2.4	1.4	1.7	2.8	1.8	2.8	3.2	3.8	2.0	2.6	2.6	4.8
Mean	2.4	2.6	2.9	3.6	2.5	2.1	2.8	3.2	2.3	2.8	2.8	3.7	2.4	2.5	2.8	4.0

Table 4. --Continued

	1-1	1-2	1-3	1-4	2-1	2-2	2-3	2-4	3-1	3-2	3-3	3-4	4-1	4-2	4-3	4-4
Flavor--Meaty																
	5.2	3.8	3.9	3.4	4.4	4.9	4.2	4.1	5.0	4.9	4.6	4.4	5.0	4.5	4.6	3.9
	5.0	4.2	4.6	3.0	4.3	5.3	4.1	4.0	5.1	4.7	4.9	3.1	5.2	5.3	4.6	3.3
	4.6	4.8	4.0	4.0	4.6	5.1	4.2	3.2	4.6	5.4	4.8	4.3	4.2	5.0	4.2	4.7
	4.6	4.6	4.6	2.9	5.0	5.0	4.5	4.0	5.5	5.1	3.8	3.5	5.0	4.7	4.8	3.9
	4.1	4.9	3.6	2.8	5.0	5.0	4.7	3.8	5.1	5.0	4.5	4.1	5.3	4.4	5.0	3.6
Mean	4.7	4.3	4.2	3.1	4.7	5.1	4.3	3.8	5.1	5.1	4.5	3.8	4.9	5.0	4.7	3.8
Flavor--Cereal-like																
	1.7	3.4	3.4	4.4	2.4	3.0	3.0	3.4	1.7	2.6	2.8	3.4	1.6	2.6	2.8	3.7
	2.5	3.1	3.4	5.2	3.4	1.8	4.4	3.8	2.4	2.1	3.1	5.0	1.8	2.3	2.4	4.5
	2.5	1.8	3.8	4.0	2.4	1.8	4.0	4.6	3.2	1.5	2.5	4.3	3.4	2.8	3.6	3.8
	2.9	2.8	2.8	5.2	2.3	2.9	2.8	3.8	1.4	2.5	2.8	4.3	2.4	2.5	3.0	4.6
	2.6	2.5	3.8	4.9	2.1	1.7	2.8	4.0	1.5	2.8	3.0	4.3	1.7	3.0	2.4	4.1
Mean	2.5	2.8	3.5	4.8	2.5	2.2	3.3	4.0	2.0	2.2	2.8	4.5	2.1	2.5	2.7	4.2

Table 4. --Continued

	1-1	1-2	1-3	1-4	2-1	2-2	2-3	2-4	3-1	3-2	3-3	3-4	4-1	4-2	4-3	4-4
Saltiness																
	2.4	1.4	2.1	1.5	2.1	2.5	1.9	1.9	3.1	3.1	3.0	3.4	4.4	3.2	3.8	4.8
	1.2	1.2	1.0	1.2	3.3	3.0	2.8	2.0	4.1	3.3	3.0	2.1	4.1	4.4	3.8	4.0
	1.4	1.1	1.2	1.8	2.4	2.0	2.5	1.6	3.0	3.0	3.6	2.4	4.4	3.9	3.4	2.7
	1.4	1.1	1.4	1.2	1.7	3.0	1.9	2.8	3.8	4.0	3.2	3.2	4.9	4.2	4.4	4.1
	1.1	1.9	1.8	1.4	2.4	2.7	2.4	1.8	3.4	3.9	3.1	3.3	4.4	4.6	3.4	3.8
Mean	1.5	1.5	1.4	1.3	2.3	2.6	2.2	2.0	3.3	3.6	3.2	3.0	4.4	4.2	3.8	3.9
Juiciness																
	5.0	3.9	5.0	4.9	4.6	4.4	4.5	5.0	4.8	5.2	4.8	4.9	4.6	5.4	4.5	5.0
	4.9	4.1	4.1	3.0	4.1	4.7	4.4	4.3	4.1	4.4	4.6	3.0	4.0	5.0	4.4	3.2
	4.8	4.7	4.6	4.8	4.1	4.1	4.5	3.6	4.4	5.1	4.6	4.4	3.9	4.6	5.0	4.7
	4.9	4.5	4.9	4.8	4.5	4.8	5.1	4.9	4.4	5.5	4.7	4.5	4.0	4.7	4.9	4.8
	4.7	4.6	4.4	4.6	5.0	4.8	4.8	4.4	4.4	4.9	4.8	4.7	4.6	4.6	4.5	4.9
Mean	4.9	4.4	4.6	4.4	4.5	4.6	4.7	4.4	4.4	5.0	4.7	4.3	4.2	4.9	4.7	4.5
Hedonic																
	4.1	3.4	4.5	4.0	4.6	4.5	4.4	4.4	5.4	5.9	5.5	5.2	5.9	5.6	5.2	4.9
	4.1	3.8	4.0	3.3	4.4	5.1	4.3	4.8	5.1	5.7	5.1	4.1	6.1	6.0	5.7	4.3
	4.2	3.7	4.0	3.7	4.5	4.4	4.8	4.1	4.8	6.0	5.4	4.6	5.5	5.6	4.9	4.8
	3.8	3.6	4.0	2.8	4.2	4.6	4.4	4.7	5.6	5.8	4.2	4.2	5.6	5.5	5.5	4.5
	3.4	4.6	3.0	2.8	5.4	5.0	3.8	3.1	5.3	5.0	5.1	5.7	5.6	5.3	5.4	3.7
Mean	3.9	3.8	3.9	3.2	4.6	4.8	4.3	4.2	5.2	5.7	5.1	4.8	5.8	5.7	5.3	4.4

