TASTE PANEL ACCEPTANCE OF MECHANICALLY DEBONED MEAT IN PREPARED DISHES

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DEBONED MEAT IN PREPARED DISHES

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CHAPTER I

INTRODUCTION

When bones sold as part of retail cuts are removed by consumers, there has often been more meat discarded than when bones are removed by professional meat cutters.

> 2,090,757 metric tons of meat per year has been wasted in the past as a human food source because much of the world's meat production has been sold in boneless form and the bones with some meat still attached are rendered for inedible uses (1, p. 38).

Mechanical-deboning can eliminate protein wastage of this manner for a world that is facing a protein crisis. Through mechanical-deboning it has been possible to recover meat and marrow from bones of beef, pork, and lamb. Nearly one billion additional pounds of meat per year could be added to the nation's food supply (2).

The nutritional value of products containing mechanically-deboned red meat has been found to be at least equal to that of products containing meat which has been boned by hand (1). However, research has shown problems with acceptability of prepared dishes to which mechanically-deboned red meat has been added. The color, texture and flavor of dishes to which mechanically-deboned red meat has been added have been found to differ from dishes that contain 100 percent hand-boned meat.

Industry has used many recipes for prepared meat dishes. However, these standardized products have always contained hand-boned meat only.

Since mechanically-deboned red meat has differing characteristics, the optimum limits to which this product can be added to prepared dishes and still be acceptable by taste standards must be defined. According to a U.S.D.A. proposal, mechanically-deboned red meat can be used in meat patties and spaghetti sauce with meat as well as other prepared dishes (2).

Sensory testing may be done for several reasons including new product development and product improvement. The flavor profile which uses a trained taste panel has proven to be "an objective method for measuring and describing flavor" (3, p. 18).

Purpose of Research

The purpose of this study was to determine if mechanically-deboned red meat is acceptable when added to meat patties and to spaghetti sauce with meat. Another purpose was to determine the highest percentage at which mechanically-deboned red meat can be added to these dishes and have them remain acceptable to the flavor profile panel used in the research.

Objectives of the Research

The objectives of the research were:

1. To define character notes and product profiles describing meat patties and spaghetti sauce with meat containing mechanically-deboned red meat by use of the flavor profile panel.
2. To determine the highest amount of mechanically-deboned red meat that can be added to each of the dishes and have them remain acceptable to the flavor profile panel.

3. To determine if prepared dishes of meat patties and spaghetti sauce with meat are acceptable to a flavor profile panel.
4. To make recommendations for further research in the area of development of prepared dishes containing mechanically-deboned red meat.

Hypotheses of Research

The following hypotheses were examined:

1. There is no significant difference in flavor and acceptability in a 100 percent ground beef patty and ones containing 10, 20, and 30 percent mechanically-deboned red meat.
2. There is no significant difference in flavor and acceptability in a ground beef patty containing 10 percent mechanically-deboned red meat and in one containing 20 percent.
3. There is no significant difference in flavor and acceptability in a ground beef patty containing 10 percent mechanically-deboned red meat and in one containing 30 percent.
4. There is no significant difference in flavor and acceptability in a ground beef patty containing 20 percent mechanically-deboned red meat and in one containing 30 percent.
5. There is no significant difference in flavor and acceptability in spaghetti sauce containing 100 percent of its meat as ground beef and in spaghetti sauce containing 10, 20, 30, and 40 percent of its meat as mechanically-deboned red meat.
6. There is no significant difference in flavor and acceptability of spaghetti with meat sauce containing 20 percent of its meat

as mechanically-deboned red meat and in spaghetti sauce containing 40 percent of its meat as mechanically-deboned red meat.

Assumptions of the Research

Assumptions were in regard to the taste panelists. They were:

1. The taste panelists are truthful in judging the products.
2. The taste panelists do not dislike spaghetti sauce with meat and ground beef patties that contain 100 percent hand-boned meat.

Assumptions were made in regard to the meat sample. They were:

1. The meat is handled properly in transit and in storage.
2. The composition of the meat sample is uniform throughout.

Limitations of the Research

The research was limited by the parameters of the taste panel which were:

1. adults between 22 and 45,
2. a trained flavor profile panel,
3. selection from a university oriented background, and
4. selection from the Payne County area.

The research was limited by the parameters of the meat sample which were:

1. meat was available only from the Beehive Company in Sandy, Utah,
2. mechanically-deboned beef only was used as the mechanically-deboned red meat portion of the samples.

Definition of Terms

Anthropometric--the study of human body measures especially on a comparative basis.

Character Notes--perceptible factors defined in descriptive or associative terms.

Fabrication-Room--part of a meat packing plant where meat is cut for sale on the retail market.

Flavor-Difference Test--a comparison or test of quality variation without indication of preference.

Flavor Profile Technique--a method of qualitative descriptive analysis of aroma and flavor. The method makes it possible to indicate degrees of difference between two samples on the basis of individual character notes, degrees of blending and the overall impression of the product (4).

Intensity Scale--a line on which a mark can be placed to indicate the degree to which a character note is perceived.

Mechanically-Deboned Red Meat--a finely minced meat slurry produced from machines. Mechanical deboning machines can strip bones clean of all meat that would otherwise be left by hand-boning methods (2). Red meat is from the flesh of lamb, pork or beef.

Taste--one of the senses, the receptors for which are located in the mouth and are activated by a large variety of different compounds in solution. Most investigators usually limit gustatory qualities to four: saline, sweet, sour, bitter. Distinguished from flavor, the experience to which taste contributes (5).

Threshold--a statistically determined point on the stimulus scale at which occurs a transition in a series of sensations or judgments.

Thresholds are of three kinds: (1) the threshold of sensation, stimulus threshold or absolute threshold, often designated as RL, is the magnitude of stimulus at which a transition occurs from no sensation to sensation; (2) the different threshold is the least amount of change of a given stimulus necessary to produce a noticeable change in sensation. It is often designated as the DL, and the interval or unit as the j.n.d. (just noticeable difference; (3) the terminal threshold is that magnitude of stimulus above which there is no increase in the perceived intensity of the appropriate quality for the stimulus (5).

CHAPTER II

REVIEW OF LITERATURE

This chapter is devoted to presenting the literature concerning the acceptability of mechanically-deboned red meat. In addition, literature was reviewed on the use of flavor profile panels as research tools for product development.

Mechanically-Deboned Red Meat

Mechanically-deboned red meat (MDM) has been defined as the product which results after muscle tissue from bone has been separated by mechanical means from the skeletal bones. It has been estimated that use of mechanically-deboned meat could allow an additional 5 to 15 pounds of meat to be recovered from a carcass which has undergone traditional hand-deboning. This could add substantially to the total food supply.

Even though the mechanical-deboning of red meat such as beef, pork and mutton is a relatively new procedure, poultry meat has been mechanically-deboned for over 10 years. Fish has been mechanically-deboned as well. Poultry meat has been used in such processed products as frankfurters and bolognas. Smith (6) used samples of mechanically-deboned goat, mutton, pork and beef for an acceptability study adding these to beef patties and frankfurters.

A description of the process by which mechanically-deboned red meat is produced helps to define nutritional and other uses of the product. Large cuts of meat, most commonly those listed in Table I are ground into a finely chopped mass. This mass is then forced through sieves under high pressure. The muscle tissue as well as a small amount of ground bone is ejected through a tube. The larger particles of bone and tissue that remain are forced out another tube. Some pulverized portions of bone are found in the product because bones are finely broken in the deboning process. The size of these particles is less than 0.018 inches due to the minute size of holes in the sieves. Bones which have lesser amounts of meat adhering to them such as bones of the plate and the short loin produce mechanically-deboned meat containing lesser percentages of protein and greater percentages of fat, ash and calcium. Although several different makes of mechanical-deboners are on the market, the make of the machine has little influence on protein, fat or moisture content (7). The usable tissue resulting from this process resembles very finely chopped meat since it is composed in great part of ground-up lean meat.

Minimum standards have been set by the United States Department of Agriculture's Safety and Quality Service. They are:

1. Mechanically-deboned meat contains a minimum of 14.0 percent of protein.
2. The minimum Protein Efficiency Ratio (PER) value is 2.5 (or an essential amino acid content of 33 percent).
3. The maximum calcium content is .75 percent.
4. The maximum fat content is 30 percent (2, p. 17560).

Tables I and II show the composition of mechanically-deboned red meat.

The color level of mechanically-deboned meat is 25 to 35 percent higher than that of hand-boned meats. The color of mechanically-deboned

TABLE I

COMPOSITION OF MECHANICALLY-DEBONED MEAT FROM WHICH BONES ARE NORMALLY RENDERED

Bone Source	Dry Matter	Ether Extract	Crude Protein	Ash	Calcium
Butcher Hogs					
Ham	54.81	39.02	10.21	4.07	1.39
Picnic	55.59	42.37	9.06	3.68	1.22
Boston Butt	43.15	26.04	13.50	2.71	0.73
Sows					
Loin	46.15	29.53	14.01	1.77	0.41
Veal					
Shoulder	26.27	7.56	12.05	5.36	1.76
Frames	26.64	6.79	17.57	2.59	0.71
Backs	24.21	5.81	15.98	2.21	0.54
Cow Beef					
Rib Plate	50.33	31.87	12.98	4.57	1.55
Rump	58.06	41.89	10.05	4.35	1.55
Short Loin	50.97	33.38	11.62	4.35	1.50
Choice Beef					
Neck	35.13	13.76	17.18	3.43	1.06
Plate	49.88	32.70	11.43	4.35	1.49

Source: R. H. Field, Mechanically-deboned red meat, Food Technology (1976).

meat is a bright red when properly handled, and a dull brownish red if pigment oxidation has been allowed to occur. The bright red color is due to: (1) the addition of heme pigments from red bone marrow, and (2) to the elimination of connective tissue.

