A TASTE PANEL SERVED ANIMAL PROTEIN AND VEGETABLE PROTEIN ENTREES

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INTRODUCTION

Even now in this highly scientific and technological era of the twentieth century, there are short supplies of food in sections of the globe. The implication is that, with the population now 3.3 billion and the probability of its doubling by the year 2000, food will be even scarcer. The most critical aspect of the problem is the scarity of protein. In Central Africa, for instance, about 50 percent of the children die before reaching school age, and at least one-third of these deaths is attributable to protein deficiency (21).

Most countries of Asia, Africa, and Latin America will suffer from this plight by 1980 (43).

Even though the problem of supplying protein to the underdeveloped countries is ever present, it will not be long before it will be an immediate problem for everyone. As pointed out by Clark (11),

> . . . changes may be expected everywhere in dietary sources of protein because of scientific and technologic advances, as well as modifications in social and cultural patterns. These problems have important implications for dietitians, nutritionists, and educators.

World population is expected to double by the end of the century or soon afterward, and increases in food

production currently lag behind population growth (41). As a consequence, per capita availability of protein is actually decreasing. So " . . . as long as we persist in thinking of food in terms of bushels of wheat (17)" and sides of beef,

> . . . we'll never have enough to go around. As soon as we learn to consider food as a conveyer of essential nutrients, and look for the cheapest and best way to get these nutrients, we'll find we have enough for all (17).

Many forecasters indicate that animal protein, due to inefficient conversion of food by animals, is becoming too costly, that man's eating habits must change to conform to what is economically feasible--the textured vegetable protein (63). Changing food habits involves changing attitudes and beliefs held about existing and new foods. Roenstock (50) has suggested that the individual must first be made aware that a problem (which would have serious consequences for him) exists and must be made to feel that there is some possible solution to the problem.

The solution to the insufficiency of costly animal protein could be vegetable protein simulating the flavor of the familiar food product. The easiest transition from the known to the unknown is by a familiar conveyer and so, to effect the transition from animal protein to vegetable protein, a familiar conveyer of flavor should be used. Therefore, knowing the importance of protein to body metabolism and being promoted by a familiar flavored and cheaper product, the individual must accept vegetable protein as a

replacement for the animal protein in the diet.

In institutional preparation of food, three important areas must be considered: nutritional content, cost of food, and consumer acceptability. Protein is an unstorable, essential constituent of all living cells. Its animal form has, in the last decade, sky-rocketed the institutional food budget. For this reason, more meat-extended dishes in the form of casseroles are appearing in institutional feeding programs. It is therefore essential that people in charge of these programs insure availability of an adequate amount of high-quality protein for a reasonable price that will be accepted by the consumer.

Because of interest in institutional preparation of food, the author proposes to use the scoring results of a taste panel's reactions to animal protein and vegetable protein entrees and to report the evaluations found.

Additional literature in this field will be reviewed and a list of companies which manufacture textured vegetable protein products will be compiled. A letter will be sent to these companies requesting samples and literature concerning the vegetable products they manufacture.

CHAPTER II

REVIEW OF LITERATURE

This chapter presents the literature read by the author to strengthen background and understanding of the problems of extreme protein deprivation facing the world today and of changing existing food habits of the people who inhabit this world in order to meet their protein requirements. In addition, reading was done in the areas of taste-panel procedure and methodology.

Protein

Gerardus Mulder, the famous Dutch chemist (1802-1880), proposed use of the term "protein," derived from the Greek language and meaning "to come first," because he believed that proteins were "unquestionaably the most important of all known substances in the organic kingdom (56)."

Proteins are essential constituents of both plant and animal cells. There is no known life without them. Plants build their own proteins from inorganic materials obtained from the soil and air. Animals form proteins characteristic of their own tissues, but in general they cannot build them from simple inorganic substances (as plants do) and must depend upon the digestion products obtained from the

proteins of their food. Since animals must have proteins for the construction and upkeep of their tissues and since, broadly speaking, they cannot make their proteins except from the cleavage products of other proteins, it follows that proteins (or their cleavage products, the amino acids) are necessary ingredients of the food of all animals (10).

Composition of Protein

Proteins, like fats and carbohydrates, are composed of carbon, hydrogen, and oxygen but, in addition, are a unique source of nitrogen. Some also have sulfur, phosphorus, and occasionally other elements. These elements make up the units known as amino acids which combine to form protein. There are at least 22 amino acids which have been determined as being physiologically important. Eight of these amino acids, necessary for normal growth and for maintenance of nitrogen balance, must be supplied from an outside source, as body synthesis is lacking or so limited as to be unable to meet metabolic needs. These essential amino acids are valine, lysine, threonine, leucine, isoleucine, trytophan, phenylalanine, and methionine. The other 14 amino acids can be synthesized by the body in adequate amounts for normal function and are termed nonessential (67).

The Body's Need for Protein

Protein is one of the most abundant components in the body. It is exceeded in amount only by one other compound--

water. The major portion of the protein is located in muscle tissue; the remainder is widely distributed in other soft tissues, blood, bones, and teeth.

Protein is present in every cell in the body. It is not a stable chemical combination which remains static once formed. Proteins are in a state of dynamic equilibrium, which means that body proteins are continually being broken down and replaced by new protein synthesized from amino acids from both dietary and tissue sources. The need for protein to build new tissue and to maintain and repair the old continues throughout life (10).

Some of the compounds essential in vital processes in the body are made from amino acids. In this group of nitrogen-containing compounds are the body enzymes, hormones, and antibodies (24).

Protein is one of the factors which contributes to the control of fluid movement in and out of cells and movement to and from the blood stream (56). Blood proteins help to maintain a normal balance between acidic and basic substances in the body. Even though protein is considered a primary body-building and body-regulating substance, the function of providing energy takes precedence when the carbohydrate and fat in the diet furnish insufficient calories. One gram of protein supplies approximately four calories.

Vegetable Protein

Historical Perspective

No form of life as we know it can exist without protein. Primitive man and his forerunners must have derived nearly all their protein from animal sources. Many of the earliest stone artifacts found with animal bones were undoubtedly the tools made especially for killing birds, fish, and other animals. Until the present day, man has had a vast animal reservoir from which to draw his protein supply, and has squandered vegetable protein as food for domesticated animals (1).

The restriction of human diets to vegetable products, which appears to have been unusual in remote history, probably never occurs even now except by deliberate choice or extreme circumstances. Many groups of people are unable to obtain sufficient animal protein for food, but no instance is known of a primitive population which has had none at all; enforced periods of abstinence have been followed by an orgy of meat-eating when opportunity has arisen (1). A vegetable diet supplemented by milk and milk products can be nutritionally adequate in every way. The rural American community described by Miron (34) had diets which contained very little animal protein. Meat was never eaten, cheese only on Sunday, and milk only in coffee and bread; but the men were capable of sustained hard physical work and the

blood chemistry of all the subjects investigated was entirely normal.

Today's Protein Problem

As populations increase, there will be competition for food between man and domestic animals. It is doubtful if the world's production of protein is keeping pace with this increase. An acre of land can produce 800,000 calories in the form of plants, but only 200,000 calories when the plants are fed to animals. Meat animals use roughly 600,000 calories from each acre's crop for their own metabolism (1). The most logical agricultural approach to the increasing world-food problem is the use of legumes which live symbiotically with nitrogen-fixing bacteria and efficiently produce protein with less depletion of nitrogen from the soil (55).

Every twenty-four hours the world has 125,000 new mouths to feed (1). With the population increase, which has resulted largely from declining death rates, there has come an appalling shortage of food. New sources of food must be found or many millions of people will die as a result of malnutrition. Many millions more will " . . . linger in the murky twilight . . . " (19) of constant mental and physical ill health. These pathetic conditions will be the direct result of lack of enough high-quality protein in the daily diet. As Zoe (73) stated:

> However bizarre it may sound, the necessity for new sources of protein food to feed the world's growing population is a problem more serious than the bomb.

Dismay is completely justified. Even though many things can be done to prevent food losses from plant disease, insect and animal ravaging, poor production efficiency, and spoilage from seasonal gluts, as well as to prevent losses from outmoded, deeply-ingrained traditional attitudes, correction of these factors alone can do no more than lessen the threat to survival. Somehow more protein has to be made available.

To the technically-trained nutritionist, nature's inefficient "Food Factories (42)," the traditional approach to food production, have a glaring fault. They are too inefficient in providing those very food items which are at once the most prized in almost all cultures and likewise the most essential for dietary needs. These most valued and physiologically valuable foods are the high-quality proteins, represented in their most familiar forms by meat, fish, fowls, eggs, and dairy products such as cheese and milk.

Unfortunately, the conversion of protein foodstuffs by animals into meat is often less than, and seldom better than, 10 percent. To a scientist, this low-conversion efficiency means the food chain is longer than it needs to be in theory. On the other hand, if the alfalfa or soybean meal were consumed directly by man, this efficiency

would jump roughly seven times to about 70 percent. Such an approach, which avoids an intermediate consumer, could have a tremendous impact on the problem of extra availability of food for human consumption (21).

Since man's digestive system cannot manufacture protein from nonprotein components in the diet and since man is totally unable to store protein in the body, the minimum daily protein requirement must be supplied or health immediately begins to suffer. If meat or other animal products are available in adequate amounts, then there is no dietary protein problem for the individual.

When animal products are not available, then protein of equal value and amount must be obtained from various dietary sources. For example, one could have vegetables and grains in an amount equal to 55 to 60 grams (Recommended Dietary Allowance for men and women), per day of high-quality animal protein (54). Since vegetable protein lacks one or more essential amino acids (26), a dependence on a single vegetable source can prove fatal. In this situation, premature death is inevitable, not from starvation but from the intervention of common, non-fatal diseases which become deadly for the malnourished.

Textured-Vegetable Protein

One answer to the protein shortage is the new class of textured, high-protein food made possible, for example, by the application of textile technology to the purified

protein which may be extracted and isolated from soybean meal. Soybean and other oilseed protein meals, the by-products of edible oil manufacture, contain impressive amounts of quite good-quality protein (39).

Soybean Protein. For centuries, the soybean (Glycine max, a native of Eastern Asia) and soybean products have constituted one of the chief sources of protein for millions of oriental people. It was cultivated extensively and was valued highly as a food centuries before written records were kept. Some of the first written records of the plant occurred in 2838 B.C., and the soybean is mentioned repeatedly in later records (1). It was included in the five sacred grains vital to Chinese existence. The first mention of soybean in the United States Department of Agriculture was not until 1898. The first soybean-oil meal made in the United States was produced in 1915 (39).

Processing Textured-Vegetable Protein. The texture of vegetable protein is quite different from the very complex structure of meat and so, to develop an imitation meat from vegetable protein, one must study the structure of meat. It is learned that vegetable protein products must have a fibrous nature. This can be achieved by the use of relatively tougher and weaker gels used as binding material for the filaments created by extrusion (4).

The patented Boyer Process (4) is one method of production of textured vegetable protein products. A protein material, such as the soybean, is dispersed in an aqueous

alkaline solution; it is then forced through a spinneret into an acid-salt bath which coagulates the protein and precipitates as filaments .003 inches in diameter. Alterations in pressure will yield variations in the density and texture of the finished product. It is not too exciting to think about eating a piece of colorless, tasteless, odorless "yarn," so with modern technological knowledge the food technologist adds modifiers to change the "yarn." Additional nutrients can be added to increase the nutritional value. It is also possible to hold the fat and cholesterol levels within acceptable limits (2). The next step is the fluffing and stretching of the filaments to prevent matting and sticking during immersion in a salt solution (pH 4.0-7.0 at 85-100° Fahrenheit) which is used to adjust the toughness of the fiber (5). To provide a variety of effects, different methods of coating the protein filament can be used.

