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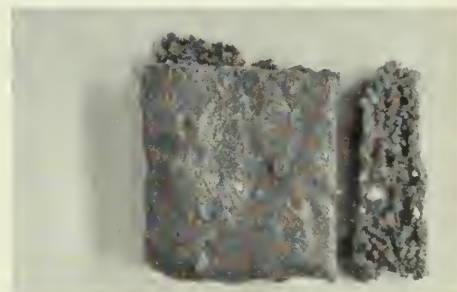
Development and Acceptability of Four Protein-Fortified Foods to Supplement the Iranian School Lunch Program



Filled



Toffee



Brownie



Oatmeal

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Development and Acceptability of Four Protein-Fortified Foods to Supplement the Iranian School Lunch Program

Daily caloric intake of Iranians tends to be low by United States standards.¹ Surveys have indicated that average daily per capita caloric intake is about 2,450 kilocalories---less than is recommended for adult males.² Only 55% of Iranian households were able to meet minimum caloric requirements, and per capita levels of consumption appear to differ by locale and environment, being

lower in cities than in rural areas and decreasing about 10% in rural areas in winter because of food shortages caused by lack of preservation facilities and transportation difficulties.

Malnutrition is not uncommon in Iran. Food grains and cereal products provide a substantial part of caloric and protein intake. The protein consumed in Iran may be of low biological value because of the

low and/or deficient amino acid content of grains and cereals. Development of a protein-fortified food with the complementary essential amino acids of soybeans, peanuts, milk, whey and eggs would result in a source of protein more conducive to the promotion of growth and health of Iranian children.

Initiation of Project

The Governor of the State of Mississippi led a trade mission to several Middle East countries in spring 1975 and was made aware of a plan by the Iranian government to initiate a program to provide a protein-fortified food supplement to each of that country's 6 million school children 6 days each week of the 9-month school year. The Governor realized that part or all of the protein-fortified food supplement could be supplied by Mississippi farmers, with a 2-ounce portion served to this many

children that often for that long requiring about 175 million pounds of raw materials each year. However, Iranian officials had made no decision as to product identity at that time.

The Governor called the Director of the Mississippi Cooperative Extension Service (MCES) on April 30, 1975 and requested that a committee of scientists meet with him on May 1. This committee was to evaluate the concept of developing high-protein foods that would meet the specifications established

by Iranian government officials. Personnel of the MCES Food and Fiber Center³ were assigned to work with the Governor on the project.

The directive from the Governor was to prepare several products according to specifications, to conduct tests for determining their acceptance, and to have products ready for evaluation by Iranian officials in a few weeks. Specifications to be met per serving (2-4 oz) of the protein-fortified products were to: (1) provide about

¹*Economics Research Service, United States Department of Agriculture, Iranian Agricultural Production and Trade (ERS-Foreign 357)*

²*Based on recommended Dietary Allowances (revised 1973) and the Food and Agriculture Organization (1974) standards.*

³*The Food and Fiber Center was organized as part of the Cooperative Extension Service with specific responsibility for conducting programs for processors and handlers of agricultural products and for assisting in the development of new products and new industries for Mississippi. Food and Fiber Center personnel are drawn from different academic disciplines and are capable of working with agribusiness firms in all phases of business functions, including product technology, progress flow, material handling, management, marketing, finance and accounting.*

one third of a child's daily recommended dietary allowance of balanced protein, (2) provide 200-400 kilocalories and other essential nutrients, (3) remain acceptable for several months during transportation, storage and distribution, (4) endure rough handling at extreme temperatures, (5) require no refrigeration, (6) be individually wrapped for protection of the product, (7) be convenient to eat, (8) have a dry, non-sticky exterior without frosting, (9) have a sweet chocolate flavor, (10) be enjoyed by children, and (11) cost not more

Scientists from various departments submitted formulations to be evaluated tentatively for nutritional content, flavor, cost and suitability for shipping. Formulations were eliminated rapidly until four protein-fortified foods---a sweet potato wafer with a filling, a toffee bar, a brownie bar and an oatmeal bar---were selected for complete evaluation.

