FORTIFICATION OF A PAKISTANI BREAD RECIPE WITH ANIMAL PROTEIN AND CALCIUM AND THE DETERMINATION OF ITS BIOLOGICAL VALUE ON WHITE RATS

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1959

Submitted to the Faculty of the Graduate School of
the Oklahoma State University
in partial fulfillment of the requirements
for the degree of
MASTER OF SCIENCE
May, 1962

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ACKNOWLEDGEMENTS

The author wishes to express grateful acknowledgement to her thesis advisor, Dr. H. F. Barbour for her invaluable guidance, keen interest and generous grants of time during the course of this study.

The Holtzman Company, Wisconsin, had supplied albino rats for the study, their prompt service is gratefully acknowledged.

Thanks are extended to Mrs. E. Schoenleber for her painstaking efforts in preparing this thesis for publication.

Finally, the author wishes to express loving thanks to her husband, Imtiaz, whose constant encouragement and moral support helped her to finish this thesis on time.

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CHAPTER I

INTRODUCTION

The amount, composition, and distribution of a nation's food supplies are the basic determinants of the adequacy of the nutrition of its people.

Although some of the people of Pakistan are healthy, there are other people whose food problems have become the problems of their community.

Much of the malnutrition which exists in Pakistan today is a matter of food availability, preference, and low income problems.

The educated people, who are a minority group, know about fat, protein, carbohydrates, calories, and a few of the minerals. The more expensive vegetables are luxuries for poor people. Staple foods such as rice and sugar are sometimes rationed. How can the mass of people who are undereducated be expected, then, to know the good or bad results of inadequate diet?

It is extremely difficult to change the views, beliefs, and values of a vast number of people in relation to their food habits.

The author's concern is that sound nutrition information shall be presented so that it is not upsetting, therefore it can be fitted into the scheme of teaching. But at the same time to enrich the composition of foods now in use may be possible. This could be achieved by

the introduction of "mixes". These mixes might contain familiar, highly nutritious, raw food materials. Mixes can be made which are of high biological value and which save time and energy. Such mixes might supply most of the food nutrients needed for good health in one simple, familiar food. The use of mixes could be introduced through home economics colleges by demonstration and use in their own institution kitchens, laboratories, and the home management residence.

In this study the author wishes to develop a mix in which non-fat dry milk and soybean flour could be added to whole-wheat flour. This mix can be used for making paratha, chapati or tanduri roti (Pakistani breads).

The addition of non-fat dry milk and soybean flour increases the animal and vegetable protein and calcium content in the diet substantially.

It is known that protein and calcium are necessary for sound body building, and it is also known that these nutrients are low in many Pakistani diets.

It is accepted that:

1. Protein content of the food supply of a majority of Pakistani people is low in amount and poor in quality.
2. Calcium content of the food supply of a majority of Pakistani people is low.
3. It will take a long period of time to change the dietary patterns of people in Pakistan.

In this study the author plans to test the following hypotheses:

1. Milk solids and soybean flour can be added to whole-wheat flour to make a desirable mix for use in Pakistan.
2. Rats fed on a mix made of dry milk solids and soybean flour plus whole wheat flour will attain a better rate and maximum level of growth than when whole-wheat flour alone is fed.
3. The use of dried milk solids and soybean flour to fortify the whole-wheat flour used in Pakistani breads is economically desirable.

It is planned to devise a Pakistani bread recipe in which an acceptable level of dry milk solids and soybean flour are added to whole wheat flour. This recipe will be tested and product evaluated for acceptability by a panel of Pakistani and Indian women and men students at Oklahoma State University. This superior mix will be used in a rat feeding experiment to establish biological value of the mix compared to whole-wheat flour alone.

CHAPTER II

REVIEW OF LITERATURE

When a new type of food is introduced in a different manner to the people of a country, some resistance is usually encountered. This resistance may be based on psychological factors that may stem from lack of sufficient knowledge. Thus, a proposed change in the food habits of a people is likely to create an adverse reaction owing to the element of newness introduced in the issue. It is recognized that a change in food habits does play a vital role in determining the success of a new food product.

If new food materials containing valuable nutrients can be combined with a currently known and well accepted food it appears likely that the resulting product may meet with lessened resistance.

Changing food habits

Fathauer (11) has very simply stated his views about food habits. He said that some relative and superficial aspects of culture change easily, but basic values and beliefs change more slowly--and sometimes with great difficulty. Before attempting to bring about any changes in the food habits of the people one should study the cultural beliefs.

The situation becomes more complex when the values of the people to be influenced are different from those of the teacher. Therefore,

it is important that changes are brought about within the circle of established food habits, and are acceptable for the framework of their value system. Criticism of nutritionally inadequate food may arouse stubbornness which is based on deep-rooted sentiments associated with such foods.

Lewin (24) found during his study that food behavior is determined by the dynamics of the food situation which includes channels through which food comes to the table, the psychological factors, and the ideology of the person who controls the channels.

But Lewin believes that it may be possible to bring about changes in food habits within a relatively short time.

Queen (41) says,

> Dietary habits are the product of generations of cultural assertion. They grow out of folkways of mores of a people, which determine what shall be clean or unclean, what shall and shall not be eaten (p. 1046).

The economical factor is one of many which dominantly molds the cultural pattern. It limits the dietary choices to beans instead of beef. The economics of income is a force which determines the choice of man's preparation of food. Food likes and dislikes are a product of taste, custom, and tradition which are ingrained in people. These may be improved with progress in education. Food habits are not originated but they are perpetuated in the people. Customs and traditions play an important role, and they regularize and preserve the existing dietary patterns of the society.

Gladston (13) expressed the belief that nutrition should be properly directed toward the needs and interests of a particular group which

should be a part of health education. The education should deal with individual goals, for the attainment of which food and diet are important.

According to Eppright (10) the nutritional program must begin with the knowledge of the way people eat, actual habits, and the nutritional status of the people with whom we are concerned. Nutrition must be taught with a socio-economic viewpoint to the public so that they recognize the role of nutrition in the welfare of communities and nations.

Babcock (3) said that the food a man eats is important for his body and spirit. The food attitudes, needs, and uses change according to the person and whether he is less healthy or more healthy. But, also the availability of the individual to offer and to receive communications changes.

Food is often associated with intimacy which carries the feeling of security, protection, love and also develops strength. But that is not all, sense of pain, rejection, deprivation, and the potential terror of starvation are also related to food.

It is desirable to help people to see how much more there is to learn than what one already knows. Use of certain foods, such as dried milk, should not arouse the feeling of inadequacy. All foods should be respected which have biological value in them.

Human beings always learn slowly so one needs to start with them where they are, considering their values. It is good to be prepared for the objections that will arise. Remember, when objections arise it means people are experiencing and trying out things to determine whether it is worthwhile to learn or not. Babcock (3) further said

that food habits are easier to change in early life than those that are already established.

Pilgrim (39) pointed out that attitudes are a product of personal beliefs and also reflect culture. They are the expression of opinion which are important in acceptance of food. Preferences of food may vary with age and education. The desire of eating is also effected by the frequency of the food served. But, culture also sets up some rules for certain foods. People should be familiarized with the food first, which might help in changing their food habits. But possibilities are that people still may not like the food.

Though there may be many factors that change dietary food habits, the length of time is an important factor in influencing food choices according to Whitehead (53).

Venable (51) said that changing the food selection pattern of children is still a great problem. Again, the eating habits may be cultural patterns, family customs, and individual rituals. Every family sets a pattern which influences the taste and eating habits of the individual.

Sometimes the food habits are the psychological or imagined outcome of a child's need. Some dietary habits may also reveal the need for attention and acceptance.

Bryan and Lowenberg (6) indicate that food preference does not depend upon taste or appetite alone, but also upon the influence by the close association of the child with members of his family. Some of the reasons why children dislike foods may be due to the taste, color, texture, appearance, method of preparation, ease in eating,

time required to eat a food, frequency of the food served, association of the food with its source or an event, and difficulty in digesting the food.

Mockmore (32) has beautifully illustrated her ideas about values and the changing world. She thinks that values should be considered an important thing because they do give meaning and direction to the lives of people. Before helping others to change their values it is better to differentiate between the values of other people and find out how lasting they are. Could they be changed or discarded?

Calcium Allowance

One of the most important factors considered in health is diet. To be in an optimum state of health one requires all those nutrients that are essential for life and growth.

