EFFECTS OF PEANUT GRITS AND PEANUT FLOUR ON QUALITY OF MUFFINS

By

NING-BIN KUO

Bachelor of Science in Home Economics

Texas A & I University

Kingsville, Texas

1978

Submitted to the Faculty of the Graduate College
of the Oklahoma State University
in partial fulfillment of the requirements
for the Degree of
MASTER OF SCIENCE
July, 1980

EFFECTS OF PEANUT GRITS AND PEANUT FLOUR

ON QUALITY OF MUFFINS

Thesis Approved:

Lea L. Ebro
Thesis Adviser

Esther Winterfeldt

[illegible]

Hazel J. Baker

Norman N. Durham
Dean of the Graduate College

ACKNOWLEDGMENTS

The author wishes to express her thanks and appreciation to her major adviser, Dr. Lea L. Ebro, for her patience, guidance, and assistance throughout this study.

Sincere appreciation is also expressed to my graduate committee: Dr. Esther A. Winterfeldt and Miss Hazel Baker, for their encouragement and support; and to Dr. J. Leroy Folks, for his invaluable assistance in the research design and data analyses of this study.

Thanks are also expressed to the seven attribute panel members, for their cooperation and support. Without them, this study would not have been possible. A note of appreciation is extended to Jean Shipman, for the muffin photographs. Special recognition is due to Gold Kist, Inc. of Atlanta, Georgia, and Southern Regional Research Center, USDA, New Orleans, Louisiana, for providing the peanut grits and peanut flour samples.

Finally, special thanks and appreciation are given to my parents, Mr. and Mrs. Dod-yu Kuo, and my husband, Geng-Hwa Lin, for their understanding, constant encouragement, and inspiration.

TABLE OF CONTENTS

LIST OF TABLES

Table | Page

LIST OF FIGURES

Figure Page

CHAPTER I

INTRODUCTION

To maintain the health of the people of the world, it is particularly important to have food which contains good quality protein. According to United Nations statistics, the 1970 world population of 3.7 billion will increase to six billion by the year 2000. The problem of maintaining protein quality becomes increasingly important as the population expands (Kato & Muramatsu, 1971).

Much of the world is deficient in animal protein, and in the United States, where most people have adequate or abundant amounts of animal protein available to them, there is concern for a possible shortage in the future. Many people in the lesser developed areas of the world have a protein deficiency in their diets, and this can be a serious health problem. In other areas, people are accustomed to meat, milk, and eggs, and are eager to maintain or expand consumption of these products at lower prices (Butz, 1974).

With a growing world population, there must be sources of inexpensive protein developed so all people will be nourished adequately. Oilseed proteins--soybeans, cottonseed, peanuts, sunflower seed, rapeseed, sesame seed--assume a vital role in two ways: to supply protein directly for human foods and to supply protein for animals which eventually become a protein source for human beings. Oilseeds are eaten as food and processed for oil. The protein remaining from

processing oilseed for oil was used very little for food in the past. Because the obvious need for low cost food proteins has brought much attention to bear on oilseed, the potential for increasing its food use is greater today (Dimler, 1971).

Peanuts are grown in many countries throughout the world. World production of peanuts is about 17.3 million tons (Lusas, 1979). In the United States, around 70 percent of the peanuts produced are used directly as food, mainly in the form of peanut butter. The U.S. produces only 9.5 percent of the total world supply of peanuts. By contrast, India, which produces nearly one-third of the total supply, probably uses 10 percent or less directly as food (Dimler, 1971; Lusas, 1979). Many studies have been done to develop peanut protein. There are a number of food systems such as bread, bakery products, dairy-type products, and meat products analog in which peanut proteins can be incorporated to increase their protein content (Rhee, Mattil, & Cater, 1973).

To motivate the consumer to eat a product enriched with nonconventional proteins may be a problem. According to Edmondson and Graham (1975),

> . . . most men and women do not ingest nutrients, they consume food. With this in mind the basic objective should be to make foods that will appeal to the consumer and will be accepted and consumed by him (p. 698).

Generally, the product must have immediate appeal to the consumer. This appeal is achieved most easily by incorporating the protein in a familiar food without changing its characteristics (Dimler, 1971). Baked products are good vehicles for utilizing oilseed proteins. The peanut proteins in flour and grits form can be substituted for

a portion of the flour commonly used in familiar baked products to develop high protein products.

Purpose and Objectives

The purpose of this research was to determine the effects of peanut grits and peanut flour on the appearance, texture, color, mouthfeel, flavor, overall impression, tenderness, and specific volume of all-purpose and whole wheat muffins enriched with these ingredients. Specific objectives were:

1. To identify the effects on the appearance, color, texture, flavor, mouthfeel, overall impression, specific volume, tenderness, and protein content of peanut grits and peanut flour when incorporated in muffins.

2. To decide which level of peanut grits or peanut flour incorporated in muffins is most acceptable to the attribute panel.

3. To make recommendations for future research in this field.

Hypotheses

The following hypotheses were postulated for this research:

H_1: There will be no significant difference in appearance, color, texture, mouthfeel, flavor, and overall impression in muffins made with all-purpose flour or whole wheat flour only and those incorporating peanut grits.

H_2: There will be no significant difference in appearance, color, texture, mouthfeel, flavor, and overall impression in muffins made with all-purpose flour or whole wheat flour only and those incorporating peanut flour.

Assumptions

The assumptions made for this study were:

1. The taste panel will be trained to detect differences objectively in each product.

2. Each batch of muffins will be prepared in the same food research laboratory under the same laboratory conditions.

Limitations

For this study, the following limitations were accepted:

1. The peanut grits used in the study were from Gold Kist, Inc., Atlanta, Georgia, while the peanut flour used was from the Southern Regional Research Laboratory, U.S. Department of Agriculture, New Orleans, Louisiana.

2. Only muffins were used for testing peanut grits and peanut flour.

Definitions

The following definitions were used in this study:

1. Oilseed flour: refers to soybean flour, cottonseed flour, peanut flour, sunflower seed flour, rapeseed flour, and sesame flour.

2. Peanut flour: milled product from particles of peanut meal which are under 16 or over 60 mesh screen size (Ayres, Branscomb, & Rogers, 1974).

3. Peanut grits: particles of peanut meal within 16-60 mesh screen size (Ayres et al., 1974).

4. DPF: defatted peanut flour which contains less than two percent residual lipids.

5. Color: "determination of hue, purity, and lightness which correlates well with human perception of color" (Noble, 1975, p. 57).

6. Texture: "the characteristic consistency: overall structure includes hardness, cohesiveness, viscosity, and elasticity" (Paul & Palmer, 1972, p. 728).

CHAPTER II

REVIEW OF LITERATURE

This chapter presents selected literature relating to peanut grits and peanut flour as protein supplements, how the protein content of the daily diet can be enhanced, uses of peanuts, processing method, the nutritive value of peanut meals, and the related researches in baked products utilizing oilseed flours.

Uses of Peanuts

The peanut (Arachis hypogaea L.) is a native South American legume grown widely throughout the tropical and subtropical areas of the world (APREA, 1973). Originally grown in ancient Peru and other Latin American areas, peanuts were introduced to Africa and Asia by explorers and early tradesmen, and eventually brought to North America by various routes (Johnson, 1964).

Although peanuts have been known to man for many centuries, their economic importance was not achieved until approximately 125 years ago. At that time oil mills for crushing peanuts were established in France, then quickly spread to other European countries, and subsequently, throughout the world. The peanut is now an important food and oil crop in the warmer areas of all six continents. Three-fourths of all peanuts grown in the world are produced by India, mainland China, the United States, Senegal, and Sudan (APREA, 1973; Lusas, 1979).

Although peanuts today are used primarily as a vegetable oil crop, their importance as a food crop has increased substantially in recent years. Due to their high content of digestible protein, their use as an edible food crop is expected to increase further because of an increased awareness of the protein shortage existing in the world (APREA, 1973).

The United States is one of the few countries of the world where peanuts are grown extensively for domestic food use. About 70 percent of the U.S. crop is used for food purposes. Edible grades of peanuts are used in the U.S. as follows: peanut butter, 52.7 percent; peanut butter sandwiches, 2 percent; salted (nut uses), 23.3 percent; candy, 20.7 percent; and others, 1.4 percent (Lusas, 1979). At present, considerable research is being directed toward improving the quality of peanut butter and other domestic food uses.

Peanut utilization in other countries has a different pattern. A very minor part of foreign grown peanuts or peanut protein finds its way into human food uses. India, the largest peanut producing country, processes her peanuts for oil and uses the defatted meal for animal feed or fertilizer. The reasons why peanuts are so unpopular as a food in India are partly because of the low social status of peanuts, and partly because India has not yet solved the processing technology necessary for making the meal and protein acceptable for food use. A special project which has been supported by UNICEF and presently in development is the use of peanut protein isolate to extend buffalo milk, also called "toning" of the milk. A workable alternative procedure would be to use peanut milk as an extender for

the buffalo milk. The high fat content of buffalo milk (about nine percent) makes its combination with peanut protein a very attractive project for India and probably for other countries as well (Smith, 1971).

Processing Method of Peanut Grits and Peanut Flour

Peanut flour is essentially a finely ground, low-fat meal, made under highly sanitary conditions. While peanut flour may be made in many ways, there are several steps that are common to all. They are: (a) peanuts must be of edible grade with no extraneous material; (b) they are cooked and ground to improve flavor and facilitate oil removal; (c) the oil is extracted by the expeller and solvent methods to about one percent; and (d) the meal is ground to pass through a 100-mesh screen (Woodroof, 1966).

In this study, peanut grits are manufactured by Gold Kist, Inc., Atlanta, Georgia. Split or whole shelled peanuts are used. Only lots which show negative test (less than eight ppb) for aflatoxin are utilized for peanut grits or flour production. Peanuts are first milled and conditioned to raise the moisture level to 10 percent. The granulated peanuts are then cooked and formed into cakes when all but 8 to 12 percent of the oil has been expressed. The cakes are ground and moisture conditioned to 10 percent prior to the flaking process. Flakes are extracted with hexane, cooked, and cooled. Particles in the 16-60 mesh size are packaged as grits (Ayres et al., 1974).

Peanut flour is obtained from Southern Regional Research Laboratory, U.S.D.A., New Orleans, Louisiana. Peanut flour is processed by direct extraction method; moistening blanched peanuts to 12 percent; heating the peanuts to 180°F and keeping them at this temperature for 30 minutes while maintaining 12 percent moisture; drying at 180°F until the moisture content decreases to about six percent; and flaking the treated peanuts, followed by solvent (hexane) extraction (Pominski, Pearce, & Spadaro, 1977).

Nutritive Value of Peanut Grits and Peanut Flour

Peanuts contain about 26 percent protein and peanut meal has almost twice that amount (Woodroof, 1966). Peanut grits or flour protein is deficient in lysine, methionine, tryptophan; and threonine and isoleucine are present at marginal levels (Wilson, 1972; Rhee et al., 1973); however, they may be supplemented with necessary synthetic amino acids to increase their nutritional quality (Rhee et al.), or they can still serve as the sole supplement by using the greater percentage of peanut grits or peanut flour to fortify the lysine deficient cereal flours (Rice, 1970; Ayres et al., 1974).

Peanut grits and flour are high in magnesium, thiamine, and niacine (Table I). This indicates that peanut grits or peanut flour is an excellent fortifier for cereal flours (Ayres et al., 1974).

The crude fiber content of the peanut grits/flour from Gold Kist, Inc. is twice as high as that of whole wheat flour, as shown in Table I, and 15 times higher than all-purpose flour, which

TABLE I

COMPOSITION OF FLOURS/GRITS, 100 GRAMS,
EDIBLE PORTION

Kind of Flour	Protein	Fat	Carbohydrate		Calcium	Phosphorus	Iron	Magnesium	Thiamin	Riboflavin	Niacin
			Total	Fiber							
	gm.	gm.	gm.	gm.	mg.	mg.	mg.	mg.	mg.	mg.	mg.
Whole Wheat[a]	13.3	2.0	71.0	2.3	41	372	3.3	113	0.55	0.12	4.3
All-Purpose:[a]											
Enriched	10.5	1.0	76.1	0.3	16	87	2.9	25	0.44	0.26	3.5
Unenriched	10.5	1.0	76.1	0.3	16	87	0.8	25	0.06	0.05	0.9
Peanut Grits/ flour[b]	57.0	0.6	30.0	4.6	140	760	2.1	370	0.70	0.48	27.0
Peanut Flour[c] (#8224-6)	63.2	1.3		3.9							

[a]Bowes and Church, 1975.

[b]Ayres et al. (1974).

[c]Pominski (1979, 1980).

is frequently used in baked products. Peanut flour from the Southern Regional Research Laboratory, USDA, is also higher in crude fiber content than in whole wheat or all-purpose flour. Most of the fiber is removed from all-purpose flour during the milling process when the bran is removed from the wheat. During this century the fiber consumption in the United States has declined 20 percent from a lesser ingestion of fruits and vegetables and 50 percent from the decrease in consumption of whole grain cereals and baked goods. It has been proposed that common diseases such as atherosclerosis, diverticulosis, cancer of the colon, and varicose veins may have developed due to the lack of fiber in the modern diet (Painter, Almeida, & Colebourne, 1972; Scala, 1974). Consumption of baked products formulated from whole wheat flour or refined flours enriched with peanut grits or peanut flour will increase the daily fiber intake.

Use of Peanut Grits

Few studies have been done on baked products utilizing peanut grits. The studies conducted at the Alabama Agricultural Experiment Station show that the peanut grits in the lower oil levels (7-12 percent) are found to be unacceptable in all products tested because they retained a gritty texture in spite of heat and moisture treatment. The peanut grits in the two higher oil levels (17-20 percent) are used satisfactorily in some baked products; e.g., peanut chip cookies and oatmeal crispies. In these studies, they concluded that for higher oil level peanut grits, it is acceptable to use peanut grits in peanut-honey spread, peanut-honey-raisin spread, ice cream,

peanut-chocolate clusters, and broiled peanut frosting (Alabama Agricultural Experiment Station, 1972). Peanut grits can also be used as a meat extender (Pominski & Spadaro, 1973).

Use of Peanut Flour in Baked Goods

Efforts to increase the available protein in man's diet have encouraged the use of high-protein plant materials as ingredients in a variety of foods. Wheat-based baked products such as breads, cakes, and cookies are popular foods and would provide an excellent means of improving nutritional quality of baked products through incroporation of vegetable proteins (McWatters, 1978).