The sweetened bars were modeled after the American "Fudge Brownie". The filled wafer was shaped like the "Moon Pie". Ingredients used that were familiar to Iranians were wheat flour, milk solids other than whey, whole eggs, sweetening agents, nuts and flavorings (Table 1). Those ingredients less familiar to Iranians were soybean constituents, whey solids, oats, sweet potato, peanut butter and chocolate. Chocolate flavor in many Middle East countries has been simulated by use of carob, a leguminous bean with chocolate flavor but containing no chocolate.

All ingredients for each formulation of the filled wafer and the sweetened bars were weighed on a top-loading Mettler balance scale and mixed by a standardized

than 18 cents per serving delivered to children in Iran.

Nutritionists, food technologists and marketing specialists from the Mississippi Agricultural and Forestry Experiment Station (MAFES), MCES specialists and a number of Mississippi State University administrators participated.⁴ Support was drawn from a number of departments---including Home Economics, Animal Science, Dairy Science, Poultry Science, Marketing, Food and Fiber, Horticulture, Information, and Research and Develop-

Product Development

procedure, using a 10-speed, Model K-45 Kitchen-Aid® mixer. Raw batter for the filled wafer was weighed, cut into 3-oz portions and baked in a conventional oven at 350°F for 12-15 minutes. The wafer was allowed to cool after removal from the oven and was weighed to determine cooked weight and amount of moisture lost during cooking. Raw batter for the sweetened bars was weighed, baked in a conventional oven at 325-350°F for 20-30 minutes, cooled, reweighed to determine cooked weight and moisture loss during cooking and then cut into 2-oz. portions.

The filled sweet potato wafer was prepared using a basic cookie recipe with part of the wheat flour replaced by sweet potatoes and soy flour. Soy flour was substituted (on a weight basis) at the rate of 16% of the wheat flour. The sweet potatoes were canned local Mississippi varieties. Spices were used to improve flavor.

Initial filling for the wafer consisted of peanut butter, honey and non-fat dry milk solids. Ingredients tried later included chocolate-flavored peanut butter, soy nuts, whey solids, corn syrup and oatmeal. All formulations were subjected to taste panel

ment.

Every effort was made to use available resources in developing products to satisfy Iranian food habits. Several Iranians enrolled as students at Mississippi State University provided information about food habits and participated in product evaluation. Additional information was supplied by the United States Department of Agriculture, Foreign Agricultural Service employees who had traveled in Iran.

evaluations and fillings containing flavored peanut butter, soy nuts and oatmeal were eliminated.

Cost of producing the fillings could have been reduced by replacing honey with corn syrup and non-fat dry milk with whey solids (retail prices of ingredients at the time of development were: corn syrup, 39¢/lb; Honey, 81¢/lb; whey solids, 11¢/lb and NFDM, 60¢/lb). Therefore, a number of formulations were prepared from the three basic ingredients, with different rates of substitution of corn syrup for honey and whey solids for non-fat dry milk. Taste panelists preferred the filling with no corn syrup because the sweetness of honey counteracted the tartness of whey. However, a filling containing some corn syrup was acceptable to taste panelists and the final formulation consisted of the three basic ingredients plus corn syrup and whey solids.

Filling for the wafer was baked and ingredients were weighed and mixed to obtain a consistency that would spread on the wafer. The completed product consisted of 1.32 oz. wafer and 0.66 oz. filling.

Variations of several basic cookie recipes were used in preparing the toffee, brownie and oatmeal

⁴See inside front cover for a list of personnel who collaborated with the research team in developing and evaluating the products.

Table 1. Ingredients used and approximate percentage of ingredients indigenous to Mississippi in four protein-fortified foods prepared for Iranian school children by Mississippi State University, 1975.

