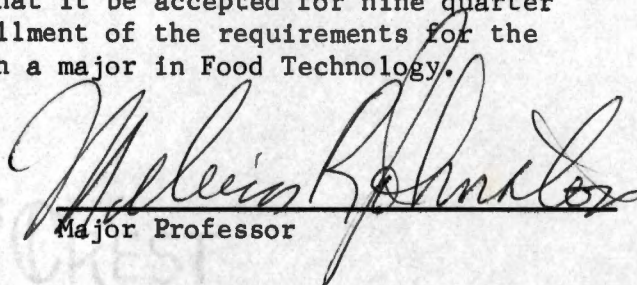


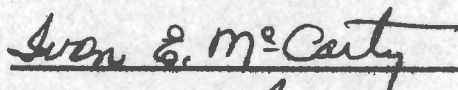
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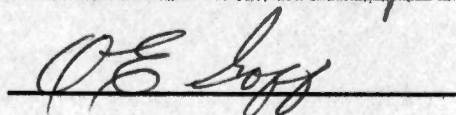
To the Graduate Council:

I am submitting herewith a thesis written by Mehmet Can Baser entitled "The Importance of the Technological Improvements on the Tarhana Product." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Food Technology.


Major Professor

We have read this thesis and
recommend its acceptance:


Ivan E. McCarty


O.E. Loff

Accepted for the Council:


Vice Chancellor for
Graduate Studies and Research

THE IMPORTANCE OF THE TECHNOLOGICAL IMPROVEMENTS
ON THE TARHANA PRODUCT

A Thesis
Presented to
the Graduate Council of
The University of Tennessee

In Partial Fulfillment
of the Requirements for the Degree
Master of Science

by
Mehmet Can Baser

June 1971

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ABSTRACT

Tarhana is a fermentation product using dried grains or flour, and yogurt with flavoring, vegetables, and spices. The preparation techniques of different tarhana products are similar. The different geographical regions prepare tarhana in a different manner, due to economy and food availability.

Three tarhana samples were used in this study: The first sample contained no ISP; the second sample was enriched with 2.5 percent of ISP; and the third contained 5.0 percent ISP.

During the fermentation period, the pH of each sample was measured by Beckman Zeromatic pH meter. Color measurements were analyzed by the Color-Eye and Hunter Color and Color Difference colorimeters.

Eight essential amino acids were calculated (mg/100g) on the basis of amount's ingredients used. The Vacuum Drying method for moisture determination, Macro Kjeldahl method to determine protein content, Fisher Fat extraction for fat content, and hot furnace (525° C.) for ash content, were used to analyze the nutritional characteristics of samples.

Taste Panel Rankings of samples for color, flavor, and aroma by two groups of panelists were statistically analyzed.

Statistical results ($p < 0.05$) of yield, pH, moisture, fat, and ash showed that there was a significant difference between the samples. The pH value, protein content, and yield of product were

higher in the samples fortified with ISP than the sample containing no ISP, respectively.

There was a significant difference between the samples in color and flavor, but no differences were found in aroma by the two groups of panelists.

Although each panelist stated that all samples and replications were acceptable, panelists preferred tarhana, at lower pH or more acidic flavor and without added ISP, above the samples that contained it.

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CHAPTER I

INTRODUCTION

As the population of the world continues to increase, the task of feeding the populace becomes increasingly critical. In underdeveloped countries of the tropical and subtropical regions of the world, plant proteins usually supply most of the protein in the diet of the people. It has been assumed that animal proteins are superior to plant proteins as food for man. Animal proteins from meat, milk, fish, and eggs make a negligible contribution to the protein of most diets. There are various reasons for this. Animal husbandry has not developed well in many of these regions, religious taboos inhibit consumption, and in many areas fishing methods are primitive, lacking modern methods, equipment, and technology. In tropical and subtropical climates, refrigeration is often lacking which makes distribution of food more difficult from areas of production to centers of consumption. Improved methods of transportation, production, and preservation in underdeveloped countries has been hampered due to lack of capital, local initiative and motivation.

People of these underdeveloped countries have used their small amounts of animal resources well and have been able to survive for centuries under these circumstances (24). Drying, salting, fumigating, and fermenting have been used by most primitive communities to preserve meat, fish, eggs, and milk.

Mass food production has been possible in developed countries because they possess advanced technology and modern food preservation methods. The adaptations of these technologies to underdeveloped areas will require considerable time, money, and the effort of technically trained people from many fields (12, 24).

Each community has its own popular food product which is frequently and commonly prepared and consumed in every home. Supplementation of such a product or products could be a way of improving the quality of the diet without changing the existing food habits.

Due to its popularity, relative simplicity of processing, and excellent keeping qualities under various conditions, tarhana has been suggested by research workers (20, 21, 24, 25, 30, 44, 48, 49, 51) as an excellent low-cost food.

Tarhana, a highly nutritious soup prepared from dried ingredients, has been eaten in Turkey, Hungary, Finland, the Balkans, Middle Eastern, and North African countries from unknown times to the present. Surveys conducted in Turkey have shown that 80 percent of the peasant communities use tarhana in the diet (30, 44).

The purpose of this study was to determine and compare the composition of tarhana from various methods of manufacture or processing.

CHAPTER II

REVIEW OF LITERATURE

In the face of a nutritional deficiency crisis among the nations of the world, additional sources of high protein foodstuffs and nutritional supplements must be found or scientifically developed from available resources (10). Meat, the most desirable protein, is not always readily available in sufficient quantity in some areas of the world. In these areas the costs are too great or the preservation facilities and distribution channels are inefficient.

The food of the vegetarian is generally bland. If the nutritive value of their diets could be made to supply the same nutrient value as meat, and also have a desirable flavor, eating for them could be more enjoyable. Narayanaras, et. al., devised a formulation which consists of a 1:1 blend of full-fat soya flour and ground nut flour, adequately fortified with calcium salts, vitamins A and D, thiamine, riboflavin and the limiting amino acids, lysine and methionine. They reported that a supplement of 40-50 g. of this protein food will supply one-third to one-half the daily requirements of protein, vitamins, and minerals for children. This protein food can also be seasoned for use in soups and savory preparations. It has a shelf life of nine months at 37°C. when packed in hermetically sealed tin cans, with little expected losses in vitamin activity (35).