The minerals form a small percentage of total body weight. They are sometimes referred to as mineral salts. Calcium is one of the important mineral elements. It is found in the bones, teeth, nails, and less than one per cent is distributed through the fluids and soft tissues of the body.

Calcium in the blood aids clothing processes; in contraction and relaxation of body muscles; aids in control of osmotic pressure and the normal functions of the nervous system.

Thus these two nutrients are very essential for the health of the human body. But unfortunately Pakistani diets lack in protein and calcium. People could lead longer and healthier lives; could show a higher level of attainment; also could have a longer period of prime

of life and a shorter percentage of the years of dependence if their lives had been lived on a higher level of health, according to Sherman (47).

Ohlson (36) says:

> ...it must be recognized that many individuals in our society will remain in excellent nutrition with intakes of 500 milligrams calcium per day and a few with less than this amount. A few will need more than this prescribed allowance (p. 335).

She further said that there is not a definite test for good calcium nutrition, and it is also known that people are different. The calcium allowance in her opinion is but a guide to use in planning food for the population.

According to Harrison (16) Vitamin D increases the efficiency of the body to absorb and utilize calcium for bone formation which is required during the life span. The standards of calcium need in children are based on the maximum retention of the calcium in the body. More efficient absorption of dietary calcium takes place when there is a need for the body to adapt to low-calcium intake. When the calcium intake is increased beyond normal requirement, then the body reduces the percentage of calcium absorption.

According to Van Syckle (50) the calcium level of the food supplies is not only affected by the income level of the family and the type of household, but the habit to use dairy products may also be an important factor.

Protein Requirement and Use

Protein is an essential constituent of all living cells in the

body such as, muscular tissues, hemoglobin, serum proteins and fibrinogen. Proteins are also a part of chemical structures of hormones, enzymes and other body secretions. Thus proteins are essential for maintenance of life and growth. Protein storage in the tissues is determined by a positive nitrogen balance. But negative nitrogen balance occurs when the protein intake is reduced so low that it is less than the amount required for growth and maintenance of body tissues. Proteins and calories should be taken in the diet in sufficient amount to prevent a negative nitrogen balance.

However, the lower the intake of proteins and calories the greater will be the need for including a high quality of protein in the diet if nitrogen balance is to be maintained, according to Leverton, Gram, and Chaloupka (22).

Nitrogen balance is also referred to as a tool by Swanson (49), which can be used to estimate the role played by non-protein calories and to establish the nutritional state of the body. She further says that any animal responds in two ways to a systematic caloric reduction in the diet: it draws on existing reserves to get the energy when food supplies insufficient amounts; and it uses both body and food nitrogen for energy which ultimately results in breakdown of body tissues.

It may be wise to consider two things when defining protein requirements of a man. First, it is important to take an account of the quality and quantity, secondly, there should be some standards by which one may judge the adequacy of a given intake.

Because proteins are composed of amino acids it would be more

simple if each amino acid requirement was determined for individual needs. This was the task that occupied Rose (43) for many years. In the long series of experiments the requirement of man was determined for each of the essential amino acids, and also for the total nitrogen. The least amount of total nitrogen needed to maintain positive balance was 3.5 grams per day.

Present nutrition studies have demonstrated that all animal species under all conditions require a continuous dietary supply of eight essential amino acids.

A table of essential amino acid requirements for young adults are those determined by Rose (44, p.642, 645) presented on the following page.

In 1946 it was reported that tryptophan could be converted to niacin by man. Perzweig et al. (38) found that it was possible to make a niacin-tryptophan content of the diet in terms of niacin equivalents. Later Horwitt (19) found 60 milligrams of tryptophan to be equivalent to one gram of niacin. It is suggested that 4.4 milligrams of niacin per 1000 calories be considered as a basic allotment, to which a 50 per cent safety factor may be added.

The standard allowances of protein recommended by the Food and Nutrition Board of National Research Council are (35, p. 18) presented on a following page.

Supplementation and Fortification of Foods

As it is known, pulses and cereals are the cheapest source of vegetable proteins. Haripada and Banerjee (15) during their study

The Daily Amino Acid Requirements of Young Adults

E.A.A.	Men Mg/day	Women Mg/day
Lysine	400 - 800	400 - 500
Threonine	300 - 500	103 - 305
Tryptophan	150 - 250	82 - 157
Valine	400 - 800	465 - 650
Isoleucine	650 - 700	250 - 450
Leucine	500 - 1100	170 - 620

Men, Mg/day

Phenylalanine:

In absence of tyrosine per day 800 - 1100

Methionine, Mg/day

In the absence of cystine 800 - 1100

Women, Mg/day

Phenylalanine:

In presence of 900 milligrams tysosine per day 120 - 220

Methionine:

In presence of 200 milligrams cystine per day 105 - 350

Protein Allowances

	Age Years	Weight lbs.	Height in.	Protein Gm.
Men	25 to 65	154	69	70
Women	25 to 65	128	64	58
Pregnant		second half		+20
Lactating				+40
Children	1 to 3	27	34	40
	4 to 6	40	43	50
	7 to 9	60	51	60
	10 to 12	79	57	70
Boys	13 to 15	108	64	85
	16 to 19	139	69	100
Girls	13 to 15	108	63	80
	16 to 19	120	64	75

on Indian pulses found that pulses are a rich source of choline, whereas cereals are poor in their choline content. During germination of pulses a significant increase in choline content was observed. Also a good amount of tocopherol is found in cereal and pulses. The tocopherol content increased in cereals and pulses during germination.

It is interesting to learn that the biological value of whole-wheat protein is higher than that of whole-wheat flour. Wheat also contains approximately one microgram per gram of riboflavin. Soft wheats have a slightly lower value, according to Hegsted, Trulson, and Stare (17).

Soil and climate have little influence on amino acid content of wheat McElroy et al. (26) states.

The task of filling the gap between the protein supplies and the protein needs must be tackled in many different ways. Much work has been done and is being done by the Food and Agricultural Organization of the United Nations. Rose (52) states:

> The only logical way to select the best product for supplementary feeding is to accumulate information on the distribution of amino acids in the diets actually consumed....We must know eventually what it is that people experiencing deficiencies fail to get, before we know what to do for them (p. 175).

Also Scrimshaw (52) pointed out that:

> ...any protein-rich food that is developed, either locally or industrially, must fulfill other criteria besides being biologically effective: it must be safe, cheap, easy to store and above all acceptable (p. 175).

In many cases foodstuffs have been tested as the sole source of proteins such as soya bean, ground nut, sunflower seed, cottonseed and

coconut. Soybean has been by far the most studied and, in fact leads the list among the vegetable proteins. It has also been used extensively and successfully in the animal feeding experiments. Somehow, soybean presents some problems as food for man. It is not easy to prepare in an acceptable form, and for this reason attempts to introduce it as a supplementary source of proteins have, in some cases, been a failure. Plat (52) had pointed out that the methods of preparation which were developed by the Chinese have centuries of tradition behind them, and therefore they cannot be introduced overnight into a new environment (p. 176).

The protein content in soybean has also been found to be capable of producing a desirable effect in mixtures of two or more of the grain products according to Sure (48). Though it is not an excellent source alone, the resulting combinations have improved biological values.

The animals which were receiving the animal-protein mixtures as their protein source grew at the same rate with those receiving the casein and vegetable-protein mixture, according to Prier and Derse (40). However, the protein efficiency of the animal protein was reduced when flour was included, but the addition of B_{12} increased the growth. These results showed that casein and vegetable-mix proteins were superior in their behavior. It was also found that the protein efficiency of the wheat bread protein was almost doubled when 20 per cent of the vegetable protein was added irrespective of the presence of Vitamin B_{12}.

In countries where there is shortage of milk, expensive animal

products, and lack of high quality inexpensive protein, deficiency may be combated with the introduction of fish flour, which would increase protein adequacy. Odorless, defatted, stable fish flour of high biologic quality has been developed from fish according to Levin and Finn (23).

Besides improving the protein of the diet it also increases the mineral content, especially of the rice diet. If fish flour can be supplemented at the 3 per cent level, it would increase the calcium content of Indian diets by 459 milligrams (assuming that a person eats 20 ounces per day). Metta (27) also found that 61 per cent of the child and adult calcium requirement could be added to a poor rice diet by use of fish flour.

A consumer acceptance test showed that a panel of 26 Indian students were not able to detect the addition of 3 per cent of fish flour.