TABLE II

ESSENTIAL ELEMENT CONTENT OF MECHANICALLY-DEBONED RED MEAT

Source	Protein %	Calcium %	Phosphorus mcg/g	Iron mcg/g	Zinc mcg/g
Mechanically-Deboned Red Meat from Cuts Shown in Table I	13.5	0.63	0.39	42.6	31.0
Utility Beef Carcass	18.6	0.01	0.17	28.0	34.0

Source: Field, Food Technology (1976).

The elimination of some strands of connective tissue has accounted for the finer, more uniform texture of products to which mechanically-deboned meat is added. The spicier flavor probably results from the minerals contained in the fine bone particles. This caused bolognas containing mechanically-deboned meat to be judged as spicier than those containing hand-boned meat only (1). In addition to the spicy flavor,

the distinctive flavor of bone marrow or iron is present also in these meat products.

United States Department of Agriculture Testing and Regulations

The United States Department of Agriculture is charged with the responsibility of regulation and inspection of meat and poultry. Before such a new meat product as mechanically-deboned meat can be produced or used, it must first be approved by the Meat and Poultry Products Inspection Division of U.S.D.A.

In preliminary investigations, the U.S.D.A. found the equipment used in mechanical-deboning to be satisfactory from the standpoint that it produces an unadulterated and sanitary product. The mechanical-deboners did not impair the product in any way by addition of foreign substances. The machines could be completely cleaned and sanitized (9).

In determining wholesomeness of the product, bone content was of major concern. Bone particle sizes measured microscopically ranged from 0.001 to 0.018 inches. The risk of mechanical damage, piercing or abrasion was found to be much less than from hand-deboning methods where the use of sharp knives to cut around bones can lead to slivers and chips of bone in the meat (9).

The U.S.D.A. has recognized that flourine and heavy metals have been known to accumulate in bone. However, search of literature and discussion with researchers have indicated that there is no apparent problem with levels of bone content that are found in mechanically-deboned meat (9).

Under previous methods of deboning meat the bones were the last tissue to be exposed to air. Muscle and bone are practically sterile until they are exposed. Therefore, adequate handling procedures for the bones between the time they are made available for mechanical-deboning and the time they are actually put through the machine are of utmost importance. Deboned meat itself is very finely minced, making it highly susceptible to bacterial growth. Adequate handling practice limits the ability of the microbiological flora to reproduce to a point where they would affect the wholesomeness of the product (9). The U.S.D.A. has proposed handling procedures as shown in Table III.

The U.S.D.A. has proposed to expand the definition of meat to include the following classes of meat: skeletal meat, heart meat, tongue meat, esophagus meat, meat trimmings, fatty meat trimmings, mechanically-deboned meat for rendering, low-temperature rendered meat, low-temperature rendered meat for processing and high-temperature rendered meat for processing (9). (See Table IV for classes of meat and definitions and Table V for the proposed rules concerning mechanically-deboned meat content in processed products.)

In testing, the U.S.D.A. used a trained taste panel to determine at what level flavor characteristics such as spicy flavor and a distinctive flavor of bone marrow or iron became apparent to the taste and thus objectionable in processed products to which mechancially-deboned meat has been added. Members were unable to determine a significant taste difference between products prepared without the addition of mechanically-deboned meat. At this time it was determined that further taste-test research was necessary to reinforce the collected data and to establish at what level the flavor characteristics

TABLE III

HANDLING PROCEDURES REQUIRED AS PREREQUISITES FOR HANDLING APPROVAL FOR MECHANICALLY-DEBONED MEAT

Raw Bones and Adhering Meat from Chilled Carcasses must be: (a) machine processed within one hour after hand-boning, or held in storage at 40°F or less for not more than 72 hours, placed immediately into freezer storage maintained at 0°F or less; (2) mixed to ensure product uniformity; and (c) identified and controlled by a procedure locally devised to control time and temperature if the raw bones and adhering meat are transferred to another establishment for use within 72 hours.

Raw Bones and Adhering Meat from Warm Carcasses of freshly slaughtered animals must be: (a) machine-processed within four hours after slaughter, or held in storage at 40°F or less for not more than 72 hours, or, if not to be machine-processed within 72 hours, placed immediately into freezer storage maintained at 0°F or less; (b) mixed to ensure product uniformity; and (c) identified and controlled by a procedure locally devised to control time and temperature if the raw bones and adhering meat are transferred to another establishment for use within 72 hours.

Mechanically-Deboned Product must be: (a) used immediately in formulating other meat food products; or (b) chilled to 40°F or below within one hour for later use. If the product will be used within 72 hours, it may be held for that period of time at 40°F or below. If not to be used within 72 hours from the time of deboning, the product must be placed directly into freezer storage maintained at 0°F or less and held at that temperature. If the product is transferred to another establishment for use within 72 hours from the time of deboning, a procedure must be locally devised to control the holding time and temperature.

Source: E. W. Murphy and R. E. Engel, The mineral element content of mechanically-deboned beef and pork, Western Hemisphere Nutrition Congress Proceedings (1977).

TABLE IV

CLASSES OF MEAT AND DEFINITIONS

Name (Class)	Definition
7. Mechanically-Deboned Meat	The product resulting from the mechanical separation and removal of most of the bone from attached skeletal muscle tissue, and containing a minimum of 14.0 percent protein with a minimum Protein Efficiency Ratio (PER) value of 2.5, a maximum fat content of 30 percent, and a maximum calcium content of .75 percent.
8. Mechanically-Deboned Meat for Processing	The product resulting from the mechanical separation and removal of most of the bone from attached skeletal muscle tissue and which fails to meet one or more of the limits prescribed for class 7, but containing a minimum of 10.0 percent protein with a minimum PER ratio of 2.5, and a maximum calcium content of 1.0 percent.
9. Mechanically-Deboned Meat for Rendering	The product resulting from the mechanical separation and removal of most of the bone from attached skeletal muscle tissue and which fails to meet one or more of the limits prescribed for class 8.

Source: United States Department of Agriculture, Animal and Plant Health Inspection Service, Definition of Meat and classes of meat, permitted uses and labeling requirements, Federal Register (1976).

TABLE V

PROPOSED RULES CONCERNING MECHANICALLY-DEBONED MEAT CONTENT IN PROCESSED PRODUCTS

Product Name	Class of Meat*												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Chopped Beef, Ground Beef	x				x	x							
Hamburger	x	x	x	x	x	x							
Beef Patties	x	x	x	x	x	x	x	x		x	x		
Fabricated Steaks, etc.	x				x	x							
Barbequed Meats	x				x								
Roast Beef, Roasted	x	x											
Corned Beef Cuts	x												
Canned Corned Beef	x	x	x	x	x	x	x	x		x	x		
Pressed Ham, etc.													
Chopped Ham	x				x								
Fresh Pork Sausage	x				x	x	x	x		x	x		
Fresh Beef Sausage	x				x	x	x	x		x	x		
Breakfast Sausage	x	x	x	x	x	x	x	x		x	x		
Whole Hog Sausage	x						x	x					
Smoked Pork Sausage	x				x	x	x	x		x	x		
Franks, Bologna, etc.	x				x	x	x	x		x	x		
Braunschweiger	x	x	x	x	x	x	x	x		x	x		
Liver Sausage	x	x	x	x	x	x	x	x		x	x		
Luncheon Meat	x	x	x	x	x	x	x	x		x	x		
Meat Loaf	x	x	x	x	x	x	x	x		x	x	x	x
Scrapple	x	x	x	x	x	x	x	x		x	x	x	x
Bockwurst	x	x	x	x	x	x	x	x		x	x		
Chili Con Carne	x	x	x	x	x	x	x	x		x	x	x	x
Chili Con Carne with Beans	x	x	x	x	x	x	x	x		x	x	x	x
Hash	x	x	x	x	x	x	x	x		x	x	x	x
Meat Stews	x			x	x								
Tamales	x	x	x	x	x	x	x	x		x	x	x	x
Spaghetti and Meatballs	x	x	x	x	x	x	x	x		x	x	x	x
Spaghetti Sauce with Meat	x	x	x	x	x	x	x	x		x	x	x	x
Lima Beans with Ham	x				x								
Chow Mein	x	x	x	x	x	x	x	x		x	x	x	x
Pork with Barbecued Sauce	x				x								
Beef with Barbecued Sauce	x				x								
Beef and Gravy	x				x								
Gravy with Beef	x				x								
Meat Pies	x				x								
Pizza	x	x	x	x	x	x	x	x		x	x	x	x
Deviled Ham, etc.	x				x	x							
Potted Meat, Deviled Meat	x	x	x	x	x	x	x	x		x	x	x	x

TABLE V (Continued)

Product Name	Class of Meat*												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Ham Tongue Spreads, 50 percent of product	x	x	x	x	x								
Ham Tongue Spreads, 50 percent optional above	x	x	x	x	x	x	x	x		x	x	x	x

*The classes of meat (see Table IV, page 14) have been defined by the U.S.D.A. Animal and Plant Health Inspection Service. The marks in the columns indicate which classes of meat can be used in the particular product. Classes 7, 8, and 9 are defined as mechanically-deboned meat.