Probably the largest source of plant protein used today is soybean protein. Between 250 and 300 million pounds of soy flour or grits go into formulation of food products yearly in the U.S.A. (52). Soya milks are used especially in the United States for infants who are allergic to the allergen in cow milk. It has long been known that the protein in raw soybeans has a low nutritive value and that cooking brings this value close to that of meat and milk (42). The main problem of soybeans is that ordinary prolonged cooking does not remove the bitter taste or destroy the trypsin inhibitor. The heating must not be prolonged nor be at too high temperatures, because this will cause a deterioration in the quality of the protein (9). In properly heat-treated soybean products, methionine is the first-limiting amino acid rather than lysine, as is the case in cereal products (19). The most effective heat treatment appears to be steaming for 15 minutes. This has been shown to completely destroy the pancreatic hypertropic factor, and to decrease the trypsin inhibitor activity by at least 95 percent. The flavor of edible isolated protein, when carefully made, is essentially bland. It is usually flavored as desired by the manufacturer (8).

The origin of tarhana is not recorded. It is suggested that this product was brought by Turkish settlers to the Middle East, Near East, Anatolia, the Balkans, Hungary, and Finland in the early tenth and eleventh centuries. Investigations have shown that tarhana was used by the Turks while they were living in Central Asia centuries ago (20, 48).

A Turkish-English Dictionary defines tarhana as a preparation of dried curds and flour from which soup is made (16). Teingrass stated

in the Persian-English Dictionary: "Tarhanay-i dug; hominy, Tarhanay-i sir; frumenty" (47).

According to Mezogazdasagi, a product consumed by early inhabitants of Hungary was quite similar to tarhana and was made by the same methods (33). P. Kivikoski (23) stated that a product "Talkuna," widely used in eleventh century Finland, was also made from fermenting flour and milk (yogurt) with yeast. This product was especially popular in old villages and towns (23). Terzioglu (49) worked on tarhana which was made and used widely, by people in Iraq, and gave a special place to this product in their diet.

After the emigration from Central Asia and settlement in Anatolia, the Turks retained their eating habits and during the time (1300-1900 AD) of the Ottoman Empire, tarhana usage spread to other countries (the Arab states, Greece, Bulgaria), within the Empire.

Seemingly, the chief reasons for tarhana being so widely used by such a large number of communities for such a long period of time, was that it was comparatively low in cost, easily prepared, a readily processed foodstuff from locally available milk and other ingredients. There are many other historical references showing that tarhana has been used by the Turks at Anatolia for the last eight hundred years (25, 44).

The practicability of supplementing a locally available food to improve the diet has been recognized in many developing countries of the world. This would improve the quality of the protein in the diet until better methods of production, processing, and distribution,

especially for animal sources of protein, were available. Foods of plant origin require supplemental protein due to their low biological value (45). Since the people in most countries derive a large percentage of their calories from grain or other carbohydrate sources, such as potatoes, yams, tapioca, et cetera, there is a need to increase the protein in these dietary ingredients in order to improve nutritionally well-being of the people (7).

Protein in most cereals and grains is deficient in one or more of the essential amino acids. Zein, a protein in corn, is deficient in lysine and tryptophan. Wheat gluten is deficient in lysine, and the protein of rice lacks adequate amounts of lysine and threonine (2, 7, 18). The biological value of these proteins could be significantly improved by supplementing with lysine, tryptophan, and isoleucine. A number of workers have reported that fortification of wheat gluten with lysine would significantly increase its biological value (2, 18). Numerous research studies have indicated that supplementation through various food combinations are possible, practical, advisable, and generally acceptable (14, 46). Some food combinations have been reported to be better nutritionally than most seed proteins, as good as most animal proteins, and can be presented in a palatable form (41).

Since the high cost of meat results both from the inefficiency with which animals convert vegetable protein into muscle, and the inefficiency of the labor and capital employed in meat production and distribution, additional sources of high protein foodstuffs must be

found (50). Some additional sources of high protein available for development are flours from fish, cotton seed, peanuts; coconut flour, sesame seed, sunflower seed, soybean, plankton, algae, fungi, and mushroom mycelium (4, 5, 35).

In Mexico, for example, legumes have been fed to Mexican people in order to increase the protein value of their foods (37). In Haiti, the government is now studying the development of a series of cereal-legume blends of improved protein content and quality to alleviate diets deficient in proper proteins (22).

In China and Japan, seaweeds are used fairly extensively as human food (9). Mezelaitis (32) has estimated that in the forests of Lithuania, it is possible to collect an average of about 30,000 tons of edible fungi per year, and that there are 15 species that are suitable for human consumption. During World War II, Germany used yeasts as a protein supplement even though it is somewhat deficient in cystine and methionine (11). During the period 1939-1945, Germany produced 39,000 tons of dried yeast as a food source yearly.

The Institute of Nutrition for Central America and Panama (INCAP) has developed a good quality vegetable mixture known as Incaparina. It is a mixture of corn meal, cottonseed flour, and sorghum flour. Incaparina has been shown to have a high biological value (17).

Andret and Van Veen (16) developed a formula for infant feeding based upon a combination of vegetable protein used by the Food and Agriculture Organization (FAO) and the United Nations Children's Fund (UNICEF).

The United States Food and Drug Administration has approved the use of mushroom mycelia in commercially produced dehydrated soups, sauces, gravy bases, and precooked frozen food (28). The advantage of

mushroom mycelium is that in a submerged culture it can take industrial waste products such as beet molasses, cane molasses, citrus molasses, corn syrup, corn canning waste liquor, and cheese whey and produce 11.6 g. of dried mycelium per liter which contains 43.7 percent protein, and 7.1 percent fat after 8 days of growth (11, 28).

Local production is not efficient because the production plant, the animal itself, takes so long a time to convert the food it eat (vegetable protein) into muscle. Labor and capital used in meat production by grazing flocks and merchandising the product is not always available or efficient. Therefore, food technology seeks higher quality and quantity of vegetable protein and more readily available animal protein from better preservation and methods of preparation. Through research, additional sources of high protein being developed to meet these needs are fish flour, cotton seed flour, peanut flour, coconut protein, sesame flour, sunflower seed flour, soybean flour, plankton, algae, fungi, and mushroom mycelium (41, 42, 43).

I. TARHANA MAKING

Tarhana, a staple food in almost every Turkish home, has been known for centuries. Today, tarhana is known in Arab states as "kisk," in Hungary as "tarhonya," and in Finland as "talkuna."