There is no insurmountable technical obstacle to the mimicry of almost any familiar textured food and therefore no limit to the versatility of such food. An ethnic, religious, or geographical dietary pattern can be met in the construction of these foods.

Changing Food Habits

As miraculous as these manufactured protein foods appear to be, there remains, nevertheless, the problem of educating the people who need them. Even though newly-introduced foods could have eliminated malnutrition, these

have not always been accepted (8). As food production and distribution increase to meet the needs of the underfed, it is important that food prejudices be understood and overcome. Changing food habits involves changing attitudes and beliefs held about existing and new foods. Roenstock (50) has suggested that the individual must first be made aware that a problem (which would have serious consequences for the individual) exists and must be made to feel that there is some possible solution to the problem.

Early feeding experiences have a direct effect on food habits (31). Once food habits have been established, they are very difficult to change. Human beings seem to want to eat foods that are known and that they are accustomed to eating. Food is closely related to the stability of social, religious, and economic institutions of a culture. The more gradually the institutions change, the less likely are the food habits to change (69).

Before changing food accepted by a people, there has to be a clear understanding of what food acceptance means. Acceptance may mean " . . . 'approved' or merely 'not rejected' in contrast with disapproval or rejection (31)." Therefore a particular food liked or disliked by an individual is his food preference. The foods chosen by a person at a particular time are food choices. An individual's whole diet and the total of food choices make up food habits.

Unusual foods create new acceptance problems, since customary adoption procedures will not work, " . . . because by definition a population can have no developed preferences in regard to foods that are novel to its members (45)." A food product is usually evaluated in terms of a common frame of reference which will accept the "normal" aroma of Limburger cheese or the bitterness of coffee. New or unusual foods which do not fit into a frame of reference are more likely to be rejected on the basis of strangeness.

As mentioned previously, the easiest transition from the known to the unknown is by a familiar conveyer. In order to facilitate this change-over, a familiar flavor should be taken from the individual's frame of reference to establish rapport with the unusual food item.

Factors Affecting Taste-Tasting

Taste-panel testing is a method employed to evaluate consumer acceptance of new food products or new recipes. This method of evaluation is also used in quality control and in research and development work on food and beverages such as, for example, the effect of formulation or processing change on a product, the effect of packaging materials on flavor, and the effect of pesticides on the flavor of fruits and vegetables (14, 22).

Many factors affect the results of the taste panel's reactions. Some of these factors are the type of taste-testing required of panel members, the environmental

conditions, and the test methods.

Definition of Flavor-Difference Testing

Flavor-difference testing has been defined as "a comparison or test of quality variation without indication of preference (27)." In contrast to consumer-preference and flavor-acceptance tests, difference tests are concerned only with whether or not a detectable difference exists between two or more treatments (37).

Control of Environmental Conditions

The judging room should be free from distraction (37) of odor and air-conditioned, or with other means of proper ventilation and temperature control. If the room and furnishings are off-white or light or neutral gray, the panelists will not be distracted by color. Lighting should be uniform (30).

No significant differences in results between morning and afternoon sessions in a paired-comparison study of bouillon reconstituted with different kinds of water were reported by Dawson (13).

The optimum number of samples that can be tested at one session without taste fatigue depends upon the product (20). More samples can be tested at one session if the product is bland than if less bland (6). Pfaffmann, Schlosberg, and Cornsweet (47) found no loss of sensitivity over an entire hour of testing involving as many as 18 triangular

comparisons. This held true for several different products. Dawson (14) also reported no taste fatigue in a panel when evaluating such effect on basic taste-dilution evaluations using triangle and paired-comparison tests.

Panel members tend to use all available information in making taste judgments. Therefore, samples should be prepared and served as uniformly as possible in all aspects not related to flavor. Size of sample, temperature, texture, appearance, and color must be controlled (15). The actual identity of each sample must be concealed by coding. If possible, the product should be tasted by the panelist in the condition in which the food is normally consumed (29).

Information about the variable to be studied can be of great help in increasing the sensitivity of discrimination tests (9). From data gathered by Logan and Medved (32), it was concluded that the scores on simulated meats do not change significantly when information is given regarding their composition. However, panel members will be influenced in decisions by knowledge of the stimulus variable and by the information given, regardless of whether or not it contradicts perceptual experiences in the test situation (48). Therefore, instructions should be clear, concise, and appropriate to the experiment.

As much time as desired may be allowed for the tasting of samples states Baker (3) and the interval between tasting of samples need not be limited. In general, water may be used between samples to remove flavors from the mouth.

The panel member may swallow the samples if desired, and the samples may be presented in random order (3).

Test Methods

The objectives of a difference test must be clearly defined before a test method can be selected. The investigator must decide: (a) whether or not it is sufficient to determine only if a difference exists; (b) whether or not the direction, extent, and importance of the difference must be known; or (c) whether or not complete analysis and description of the flavor is needed (22).

In considering the number of samples to offer, it was found that the multiple-comparison method has several advantages over the triangle method. These are (a) detection of smaller differences between treated and untreated samples, (b) additional information about the direction and importance of the differences, (c) less time and fewer samples required, (d) more efficiency when panels have not been especially selected or trained, and (e) no influence by small differences in color and texture (29).

Rating scales have been found to be one of the most important tools for flavor-difference panel testing. Ranking may be used to specify the dimension of the difference as to the intensity of a characteristic and when actual values are not needed or are difficult to provide. It is a fast method of discriminating multiple samples. The nine-point hedonic scale is the one most frequently used (46),

with verbal designations ranging from "like extremely" to "dislike extremely." The data obtained in this manner can be statistically analyzed in a variety of ways.

Summary

One challenging fact emerges from the author's readings on human dietary protein requirements--the need for ever-increasing amounts of nutritionally adequate protein to feed the growing world population. Traditionally animals have been considered the most desirable source of high-quality protein; however, the supplies of high-grade animal protein are not large, and, in fact, the majority of the world's population does not have even enough animal protein to meet sub-minimum levels.

The broad spectrum of mimicry possible with simulated meat to increase protein stores is impressive. The versatility of the products is almost unlimited. For today's domestic market, these products represent a new class of nutritionally controllable convenience foods. As meat analogues these can be made available in costs ranging from one-half to one-fifth of their cooked, natural-meat counterparts.

To achieve best results in a flavor-difference testing, the control of environmental condition is important; the objectives of the test must be clearly defined; the comparison by multiple-sample rather than by triangle test appears to be better suited to elicit correct answers; and use of

the nine-point hedonic rating scale is preferable.

It is concluded from the literature that, if the problem of food acceptance can be solved, the critical shortages of protein for human consumption may be ultimately eliminated.

Before proceeding further, it seems advantageous to define the following terms:

Definitions of Terms Used

Casserole - a dish containing high-protein foods combined with bland foods and bound by a sauce.

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

Hedonic Scale - a rating scale having to do with the rating of pleasure.

Nonparametric Statistical Test - is a test whose model does not specify conditions about the parameters of the population from which the sample was drawn.

Taste Panel - a group of persons, primarily inexperienced, who evaluate the characteristics of food samples subjectively.

Textured-Vegetable Protein - (also called, simulated meats, meat analogs) a term applied to plant proteins which have been spun into filaments and pressed together with edible binders to form meat substitutes.

TVP - Textured-Vegetable Protein, a trademark of Archer Daniels Midland Company, for their food product.

CHAPTER III

METHODS AND PROCEDURE

This chapter reports the methods followed by the author to acquire evaluations of a taste-panel's reactions to entrees containing animal protein and entrees containing vegetable protein. These procedures were as follows:

1. Selection of three vegetable protein products which simulated the protein flavors of three different animals--beef, chicken, and pork.
2. Selection of three familiar recipes in which the vegetable protein could be substituted for the animal protein.
3. Numerical evaluations of the panel's reaction to the two different sources of protein.

Vegetable Protein Product Selected

A list of companies was compiled from the literature reviewed. Six companies were found to be preparing a marketable product at this time. This list will be found in Appendix A. A letter was composed (see Appendix A) and sent to these six firms, asking for samples of the information concerning their products. Four companies responded (see Appendix A).

The criteria set up for the selection of a vegetable-protein product to be used in the entrees were the following:

1. similarity of appearance to animal protein to be used in recipe,
2. nutritional content as related to that of animal product,
3. cost as compared with its animal counterpart.

These criteria were obtained with a controlled food product called TVP--a textured-vegetable protein from Archer Daniels Midland Company. It is a dehydrated product which, when partially hydrated, readily absorbs fats and oils and becomes tender and chewable when fully hydrated. This controlled food product (TVP) is available in a variety of flavors as well as sizes and shapes. Flavoring of the all-vegetable protein (TVP) is almost limitless and can be obtained in chicken, beef, ham, bacon, fruit, nut, or special seasonings. The physical forms in which TVP may be obtained are granules, chunks, strips, and chips, with each one of these forms coming in various sizes. This product (TVP) is based on the rich natural protein of the soybean which, of all the vegetable proteins, is the highest in the quality and quantity of the amino acids needed for health and growth (2).

Similarity of Appearance

In as far as possible, the all-vegetable protein should simulate the same flavor, shape, and size as that of the animal-protein item being evaluated by the same recipe. Since TVP comes in an array of flavors, it was possible to use beef, chicken, and ham flavored items. By observation of TVP after hydration, it was decided that the following granules and chunks best suited the similarity of appearance to animal protein used in the recipes:

TABLE I*

TVP PHYSICAL PROPERTIES (2)

TVP PRODUCT TYPE	BULK DENSITY lbs./cu. ft.	SHAPE	APPROXIMATE DIMENSIONS
Granules #6	38	cylindrical	1/8" dia. X 1/4" long
Granules #8	37	cylindrical	3/16" dia. X 1/4" long
Chunks #10	31	rectangular cross section	3/8" X 3/8" X 1/2"
Chunks #15	29	rectangular cross section	3/8" X 3/8" X 3/4"

*Complete Table I in Appendix B.

Nutritional Content

Proteins are the fundamental structural components of all living cells. They are also irreplaceable components of various enzymes, hormones, and other body secretions and are almost the sole form in which man can replace lost nitrogen. A source of uniform quality protein is provided by textured-vegetable items in conjunction with controlled flavor, texture, and color. Since proteins serve such important and essential functions in the body, since about 18 percent of the body is in the form of protein, and since certain indispensable protein components can be obtained only through dietary intake, it is obvious that the quality and amounts of protein in the daily diet are a matter of considerable importance.

The following Table II illustrates a typical analysis of TVP:

TABLE II

ANALYSIS OF TVP (2)

Protein	50%
Carbohydrates	32%
Moisture	8%
Ash	6%
Fiber	3%
Fat	Less than 1%

An important function of dietary protein is the provision of amino acids for the body to build new tissue and to maintain the tissue already formed. In addition, amino acids are used to form nitrogen-containing substances essential to body functions, such as the enzymes, antibodies, and some of the hormones. Protein serves also in certain body-regulating capacities and provides energy. The following Table III gives the composition of the essential amino acids of TVP as compared with beef muscle:

TABLE III

ESSENTIAL AMINO ACID COMPOSITION OF TVP (2)

	TVP		BEEF MUSCLE	
	mg/g TVP 8% Moist	mg/g N[1]	mg/g Beef[3] 8% Moist	mg/g N[2]
Isoleucine	27.3	328	20	323
Leucine	39.3	471	30.2	488
Lysine	30.7	368	33.2	537
Methionine	5.7	68	-	-
Cystine	7.7	92	-	-
Methionine + Cystine	13.4	160	15.6	253
Phenylalanine	27.8	334	-	-
Tyrosine	20.2	243	-	-
Phenylalanine + Tyrosine	48.0	577	26.4	428
Threonine	19.6	236	17.2	278
Tryptophane	7.1	85	3.9	63
Valine	29.9	359	19.8	321

1 1 g TVP (8% moisture) = 0.0833 g N
2 1 g Beef (8% moisture) = 0.0618 g N
3 mg/g N x .0618 = mg/g Beef

Table III points out that in all areas except leucine, lysine, methionine + cystine, and threonine, the mg/g of nitrogen in the TVP were higher than that in the beef muscle. Even in these four, only methionine + cystine showed a significant difference.