Bread

Bread in some form is universally consumed; therefore, fortification of bread provides an opportunity to upgrade the nutritional level of many people (Rooney, Gustafson, Clark, & Cater, 1972). Bread available commercially carries only eight percent protein. Food scientists are currently investigating ways to fortify bread by incorporating oilseed or other alternative sources of high protein products. Commercially available soy protein products have already been successfully incorporated in bread (Khan, Rhee, Rooney, & Cater, 1975).

Up to five to ten percent replacement of wheat flour with non-wheat flours, especially high protein concentrates and oilseed flours, has been successful in bread (Bacigalupo, Valle-Riestra, Widmer, & Vara, 1967); however, at higher replacement levels, loaf volume is severely decreased along with serious deterioration of crumb color,

grain, and texture (Matthews, Sharpe, & Clark, 1970; Sidwell & Hammerle, 1970). The maximum level of replacement depends on the type of nonwheat flour, the strength of the wheat flour, the baking procedure, and the dough stabilizing compounds used (Dendy, Clarke, & James, 1970; Pringle, Williams, & Hulse, 1969). The dough conditioner permits nonwheat flours to replace wheat flour without loss of bread quality (Tsen, Hoover, & Phillips, 1971).

Matthews, Sharpe, and Clark (1970) compared the baking properties of various oilseed flours as replacements for 25 percent of the wheat flour. These breads had low loaf volume. In replacing wheat flour with oilseed flour at high levels (25 percent or more), changes must be made in one or more of the following: decreasing time or speed of mixing, decreasing consistency of doughs, decreasing fermentation and proofing time, and increasing levels of ingredients such as yeast or fat. Heat-treatment in processing may drastically affect dough-making properties of oilseed flours. For example, the roasting of peanuts before the preparation of the flour dramatically improves the breadmaking quality of peanut flour (Matthews et al., 1970).

Rooney et al. (1972) compared the baking properties of several oilseed flours and concluded that defatted peanut flour (DPF) had excellent baking properties and produced bread with good loaf volume and acceptable interior properties. The protein content of the oilseed-substituted bread was increased by more than 35 percent.

Bookwalter, Warner, Anderson, & Bagley (1978) evaluated effect of fortifying degermed cornmeal with defatted peanut flour.

Protein efficiency ratio (PER) increased from 0.3 to 1.4 with 15 percent DPF. Leavened and unleavened breads were acceptable when prepared with blends containing up to 20 percent DPF.

Cookies

Nonwheat proteins used in cookie formulas have exhibited greater water retention properties than wheat flour and thus have possessed a greater capacity for competing for the limited free water in cookie dough (Kissell & Yamazaki, 1975); cookies containing these types of proteins fail to develop typical spread and top grain characteristics during baking. Various techniques have been investigated to modify or improve the baking performance of flours from soybeans (Kissell & Yamazaki, 1975; Tsen, Farrell, Hoover, & Crowley, 1975b), wheat (Tsen, Bauck, & Hoover, 1975a), and peanuts (Beuchat, 1977). These have included addition of surfactants or dough conditioners to bread and cookie formulations and enzymatic or chemical hydrolysis of the protein itself.

The levels at which oilseed flours could be used to replace wheat flour in cookies also have been investigated. Glandless cottonseed could be used only at low levels without adversely affecting physical and sensory qualities of sugar cookies (Fogg & Tinklin, 1972). Wheat flour fortified with either 12 percent whole or dehulled soybean products produced acceptable chocolate chip, coconut, oatmeal, and sugar cookies (Tsen et al., 1975a).

McWatters (1978) investigated the cookie baking properties of defatted peanut, soybean, and field pea flours. Peanut and field pea

flours exhibited dough handling properties much like those of the 100 percent wheat flour controls. Diameter, height, spread characteristics, textural quality, and sensory quality attributes of cookies were not affected adversely by use of peanut flour up to 30 percent. Total protein content was increased by about one and one half percent with each increment of peanut and soybean flours. Cookies prepared with 30 percent of these flours contained twice as much protein as the 100 percent wheat flour control.

Muffins

Some researchers have developed muffins enriched with soy flour at a level of 50 percent (Circle and Johnson, 1958). Faulkner and Simpson (1946) enriched muffins and cakes with three types of soy flour constituting 26.2 percent by volume of total flour used. Sensory evaluation indicated that there was little difference in the flavor of the muffins due to the type of soy flour; however, muffins prepared with high fat soy flour were the only products in the study rated "good."

Thayer (1974) conducted a study on the acceptability of six variations of muffins (bacon, cornettes, bran muffins, cheese muffins, graham gems, peanut butter muffins, and pumpkin muffins) containing 20 percent deglanded cottonseed flour. In this study, the organoleptic characteristics: appearance, texture, flavor, color, and overall acceptability, were evaluated. A five point scale (5=excellent, 1=unacceptable) was used. An analysis of variance was performed on the taste panel scores; the data on weight, volume, and specific gravity; and the color readings. Duncan's multiple range test was

used on the weight, volume, specific gravity, and the color readings. The results showed that peanut butter muffins were most acceptable and graham gems (muffins) the least. Ratings for appearance, flavor, and acceptability were affected by the kind of muffin; ratings for texture and color were not.

Sproul (1975) has developed whole wheat muffin formulations enriched with soy flour, peanut flour, and cottonseed flour at a 25 percent (Volumetric) level. In this study, the flavor, color, texture, and overall acceptability of the baked products were evaluated by a trained taste panel. Each characteristic being evaluated was rated on a six point scale ranging from very acceptable to very unacceptable. The panelists were asked to judge the samples without comparison to the others and to check the appropriate box on the score card. Then the responses were evaluated by giving each response a point value. "Very acceptable" received six points, "acceptable" five points, and so forth. The total number of points in each category was determined by adding the point values of all responses and a mean score was determined. The data obtained from the nutritive value and acceptability tests were analyzed for significant differences between the means using the t-test at 0.01 and 0.05 levels. An analysis of variance was performed to determine significant differences between the sample mean at 0.001. 0.01, and 0.05 levels. The results showed that the soy muffins were the most acceptable in all four characteristics and the cottonseed enriched muffins were the least acceptable. The t-test showed there was no significant difference between the peanut enriched muffins and the whole wheat products at the 0.01 and 0.05 levels. The

protein content of the muffins enriched with peanut flour has increased 46.94 percent over the wheat control products. Sproul concluded that soy and peanut flours could be used successfully at 25 percent level in muffins.

Although there have been some studies of muffins enriched with high levels of soy flour (50 percent) and peanut flour (25 percent), other studies are needed to determine what other oilseeds can be used and at what levels in muffins. Studies are also needed regarding the extent the nutritive content of baked products could be enhanced by nonconventional high protein flours. Information on organoleptic qualities as judged by trained attribute panels and acceptability of enriched products by consumers are also needed.

CHAPTER III

METHOD

The purpose of this study was to investigate the nutritive content and organoleptic qualities of muffins prepared with different levels (0, 10, 20, and 30 percent) of peanut grits and peanut flour substituted for part of the all-purpose and whole wheat flour. Subjective and objective evaluations were performed. The experimental design and procedure are outlined in this chapter.

Type of Research Design

The research design was a split-split-plot design (Snedecor & Cochran, 1973). The main-plot-treatment was all-purpose flour or whole wheat flour. The split-plot-treatment was peanut grits or peanut flour. The split-split-plot-treatments were the four variations in the levels of peanut grits or peanut flour. All treatments were replicated four times.

Product Development

Formula and Ingredients

The formula used was a drop batter muffin (Table II). The peanut grits were obtained from the Gold Kist, Inc., Atlanta, Georgia, while the peanut flour was obtained from the Southern Regional Research

Laboratory, U.S.D.A., New Orleans, Louisiana. The other ingredients were purchased from a local supermarket.

TABLE II

FORMULA FOR MUFFINS[a]

Ingredient	Weight (gms)
Flour[b]	
All-purpose	220.0
Whole Wheat	220.0
Sugar	50.0
Baking Powder (double-acting)	10.8
Salt	3.0
Milk	241.0
Egg	48.0
Salad Oil	24.0

[a]Formula was adapted from McWilliam's Experimental Foods Laboratory Manual, 1977, p. 266.

[b]Peanut grits and peanut flour in the amounts of 10, 20, and 30 percent were substituted for whole wheat flour and all-purpose flour by weight.

Procedures for Preparing the Muffins

The procedures were adapted from the Experimental Foods Laboratory Manual (McWilliams, 1977).

1. Lightly grease bottom of muffin cup.
2. Weigh and sift the dry ingredients together three times.
3. Beat the egg until blended, but not foamy.
4. Weigh liquid ingredients, add to the egg, then beat gently with egg beater just enough to blend the liquids homogeneously.
5. Make a well in the dry ingredients, and add the liquid ingredients all at one time.
6. Stir gently, but efficiently with a wooden spoon, just enough to moisten dry ingredients. Try to have all ingredients moisted with 16 strokes.
7. Use a #20 dipper to place the batter in each muffin cup.
8. Bake at 425°F for 15 minutes.
9. Loosen and remove muffin from muffin cup.

Equipment

Major pieces of equipment used included an upright refrigerator to store ingredients, an institutional electric deck oven (General Electric, Mod. CN 50), a digital balance (Mettler PC4400, Delta Range), and a Radarange oven (Amana, Mod. RR-4). Utensils used were six 12-cup aluminum muffin pans, mixing bowls, plastic containers, wooden spoon, ruber scrapers, egg beater, a #20 dipper, white plates, platters, and plastic wrap.

Preliminary Procedure

Several trials of muffins were conducted in an Experimental Foods class taken by the researcher a semester prior to the actual research. Muffins enriched with three levels (0, 15, and 30 percent) of peanut flour were prepared during the laboratory sessions of the class. Four of the class members served as panelists during the six experiment periods. By using average scores from the sensory evaluation, it was found that all three variations of muffin--the standard (all-purpose flour), 15 percent peanut flour substitution, and 30 percent substitution, were all acceptable; however, the 15 percent level of muffins scored higher than those with the 30 percent level. Muffins with 30 percent peanut flour substitution had peanut flavor, and were slightly soggy. In the pilot study, the amount of sugar was adjusted from 25 grams to 50 grams, the baking time was adjusted to 15 minutes, and a #20 dipper was used to place the batter into muffin cups instead of weighing 60 grams batter for each muffin cup.

Experimental Procedure

A day before preparation of the muffins, the dry ingredients were weighed to the nearest 0.01 gram on a Mettler PC4400 digital balance, stored in plastic containers, then placed in the refrigerator. On the day of preparation, liquid ingredients were weighed. All the ingredients were brought to room temperature prior to mixing. Muffins were prepared following the order listed in the procedure. The formula provided batter for nine muffins.

There were 72 muffins made each day in eight batches with two baking periods for eight days. In the first baking period, 36 all-purpose (or whole wheat) muffins were placed in the oven, in four batches. There were nine muffins with 0 percent peanut grits (or peanut flour), nine with 10 percent grits (or peanut flour), nine with 20 percent peanut grits (or peanut flour), and nine with 30 percent grits (or peanut flour). The muffins were placed in three muffin pans in a randomized order by peanut grits (or peanut flour) level. While these muffins were baking, the other 36 all-purpose (or whole wheat) muffins with 0, 10, 20, and 30 percent peanut flour (or peanut grits) were prepared and placed in the three muffin pans in a randomized order by peanut flour (or peanut grits) level for the second baking period.

Baked muffins were loosened and left tilted in pans to cool for five minutes, then placed on platters. For each variation, seven of the nine muffins were randomly chosen for sensory evaluation. Objective evaluations were made on two randomly selected muffins.

Data Collection

Data collection included subjective evaluation of six organoleptic qualities of muffins by a trained attribute panel, and objective measurements of weight, volume, and tenderness by shear force. The protein content was calculated using amino acid tables (Food and Agriculture Organization of the United Nations, 1970).

Subjective Evaluation

In this study, seven taste panel members were selected on the

basis of their taste sensitivity. Panel members included faculty, staff, and students in the Division of Home Economics who have previously gone through a screening process involving identification of the four basic tastes, and recognition of a variety of food substances by smell.

The panelists were trained before the experiment started. The functions of the training period were to show the judges that effort and concentration were essential in evaluation of foods and to develop a common understanding of terminology and procedures among the panelists (Campbell, Penfield, and Griswold, 1979). A triangle test was used in the training period, then afterwards, panelists were informed of sample identities. Standard sample was also shown to the panelists.

The six attributes evaluated were appearance, texture, color, mouthfeel, flavor, and overall impression. A five point scale (5=excellent, 4=good, 3=fair, 2=poor, 1=unacceptable) previously used in another research (Thayer, 1974) was used. Some of the descriptors were modified for this study. A description of the standard muffin was printed on the score card. Written instructions were given to each member. Space was also provided on the score card for panelists to make any comment they wished to add regarding the sample products (Appendix A).

A total of 16 sensory evaluation sessions were held at 11:00 a.m. for eight days. There were two sessions each day. Constant and controlled conditions were maintained during the sensory evaluation period: time of day, room and room temperature, privacy in sampling,

and noise level. The conditions that were controlled in regard to the food products were those of product ingredients, preparation procedures, oven type, oven temperature, and baking time (Campbell et al., 1979).

Freshly baked and cooled muffins were cut into halves and individual halves of each variation were arranged on white plates by code and covered with plastic wrap. On each session, four halves of muffins were warmed in a radarange oven for 15 seconds and served to each panelist. Double distilled, demineralized water was provided for the panelists to rinse the mouth between samples. Placement of the sample halves for each panelist was by random assignment based on type of flour (by day), and by type and level of peanut grits or peanut flour (by session). An example for one day is shown in Appendix B.

Objective Evaluation

Two muffins from each variation at every session were randomly chosen and reserved for objective evaluation.

Weight and Volume. Muffins from each variation were weighed on a digital balance, and volume was obtained by rapeseed displacement. The specific volume was then calculated from the weight and volume figures.

Tenderness. The Instron Universal Testing Instrument Model 1122 was used to measure tenderness. Tenderness values were expressed by the shear force (kg/g) required to shear top and bottom crusts of muffins.

Photography. Pictures of halves of each variation of muffins were taken to illustrate and record appearance, volume, and texture.

Protein Content. Total protein and amino acid values of muffins in each variation were calculated using FAO amino acid tables.