Basically, it is a dried soup material which is made the way mothers and grandmothers have made it in the past. Usually, it is made during summer and early autumn months to utilize the sun for drying. Tarhana is made differently in the three geographical regions of Turkey.

The procedure is quite similar in each area, only the amount and kinds of the ingredients used may differ depending upon customs and

seasonal availabilities in the East, West, and the middle part of the country.

In the West and Northwest of Turkey, people make tarhana in a more sanitary manner, and, consequently, the final product has a more dependable quality. Some housewives prefer to use wheat flour instead of broken wheat, which may give a more unique product.

II. COMPOSITION OF TARHANA

Tarhana is divided into two groups or kinds, depending upon whether its main ingredient is wheat or flour.

1. "goce": (gogea), "yarma," meaning cracked or broken wheat. This form of tarhana making and consumption is especially popular in middle and eastern parts of Turkey. Also, tarhana from these regions is called "goce tarhanasi."

2. Flour: The product from good quality soft wheat, Tarhana made of flour is very common in western parts of Turkey and in the Balkans. Also, it is called "Istanbul tarhanasi," meaning tarhana that belongs to Istanbul.

3. Yogurt: Yogurt is one of the oldest fermented milk foods. It is very popular in Europe, Asia, and Africa, especially in those countries bordering the Eastern Mediterranean coast. It is spelled in several ways (yogur, yoghurth, yahgourth), and is known by quite different names in different parts of the world--"Leben or leben-raib" in Egypt-Arabia; "Matzoon or Madzoon" in Armenia; "naja" in Bulgaria; dahi or daehdi" in India.

Yogurt is a quick-curdled, decidedly acid preparation containing little or no alcohol (1, 2). In the many developing countries of Europe, Asia, and Africa, yogurt is more likely to be produced from a naturally soured milk and to be consumed by the adult populace more than fresh whole milk. It is generally considered a safe product and possesses a unique flavor which appeals to many people. Nutritionists are considering the incorporation of other nutrients with this product, in order to make it a complete food for use in these areas (26).

Van Veen (12) reported on the need, the value, and practical attainability of an inexpensive and tasty food for the Asian and African people. Consumers in the Americas are becoming more aware of the fine properties of yogurt, and its consumption is increasing, particularly in larger cities.

Modern yogurt manufacture depends upon a high degree of mechanization and sanitation. In Europe, one of the yogurt plants, in Versailles, France, produces over 100,000 containers daily and delivers it by truck to Paris and its environs.

Principle and manufacture of yogurt: Yogurt, like other modern fermented milks, is made with suitable bacterial cultures. For yogurt made in America from concentrated milk, the heat treatment usually falls within the range of 82° C. (179° F.) for 90 minutes to 93° C. (199.4° F.) for 30 to 60 minutes. This treatment is too severe for milk of normal solids content, however, causing a weak-boiled product. For this type of yogurt, Pette (26) recommends an exposure of ten minutes at 80° C. to 90° C. (176° F. to 194° F.). Milk for yogurt can be whole

or skim milk, although fat improves the flavor of the product. Frequently, it is homogenized before inoculation (39). After the heat treatment, the milk is cooled to about 48° C. (118° F.) and inoculated with 2 to 3 percent of yogurt culture. The fermentation is a lactic acid type. Cultures of an approximately 1:1 ratio of Lactobacillus bulgaricus and Streptococcus thermophilus organisms are added to the milk (2). The inoculum is mixed well with the milk; the mixture is dispensed in the final retail containers, usually jars, or cartons, and these are incubated at 45° C. (113° F.). The final acidity desired in yogurt depends on the taste of the consumer, but most seem to prefer a product with a titratable acidity of 0.85 to 0.90 percent (13, 40). To achieve this range, many producers remove the yogurt from the incubator when the acidity reaches 0.65 to 0.70 percent. Further acid formation occurs while the product is being cooled (39, 40). The yogurt is cooled to about 5° C. (41° F.) and held at this temperature until distributed to the consumer. Under these conditions, the product can be kept satisfactorily for 1 to 2 weeks (26, 39).

Quality of yogurt: Depending upon the geographical area, the type of milk used, and the processing treatment, yogurt is either a liquid or a gel. The protein content varies from 0 to 20 percent. Much plain yogurt contains 1.7 percent fat, but in the United States, where no Federal Standards of Identity exist for the product, it averages about 3.3 percent fat, Table I.

TABLE I
COMPOSITION OF YOGURT

INGREDIENTS	PERCENTAGES
Moisture	88.42
Fat (EE)	1.71
Total Protein (CP)	3.78
Carbohydrate ^a (NFE)	5.36
Ash	0.69
TOTAL SOLIDS	11.58

^aPercent of NFE calculated: Percent NFE = percent of total - percent ($H_2O + EE + CP + Ash$).

Defects of yogurt: Flavor defects are common to yogurt just as they are in any milk product. Perhaps the most common fault is the absence of a typical yogurt flavor and aroma. Yogurt may display a harsh flavor and heavy body, almost like Neufchatel cheese. Unclean and bitter flavors in yogurt sometimes result from using poor quality milk or contaminated starter. Certain strains of Lactobacillus bulgaricus can cause a bitter taste (1, 2).

Slow acid production by yogurt cultures have been traced to bacteriophage attacking the cells of Streptococcus termophilus (29). In the final package, good quality yogurt should not have more than 1.0 to 1.2 percent acid. The pH should be approximately 4.4. Weak curd formation is a serious problem with yogurt made from milk of normal solid content. According to the results of Pette and Lolkema (30), a weak curd is most likely to result if the solid content of the milk is low, or if a significant amount of the milk is from cows early in the lactation cycle. Sometimes, but not always, associated with weak curd formation is whey separation caused by an incorrect salt balance in the milk. Firmness of the curd from "weak curd" milk can be increased by adding 1 to 2 percent of dry milk solids and a small amount of calcium chloride to the milk.

4. Milk: Either pasteurized or raw milk is used during fermentation to wet hands while kneading.

5. Tomatoes: Completely mature, good quality tomatoes are used. Less juicy and seedless ones are preferred. They give flavor, aroma and color to the final product.

6. Onion: Mature, hot, white onions are preferred for tarhana making. This gives more flavor and a longer shelf-life to tarhana.

7. Pepper: Good quality, fresh red peppers are excellent for tarhana making. Most people like hot ones, and often add additional hot fresh green peppers.

8. Salt: Three basic reasons for adding salt to tarhana products are: to enhance flavor, to speed fermentation, and to give longer shelf-life.