Source: United States Department of Agriculture, Animal and Plant Health Inspection Service, Federal Register (1976).

of bone as mentioned earlier could be detected in other processed products and prepared dishes (2).

Need for Additional Protein Sources

Protein is exceeded in amount in the body by only one compound--water. Proteins are constantly in a state of dynamic equilibrium. This means that they are continually being broken down and replaced by new protein which is synthesized either from body tissue sources or from dietary sources.

It has been estimated that from one-fourth to one-half of protein intake should come from complete animal sources, and that 15 to 20 percent of the day's total calories should come from protein.

The development of mechanically-deboned meat has provided a possible

protein addition to the food supply. Present protein sources may not be in ample supply for the future. How to feed the growing population has been a question of great concern to the world community. Overpopulation, hunger and P.C.M. evidenced in marasmus and kwashiorkar have always gone together. Laboratory values and anthropometric measures have uncovered marasmus and kwashiorkar not only in underdeveloped nations but in more developed countries including the United States.

Since protein is a critical nutrient and is in short supply, world wide protein sources such as mechanically-deboned meat must be researched so that they can be effectively and efficiently worked into our food supply. Since the protein content of mechanically-deboned meat and meats is comparable to that of other foods yielding protein, it may be considered one of the newer sources.

Differences in Mechanically-Deboned Red Meat and Hand-Boned Meat

Nutrient Considerations

It is obvious that differences between hand-boned meat and mechanically-deboned meat do exist. The nutrient differences include calcium, iron, ascorbic acid and essential amino acid percentages (1).

The higher amount of calcium in mechanically-deboned meat has been considered from the standpoint of advantages as well as disadvantages. Concern has been expressed as an outcome of many nutritional assessment studies regarding total calcium intake in the diet. Meat is a food that is deficient in calcium but calcium is one of the main constituents of bone which is incorporated into mechanically-deboned meat. Mechanically-deboned meat should therefore be considered as a dietary calcium source.

As long as bone particle size is controlled and the amount incorporated into finished products cannot be detected in any way by taste, the presence of additional calcium may be of benefit (2). For persons whose customary intake of calcium falls below the recommended dietary allowance of 800 milligrams per day for adults, calcium from mechanically-deboned meat would be of nutritional benefit (10). The question as to whether the large amounts of calcium present in mechanically-deboned meat from bone particles poses a hazard to health needs to be carefully assessed. As long as the particle size can be controlled, and the amount incorporated into finished product not detectable in any way, researchers at the U.S.D.A. are of the opinion that far from being objectionable, the presence of additional calcium may be of benefit (10). Those persons who are hyperabsorbers of calcium are most likely to be at some risk from the larger calcium intakes (10).

Even though bone contains only 0.01 percent iron or less, mechanically-deboned meat is significantly higher in iron than is hand-boned meat. This is due to the presence of bone marrow which contains iron. Field (1) has indicated that mechanically-deboned meat from commercial sources contains 4.3 to 6.3 milligrams of iron per 100 grams. This means approximately twice as much iron may be present in commercial samples of mechanically-deboned meat as compared to hand-boned meat. Although hand-boned red meat is traditionally a good source of dietary iron, mechanically-deboned meat may be an even better source. Additional research can answer questions concerning the extent to which both iron and calcium from mechanically-deboned red meat is absorbed by the body.

Ascorbic acid is not present in hand-boned meat. According to Cox et al. (11) there are 13 to 15 milligrams of ascorbic acid per 100 milliliters of human bone marrow cells. Other researchers have found that mechanically-deboned meat being prepared commercially contains two to three milligrams of ascorbic acid per 100 grams on a fresh weight basis. One would expect the ascorbic acid to be higher since the product contains bone marrow, however when exposed to air the values are lowered since ascorbic acid is easily oxidized. Mechanically-deboned meat produced from cured pork has higher levels of ascorbic acid since a form of ascorbic acid is used in the cure (1).

The quality of protein in foods can be evaluated by expressing the eight essential amino acids (those not produced by the human body) as a percentage of the total amino acids present. Total amino acids include essential and non-essential (those that can be manufactured by the body) amino acids. Field (1) states that essential amino acid percentages for mechanically-deboned meat are as follows for parts which are commonly used for deboning: beef plates, 24 to 39 percent; lamb necks, 38 to 39.6 percent; pork backs, 35 to 39 percent; beef necks, 32 to 39 percent; beef ribs, 34 to 36 percent; veal legs, 37.6 percent; and pork necks, 36 to 40 percent. Bones with more meat attached generally produced mechanically-deboned meat with higher amino acid percentages. In comparison, hand-boned beef, pork and lamb amino acid percentages range from 39 to 40 percent.

Sensory Considerations

From the preceding discussion it is obvious that the nutritional value of products containing mechanically-deboned meat is at least equal

to and sometimes more than that of products containing hand-boned meat only. Nevertheless, problems associated with color, texture and flavor of finished products containing mechanically-deboned meat do exist.

The color of mechanically-deboned meat is a bright red when fresh, properly chilled, vacuum-mixed mechanically-deboned meat is presented. However, the color will appear dull brownish-red if pigment oxidation has been allowed to occur. This pigment oxidation will not occur if handling procedures as outlined in Table III are followed. The brighter red color of fresh mechanically-deboned meat is thought to be due to the elimination of the connective tissue which is in meat. Connective tissue has no pigments. The color level of mechanically-deboned red meat from fabrication-room bones is 25 to 35 percent higher than that of hand-boned meat (1).

The elimination of some strands of connective tissue from mechanically-deboned meat also partially accounts for the finer, more uniform texture of processed products which contains mechanically-deboned meat. Field, Riley and Corbridge (12) found that sensory panel members preferred bologna made from hand-boned meat because it was more similar in texture to that available in retail stores.

There has also seemed to be a difference in flavor. Bolognas made with high percentages of mechanically-deboned meat have been judged as spicier than those made with hand-boned meat only. The spicier flavor probably originates from the minerals in the fine bone particles. In addition to the spicy flavor, a flavor distinction of bone marrow or iron also is present in products made from meat which is high in bone marrow (1).

Sensory Evaluation

Taste testing has proved useful in evaluating consumer acceptance of new food products or new recipes (14). Various methods of taste evaluation have also been used in quality control and in research and development work with food and beverages.

Research has shown that mechanically-deboned meat could prove to be a valuable addition to our food supply. From the previous discussion it is obvious that mechanically-deboned meat is safe for human consumption (9) as well as being nutritionally adequate as a protein source (7) (10). The problem presently lies in acceptability. Taste panelists have previously objected to certain percentage levels of mechanically-deboned meat when the differing color, texture, and flavor of the products were too powerful to be considered acceptable (1) (12). There is need to define the percentage levels at which mechanically-deboned meat is acceptable in various dishes so that the products can be successfully incorporated into the present market. The purpose of this research was to determine the acceptability of mechanically-deboned beef at different percentage levels in prepared meat dishes through the use of a trained taste panel.

Functional Considerations

Field, Riley and Corbridge (12) found that there were no significant differences in emulsifying capacity or emulsion stability between hand-boned meat and mechanically-deboned meat. The bind value of mechanically-deboned meat from fabrication-room bones compared favorably with that of beef and pork trimmings of similar protein levels. There

has been no compensation needed for reduced bind in formulations of processed meat products when 10, 20 and 30 percent mechanically-deboned meat has been added.

Varying pH is another factor that has affected use of mechanically-deboned meat. Anderson and Gillet (13) observed that the pH of marrow extracts was more than a full unit higher than that of muscle extracts from the same animal. They also found that adding muscle to marrow increased the pH of the muscle. The proportion of marrow to muscle present in mechanically-deboned meat varies widely. However, pH values of six to seven for mechanically-deboned meat from fabrication-room bones are not uncommon. Anderson and Gillet (13) suggested that higher pH values in mechanically-deboned meat increase the extractability of protein. Industry personnel have often noted that mixing of fresh mechanically-deboned meat at 0°C soon forms a sticky, rubbery product. It has been determined that this is a result of the higher pH (13).

Flavor Profile Method of Sensory Testing

The purpose of the flavor profile method of sensory testing is "to record analysis in which all flavor components can be considered in perspective" (4, p. 377). The panelists is trained to consider all the flavors that he/she preceives. The intensities of these flavors are then recorded on a scale. An instrument is developed specifically for the product to be tested.

The flavor panel consists of four to six people trained in the profile method. Panel members individually examine the product and then discuss their findings as a group. After this discussion, a concise description can be written which combines the panel members' conclusions.

Thus, the profile method takes into consideration the total impression of flavor factors according to type, intensity and order of perception.

A flavor profile panel is developed through experience by interaction of the panel members among themselves. Discussion of the product by the group after individual examination is an important part of development and use of the panel.

Several disadvantages as well as advantages of the flavor profile technique have been found: (1) the training and conducting of flavor profile panels is time-consuming and, thus, expensive; (2) individual responses to flavor cannot be quantified; (3) a three-point intensity scale lacks precision; and (4) there is a potential danger in using only open discussion techniques (4).