TOFFEE BAR

Ingredients:

Semi-Sweet Chocolate Morsels
 Corn Syrup
 Flour, All Purpose, Enriched
 Sugar, Brown
 Margarine
 Peanuts
 Egg, Whole
 Honey
 Non-Fat Dry Milk Solids
 Soy Concentrate
 Butter Flavoring
 Imitation Vanilla Flavoring
 Lecithin
 Potassium Sorbate
 Tenox 6

Total Mississippi Products 41%

BROWNIE BAR

Ingredients:

Sugar, White, Granulated
 Egg, Whole
 Oil
 Peanuts
 Flour, All Purpose, Enriched
 Corn Syrup
 Soy Flour
 Cocoa
 Whey Solids
 Non-Fat Dry Milk Solids
 Imitation Vanilla Flavoring
 Salt
 Butter Flavoring
 Lecithin
 Potassium Sorbate
 Tenox 6

Total Mississippi Products 46%

OATMEAL BAR

Ingredients:

Oats, Quick
 Egg, Whole
 Sugar, White, Granulated
 Milk Chocolate Morsels
 Sugar, Brown
 Oil
 Peanuts
 Flour, All Purpose, Enriched
 Corn Syrup
 Non-Fat Dry Milk Solids
 Soy Flour
 Salt
 Imitation Vanilla Flavoring
 Butter Flavoring
 Lecithin
 Potassium Sorbate
 Tenox 6

Total Mississippi Products 37%

**SWEET POTATO WAFER
 WITH FILLING**

Ingredients:

Sugar, White, Granulated
 Sweet Potato
 Soy Flour
 Flour, All Purpose, Enriched
 Egg, Whole
 Vegetable Shortening
 Vanilla Extract
 Salt
 Peanut Butter
 Corn Syrup
 Whey Solids
 Non-Fat Dry Milk Solids
 Honey

Total Mississippi Products 53%

bars. Protein content was increased by replacing part of the wheat flour with defatted soy flour, soy concentrate, non-fat dry milk and whey solids alone or in combination. Substitution with soy ingredients ranged (on a weight basis) from 21 to 51% of the wheat flour. Part of the sugar was replaced with other sweetening agents and traditional shortenings were replaced with a mixture of vegetable oils. Imitation flavorings were used rather than pure extracts. Using no liquid ingredients other than whole eggs, flavorings and limited quantities of honey or corn syrup resulted in a thick, dry batter; therefore, vegetable oil was added to improve handling and increase degree of unsaturation in 2 of the products.

The filled sweet potato wafers produced with the first combination of ingredients (Formulation 1) and the toffee bars, brownie bars and oatmeal bars produced with the first two combinations of ingredients (Formulation 1 and Formulation 2) failed to meet the specifications stipulated in the Governor's directive. However, evaluations of these formulations are presented below for future reference.

Formulation 1---Samples of each of the four protein-fortified foods produced with the first combinations of ingredients were wrapped in heat-sealable, coated cellophane and hermetically sealed in tin cans for storage at 100° F for

3 weeks, to simulate 3-months exposure to the Iranian climate. Also, duplicate samples were stored at room temperature (70° F). Sensory evaluations (using flavor profile, hedonic scale and ranking procedure) were made after 1, 2 and 3 weeks of storage. Deterioration in appearance and color (color fading and cracking) of each product had started after 7 days in storage and was appreciable after 35 days of storage (Figures 1, 2, 3 and 4). Sensory evaluation scores of each product also were low. Therefore, another combination of ingredients (Formulation 2) was used for each product.

Formulation 2---The major change from Formulation 1 to Formulation 2 of all products was the addition of whole egg and sweetening agents other than sugar in an attempt to avoid moisture loss. Also, five kinds of sweet potato wafers were produced ---plain, spiced and orange-flavored with filling; spiced and orange-flavored without filling. The filling was the same as that used in Formulation 1.