Cost Comparison

Cost of textured-vegetable protein varies over a wide range. Most expensive are those products fabricated from the spun-soy textured protein which is produced still in very small operations. Unflavored spun-soy fibers in an acid-salt media cost about 50 cents a pound. Prices of the finished form marketed to consumers are in the range of two-thirds to three-quarters of the meat which can be replaced. Expanded-soy textured protein, such as TVP, is produced by less expensive processes on a larger production scale. Cost of the unflavored expanded-soy textured protein in chunk or granular dry form varies from four to twelve cents a pound. Since the dry form rehydrates (see Table IV, Appendix B) with approximately one to two parts of water, the cost of an as-served-portion is in the range of four to thirteen cents a pound (60).

The following figure shows a graphic illustration of this:

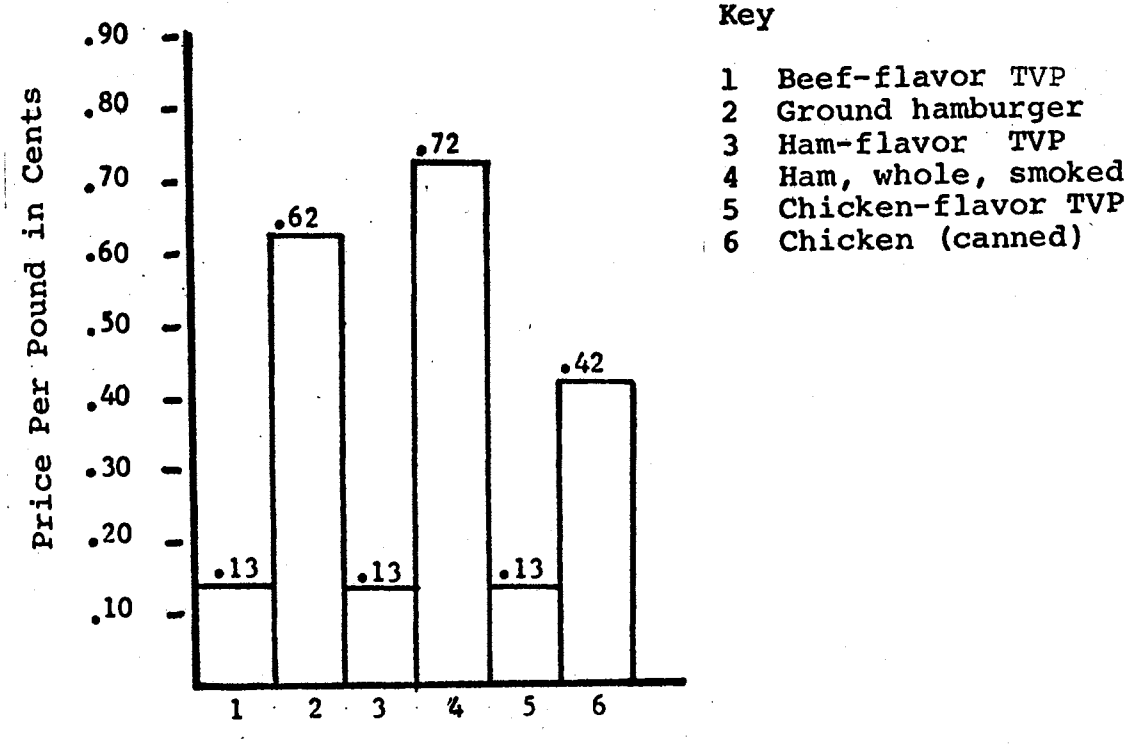

Figure 1 Cost Comparison*

Evaluation of Recipes Used

Even though the use of these newly-introduced vegetable-protein food products could eliminate protein malnutrition in human diets, they are not always accepted because of cultural food idiosyncrasies (8, 45). To aid acceptance, these foods should fit into an individual's frame of reference through familiar form--flavors, shapes, sizes, recipes, etc. The casserole entree dish and salad

*United States Department of Labor: 1969 Estimated Retail Food Prices. Bureau of Labor Statistics, 1969.

entree were the familiar forms used as the conveyer of the all-vegetable product (TVP) for this tasting panel. It was felt that the casserole and salad entree dishes were sufficiently popular with the people in this area that they could in no way be considered unusual in themselves and therefore would not contribute in any way to a statistical difference when panel members would make evaluations. In the preliminary evaluation by the author and three other persons, several four-serving yield recipes were evaluated for all-over consumer acceptability and appearance in casserole and salad. These recipes were prepared with both the animal product and the TVP. The three recipes selected were Quaker Spaghetti, Ham-Noodle Casserole, and Chicken Salad, the ingredients for which may be found in Appendix B.

The recipes had been calculated for 50 three-ounce servings. For the tasting panel, one-half-ounce servings were considered as adequate, therefore the recipes yielded 300 one-half-ounce servings.

Test Method

Statistical advice was sought in setting up the test, designing the score card, and selecting the taste panel. In view of the many areas of food tasting which could be evaluated by such a panel, the statistician recommended that the test be set up to evaluate quality variation without indication of preference by the panel member. The preference (if any) appears in the statistical analysis. It was

decided to have the panel evaluate only one quality--flavor; so the test was set up as a flavor-difference test (14). Panel members were not given a description of a flavor but were asked to rate each sample individually within their own frame of reference, thereby following the approach taken by an individual when first introduced to a new type of food. For example, the individual evaluates the new food within his personal frame of reference and in relation to associates at the time of tasting.

It has been suggested by Siegel (58) that, when dealing with the behavioral sciences, such as a taste panel's reaction, nonparametric statistics be applied. The assumptions associated with nonparametric statistics, according to Siegel, are much weaker than those associated with parametric statistics. Therefore, to increase the precision of the test the following criteria were utilized:

1. a taste panel as large as could be easily accommodated within the time span allowed--preferably over 100 persons--and

2. a built-in check of the panel member's reliability.

In considering the number of samples to offer, the statistician had pointed out the following advantages of multiple-comparison method of sampling as good reasons for presenting four samples of each recipe:

1. detection of smaller differences between treated and untreated samples;

2. additional information about the direction and importance of the differences;

3. more efficiency when panels have not been especially trained; and

4. no influence by small differences in color and texture.

In addition, the statistician had advocated placing in the test method a built-in taste-sensitivity check of a panel member's reliability because such a large group of people were gathered together for only one time. Screening or reliability checking of panel members can generally be accomplished by pre-testing (40), but is only feasible when a panel is small in number (29). The taste-sensitivity check was therefore evaluated by presenting two identical samples of each protein item. For reliability, each one of the pairs was scored by the panel member within a range of similarity.

Three recipes were chosen to be tested within the period of one hour. Since no loss of taste sensitivity was found (48) for a time period of an entire hour with several different products and comparisons, each panel member was asked to taste twelve samples. Each group of the three recipes contained four samples coded as A, B, C, and D (16). For example, using the Quaker Spaghetti recipe, there were four samples (A, B, C, and D). A and C samples were identical and B and D were identical. This replica of each sample to be tasted was the statistically adviced built-in reliability check on the untrained and non-screened

panel member. The four samples of each recipe were presented in a straight line on three separate tables.

Panel members tend to use all available information in making judgments (14). Therefore the hot casserole entrees were served in identical, stainless-steel, chafing dishes holding two-inch, half-counter pans (15). Quaker Spaghetti and Ham-Noodle Casserole (the hot entrees) were served in eight of these dishes. Four contained Quaker Spaghetti, of which two (coded as A and C) contained the animal-protein product and two (coded as B and D) contained the textured vegetable-protein (TVP) product. The other four contained Ham-Noodle Casserole and were also coded in the same manner as the Quaker Spaghetti. The Chicken Salad was served from four identical two-quart, stainless-steel bowls and was coded in a similar manner (see Table V, page 31).

Information about the variable to be evaluated can be of great help in increasing sensitivity of discrimination (9, 32), so it had been decided that panel members could have prior knowledge of the product being tested. Accordingly, there was no concealment about the type of product to be tasted in the invitation to participate.

Score Card

In designing the score card for this particular taste evaluation, the statistician advised using the nine-point hedonic scale (46). This scale has verbal designations ranging from "like extremely" to "dislike extremely."

TABLE V

SAMPLE CODING

QUAKER SPAGHETTI

Sample A	Sample B	Sample C	Sample D
Recipe with meat	Recipe with TVP	Same as Sample A	Same as Sample B

HAM-NOODLE CASSEROLE

Sample A	Sample B	Sample C	Sample D
Recipe with meat	Recipe with TVP	Same as Sample A	Same as Sample B

CHICKEN SALAD

Sample A	Sample B	Sample C	Sample D
Recipe with meat	Recipe with TVP	Same as Sample A	Same as Sample B

The nine-point scale gives a greater range of sensitivity than one with fewer degrees (68). Data obtained in this manner can be statistically analyzed.

It was believed important that the score card be limited to one sheet to make it easier for the panel member to use and for results to be recorded. The score card design included a new statistical method allowing for true "no preference" vote, by a column titled "neither like nor dislike." Appendix D illustrates the score card used to evaluate the twelve samples.

Taste Panel

By statistical advice, one of the criteria set up was to have as large a taste panel membership as could be easily accommodated within the time-span of one hour, preferably over 100 persons. Therefore, a selected rather than a trained taste panel was sought (29, 40). A letter (see Appendix C) inviting participation was sent out through campus mail nine days before the panel met. It went to University professors, students, and employees of Residence Hall Food Service and Student Union Food Service. Notices (see Appendix C) of the day of the test were posted on bulletin boards and in elevators of many of the campus classroom buildings and residence halls. Instructors in the College of Home Economics were asked to announce the time and place during their class meetings held on the same day the taste panel was to meet. After the panel meeting, a

thank-you note was sent to each participant (see Appendix C).

Test Environmental Factors

The taste panel met in the experimental food laboratory of the Home Economics Building on the campus of Oklahoma State University on a Wednesday afternoon (38), from 2:30 to 3:30 P.M., April 30, 1969. The neutral-colored, 20-by-40-foot room was large enough to contain the activity. It was odor-free and air-conditioned and, in as far as possible, lighting was uniform (37).

Each panel member was allowed as much time as desired for tasting the samples, and an unlimited time interval between tasting the different samples. Water was provided to remove flavors from the mouth, and the panel member was asked to take a swallow of water after tasting each sample (3). Swallowing of the samples was permitted.

CHAPTER IV

RESULTS AND DISCUSSION

Limitations of the Research

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

1. adults over 18,
2. an untrained panel, and
3. selection from a university oriented background.

In addition to the above restrictions, the research was further limited by the technological criteria imposed by the company from which the test product was obtained. These were as follows:

1. product from an oil seed--soybeans, and
2. process used to create the texture in the product.

Numerical Results

The panel members were untrained and met only at the time of the tasting. The instructions were contained at the top of each score card (see Appendix D), which was given them as they entered the experimental food laboratory. This approaches the situation called for in the research, for this type of person might enter a cafeteria or restaurant

accompanied by friends all bringing their food idiosyncrasies with them.