Procedure for Selection of Panel Members

In order to obtain qualified panelists, screening processes should be conducted. These processes should include specific tests.

Panelists should be able to discriminate differences between solutions or substances of known chemical composition. This can be done by asking the panelist to differentiate between the four basic tastes (sweet, sour, salty and bitter).

Panelists should be able to recognize flavors and odors. This can be tested by asking panelists to identify common odors such as mint, vanilla, pineapple, wintergreen oil and peppermint.

The panelist's performance and ability to discriminate differences can be checked by comparing a single panelist's performance against the performance of the others in the group. Tests used in screening panelists for use in research should include both flavor identification tests

as well as identification tests. Ranking of concentrations of solutions such as sucrose from high to low concentration is another type of screening test that is generally done.

Selection and Training of Panel Members

Many factors may affect the results of taste panelist's reactions. Some of these factors are: the type of taste testing required of panel members, the environmental conditions and the test methods.

In the development of sensory evaluation techniques, there has been a strong orientation toward the stimulus and its properties. When a taste panel is trained for research a different area is emphasized as well. The receptor or the taste panel receives as much attention as the stimulus or the product to be tested.

Reproducibility of test results is the main advantage of taste panels. Good memory and experience on the part of the panelists contributes to precision.

An individual's interest in participating in sensory testing is an important criterion in selection. After careful selection, maintaining a satisfactory level of motivation is important for obtaining consistent, useful results.

Research has indicated that the best time for testing is 10:00 to 11:00 a.m. and 3:00 to 4:00 p.m. (15). Panelists should have the ability to taste and smell accurately. These characteristics will enable the panelists to produce reliable and consistent results.

Panelists should be intelligent and able to work with others. They should be neither quiet nor dominant. Age, sex or smoking habits need not be considered (15). In addition, training helps familiarize

panelists with a laboratory situation, helps panelists overcome personal preferences and biases, and teaches the recognition of small differences. Training can help panelists to compare flavors in spite of time lags that may occur between samples.

Panelists need training in two ways: (1) in test methods and general examination technique; and (2) in the specific product to be tested. In training the following points are included:

1. Train panel members on the products to be tested.
2. Give panel members enough information about the test to stimulate their interest and to let them know what is expected from them.
3. Stimulate additional interest by having testers participate in setting up the score sheet.
4. Keep the score sheet simple.
5. Supply reference samples whenever possible.
6. Allow members to compare their scores with those of experienced panelists (after completion of the test).
7. Keep members informed as to the results of the tests and their effect on the project.
8. Don't discard testers if they fail on one produce--they may be 'experts' on another. Judges incapable of judging one product may be suitable for judging other products.
9. Treat training as a continuous process with refresher training courses whenever the panel falls out of line (15, p. 12).

Selection of the Scoring Instrument

The scoring instrument used by the flavor profile panel is the method defined by Martin (16). The instrument is used to record the panelists' reactions.

Panelists are given product evaluation forms with a series of 15 centimeter scales indicating intensity from weak to strong (see Appendix C). At the beginning sessions for testing the particular product, the panel should identify the character notes which adequately define the product. The panelists are then asked to mark the scale with the

intensity of the character note. A discussion among the panelists should then take place.

After these procedures the researcher should assign numerical values to the intensity scale. The scale can be marked in centimeters--zero being the weakest and 15 being the strongest for any character note.

Sneed (17) indicated that panelists should use common character notes which should be printed on the evaluation form to facilitate statistical analysis. This can be accomplished at the beginning discussion sessions of the trained panel as discussed earlier.

Acceptability of Mechanically-Deboned Meat

Field, Riley and Corbridge (12) found that bolognas made from 100 percent machine-boned meat were not objectionable to untrained taste panelists. The study showed that this bologna differed organoleptically from that made with hand-boned meat. A frankfurter containing "15 percent mechanically-deboned turkey meat is comparable to an all hand-boned meat frankfurter" (12, p. 204). It is probable that at least "15 percent mechanically-deboned meat could be added without any detrimental effect to flavor or texture" (12, p. 204). As pointed out by Smith (6):

> The addition of four percent mechanically-deboned meat does not affect flavor, texture, or overall palatability of pork sausage. On the basis of overall satisfaction frankfurters containing 40 percent mechanically-deboned goat meat and 10, 20, or 40 percent mutton are more acceptable than control frankfurters consisting of hand-boned beef and pork only (p. 105).

Mechanically-deboned pork could not be used at levels greater than 10 percent because of significant decreases in flavor, juiciness, texture, overall satisfaction and cooking shrinkage in comparison to corresponding values for control frankfurters. Addition of 20 percent

mechanically-deboned beef increased texture desirability in comparison to beef patties prepared from manually deboned beef (control). These data suggested that 20 percent mechanically-deboned goat, mutton or beef can be used to manufacture beef patties without detracting seriously from the palatability characteristics of the cooked product (12).

The United States Department of Agriculture's Food Safety and Quality Service found that taste panel members were unable to detect a significant taste difference between products prepared without the addition of mechanically-deboned meat and products prepared with the addition of mechanically-deboned meat even at levels above 20 percent (2).

In comparing a 20 percent mechanically-deboned beef patty with one containing hand-boned meat only, Sneed (17) found that the 20 percent mechanically-deboned beef patty had a characteristic graininess and aftertaste. This patty was also judged to have less beefy flavor than the 100 percent hand-boned beef patty.

CHAPTER III

IMENTAL PROCEDURE

This study to investigate and compare the acceptability of mechanically-deboned beef in differing concentrations added to selected meat dishes. The objectives of the research were:

1. To determine if prepared dishes of meat patties and spaghetti with meat sauce are acceptable to a flavor profile panel when mechanically-deboned beef is added to the dishes.
2. To determine the highest amount of mechanically-deboned beef that can be added to each of the dishes and have them remain acceptable to the flavor profile panel.
3. To define character notes and product profiles describing meat patties and spaghetti sauce with meat containing mechanically-deboned beef by use of the flavor profile panel.
4. To make recommendations for further research in the area of development of prepared dishes containing mechanically-deboned beef.

The experimental procedure and materials which were used are outlined in this chapter.

Taste Panel Selection

The five panelists who participated in the study included a statistician, a university instructor in the area of family relations and

child development, a dietetic intern, a secretary, and a food and nutrition specialist for extension home economics. The taste panelists were recruited by personal contact. The panelists were part of a flavor profile panel of six who had been trained during the summer of 1977. The panel was selected and trained in a previous department study (17). Time scheduling prevented one panelist from the original group of six from participating in the research.

Training of Panel Members

Training of panel members began during the screening process. During orientation, an introduction to the flavor panel and to panel procedures were given. One odor and two taste tests were given to prospective panelists. The first taste test was basic tastes. This test measures only the person's ability to differentiate between the four basic tastes (sweet, sour, salty and bitter) by tasting four solutions prepared for this purpose. The four basic taste solutions were at above-threshold concentrations of 2.0 percent sucrose, 1.0 percent salt, 0.5 percent citric acid and 0.25 percent quinine sulfate. Each individual was to identify the basic tastes.

In the second taste test each individual was to rank solutions of 1.0 percent, 2.0 percent, 3.0 percent and 4.0 percent sucrose solutions. The solutions were to be placed in order from high to low concentration. This ranking test measures the person's ability to differentiate among varying concentration levels.

An odor identification test was given to participants with 15 odors including: amyl acetate, coconut, oil of nutmeg, oil of sassafras, black walnut, clove oil, orange oil, cassia oil, anise oil, peppermint

oil, pineapple, lemon oil, wintergreen oil, mint and vanilla. Odor samples were prepared in tightly covered bottles containing cotton onto which two to three drops of oil or the extract were placed. Discussion followed as well as a re-evaluation of odors which were not identified by panelists.

All participants in the research were of general good health. They had no allergies nor present sinus conditions.

A more detailed orientation was given to the six people who continued training. Seven people originally started in the screening process. At this time more details about the methods and scales to be used were explained. During the training, the goal was to develop the panelist's sensitivity to odor, flavor, methodology and nomenclature by profiling the following foods: apple juice, V-8 juice, bakery bread, beef patties, and beef patties containing 20 percent mechanically-deboned beef.

The panel met at 2:00 p.m. for two days a week. All training and testing took place in the Home Economics East Building on the Oklahoma State University campus.

Panelists were provided with distilled water to rinse the mouth between samples. It was the choice of the individual whether to rinse but they were asked to be consistent.

Reliability of the Panelists

All panelists used in the research had correctly identified the four basic tastes when presented during training. All panelists correctly placed sucrose solutions in order from high to low concentration. Of the 15 odors that were tested, two panelists correctly identified

4 of the 15 odors, or 26 percent of the odors. Two panelists correctly identified 44 percent of the odors. While not being able to name the odor, panelists could often describe it or identify a familiar product that contained the odor. When asked to profile the various products panelists were able to verify several character notes independently and could discriminate between the intensity of a given character note (17).

Mechanically-Deboned Beef Samples Tested

In order to accomplish the objectives of the research, two meat dishes containing mechanically-deboned beef were tested by the flavor profile panel. Meat patties that contained 10, 20, and 30 percent mechanically-deboned beef were tested with a control beef patty which contained hand-boned meat only. Samples of spaghetti sauce with meat that contained 10, 20, 30, and 40 percent mechanically-deboned beef were tested with a control sample of spaghetti with meat sauce that contained hand-boned meat only. The panelists were asked to define character notes, describe the intensity of these character notes and order the products in the sequence of their preference.