Two batches of each bar and of each kind of sweet potato wafer were baked---one with no additive; the other with a preservative,⁵ an antioxidant⁶ and an emulsifier.⁷ Samples of each batch were wrapped in heat-sealable, coated cellophane and hermetically sealed in tin cans for storage at 100° F.⁸

Appearance and texture of the sweet potato wafers with additives

were satisfactory after 7 days storage at 100° F (Figure 1) but the filled wafers without lecithin were dry and crumbly. Taste panelists' flavor ratings were highest for the plain filled wafer, with the spiced wafer in third place just behind the orange-flavored wafer.

The toffee, brownie and oatmeal bars without additives were crumbly after 17 days of storage at 100° F (Figures 2,3 and 4). Texture and body of the bars with additives were satisfactory after 17 days storage at this temperature. The addition of lecithin and whole egg no doubt influenced the results. They served as emulsifiers and caused better distribution of shortening in the batter. Sensory evaluations were generally satisfactory, but results of the evaluation and comments by taste panelists indicated a need for additional minor modifications in the formulation of the bars.

Formulation 3---The second combination of ingredients used in the three bars was modified slightly using results of the evaluation and comments of taste panelists as a guide. Batches of each bar were baked and sealed for storage at 100° F as were the bars of earlier formulations. Appearance and texture of the bars formulated with additives were acceptable after 7 days of storage and there was little or no crumbling or drying (Figures 2,3 and 4). Flavor of the bars was rated acceptable by taste panelists.

Product Evaluation

The Formulation 2 plain, spiced and orange-flavored sweet potato

wafers with filling and the Formulation 3 oatmeal, toffee and

brownie bars were selected for further evaluation before shipment.

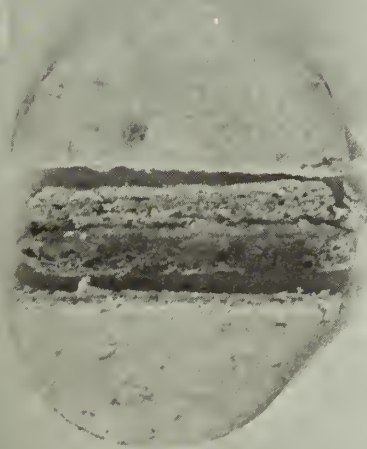
⁵Potassium sorbate at 0.05% of total ingredient weight.

⁶Tenox 6[®] at 0.02% of total lipid weight.

⁷Sta-Sol (soy) Lecithin Concentrate[®] at 0.01% of shortening weight. This was not added to the sweet potato wafers.

⁸Appearance and sensory evaluation scores of the first formulation of each product were poorest for those stored at the higher temperature; consequently, no products of Formulation 2 or subsequent formulations were stored at room temperature.