Kik (21) has found that proteins of perch had supplementary value for milled rice. Perch had a higher content of riboflavin and niacin, free pantothenic acid, biotin, folic acid, inositol and para-aminobenzoic acid than whole rice and was also higher in calcium, phosphorous and some iron. Non-fat dry skimmed milk solids are being more and more incorporated into breads. Jack and Vesta (20) found that non-fat dry skimmed milk solids can be incorporated into the breads at 0, 6, 10, and 14 per cent based on flour as 100 per cent. A consumption of 104.4, 107.5, and 112.6 per cent for 6, 10, and 14 per cent milk solids breads using 100 per cent for the consumption of control bread, showed that people preferred the higher percentage of milk solids.

Riggs, Beaty, and Johnson (42) found that when the addition of

6 per cent of non-fat dry skimmed milk solids were added to enriched wheat flour, the results were slightly better than when milk solids were added to whole-wheat flour.

Bechtel and Meisner (4) used a sensory test to judge the freshness of wheat bread in relation to compressibility, crumbliness, and swelling power at 24 hour intervals for six days. They found that as the proportion of gluten to starch was increased bread staled less rapidly, and staleness increased after the third day.

It was indicated by Rosenberg and Rodenburg (45) that white flour is very low in lysine. Upon baking, an average of 15 per cent of lysine was destroyed, and upon toasting, 5 to 10 per cent more of lysine content was lost. There were also some losses during storage at room temperature.

Recent studies by Dekkar (8) concluded that the amount of thiamine that was lost from 0 to 60 per cent in bread making was dependent upon yeast used. Thiamine was converted to a compound which could be converted to thiochrome. This compound was decomposed and untraceable during baking.

The National Research Council (34) found that variations in the type of baking powder, fat, mineral mixture or water did not alter the concentration of lysine. The addition of certain amounts of sugar increased the destruction of lysine, unless the baking time was reduced. The lysine content was doubled by mixing with milk.

Hegsted, Trulson, and Stare (17) express their views that:

> ...particularly in those countries where the total food supply is limited, the enrichment of certain foods offer a method of increasing the consumption of nutrients which

> are not available and will not be available in the form of natural foods for a long time to come. In overall economy of the country, enrichment deserves consideration as an alternative to changes in agricultural production.... The authors in common with others who favor the improvement of the diet by changing the food habits rather than enrichment, fail to indicate a practical scheme for achieving this....It appears therefore, that the enrichment program rests upon a sound logical basis (p. 246).

Mauron et al. (25) studied the availability of lysine, methionine, and tryptophan in condensed milk and milk powder. They found that no destruction of tryptophan, tyrosine, and methionine occurred in any milk. A 6 per cent destruction of α-amino groups was noted in slightly scorched roller-powdered milk (B). There was no destruction of lysine in boiled milk, but 3 per cent destruction took place in spray-dried milk. Roller-dried milk (A) had 13 per cent lysine and in roller-powdered milk (B) there was 26.6 per cent.

No inactivation of tryptophan and tyrosine was found in any milk. Methionine was slightly inactivated in roller-dried milk only. Lysine was inactivated in roller-dried milk (A), of a 20 per cent level and in roller-powdered milk (B) at a 45.8 per cent level.

Deshpande, Harper, and Elvehjem (9) found that growth rate in rats was increased from 3 to 21 grams per week when 78 per cent of white flour was supplemented with 0.5 per cent of L-lysine and 0.4 per cent of DL-threonine. Further growth occurred when seven more amino acids were added.

They also found lysine was limiting for growth. Liver fat did not accumulate when the diet contained 78 per cent of white flour. However, when flour was fed at a 5.4 per cent protein level, fatty infiltration occurred, which was prevented by lysine supplement.

Maximum growth was achieved when protein was a part of supplements. But growth was not rapid when the intact protein was replaced with equivalent quantities of essential and non-essential amino acids.

According to the studies made by Hegsted, Trulson, and Stare (17) the biological value of whole-wheat protein is higher than that of white flour. The total amount of protein available for the body was increased by the use of whole-wheat flour, but the energy gained by the whole-wheat flour is largely lost by less efficient digestion.

Mitchell (29) gave values of 61 to 52 per cent as the total utilization of whole-wheat and white flour respectively. He also found that wheat like all other cereal grains, lacks in lysine.

It is also known that the utilization of dietary protein increases as the lysine and tryptophan content approaches that of the muscle tissue. Albanese et al. (1) reported that when lysine was used to supplement wheat gluten its nutritive value increased to that of milk proteins.

Improved nutrition in terms of a change in infant bodyweight occurred when L/T ratios of 6.0 to 7.0 were maintained by lysine additions to the diets which provided a minimum of 100 calories and 3.5 grams of protein per kilogram per day.

According to Schroeder, Jacobellis, and Smith (46, p. 560),

> Commercial processing as used in the preparation of evaporated milk and milk powder does not decrease the nutritive value of the protein constituents....It was always found that digestibility and biological value of milk protein do not change if milk is kept in frozen storage for 5 months.

The efficiency of the protein of preheated skim milk powder was compared with that of a powdered milk which was not preheated. The

results showed that the efficiency of the protein of the preheated milk was decreased in proportion to the degree and time of heating.

The protein efficiency of the preheated skimmed milk powder when compared with a powder which was not preheated, was reduced to 13 to 15 per cent at a temperature of 63°C. for 30 minutes, as described by Cook et al. (7).

Hodson and Miller (18) tested the efficiency of pasteurized milk proteins and non-fat dry milk proteins which were stored for one to two years under favorable conditions. They found that protein efficiency in both the cases was similar when used for rat growth. Also lysine content of both the milks stored under proper conditions were similar.

Pearce et al. (37) have worked with the storage life of a dehydrated mixture of eggs and milk in comparison with that of milk with similar protein, fat and carbohydrate content. They found the storage life of the dehydrated mixture of milk and egg was shorter than the other mixture. They further found that when there was an increase in egg content, the shorter was the storage period required, particularly above the temperature of 80°F. They based the information on assays of palatibility and storage.

Nath, Singh, and Nath (33) have found that there is a decrease in soluble polysaccharide content in chapatis, irrespective of the storage conditions and packing methods during aging. There was a complete decrease of the soluble polysaccharide in a chapati within 24 hours. All these changes that took place in chapati are same as in bread. When the wheat flour was stored for a long time there was a decreased

concentration of maltose and increased concentration of glucose.

Tasting Panel

Panels have been used in many experimental procedures which deal with a certain product or a special flavor problem. According to Girardot, Peryam, and Shapiro (12):

> The panel member is usually required to deal analytically with a complex situation. Hence simple factors such as sensitivity to the four basic tastes or various odors will only partially determine a person's value as a panel member. His level of performance in complex test situations will depend also on other factors, including rate of adaptation and recovery, memory for flavor properties, adjustment to the test situation, skill in handling flavor perceptions and, finally, the degree of his interest and motivation (p. 140).

The authors also suggest that the larger the group of participants the better will be the possibility of finding people of superior ability. If people are not qualified, they may be rejected.

It is also recommended that test materials or products should be the same that would be used later.

A proper environment is important for taste testing, according to Mitchell (31). It should be air-conditioned and distraction-free so that the members may be able to concentrate fully.

In selection of panel members certain procedures were used by some authors. Girardot, Peryam, and Shapiro (12) state that:

> The procedure which has been evolved has provided efficient panels and is workable from the standpoint of time and effort involved. It involves two stages: first, testing of ability to make simple discriminations of differences between samples; second, testing of ability to reproduce qualitative judgment (p. 140).

This author also stated that many panel members do poorly because they are not motivated.

Animal Feeding

Mitchell, Hamilton, and Shields (30) wanted to find out the contribution of non-fat skimmed milk solids to the nutritive value of whole-wheat breads. They used albino rats weighing 40 to 45 grams for the experimental feeding. This experimental feeding was planned for 12 weeks or, until one of their trios had gained 100 grams or more in body weight.

The daily requirements of the rat have also been known. Following is the summary of known requirements as given in Griffith and Farris (14, p. 97).

Dietary Requirements of Rats

Nutrient	Amount
Protein	25 - 30%
Calcium mg.	40 - 50
Fat mg.	25 of methyl linoleate
Fiber	-------
Vitamin A	15 - 20 microgram of carotene per kilo of body weight
Vitamin D	Not required if Ca:P ratio is between 1:1, 2:1
Thiamine	1 microgram per gram of food or 10 microgram per day
Riboflavin	40 microgram per day
Iron mg.	0.25
NaCl	Sodium = 0.5% Chlorine = 5 mg.