9. Spices: Spices play an important role in the development of flavor and aroma in the tarhana. The most commonly used commercial spices include the following:

(a) Hyssop: (*Hyssopus officianis* or *Echinophore sibthropiana*). This is a summer plant or flower which grows at the higher elevations of the Mediterranean coast. It contains an etheric oil called Phytosterin which produces a pleasant aroms and taste when added to tarhana. Housewives in Turkey and Greece use this plant in pickles, tarhana, and some other preserved foods.

(b) Fennel Flower: (*Foeniculum vulgare*; *Anethum graveolens* L. = *Pastinaca graveolens* Bernh = *Peucedanum g: Beneth*). This plant was known almost 3,000 years ago. Early Egyptians used this flower for medicinal purposes. It belongs to the Umbelliferae family and grows naturally along river banks in the high mountainous areas. It can grow to 8-10 feet in height. The flowers contain cola and oil which give desirable odor and flavor when added to tarhana.

(c) Mint: (Menta). Origin of this plant is China, and it has been known in Egypt since 1500 B.C. Ancient Romans used to keep this flower in their kitchens as a spice. It is widely used in medicine and in the liquor industry. Either fresh or dried leaves can be used in tarhana.

(d) Parsley: (Petioselinum Hortense). This plant is the most popular of the garden herbs grown in every country. The leaves are used for flavoring or for garnishing. The plant is a biennial of the Umbelliferae family and a native of Europe. It has been in cultivation for over 2,000 years. Parsley is also very high in iron, Vitamin A, and Vitamin C.

Other spices and flavoring flowers which are used in tarhana where they regionally grow are shervil, cress and watercress.

CHAPTER III

MATERIALS AND METHODS

I. PREPARATION OF TARHANA PRODUCTS

In this study, the preparation of tarhana samples was accomplished according to the recipe as presented in Table II. The samples were replicated three times. One replication from every sample was made at one day intervals, Table III.

Good quality soft A-1 wheat flour¹ was blended with plain yogurt.² Composition of the yogurt is presented in Table 1, page 12. For each replication of each sample, the same amount of vine-ripened, canned tomatoes, canned diced red peppers and peeled mature onions, salt and spices were blended together. The mixture was heated to boiling and simmered at medium heat for two hours, then allowed to cool to 35° C., then added to the flour and yogurt. In addition to the basic ingredients (Table II) 32 and 64 grams of Promine-D was added to Samples 2 and 3, respectively.

All samples were allowed to ferment for 120 hours at 21° C. Each sample was kneaded for 10 minutes at 12-hour intervals to insure uniform rising. During the period of fermentation, all samples were

¹Obtained from The Great Western Foods Company, Knoxville, Tennessee.

²Obtained from Breakstone Yogurt Company, New York City, New York.

TABLE II
TYPICAL PROXIMATE ANALYSIS OF PROMINE-D^a

CONTENT	PERCENTAGE
Moisture	4.7
Protein (N x 6.25)	91.8
Protein (moisture-free basis)	96.5
Water-dispersible protein (as percent of the total protein)	75.0
Crude fiber	0.1
Ash	3.4
Sodium	1.7
Potassium	0.2
Phosphorus	0.8
pH in aqueous dispersion	7.0

^aFrom product information sheet of Technical Service bulletin from Central Soya Chemurgy Division, Chicago, Illinois.

TABLE III
AMOUNTS OF INGREDIENTS USED IN PREPARATION AND
EXPERIMENTAL TARHANA SAMPLES

INGREDIENTS	SAMPLE		
	<u>1</u>	<u>2</u> (grams)	<u>3</u>
Wheat Flour	300	300	300
Yogurt	300	300	300
Tomatoes	150	150	150
Onion	150	150	150
Red Pepper	150	150	150
Salt	24	24	24
Yeast	7.5	7.5	7.5
Spices	1.5	1.5	1.5
ISP ^a	--	32	64
Fermentation Time (in hours)	120	120	120

^aISP is usually merchandised as Promine-D, a sodium soy proteinate.

tested twice daily for aroma, appearance, and pH. Changes in pH during fermentation for all samples are presented in Figure 1.

After 5 days of fermentation, all samples were transferred to trays and dried in a hot air oven at 47°C . - 52°C . for 42 hours. After drying, each sample was ground and sieved through a 20-mesh screen. Finally, all finished products were placed into separate hermetic containers and stored until analysis could be performed.

II. ANALYTICAL TESTS AND METHODS

pH Measurements

During the fermentation period, the pH of each sample was measured and recorded twice daily by Beckman Zeromatic pH meter.

Product yield

Yield of the product was calculated on the basis of all ingredients used and the weight of the product from each replication. Weighing was done soon after the product was taken from the air-drying oven.

Color measurements

The color-eye (model D-1, IDL, Division of Kollomorgen Corporation) and Hunter Color and Color Difference Colorimeters were used to measure the color of the final dehydrated (20 mesh) products. The white glass reference standard (the "A" Block) was put in the standard reflectance port. The sample holder was a colorless $1'' \times 1\frac{1}{2}'' \times 2\frac{1}{2}''$ glass box. The values for X, Y, Z, and $\bar{x}$ were recorded from the microdial and converted to the C.I.E. system.