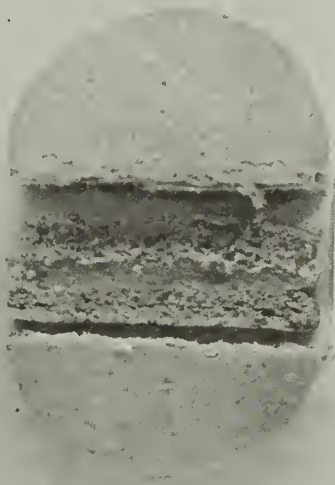
WITHOUT PRESERVATIVE



35 DAYS

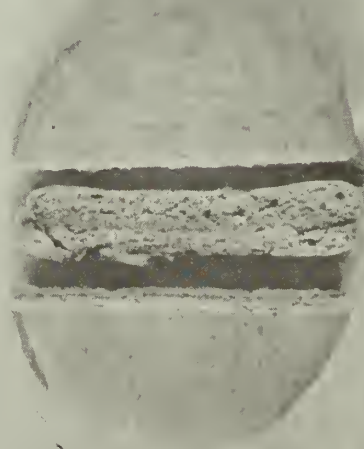
70° F

FILLED



35 DAYS

100° F



7 DAYS

100° F

WITH PRESERVATIVE



FRESH

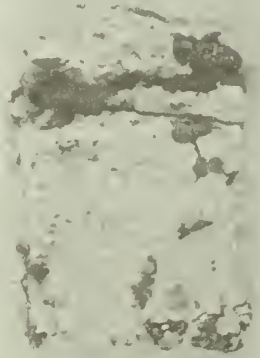
Figure 1. Formulations of the sweet potato wafer with a filling (first formulation photographed 35 days after baking, second formulation photographed 7 days after baking and immediately after baking).

WITHOUT PRESERVATIVE



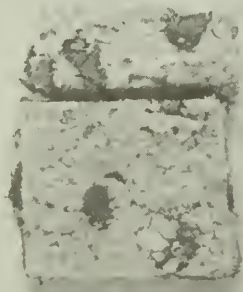
17 DAYS

100° F



35 DAYS

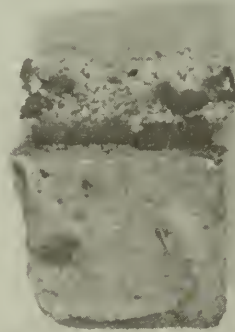
70° F



35 DAYS

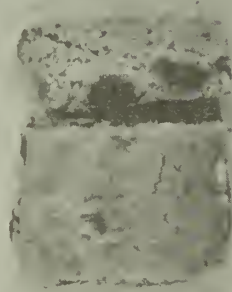
100° F

TOFFEE



17 DAYS

100° F



7 DAYS

100° F



FRESH

WITH PRESERVATIVE

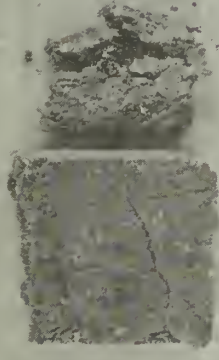
Figure 2. Three formulations of the toffee bar (first formulation photographed 35 days after baking, second formulation photographed 17 days after baking, third formulation photographed 7 days after baking and immediately after baking).

WITHOUT PRESERVATIVE



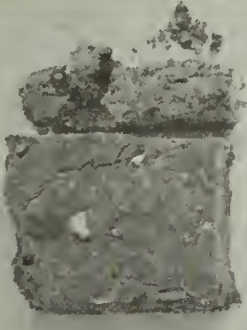
17 DAYS

100° F



35 DAYS

70° F



35 DAYS

100° F

BROWNIE



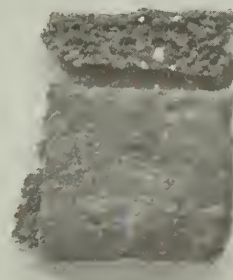
17 DAYS

100° F



7 DAYS

100° F

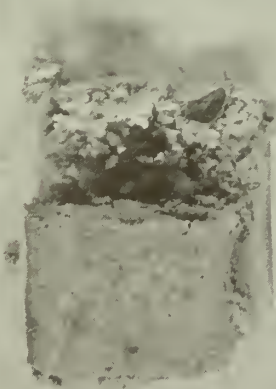


FRESH

WITH PRESERVATIVE

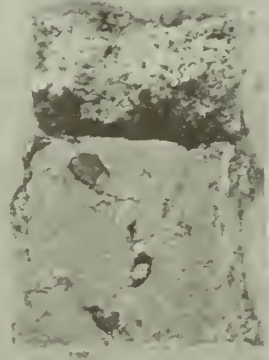
Figure 3. Three formulations of the brownie bar (first formulation photographed 35 days after baking, second formulation photographed 17 days after baking, third formulation photographed 7 days after baking and immediately after baking).