Sample Preparation

Mechanically-deboned beef was obtained from the Beehive Machinery Company in Sandy, Utah. The moisture content for this product is 65.8 percent (18). Lean ground beef was obtained from a local grocery store.

Meat patties were prepared and frozen one week prior to test days. The meat to be used was thawed one day in advance of test days.

The patties were prepared by manually mixing the mechanically-deboned beef and the lean ground beef. The mechanically-deboned beef

was pressed against the side of the bowl to facilitate mixing since the product had a rubbery texture at 0°C. The mixture was then crumbled together with the fingers to insure a uniform product. A 10 centimeter needlework hoop was then used to form the meat patty. Each meat patty contained 125 grams of the mixture. Meat patties containing 10, 20, 30, 40 and 00 percent mechanically-deboned beef were made to be used on test days. Each panelist received 25 grams of the 125 grams of meat in spaghetti sauce and patty samples.

On the days when meat patties were to be tested the patties were thawed and pan-fried. The patties were pan-fried for five minutes on one side and four minutes on the other at 350°F to reach a medium-well degree of doneness. After cooking the patties were cut into five equal portions and placed into color coded dishes to be tested by the panelists.

Spaghetti sauce with meat was tested on alternate test days when meat patties were tested. The same method used used to prepare the meat for the spaghetti sauce. The meat patties containing 10, 20, 30, 40 and 00 percent mechanically-deboned meat were cooked and then crumbled into hot spaghetti sauce. The spaghetti sauce was identical for all percentage levels of mechanically-deboned beef. The spaghetti sauce and meat mixture was then poured over hot pasta in color coded dishes to be tested by the panelists. (See Appendix B for the spaghetti sauce recipe.) Convenience packaged spaghetti noodles were used.

Since electrical equipment is more closely controlled and since gas odors may occur with the use of gas equipment, an electric skillet was used to cook the meat patties. Stainless steel equipment and utensils were used because they do not impart an odor or flavor. Sample

preparation began at 8:00 a.m. on the days the samples were to be tested. The testing followed at 9:00 a.m. on Wednesdays and Fridays.

Use of the Flavor Profile Panel

All five panelists tested each percentage level of meat patties and spaghetti sauce with meat. All percentage levels were tested on three different days. Each product had a total of 15 sensory evaluation tools filled out by their characteristics. After all percentage levels contained in each of the two dishes had been tested three times each for a total of six different taste sessions further taste testing was done to accomplish objectives. At this time sessions began where only two percentage levels were tested per test day. (See Appendix C for the test day schedule.) To speed research, on some days two samples were presented to each panelist. The panelists were then asked to clear their taste buds by having unsalted crackers and distilled water.

Samples were presented in Pyrex ramekins that were randomly color coded. Samples were presented on a white background. Distilled water was provided for rinsing. The panelists sat one meter apart, separated by off-white partitions. The preparation area was partitioned out of the sight of the panelists. Samples were kept warm and covered in a 150°F oven until the panelists were ready to taste the next samples.

Method for Recording Taste Results

The sensory evaluation tool was developed by the panel members themselves. After they had tasted both the meat patties and the spaghetti sauce, character notes were decided upon and defined by the group. Discussion was held with the panelists in order to achieve unanimity

in the interpretation of the scoring system (see Appendix D).

The researcher assigned numerical values to the intensity scales by measuring the scale in centimeters--zero being the weakest and 15 being the strongest for any given character note. The numerical scores which were assigned were unknown to the panelists.

Panelists were also asked to rank the products according to their preference. The number one being the most preferred item (see Appendix A).

Analysis of Data

The Friedman's test for multiple observations per sampling unit was used to test agreement of panelists in regard to their ranking of samples according to preference (see Appendix E).

Polar coordinate scales were used to compare the varying percentage levels of the meat dishes. In Figure 1, an illustration of the way the scales were used to compare character note means gathered from the sensory evaluation tools is shown. An open space in the center with little crossing over of lines shows a small difference in the products (see Appendix E). The numbers on the wheel correspond to the number of the character note on the sensory evaluation tool (see Appendix A).

Computer analysis with randomized block design was used to identify the character notes by which the samples differed (see Appendix F). All data were recorded and compiled on computer cards from the sensory evaluation tools. The Statistical Analysis System (SAS), a package of computer programs for statistical analyses was used to analyze the data. Computations were performed at the Oklahoma State University Computer Center.

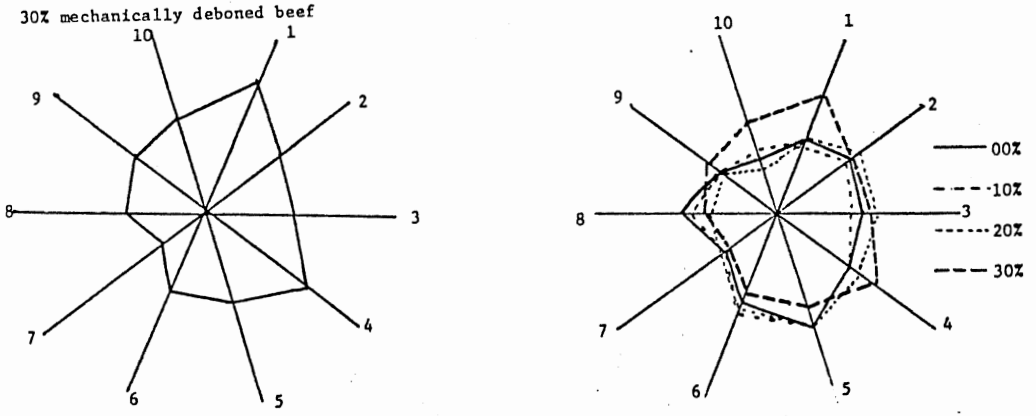

Figure 1. Polar Coordinate Scales

CHAPTER IV

RESULTS AND DISCUSSION

The purpose of this study was to determine if mechanically-deboned beef is acceptable when added to meat patties and spaghetti sauce with meat. Another purpose was to determine the highest percentage of mechanically-deboned beef which can be added to these dishes and have them remain acceptable to the flavor profile panelists in the research. Objectives of the research were:

1. To define character notes and product profiles describing meat patties and spaghetti sauce with meat containing mechanically-deboned beef by use of the Flavor Profile Panel.
2. To determine the highest amount of mechanically-deboned beef that can be added to each of the dishes and have them remain acceptable to the Flavor Profile Panel.
3. To determine if prepared dishes of meat patties and spaghetti sauce with meat are acceptable to a Flavor Profile Panel when mechanically-deboned beef is added to the dishes.
4. To make recommendations for further research in the area of development of prepared dishes containing mechanically-deboned beef.

Hypotheses of Research

The following hypotheses were examined:

1. There is no significant difference in flavor and acceptability in a 100 percent ground beef patty and one containing 10, 20, and 30 percent mechanically-deboned beef.
2. There is no significant difference in flavor and acceptability in a ground beef patty containing 10 percent mechanically-deboned beef and in one containing 20 percent.
3. There is no significant difference in flavor and acceptability in a ground beef patty containing 10 percent mechanically-deboned beef and in one containing 30 percent.
4. There is no significant difference in flavor and acceptability in a ground beef patty containing 20 percent mechanically-deboned beef and in one containing 30 percent.
5. There is no significant difference in flavor and acceptability in spaghetti sauce containing 10, 20, 30, and 40 percent of its meat as mechanically-deboned beef and in one containing 100 percent ground beef.
6. There is no significant difference in flavor and acceptability of spaghetti sauce with meat containing 30 percent of its meat as mechanically-deboned beef and in one containing 40 percent.

Each hypothesis of no difference in flavor was tested with respect to each of the 10 character notes on the Sensory Evaluation Tool (see Appendix A). For each test, the data were considered to have come from a randomized block design with five, four or two treatment conditions, depending on the number of percentages involved in the hypothesis being tested. The design also consisted of five blocks (panelists) with three observations per cell representing the different days of testing. The response was taken to be the distance from the left end of the scale at

which the panelist made a mark representing the intensity of the individual character note as perceived by the panelist.

The first hypothesis was rejected. The panelists found the percentage levels were different in regard to the following character notes: color by appearance, texture by mouthfeel, beefy flavor and aftertaste. There was found, however, to be no significant difference in the other character notes (see Appendix F).

The second hypothesis was accepted. The panelists found that there was no significant difference in meat patties with 10 percent added mechanically deboned beef and meat patties with 20 percent added mechanically-deboned beef.

The third hypothesis was rejected. The panelists found the percentage levels of 10 and 30 percent mechanically-deboned beef to be significantly different in regard to the following character notes: color by appearance, graininess by mouthfeel, chalky flavor and aftertaste. There was found to be no significant difference in the other character notes (see Appendix F). The panelists found that there was a significant difference in meat patties with 10 percent added mechanically-deboned beef and meat patties with 30 percent added mechanically-deboned beef.

The fourth hypothesis was rejected. The panelists found the percentage levels of 20 and 30 percent added mechanically-deboned beef in patties to be significantly different in regard to the following character notes: beefy flavor, chalky flavor and aftertaste (see Appendix F). There was found to be no significant difference in the other character notes. The panelists found that there was a significant difference in meat patties with 20 percent added mechanically-deboned

beef and in patties with 30 percent added mechanically-deboned beef.