Data Analyses

A split-split-plot design was used for this study. Using the Statistical Analysis System (Barr & Goodnight, 1972), an Analysis of Variance (ANOVA) was performed on the taste panel scores; the data on weight, volume, and specific volume; and shear force. After these data were calculated, a Least Significant Difference Test (LSD) (Snedecor & Cochran, 1973) was performed to determine whether there were significant differences between pairs of mean values obtained from objective and subjective evaluations.

Results by ANOVA and LSD were similar, but they were also slightly different. LSD values may indicate significant difference ($p<0.05$) between some of the variables, whereas ANOVA may not always indicate the same results. This is caused by some overlap of characteristics between samples. When LSD values were not significant, however, they were consistent with the results by ANOVA (F test).

The formula for obtaining the least significant difference (LSD) between any two treatment effects is as follows:

$$LSD = t_{(f,\ \alpha/2)}\left(\frac{2\ MSE}{n}\right)^{1/2}$$

f: degree of freedom of mean square of error
α: significant level, in this study, was five percent
n: sample number
MSE: mean square of error

If there are any differences between the treatment means greater than the LSD, then the effects of the two treatments are significantly different at the five percent level.

CHAPTER IV

RESULTS AND DISCUSSION

This chapter includes the data analyses to indicate if there were differences in appearance, texture, color, mouthfeel, flavor, overall impression, specific volume, and tenderness by shear force of muffins made with all-purpose flour or whole wheat flour only, and those incorporating one of the two types of peanut flour. A trained taste panel evaluated the organoleptic characteristics of the products prepared. The rapeseed displacement method was used to measure the volume, while the Instron Universal Testing Instrument Model 1122 was used to measure tenderness objectively. Analysis of Variance (ANOVA) and Least Significance Difference (LSD) were determined for all the data except for nutritive values.

Nutritional Quality

One objective of the study was to enhance the protein content of muffins by substituting peanut grits or peanut flour for a portion of the all-purpose or whole wheat flour. Based on the experimental procedure adapted for the study, 0, 10, 20, and 30 percent peanut grits or peanut flour was substituted for part of the all-purpose or whole wheat flour. As expected, the protein content of the muffins increased as the amount of peanut grits or peanut flour, substituted for a portion of the all-purpose or whole wheat flour, was increased (Tables III and IV).

The values for the essential amino acids and some nonessential amino acids are also shown in Tables III and IV for all-purpose and whole wheat muffins. The level of each amino acid content in either all-purpose or whole wheat standard muffin increased with each increase in peanut grits or peanut flour levels. The nutritional quality of muffins can be improved by substituting peanut grits or peanut flour for either all-purpose or whole wheat flour.

Sensory Evaluation

Muffins were evaluated for characteristic qualities by a seven-member attribute panel and the results were transposed into tables of differences (Tables V and VI), and Figures (Figures 1-12) (Five-Point Scale, Appendix A).

Appearance

The level of peanut grits in all-purpose muffins significantly affected ($p<0.05$) the appearance attribute. As shown in Figure 1, the mean score for the appearance decreased as the level of peanut grits increased. Panelists could detect an appearance difference between the 0 and 30 percent muffins, as well as between the 0 and 20 percent muffins. No appearance differences could be detected between the 0 and 10 percent levels, 10 and 30 percent levels, 10 and 20 percent levels, and 20 and 30 percent levels (Table V). When peanut grits were substituted for whole wheat flour, similar results were obtained. As shown in Figure 2, the mean score for the appearance decreased as the level of peanut grits increased. There were significant differences ($p<0.05$) between 0 and 30 percent levels muffins and the 0 and 20

TABLE III

PROTEIN AND AMINO ACID CONTENT OF ALL-PURPOSE MUFFIN (GMS/MUFFIN)[a]

Level	Protein	Isoleu-cine	Leu-cine	Ly-sine	Methio-nine	Phenyl-alanine	Threo-nine	Trypto-phane	Valine	Cys-tine	Tyro-sine
0%	11.39	0.19	0.33	0.16	0.08	0.22	0.13	0.02	0.24	0.07	0.14
Peanut Grits[b]											
10%	12.56	0.22	0.40	0.19	0.09	0.27	0.16	0.03	0.28	0.08	0.18
20%	13.72	0.26	0.48	0.23	0.10	0.32	0.19	0.05	0.33	0.09	0.23
30%	14.89	0.29	0.55	0.27	0.11	0.38	0.22	0.06	0.37	0.10	0.28
Peanut Flour[c]											
10%	12.71			0.20							
20%	14.03			0.24							
30%	15.35			0.29							

[a]The formula provided nine muffins.

[b]Peanut grits were from Gold Kist, Inc.

[c]Peanut flour was from Southern Regional Research Laboratory, USDA.

TABLE IV

PROTEIN AND AMINO ACID CONTENT OF WHOLE WHEAT MUFFIN (GMS/MUFFIN)[a]

Level	Protein	Isoleu-cine	Leu-cine	Ly-cine	Methio-nine	Phenyl-alanine	Threo-nine	Trypto-phane	Valine	Cys-tine	Tyro-sine
0%	12.12	0.02	0.39	0.20	0.09	0.25	0.17	-	0.32	0.10	0.18
Peanut Grits[b]											
10%	13.22	0.22	0.45	0.24	0.10	0.30	0.19	0.01	0.36	0.10	0.22
20%	14.31	0.27	0.52	0.27	0.11	0.35	0.22	0.03	0.39	0.11	0.27
30%	15.41	0.31	0.59	0.30	0.12	0.40	0.25	0.04	0.43	0.12	0.31
Peanut Flour[c]											
10%	13.37			0.24							
20%	14.61			0.28							
30%	15.86			0.33							

[a]The formula provided nine muffins.

[b]Peanut grits were from Gold Kist, Inc.

[c]Peanut flour was from Southern Regional Research Laboratory, USDA.

TABLE V

LSD TEST OF MEAN SCORES OF SENSORY EVALUATION FOR DIFFERENT LEVELS OF PEANUT GRITS OR PEANUT FLOUR IN ALL-PURPOSE MUFFINS

Type of Peanut Flour	Characteristics											
	Appearance						Texture					
Peanut Grits			30	20	10	0[a]			30	20	10	0
			3.357	3.500	3.679	3.893			3.179	3.286	3.750	3.464
	0[a]	3.893	0.536*	0.393*	0.214[b]		0	3.464	0.285	0.178	0.236	
	10	3.679	0.322	0.179			10	3.750	0.571*	0.464*		
	20	3.500	0.143				20	3.286	0.107			
	30	3.357					30	3.179				
Peanut Flour			30	20	10	0			30	20	10	0
			3.714	4.000	3.821	3.857			3.464	3.821	3.607	3.821
	0	3.857	0.143	0.143	0.036		0	3.821	3.357*	0.0	0.214	
	10	3.821	0.107	0.179			10	3.607	0.143	0.214		
	20	4.000	0.286				20	3.821	0.357*			
	30	3.714					30	3.464				

TABLE V (Continued)

Type of Peanut Flour	Characteristics											
	Color						Mouthfeel					
Peanut Grits			30[a]	20	10	0			30	20	10	0
			2.929	3.286	3.643	4.036			3.214	3.393	4.107	3.857
	0[a]	4.036	1.107*	0.750*	0.393*		0	3.857	0.643*	0.464*	0.250[b]	
	10	3.643	0.714*	0.357*			10	4.107	0.893*	0.714*		
	20	3.286	0.357*				20	3.393	0.179			
	30	2.929					30	3.214				
Peanut Flour												
			30	20	10	0			30	20	10	0
			3.821	3.893	4.036	4.250			3.714	4.000	3.929	3.893
	0	4.250	0.429*	0.357*	0.214		0	3.893	0.179	0.107	0.036	
	10	4.036	0.215	0.143			10	3.929	0.215	0.071		
	20	3.893	0.072				20	4.000	0.286			
	30	3.821					30	3.714				

TABLE V (Continued)

Type of Peanut Flour	Characteristics											
	Flavor						Overall Impression					
Peanut Grits			30[a]	20	10	0			30	20	10	0
			2.536	2.786	3.714	4.036			2.714	3.071	3.857	3.893
0[a]	4.036	1.500*	1.250*	0.321[b]		0	3.893	1.179*	0.822*	0.036	
10	3.714	1.178*	0.928*			10	3.857	1.143*	0.786*		
20	2.786	0.250				20	3.071	0.357*			
30	2.536					30	2.714				
Peanut Flour			30	20	10	0			30	20	10	0
			3.571	3.750	4.179	4.000			3.536	3.750	4.071	3.964
0	4.000	0.429*	0.250*	0.179		0	3.964	0.428*	0.214	0.107	
10	4.179	0.608*	0.429*			10	4.071	0.535*	0.321		
20	3.750	0.179				20	3.750	0.214			
30	3.571					30	3.536				

[a]Level of substitution.

[b]Differences between two means. "*" means that there is significant difference ($p<0.05$) between two means.

TABLE VI

LSD TEST OF MEAN SCORES OF SENSORY EVALUATION FOR DIFFERENT LEVELS OF PEANUT GRITS OR PEANUT FLOUR IN WHOLE WHEAT MUFFINS

Type of Peanut Flour	Characteristics										
	Appearance						Texture				
Peanut Grits			30[a]	20	10	0			30	20	10	0
			3.143	3.143	3.214	3.571			3.286	3.179	3.250	3.500
0[a]	3.571		0.428*	0.428*	0.357[b]		0	3.500	0.214	0.321	0.250	
10	3.214		0.071	0.071			10	3.250	0.036	0.071		
20	3.143		0.0				20	3.179	0.107			
30	3.143						30	3.286				
Peanut Flour												
			30	20	10	0			30	20	10	0
			3.357	3.750	3.536	3.643			3.643	3.786	3.893	3.536
0	3.643		0.286	0.107	0.107		0	3.536	0.107	0.250	0.357*	
10	3.536		0.179	0.214			10	3.893	0.250	0.107		
20	3.750		0.393*				20	3.786	0.143			
30	3.357						30	3.643				

TABLE VI (Continued)

Type of Peanut Flour	Characteristics											
	Color						Mouthfeel					
Peanut Grits			30	20	10	0			30	20	10	0
			3.071	2.964	3.143	3.929			2.929	3.250	3.500	3.714
0[a]	3.929		0.858*	0.965*	0.786*		0	3.714	0.785*	0.464*	0.214	
10	3.143		0.072[b]	0.179			10	3.500	0.571*	0.250		
20	2.964		0.107				20	3.250	0.321			
30	3.071						30	2.929				
Peanut Flour												
			30	20	10	0			30	20	10	0
			3.964	3.929	4.036	3.750			3.893	4.107	3.929	3.643
0	3.750		0.214	1.179	0.286		0	3.643	0.250	0.464*	0.286	
10	4.036		0.072	0.107			10	3.929	0.036	0.178		
20	3.929		0.035				20	4.107	0.214			
30	3.964						30	3.892				

TABLE VI (Continued)

Type of Peanut Flour	Characteristics											
	Flavor						Overall Impression					
Peanut Grits			30	20	10	0			30	20	10	0
			2.607	2.786	3.179	3.750			2.786	2.929	3.250	3.679
0[a]	3.750		1.143*	0.964*	0.571*		0	3.679	0.893*	0.750*	0.429*	
10	3.179		0.572*	0.393*			10	3.250	0.464*	0.321		
20	2.786		0.179[b]				20	2.929	0.143			
30	2.607						30	2.786				
Peanut Flour			30	20	10	0			30	20	10	0
			3.464	3.750	3.750	3.750			3.714	3.929	3.750	3.679
0	3.750		0.286	0.0	0.0		0	3.679	0.035	0.250	0.071	
10	3.750		0.286	0.0	0.0		10	3.750	0.036	0.179		
20	3.750		0.286				20	3.929	0.215			
30	3.464						30	3.714				

[a]Level of substitution.

[b]Differences between two means. "*" means that there is significant difference ($p<0.05$) between two means.

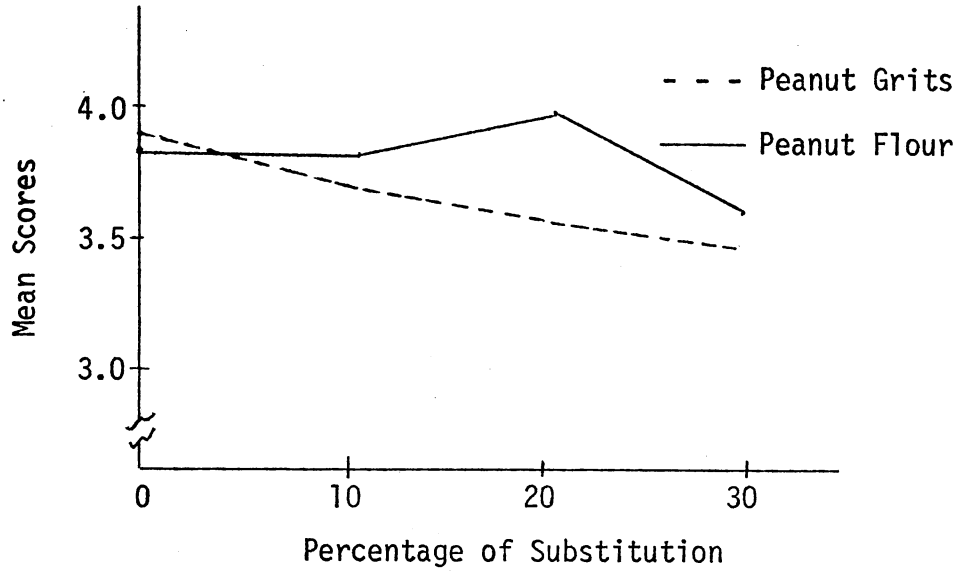


Figure 1. Mean Scores of Appearance in All-Purpose Muffins with Peanut Grits or Peanut Flour