Rats have been used for many experimental works because results could

be determined more easily as the age of a man is thirty times that of a rat.

> On the assumption that dating from birth the life span of the albino rat is three years, ...then such a rat may be regarded as corresponding to a man of ninety years (14, p. 17).

CHAPTER III

METHOD OF PROCEDURE

In Pakistan whole wheat flour is used for bread making. When the author was formulating a recipe for the desired bread mix she used American all-purpose white flour for the preliminary experimental work.

In the basic recipe for chapatis and paratha[1] the following proportions were used:

223 grams all-purpose white flour

1/2 teaspoon salt

3/4 cup of water

This was a sufficient amount to handle easily. The dough from this recipe yielded six, seven and one-half to eight inch chapatis.

When bread was cooked it was tough and rubbery and heavy in texture. It appeared that American all-purpose white flour was very rich in gluten content.

Skimmed milk solids were substituted at 15 per cent, 12 per cent, 10 per cent, 8 per cent and 6 per cent of the flour in the basic recipe to enrich its nutritive value.

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[1]Chapatis and parathas are Pakistani breads. They are alike except that clarified butter, called ghee, is spread on the thinly rolled dough for paratha.

At a 12 per cent level dough was sticky and difficult to handle and bread was not tender.

At a 10 per cent level though, the dough was not as sticky as the above levels, but the bread was not a satisfactory product. The product was still tough, heavy and less desirable when 6 per cent dry skimmed milk solids were added.

The final product which was most acceptable and tender was found to have an 8 per cent level of dry skimmed milk solids with all-purpose white flour. Then the author tried to incorporate a variety of ingredients into the basic recipe to change and improve the texture of the chapatis, and to further increase their nutritional value.

To the same all-purpose white flour basic recipe, one teaspoon of double-acting baking powder was added. Chapatis did not puff, but they were tender. Parathas were puffy, soft and golden brown in color. For the final taste panel no baking powder was added to the bread because it is not a common practice in Pakistan.

The basic all-purpose white flour recipe with 8 per cent of dry skimmed milk solids, plus double-acting baking powder produced better results than the basic recipe without baking powder and dry skimmed milk solids. In both the cases, parathas were better than chapatis.

The effect of storage and staling were also observed for the basic recipe, 8 per cent dry skimmed milk solids enriched recipe, and basic recipe with baking powder included. Breads were stored at room temperature, wrapped in cloth for three days. The breads with dry skimmed milk solids retained more moisture than the basic recipe

with and without baking powder.

After determining the desirable ratio of dry skimmed milk solids to be 8 per cent of the flour in the basic recipe, the next step was to reduce the gluten content of the flour. To do this, it was decided to try whole-wheat pastry flour for chapatis and parathas.

For the basic recipe using the whole-wheat pastry flour the following proportions were used:

223 grams whole-wheat pastry flour

1/2 teaspoon salt

3/4 cup of water

In these basic proportions 8 per cent of dry skimmed milk solids, plus medium-fat soybean flour at 10, 15, and 20 per cent levels were substituted for part of the pastry flour.

At the 10 per cent level of soybean flour the dough was heavy, compact, but tender. Flavor was good.

At 15 per cent level of soybean flour the flavor of the bread was good. Color was more yellow. The product was tender and puffed well. Bread browned evenly, and paratha was flaky when puffed with steam.

When 20 per cent of soybean flour was added the dough was very compact, heavier, flavor changed and bread was very yellow. The bread was also heavier in texture when cooked.

The final proportion of soybean flour was found to be most acceptable at a 15 per cent level.

The all-purpose white flour basic recipe with 8 per cent replaced by dry skimmed milk solids and 15 per cent replaced by

medium-fat soybean flour were substituted for whole-wheat pastry flour. The kind of flour used was the only variable. The product consisting of whole-wheat pastry flour, 8 per cent skimmed milk solids plus 15 per cent of soybean flour was better than that in which all-purpose white flour was used. The chapatis puffed and were light in texture and color. The parathas were heavier and translucent. They were compact, but good in flavor and color, and were tender.

The author further tried to increase the nutritive value of the basic whole-wheat pastry flour recipe. This time 10 per cent of dry skimmed milk solids were used instead of 8 per cent. The proportions were as follows:

336 grams whole-wheat pastry flour

66 grams of medium-fat soybean flour

44 grams dry skimmed milk solids

1 teaspoon salt

1 1/2 cups of water

The bread prepared from this dough was tender, good in flavor and texture was good.

It was then decided to present the products from Basic Recipe A unenriched consisting of:

446 grams whole-wheat pastry flour

1 teaspoon salt

1 1/2 cups of water

and Basic Recipe B enriched consisting of:

336 grams whole wheat-pastry flour

66 grams medium-fat soybean flour

44 grams dry skimmed milk solids

1 teaspoon salt

1 1/2 cups of water

to a panel of Pakistani and Indian students to test the difference between the color, flavor, texture, and acceptability of the products.

Taste Panel Evaluation

A preliminary tasting panel was called to judge the ability of panel members, and to find out whether they were able to reproduce qualitative judgments.

The initial group for the tasting panel consisted of a total number of 30 panel members. These were students from Pakistan and India, attending Oklahoma State University. There were 11 women and 19 men students on the panel.

Letters were sent to the panel members in which they were requested to indicate days of the week and hours of the day when it would be possible for them to attend the panel.

Out of 30 members only 15 were consistently present, and only 11 members were selected because of their lack of sensitivity to the flavor involved. Two pairs of coded samples were presented to the observers. Each pair consisted of chapatis and parathas from two different basic recipes, Basic Recipe A and Basic Recipe B.

The panel members were requested to indicate the difference in

color, flavor, texture and acceptability of the products from the two basic recipes. The same number of samples were served to panel members each time and the product was repeated on three different occasions.

The days and hours selected by the panel members to evaluate the products were Monday and Friday at:

11:00 - 12:00	Noon
2:00 - 3:00	p.m.
3:00 - 4:00	p.m.

The breads were prepared in the morning of the day they were evaluated. Samples were placed on white paper plates and covered with cellophane paper. Only water was served for drinking.

The panel members came on their selected hours and evaluated the bread in the presence of the author. The members who came to taste in the morning found the bread samples warm, and those who came later in the afternoon found the bread at room temperature.

The panel members were requested to do no talking during their tasting sessions.

Each panel member was required to take one plate, which consisted of four samples -- A and AA, D and DD. All single letters were used to denote chapatis. The double letters were used to differentiate parathas.

The addition of 15 per cent of medium-fat soybean flour gave a medium yellow color to the bread. In some cases it was very much appreciated, and in some cases it was less acceptable.

Method of Cooking Breads

The ingredients were carefully weighed and measured. Each bread dough stood for 25 minutes at room temperature (approximately 75°F. - 80°F.) before it was cooked. After 25 minutes, the dough was kneaded and rolled out into breads. Then the breads were cooked on a cast iron skillet over a gas range. Clarified butter fat (ghee) was used to cook parathas. The diameter of each bread was seven and one-half to eight inches, and one bread supplied four samples.

Animal Feeding

Weanling Albino male rats weighing 44 to 50 grams were used. Fifteen rats were divided into three groups. Each rat was confined to an individual wire mesh cage with removable bottom trays. Paper was changed in the trays daily and cages were scrubbed weekly with a strong detergent and water solution. The temperature of the room was maintained at 80°F. throughout the length of the experiment. The animal room was cleaned every day.

Group I, the control group, received an adequate diet. This diet provided the required nutrients per 10 grams of feed given to the rat. The standard amount of these nutrients was taken from Griffith and Farris (14, p. 97).

Nutrients Provided by Ten Grams of Feed

Gm. Protein	Gm. Fat	Gm. Fiber	Mg. Calcium	I.U. Vit. A	Mg. Thiamine	Mg. Riboflavin	Mg. Niacin	Mg. Iron	NaCl gm.	Mg. Phosphorus
2.58	.45	.05	63.01	3.32	.04	.10	.23	.31	.11	53

Group II animals received a diet composed entirely of Basic Recipe A, whole wheat-pastry flour and salt.