There were a total of 157 panel members who participated in the research. Since the assumptions associated with nonparametric statistics are much weaker than parametric statistics, the precision of the test was increased by enlarging the size of the panel. Much effort was put into obtaining a panel of 100 and this effort was rewarded with a group of 157. Figure 2 shows that of the 157 participants, 76 were men and 81 were women. This ratio of 47.7% men to 52.3% women is approximately the same distribution of sexes as there was in the United States as of the 1960 census.* There were 26 persons in the under-20 age group, 53 in the 20-25 age group, 33 in the 25-35 age group, and 45 in the over-35 age group. This distribution is illustrated in Figure 3. There were, however, no persons under 18 as participating panel members. Again the ratio of age groups (under-20, 16.5%; 20-25 age group, 33.8%; 25-35 age group, 21.1%; over-35 age group, 28.6%), was representative of the current national average in these particular age groups.* The author feels this was representative of the sex and age groups which would normally come to a commercial eating establishment.

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*United States Department of Commerce: 1960 Census of Population. Bureau of the Census 1: 831, 1960.

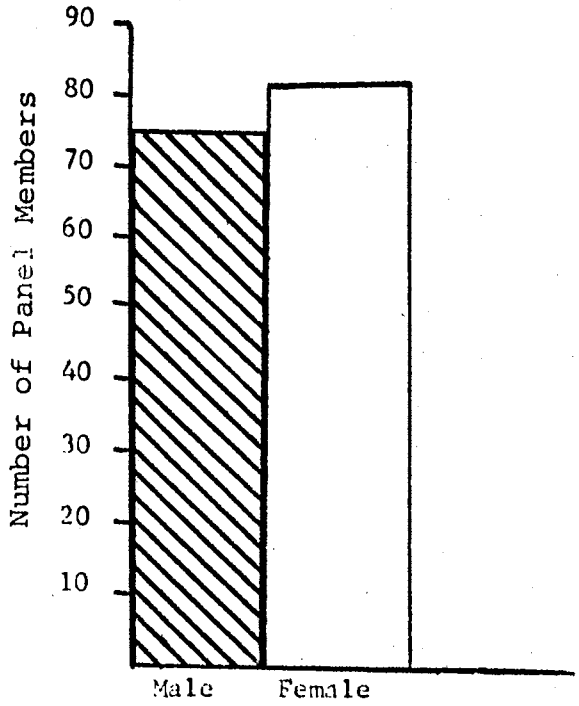

Figure 2. Sex Distribution of Taste Panel

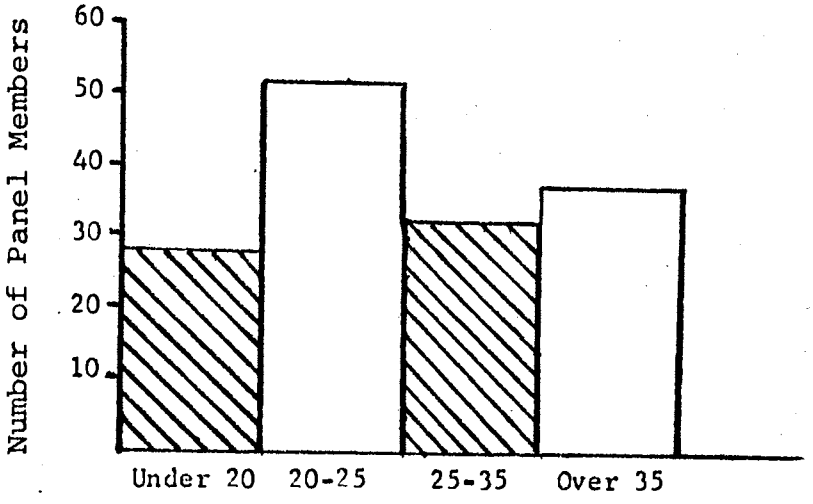

Figure 3. Age Group Distribution of Taste Panel

Statistical Results

All data were coded and compiled on IBM Code Sheets (see Appendix D) so as to use the IBM Computer Model 360 at the Computer Center, Oklahoma State University. A program was planned, using Friedman's two-way analysis of variance by rank (58). On the score card, each panel member was asked to evaluate only one quality--flavor of the particular dish tasted. For each dish (there were 12 to be tasted), there were nine degrees of flavor (from like extremely to dislike extremely) which could be scored. These scores were ranked separately within a given sample of each recipe. Therefore, with four samples of each recipe, the ranking was 1, 2, 3, and 4, one being the highest given. The following Table illustrates this with the ranks assigned being in parenthesis:

TABLE VI

ILLUSTRATION OF RANKING SCORE COLUMN RESPONSES

CHICKEN SALAD	Score Columns								
	1	2	3	4	5	6	7	8	9
Sample A		✓ (1)							
Sample B				✓ (3)					
Sample C			✓ (2)						
Sample D					✓ (4)				

The null hypothesis (H_o = A=B=C=D) adopted for this research, and to be tested, was the assumption that all four samples of each recipe were equal (could not be flavor-discriminated apart). With the alternate hypothesis, that at least two of the dishes are not equal, the Friedman test was utilized to determine whether or not the rank totals (Rj) differ significantly. To test the null hypothesis, the value of a statistic which Friedman denotes as χ_r^2 (called Friedman's statistic and hereafter in this research will be denoted by F) was computed on the IBM Model 360. The formula used in the computerized analysis, given in Siegel (58), is as follows:

$$F = \frac{12}{Nk(k+1)} \sum_{j=1}^{k} (R_j)^2 - 3N(k+1)$$

Applying the above formula to the ranks assigned to the flavor-score each panel member gave to a given sample, gave the following F statistic with 3 d.f. for:

Quaker Spaghetti	= 209.6125
Ham-Noodle Casserole	= 215.4834
Chicken Salad	= 62.3105

The probability associated with the F statistic for Friedman's two-way analysis of variance by ranks was less than .001 for all three recipes. Therefore, the null hypothesis would be rejected and it was concluded that a flavor-difference of statistical significance could be determined by the panel.

If in an analysis of variance, there is a significant difference, it is often desirable to know where the difference lies and on what it depends. In this research, it was checked to see if the difference was influenced by the age or sex of the panel member. Duncan's Multiple Range Test (18) was used for this purpose. The data were analyzed by the computer using the following formula:

$$s_{\bar{x}} = \sqrt{EMS/n}$$

It was found that the panel members could flavor-discriminate between the samples and that the sample scores did not depend on sex. There was significant difference (see Appendix E) noted between the age groups for samples A and C in the Chicken Salad.

Graphic Illustration

In graphic illustration (see Appendix E, Table IX) of the panel responses as shown in the score columns, it was of interest to note the median of all animal-protein dishes (Samples A and C) fell in column three (like moderately). The median of Quaker Spaghetti and Ham-Noodle vegetable-protein samples B and D fell in column six (dislike slightly). For the vegetable-protein sample B of Chicken Salad, the median fell in column four (like slightly) and sample D (vegetable-protein) fell in column five (neither like nor dislike).

Score Card Questions

At the bottom of the score card (see Appendix D), the taster was asked to answer three questions. These were:

1. If any of these entree dishes were offered in a cafeteria, would you purchase them?
2. Would it make a difference in your selection if you were told the protein was derived from a vegetable source rather than animal?
3. Would you accept vegetable-protein as a replacement for meat in your diet?

Table VII shows the distribution of the answers by sex and age.

TABLE VII

DISTRIBUTION OF ANSWERS
BY AGE AND SEX

	Question 1				Question 2				Question 3			
Sex	Male		Female		Male		Female		Male		Female	
Yes	48		57		16		28		27		38	
No	11		14		43		46		32		33	
No response	17		10		17		7		17		10	
Column totals	76		81		76		81		76		81	
Age groups*	1	2	3	4	1	2	3	4	1	2	3	4
Yes	19	35	20	31	5	14	11	14	10	20	13	22
No	4	9	6	6	18	30	15	26	12	24	11	18
No response	3	9	7	8	3	9	7	5	4	9	9	5
Column totals	26	53	33	45	26	53	33	45	26	53	33	45

*Age Group Key: 1 = under 20; 2 = 20-25; 3 = 25-35; 4 = over 35.

These data were analyzed by the computer for Chi square (X^2) and it was found that none of the answers for any of the three questions depended on sex or age (see Appendix D). In the chart below are the percentages of answers to each question. It was of interest to note that 67.5% of the tasters felt they would purchase any of the entree dishes if offered on a cafeteria line, and that 56.3% did not feel it would make any difference in their selection if they had been told the protein was derived from vegetable sources. It seemed to be unresolved in their minds whether or not they would accept vegetable-protein as a replacement for animal-protein (meat) in their diet.

	YES	NO	NO RESPONSE
Question 1	67.5%	15.9%	16.6%
Question 2	28.0%	56.3%	15.7%
Question 3	41.4%	42.0%	16.6%

CHAPTER V

SUMMARY AND CONCLUSIONS

The food service industry is facing a new set of challenges that demand a fresh look at traditional foods and traditional menus. Few industries are required to cope with so many totally unexpected variations in the cost of their raw material as is food service. Of even more importance to the industry, this raw material (bound by personal idiosyncrasies) is essential to maintain life. Because textured-vegetable protein is such an important, new and different kind of ingredient, the author felt it would be of importance to ascertain the consumer's acceptance of it. This was done by evaluating the reaction of a selected taste panel to the flavor of vegetable protein in entree dishes. The taste panel was composed of 157 members. Of these, 76 were male and 81 were female with age groups ranging from 18-20, 20-25, 25-35, and over-35.

Three flavors--beef, ham, and chicken--of textured-vegetable protein were prepared in a familiar form. The casserole entree dish (Quaker Spaghetti and Ham-Noodle Casserole) and salad entree (Chicken Salad) were the familiar forms used as the conveyer of the new food product. Each panel member was asked to taste twelve samples (four

of each of the above named recipes).

The nine-point hedonic scale was used in the design of the score card ranging from "like extremely" to "dislike extremely." Included in the design, was a column allowing for a true "no preference" vote. At the bottom of the score card, three questions were posed to the panel members concerning reactions to their acceptance of textured-vegetable protein products.

The null hypothesis, all samples are equal, was rejected because the probability associated with the F statistic for the analysis of variance by ranks was less than .001 for all three recipes. Therefore, the alternate hypothesis, that at least two of the samples are not equal, was accepted. The responses of the panel members revealed they could flavor-discriminate between the samples. The results showed the sample scores did not depend on sex, and only in the Chicken Salad samples, A and C, was significant difference statistically noted in the age groups. The median of all animal-protein dishes fell in the "like moderately" column. On the other hand, the median of vegetable-protein dishes of beef-flavor and ham-flavor fell in the "dislike slightly" column. In contrast, Chicken Salad vegetable-protein samples (B and D), fell in different columns. Sample B in "like slightly" and the built-in check replica, sample D, in "neither like nor dislike" columns.

There were 67.5% of the panel members who felt they would purchase any of the entree dishes if offered on a

cafeteria line, and 56.3% did not feel it would make any difference in their selection if they had been told the protein was derived from vegetable sources.

The author feels the above noted results of this research, along with previous studies in nutritional content and cost analysis, justify the consideration of textured-vegetable protein products in institutional food service. In addition, the author futher believes that with some additional work in the area of recipe refinement, the textured-vegetable protein products would be as acceptable to individuals as their animal-protein counterparts.

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APPENDIX A

LIST OF COMPANIES AND CORRESPONDENCE

COMPANIES WHICH MANUFACTURE TEXTURED VEGETABLE PROTEIN PRODUCTS

TVP - Textured Vegetable Protein
Archer Daniels Midland Company
733 Marquette Avenue
Minneapolis, Minn. 55440

Bontrae, Spun-soy Textured Protein
General Mills, Inc.
Central Research Laboratories
James Ford Bell Research Center
9000 Plymouth Avenue
Minneapolis, Minn. 55440

Edi-pro, Spun-soy Protein
Ralston Purina, Special Soy Products Dept.
835 South Eighth Street
St. Louis, Missouri 63199

Texgran, Expanded-soy Textured Protein
Swift & Company
115 West Jackson Blvd.
Chicago, Ill. 60604

Textrasoy, Expanded-soy Textured Protein
H. B. Taylor Company
4830 S. Christiana Avenue
Chicago, Ill. 60632

Hydrated Vegetable Protein Foods
Worthington Foods, Inc.
900 Proprietors Road
Worthington, Ohio 43085

E 2-4 Brumley Apt. O.S.U.
Stillwater, Okla. 74074
February 15, 1969

Re: Textured Vegetable Protein Products

Dear Sirs:

I am a graduate student at Oklahoma State University in the College of Home Economics, Department of Foods, Nutrition and Institution Administration and am completing my Dietetic Internship. During my internship, I have elected to do my master's research work in the area of meat analogs. I am interested in testing whether or not a selected test panel can detect between an entree dish using animal protein and one using vegetable protein.