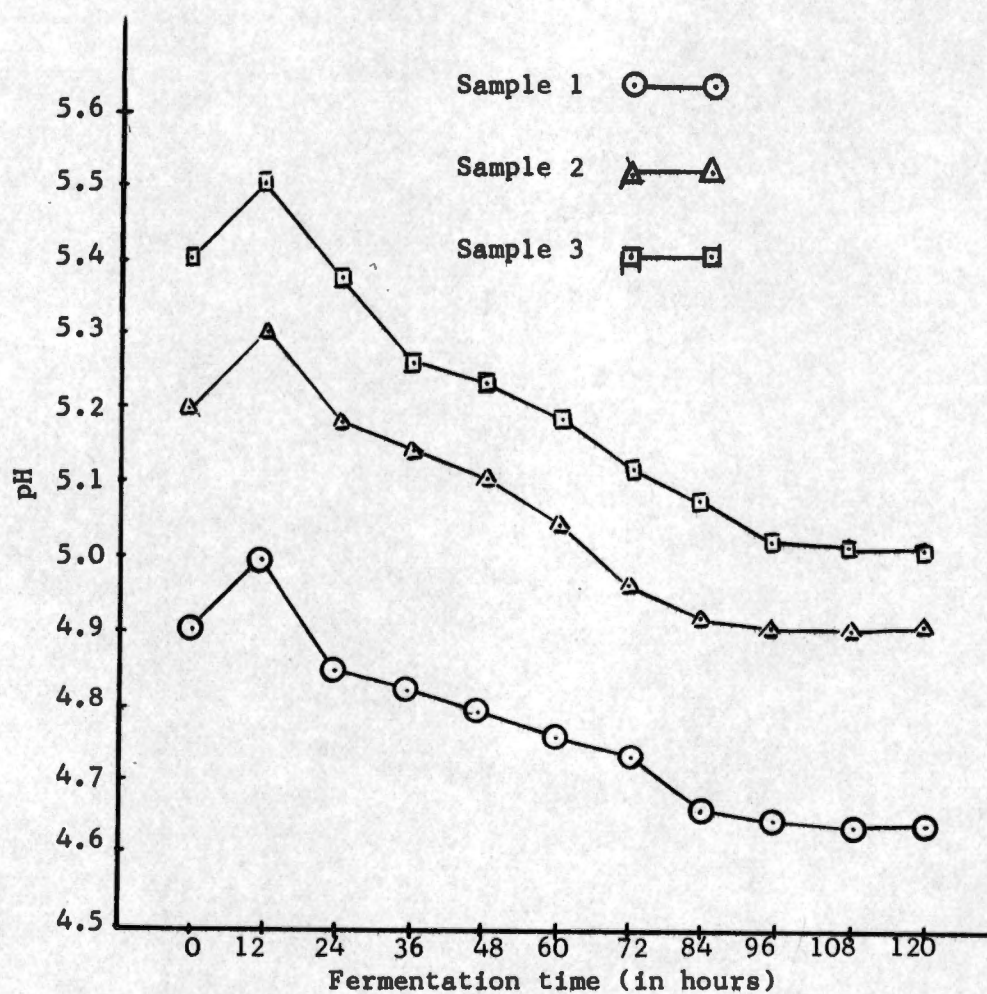


Figure 1. pH curve of experimental tarhana samples during fermentation.

These data were used to calculate chromaticity coordinates, dominant wave lengths, purity, luminosity, the hue angle, yellow index, saturation index, lightness index, and Yonkin index. All samples were dehydrated and three readings were made on each replicate.

Calculated amino acid content

Eight essential amino acids (standpoint of human nutrition) in three tarhana samples were calculated on the basis of the table given in the "Content of Food," by F.A.O. 1970, Rome, Italy.

Protein determination

Protein determination of samples were made by the Macro Kjeldahl method for determination of total nitrogen. Total protein percentage was based upon the following formula:

$$\text{Percent of protein} = \text{percent of nitrogen} \times 6.25,$$

Fat determination

The Fisher fat determination apparatus was used to determine fat content of tarhana samples. Two analyses were conducted on each replicate.

Ash determination

The mineral elements, or ash elements, are those exclusive of C, that remain in the ash when a food material is burned. The 20-mesh dried samples were analyzed by burning them at $525^{\circ}\text{C.} (\pm 20^{\circ}\text{C.})$ for 18 hours and weighing the ash remaining. Percent ash was calculated by this formula:

$$\text{percent ash} = \frac{\text{crucible with ash} - \text{crucible empty (g)}}{\text{crucible with sample (g)} - \text{empty crucible (g)}} \times 100$$

Taste panel

Ranking difference method was conducted for sensory evaluation of the tarhana samples. Two groups of taste panels were served samples to evaluate color, flavor, and aroma of three tarhana soups which were for this experiment. The first group of panelists had never tasted the product before, while the second group of panelists had tasted many kinds of tarhana soup in the past.

A total of 12 panelists evaluated the product during three sittings. Thus, there were three replications of the taste panel.

Statistical analysis

All data were analyzed by the analysis of variance method using ANOVAR program, modified by E. Larmond (27). Significant differences between means were determined by Duncan's Multiple Range Test.

CHAPTER IV

EXPERIMENTAL RESULTS AND DISCUSSION

Preliminary to the initiation of this study, a sample of commercially produced tarhana was obtained from "CAPA MARKA GIDA SANAYII A. S., ISTANBUL-TURKEY" for analysis. Analysis of the commercial product was identical with that later performed on the experimental samples, with the exception of sensory evaluation. Insufficient quantity of the commercial sample was available for sensory testing. On the basis of the analysis, a formula (Table III, page 18) was selected for the production of the experimental tarhana to closely approximate the product currently available on a commercial scale in some underdeveloped areas. Although not included in the statistical analysis of the data, composition of the commercial sample will be discussed under the appropriate headings.

Color data obtained from both the Color-Eye and Hunter Color and Color Difference instruments are presented in Table IV. Since there were no prior color data on tarhana, these data are presented only for the purpose of establishing color characteristics for the product used in this study. The values for X, Y, Z, and $\bar{x}$ are recorded values from the Color-Eye and were used to calculate Chromaticity Coordinates, Purity, Luminosity, Hue angle, Lightness Index, Yellow Index, Saturation Index, and Yonkin Index. Hunter a and b values were recorded from

TABLE IV
COLOR ANALYSIS OF EXPERIMENTAL TARHANA USING COLOR-EYE
AND HUNTER COLOR AND COLOR DIFFERENCE METHOD

TRISTIMULUS VALUES	SAMPLE		
	1	2	3
X =	59.56	64.51	68.99
Y =	58.22	63.57	69.99
Z =	39.94	45.45	58.53
$\bar{x}$	33.59	37.71	48.89
Chromaticity Coordinates			
x =	0.38	0.37	0.35
y =	0.37	0.37	0.36
Color =	Yellow	Yellow	Yellow
Dominant Wave Length	580 m μ	578 m μ	576 m μ
Purity (percent)	34.2	42.8	23.6
Luminosity	58.22	63.57	69.99
Hunter a =	5.42	3.52	2.92
b =	6.14	4.22	7.71
Hue Angle	1.13	1.19	4.01
Yellow Index	0.567	0.526	0.364
Saturation Index	22.62	15.53	22.95
Lightness Index	7.63	7.97	8.37
Yonkin Index	35.31	33.46	9.97

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the H.C.D.M. Color and Dominant Wave Length were determined by reference to I.C.E. Chromaticity Diagram (Figure 2, Appendix). Although the Dominant Wave Length increased from 576 $m\mu$ to 580 $m\mu$ addition of ISP, the color of all samples remained in the Yellow Index according to Illuminant "C."