Group III animals received as their sole source of food Basic Recipe B, composed of whole-wheat pastry flour, medium-fat soybean flour and dry skimmed milk solids. The food was weighed out to the rats daily. On weekends a double amount of food was given. An unlimited amount of distilled water in glass drinking tubes was provided to the rats. All the rats were fed ad libitum. Small crockery feeding cups were used for the food mixtures for all three groups.

All the rats were weighed in the beginning of the experiment and each succeeding Tuesday and Friday.

Rats in all three groups were marked in the following manner.

Rat No. one had no notch on the ears.

Rat No. two had one notch on right ear.

Rat No. three had one notch on left ear.

Rat No. four had two notches on right ear.

Rat No. five had two notches on left ear.

This method of marking was used to distinquish rats from each other within a group.

It is believed that a period of time sufficient to allow the control animals to gain 100 grams of body weight is long enough to establish the biological value of the feed eaten (30).

CHAPTER IV

RESULTS AND DISCUSSION

When the desired bread mixes were formulated, the products were presented to a panel of eleven Pakistani and Indian students. The average scores for eleven panel members for three taste panels in relation to color, flavor, texture and acceptability are presented in Table 1.

The averages of color, flavor, and texture were compared with the acceptability score to find out the total acceptance of the panel members for the product presented.

The average total score for enriched paratha (FF), in respect to flavor, texture and acceptability in the third taste panel, were beneath the average total score for unenriched paratha (CC). The average score for color, flavor, and texture combined were identical. However, the average total scores for all three taste panels for chapati and paratha revealed a superior score for enriched products.

See Tables A, B, and C in the Appendix detailed scores.

Table 1. -- The Average Scores of Eleven Panel Members

Product	Color	Flavor	Texture	Average of color, flavor and texture	Acceptability	Average Total Score
Basic Recipe A						
A	2.54	2.63	2.09	2.42	2.72	2.57
B	2.81	2.63	2.27	2.57	2.72	2.64
C	2.72	2.72	2.63	2.69	2.72	2.70
Average						2.63
Basic Recipe B						
D	2.72	2.63	2.63	2.66	2.63	2.64
E	2.54	2.81	2.72	2.69	2.90	2.79
F	2.90	2.63	2.90	2.81	2.81	2.81
Average						2.74
Basic Recipe A						
AA	3.18	3.27	2.81	3.08	3.09	3.08
BB	3.18	2.90	3.27	3.11	3.18	3.14
CC	3.18	3.27	3.45	3.30	3.36	3.33
Average						3.18
Basic Recipe B						
DD	3.54	3.45	3.45	3.48	3.45	3.46
EE	3.27	3.27	3.45	3.33	3.45	3.39
FF	3.54	3.09	3.27	3.30	3.27	3.28
Average						3.37

The panel members preferred the chapatis which were uniform on all sides and evenly browned. Puffiness in the breads was much appreciated. In the case of parathas the scores ran very high. Most of the members liked the golden brown color of the unenriched bread made from Basic Recipe A. There were others who preferred the yellow-brown color of the enriched bread made from Basic Recipe B.

Although the results were encouraging, the author wishes to

mention a few limitations and difficulties she had to face. All the taste panel members were students. These students were not familiar with a definite standard product. They judged the breads to be evaluated in comparison with the breads the individual had eaten in their homes. So, the results revealed many similarities and differences in their judgment.

When favorable results were obtained from the taste panel the experimental procedures were continued further. Basic Recipes A and B were fed to white rats and their growth was compared with the animals in a control group. The Control Group I was fed all the nutrients known to be needed for growth by the white rat (14, p. 97). Group II was fed unenriched Basic Recipe A and Group III was fed enriched Basic Recipe B.

Food intake and weight gain of all the rats in Groups I, II and III are presented in Tables D, E, and F in the Appendix.

The average weekly food intake and weight gain of the five rats in each of the three groups are presented in Table 2.

It is obvious that the degree of attainment of growth was best in the Control Group I, next to the best was the Group III which was on enriched Basic Recipe B. The slowest growth rate was observed in the animals receiving unenriched Basic Recipe A. See Plate 1 on the following page. At the end of the experimental procedure one rat in each group was anesthetized and its body examined internally.

The animal in the Control Group I had deposits of fat throughout the abdominal cavity. All the organ tissues appeared normal. Reproductive organs were also normal. The heart and kidney had layers of

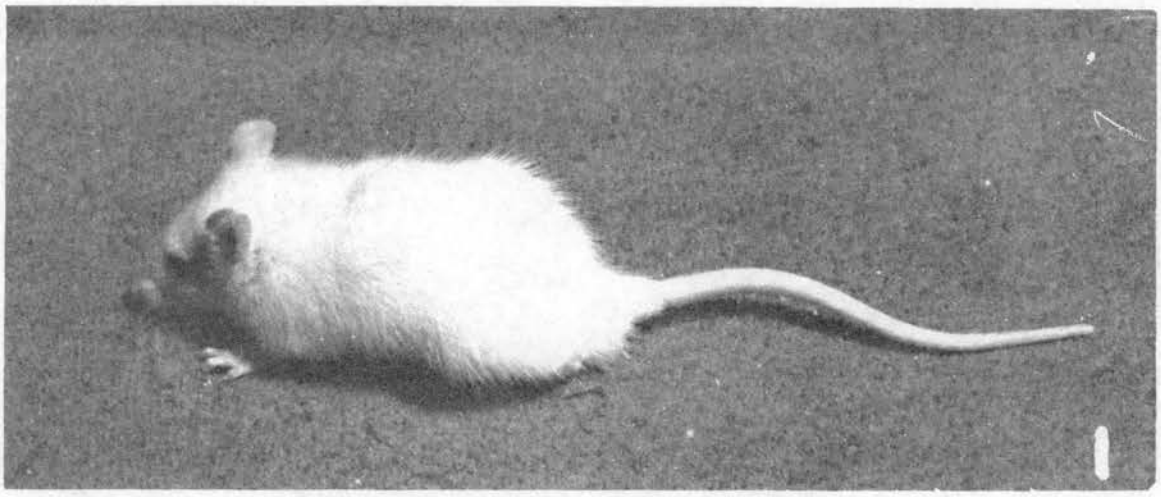
1. Rat from Group II (unenriched)

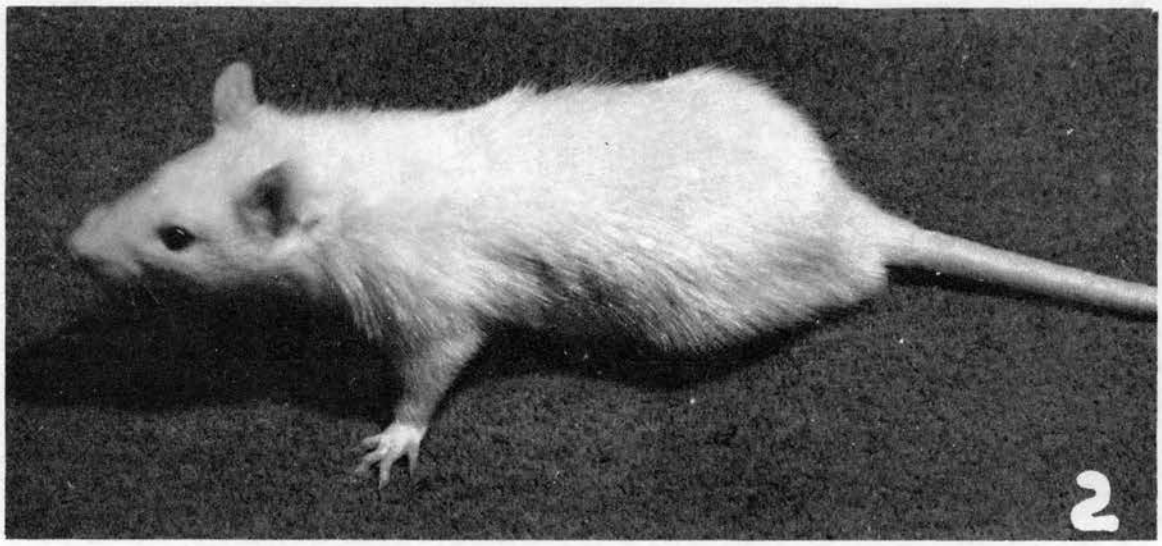
2. Rat from Group III (enriched)