Having done extended research reading in this area, I feel that the answer to the world animal protein shortage may lie in extensive use of vegetable protein--introduced via a simulated meat.

I am interested in using your product in my research. Would your company be interested in sponsoring my project or some part of it? I would appreciate any help, assistance, information, technical data, recipes, and samples you can supply me.

Thank you.

Sincerely,

Gretchen V. Collins
Dietetic Intern
Oklahoma State University

Mary E. Leidigh, Associate Professor
Food, Nutrition and Institution
Administration
Oklahoma State University

Processors of agricultural products

ADM

ARCHER DANIELS MIDLAND COMPANY 4666 FARIES PARKWAY DECATUR, ILLINOIS 62521 TELEPHONE: 429-2911

February 19, 1969

Miss Gretchen Collins
E 2-4 Brumley Apt.
Oklahoma State University
Stillwater, Oklahoma 74074

Dear Miss Collins:

Thank you very much for your letter and interests in textured vegetable protein. Your proposed work with TVP sounds very interesting.

We will be happy to provide you with TVP and technical advice for your project. As soon as you have your requirements please let us know and we will send the material immediately.

Thank you again for your interests.

Yours very truly,

David Meldahl

D. R. Meldahl
Food Products Div.

b

H. B. TAYLOR CO.
MANUFACTURERS OF FLAVORS, COLORS, FOOD ESSENTIALS

4830 SOUTH CHRISTIANA AVENUE · CHICAGO, ILLINOIS 60632 · (312) 254-4805

February 20th, 1969

Miss Gretchen Collins
E 2-4 Brumley Apt. O.S.U.
Stillwater, Oklahoma 74074

Dear Miss Collins:

Under separate cover I am enclosing two (2) samples of TEXTRASOY and various recipes.

I am also enclosing a copy of our technical bulletin "TEXTRASOY-TEXTURED VEGETABLE PROTEIN".

At the present time we are unable to sponsor your project, as all our efforts are centered in our own research, however, we do wish you luck and thank you for considering us.

Very truly,

H. B. TAYLOR CO.

Kenneth B. Basa

Kenneth B. Basa
Laboratory Director

KBB/mkf
encl-

RALSTON PURINA COMPANY

CHECKERBOARD SQUARE ▪ SAINT LOUIS, MISSOURI 63199

February 27, 1969

Miss Gretchen Collins
Dietetic Intern
Oklahoma State University
E 2-4 Brumley, Apt. O.S.U.
Stillwater, Oklahoma 74074

Dear Miss Collins:

With reference to your letter dated February 15, 1969 regarding spun soy textured protein, we are delighted to hear of your forthcoming research project. Needless to say, the more people we can recruit to conduct this kind of evaluation, the sooner we shall find soy protein being used in more natural products. This is a dynamic area and should provide you with much useful information for purposes of writing your thesis.

The initial parameter you have established for yourself is a most interesting one. It is doubtful in many cases that one can distinguish between vegetable protein and animal protein in certain foods. We feel that taste panels can distinguish between vegetable protein which has been made by extrusion from soy flour versus one which has been spun into fiber from isolated soy protein, such as our textured Edi-Pro, in certain food products. We recognize the fact on the other hand, in certain products it is difficult to distinguish the different sources of soya protein. There is no question in our mind that in many cases it would be difficult to distinguish between animal protein and vegetable protein, e.g. imitation ham squares and imitation sour cream. An interesting product is the utilization of bacon fiber in scrambled eggs, added just at the point where scrambled eggs are beginning to become firm.

You may be sure that we will help in any that is possible during your internship to provide the technical data and samples to support your work. You may be aware of the Danforth Foundation, which has been set up for purposes of supplying funds to worthwhile projects in colleges and universities. You may wish to investigate the potential support that you might secure from this foundation. We stand ready here at Checkerboard Square to offer that which you may feel we qualify to offer. Please do not hesitate to contact us for help or assistance at any time.

Very sincerely yours,

Doyle W. Ramey, Manager
Technical Sales Service
Edible Protein

G 65 G jw

(614) 885-9511

WORTHINGTON FOODS, INC. 900 PROPRIETORS ROAD • WORTHINGTON, OHIO 43085

March 3, 1969

Miss Gretchen Collins, Dietetic Intern
Oklahoma State University
E - 2-4 Brumley Apartment
Stillwater, Oklahoma 74074

Dear Miss Collins:

Thank you for your letter to Worthington Foods. Mr. Leiss has left the company, so your letter was referred to me for reply.

We certainly agree with your opinion that vegetable protein foods are the answer to the world animal protein shortage. We would be glad to assist your research however we can.

We are sending, under separate cover, several publications for your information. Before we can suggest a suitable recipe and product for your test panel, you will need to decide which meat or meats you wish to use. You might like to compare bacon, chipped smoked turkey, lean ground beef hamburger and/or thinly sliced smoked beef slices with the suitable Worthington parallel. We have several recipes available for panel testing for each of these products which we will send upon request. We will also supply you with the product you need. We would like to request, in return, a copy of the work done with our foods.

In most cases, we at Worthington do not think of our foods as meat substitutes. They are delicious, protein-rich foods suitable for use as an entree in a menu. If you prepare identical dishes using, for instance, bacon and Stripples, chances are that every taste panel member will be able to detect which is the real meat. A better question might be whether the tasters would accept the vegetable protein foods as a replacement in the absence of meat. The choice of the future will not be meat or no meat, it will be between the vegetable protein foods available for entrees; whether they are palatable or not is the present concern.

We look forward to receiving further information about your impending test panel research. Please feel free to write anytime for more information.

Sincerely,

Linda Saling

(Mrs. J.H. Saling)
Nutritionist

JHS:sk
Separate Cover

E 2-4 Brumley Apt. O.S.U.
Stillwater, Okla. 74074
April 6, 1969

Mr. David R. Meldahl
Archer Daniels Midland Company
Food Products Division
4666 Faries Parkway
Decatur, Illinois 62521

Dear Mr. Meldahl,

I appreciate your offer to provide the TVP with which to do my research. The following are the items that are needed for the test:

Beef flavor-M	Ham flavor-M	Chicken flavor-M
7 1/2 lbs. Granules #6	15 lbs. Chunks #10	7 1/2 lbs. Chunks # 8
3 lbs. Granules #8		7 1/2 lbs. Chunks #10
3 lbs. Granules #5		

The tasting panel will consist of 90-100 people. I will need enough of each flavored TVP product to prepare 2 beef dishes (Baked Spaghetti), 2 ham dishes (Ham-noodle Casserole), and 2 chicken dishes (Chicken Salad) and to standardize recipes as well as to cover any mistakes. In your estimation will the 15 lbs. of each flavored TVP item in the amounts listed above be sufficient for these needs?

I am also interested in the following materials:

1. A Ham Load Recipe
2. A Consumer's Comparative Price List (comparing vegetable protein with animal protein)
3. Colored Pictures of the Finished Products
4. Bulletin Board Material
5. History of Archer Daniels Midland Company
6. How the TVP is processed (to be used in the general explanation of the thesis).

The recipe standardization will be started Monday, April 14th, with the tasting panel meeting Wednesday, April 30th. I am looking forward to working with your products.

Sincerely,

Gretchen Collins, Dietetic Intern
Oklahoma State University

Mary E. Leidigh, Associate Professor
Food, Nutrition and Institution Administration
Oklahoma State University

Processors of agricultural products

ADM

ARCHER DANIELS MIDLAND COMPANY 4666 FARIES PARKWAY DECATUR, ILLINOIS 62526 TELEPHONE: 217 423-2571

April 16, 1969

Miss Gretchen Collins
E 2-4 Brumley Apt.
Oklahoma State University
Stillwater, Oklahoma 74074

Dear Miss Collins:

The samples of TVP have been ordered and should arrive in about one week to ten days.

A price list of all TVP products are in the enclosed brochure. From the price list you will be able to compare TVP (on a hydrated basis, 1 pound TVP and 2 pounds water equal 3 pounds meat) and the cost of various kinds of meats.

We cannot divulge any information regarding our process procedure as it is currently being patented.

We are arranging to have a copy of our annual statement sent to you. It will give you a brief history of ADM.

If you have any further questions or if you need additional sample material please feel free to call on us.

Yours very truly,

D. R. Maldahl
Soya Specialties

b

Encl:

SAMPLE REQUISITION

ADM

ARCHER-DANIELS-MIDLAND COMPANY MINNEAPOLIS, MINNESOTA 55440

ORIGINATING OFFICE	SR DATE	SALESMAN AND SALES OFFICE	SAMPLE REQUISITION NUMBER
Decatur	4/17/69	DTM	3108

SHIP TO
Gretchen Collins
E 2-4 Brumley Apt.
Oklahoma State University
Stillwater, Oklahoma 74074
ATTN.

FOR TRANSMITTAL TO
ATTN.

SHIP VIA	SHIPPED FROM
Best Way	Decatur
FILLED BY	DATE SHIPPED

QUANTITY & CONT.	PRODUCT CODE	DESCRIPTION	
10 #	65-302	TVP Beef Flavor M Granules #6	NO
5 #	65-304	TVP Beef Flavor M Granules #8	
5 #	65-308	TVP Beef Flavor Chunks #10	
15 #	65-227	TVP Ham Flavor M Chunks #15	
10 #	65-174	TVP Chicken Flavor M Chunk #10	
10 #	65-172	TVP Chicken Flavor M Granules #8	CHARGE

FORM 9016 REV. 3-66

NO CHARGE

CUSTOMER COPY

APPENDIX B

R E C I P E S

QUAKER SPAGHETTI

Ingredients	50 3-oz. sv.
Ground Beef (or hydrated TVP**)	12 lbs.*
Salt	3 T.
Pepper	1 t.
Oil	3/4 C.
Onions, diced	1 C. + 2 T.
Green Pepper, diced	1 C. + 2 T.
Tomato sauce	1 #10 can
Tomatoes, diced	3/4 #10 can
Oregano	2 1/4 t.
Garlic salt	3 T.
Mushroom pieces	1 1/2 C.
Parsley, dried	1 T. + 1 1/2 t.
Thyme	1 1/2 t.
Bay Leaf	2 1/2
American Cheese, grated	3/4 lbs.
Spaghetti (A. P.)	6 lbs.

Directions

1. Cook first three ingredients in a large stock pot until well done.
2. Saute onions and peppers in oil until tender then add the tomato sauce and diced tomatoes. Cook 10 minutes; add next 8 ingredients and simmer for 30 minutes.
3. Divide sauce into two stock pots (equally). Add 6 lbs. of the cooked beef to one and 6 lbs. of hydrated TVP to the other. Continue to simmer for 30 minutes.
4. Cook spaghetti until tender. Add half to TVP mixture and half to the beef mixture.
5. Divide each mixture into 4 two-inch half-counter pans. (Pan yield for taste panel will be 75 one-half-ounce servings.)
6. Sprinkle grated American Cheese over top.
7. Bake until cheese melts; about 25 minutes at 300°.

* For taste panel, use 5 lbs. of each. Use half the salt and pepper for each.