The fifth hypothesis was rejected. The panelists found the five levels of mechanically-deboned beef in spaghetti sauce to be significantly different in regard to the following character notes: color by appearance, texture by appearance, chewiness by mouthfeel and beefy flavor (see Appendix F). There was found to be no significant difference in the other character notes.

The sixth and last hypothesis was rejected. The panelists found that the spaghetti sauce with 30 percent mechanically-deboned beef was significantly different from the sample with 40 percent added mechanically-deboned beef in regard to these character notes: beefy flavor and chalky flavor. There was found to be no significant difference in the other character notes (see Appendix F). The panelists found that there was a significant difference in spaghetti sauce with meat with 30 percent added mechanically-deboned beef and spaghetti sauce with meat with 40 percent added mechanically-deboned beef.

Each hypothesis of no difference in acceptability was tested using the Friedman Test applied to the ranks assigned to the samples tested by the panelists each day. Although all percentage levels were found to be significantly different with the exception of the 10 and 20 percent levels of mechanically-deboned beef added to the meat patties, the Friedman Test showed that panelists were not in agreement in their ordering sequence of the products by preference (see Appendix E).

The method by which samples are kept warm before being served to panelists needs to be improved. Since it was essential that the temperature of all meat samples be consistent, the samples were kept covered in an oven at 150°F until panelists were ready to test the next

sample. By this method, samples tested toward the end of the session had differing characteristics resulting from being held in the oven. The use of warming plates might be a better method to keep samples at a consistent temperature. In the event that warming plates are not available, preparation of samples could be delayed until all panelists are present. This would eliminate holding samples in the oven until the arrival of the panelists.

The panelists were also asked to indicate on the Sensory Evaluation Tool if they would buy the dish that they were testing. TABLE VI shows the number of times panelists indicated that they would buy the product that they were testing.

TABLE VI

ACCEPTABILITY OF THE PRODUCTS

Product	Would you buy this product? Yes	No
Meat Patties		
00 percent added MDB	15	
10 percent added MDB	15	
20 percent added MDB	14	1
30 percent added MDB	2	13
Spaghetti with Meat Sauce		
00 percent added MDB	15	
10 percent added MDB	15	
20 percent added MDB	13	2
30 percent added MDB	11	4
40 percent added MDB	1	14

On the basis of this research 20 percent is the highest level at which mechanically-deboned beef can be added to a meat patty and have it not change in acceptability to a Flavor Profile Panel. The highest level at which mechanically-deboned beef can be added to spaghetti sauce with meat and there will be no change in acceptability to the Flavor Profile Panel is 30 percent.

CHAPTER V

SUMMARY AND RECOMMENDATIONS

Summary

The results of data from flavor profiles collected by use of a Sensory Evaluation Tool developed and used by a Flavor Profile Panel are presented. Data from test days repeated three times each to compare the acceptability of varying levels of mechanically-deboned beef in two prepared meat dishes are included. The samples were meat patties containing 00 percent, 10 percent, 20 percent, and 30 percent mechanically-deboned beef. Other samples were: spaghetti sauce with meat containing 00 percent, 10 percent, 20 percent, 30 percent, and 40 percent of its meat as mechanically-deboned beef. Data are presented from flavor profiles repeated three times each in addition to the above to compare the following pairs: meat patties containing 10 percent mechanically-deboned beef and meat patties containing 20 percent mechanically-deboned beef; meat patties containing 10 percent mechanically-deboned beef and meat patties containing 30 percent mechanically-deboned beef; meat patties containing 20 percent mechanically-deboned beef and meat patties containing 30 percent mechanically deboned-beef; spaghetti sauce with meat containing 30 percent of its meat as mechanically-deboned beef; and spaghetti sauce containing 40 percent of its meat as mechanically-deboned beef.

Data were collected from five panel members. The data were analyzed using the randomized block design, the Friedman test for multiple observations per sampling unit and Polar Coordinate Scales to test similarity of flavor profiles for varying percentages of mechanically-deboned beef added to the two meat dishes.

Character notes for meat dishes containing mechanically-deboned beef were defined by the panelists. They were: color by appearance, texture by appearance, moisture by mouthfeel, graininess by mouthfeel, texture by mouthfeel, chewiness, salty flavor, beefy flavor, chalky flavor and aftertaste.

The researcher concluded that meat dishes containing mechanically-deboned beef are acceptable to a Flavor Profile Panel. Twenty percent is the largest percentage of mechanically-deboned beef which can be added to a meat pattie and have it remain acceptable to a Flavor Profile Panel. The researcher concluded that 30 percent is the highest level at which mechanically-deboned beef can be added to the meat portion of spaghetti sauce and have it remain acceptable to a Flavor Profile Panel. Although the panel rejected meat dishes containing higher percentage levels of mechanically-deboned beef, the panel did give different responses to these higher percentage levels. Similarities in intensity of character notes were found for all percentage levels of mechanically-deboned beef added to the two meat dishes.

Recommendations

Further studies could be done with mechanically-deboned beef added to a variety of meat dishes. Testing with different populations, especially children and the elderly might produce different test results and

provide information about the general acceptability of products containing mechanically-deboned meat.

Studies as to the kinds of products most adaptable to the addition of the mechanically-deboned meat as well as those which would be enhanced nutritionally by the addition are needed.

Based on the results of the research presented in this paper, along with previous studies in nutritional content, the use of mechanically-deboned beef in prepared meat dishes by industry and in institutional food service would be justified.

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APPENDIXES

APPENDIX A

SENSORY EVALUATION TOOL

SENSORY EVALUATION TOOL
(Example)

Name John Doe Date 9/27/77 Code _____

1. Appearance

a) Color

light	moderate	dark
	x	

b) Texture

fine	moderate	coarse
x		

2. Mouthfeel

a) Moisture

dry	moderate	very moist
x		

b) Graininess

smooth	moderate	very grainy
	x	

c) Texture

mushy	moderate	firm
	s	

d) Chewiness

tender	moderate	tough
x		

3. Flavor

a) Salt

weak	moderate	strong
	x	

b) Beef Flavor

weak	moderate	strong
	x	

c) Chalky Flavor

weak	moderate	strong
x		

4. Aftertaste

weak	moderate	strong
x		

Comments:

Would you buy this product? yes

How often and under what conditions? once a week

Others?

Please compare this dish with the others and number it in the order of your preference in the right hand corner. The number one is your most preferred item.

THANK YOU

APPENDIX B

SPAGHETTI SAUCE RECIPE

RECIPE FOR SPAGHETTI SAUCE*

Garlic salt	1 tsp.
Onion, chopped	1 1/2 c.
Tomato paste	12 oz.
Hot water	4 c.
Oregano	1 tsp.
Salt	2 tsp.
Pepper	1/2 tsp.

1. Assemble ingredients and equipment.
2. Combine garlic salt, onion and cook in kettle.
3. Mix tomato paste with hot water and seasonings.
4. Stir into meat mixture.
5. Simmer over low heat 35 to 40 minutes or until sauce is thickened.

Yield--8 servings.

*Recipe taken from Leidigh et al., Food Preparation Manual, 1974.

APPENDIX C

SCHEDULE FOR TESTING

SCHEDULE FOR TESTING

Day 1 ---- Meat patties at 00, 10, 20, 30 percent added mechanically-deboned beef

Day 2 ---- Spaghetti sauce with 00, 10, 20, 30, 40 percent added mechanically-deboned beef as part of the meat portion

Day 3 ---- Discussion of products to form sensory evaluation tool

Day 4 ---- Meat patties at 00, 10, 20, 30 percent added mechanically-deboned beef

Day 5 ---- Spaghetti sauce with meat 00, 10, 20, 30, 40 percent added mechanically-deboned beef

Day 6 ---- Meat patties with 00, 10, 20, 30 percent added mechanically-deboned beef

Day 7 ---- Spaghetti sauce with 00, 10, 20, 30, 40 percent added mechanically-deboned beef

Day 8 ---- Meat patties with 00, 10, 20, 30 percent mechanically-deboned beef

Day 9 ---- Spaghetti sauce with 00, 10, 20, 30, 40 percent added mechanically-deboned beef

Day 10 --- Meat patties with 10 and 30 percent added mechanically-deboned beef

Day 11 --- Meat patties with 10 and 30 percent mechanically-deboned beef

Day 12 --- Meat patties with 20 and 30 percent mechanically-deboned beef and spaghetti sauce with 30 and 40 percent mechanically-deboned beef

Day 13 --- Meat patties with 10 and 20 percent added mechanically-deboned beef and spaghetti sauce containing 30 and 40 percent mechanically-deboned beef

Day 14 --- Meat patties with 20 and 30 percent added mechanically-deboned beef and spaghetti sauce containing 30 and 40 percent mechanically-deboned beef

Day 15 --- Meat patties containing 20 and 30 percent mechanically-deboned beef and meat patties containing 10 and 20 percent mechanically deboned beef

Day 16 --- Meat patties containing 10 and 20 percent mechanically-deboned beef and meat patties containing 10 and 30 percent mechanically deboned beef

APPENDIX D

DEFINITION OF TERMS ON THE SENSORY EVALUATION TOOL

DEFINITION OF TERMS ON THE SENSORY EVALUATION TOOL

Note: After panelists had tasted samples of meat patties and spaghetti sauce containing mechanically-deboned beef a meeting was held to define terms in order to formulate a sensory evaluation tool for the two prepared meat dishes.