3. Rat from Group I (Control)

PLATE I

Photographs of rats of same age from Groups I, II and III





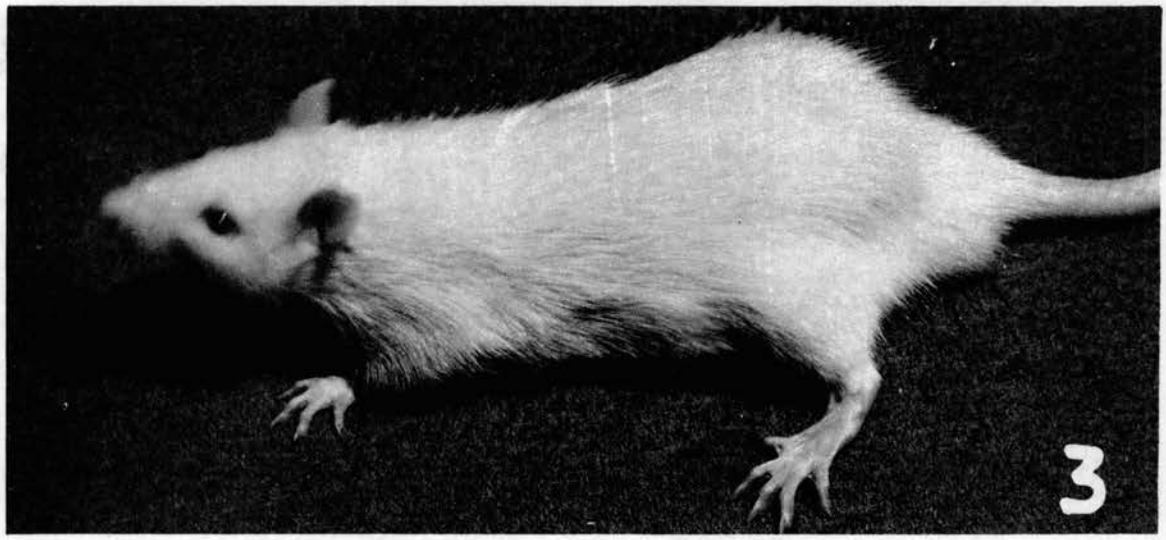


Table 2. -- Average Weekly Food Intake and Weight of Rats in Groups I, II and III

Week	Weekly Average	Control Group I Grams	Unenriched Group II Grams	Enriched Group III Grams
1st Week	Food Intake	7.3	7.6	9.2
	Weight	54.5	48.8	55.6
2nd Week	Food Intake	10.4	6.8	8.3
	Weight	88.1	50.6	74.9
3rd Week	Food Intake	12.8	5.6	8.8
	Weight	125.4	57.3	82.5
4th Week	Food Intake	15.6	5.9	9.3
	Weight	158.4	57.3	101.4
5th Week	Food Intake	17.8	6.0	8.8
	Weight	190.6	60.0	108.7
	Terminal Weight	210.4	64.6	112.6

fat. This group was very well nourished. The coat was smooth and glossy. The feet, tail and nose were pink in color, but eyes were brighter pink. This animal was 14 3/4 inches long and 1 1/8 inches across the ribcase.

The rat in Group II (unenriched) was very small. This animal had a dull coat and was stunted. The ribcase area was crowded and measured three-fourths inch across the chest. The length of this animal was 9 1/2 inches.

The rat in Group III (enriched) had no fat around the heart and kidney, but there was a considerable distribution of fat in the abdominal cavity. All organs appeared normal and the sperm sac was filled with sperm. The coat was smooth and eyes, tail and nose were pink. The length of this animal was 12 inches long and 1 inch across the ribcase.

The nutrient value of Recipe A and B is presented in Table 3. It will be noted that the grams of protein in enriched recipe is almost doubled that of the unenriched recipe. The quality of protein has been improved with the addition of animal protein. The calcium in the enriched recipe is somewhat more than three times that of the unenriched recipe. It is also evident that the B vitamins have been substantially increased in the enriched recipe.

In Table 4, the distribution of essential amino acids are presented in four foods considered for inclusion in Pakistani bread recipes. It can be seen that essential amino acids of dry skimmed milk solids, and soybean flour supplement the amino acids of the whole-wheat flour in a very desirable way.

Table 3. -- Nutrient Value of Basic Recipes A and B[2]

Basic Recipe A (Unenriched) Constituents	Wt. in Gms.	%	Gms. Pro-tein	Gms. Fat	Gms. Fiber	Mg. Ca	I.U. Vit. A	I.U. Vit. D	Mg. Thia-mine	Mg. Ribo-flavin	Mg. Niacin	Mg. Iron	Mg. Phos-phorous
W.Wheat pastry[3] flour	446	99	39.	3.77		69.9	577.		.36	.08		4.46	4.50
Salt	5	1											
Water 1½ C.													
Yield:													
8 Chapatis	451	100	39.	3.77		69.9	577.		.36	.08		4.46	4.50
Basic Recipe B (Enriched)													
W.wheat pastry flour	336	74.6	27.9	2.7		50.4	435.		.26	.15		3.36	339.3
Soybean flour (med. fat)	66	14.6	28.05	4.29	1.72	161.0	72.6		.54	.22	1.72	8.58	402.6
Dry skim milk solids	44	9.7	15.6	.44			18.		1.5	.86	.48	.26	453.2
Salt	5	1.1											
Water 1½ C.													
	451	100	71.55	7.43	1.72	211.4	525.6		2.30	1.23	2.20	12.20	1195.1

[2]Composition of Foods. Raw,Processed and Prepared. U. S. Department of Agriculture Handbook No. 8, 1950.

[3]Bradley, A. V.: Tables of Food Values. Rev. ed. Peoria, Illinois. Chas. A. Bennett Co., Inc. p. 68, 1956.

Table 4. -- Essential Amino Acid Distribution in Foods Considered
Value of Foods in 100 Grams, Edible Portion[4]

Foods	Tryptophan Grams	Threonine Grams	Isolencine Grams	Leucine Grams	Lysine Grams	Methionine Grams	Phenylene Grams	Valine Grams
Dried Skimmed Milk Solid	.502	1.641	2.271	3.493	2.768	.870	1.251	1.774
Whole-wheat Flour	.164	.383	.577	.892	.365	.203	.657	.616
Soya bean flour (medium fat)	.640	1.831	2.501	3.588	2.940	.625	2.300	2.441

[4]Amino Acid Content of Foods, Home Economics Research Report No. 4. United States Department of Agriculture 1957.

The results of the rat feeding experiment helps one to see that increased intake of animal and vegetable protein, along with calcium, permits a much improved rate of growth over a diet composed of whole-wheat flour and salt alone.

If the human being responds as the rat has done, there is evidence that the use of enriched Basic Recipe B for bread making in Pakistan could greatly improve the health and well being of people who eat large quantities of bread.

If health and well-being are dependent upon the availability of foods in a country, the introduction of an enriched bread package mix which increased substantially the protein and calcium of the diet can be of great value. It is very important to realize that a nation can better survive when its people are healthy and strong. When the body is fed with all the nutrient it requires for normal growth and well being, then only, healthy minds can be a source of valuable contributions to the nation.

Though the whole-wheat pastry flour was used for the experimental study in the United States, there is no reason why atta[5] cannot be substituted in Pakistan. Because whole-wheat bread flour in the United States, made of hard wheat, is high in gluten content it was not used in the breads in this study. To reduce the gluten of the flour a whole-wheat pastry flour made of soft wheat which is low in gluten content was selected. This pastry flour closely approximates the atta used in Pakistan in making chapaties and parathas. Soybean flour is a

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[5]Atta is whole-wheat flour made from many varieties of wheat milled together.

very rich source of vegetable protein but its use is not common in Pakistan. Gram[6] is another vegetable protein which can be substituted for soybean flour.

It was not possible to obtain atta and gram flour from Pakistan because of shipping regulations.

It is known that dried skimmed milk solids are being prepared from the buffalo milk in India but this product is not easily available yet. Locally produced food products should be brought into use to improve the standards of health and living in Pakistan.

When the bread mix was prepared in the United States the cost of a two-pound package mix was as follows:

Foods	Amount in grams	Cost
Whole-wheat pastry flour	681	.340
Soybean flour (med. fat)	136.2	.123
Dry skimmed milk solids	90.8	.091
Total Cost		.554

This package mix appears to be expensive. However, whole-wheat pastry flour is more expensive in the United States than atta is in Pakistan as it is seldom used. If atta is substituted for whole-wheat pastry flour this mix will be economically feasible for many people.