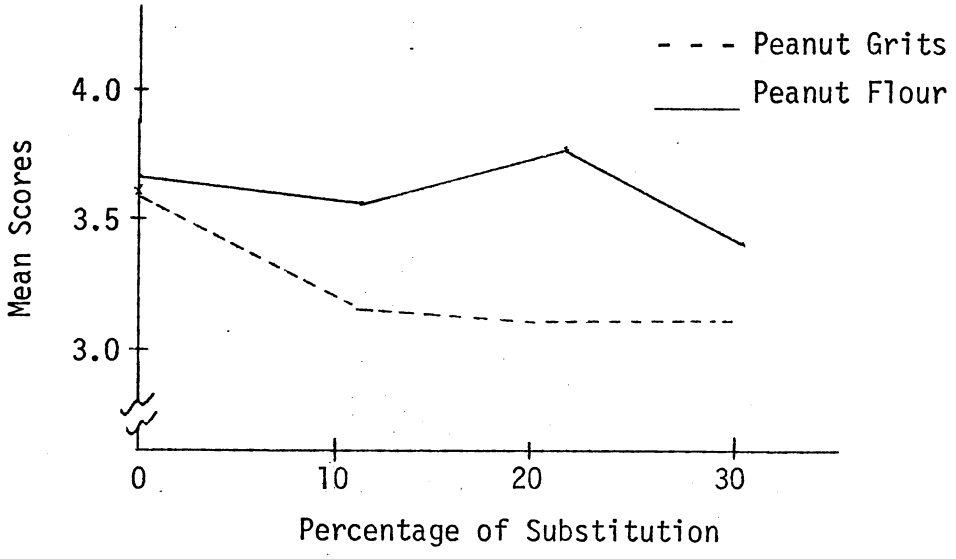


Figure 2. Mean Scores of Appearance in Whole Wheat Muffins with Peanut Grits or Peanut Flour

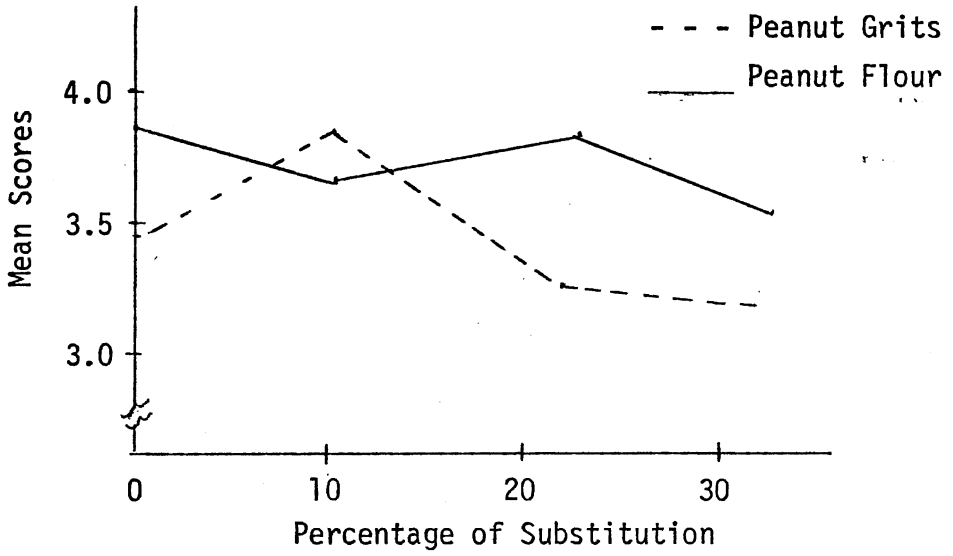


Figure 3. Mean Scores of Texture in All-Purpose Muffins with Peanut Grits or Peanut Flour

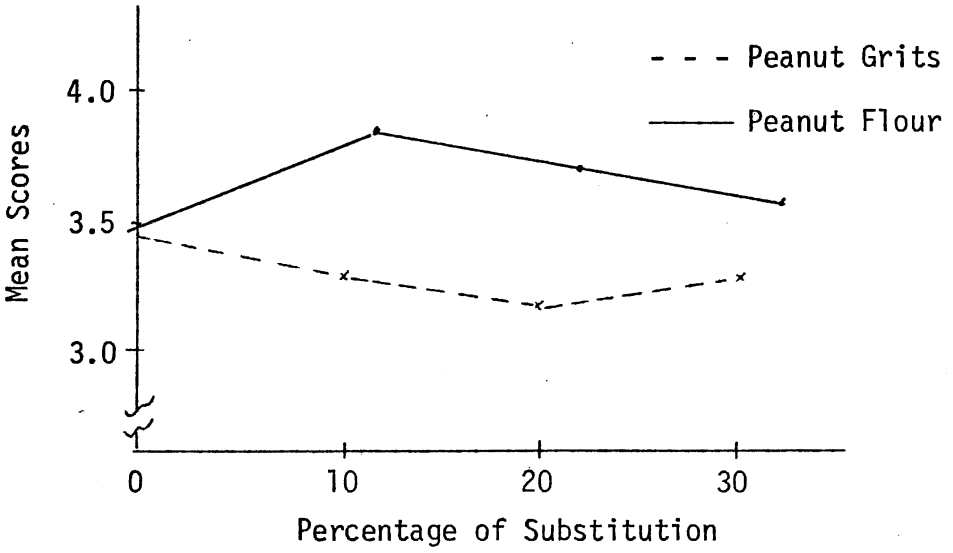


Figure 4. Mean Scores of Texture in Whole Wheat Muffins with Peanut Grits or Peanut Flour

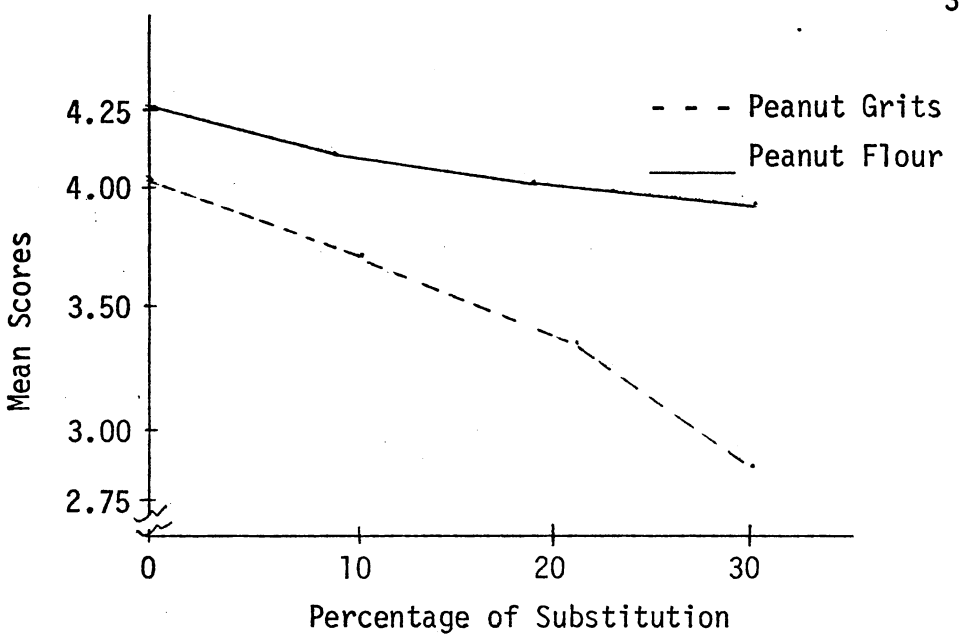


Figure 5. Mean Scores of Color in All-Purpose Muffins with Peanut Grits or Peanut Flour

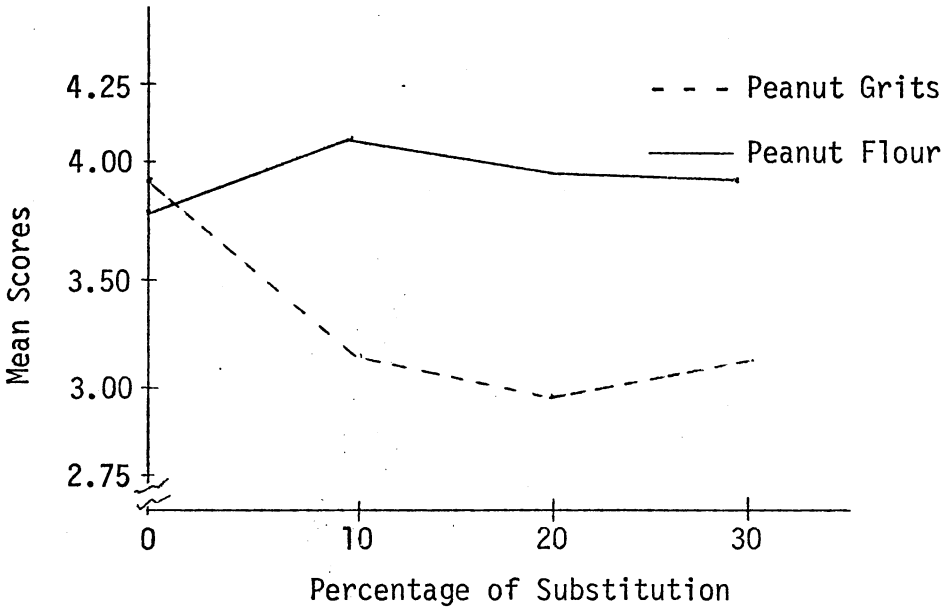


Figure 6. Mean Scores of Color in Whole Wheat Muffins with Peanut Grits or Peanut Flour

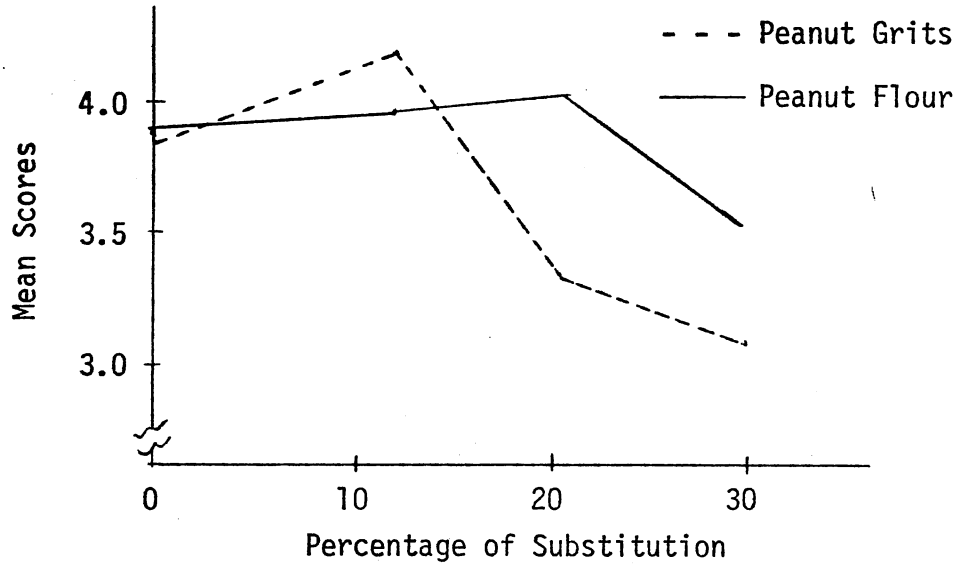


Figure 7. Mean Scores of Mouthfeel in All-Purpose Muffins with Peanut Grits or Peanut Flour

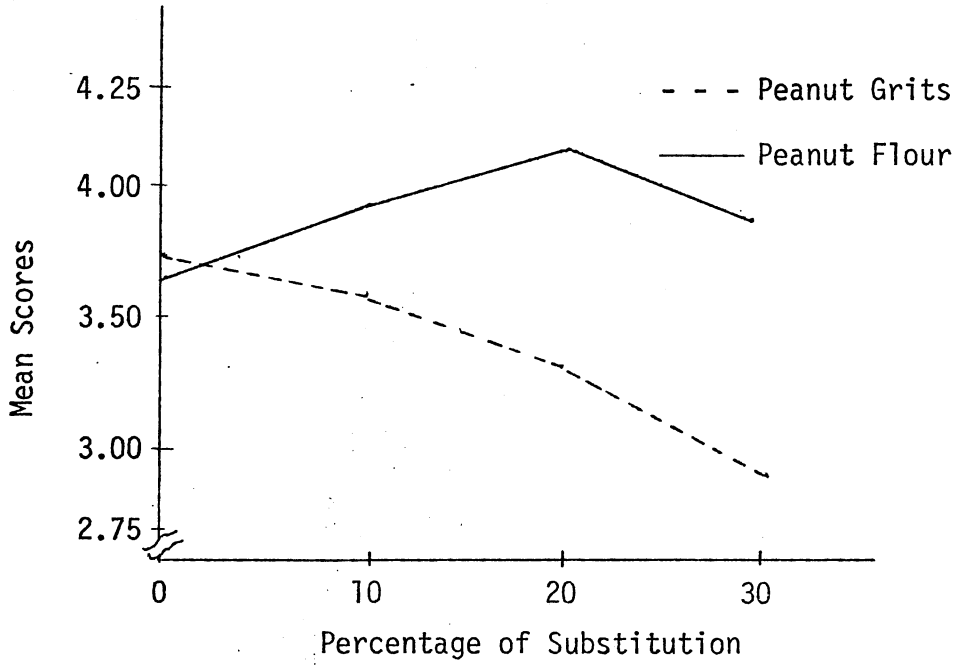


Figure 8. Mean Scores of Mouthfeel in Whole Wheat Muffins with Peanut Grits or Peanut Flour

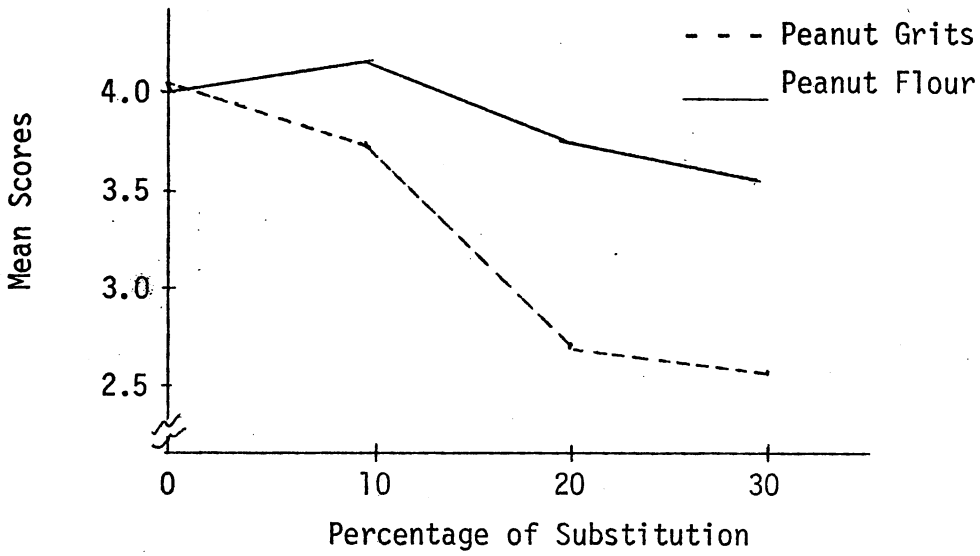


Figure 9. Mean Scores of Flavor in All-Purpose Muffins with Peanut Grits or Peanut Flour