** Hydrate TVP by pouring boiling water (170° to 210° F.) over 1 lb. of #6 beef-flavor granules, 1 lb. of #8 beef-flavor granules, and 1 lb. of #10 beef-flavor chunks.

HAM-NOODLE CASSEROLE

Ingredients	50 3-oz. sv.
Margarine	1 C. + 2 T.
Milk	2 qt. + 1 C.
Flour	1 C. + 2 T.
Salt	1 T. + 1 1/2 t.
Mustard, powdered	2 1/4 t.
Cheddar cheese, extra sharp, grated	3 lbs.
Macaroni, cooked	2 qt. + 1/2 pt.
Ham (or hydrated TVP**), cubed	2 qt.*
Cracker crumbs	2 qt. + 1 C.
Margarine, melted (for crumbs)	2/3 C.

Directions

1. Make a white sauce from the first four ingredients. Add next two ingredients while stirring. This makes a cheese sauce.
2. Cook macaroni until tender. Add to cheese sauce.
3. Divide into two stock pots (equally).
4. Add 4 C. of cubed Ham to half and
   4 C. of TVP to the other.
   Simmer for 10 minutes.
5. Divide each mixture into 4 two-inch half-counter pans. Sprinkle with buttered crumbs. (Pan yield for taste panel will be 75 one-half-ounce servings.)
6. Bake with foil covering; about 25 minutes at 300°.

* For taste panel, use 1 qt. of each.

** Hydrate TVP by pouring boiling water (170° to 210°F.) over the #15 ham-flavor chunks and let stand for 10-15 minutes.

CHICKEN SALAD

Ingredients	50 3-oz. sv.
Chicken, cooked diced (or hydrated TVP**)	15 lbs.*
French dressing	2 C.
Mayonnaise	9 C.
Sweet pickle relish	1 1/2 C.
Onions, diced	3/4 C.
Celery, Diced	9 lbs.
Lemon juice	3 T.
Salt	6 T.
White pepper	1 T.

Directions

1. Marinate chicken in 1 C. French dressing for 3 hours. (Do the same with TVP.)
2. Mix the rest of the ingredients together in one bowl and then divide into two containers.
3. Add marinated chicken to one bowl and marinated TVP to the other.
4. Fill a lettuce lined bowl with 1/4 of the mixture. There will be 4 two-qt. bowls with the chicken mixture and 4 2-qt. bowls with the TVP mixture.

* For taste panel, use 7 1/2 lbs. of each.
** Hydrate TVP by pouring boiling water (170° to 210°F.) over 1 7/8 lbs. of #8 chicken-flavor granules and 1 7/8 lbs. of #10 chicken-flavor chunks.

TABLE I

TVP PHYSICAL PROPERTIES (2)

TVP PRODUCT TYPE	BULK DENSITY lbs./cu. ft.	SHAPE	APPROXIMATE DIMENSIONS
Granules #1	40	irregular	98% thru #6 screen 5% thru #35 screen
Granules #6*	38	cylindrical	1/8" dia. X 1/4" long
Granules #8*	37	cylindrical	3/16" dia. X 1/4" long
Chunks #5	34	rectangular cross section	3/8" X 3/8" X 1/4"
Chunks #10*	31	rectangular cross section	3/8" X 3/8" X 1/2"
Chunks #15*	29	rectangular cross section	3/8" X 3/8" X 3/4"
Strips #5	29	rectangular cross section	3/8" X 1/8" X 5/8"
Strips #10	26	rectangular cross section	3/4" X 1/8" X 5/8"

*Granules and chunks selected to use.

TABLE IV

TVP HYDRATION TIME (2)

Water Temperature

TVP Product Type		Hot to Boiling (170 to 210°F)	Warm to Hot (130 to 170°F)	Warm (100 to 130°F)	Room Temperature (60 to 100°F)
Granules	#1	4-5 minutes	5-10 minutes	10-15 minutes	20-30 minutes
	#6*	7-10 "	10-15 "	15-20 "	30-40 "
	#8*	10-15 "	15-20 "	20-30 "	40-60 "
Chunks	#5	10-15 "	15-20 "	20-30 "	40-60 "
	#10*	10-15 "	15-20 "	20-30 "	40-60 "
	#15*	10-15 "	15-20 "	20-30 "	40-60 "
Strips	#5	10-15 "	15-20 "	20-30 "	40-60 "
	#10	10-15 "	15-20 "	20-30 "	40-60 "

APPENDIX C

INVITATIONAL CORRESPONDENCE

OKLAHOMA STATE UNIVERSITY
College of Home Economics
Department of Food, Nutrition, and Institution Administration
April 21, 1969

Dear

To complete the requirements of my Master's Degree in the College of Home Economics, Department of Food, Nutrition and Institution Administration, I am doing research in the area of simulated meat. This research requires interested persons who would be able to participate in a food tasting panel.

I should like to invite you to be a member of this panel. This would necessitate 15 to 20 minutes of your time on

Wednesday, April 30th
between 2:30-3:30 PM
at HEW in Room 403

Please return (by campus mail) your answer. Thank you.

Gretchen Collins
Dietetic Intern

- -

(Send to Gretchen Collins, Dietetic Intern HEE 103)

I will, will not, be able to participate.

Signed _____

Are YOU interested in NEW FOODS?

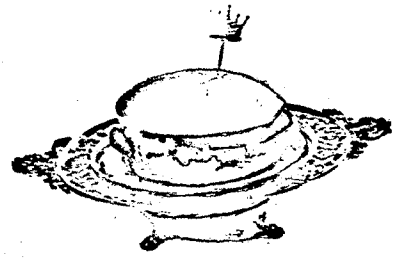
Take 15 minutes of your time —

Come to: Room 403 4th floor

Wed. April 30th

Home Ec. West

2:30 p.m. - 3:30 p.m.



& test your taste buds!

G. Collins

May 1, 1969

Dear

There were 157 people who participated in the tasting panel and I would like to thank you for contributing your data. If you will let me know, I'll be glad to share the results when they have been compiled.

Thank you again for your time and interest.

Gretchen Collins
Dietetic Intern
HEE 103

APPENDIX D

DATA COLLECTING FORMS

OKLAHOMA STATE UNIVERSITY
College of Home Economics
Department of Food, Nutrition and Institution Administration
April 30, 1969

Name_____ Age (circle one) If under 20, age_____

Sex Male Female Under 25 25-35 Over 35

Before you are four entree dishes, check how much you like or dislike the flavor of EACH SAMPLE. Please take a swallow of water after tasting each sample.

QUAKER SPAGHETTI

	like extremely	like very much	like moderately	like slightly	neither like nor dislike	dislike slightly	dislike moderately	dislike very much	dislike extremely
Sample A									
Sample B									
Sample C									
Sample D									

HAM-NOODLE CASSEROLE

Sample A									
Sample B									
Sample C									
Sample D									

CHICKEN SALAD

Sample A									
Sample B									
Sample C									
Sample D									

If any of these entree dishes were offered in a cafeteria, would you purchase them? yes no

Would it make a difference in your selection if you were told the protein was derived from a vegetable source rather than animal? yes no

Would you accept vegetable protein as a replacement for meat in your diet? yes no

COMMENTS:

IBM CODE SHEET

Column Number	Information
1, 2, 3	Card identification number
4	Sex
5	Age
6 - 13	Quaker Spaghetti's ranked score
14 - 21	Ham-Noodle Casserole's ranked score
22 - 29	Chicken Salad's ranked score
30	Answer to question 1
31	Answer to question 2
32	Answer to question 3
33 - 36	Quaker Spaghetti's raw score
37 - 40	Ham-Noodle Casserole's raw score
41 - 44	Chicken Salad's raw score

Code Numbers used to identify the following:

Card ID number:	The cards were alphabetized and assigned a corresponding number from 1 to 157.
Sex:	Male 1, female 2
Age:	Under 20 1 20 - 25 2 25 - 35 3 Over 35 4
Question answers:	Yes 1, no 2, no response 9
Ranked score:	Highest score given by panel member to each dish 1 Next highest 2 Next highest 3 Lowest given 4
Raw score:	Exact score given each dish 1 - 9

APPENDIX E

D A T A

TABLE VIII

RAW DATA TAKEN FROM SCORE CARDS

QUAKER SPAGHETTI

Sample A

Score Column	Panel Responses	Age Groups 1	2	3	4	Sex 1	2
1	19	7	5	4	3	10	9
2	44	4	13	12	15	20	24
3	51	9	18	9	15	23	28
4	22	2	8	5	7	11	11
5	9	3	4	2	-	6	3
6	5	-	2	1	2	2	3
7	3	-	2	-	1	2	1
8	4	1	1	-	2	2	2
9	-	-	-	-	-	-	-

Sample B

Score Column	Panel Responses	Age Groups 1	2	3	4	Sex 1	2
1	1	-	-	1	-	-	1
2	8	3	3	-	2	3	5
3	16	3	5	3	5	9	7
4	22	4	6	3	9	11	11
5	17	4	7	4	2	14	3
6	26	1	9	6	10	9	17
7	26	6	5	7	8	11	15
8	26	4	10	6	6	14	12
9	15	1	8	3	3	5	10

Score Column Key

1 Like extremely
2 Like very much
3 Like moderately
4 Like slightly
5 Neither like nor dislike
6 Dislike slightly
7 Dislike moderately
8 Dislike very much
9 Dislike extremely

Age Group Key

1 Under 20
2 20 - 25
3 25 - 35
4 Over 35

Sex Key

1 Male
2 Female

TABLE VIII (Continued)

QUAKER SPAGHETTI

Sample C

Score Column	Panel Responses	Age Groups 1	2	3	4	Sex 1	2
1	17	3	6	4	4	10	7
2	51	9	13	9	20	19	32
3	53	9	20	9	15	27	26
4	12	2	2	5	3	5	7
5	12	1	5	4	2	7	5
6	5	1	3	1	-	4	1
7	4	-	2	1	1	1	3
8	3	1	2	-	-	3	-
9	-	-	-	-	-	-	-

Sample D

Score Column	Panel Responses	Age Groups 1	2	3	4	Sex 1	2
1	3	-	1	-	2	-	3
2	3	1	2	-	-	2	1
3	33	6	9	7	11	15	18
4	24	2	10	5	7	14	10
5	11	2	6	2	1	9	2
6	17	2	5	6	4	6	11
7	31	6	5	7	13	14	17
8	17	3	6	3	5	9	8
9	18	4	9	3	2	7	11

Score Column Key

1 Like extremely
2 Like very much
3 Like moderately
4 Like slightly
5 Neither like nor dislike
6 Dislike slightly
7 Dislike moderately
8 Dislike very much
9 Dislike extremely

Age Group Key

1 Under 20
2 20 - 25
3 25 - 35
4 Over 35

Sex Key

1 Male
2 Female

TABLE VIII (Continued)

HAM-NOODLE CASSEROLE

Sample A

Score Column	Panel Responses	Age Groups 1	2	3	4	Sex 1	2
1	19	2	5	4	8	7	12
2	54	7	20	17	10	26	28
3	50	9	18	4	19	25	25
4	18	8	3	5	2	11	7
5	8	-	4	2	2	3	5
6	6	-	3	1	2	4	2
7	1	-	-	-	1	-	1
8	1	-	-	-	1	-	1
9	-	-	-	-	-	-	-

Sample B

Score Column	Panel Responses	Age Groups 1	2	3	4	Sex 1	2
1	4	1	2	-	1	3	1
2	8	3	2	1	2	6	2
3	14	3	3	2	6	6	8
4	23	4	3	6	10	8	15
5	14	5	8	1	-	12	2
6	32	5	9	7	11	15	17
7	23	4	10	5	4	12	11
8	24	1	10	6	7	11	13
9	15	-	6	5	4	3	12

Score Column Key

1 Like extremely
2 Like very much
3 Like moderately
4 Like slightly
5 Neither like nor dislike
6 Dislike slightly
7 Dislike moderately
8 Dislike very much
9 Dislike extremely