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[6]Gram is a legume grown in Pakistan and made into a flour.

CHAPTER V

SUMMARY AND CONCLUSION

This study was carried out with a purpose of improving the nutritive value of Pakistani breads. It was desired to develop a mix that would increase the protein of high biological value and the calcium. Since bread is eaten all over Pakistan as a main food, this was a simple way of improving the nutritional level of the people of Pakistan without altering their food habits.

The addition of dry skimmed milk solids and medium fat soybean flour to the whole-wheat flour accomplished the development of a Pakistani bread mix with much increased quality of protein and quantity of protein and calcium.

During the experimental part of the study whole-wheat flour, all-purpose white flour, and whole-wheat pastry flour were used. Whole-wheat pastry flour low in gluten content was closely related to whole-wheat flour in Pakistan. The dough made of the pastry flour was easy to handle. Baking powder was also added to determine its effect upon the texture of the bread. The bread, when cooked, was tender and good. Since the use of baking powder is not a common practice in Pakistan it was not included in the final bread mix.

Dried eggs are a good source of animal protein, but the storage life requires certain environmental conditions which may create

problems in storing the mix in Pakistan.

The final product which was suitable for bread making was found to consist of whole-wheat pastry flour, 15 per cent medium fat soybean flour and 10 per cent dry skimmed milk solids (Basic Recipe B).

The storage qualities of dry skimmed milk solids and medium fat soybean flour are better than dried eggs. These ingredients could be stored at a room temperature in air-tight containers.

When the bread mix was formulated it was then presented to a group of eleven panel members from India and Pakistan. Their performances showed many similarities and many differences. However, the results were favorable. Parathas were accepted better than chapatis. There was a distinct difference between the color and texture of the bread when compared with the bread made from whole-wheat pastry flour alone. The breads were tender, yellow-brown in color and compact in appearance.

After the bread recipes were evaluated favorably by the panel members the recipe was fed to three groups of five rats. Control Group I, receiving an adequate diet, was compared to Group II, receiving unenriched Basic Recipe A and Group III, receiving enriched Basic Recipe B. The rats in Group I performed very well. They were healthy in all respects and grew very fast. Group I and Group III rats gained 100 grams and above during a period of 36 days. However, the rats in Group II were slow in growth. They were irritable and their fur was not glossy. Overall size was small.

It is obvious that food does play an important role in the development of one's physique. The author wishes to recommend that a

two-pound package mix composed of enriched Basic Recipe B should be introduced in her country, Pakistan. Locally grown foods should be used to their best advantage.

Legume called gram flour could be used to replace soybean flour which is not grown in Pakistan. India is experimenting with the production of dry skimmed buffalo milk solids. Buffalo milk is available in Pakistan. Imported dry milk solids can be obtained, but are not commonly sold in Pakistan markets. Odorless fish flour may be useful.

The faculty of home economics colleges are in a position to introduce this enriched Basic Bread Recipe in their hostel kitchens, their home management residences and their food and nutrition classes. If government support and cooperation can be obtained in the introduction of this improved bread mix then the fruits of the enrichment program shall soon be reaped by the people of Pakistan.

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A P P E N D I X

F I N A 500

Foods, Nutrition, and
Institutional Administration
Oklahoma State University
Stillwater, Oklahoma

November 1, 1961

Dear _____:

A thesis study on different methos of enriching chapatis and parathas and its effect on their acceptability is being conducted. Your participation as a tasting panel member is greatly needed.

This study is to determine a means of supplying and introducing protein and calcium into Pakistani breads which are commonly used.

There will be three preliminary taste panels during which individual performances will be evaluated. Those who indicate their ability to consistently make the same choices will be asked to stay on the panel. The final panel members will be requested to evaluate breads on Monday and Friday afternoons, during the hour of their choice. At these times panel members will be requested to taste and score four different samples of breads. The Food Research Laboratory in the New Home Economics Building (Room 403) will be used.

If you are willing to serve on this tasting panel please check one or more of the hours which will be convenient for you. If no suggested time is convenient will you add any other hour on Monday and Friday afternoons when you could help with this evaluation. Your prompt reply will be appreciated. Please use the self addressed campus mail envelope.

Thank you very much for your time and consideration.

Monday and Friday November 13, 17, 20, 27, December 1, 4 and 8	Possible Hours 11:00 - 12:00 noon 2:00 - 3:00 p.m. 3:00 - 4:00 p.m.
Other suggested hours on Monday afternoon Friday afternoon	_____ _____ _____

Sincerely,

H. F. Barbour
FNIA Dept. Head

Zohara Imtiaz
Graduate Student

Foods, Nutrition and
Institutional Administration
Oklahoma State University
Stillwater, Oklahoma

November 8, 1961

Dear _____:

With reference to my letter of November 1, 1961 regarding the tasting panel for my thesis project, I have to inform you that the tasting panel has been scheduled as follows:

Monday November 13
Friday November 17
Monday November 20
Friday November 27

The hours are:

11:00 a.m.	to	12:00 noon
2:00 p.m.	to	3:00 p.m.
3:00 p.m.	to	4:00 p.m.

You may please come at any of the above hours, according to your convenience.

Thanking you for your participation,

Yours sincerely.

Zohara Imtiaz
Graduate Student

F I N A 500

Foods, Nutrition, and
Institutional Administration
Oklahoma State University
Stillwater, Oklahoma

November 28, 1961

Dear _____:

With reference to my letter of November 1, 1961 regarding the tasting panel for my thesis project, I have to inform you that you have been chosen to continue as a panel member for three more times.

Your scores on the preliminary tasting panels indicated that you can consistently evaluate the quality of the breads submitted.

These panels will be held on Monday and Friday December 4, 8, and 11. The hours will be as follows:

Noon	11:00 - 12:00
P.M.	2:00 - 3:00
P.M.	3:00 - 4:00

You may please come at any of the above hours according to your convenience. I am grateful for the time and help you gave me in the completion of this project.

Thank you very much.

Sincerely yours,

Helen F. Barbour
FNIA. Dept. Head

Zohara Imtiaz
Graduate Student

FNIA 500

PROJECT OF ZOHARA IMTIAZ

Score Sheet for Pakistani Breads

Product _____

Name _____ Date _____

You have one sample of each, Paratha and Chapati, before you. Please examine and score the sample with respect to the stated qualities in question using the following scale:

Poor - - - - 1
Fair - - - - 2
Good - - - - 3
Very Good - 4

Qualities in Question	Score	Comments
1. Colour		
2. Flavour		
3. Texture[7]		
4. Acceptability		

Suggestions for improvement:

[7]Texture is defined as manner of structure, manner of union of the particles of a substance, i.e., fine, coarse, crisp, gummy, flaky, tough or tender.

Table A. -- Results of Eleven Taste Panel Members for Chapatis

A Color	A Flavor	A Texture	A Accept-ability	D Color	D Flavor	D Texture	D Accept-ability
2	2	1	2	2	2	2	2
2	2	1	3	3	2	3	1
2	3	3	3	3	3	2	3
3	3	3	3	2	2	2	2
2	3	2	3	3	2	2	2
3	4	3	3	4	4	3	4
3	2	2	3	3	3	2	3
3	2	1	2	2	3	4	4
2	2	2	2	3	3	3	3
3	3	2	3	2	2	3	2
3	3	3	3	3	3	3	3
28	29	23	30	30	29	29	29
2.54	2.63	2.09	2.72	2.72	2.63	2.63	2.63
Avg. of color flavor and texture		2.42				2.66	
Avg. total score of 11			2.57				2.64

B	B	B	B	E	E	E	E
3	2	1	2	3	3	3	3
2-	2	1	2-	3	3	3	3
1	2	1	1	2	2	2	2
3	2	2	2	2	2	3	3
3	3	3	3	2	2	1	2
4	3	3	4	3	3	2	3
3	3	2	3	2	3	2	3
3	2	2	2	3	4	4	4
2	3	3	3	2	2	3	2
3	3	3	4	2	3	3	3
4	4	4	4	4	4	4	4
31	29	25	30	28	31	30	32
2.81	2.63	2.27	2.72	2.54	2.81	2.72	2.90
Avg. of color texture and flavor		2.57				2.69	
Avg. total score of 11			2.64				2.79