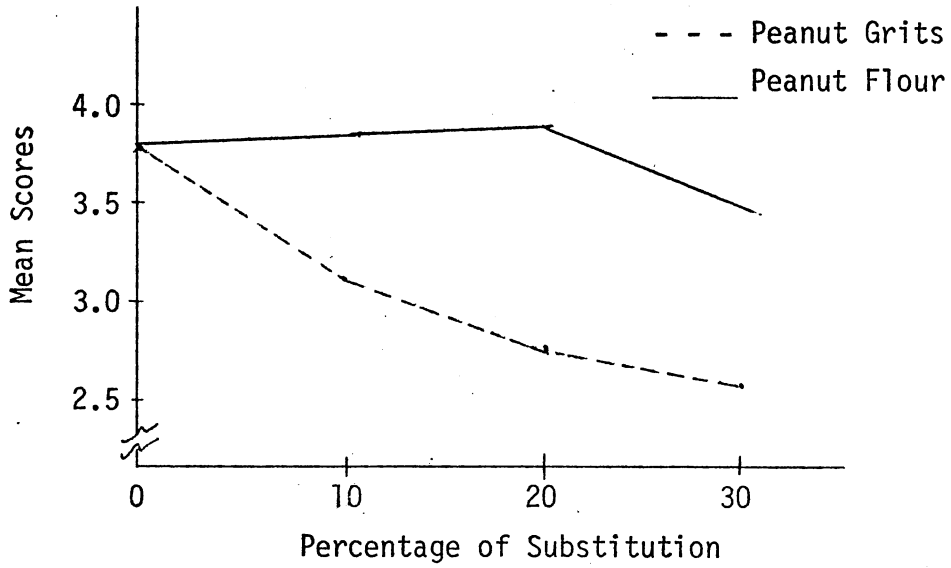


Figure 10. Mean Scores of Flavor in Whole Wheat Muffins with Peanut Grits or Peanut Flour

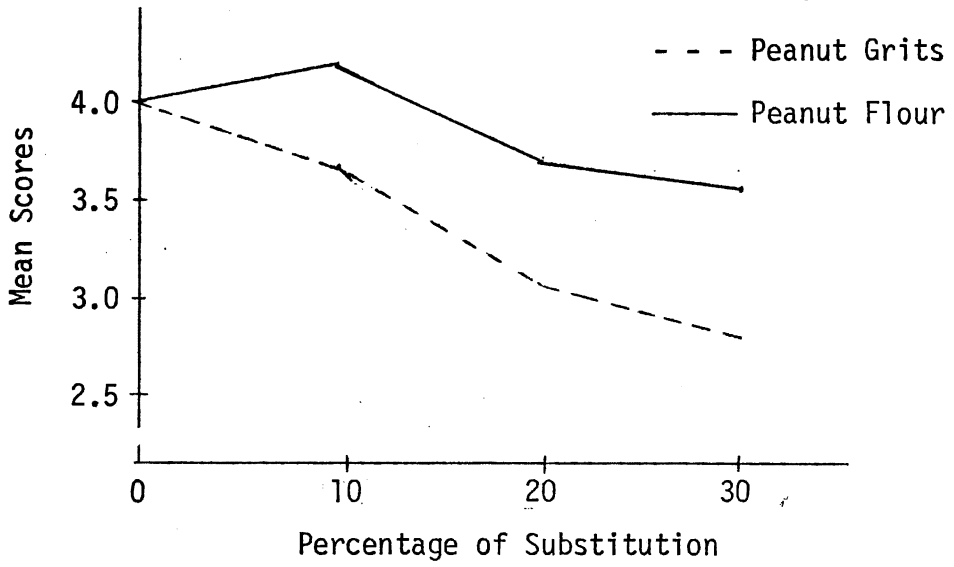


Figure 11. Mean Scores of Overall Impression in All-Purpose Muffins with Peanut Grits or Peanut Flour

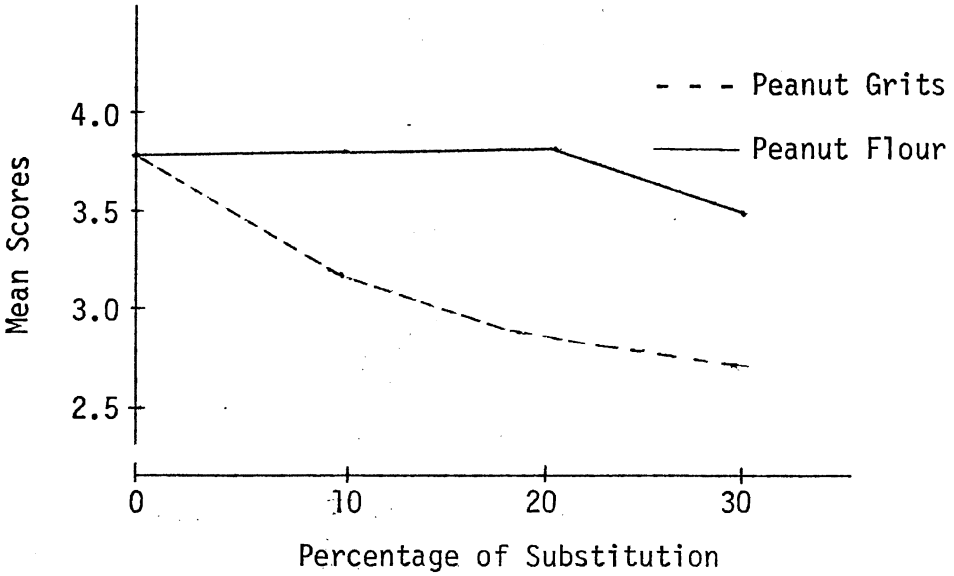


Figure 12. Mean Scores of Overall Impression in Whole Wheat Muffins with Peanut Grits or Peanut Flour

percent levels muffins. No appearance differences could be detected between the 0 and 10 percent levels, 10 and 30 percent levels, 10 and 20 percent levels, and 20 and 30 percent levels (Table VI).

The level of peanut flour in all-purpose muffins did not affect the attribute in appearance. As shown in Figure 1, the mean score for the appearance decreased at the 10 percent level, then increased at the 20 percent level, and again decreased at the 30 percent level; however, the mean score differences were not statistically significant at the 0.05 level. When peanut flour was substituted for whole wheat flour, a significant difference ($p<0.05$) was detected. As shown in Figure 2, the mean score decreased at the 10 percent level, then increased at the 20 percent level, and again decreased at the 30 percent level. Although the mean score for each level varied, the only significant difference ($p<0.05$) was found between the 20 and 30 percent muffins (Table VI).

Texture

The levels of peanut grits substituted for all-purpose flour had some effects on scores for the attribute texture. As shown in Figure 3, the mean score increased at the 10 percent level, and decreased as the levels of peanut grits were increased to 20 and 30 percent. There were significant differences ($p<0.05$) between 10 and 20 percent muffins, as well as 10 and 30 percent muffins. The panelists could not detect a difference between the other levels (Table V). When peanut grits were substituted for whole wheat flour, the mean scores decreased slightly as the level of peanut grits increased up

to the 20 percent level, then the mean score increased slightly at the 30 percent level (Figure 4); however, the differences between the mean scores were not statistically significant at the 0.05 level (Table VI).

When peanut flour was substituted for all-purpose flour, the level of peanut flour did have some effects on the attribute texture. The mean score for texture decreased at the 10 percent level, increased at the 20 percent level, and decreased at the 30 percent level (Figure 3). Panelists could detect the differences between 0 and 30 percent muffins, and 20 and 30 percent muffins. The differences in mean scores between the other levels were not statistically significant at the 0.05 level (Table V). When peanut flour was substituted for whole wheat flour, the mean score increased at the 10 percent level, then decreased as the levels of peanut flour were increased to 20 and 30 percent (Figure 4). Panelists could detect the difference between 0 and 10 percent muffins. The differences between the rest of the mean scores were not significant ($p<0.05$) (Table VI).

Color

The mean score of the color attribute for the all-purpose muffins containing peanut grits decreased as the level of peanut grits increased (Figure 5). Panelists could detect the differences between all the levels (Table V). When peanut grits were substituted for whole wheat flour, the mean score decreased as the level of peanut grits increased (Figure 6). Panelists could detect the differences between the 0 and 30 percent muffins, 0 and 20 percent muffins, and 0 and 10 percent muffins. The mean score differences between the other

levels of muffins were not statistically significant at the 0.05 level (Table VI).

When peanut flour was substituted for the all-purpose flour, the effects on the attribute color are shown in Figure 5. The mean score decreased as the level of peanut flour increased. There were significant differences ($p<0.05$) between 0 and 30 percent muffins, and 0 and 20 percent muffins. The differences between the 0 and 10 percent levels, 10 and 30 percent levels, 10 and 20 percent levels, and 20 and 30 percent levels were not significant ($p<0.05$) (Table V). When peanut flour was substituted for whole wheat flour, the mean score increased at the 10 percent level, then decreased as the levels of peanut flour were increased to 20 and 30 percent (Figure 6); however, the differences were not statistically significant at the 0.05 level (Table VI).

Mouthfeel

The all-purpose muffins containing peanut grits did have effects on the attribute mouthfeel. The mean scores for mouthfeel increased at the 10 percent level, then decreased as the levels of peanut grits were further increased (Figure 7). There were significant differences ($p<0.05$) between 0 and 30 percent muffins, 0 and 20 percent muffins, 10 and 20 percent muffins, and 10 and 30 percent muffins. The differences between the 0 and 10 percent levels, and the 20 and 30 percent levels were not statistically significant at the 0.05 level (Table V). When peanut grits were substituted for whole wheat flour, the mean score of mouthfeel decreased as the level of peanut grits increased (Figure 8). There were significant differences ($p<0.05$) between 0 and

30 percent muffins, 0 and 20 percent muffins, and 30 and 10 percent muffins. The differences between the rest of the levels were not statistically significant at the 0.05 level (Table VI).

The mean score of mouthfeel for the all-purpose muffins containing peanut flour increased slightly as the level of peanut flour increased up to the 20 percent substitution, then decreased at the 30 percent level (Figure 7); however, the differences were not statistically significant at the 0.05 level (Table V). When peanut flour was substituted for whole wheat flour, the mean score increased as the level of peanut flour increased up to the 20 percent level, then decreased at the 30 percent level (Figure 8). There was a significant difference ($p<0.05$) between 0 and 20 percent muffins. The differences between the rest of the levels were not statistically different at the 0.05 level (Table VI).

Flavor

The all-purpose muffins containing peanut grits did affect the attribute flavor. The mean score decreased sharply as the level of peanut grits increased (Figure 9). The differences between 0 and 30 percent muffins, 0 and 20 percent muffins, 10 and 30 percent muffins, and 10 and 20 percent muffins were statistically significant at the 0.05 level. No significant differences ($p<0.05$) could be detected between the 0 and 10 percent levels and the 20 and 30 percent levels (Table V). When peanut grits were substituted for whole wheat flour, the mean score decreased as the level of peanut grits increased (Figure 10). All the differences, except the difference between 20 and 30 percent muffins, were significant ($p<0.05$) (Table VI).

The mean score for flavor for the all-purpose muffins containing peanut flour increased slightly at the 10 percent level, then decreased as the levels of peanut flour were increased to 20 and 30 percent (Figure 9). All the differences, except the 0 and 10 percent levels and the 20 and 30 percent levels were statistically significant at the 0.05 level (Table V). With whole wheat flour, the mean score remained the same when the level of peanut flour increased up to the 20 percent level, then decreased slightly at the 30 percent level (Figure 10); however, the differences were not significant ($p<0.05$) (Table VI).

Overall Impression

The all-purpose muffins containing peanut grits did have effects on the attribute overall impression. The mean score decreased as the level of peanut grits increased (Figure 11). There were significant differences ($p<0.05$) between all the levels excpet the 0 and 10 percent muffins (Table V). When substituting peanut grits for whole wheat flour, the mean score decreased as the level of peanut grits increased (Figure 12). There were significant differences ($p<0.05$) between the 0 and 30 percent muffins, 0 and 20 percent muffins, 0 and 10 percent muffins, and 10 and 30 percent muffins. The differences between the 10 and 20 percent levels and the 20 and 30 percent levels were not statistically significant at the 0.05 level (Table VI).

The mean score for all-purpose muffins containing peanut flour increased slightly at the 10 percent level, then decreased as the levels of peanut flour were further increased (Figure 11). There were

significant differences ($p<0.05$) between the 0 and 30 percent muffins and the 10 and 30 percent muffins. The differences between the rest of the levels were not statistically significant at the 0.05 level (Table V). When peanut flour was substituted for whole wheat flour, the mean score increased as the level of peanut flour increased up to the 20 percent level, then decreased at the 30 percent level (Figure 12); however, the differences between the levels were not statistically significant at the 0.05 level (Table VI).

During the sensory evaluation period, some of the panelists did detect a somewhat "roasted peanut" flavor when peanut grits were substituted for all-purpose flour or whole wheat flour at the 30 percent level. A few of the panelists made the comment that all-purpose and whole wheat muffins containing 30 percent of the peanut flour had a slightly bitter taste. No "raw peanut" flavor was detected, however, in any of the products prepared.

As the level of peanut grits increased, the color of the all-purpose muffins and the whole wheat muffins became darker than the standard products. This can be seen on the results from sensory evaluation. With peanut flour the same effects were observed but to a lesser extent. These results concurred with results previously reported by McWatters (1978) that appearance and color scores of cookies were influenced significantly by increased levels of peanut flour in the formula. Browning and appearance variation in top grain were slightly increased as the levels of peanut flour increased.

For overall impression, peanut grits could be substituted for all-purpose flour up to 20 percent or whole wheat flour in muffins up

to 10 percent without affecting the acceptability of the product (mean score 3.0 or higher in a 5.0 scale). Peanut flour could be substituted for either all-purpose or whole wheat flour up to 30 percent by weight without affecting acceptability of muffins (mean score 3.0 or higher). This is similar to the results reported earlier by Sproul (1975) where whole wheat muffins containing 25 percent peanut flour by volume were judged as acceptable products by a trained attribute panel.

Objective Evalution

Prior to sensory evaluation, two of the muffins from each variation were randomly selected from each batch for objective tests. Objective tests were performed after the sensory evaluation.