Table 5. Cooking time and percent cooking losses of the cooked beef-soy-salt patties.

	1-1	1-2	1-3	1-4	2-1	2-2	2-3	2-4	3-1	3-2	3-3	3-4	4-1	4-2	4-3	4-4
Cooking Time (min)																
	44	45	44	44	44	47	45	47	44	45	47	44	44	45	47	40
	45	43	47	43	45	45	45	43	45	45	43	40	45	43	45	43
	42	47	45	45	49	47	45	40	50	49	45	45	50	48	48	45
	45	49	49	49	45	51	45	49	49	49	45	45	51	45	44	44
	50	45	49	45	45	50	--	--	45	48	45	--	--	49	45	42
Mean	45.2	45.8	46.8	45.2	45.6	48.0	45.2	44.9	46.6	47.2	45.0	43.7	47.7	46.0	45.8	42.8

	1-1	1-2	1-3	1-4	2-1	2-2	2-3	2-4	3-1	3-2	3-3	3-4
Percent Cooking Losses												
	36.85	36.92	35.38	33.42	38.14	36.43	35.47	34.37	37.02	36.79	36.27	35.05
	36.22	35.89	36.25	32.47	37.43	37.18	36.15	34.19	37.79	36.34	36.85	32.47
	36.01	36.41	33.85	33.08	38.40	35.89	34.62	33.85	37.24	37.50	35.38	33.85
	37.11	37.11	33.68	33.50	36.50	36.76	34.01	34.87	36.92	35.71	36.22	34.01
	37.47	36.50	34.78	34.36	36.76	37.34	36.92	36.34	37.24	37.08	35.55	33.33
Mean	36.73	36.57	34.79	33.37	37.45	36.72	35.43	34.72	37.24	36.68	36.05	33.74

	4-1	4-2	4-3	4-4
	38.97	38.82	36.76	34.69
	37.91	36.73	35.22	35.02
	38.20	37.95	35.22	34.61
	40.15	39.33	33.33	35.50
	39.28	38.26	36.39	34.35
Mean	38.90	38.22	35.38	34.83

Table 6. Analysis of variance mean squares for sensory evaluations of cooked beef-soy-salt patties.

Source of variation	DF	Mean Squares: Aroma Beef.	Aroma Cereal-like	Flavor Beef.	Flavor Cereal-like	Juiciness	Saltiness	Hedonic	Cooking loss
Replications	4	0.43	0.97	0.01	0.28	0.06	0.32	0.29	1.27
Blocks (adj.)	15	0.23	0.37	0.32	0.54	0.18	0.42	0.28	0.58
Treatments (unadj.)	15	0.36	1.26	1.41	3.52	0.19	5.29	2.68	11.99
Intra-block error	45	0.16	0.19	0.11	0.21	0.09	0.14	0.17	0.69
Total	79								
Effective Error Variance (E_e^1)		0.16	0.22	0.13	0.25	0.10	0.16	0.18	0.69
Relative Efficiency		103	110	125	120	110	128	107	101
Adjusted Treat. Ms.[a]		0.36*	0.28+	0.34**	0.81**	0.04ns	1.11**	0.60**	11.99**

a = no adjustment made if relative efficiency was < 105
ns = statistically non-significant
+ = .05 < P ≤ .10
* = .01 < P ≤ .05
** = P ≤ .01

Table 7. Analysis of variance mean squares and significance for cooking time of the beef-soy-salt patties with missing data.