Age Group Key

1 Under 20
2 20 - 25
3 25 - 35
4 Over 35

Sex Key

1 Male
2 Female

TABLE VIII (Continued)

HAM-NOODLE CASSEROLE

Sample C

Score Column	Panel Responses	Age Groups 1	2	3	4	Sex 1	2
1	22	2	7	9	4	10	12
2	46	6	15	10	15	21	25
3	47	8	15	6	18	21	26
4	20	3	7	4	6	10	10
5	12	5	4	2	1	7	5
6	8	2	4	2	-	6	2
7	-	-	-	-	-	-	-
8	1	-	1	-	-	-	1
9	1	-	-	-	1	1	-

Sample D

Score Column	Panel Responses	Age Groups 1	2	3	4	Sex 1	2
1	1	1	-	-	-	-	1
2	9	1	4	2	2	6	3
3	14	5	3	3	3	7	7
4	19	7	1	3	8	9	10
5	20	3	9	3	5	12	8
6	26	3	9	10	4	12	14
7	28	4	11	4	9	15	13
8	17	1	6	1	9	3	14
9	23	1	10	7	5	12	11

Score Column Key

1 Like extremely
2 Like very much
3 Like moderately
4 Like slightly
5 Neither like nor dislike
6 Dislike slightly
7 Dislike moderately
8 Dislike very much
9 Dislike extremely

Age Group Key

1 Under 20
2 20 - 25
3 25 - 35
4 Over 35

Sex Key

1 Male
2 Female

TABLE VIII (Continued)

CHICKEN SALAD

Sample A

Score Column	Panel Responses	Age Groups 1	2	3	4	Sex 1	2
1	17	5	2	4	6	6	11
2	41	9	14	8	10	20	21
3	46	7	16	7	16	22	24
4	22	3	8	5	6	14	8
5	8	1	4	3	-	6	2
6	6	-	2	3	1	1	5
7	4	-	2	-	2	3	1
8	10	1	3	2	4	4	6
9	3	-	2	1	-	-	3

Sample B

Score Column	Panel Responses	Age Groups 1	2	3	4	Sex 1	2
1	5	1	-	-	4	2	3
2	23	4	9	4	6	16	7
3	28	8	6	2	12	10	18
4	26	6	10	4	6	14	12
5	22	3	12	6	1	14	8
6	20	3	5	6	6	8	12
7	19	1	5	6	7	7	12
8	8	-	4	2	2	4	4
9	6	-	2	3	1	1	5

Score Column Key

1 Like extremely
2 Like very much
3 Like moderately
4 Like slightly
5 Neither like nor dislike
6 Dislike slightly
7 Dislike moderately
8 Dislike very much
9 Dislike extremely

Age Group Key

1 Under 20
2 20 - 25
3 25 - 35
4 Over 35

Sex Key

1 Male
2 Female

TABLE VIII (Continued)

CHICKEN SALAD

Sample C

Score Column	Panel Responses	Age Groups 1	2	3	4	Sex 1	2
1	9	2	2	2	3	3	6
2	38	4	10	14	10	13	25
3	39	4	16	5	14	22	17
4	18	2	5	7	4	10	8
5	19	5	9	2	3	12	7
6	18	7	3	1	7	9	9
7	7	1	4	-	2	4	3
8	4	-	2	1	1	2	2
9	5	1	2	1	1	1	4

Sample D

Score Column	Panel Responses	Age Groups 1	2	3	4	Sex 1	2
1	6	3	1	-	2	2	4
2	16	2	4	5	5	4	12
3	14	2	6	2	4	9	5
4	30	3	9	6	12	15	15
5	26	8	7	7	4	13	13
6	23	4	7	5	7	11	12
7	20	1	10	4	5	13	7
8	11	-	7	-	4	5	6
9	11	3	2	4	2	4	7

Score Column Key

1 Like extremely
2 Like very much
3 Like moderately
4 Like slightly
5 Neither like nor dislike
6 Dislike slightly
7 Dislike moderately
8 Dislike very much
9 Dislike extremely

Age Group Key

1 Under 20
2 20 - 25
3 25 - 35
4 Over 35

Sex Key

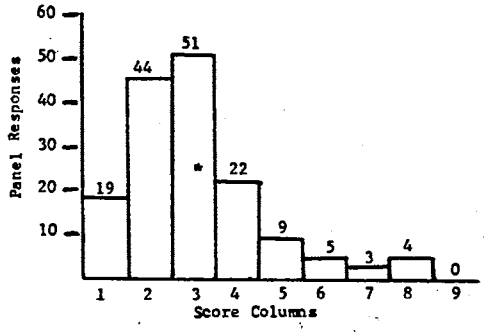
1 Male
2 Female

TABLE IX

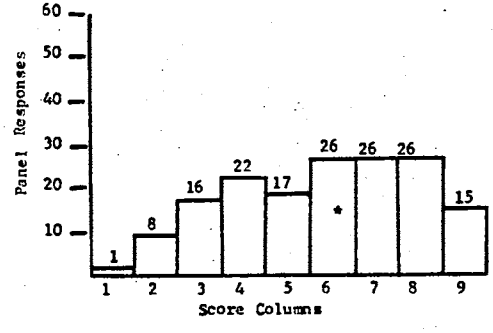
GRAPHIC ILLUSTRATION OF PANEL RESPONSES TO SCORE COLUMNS

QUAKER SPAGHETTI

Sample A



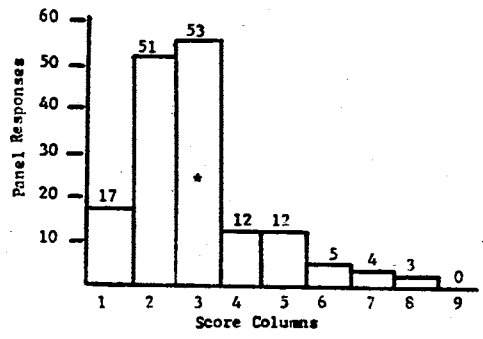
Sample B



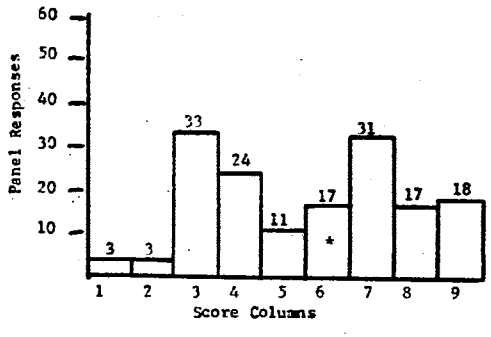
Score Column Key

1 Like extremely
2 Like very much
3 Like moderately
4 Like slightly
5 Neither like nor dislike
6 Dislike slightly
7 Dislike moderately
8 Dislike very much
9 Dislike extremely

Sample C



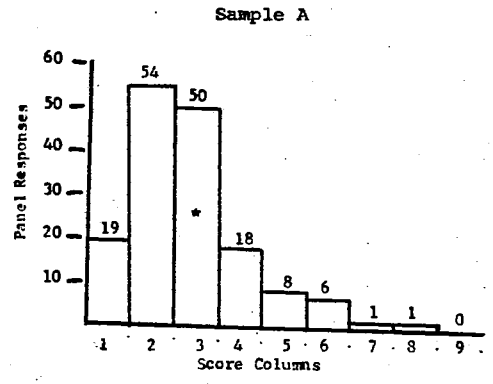
Sample D

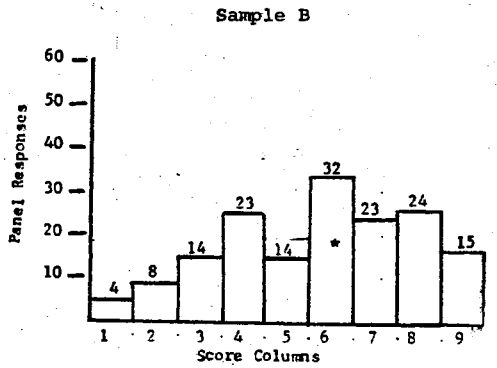


* Median fell in this Group

TABLE IX (Continued)

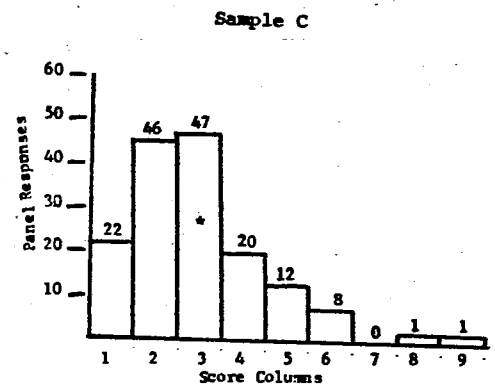
HAM-NOODLE CASSEROLE

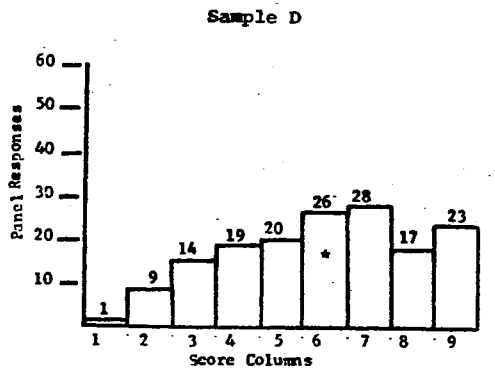




Score Column Key

1 Like extremely
2 Like very much
3 Like moderately
4 Like slightly
5 Neither like nor dislike
6 Dislike slightly
7 Dislike moderately
8 Dislike very much
9 Dislike extremely



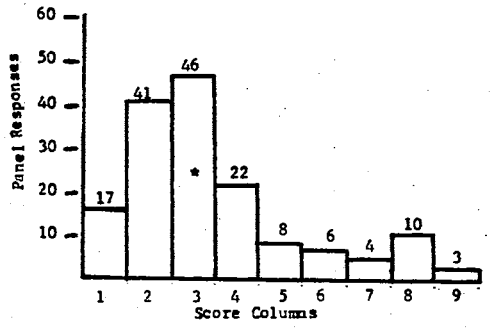


* Median fell in this group

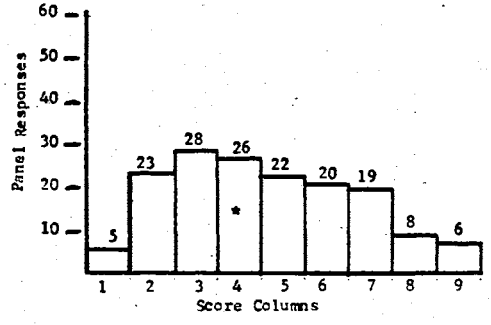
TABLE IX (Continued)

CHICKEN SALAD

Sample A



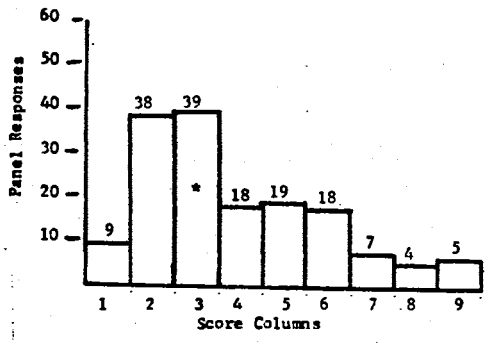
Sample B



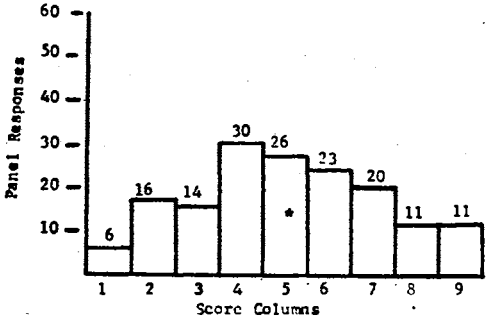
Score Column Key

1 Like extremely
2 Like very much
3 Like moderately
4 Like slightly
5 Neither like nor dislike
6 Dislike slightly
7 Dislike moderately
8 Dislike very much
9 Dislike extremely