Specific Volume

The results from ANOVA indicated that the variations in specific volume among muffins were not significant ($p<0.05$) (Table VII). When peanut grits were substituted for all-purpose flour, the mean of the specific volume decreased as the level of peanut grits increased (Figure 13). The LSD test showed that there were significant differences ($p<0.05$) between 0 and 30 percent muffins, 0 and 20 percent muffins, 10 and 30 percent muffins, and 10 and 20 percent muffins. The differences between the 0 and 10 percent levels and the 20 and 30 percent levelswere not statistically significant at the 0.05 level (Table VIII). The mean value of specific volume for whole wheat muffins containing peanut grits decreased as the level of peanut grits increased (Figure 14). The LSD test showed that there were significant differences

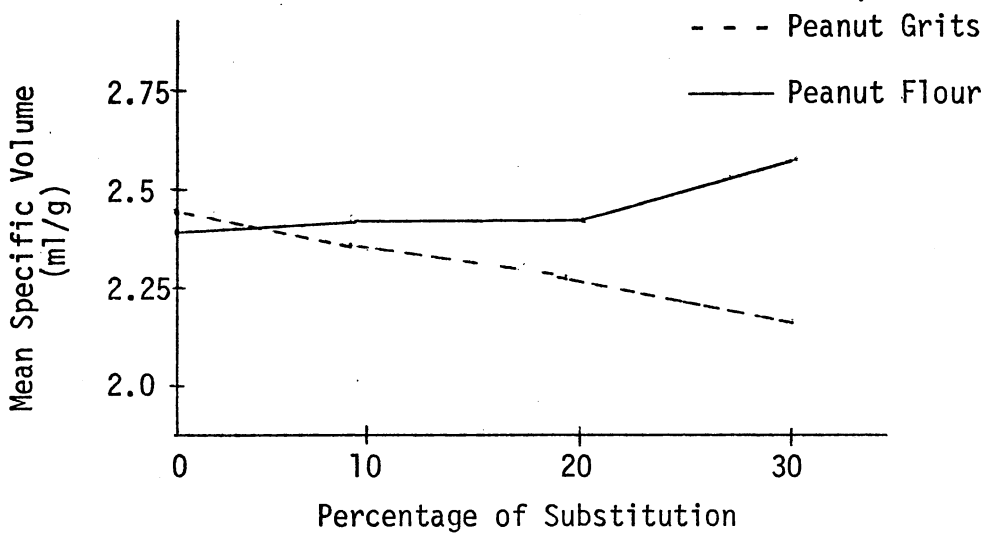


Figure 13. Mean Specific Volume (ml/g) in All-Purpose Muffins with Peanut Grits or Peanut Flour

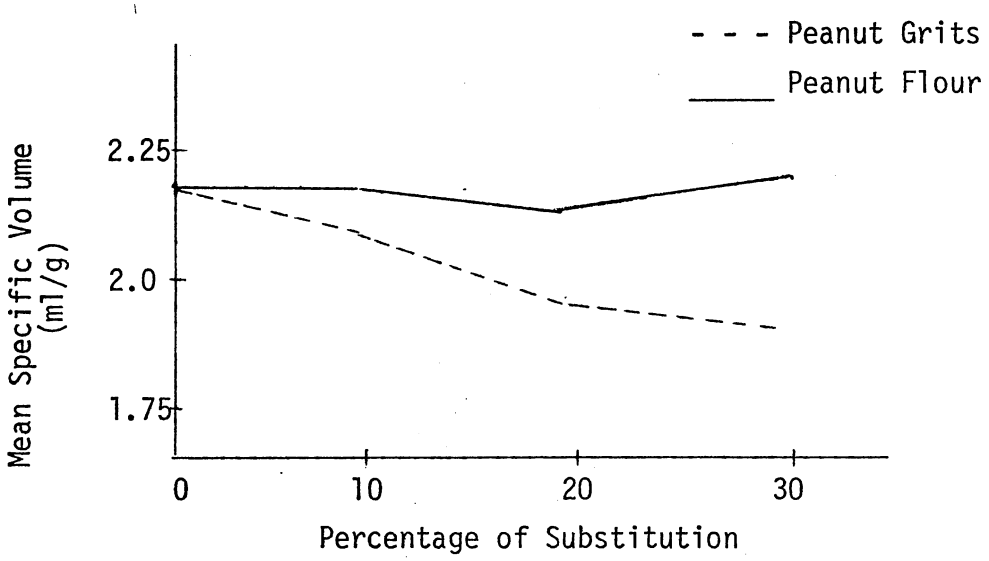


Figure 14. Mean Specific Volume (ml/g) in Whole Wheat Muffins with Peanut Grits or Peanut Flour

TABLE VII

STATISTICAL SIGNIFICANCE[a] OF OBJECTIVE MEASUREMENT

Measurement	Significance Level
Specific Volume	0.5067
Shear Force (Top)	0.3519
Shear Force (Bottom)	0.5055

[a]In the computer analysis, the smallest probability listed was 0.001; higher probabilities were listed as more exact numerical values.

TABLE VIII

LSD TEST OF MEAN SPECIFIC VOLUME FOR DIFFERENT LEVELS OF PEANUT GRITS IN ALL-PURPOSE MUFFINS AND WHOLE WHEAT MUFFINS[a]

Type of Muffins	Level of Peanut Grits (%)			
All-Purpose	0	10	20	30
	2.461	2.340	2.197	2.109
Whole Wheat	0	10	20	30
	2.179	2.102	1.941	1.882

[a]Means not underscored by the same lines are significantly different ($p<0.05$).

($p<0.05$) between all the levels except the 0 and 10 percent levels and 20 and 30 percent levels (Table VIII).

As shown in Figure 13, the mean of specific volume for all-purpose muffins containing peanut flour decreased slightly as the level of peanut flour increased up to the 20 percent level, then increased at the 30 percent level. Although the means varied, there were no significant differences ($p<0.05$) between the levels (Table IX). When peanut flour was substituted for whole wheat flour, the mean specific volume decreased as the level of peanut flour increased up to the 20 percent level, then increased at the 30 percent level (Figure 14). The differences between the means were not statistically significant at the 0.05 level (Table IX).

LSD and ANOVA results were not always consistent when there were significant differences between variables, but when the means were not significant ($p<0.05$), LSD and ANOVA results were always consistent.

TABLE IX

LSD TEST OF MEAN SPECIFIC VOLUME FOR DIFFERENT LEVELS OF PEANUT FLOUR IN ALL-PURPOSE MUFFINS AND WHOLE WHEAT MUFFINS[a]

Type of Muffins	Level of Peanut Flour (%)			
All-Purpose	30	0	10	20
	2.505	2.425	2.378	2.375
Whole Wheat	0	10	30	20
	2.183	2.179	2.148	2.123

[a]Means not underscored by the same lines are significantly different ($p<0.05$).

Tenderness

Tenderness characteristic of muffins was evaluated by shear force (kg/g) using Instron Universal Testing Instrument.

Top Crust. All-purpose muffins containing peanut grits, at four levels, showed no significant difference ($p<0.05$) in the ANOVA test (Table VII); however, there were slightly different results from the LSD test. As shown in Figure 15, the mean value for top crust increased at the 10 percent level, decreased at the 20 percent level, then increased slightly at the 30 percent level. There were significant differences ($p<0.05$) between 10 and 30 percent, and 10 and 20 percent levels in all-purpose muffins. There were no significant differences ($p<0.05$) between the other levels (Table X) which were consistent with the results of ANOVA. When peanut grits were substituted for whole wheat flour, the mean value of top crust varied slightly (Figure 15); however, there were no significant differences ($p<0.05$) between the means (Table X) from the LSD test which were consistent with the ANOVA test.

The mean value of shear force for top crust in all-purpose muffins or whole wheat muffins containing peanut flour varied slightly (Figure 16); however, the differences were not statistically significant at the 0.05 level when tested by LSD (Table XI). The results were consistent with the ANOVA test (Table VII).

Bottom Crust. The mean value of shear force for bottom crust of all-purpose muffins containing peanut grits increased at the 10 percent level, decreased at the 20 percent level, then increased at the

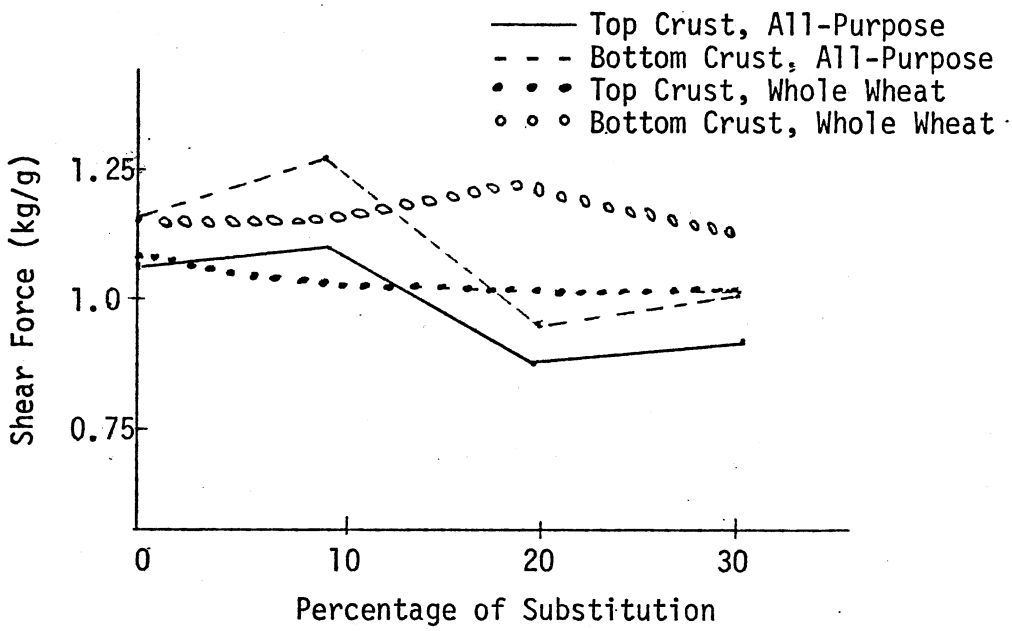


Figure 15. Tenderness by Shear Force (kg/g) for Top and Bottom Crust in Muffins with Peanut Grits

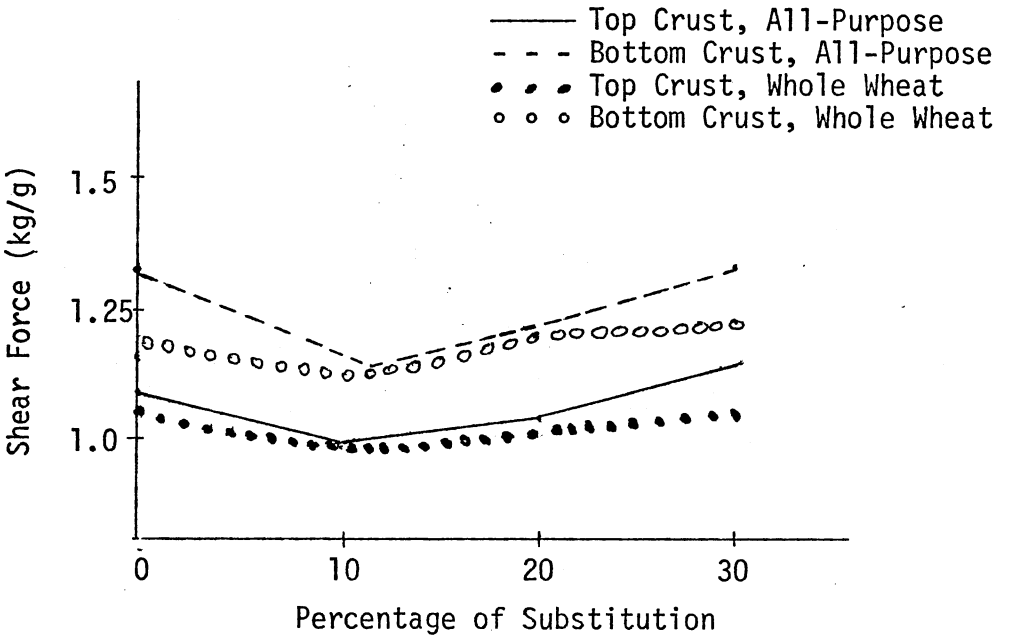


Figure 16. Tenderness by Shear Force (kg/g) for Top and Bottom Crust in Muffins with Peanut Flour

TABLE X

LSD TEST OF MEAN SHEAR FORCE OF TOP CRUST FOR DIFFERENT LEVELS OF PEANUT GRITS IN ALL-PURPOSE MUFFINS AND WHOLE WHEAT MUFFINS[a]

Type of Muffins	Level of Peanut Grits (%)			
All-Purpose	10	0	30	20
	1.101	1.068	0.890	0.881
Whole Wheat	0	10	20	30
	1.081	1.042	1.033	0.994

[a]Means not underscored by the same lines are significantly different ($p<0.05$).

TABLE XI

LSD TEST OF MEAN SHEAR FORCE OF TOP CRUST FOR DIFFERENT LEVELS OF PEANUT FLOUR IN ALL-PURPOSE MUFFINS AND WHOLE WHEAT MUFFINS[a]

Type of Muffins	Level of Peanut Flour (%)			
All-Purpose	30	0	20	10
	1.172	1.087	1.040	1.004
Whole Wheat	0	20	30	10
	1.054	1.035	1.027	1.007

[a]Means not underscored by the same lines are significantly different ($p<0.05$).

30 percent level (Figure 15). As shown in Table XII, when the LSD test was conducted, there were significant differences ($p<0.05$) between 10 and 30 percent muffins and 10 and 20 percent muffins; however, the differences between the rest of the levels were not statistically significant at the 0.05 level (Table XII) which were consistent with the ANOVA test. When peanut grits were substituted for whole wheat flour, the mean value varied slightly (Figure 15); however, the differences were not significant ($p<0.05$) in both the LSD and ANOVA (Tables VII and XII).

TABLE XII

LSD TEST OF MEAN SHEAR FORCE OF BOTTOM CRUST FOR DIFFERENT LEVELS OF PEANUT GRITS IN ALL-PURPOSE MUFFINS AND WHOLE WHEAT MUFFINS[a]

Type of Muffins	Level of Peanut Grits (%)			
All-Purpose	10	0	30	20
	1.265	1.155	0.987	0.962
Whole Wheat	20	10	0	30
	1.180	1.162	1.155	1.107

[a]Means not underscored by the same lines are significantly different ($p<0.05$).