Table A (Continued) -- Results of Eleven Taste Panel Members for Chapatis

C Color	C Flavor	C Texture	C Accept-ability	F Color	F Flavor	F Texture	F Accept-ability
3	2	2	2	3	3	2	2
2+	3	2+	3	3	2	3+	2
3	3	3	3	2	3	3	3
2	2	3	2	3	2	3	3
3	3	2	3	2	3	3	3
4	4	3	3	4	3	3	3
2	2	3	3	3	2	3	3
2	2	2	2	3	3	3	3
3	3	3	3	3	2	2	2
2	2	2	2	2	2	3	3
4	4	4	4	4	4	4	4
30	30	29	30	32	29	32	31
2.72	2.72	2.63	2.72	2.90	2.63	2.90	2.81
Avg. total score for 11			2.70				2.81
Avg. for color flavor and texture		2.69				2.81	
Avg. total score of 11 for 3 days		2.63					2.74

Table B. -- Results of Eleven Taste Panel Members for Paratha

AA Color	AA Flavor	AA Texture	AA Accepta-bility	DD Color	DD Flavor	DD Texture	DD Accepta-bility
3	4	4	3	4	3	2	2
2	2+	2+	2+	4	3	4	4
4	4	3	4	3	3	3	3
3	3	2	2	4	3	3	3
3	4	4	4	2	4	4	3
3	3	2	3	4	4	4	4
4	4	3	3	4	4	4	4
4	3	3	3	3	4	4	4
3	3	3	3	4	4	4	4
3	3	3	4	3	2	2	3
3	3	2	3	4	4	4	4
35	36	31	34	39	38	38	38
3.18	3.27	2.81	3.09	3.54	3.45	3.45	3.45
Avg. of color flavor and texture		3.08				3.48	
Avg. total score of 11			3.08				3.46

BB	BB	BB	BB	EE	EE	EE	EE
3	1	3	2	4	2	3	3
3	2+	3-	3	4	4	4	4
2	3	3	3	3	3	4	3
2	2	2	2	3	3	3	3
4	4	4	4	3	2	2	2
3	4	3	3	4	4	4	4
4	3	4	4	3	4	3	4
3	3	3	3	4	4	4	4
4	4	4	4	2	3	4	3
3	2	3	3	2	3	3	4
4	4	4	4	4	4	4	4
35	32	36	35	36	36	38	38
3.18	2.90	3.27	3.18	3.27	3.27	3.45	3.45
Avg. of color texture and flavor		3.11				3.33	
Avg. total score of 11			2.64				3.29

Table B (Continued). -- Results of Eleven Taste Panel Members for Paratha

CC Color	CC Flavor	CC Texture	CC Accepta-bility	FF Color	FF Flavor	FF Texture	FF Accepta-bility
3	3	3	3	3	3	2	2
3	3	3	3	4	3	4	3
3	3	3	3	4	3	4	4
3	2	3	3	3	3	3	3
4	3	4	4	3	4	4	4
3	4	4	3	4	4	4	4
3	4	4	4	4	3	4	4
3	3	3	3	4	3	3	3
3	4	4	4	3	2	2	2
3	3	3	3	3	2	2	3
4	4	4	4	4	4	4	4
35	36	38	37	39	34	36	36
3.18	3.27	3.45	3.36	3.54	3.09	3.27	3.27
Avg. of color flavor and texture		3.30				3.30	
Avg. total score of 11			3.33				3.28
Avg. of total score of 11 for 3 days			3.18				3.37

Table C. -- Composition of a Stock Diet[8]

Constituents	Amount - Grams
Skim milk powder	350
Whole-wheat flour	650
Corn meal (commercial)	150
White flour (enriched)	150
Brown rice flour	150
Soybean flour	100
Yeast (Brewers)	30
Wesson oil	46
Cod liver oil (U.S.P.)	4
Iodized salt	10
Salt mixtures*	10
	1650
*Calcium carbonate	90
Ferric citrate	10
Manganese sulphate	1

[8]Miller, C. D., and Schlack, C. A.: Dental caries in two strains of rats fed diets of two degrees of fineness. J. Nutrition 66: 105, 1958.

Table D. -- Food Intake and Weight Gain of Rats in Control Group I

Date	Group I Control	Average Daily Food Intake		Average Weekly Weight	
		Grams	Grams	Grams	Grams
	Rat 1	5.8		56.0	
1st	2	6.9		48.0	
Week	3	7.9		56.0	
	4	7.4		56.0	
	5	8.7		56.5	
			7.3		54.5
	Rat 1	10.1		80.0	
2nd	2	8.0		76.5	
Week	3	11.4		84.5	
	4	11.6		93.0	
	5	10.7		98.5	
			10.4		88.1
	Rat 1	11.7		123.0	
3rd	2	9.3		97.0	
Week	3	14.7		125.5	
	4	14.7		136.0	
	5	13.7		144.5	
			12.8		125.2
	Rat 1	15.6		156.0	
4th	2	9.1		116.0	
Week	3	20.6		168.5	
	4	19.3		174.5	
	5	13.4		177.0	
			15.6		158.4
	Rat 1	18.4		185.0	
5th	2	11.4		135.5	
Week	3	19.7		210.5	
	4	18.3		209.0	
	5	17.4		213.0	
			17.0		190.6

Table E. -- Food Intake and Weight Gain of Rats in Group II

Date	Group II (Unenriched)	Average Daily Food Intake		Average Weekly Weight	
		Grams	Grams	Grams	Grams
1st Week	Rat 1	5.1		49.5	
	2	8.9		51.0	
	3	8.0		51.0	
	4	8.3		47.0	
	5	7.7		45.5	
			7.61		48.8
2nd Week	Rat 1	4.4		48.5	
	2	7.3		52.0	
	3	7.9		52.5	
	4	8.3		53.0	
	5	6.1		47.0	
			6.8		50.6
3rd Week	Rat 1	4.7		54.0	
	2	4.9		53.0	
	3	7.3		54.0	
	4	5.9		59.5	
	5	5.3		49.0	
			5.6		54.0
4th Week	Rat 1	4.7		54.0	
	2	5.4		59.0	
	3	6.0		58.5	
	4	8.0		63.5	
	5	5.3		51.5	
			5.9		57.3
5th Week	Rat 1	5.3		56.0	
	2	5.7		62.5	
	3	6.0		61.0	
	4	7.9		65.5	
	5	5.0		55.0	
			6.0		60.0

Table F. -- Food Intake and Weight Gain of Rats in Group III

Date	Group III (Enriched)	Average Daily Food Intake		Average Weekly Weight	
		Grams	Grams	Grams	Grams
1st Week	Rat 1	8.9		57.5	
	2	8.4		56.0	
	3	9.9		54.0	
	4	9.9		57.5	
	5	8.9		53.0	
			9.2		55.6
2nd Week	Rat 1	6.6		76.0	
	2	8.0		70.0	
	3	9.7		76.5	
	4	10.4		84.5	
	5	6.7		67.5	
			8.3		74.9
3rd Week	Rat 1	9.0		77.0	
	2	7.6		80.5	
	3	10.7		93.5	
	4	8.5		89.0	
	5	8.1		72.5	
			8.8		82.8
4th Week	Rat 1	8.6		107.0	
	2	7.4		96.0	
	3	11.7		119.0	
	4	9.6		99.0	
	5	9.0		86.0	
			9.3		101.4
5th Week	Rat 1	7.9		114.0	
	2	7.4		106.0	
	3	11.4		131.5	
	4	8.3		98.0	
	5	8.9		94.0	
			8.8		108.7

VITA

Zohara Imtiaz

Candidate for the degree of

Master of Science

Thesis: FORTIFICATION OF A PAKISTANI BREAD RECIPE WITH ANIMAL PROTEIN AND CALCIUM AND THE DETERMINATION OF ITS BIOLOGICAL VALUE ON WHITE RATS

Major Field: Food, Nutrition, and Institution Administration

Biographical:

Personal Data: Born in Hydrabad Deccan, India, March 24, 1938, the daughter of Dr. and Begum S. A. Jamalulla.

Education: Attended St. Mary's Convent School in Multan, West Pakistan; received High School Certificate from the University of Punjab, West Pakistan, in 1955; received Bachelor of Science degree from the University of Punjab, West Pakistan in 1959; completed requirements for the Master of Science degree in Food, Nutrition and Institution Administration at Oklahoma State University in May, 1962.