The calculated quantity of eight amino acids of all samples are presented in Table V. Difference between the commercial and control sample can possibly be explained on the basis of differences in amounts of ingredients used. Samples 2 and 3 were fortified with 2.5 and 5.0 percent ISP, respectively. The addition of ISP increased individual amino acid contents from 45 percent for Methionine to 150 percent for Lysine.

The addition of ISP exerted a profound buffering effect on the tarhana mix. The initial pH was 4.5, 5.2, and 5.4 (Figure 1, page 20) for Samples 1, 2, and 3, respectively. During the first 12 hours of fermentation, all samples showed increases in pH, then gradually decreased throughout the remainder of the fermentation period. All samples displayed similar patterns of pH change and retained the same relative differences throughout fermentation, as indicated in initial pH. The final pH of control sample was 4.64 as compared to 4.60 for the commercial sample. The final pH of Samples 2 and 3 was 4.90 and 5.00, respectively.

The ISP added to the tarhana mix was a dried sodium soy proteinate product and possessed functional properties of a thickening and/or emulsifying agent. Therefore, the effect of ISP on fermentation

TABLE V
THE CALCULATED ESSENTIAL AMINO ACIDS CONTENT^a
OF EXPERIMENTAL TARHANA

AMINO ACIDS	COMMERCIAL	SAMPLE		
		1 (CONTROL)	2	3
Isoleucine	209.0	214.0 ^b	336.9	453.0
Leucine	343.3	365.6	557.9	753.6
Lycine	201.3	213.9	386.0	531.5
Methionine	85.2	92.1	118.5	143.3
Phenylalanine	238.6	245.9	381.2	508.8
Threonine	170.4	176.9	269.3	356.6
Tryptophan	43.8	45.9	88.6	115.0
Valine	260.3	267.7	375.8	488.2

^aCalculated A.A. value of samples was based on the tables given by F.A.O., 1970, "Content of Food," Rome, Italy.

^bMilligram in hundred grams.

strongly suggests the possibility that during hydration the protein molecules were accepting H^+ ions from the solution. Since pH is a measure of H^+ ion concentration, any increase in H^+ ions would result in an increase in pH. Also, the fermenting mass contained other substances capable of competing for both the water and H^+ ions within the system and could have affected H^+ in concentration.

Analysis of variance data for pH, yield, and moisture are presented in Table VI. The pH of Sample 1 was found to be significantly different from that of Sample 3.

Although a significant difference was found between all samples for yield of product, the difference reflects the additional 32 g. and 64 g. of ISP added to Samples 2 and 3, respectively, and not a real difference in percent yield. A significant difference was found between all samples for moisture content. No concerted effort was made to control the drying of the samples nor the final moisture of individual samples. The slight difference exhibited between Samples 2 and 3 might possibly be due to the arrangement in the drying chamber. The difference between samples containing ISP and the control could be due to increased porosity in the drying cake as a result of added protein, thereby causing them to give up moisture more readily.

Analysis of variance data for protein, fat, and ash content of all samples are presented in Table VII. A significant difference was found between all samples in protein content. This difference was expected and reflects the amount of ISP added to Samples 2 and 3. The protein content of commercial sample was found to be intermediate between the control sample and Sample 2 (20.13 percent).

TABLE VI
YIELD, MOISTURE, AND pH VALUES OF EXPERIMENTAL
TARHANA SAMPLES

SAMPLE	AVERAGE VALUE* (Percent)		
	pH	Yield	Moisture
1	4.77 ^b	28.00 ^a	6.09 ^c
2	5.05 ^{ab}	30.27 ^b	4.72 ^a
3	5.21 ^a	32.90 ^c	4.98 ^b

*Each figure is the average of three replications.

Means in the same column with different subscripts are significantly different ($p < 0.05$) as determined by Duncan (1955).

TABLE VII
 PROTEIN, FAT, AND ASH VALUES OF
 EXPERIMENTAL TARHANA SAMPLES

SAMPLE	Average Value* (Percent)		
	Protein	Fat	Ash
1	16.47 ^a	1.84 ^a	7.60 ^a
2	22.40 ^b	1.53 ^b	8.17 ^b
3	27.91 ^c	1.58 ^b	7.85 ^a

*Each figure is the average of three replications.

Means in the same column with different subscripts are significantly different ($p < 0.05$) as determined by Duncan (1955).

The fat content of the control sample differed significantly from Samples 2 and 3 and was comparable to the commercial sample (1.80 percent). The slight but significantly lower fat content of Samples 2 and 3 could possibly be due to fermentation and the diluting effect of the added ISP.

The ash content of Sample 2 was found to be significantly higher than the other two samples. This difference can be attributed to slight difference in formulation. The ash content of commercial sample was 10.30 percent and would also reflect a difference due to ingredients used.

Sensory panel data for color, flavor, and aroma are presented in Tables VIII, IX, and X. Test panelists were divided into two groups. Group A was composed of seven Americans who had never tasted tarhana before. Group B was composed of five students from Middle Eastern countries and were familiar with tarhana. The soup was prepared for tasting by each group. Each group evaluated the soup at three separate settings.

It is of interest to note the similar response of the two groups. Although there was a difference in magnitude of values, both groups preferred the control sample over the experimental samples for color and flavor. Neither group expressed a difference in aroma between the samples.

The preferred color of soup by all panelists was one approaching a yellowish orange with a dominant wave length of 576 m μ and lightness index of 8.37.

TABLE VIII

COLOR PREFERENCE RANKING VALUES OF EXPERIMENTAL SAMPLES OF
TARHANA BY SENSORY PANELISTS OF
TWO DIFFERENT NATIONALITIES

SAMPLE	PANELISTS	
	Group A*	Group B**
1	0.45 ^c	0.62 ^c
2	0.04 ^b	-0.11 ^b
3	-0.49 ^a	-0.51 ^a

*Seven American panelists, three replications.

**Five Middle-East panelists, three replications.

Means in the same column with different subscripts are significantly ($p < 0.05$) different as determined by Duncan (1955).

TABLE IX

FLAVOR PREFERENCE RANKING VALUES OF EXPERIMENTAL SAMPLES OF
TARHANA BY SENSORY PANELISTS OF
TWO DIFFERENT NATIONALITIES

SAMPLE	PANELISTS	
	Group A*	Group B**
1	0.2833 ^b	0.34 ^b
2	0.0 ^a	0.06 ^a
3	-0.2833 ^a	-0.40 ^a

*Seven American panelists, three replications.