Similarly, when peanut flour was substituted for all-purpose flour or whole wheat flour, the mean values varied (Figure 16); however, the differences were not statistically significant at the 0.05 level in LSD and ANOVA (Tables VII and XIII).

TABLE XIII

LSD TEST OF MEAN SHEAR FORCE OF BOTTOM CRUST FOR DIFFERENT LEVELS OF PEANUT FLOUR IN ALL-PURPOSE MUFFINS AND WHOLE WHEAT MUFFINS[a]

Type of Muffins	Level of Peanut Flour (%)			
All-Purpose	0	30	20	10
	1.339	1.314	1.190	1.162
Whole Wheat	30	20	0	10
	1.213	1.190	1.162	1.153

[a]Means not underscored by the same lines are significantly different ($p<0.05$).

Based on the results of the tenderness measurement, it can be stated that when peanut flour was substituted for either all-purpose or whole wheat flour, the level of peanut flour (up to the 30 percent level) did not significantly ($p<0.05$) affect the tenderness of the muffins. When peanut grits were substituted for whole wheat flour,

the level of peanut grits (up to 30 percent) did not significantly ($p<0.05$) affect the tenderness of the muffins; however, the level of peanut grits in the all-purpose muffins did have some effects on tenderness. Muffins with 20 and 30 percent peanut grits were significantly ($p<0.05$) more tender than the 10 percent level.

Photography

Photographs of all-purpose muffins with peanut grits are shown in Figure 17, while those with peanut flour are shown in Figure 18. Whole wheat muffins with peanut grits are illustrated in Figure 19, while muffins with peanut flour are shown in Figure 20. The photographs in Figures 17 and 19 show discernible changes in heights, indicating that as the levels of substitution increase in peanut grits for both all-purpose and whole wheat muffins, the height of the muffins decreases. These findings support the LSD tests on specific volume (Table VIII). The level of peanut grits substitutions significantly ($p<0.05$) affected specific volume.

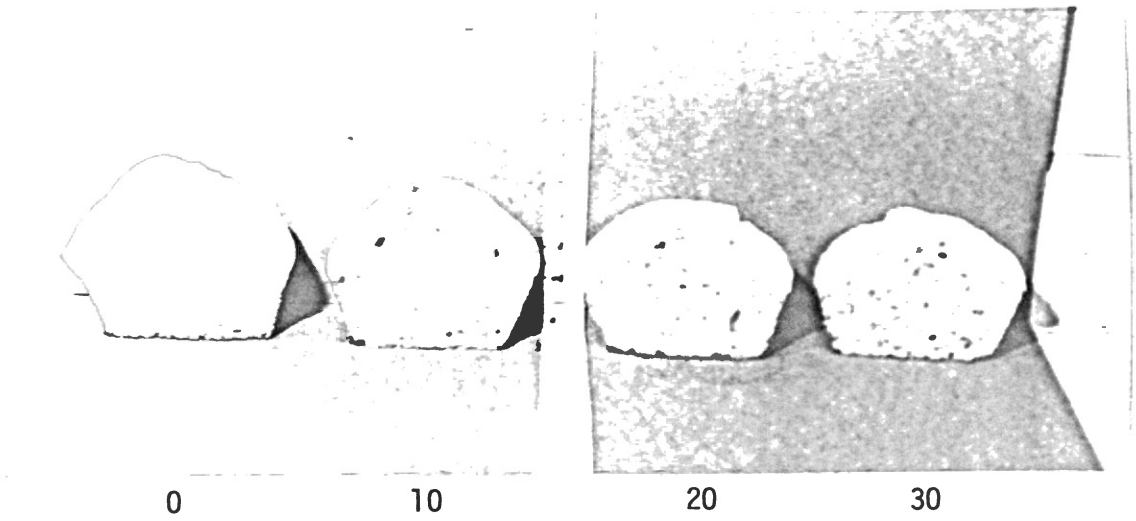


Figure 17. All-Purpose Muffins with Peanut Grits

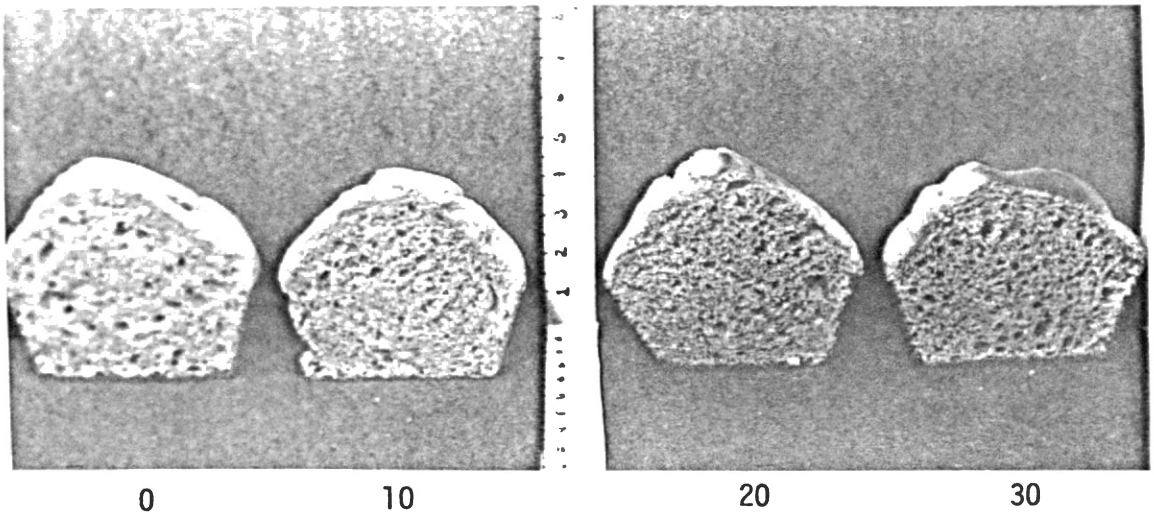
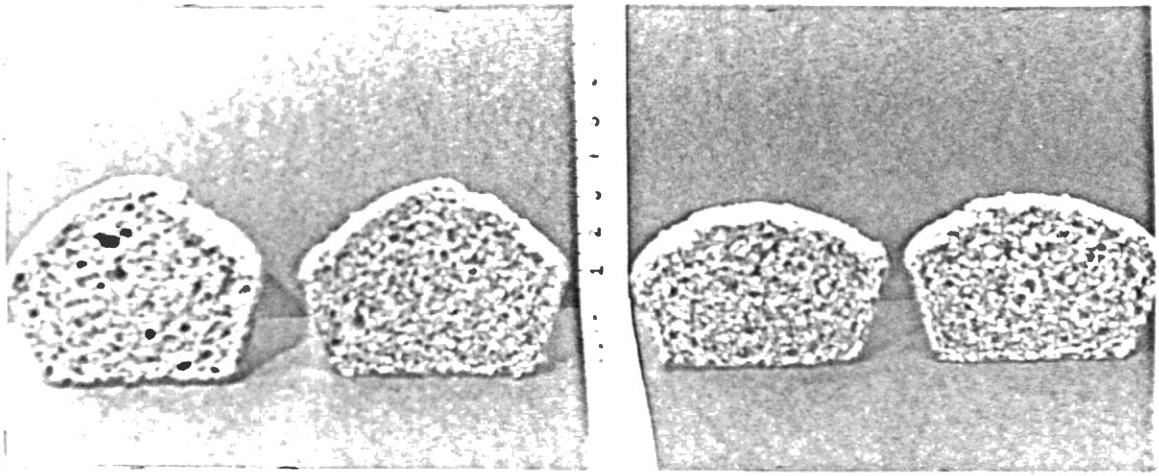


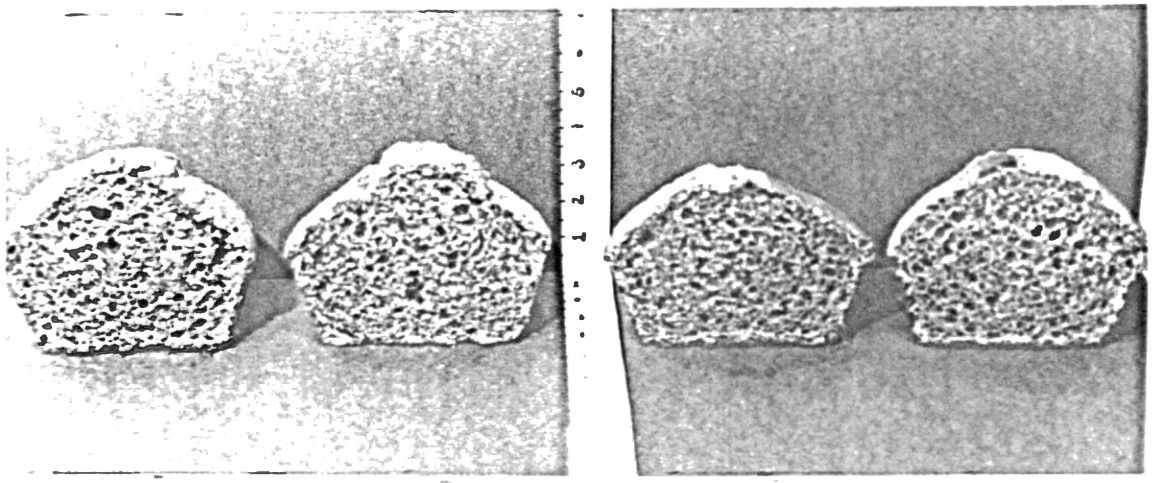
Figure 18. All-Purpose Muffins with Peanut Flour



0 10 20 30

Percentage of Substitution

Figure 19. Whole Wheat Muffins with Peanut Grits



0 10 20 30

Percentage of Substitution

Figure 20. Whole Wheat Muffins with Peanut Flour

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The purpose of this research was to determine the effects of peanut grits or peanut flour on appearance, color, texture, flavor, mouthfeel, and overall impression of muffins. Peanut grits or peanut flour was incorporated into both all-purpose flour and whole wheat flour muffins at four different levels: 0 percent, 10 percent, 20 percent, and 30 percent.

A review of the literature revealed that because of an increased awareness of the protein shortage in the world, the use of peanuts as an edible food crop is expected to increase. There are a number of food systems such as bakery products, dairy-type products, and meat analog in which peanut protein can be incorporated to increase the protein content. Although there has been some studies of muffins enriched with high levels of soy flour and peanut flour, other studies are needed to determine what other oilseeds can be used and at what levels in muffins. Studies are also needed regarding the extent to which nutritive content of baked products could be enhanced by nonconventional high protein flours. Investigations on organoleptic qualities as judged by trained attribute panelists and acceptability of enriched products by consumers are also needed.

The research was conducted using experimental procedures. The criteria related to products and laboratory conditions. A trained

seven-member attribute panel evaluated the muffins. The characteristics by subjective evaluation were appearance, texture, color, mouthfeel, flavor, and overall impression. A five-point scale was used by the panelists. The Instron Universal Testing Instrument Model1111122 was used to measure tenderness by shear force (kg/g). Volume was measured by rapeseed displacement method. Pictures of halves of muffins were taken to record the appearance, texture, and volume. The research activities involving a taste panel were conducted in eight days with peanut grits or peanut flour substitution being evaluated four times. Data were analyzed using the split-split-plot design, Analysis of Variance, and Least Significant Difference.

Protein and amino acid analyses were determined through the use of data from the Food and Agriculture Organization and from other literature. The mean values of protein content for standard muffins were compared with values for each variation of muffins which incorporated the peanut grits or peanut flour. Amino acid values were determined for Isoleucine, Leucine, Lysine, Methionine, Phenylalanine, Threonine, Tryptophane, Valine, Cystine, and Tyrosine.

Summary and Conclusions

Results indicated that the protein and amino acid content of the standard muffins were improved when peanut grits or peanut flour was incorporated at 10, 20, and 30 percent levels. There was a difference in nutritional quality between the standard muffins and muffins with peanut grits or peanut flour, based on amino acid tables (Tables III and IV).

Hypothesis one (H_1) stated that there would be no significant difference in appearance, texture, color, mouthfeel, flavor, and overall impression between the standard muffins and those incorporating peanut grits. Hypothesis Two (H_2) stated that there would be no significant difference in appearance, texture, color, mouthfeel, flavor, and overall impression between the standard muffins and those incorporating peanut flour. When individual characteristics under each variation of muffins were evaluated (Tables V and VI), hypotheses one and two were rejected.

A summary of sensory evaluation results showing the substitution levels indicating no significant differences ($p<0.05$) from the standard product and the maximum level of substitution judged acceptable by the attribute panel are shown in Table XIV. In terms of overall acceptability (mean scores 3.0 or higher on a 5.0 scale), peanut flour could be substituted up to the 30 percent level in the all-purpose and whole wheat muffins. When Least Significant Difference (LSD) values were determined, however, color and flavor characteristics were affected by level of substitution. Up to 10 percent of peanut flour could be substituted for all-purpose flour without significantly affecting ($p<0.05$) color and flavor, and up to 20 percent without affecting ($p<0.05$) texture and overall impression of muffins. In whole wheat muffins, peanut flour could be substituted up to 30 percent without significantly affecting ($p<0.05$) appearance, color, flavor, and overall impression (Table XIV). For overall acceptability (mean scores 3.0 or higher on a 5.0 scale), peanut grits could be substituted for all-purpose flour and whole wheat flour up to 10 percent for flavor

and at the higher percentages for the other quality characteristics. When LSD values were computed, however, texture was the only characteristic not affected by level of substitution. In all-purpose muffins, peanut grits could be substituted up to 10 percent without significantly affecting ($p<0.05$) appearance, mouthfeel, and overall impression. Up to 10 percent peanut grits could be substituted for whole wheat flour without significantly affecting ($p<0.05$) appearance and mouthfeel (Table XIV).

TABLE XIV

SUMMARY OF SENSORY EVALUATION RESULTS

Quality Characteristics	Type of Muffins			
	All-Purpose		Whole Wheat	
	P. Flour	P. Grits	P. Flour	P. Grits
Appearance	30[a](30)[b]	10 (30)	30 (30)	10 (30)
Texture	20 (30)	30 (30)	20&30 (30)	30 (30)
Color	10 (30)	-- (20)	30 (30)	-- (10&30)
Mouthfeel	30 (30)	10 (30)	10&30 (30)	10 (20)
Flavor	10 (30)	10 (10)	30 (30)	-- (10)
Overall Impression	20 (30)	10 (20)	30 (30)	-- (10)

[a]Substitution level (%) indicating no significant difference ($p<0.05$) from standard.