Color (Appearance)--The characteristic brown color of cooked ground beef.

Texture (Appearance)--The rubbery fine appearance that is characteristic of mechanically-deboned beef.

Moisture (Mouthfeel)--A slightly or moderately wet feeling in the mouth.

Graininess (Mouthfeel)--A granular or pebbly feeling in the mouth.

Texture (Mouthfeel)--The coarse texture characteristic of cooked ground beef.

Chewiness (Mouthfeel)--A tough, rubbery mouthfeel.

Salt (Flavor)--The degree of saltiness by taste.

Beefy (Flavor)--The degree to which the beefy flavor can be perceived by taste.

Chalky Flavor--A chalky flavor characteristic of mechanically-deboned beef.

Aftertaste--A medicinal, bitter taste that is characteristic of mechanically-deboned beef.

APPENDIX E

FRIEDMAN TEST FOR DETERMINING ACCEPTABILITY OF SAMPLES

TABLE VII

FRIEDMAN TEST FOR DETERMINING ACCEPTABILITY OF SAMPLES--MEAT PATTIES

Panelist	Percentages Tested	Test Day	Product	Percentage Chosen as Most Acceptable	W Value*
A	10 & 20	1	Meat Patties	10	
		2		10	
		3		20	
B		1		10	
		2		10	
		3		20	
C		1		10	
		2		10	
		3		10	
D		1		10	
		2		10	
		3		20	
E		1		10	
		2		20	
		3		10	1.66666
A	10 & 30	1	Meat Patties	30	
		2		10	
		3		10	
B		1		10	
		2		30	
		3		10	
C		1		10	
		2		30	
		3		10	
D		1		10	
		2		10	
		3		10	
E		1		10	
		2		10	
		3		10	5.4
A	20 & 30	1	Meat Patties	20	
		2		30	
		3		20	
B		1		20	
		2		30	
		3		20	
C		1		20	
		2		20	
		3		20	
D		1		30	
		2		20	
		3		20	

TABLE VII (Continued)

Panelist	Percentages Tested	Test Day	Product	Percentage Chosen as Most Acceptable	W Value*
E	20 & 30	1	Meat Patties	20	
		2		20	
		3		20	5.4

*A W value of greater than 9.488 indicated that the agreement among the panelists was more than chance. The level of significance was set at .05.

TABLE VIII

FRIEDMAN TEST FOR DETERMINING ACCEPTABILITY OF SAMPLES--
SPAGHETTI SAUCE WITH MEAT

Panelist	Percentages Tested	Test Day	Product	Percentage Chosen as Most Acceptable	W Value*
A	30 & 40	1	Spaghetti with	30	
		2	Meat Sauce	40	
		3		30	
B		1		30	
		2		40	
		3		40	
C		1		30	
		2		30	
		3		30	
D		1		30	
		2		30	
		3		30	
E		1		30	
		2		30	
		3		30	5.4

*A W value of greater than 9.4888 indicated that the agreement among the panelists was more than chance. The level of significance was .05.

APPENDIX F

RANDOMIZED BLOCK TEST FOR DETERMINING DIFFERENCES IN CHARACTER NOTES

EXPLANATION OF APPENDIX F

Column 1 starting at the left hand side indicates the character note that was being tested.

Column 2 indicates that the scoring between the panelists for that particular character note was different when the column says "yes".

Column 3 identifies the panelists that described a difference in that character note among the varying percentage levels. The way the numbers are underlined in this column indicates the percentages that were not significantly different from each other. The percentages connected by the underline are not significantly different.

Column 4 indicates the least significant difference for column 3.

Column 5 indicates that the scoring between the days for that particular character note was different when the column says "yes".

Column 6 indicates which percentages were not significantly different by the underline method described in column 3.

Column 7 is the least significant difference for column 6.

Column 8 is an explanation of column 6.

TABLE IX

ANALYSIS OF MEAT PATTIES--00 PERCENT, 10 PERCENT, 20 PERCENT, AND 30 PERCENT MECHANICALLY-DEBONED MEAT

Character Note that Showed Difference	Scoring Between Panelists was Different	Panelist(s) that Described Differences	LSD Mean	Scoring Between Days was Different	Overall Scoring	LSD Mean	Percent that is/are Different by Overall Means (All Panelists)
Color by Appearance	Yes	B- 10% 00% 20% 30% 3.76 4.70 9.13 9.30	.88	No	10% 00% 20% 30% 5.48 5.81 8.86 9.67	2.04	The group of 00% and 10% is different from the group of 20% and 30%
Moisture by Mouthfeel	Yes			No			Overall means showed no difference.
Texture by Mouthfeel	Yes	E- 20% 30% 00% 10% 2.96 4.86 8.56 10.50	1.34	No	30% 10% 00% 20% 6.81 8.31 8.94 9.30	1.51	30% is different from the group of 00%, 10% and 20%
Salty Flavor	Yes			Yes			Overall means showed no difference
Beefy Flavor	Yes	D- 30% 00% 20% 10% 4.20 8.56 9.20 11.43	1.98	Yes	30% 20% 00% 10% 4.61 6.95 7.50 7.93	1.75	30% is different from the group of 00%, 10% and 20%
Chalky Flavor	Yes			No	10% 00% 20% 30% 3.40 4.12 4.47 6.31	2.01	30% is different from 00%, 10% and 20%
Aftertaste	Yes	D- 00% 20% 00% 30% 2.13 2.23 2.43 8.86	2.01	No			Overall means showed no difference
Analysis of Meat Patties 10% and 20% MDM							
Color by Appearance	Yes			Yes			Overall means showed no difference
Moisture by Mouthfeel	Yes			Yes			Overall means showed no difference
Chewiness by Mouthfeel	Yes			No			Overall means showed no difference
Salty Flavor	Yes			Yes			Overall means showed no difference
Beefy Flavor	Yes			No			Overall means showed no difference

TABLE IX (Continued)

Character Note that Showed Difference	Scoring Between Panelists was Different	Panelist(s) that Described Differences	LSD Mean	Scoring Between Days was Different	Overall Scoring	LSD Mean	Percent that is/are Different by Overall Means (All Panelists)
Analysis of Meat Patties, 10% and 30% MDM							
Color by Appearance	Yes			No	10% 30% 5.88 7.46	1.52	10% and 30% are different
Texture by Appearance	Yes			No			Overall means showed no difference
Moisture by Mouthfeel	Yes			No			Overall means showed no difference
Graininess by Mouthfeel	Yes			No	10% 30% 4.76 6.72	1.32	10% and 30% are different
Texture by Mouthfeel	Yes			No			Overall means showed no difference
Chewiness by Mouthfeel	Yes			No	30% 10% 5.15 6.53	.97	30% and 10% are different
Salty Flavor	Yes			No			Overall means showed no difference
Beefy Flavor	Yes			No			Overall means showed no difference
Chalky Flavor	Yes			No	10% 30% 3.07 4.78	1.45	10% and 30% are different
Aftertaste	Yes			No	10% 30% 3.07 4.78	.96	10% and 30% are different

TABLE IX (Continued)

Character Note that Showed Difference	Scoring Between Panelists was Different	Panelist(s) that Described Differences	LSD Mean	Scoring Between Days was Different	Overall Scoring	LSD Mean	Percent that is/are Different by Overall Means (All Panelists)
Analysis of Meat Patties, 20% and 30% MDM							
Color by Appearance	Yes			No			Overall means showed no difference
Texture by Appearance	Yes			No			Overall means showed no difference
Moisture by Mouthfeel	Yes			No			Overall means showed no difference
Chewiness by Mouthfeel	Yes			No			Overall means showed no difference
Salty Flavor	Yes			No			Overall means showed no difference
Beefy Flavor	Yes			No	30% 20% 4.70 6.65	1.25	30% and 20% are different
Chalky Flavor	Yes			Yes	20% 30% 4.02 6.43	.91	20% and 30% are different
Aftertaste	Yes			Yes	20% 30% 4.32 5.77	1.03	20% and 30% are different

TABLE X

ANALYSIS OF SPAGHETTI SAUCE WITH MEAT--00 PERCENT, 10 PERCENT, 20 PERCENT, 30 PERCENT, AND 40 PERCENT MECHANICALLY-DEBONED MEAT