WITHOUT PRESERVATIVE



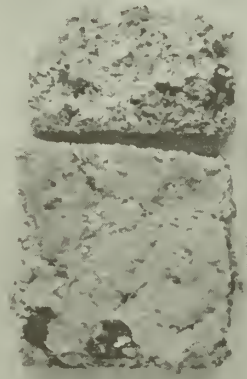
17 DAYS

100° F



35 DAYS

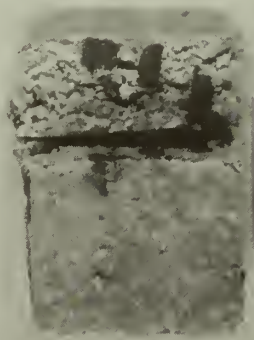
70° F



35 DAYS

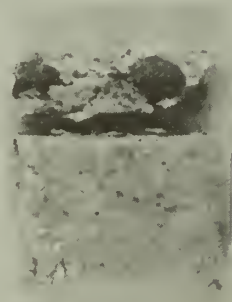
100° F

OATMEAL



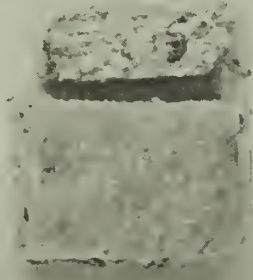
17 DAYS

100° F



7 DAYS

100° F



FRESH

WITH PRESERVATIVE

Figure 4. Three formulations of the oatmeal bar (first formulation photographed 35 days after baking, second formulation photographed 17 days after baking, third formulation photographed 7 days after baking and immediately after baking).

Table 2. Test panel rankings of the overall eating quality of protein-fortified toffee, oatmeal and brownie bars and their nearest commercial facsimiles, after storage at 100° F for 1 and 3 weeks.

Product	Material Wrap ¹	Ranking ²	
		After storage for	
		1 week	3 weeks
Protein-Fortified Toffee Bar ³	Coated Cellophane	2.22	2.33
Protein-Fortified Oatmeal Bar	Coated Cellophane	2.44	3.78
<i>Commercial Oatmeal Facsimile</i>	<i>Original</i>	4.33	3.89
<i>Commercial Oatmeal Facsimile</i>	<i>Coated Cellophane</i>	3.56	4.00
Protein-Fortified Brownie Bar	Coated Cellophane	4.89	4.56
<i>Commercial Brownie Facsimile</i>	<i>Original</i>	5.00	5.00
<i>Commercial Brownie Facsimile</i>	<i>Coated Cellophane</i>	5.56	4.44

¹ The commercial facsimiles in their original wrap and wrapped in heat-sealable coated cellophane were hermetically sealed in tin cans.

² Lowest score indicates best overall quality characteristics.

³ A commercial facsimile could not be obtained.

Iran. No change was made in the formulation of the wafers and the brownie bar, but real chocolate morsels were substituted for the chocolate-flavored baking chips used in the Formulation 3 toffee and oatmeal bars. All products were prepared with the additives used in earlier formulations. Samples of each product were baked, wrapped in heat-sealable, coated cellophane and hermetically sealed in tin cans for storage at 100° F.

Appearance and texture of each product immediately after baking were better (less dryness and crumbliness) than for products of earlier formulations (Figures 1, 2, 3 and 4). The wafers were dryer and more crumbly at the end of each week of four weeks of storage. Appearance and texture of the other products were satisfactory after four weeks of storage.

Sensory evaluations were made of each product after 1, 2, 3 and 4 weeks of storage. A two-part evaluation procedure was used: (1) comparison of the overall eating

quality of each protein-fortified bar with that of the nearest commercial facsimile and (2) determination of specified quality characteristics and overall eating quality of each protein-fortified bar and wafer, using a hedonic scale.