Source of variation	DF	Mean Square and Significance
Replications	4	25.47
Treatments	15	9.33*
Error	56	4.34
Total	75	

* = $.01 < P \leq .05$

Table 8. Explanation of Flavor Terms

Aftertaste: Flavor factors (tastes and odors) perceived in the mouth and nose after food has been swallowed. It is the final impression made by a food. Duration refers to the length of time that the aftertaste lingers in the mouth and nose. It is measured as being short, moderate or long.

Aroma: Odors and feelings perceived by the nose when a product or substance is sniffed.

Astringent: A feeling, brought about by certain tastes, which causes a puckering or tightening of the tissues in the mouth or throat.

Beany (soybean)-hay-green: Similar in characteristics to that of beans, specifically soybeans. It is also combined with the hay-green notes, reminiscent of growing plants.

Bitter: One of the primary tastes. It can be characterized through solutions of caffeine or quinine.

Browned: The aroma and flavor that results from the reaction of amino acids and reducing sugars and/or the caramelization of sugars, when the meat mixture is heated.

Browned beef and fat: An odor reminiscent of the drippings of beef and fat in a pan after beef has been broiled. It also refers to the taste of beef browned in a skillet and its associated fried fat.

BSM: The taste comprised of bloody, salty and metallic notes.

Cereal: Composed of a grainy, green (plant-like), hay aroma which is not necessarily cooked. At high levels some could identify this specifically as soy but at lower levels, was found as more of a grainy smell. The cereal identity was also found as a flavor with grainy characteristics.

Chewy: Needing to be chewed--the act of crushing or grinding with teeth.

Cooked cereal: Has qualities resembling a cooked breakfast cereal, but is not distinctly similar to any certain type.

Dry: An odor which gives the general impression that the product is dry as opposed to being juicy.

Flavor: Flavor by-mouth sensations perceived by the tongue, mouth, throat and nose when food is eaten. This includes feeling factors, tastes, odors and aftertastes.

Grainy-dusty-earthy: Reminiscent of the aroma components of earthy, growing plants and of a grain elevator.

Mealy mouthfeel: The feeling in the mouth of small pieces or particles, present during or after the sample is chewed.

Metallic: Having a flavor resembling a metal.

Nutty: An aftertaste, noted by one panelist, associated with the soy protein.

Oily mouthcoating: A film of oil (from fat) that covers the mouth and throat.

Overall: The comprehensive aroma or flavor of the product, scored as)(, threshold; 1, slight; 2, moderate; or 3, strong.

Salty: One of the four primary tastes, represented by a sodium chloride solution. It was also detected as an odor.

Short lag: A short passage of time before the flavor of the mixture was released and could be perceived in the mouth.

Sour: A primary taste, caused by acids.

Springy mouthfeel: The bouncy feel of the meat against the teeth when chewed.

Squeaky: A short, shrill noise (squeak) made when the meat rubs up and down against the teeth while chewed.

Starchy: A starchy mouthfeel and flavor likened to half cooked oatmeal.

Sweet: One of the primary tastes found in both the meat and textured soy. It is a lighter and more delicate taste than that of a water dilution of table sugar. Sweet also describes the aroma found in some of the beef and beef-soy patties.

Table 9. Abbreviations and scoring used in reporting the flavor profile panels.

Abbreviations

pred. = predominates
br. = browned
m.c. = mouthcoating
m.f. = mouthfeel
slt. = slight
mod. = moderate
* = blending of character notes

Scoring

)(= just recognizable
1 = slight
2 = moderate
3 = strong

Flavor Profiles

Warmed Soy + Water

AROMA

Overall 1 to 1+
Grainy-dusty-earthy 1 to 1+
Beany (soybean)-hay-green 1 to 1+
Cooked cereal)(

FLAVOR

Overall 1
Sweet)(
Bitter 1
Mealy
Starchy
Astringency)(
Other:
sour

AFTERTASTE

Short duration
Sour
Bitter
Other:
nutty

Ground beef plus:

0.0% soy + 0.0 g. salt	0.0% soy + 0.4 g. salt	0.0% soy + 0.8 g. salt	0.0% soy + 1.2 g. salt
AROMA			
Overall 1+	Overall 1- blended	Overall 1 to 1+ Br. beef & fat pred.	Overall 1 blended
Br. 1 to 2	Br. beef & fat 1 to 1-	Br. beef & fat 1 to 1+	Br. beef & fat)(to 1+
Br. beef 1 to 2	Other:	Other:	Salty)(to 1-
Fried fat 1 to 2	salty)(	cereal)(	Other:
Sweet)(to 1	sweet)(	salty)(	cereal)(
Other:	cereal)(	sweet)(	
salty)(to 1			
FLAVOR			
Overall 1+	Overall 1+ Br. beef & fat pred.	Overall 1+ blended	Overall 1+ to 2 Salt pred.
Br. beef 1 to 2	Br. beef & fat 1+ to 2	Salty 1- to 1+	Salty 1+ to 2
Oily m.c.	Salty)(to 1+	Br. beef & fat 1 to 1+	Br. beef & fat 1- to 1+
Springy m.f.	Springy m.f.	Springy m.f.	Springy m.f.
Mealy m.f.	BSM)(	BSM)(	Other:
BSM 1 to 2	Other:		BSM
Other:	cereal)(		squeaky
sweet)(	squeaky		
salty)(			
cereal)(			
AFTERTASTE			
Long duration	Mod. to long duration	Mod. duration	Short to mod. duration
BSM 1	Oily m.c.	Oily m.c.	Oily m.c.
Oily m.c.	BSM 1	BSM)(+	BSM)(
		Other:	Salty)(short duration
		salty)(	Other:
			cereal)(

Ground beef plus: 2% soy + 0.0 g. salt	2% soy + 0.4 g. salt	2% soy + 0.8 g. salt	2% soy + 1.2 g. salt
AROMA			
Overall 1 to 1+	Overall 1 blended	Overall 1 blended	Overall 1- to 1
Br. beef & fat 1 to 1+	Br. beef & fat 1	Br. beef & fat 1	Br. beef & fat 1 to 1+
Cereal)(to)(+	Cereal)(	Cereal)(	Cereal)(to 1
	Other:		Other:
	sweet)(+		salty)([b]
FLAVOR			
Overall 1 to 1+	Overall 1+	Overall 1+	Overall 1+ to 2 Salt pred.
Br. beef & fat 1 to 2	Br. beef & fat 1	Br. beef & fat 1 to 1+	Salty 1+ to 2
Cereal)(to 1-	Springy m.f.	Salty)(+ to 1	Br. beef & fat 1 to 1+
Springy m.f.	Salty)(	Cereal)(to)(+	Springy m.f.
Other:	Other:	Springy m.f.	Other:
BSM)(to 1[a]	cereal)([b]		cereal)(to)(+[a]
Oily m.c.	BSM)(to 1-[b]		BSM)(
	Oily m.c.		
AFTERTASTE			
Mod. to long duration	Mod. duration	Short to mod. duration	Short to mod. duration
Oily m.c.	Slt. oily m.c.	Oily m.c.	Oily m.c.
BSM 1	BSM)(	BSM)(	Salty)(short duration
		Other:	Other:
		salty)(	BSM)([b]

[a] = perceived by 66% of the panelists
[b] = perceived by 50% of the panelists

Ground beef plus: 6% soy + 0.0 g. salt	6% soy + 0.4 g. salt	6% soy + 0.8 g. salt	6% soy + 1.2 g. salt
AROMA			
Overall 1 to 1+	Overall 1+ to 2	Overall 1 to 1+	Overall 1
Br. beef & fat 1 to 1+	Br. beef & fat 1+ to 2	Br. beef & fat 1 to 1+	Br. beef & fat 1
Cereal)(	Cereal)(	Cereal)(to 1	Cereal)(to 1+
Sweet)(	Other:	Other:	Other:
Other:	salty)(	salty)(	salty)(
dry	sweet)(		sweet)(
FLAVOR			
Overall 1	Overall 1	Overall 1	Overall 1+ Salt pred.
Br. beef & fat 1 to 2	Br. beef & fat 1 to 1+	Salty)(+ to 1	Salty 1 to 2
Cereal)(to 1	Salty)(exterior 1	Br. beef & fat 1 to 1+	Br. beef & fat 1- to 1
Salty)(to 1+	Cereal)(	Cereal)(to)(+	Cereal)(to 1-
Mealy m.f.	Chewy	Chewy	Chewy
Springy m.f.	Mealy m.f.	Mealy m.f.	Mealy m.f.
Sweet)(	Other:	Other:	Other:
Other:	short lag	sweet)(	sweet)(
chewy	oily m.c.	slt. oily m.c.	
BSM	sweet)(		
	metallic		
AFTERTASTE			
Long duration BSM	Short to mod. duration	Short duration	Short duration
Oily m.c.	Slt. oily m.c.	Slt. oily m.c.	Slt. oily m.c.
Other:	Slt. BSM	Salty)(+	Salty)(
cereal		Other:	Other:
		slt. BSM	cereal)(
		br. beef & fat	