Sample C



Sample D



* Median fell in this group

TABLE X

RAW DATA FOR ANALYSIS OF VARIANCE BY AGE X DISH

QUAKER SPAGHETTI

Age	Dish A	Dish B	Dish C	Dish D	Marginal Means
1	1.84	3.09	1.82	3.23	2.49
2	1.76	3.32	1.78	3.11	2.49
3	1.38	3.50	1.88	3.18	2.48
4	1.94	3.14	1.59	3.17	2.47
Marginal Means	1.73	3.27	1.77	3.17	2.49 Grand Mean

HAM-NOODLE CASSEROLE

Age	Dish A	Dish B	Dish C	Dish D	Marginal Means
1	1.82	3.05	2.03	3.14	2.15
2	1.76	3.17	1.88	3.17	2.49
3	1.66	2.23	1.63	2.88	2.35
4	1.69	3.05	1.65	3.59	2.49
arginal eans	1.73	3.12	1.80	3.19	2.46 Grand Mean

CHICKEN SALAD

Age	Dish A	Dish B	Dish C	Dish D	Marginal Means
1	1.65	2.32	2.75	2.88	2.40
2	2.11	2.73	2.09	3.05	2.49
3	2.09	3.19	1.81	3.88	2.49
4	1.49	2.78	2.51	2.76	2.49
Marginal Means	1.94	2.75	2.29	2.89	2.47 Grand Mean

Dish Key

A = Recipe w/ Meat
B = Recipe w/ TVP
C = Same as A
D = Same as B

Age Key

1 = under 20
2 = 20 - 25
3 = 25 - 35
4 = over 35

TABLE XI

ANALYSIS OF VARIANCE
AGE X DISH

QUAKER SPAGHETTI

Source	d.f.	ss	ms	$F_{calc.}$	$F_{tab.}$	
					.05	.01
total	415	468.59	-	-	-	-
age	3	0.05	0.01	0.0329	2.62	3.83
dish	3	225.36	75.12	128.0449**	2.62	3.83
age X dish	9	8.48	0.94	1.6077	1.90	2.46
exp. error	400	234.67	0.58	-	-	-

HAM-NOODLE CASSEROLE

total	415	491.04	-	-	-	-
age	3	1.82	0.60	0.8743	2.62	3.83
dish	3	202.63	67.54	97.2892**	2.62	3.83
age X dish	9	8.87	0.98	1.4203	1.90	2.46
exp. error	400	277.70	0.69	-	-	-

CHICKEN SALAD

total	415	481.18	-	-	-	-
age	3	0.71	0.23	0.2410	2.62	3.83
dish	3	59.43	19.81	20.1276**	2.62	3.83
age X dish	9	27.33	3.03	3.0862**	1.90	2.46
exp. error	400	393.70	0.98	-	-	-

* = statistically significant at the .01 level
** = statistically significant at the .05 level

Source = source of variation
d.f. = degrees of freedom
ss = sums of squares
ms = mean squares
$F_{calc.}$ = calculated with use of the computer
$F_{tab.}$ = observed from*

*G. W. Snedecor, and W. G. Cochran: Statistical Methods. Tables of Percentage Points of the Inverted Beta (f) Distribution. Ames, Iowa: The Iowa State University Press, 1967.

TABLE XII

DUNCAN'S MULTIPLE RANGE TEST
AGE X DISH

Number of Means		2	3	4
SSR		2.77	2.92	3.02
Quaker Spaghetti	$(s_{\bar{x}})$ (SSR) =	2.08	2.19	2.27
Ham-Noodle	" =	2.26	2.38	2.46
Chicken Salad	" =	2.69	2.84	2.93

	Dish A	Dish C	Dish B	Dish D
QUAKER SPAGHETTI	17.355	17.740	32.740	31.759
	0.385		0.981	
HAM-NOODLE CASSEROLE	17.384	18.028	31.298	31.999
	0.644		0.701	
CHICKEN SALAD	19.471	22.961	27.596	28.990
	3.490*		1.394	

* = statistically significant

TABLE XIII

RAW DATA FOR ANALYSIS OF VARIANCE SEX X DISH

QUAKER SPAGHETTI

		Dish A	Dish B	Dish C	Dish D	Marginal Means
Sex	M	1.82	3.27	1.73	3.10	2.48
	F	1.78	3.31	1.68	3.20	2.49
Marginal Means		1.80	3.29	1.71	3.15	2.49 Grand Mean

HAM-NOODLE CASSEROLE

		Dish A	Dish B	Dish C	Dish D	Marginal Means
Sex	M	1.78	3.08	1.88	3.22	2.49
	F	1.71	3.24	1.61	3.25	2.45
Marginal Means		1.74	3.16	1.74	3.24	2.47 Grand Mean

CHICKEN SALAD

		Dish A	Dish B	Dish C	Dish D	Marginal Means
Sex	M	1.90	2.62	2.25	2.95	2.43
	F	2.05	2.75	2.21	2.96	2.49
Marginal Means		1.97	2.68	2.23	3.95	2.46 Grand Mean

Dish Key

A = Recipe w/Meat
B = Recipe w/TVP
C = Same as A
D = Same as B

Sex Key

M = male
F = female

TABLE XIV

ANALYSIS OF VARIANCE
SEX X DISH

QUAKER SPAGHETTI

Source	d.f.	ss	ms	$F_{calc.}$	$F_{tab.}$ .05	$F_{tab.}$ .01
total	599	676.72	-	-	-	-
sex	1	0.02	0.59	0.0364	2.62	3.83
dish	3	325.61	0.02	183.2931**	2.62	3.83
sex X dish	3	0.54	108.53	0.3064	1.90	2.46
exp. error	592	350.55	0.18	-	-	-

HAM-NOODLE CASSEROLE

total	599	691.87	-	-	-	-
sex	1	0.23	0.23	0.3777	2.62	3.83
dish	1	317.97	105.99	169.6325**	2.62	3.83
sex X dish	3	3.75	1.25	2.0042*	1.90	2.46
exp. error	592	369.90	0.62	-	-	-

CHICKEN SALAD

total	599	698.45	-	-	-	-
sex	1	0.62	0.62	0.6035	2.62	3.83
dish	1	88.02	29.34	28.5288**	2.62	3.83
sex X dish	3	0.90	0.30	0.2934	1.90	2.46
exp. error	592	608.89	1.02	-	-	-

* = statistically significant at the .01 level
** = statistically significant at the .05 level

Source = source of variation
d.f. = degrees of freedom
ss = sums of squares
ms = mean squares
$F_{calc.}$ = calculated with use of the computer
$F_{tab.}$ = observed from*

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*G. W. Snedecor, and W. G. Cochran: Statistical Methods. Tables of Percentage Points of the Inverted Beta (F) Distribution. Ames, Iowa: The Iowa State University Press, 1967.

TABLE XV

DUNCAN'S MULTIPLE RANGE TEST
SEX X DISH

Number of Means		2	3	4
SSR		2.77	2.92	3.02
Quaker Spaghetti	$(s_{\bar{x}})$ (SSR) =	1.74	1.83	1.89
Ham-Noodle	" =	1.78	1.88	1.94
Chicken Salad	" =	2.74	2.88	2.98

	Dish A	Dish C	Dish B	Dish D
QUAKER SPAGHETTI	18.033	17.133	32.966	31.523
	0.900		1.443	
HAM-NOODLE CASSEROLE	17.486	17.499	31.666	32.410
	0.013		0.753	
CHICKEN SALAD	19.766	22.353	26.899	29.599
	2.586		2.700	

TABLE XVI

RAW DATA FOR CHI SQUARE ANALYSIS OF SCORE CARD QUESTIONS BY SEX

QUESTION 1

Answers	Sex M	Sex F	
1	48 / 58.53	57 / 56.46	105
2	11 / 12.72	14 / 12.27	25
3	17 / 13.74	10 / 13.25	27
	76	81	157

QUESTION 2

Answers	Sex M	Sex F	
1	16 / 21.01	28 / 22.98	44
2	43 / 42.51	46 / 46.48	89
3	17 / 11.46	7 / 12.53	24
	76	81	157

QUESTION 3

Answers	Sex M	Sex F	
1	27 / 31.05	38 / 33.94	65
2	32 / 31.05	33 / 33.94	65
3	17 / 12.89	10 / 14.10	27
	76	81	157

Sex Key

M = male
F = female

Answer Key

1 = yes
2 = no
3 = no response

d.f. = 2

Observed / Tabulated

TABLE XVII

RAW DATA FOR CHI SQUARE ANALYSIS OF SCORE CARD QUESTIONS BY AGE

QUESTION 1

Answers	Age 1	Age 2	Age 3	Age 4	
1	19 / 17.38	35 / 35.44	20 / 21.40	31 / 30.78	105
2	4 / 4.14	9 / 8.43	6 / 5.09	6 / 7.32	25
3	3 / 4.47	9 / 9.11	7 / 5.50	8 / 7.91	27
	26	53	33	45	157

QUESTION 2

Answers	Age 1	Age 2	Age 3	Age 4	
1	5 / 7.28	14 / 14.85	11 / 8.96	14 / 12.89	44
2	18 / 14.73	30 / 30.04	15 / 18.14	26 / 26.07	89
3	3 / 3.97	9 / 8.10	7 / 4.89	5 / 7.03	24
	26	53	33	45	157

QUESTION 3

Answers	Age 1	Age 2	Age 3	Age 4	
1	10 / 11.34	20 / 23.99	13 / 9.59	22 / 20.06	65
2	12 / 9.94	24 / 21.04	11 / 8.41	18 / 17.59	65
3	4 / 4.71	9 / 9.96	9 / 3.98	5 / 8.33	27
	26	53	33	45	157

Age Key

1 = under 20
2 = 20 - 25
3 = 25 - 35
4 = over 35

Answer Key

1 = yes
2 = no
3 = no response

d.f. = 6

Observed / Tabulated

TABLE XVIII

CALCULATED CHI SQUARE ANALYSIS OF SCORE CARD QUESTIONS FOR AGE AND SEX

QUESTION 1	$X^2 = 1.2402$	$X^2 = 1.3743$
QUESTION 2	$X^2 = 5.7382$	$X^2 = 3.3323$
QUESTION 3	$X^2 = 2.5009$	$X^2 = 9.5371$
	d.f. = 2	d.f. = 6
	$X^2_{(.05,2)} = 5.99$	$X^2_{(.05,6)} = 12.59$
	$X^2_{(.01,2)} = 9.21$	$X^2_{(.01,6)} = 16.81$

Note: Answers for any of the three questions do not depend on sex or age.

VITA

2

Gretchen Vedder Ross

Candidate for the Degree of

Master of Science

Thesis: A TASTE PANEL SERVED ANIMAL PROTEIN AND VEGETABLE PROTEIN ENTREES

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Professional Experience: Taught kindergarten in Salina, Kansas, from September, 1959, to May, 1962; taught Advanced Tailoring in Adult Education in Dayton, Ohio, from September, 1963, to May, 1964; taught kindergarten in Oklahoma City, Oklahoma, from January, 1965, to May, 1965; Assistant Nutritionist for Oklahoma State University

Nursery Schools, Summer 1968; presently employed as an Administrative Dietitian at Presbyterian Hospital in Dallas, Texas; registered member of American Dietetic Association and Dallas Dietetic Association; member of American Home Economics Association; member of American Society for Hospital Food Service Administrators; member of American Association of University Women, and member of Phi Upsilon Omicron, honorary Home Economics fraternity.