The protein-fortified toffee bar consistently ranked higher than all other products evaluated (Table 2); the commercial brownie and the protein-fortified brownie ranked lowest. All of the protein-fortified bars were rated about as good or superior to their commercial counterparts after 3 weeks of storage. All products in unsealed wrapping were extremely hard and dry after 3 weeks of storage. The taste panel ratings of overall eating quality of the protein-fortified products were highest for the toffee bars, followed in decreasing order by the brownie bar, the oatmeal bar and the spiced, plain and orange-flavored filled wafers (Table 3). Ratings of overall eating quality of the plain and spiced wafers were higher after 4 weeks of storage. Appearance, body and

texture and mouthfeel of the brownie were rated as having improved with storage.

All sensory evaluations reported above were made by adult taste panelists.⁹ However, the products tested were developed for feeding to Iranian school children. Therefore, sensory evaluations were conducted with two groups of children (1) day-care nursery children ranging in ages from 3 to 9 years and (2) 4-H Club members ranging in ages from 12 to 17 years.

The day-care nursery children were offered a 1¼-oz serving of the three bars and the spiced wafer on two successive days at the regular 9 AM and 3 PM snack times. A glass of beverage was offered with each serving and a different high-protein fortified product was served each time. Each child was given an evaluation form (Figure 5) and instructed to color the face that best expressed their feelings about the product.

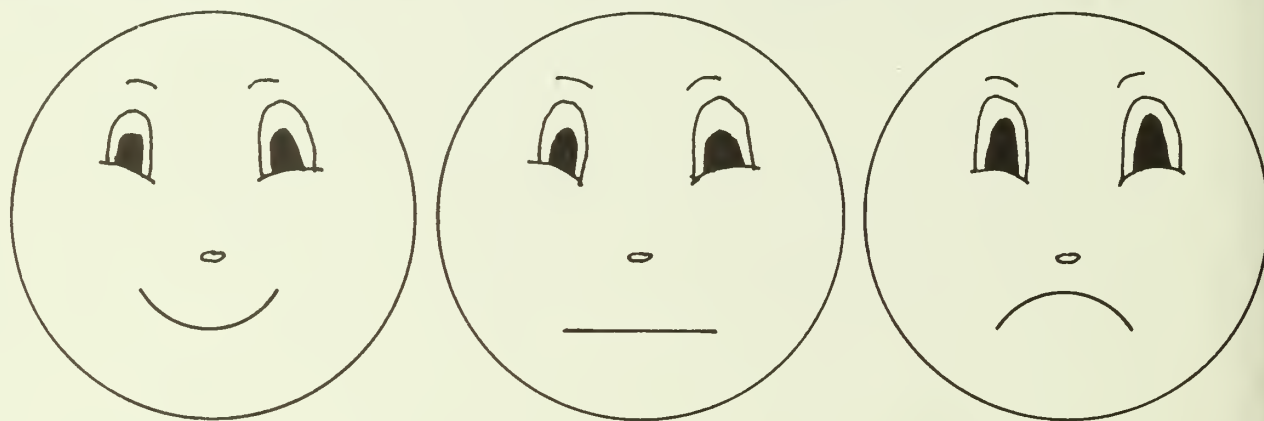
The nursery teacher and one of the investigators helped the children check the appropriate

⁹ Some panelists were familiar with soy flavor, others were not.

Table 3. Results of taste panel evaluations of protein-fortified products after 1 and 4 weeks of storage at 100° F.¹

Product	Quality Characteristics								Overall Eating Quality	
	Appearance		Body & Texture		Mouthfeel		Flavor			
	1 week	4 weeks	1 week	4 weeks	1 week	4 weeks	1 week	4 weeks	1 week	4 weeks
Bars:										
Brownie	4.63	5.26	5.31	5.46	4.88	5.33	4.63	4.53	5.00	4.80
Oatmeal	5.63	5.26	5.88	5.13	5.38	4.80	5.63	4.33	5.64	4.80
Toffee	5.88	5.73	5.88	5.53	5.88	5.40	5.75	4.46	5.86	4.86
Wafer with Filling:										
Plain	4.25	4.40	3.38	3.80	3.63	4.06	4.50	3.73	3.25	3.80
Spiced	4.38	4.53	3.25	3.86	3.88	4.20	4.50	4.26	3.79	3.93
Orange-flavored	3.88	4.40	2.88	3.80	3.50	4.33	4.63	3.60	4.00	3.46

¹excellent = 7; very good = 6; good = 5; medium = 4; fair = 3; poor = 2; very poor = 1



CONSUMED: All _____ 3/4 _____ 1/2 _____ 1/4 _____ None _____

Figure 5. Sensory evaluation form used for children 3-9 years of age.