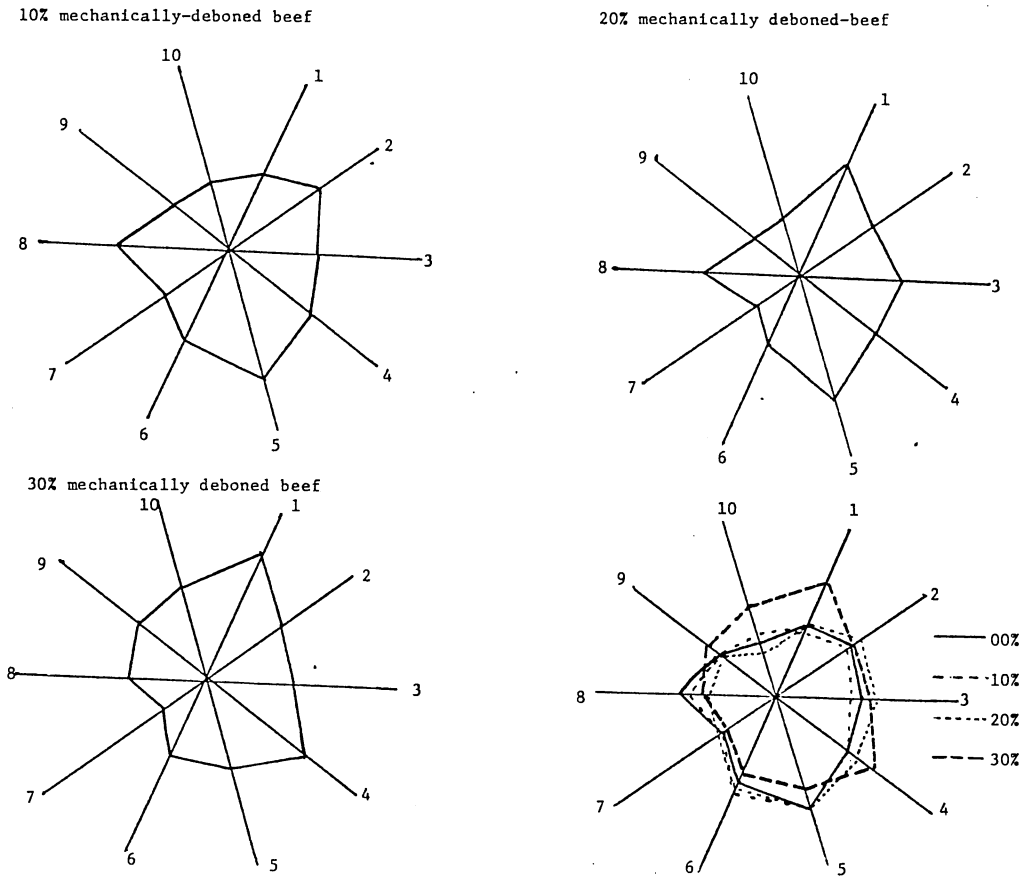
Character Note that Showed Difference	Scoring Between Panelists was Different	Panelist(s) that Described Differences	LSD Mean	Scoring Between Days was Different	Overall Scoring	LSD Mean	Percent that is/are Different by Overall Means (All Panelists)
Color by Appearance	Yes	A- 10% 00% 30% 20% 40% 3.50 3.66 4.86 6.03 7.23 E- 00% 10% 20% 30% 40% 4.46 4.50 7.36 9.00 9.50	.98 .28	No	00% 10% 30% 40% 20% 4.72 5.06 5.72 7.36 7.60	1.14	The group of 00%, 10% and 30% was found different from the group of 40% and 20%
Texture by Appearance	No	E- 00% 10% 20% 40% 30% 4.46 4.50 7.36 9.00 9.50	1.09	No	30% 40% 10% 00% 20% 6.56 6.58 7.53 8.16 8.88	1.43	The group of 30% and 40% is different from the group of 00% and 20%. Panelists are not sure as to which group the 10% belongs.
Texture by Mouthfeel	No			No	40% 30% 20% 10% 00% 5.62 5.90 6.88 7.56 8.86	1.23	The group of 40% and 30% is different from the group of 10% and 00%, 20% is similar to 30%.
Chewiness by Mouthfeel	Yes	A- 30% 40% 00% 20% 10% 4.16 4.40 6.46 6.96 8.13	1.03	No	40% 30% 20% 10% 00% 5.30 6.50 6.80 7.04 7.61	1.44	The group of 40% and 30% is different than the group of 00% and 10%. Panelists are not sure as to which group 20% belongs.
Beefy Flavor	Yes	E- 30% 40% 20% 10% 00% 4.53 5.40 6.60 8.16 8.20	1.09	No	30% 40% 10% 20% 00% 4.42 4.53 5.96 6.07 6.42	1.82	00% is different from the group of 10%, 20%, 30%, and 40%. 00% is not different from 10% and 20%.
Salty Flavor	Yes			No			Overall means showed no difference
Chalky Flavor	Yes	B- 10% 00% 30% 20% 40% 2.60 3.06 3.46 3.70 4.80	.28	No			Overall means showed no difference
Aftertaste	Yes			No			Overall means showed no difference

TABLE X (Continued)

Character Note that Showed Difference	Scoring Between Panelists was Different	Panelist(s) that Described Differences	LSD Mean	Scoring Between Days was Different	Overall Scoring	LSD Mean	Percent that is/are Different by Overall Means (All Panelists)
Analysis of Spaghetti Sauce with Meat, 30% and 40% MDM							
Color by Appearance	Yes			No			Overall means showed no difference
Texture by Appearance	Yes			Yes			Overall means showed no difference
Moisture by Mouthfeel	Yes			Yes			Overall means showed no difference
Salty Flavor	Yes			No			Overall means showed no difference
Beefy Flavor	Yes			No	40% 30% 4.46 5.87		40% is different from 30%
Chalky Flavor	Yes			No	30% 40% 4.22 6.15		30% is different from 40%
Aftertaste	Yes			No			Overall means showed no difference

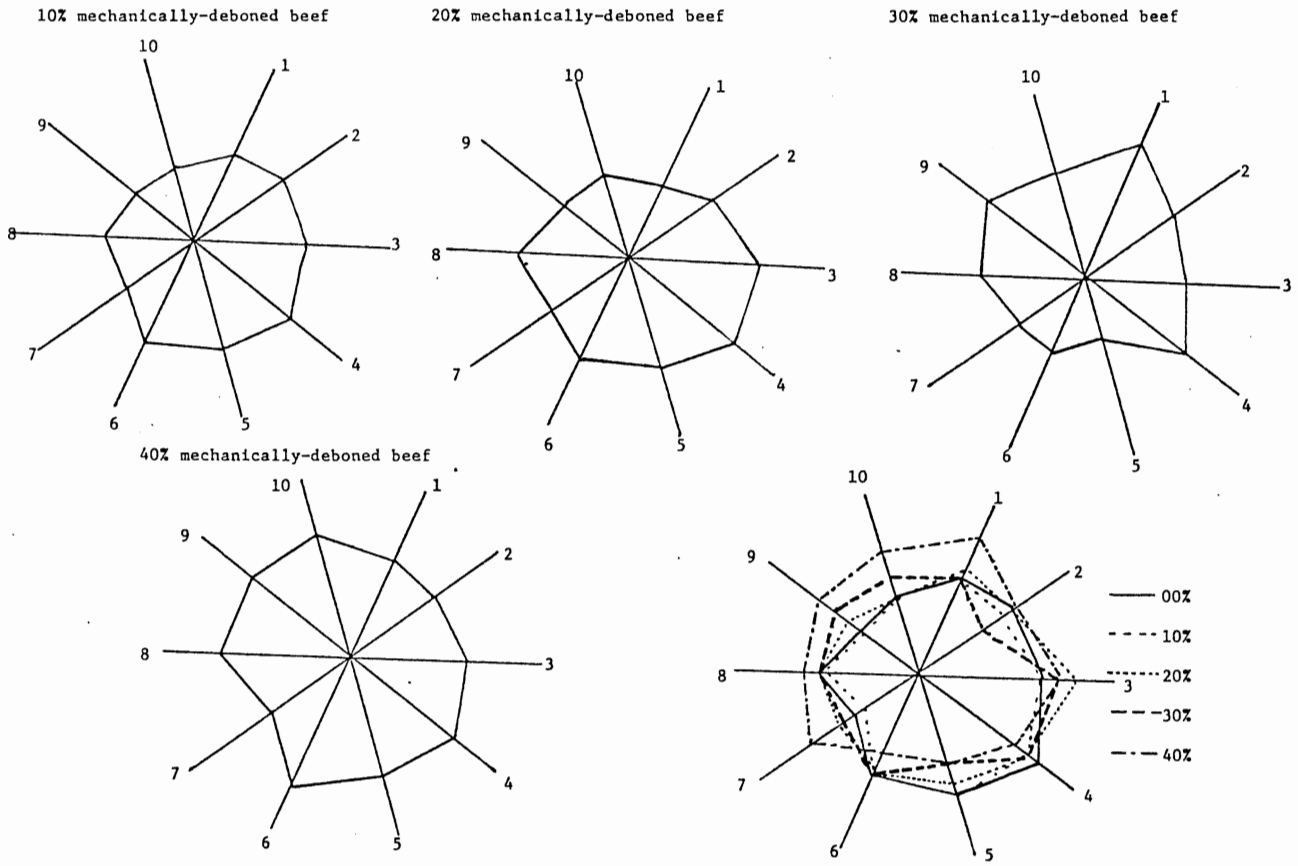
APPENDIX G

POLAR COORDINATE SCALES COMPARING PERCENTAGE LEVELS OF MECHANICALLY-DEBONED MEAT



The three test days where all percentage levels were tested, 00 10, 20, and 30 were averaged and placed on the scales above.

Figure 2. Meat Patties--Average of Panelists' Scores on Polar Coordinate Scales



The three test days where all percentage levels were tested, 00, 10, 20, 30, and 40 were averaged and placed on the scales above.

Figure 3. Spaghetti Sauce with Meat--Average of Panelists' Scores on Polar Coordinate Scales

VITA

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