Ground beef plus:

10% soy + 0.0 g. salt	10% soy + 0.4 g. salt	10% soy + 0.8 g. salt	10% soy + 1.2 g. salt
AROMA			
Overall 1 Cereal	Overall 1- to 1	Overall 1 to 1+ blended	Overall 1 Cereal pred.
Cereal 1 to 1+	Cereal 1 to 2-	Cereal)(to 2	Cereal)(+ to 1+
Br. beef & fat)(+ to 1	Br. beef & fat)(to 1	Br. beef & fat)(to 1+	Br. beef & fat 1- to 1
Other:	Sweet)(	Other:	Other:
salty)(	Other:	salty)(	salty)(to 1[b]
sweet)(	salty)(	sweet)(+	sweet
FLAVOR			
Overall 1 Cereal	Overall 1	Overall 1 to 2-	Overall 1+ Salt pred.
Cereal 1 to 1+	Cereal 1 to 2	Salty)(+ to 2-	Salty 1+ to 2
Br. beef & fat)(to 1-	Br. beef & fat)(to 1	*-Br. beef & fat 1- to 1	*-Br. beef & fat 1- to 1+
Mealy m.f.	Sweet)(	*Cereal 1- to 2-	*Cereal)(to 1+
Other:	Slt. chewy	Mealy m.f.	Mealy m.f.
sweet)(	Mealy	Other:	Other:
BSM)(	Other:	chewy	BSM)(
	salty)(	BSM)(	
	BSM)(		
AFTERTASTE			
Mod. to long duration	Short to mod. duration	Mod. duration	Short to mod. duration
Cereal)(	Slt. oily m.c.	Oily m.c.	Oily m.c.
Oily m.c.	Cereal)(	Other:	Salty)(
BSM)(	Other:	cereal)([b]	Other:
	BSM)(	salty)([b]	BSM 1
	astringency)(-	BSM	cereal)([a]

[a] = perceived by 66% of the panelists

[b] = perceived by 50% of the panelists

EFFECT OF SALT ON THE SENSORY CHARACTERISTICS OF BEEF AND BEEF-SOY PATTIES

by

CAROL ANNE GARDZE

B.S., University of Illinois, 1976

AN ABSTRACT OF A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Foods and Nutrition

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1977

Increased acceptance of soy proteins as meat extenders has brought attention to the undesirable flavor characteristics of soy. The addition of salt to soy products has a masking effect which was studied, using ground beef patties. Patties were substituted with four levels of soy (0, 2, 6 and 10%) and salt was added at four levels (0, 0.4, 0.8 and 1.2 g) to determine its effect. Various sensory characteristics were evaluated by a rating and a flavor profile panel. Cooking time was decreased only by the highest levels of salt and soy. Cooking losses increased with added salt, but decreased with added soy.

As scored by the rating panel, meaty aroma was not affected by salt level, but increasing soy levels generally decreased meaty aroma. Salt caused little change in cereal-like aroma but increasing soy levels increased this aroma. Meaty flavor generally decreased with increased soy, while the lowest salt level increased meaty flavor. Cereal-like flavor increased with added soy but decreased with some salt levels. Saltiness increased with each increase in salt, but decreased with added soy only for the samples containing 1.2 g salt. Changing the salt and soy levels had no effect on the juiciness scores. Generally, the 0.4 and 0.8 g salt additions to each soy level were scored higher in the hedonic rating.

The flavor profiles showed trends similar to the rating panel. Many of the components of aroma, flavor and aftertaste of the soy were lost when it was combined with the beef. The addition of salt affected the flavor of the samples by masking the cereal note in some cases and enhancing it in others. Salt dominated some samples and broke their flavor blends, increased the sweet character in some patties, decreased oily mouthcoating and the BSM note, and altered the mouthfeel of various samples. Soy additions decreased oily mouthcoating and changed the mouthfeel of the

samples from springy to mealy. Soy additions slightly shortened the aftertaste duration of the samples, while added salt shortened the aftertaste duration and BSM note.