[b]Maximum level (%) of substitution judged acceptable by attribute panel (mean scores 3.0 or higher on a 5.0 scale).

The objective evaluation of specific volume (ml/g) revealed that peanut grits could be substituted up to the 10 percent level in all-purpose and whole wheat muffins without significantly ($p<0.05$) affecting the specific volume of the muffins. In both all-purpose and whole wheat muffins, peanut flour could be substituted up to the 30 percent level without significantly ($p<0.05$) affecting the specific volume of muffins. The evaluation of tenderness by shear force (kg/g) indicated that peanut flour could be substituted for either all-purpose or whole wheat flour up to the 30 percent level without significantly ($p< 0.05$) affecting the tenderness of the muffins. Peanut grits could also be substituted for whole wheat flour up to the 30 percent level without significantly ($p<0.05$) affecting the tenderness of the muffins; however, the level of peanut grits in the all-purpose muffins did have some effect on tenderness. All-purpose muffins with 20 and 30 percent levels of peanut grits were significantly ($p<0.05$) more tender than the ten percent level; however, when all four levels of peanut grits were compared (0, 10, 20, and 30 percent), there were no significant differences ($p<0.05$) in tenderness (Tables X and XII).

Recommendations

To promote consumer acceptance of nonconventional protein sources as a nutritive enhancer, the food products must have immediate appeal to the consumer. The acceptability of all-purpose or whole wheat muffins with peanut grits was less than those incorporating peanut flour. It is recommended that peanut grits be used to supplement other kinds

of muffins which have a coarse texture such as cornmeal muffins. Other studies would also need to be conducted to investigate the acceptability of muffins when substituting peanut flour at a higher level in all-purpose and whole wheat muffins.

Other objective tests could be used such as objective measurement of moisture and color, spectrophotometric analysis, viscosity, and adhesion. In accomplishing these tests, it would be possible to determine more completely and objectively the full effects of peanut grits and peanut flour on a baked product. Calculating the protein and amino acid content of the baked products using amino acid tables or conducting protein efficiency ratio (PER) studies will also be beneficial.

Hopefully, the results and recommendations offered in this study can be utilized by food technologists, dietitians, and other individuals in developing other food systems incorporating unconventional sources of protein to improve the populations' protein deficit. In addition, it is hoped that nutrition education materials could be developed to promote further consumer acceptance of unconventional protein sources.

SELECTED BIBLIOGRAPHY

Alabama Agricultural Experiment Station. Development and Use of Defatted Peanut Flours, Meals, and Grits. Auburn University, Auburn, Ala., Bulletin 431, 1972.

American Peanut Research and Education Association, Inc. Peanuts-Culture and Uses. Roanoke, Va.: Stone Printing Co., 1973.

Ayres, J. L., Branscomb, L. L., & Rogers, G. M. Processing of Edible Peanut Flour and Grits. J. Am. Oil Chem. Soc., 1974, 51, 133-136.

Bacigalupo, A., Valle-Riestra, J., Widmer, D. W., & Vara, J. Bread Enrichment with Protal-Peruvian Cottonseed Flour. Cereal Sci. Today, 1967, 12(10), 431-437.

Barr, A. J. & Goodnight, J. H. Statistical Analysis System. North Carolina: North Carolina State University, Dept. of Statistics, 1972.

Beuchat, L. R. Modification of Cookie-Baking Properties of Peanut Flour by Enzymatic and Chemical Hydroloysis. Cereal Chem., 1977 54(3), 405-414.

Bookwalter, G. N., Warner, K., Anderson, R. A., & Bagley, E. G. Cornmeal/Peanut Flour Blends and Their Characteristics. J. of Food Sci., 1978, 43, 1116-1120.

Bowes, A. D. & Church, C. F. Food Values of Portions Commonly Used. Philadelphia & Toronto: J. B. Lippincott Co., 1975.

Butz, E. L. World Protein Markets--A Supplier's View. J. Am. Oil Chem. Soc., 1974, 51, 57A-58A.

Campbell, A. M., Penfield, M. P., & Griswold, R. M. The Experimental Study of Food (2nd ed.). Boston: Houghton Mifflin Co., 1979.

Circle, S. J. & Johnson, D. W. Edible Isolated Soybean Protein. In Altschul, A. M. (Ed.), Processed Plant Protein Foodstuffs. New York: Academic Press, Inc., 1958.

Dendy, D. A. V., Clarke, P. A., & James, A. W. The Use of Blends of Wheat and Nonwheat Flours in Bread Making. Tropical Science, 1970, 12, 131-141.

Diet, Intestinal Flora, and Colon Cancer. Nutr. Rev., 1975, 33(5), 136-137.

Dimler, R. J. Production and Use of Oilseed Proteins. J. Am. Oil Chemists' Soc., 1971, 48, 400-402.

Edmondson, J. E. & Graham, D. M. Animal Protein-Substitutes and Extenders. J. Animal Sci., 1975, 41(2), 698-702.

Faulkner, E. C. & Simpson, J. I. A Comparative Study of Soy Flours for Use in Baking, II. Effect on Quality of Muffins and Cakes. J. Food Res., 1946, 11, 454-459.

Fogg, N. E. & Tinklin, G. L. Influence of Glandless Cottonseed Flour on Quality, Acceptability, and Amino Acid Content of Sugar Cookies. Cereal Sci. Today, Mar., 1972, 70-74; 92.

Food and Agriculture Organization of the United Nations. Amino-Acid Content of Foods and Biological Data on Proteins. FAO: Nutritional Studies, No. 24, 1970.

Johnson, F. R. The Peanut Story. Murfreesboro, N.C.: Johnson Pub. Co., 1964.

Kato, J. & Muramatsu, N. Amino Acid Supplementation of Grain. J. Am. Oil Chemists' Soc., 1971, 48(8), 415-419.

Khan, M. N., Rhee, K. C., Rooney, L. W., & Cater, C. M. Bread Baking Properties of Aqueous Processed Peanut Protein Concentrates. J. of Food Sci., 1975, 40, 580-583.

Kissell, L. T. & Yamazaki, W. T. Protein Enrichment of Cookies with Wheat Gluten and Soy Flour Derivatives. Cereal Chem., 1975, 52, 638-648.

Lusas, E. W. Food Uses of Peanut Protein. J. Am. Oil Chemists' Soc., 1979, 56(3), 425-430.

Matthews, R. H., Sharpe, E. J., & Clark, W. M. The Use of Some Oilseed Flours in Bread. Cereal Chem., 1970, 47(3), 181-189.

McWatters, K. H. Cookie Baking Properties of Defatted Peanut, Soybean, and Field Pea Flours. Cereal Chem., 1978, 55(6), 853-863.

McWilliams, M. Experimental Foods Laboratory Manual. Fullerton, Ca.: Plycon Press, 1977.

Noble, A. C. Instrumental Analysis of the Sensory Properties of Food. Food Tech., December, 1975, 56-60.

Painter, N. S., Almeida, A. Z., & Colebourne, K. W. Unprocessed Bran in Treatment of Diverticular Disease of the Colon. British Medical J., 1972, 2, 137-140.

Paul, P. C. & Palmer, H. H. Food Theory and Applications. New York: John Wiley & Sons, Inc., 1972.

Pominski, J. (Chemical Engineer, Food Products Research, Engineering and Development Laboratory, Southern Regional Research Center, U.S. Department of Agriculture, Science and Education Administration). Personal communication, August 30, 1979.

Pominski, J. (Chemical Engineer, Food Products Research, Engineering and Development Laboratory, Southern Regional Research Center, U.S. Department of Agriculture, Science and Education Administration). Personal communication, April 15, 1980.

Pominski, J., Pearce, H. M., Jr., & Spadaro, J. J. Direct Extraction Process for the Production of a White, Defatted, Food-Grade Bland Peanut Flour, II, Heat and Moisture Treatment. Paper presented at the American Peanut Research and Education Association Meeting, Asheville, N.C., July, 1977.

Pominski, J. & Spadaro, J. J. Peanut Protein Foods. Peanut Journal and Nut World, 1973, 52(11), 29.

Pringle, W., Hulse, J. H., & Williams, A. Mechanically Developed Doughs from Composite Flours. Cereal Sci. Today, Mar., 1969; 114, 116, 118, 120.

Rhee, K. C., Mattil, K. F., & Cater, C. M. Recovers Protein from Peanuts. Food Engineering, May, 1973, 82-86.

Rice, E. E. Nutritive Values of Oilseed Proteins. J. Am. Oil Chemists' Soc., 1970, 47(10), 408-413.

Rooney, L. W., Gustafson, C. B., Clark, S. P., & Cater, C. M. Comparison of the Baking Properties of Several Oilseed Flours. J. Food Sci., 1972, 37, 14-18.

Scala, J. Fiber--the Forgotten Nutrient. Food Tech., Jan., 1974; 34-36.

Sidwell, V. D. & Hammerle, O. A. Changes in Physical and Sensory Characteristics of Doughs and of Bread Containing Various Amounts of Fish Protein Concentrate and Lysine. Cereal Chem., 1970, 47(11), 739-745.

Smith, A. K. Practical Considerations in Commercial Utilization of Oilseeds. J. Am. Oil Chemists' Soc., 1971, 48(1), 38-42.

Snedecor, G. M. & Cochran, W. G. Statistical Methods (6th ed.). Ames, Iowa: The Iowa State University Press, 1973.

Spadaro, J. J. Uses of Defatted and Partially Defatted Peanut Flours. J. Am. Oil Chemists' Soc., 1979, 56, 474-475.

Sproul, M. H. A Comparison of the Nutritive Properties and Acceptability of Baked Goods Enriched with Oilseed Flours. Unpublished M.S. Thesis, California State University, 1975.

Thayer, J. D. Variations to Improve the Acceptability of Muffins Containing Deglanded Cottonseed Flour. Unpublished M.S. Thesis, Louisiana Tech University, 1974.

Tsen, C. C., Bauck, L. J., & Hoover, W. J. Using Surfactants to Improve the Quality of Cookies Made from Hard Wheat Flours. Cereal Chem., 1975a, 52(1), 629-637.

Tsen, C. C., Farrell, E. P., Hoover, W. J., & Crowley, P. R. Extruded Soy Products from Whole and Dehulled Soybeans Cooked at Various Temperatures for Bread and Cookie Fortifications. Cereal Foods World, 1975b, 20(9), 413-418.

Tsen, C. C., Hoover, W. J., & Phillips, D. High Protein Breads. Baker's Digest, 1971, 45(2), 20-26.

Wilson, C. T. The Present and Future Role of Peanuts in Meeting the World's Need for Food. J. Am. Oil Chemists' Soc., 1972, 49(8), 343A-344A.

APPENDIXES

APPENDIX A

SENSORY EVALUATION OF MUFFINS

INSTRUCTIONS TO TASTE PANEL MEMBERS

This study will consist of 16 tasting sessions (2 sessions/day) over an eight-day period. Sensory evaluation will be held at 11:00 a.m. on the following days:

February 5	February 11
February 6	February 12
February 7	February 14
February 8	February 15

Please be present at each session.

Smoking, eating, or drinking spicy foods or beverages, or use of perfume should be avoided one hour before the taste session.

At every session, you will be asked to evaluate four formulations of muffins. Please examine, taste, and score the product carefully using the scales indicated.

The numbers 1-5 should appear in the blanks beside appearance, texture, etc. Please add any other comments you wish to make with the number or on the space provided.

Be sure to complete the entire score card.

Please take a swallow of water to rinse the mouth after tasting each sample.

You are requested not to discuss the samples with the other judges.

After tasting, place the score card on the table.

THANK YOU FOR PARTICIPATING IN THIS STUDY.

SCORECARD FOR SENSORY EVALUATION OF MUFFINS

NAME_____ DATE_____

APPEARANCE				
TEXTURE				
COLOR				
MOUTHFEEL				
FLAVOR				
OVERALL IMPRESSION				

COMMENT:_____

_____

RATING SCALE: 5 Very Good 2 Poor
4 Good 1 Unacceptable
3 Fair

Description of Standard Muffins

Appearance (exterior)
- Straight sides
- Slightly rounded tops, pebbled rather than smooth

Texture (grain)
- Uniform medium texture
- Free from tunnels
- Breaks easily without crumbling

Color
- Exterior--golden brown with slight sheen (uniform brown)
- Interior--creamy white (uniform light brown)

Mouthfeel
- Tender
- Slightly moist

Flavor
- Delicate, slightly sweet and pleasing
- Peak flavor when served hot

Overall Impression
- Overall judgment of the above attributes

APPENDIX B

EXAMPLE OF ONE-DAY RANDOM PLACEMENT OF MUFFINS BY JUDGE AND PEANUT GRITS OR PEANUT FLOUR LEVEL

Day 1

A_0^a

Judge No.	First Taste Session				Judge No.	Second Taste Session			
1		B_0^b			1		B_1^b		
	30	0	10	20[c]		20	30	0	10[c]
2		B_0			2		B_1		
	10	30	0	20		0	30	20	10
3		B_1			3		B_0		
	30	20	10	0		30	10	0	20
4		B_0			4		B_1		
	0	10	20	30		10	30	20	0
5		B_1			5		B_0		
	10	20	30	0		20	0	10	30
6		B_1			6		B_0		
	0	10	30	20		10	0	30	20
7		B_1			7		B_0		
	20	30	10	20		10	20	0	30

[a]A_0 denoted all-purpose muffins. A_1 denoted whole wheat muffins.

[b]B_0 denoted peanut grits. B_1 denoted peanut flour.

[c]Percentage of peanut grits or peanut flour substitution.

VITA

NING-BIN KUO

Candidate for the Degree of

Master of Science

Thesis: EFFECTS OF PEANUT GRITS AND PEANUT FLOUR ON QUALITY OF MUFFINS

Major Field: Food, Nutrition and Institution Administration

Biographical:

Personal Data: Born in Taiwan, Republic of China, May 9, 1951, the daughter of Mr. and Mrs. Dod-yu Kuo.

Education: Graduated from Ching-Mei High School, Taipei, Taiwan, R.O.C. in June, 1969; received Bachelor of Science in Home Economics degree in General Dietetics from Texas A & I University in December, 1978; completed the requirements for Master of Science degree at Oklahoma State University in July, 1980.

Organization: Food Nutrition Association of the Republic of China.