**Five Middle-East panelists, three replications.

Means in the same column with different subscripts are significantly ($p < 0.05$) different as determined by Duncan (1955).

TABLE X
AROMA PREFERENCE RANKING VALUES OF EXPERIMENTAL SAMPLES OF
TAHRANA BY SENSORY PANELISTS OF
TWO DIFFERENT NATIONALITIES

SAMPLE	PANELISTS	
	Group A*	Group B**
1	0.121 ^a	0.057 ^a
2	0.081 ^a	0.170 ^a
3	-0.202 ^a	-0.227 ^a

*Seven American panelists, three replications.

**Five Middle-East panelists, three replications.

Means in the same column with the same subscripts are not significantly ($p < 0.05$) different as determined by Duncan (1955).

Both panels preferred the flavor of the control sample and found it to be significantly different from the experimental samples. Thus the panelists apparently preferred the acidic indicated by the lower pH (4.6) of the control to the more bland flavor of the experimental samples (pH 4.9 and 5.0). However, insufficient testing was conducted to ascertain if preference expressed was due to acidic flavor or possibly due to other mouth feel characteristics.

Since the ISP added to the mix has functional properties of a thickening and/or emulsifying agent, and no concerted attempt was made to control the soup viscosity, which might have influenced panel members. Additional work in this area is indicated.

CHAPTER V

SUMMARY

Tarhana is a dried soup product produced by first fermenting a mixture of cracked wheat or flour, yogurt, vegetables, and spices, removing the moisture from the fermented mass to provide storage stability and grinding to a fine powder before packaging. Tarhana has been produced and consumed by people of Turkey, Middle East, and the Balkan countries for many centuries, as a basic source of protein in their diet. Tarhana protein is derived mainly from its vegetable ingredients. Thus, the nutritive value of tarhana is deficient in certain amino acids. The purpose of this study was to investigate the fortification of tarhana with ISP, to improve its nutritional balance, and the effect of fortification on consumer acceptance.

1. Addition of ISP to tarhana mix increased the protein content and the calculated quantity of eight essential amino acids.

2. Difference in fat, ash, and yield between the samples, although found to be significant in some instances, possibly reflect a difference due to experimental error or formulations.

3. The addition of ISP profoundly influenced the acidic characteristics of tarhana. Both samples containing ISP displayed slower fermentation and increased pH at the conclusion of 120 hours of fermentation. The pH of the final product was 4.6, 4.9, and 5.0, respectively, for Samples 1, 2, and 3.

4. Both the American and Middle-East panelists expressed a preference for the color and flavor of the non-fortified over the fortified samples. No preference was expressed with regard to aroma.

5. The panelists preferred the sample with the lowest pH most and the sample with the highest pH least. However, insufficient data were available to state if acidic taste was the only quality attribute contributing to preference.

6. Fortification of tarhana is theoretically possible; however, additional work will be necessary in order to gain consumer acceptance.



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LITERATURE CITED

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APPENDIX

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TABLE XI
AVERAGE pH OF THREE TARHANA SAMPLES
RECORDED DURING FERMENTATION

Hour Readings	SAMPLE		
	1	2	3
1st	4.90	5.21	5.40
12th	5.00	5.29	5.50
29th	4.85	5.25	5.38
36th	4.83	5.16	5.27
48th	4.80	5.09	5.26
60th	4.76	5.02	5.22
72nd	4.72	4.96	5.13
84th	4.67	4.92	5.09
96th	4.65	4.89	5.01
108th	4.64	4.89	5.00
120th	4.64	4.90	5.00

TABLE XII
PERCENT OF PRODUCT YIELDED IN THREE TARHANA SAMPLES

REPLICATIONS	SAMPLE		
	1	2	3
I	27.9	30.2	32.5
II	28.4	30.1	33.3
III	27.7	30.5	32.9
Average	28.0	30.3	32.9

TABLE XIII
PERCENT MOISTURE CONTENT OF THREE TARHANA SAMPLES

REPLICATIONS	SAMPLE		
	1	2	3
I	6.23	4.80	5.02
II	6.05	4.66	4.91
III	6.60	4.98	5.39
IV	6.70	4.88	5.24
V	5.45	4.82	4.69
VI	5.52	4.19	4.62
Average	6.09	4.72	4.98

TABLE XIV
PERCENT FAT CONTENT OF THREE TARHANA SAMPLES

REPLICATIONS	SAMPLE		
	1	2	3
I	1.90	1.66	1.38
II	1.88	1.58	1.47
III	1.81	1.47	1.52
IV	1.80	1.50	1.49
V	1.82	1.47	1.84
VI	1.83	1.50	1.85
Average	1.84	1.53	1.59

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TABLE XV
PERCENT ASH CONTENT OF THREE TARHANA SAMPLES

REPLICATIONS	SAMPLE		
	1	2	3
I	7.68	7.88	7.61
II	7.56	7.82	7.74
III	7.46	8.35	7.87
IV	7.51	8.49	7.94
V	7.84	8.25	7.81
VI	7.54	8.21	8.11
Average	7.60	8.17	7.85

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TABLE XVI
PERCENT PROTEIN CONTENT OF THREE TARHANA SAMPLES

REPLICATIONS	SAMPLE		
	1	2	3
I	16.18	22.37	28.47
II	16.32	21.73	28.07
III	16.40	22.68	27.70
IV	16.26	22.58	27.56
V	16.84	22.67	27.65
VI	16.81	22.38	28.03
Average	16.47	22.40	27.91

TABLE XVII

RANKING DIFFERENCE DATA FROM THE FIRST GROUP OF PANELISTS
IN THREE TARHANA SAMPLES

PANELIST NUMBER	PREFERENCE								
	Color			Flavor			Aroma		
	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
1	1*	2	3	1	2	3	2	3	1
2	1	2	3	3	2	1	3	2	1
3	1	3	2	1	3	2	3	2	1
4	1	3	2	1	3	2	3	1	2
5	3	1	2	1	2	3	3	1	2
6	1	2	3	3	2	1	1	2	3
7	1	3	2	1	2	3	1	3	2
8	2	1	3	1	2	3	1	2	3
9	2	1	3	2	3	1	1	2	3
10	1	2	3	1	3	2	1	2	3
11	2	1	3	2	1	3	1	2	3
12	2	1	3	2	1	3	1	2	3
13	1	2	3	2	1	3	1	2	3
14	2	1	3	1	3	2	2	1	3
15	1	2	3	1	2	3	2	1	3
16	1	2	3	2	1	3	1	2	3
17	1	2	3	2	3	1	2	3	1
18	3	2	1	3	2	1	3	2	1
19	1	2	3	2	3	1	2	1	3
20	2	1	3	1	3	2	2	1	3
21	1	3	2	1	2	3	1	2	3

*Choice in number of sample.

TABLE XVIII

RANKING DIFFERENCE DATA FROM THE SECOND GROUP OF PANELISTS
IN THREE TARHANA SAMPLES

PANELIST NUMBER	PREFERENCE								
	Color			Flavor			Aroma		
	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
1	3 *	1	2	2	3	1	1	2	3
2	1	3	2	2	1	3	3	2	1
3	2	3	1	1	2	3	3	1	2
4	1	3	2	2	3	1	2	3	1
5	1	2	3	1	3	2	1	2	3
6	1	2	3	2	3	1	2	1	3
7	1	2	3	1	2	3	2	3	1
8	1	2	3	1	3	2	3	1	2
9	1	2	3	1	2	3	1	3	2
10	2	1	3	1	2	3	1	3	2
11	1	2	3	2	3	1	1	2	3
12	1	2	3	1	3	2	3	1	2
13	1	2	3	1	2	3	2	1	3
14	1	2	3	1	2	3	2	1	3
15	1	2	3	1	3	2	2	1	3

*Choice in number of sample.

GRADING CHART FOR TARHANA SOUP

DATE _____

NAME _____

You will receive three Tarhana samples. Please arrange the samples in the following columns which express your opinion of each one.

	<u>Color</u>	<u>Flavor</u>	<u>Aroma</u>
1st Choice	_____	_____	_____
2nd Choice	_____	_____	_____
3rd Choice	_____	_____	_____

COMMENTS:



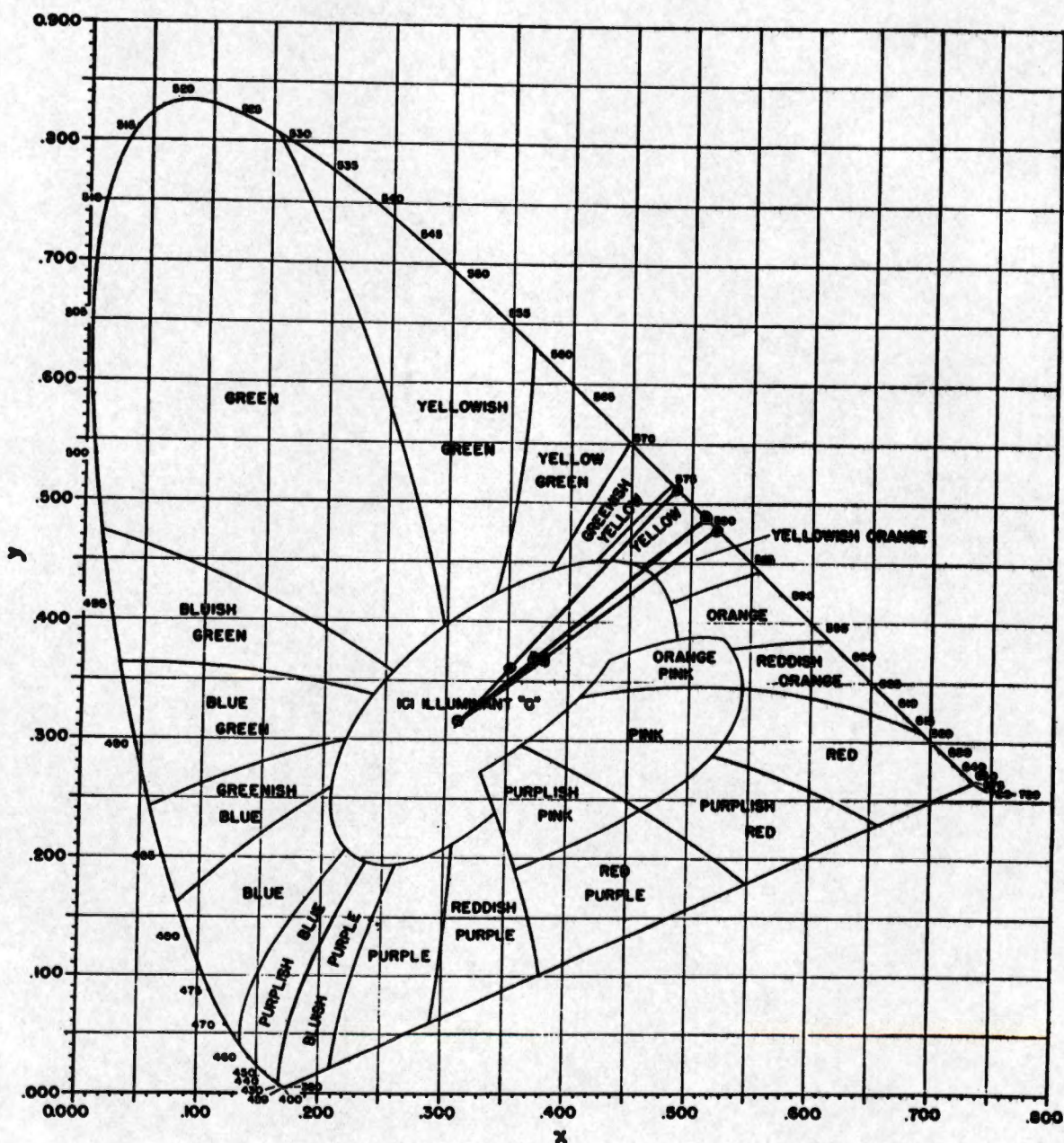


Figure 2. The (x,y)-chromaticity diagram of the ICI system.

VITA

The author was born in Denizli, Turkey, on December 3, 1938. He was graduated from Denizli High School, Denizli, Turkey, in 1958. From 1959 to 1965 he attended Veterinary College of Ankara University, Ankara, Turkey, where he received a Veterinary Medicine Degree. In February, 1966, he arrived in the United States on a scholarship plan sponsored by the Turkish Government. He attended New York University English Language School until he began studying toward a Master of Science degree in Food Technology in the College of Agriculture of The University of Tennessee in January, 1967. Since then, he has been working to complete the requirements for the degree of Master of Science.