Table 4. Evaluation of 4 protein-fortified foods by 3- to 9-year-old day-care nursery children

Product	Sample Size No.	Rating			Portion Consumed				
		Liked	Indifferent	Disliked	All	3/4	1/2	1/4	None
		%	%	%	No.	No.	No.	No.	No.
Oatmeal Bar	16	88	6	6.25	10	2	2	2	0
Brownie Bar	15	100	0	0	15	0	0	0	0
Toffee Bar	20	90	5	5.00	19	0	0	1	0
Spiced Wafer with Filling	19	89	10	0	18	0	1	0	0

blank at the bottom of the form. The children were not told what the products were or why they were

served something different than the usual. The percentage of children indicating that they liked

the products ranged from 88 for oatmeal bar to 100 for the brownie bar (Table 4).

Table 5. Evaluation of 4 protein-fortified foods by 12- to 17-year-old 4-H Club members.

Reactions	Oatmeal	Brownie	Toffee	Spiced Wafer with filling
	%	%	%	%
I would frequently eat	28	28	24	0
I like and would eat now and then	28	12	32	20
Sub-Total	56	40	56	20
I would eat if available, but would not go out of my way	20	28	12	20
Sub-Total	76	68	68	40
I do not like, but would eat on occasion	8	4	24	16
I would hardly ever eat	16	28	8	44
Sub-Total	24	32	32	60

Table 6. Evaluation of 4 protein-fortified foods by 9- to 12-year-old students in 3 Iranian schools.¹

Evaluation	Brownie	Toffee	Oatmeal	Filled Wafer
	%	%	%	%
Excellent	32	44	49	24
Good	18	29	24	24
Fair	30	17	13	22
<i>Excellent good and fair</i>	<i>80</i>	<i>90</i>	<i>86</i>	<i>70</i>
Bad	20	10	14	30

¹Frah City School, Tehran, Iran; Debestan Said Naficy School, 15 miles from Tehran, Iran; Dr. Reazazadeh Shangl School at Khoy, West Azarbajjan, Iran.

The 4-H Club members were served the three bars and the spiced wafer at the same time and asked to indicate how frequently they would eat each. The percentage who found the products acceptable, as indicated by how often they would consume them, ranged from 40 for the spiced filled wafer to 76 for the oatmeal bar (Table 5).

Evaluation of the products by day-care nursery children and 4-H Club members was completed in September 1975. Quantities of each product sufficient for evaluation by Iranian school children were baked, wrapped, and labeled for shipment. The Iranian government did not require nutritional information on the label; therefore, only the name of each product, ingredients contained and the name of the developer were listed.

The Governor organized and led

another trade mission to the Middle East in October and scheduled a private conference for presenting samples of the products to the Prime Minister of Iran when in that country. Two members of the team (Ammerman and Rosenberger) helped with development of the products, participated in the trade mission and conducted taste panel tests with 9- to 12-year-old boys and girls in three Iranian schools---one urban, one suburban and one in a remote rural area.

The cookies were sampled by officials of the Iranian Government and were judged suitable for the school lunch program by the staff of the Ministry of Commerce and by Dr. Taranchi of the Institute of Nutrition. Taste panel tests were administered by the teacher in charge of each room,

with the assistance of Iranian school officials.

Children in each room were presented the cookies and a form for checking their evaluation of them, but were not told that the cookies had been developed in and brought from the United States or that they were in any way unusual or different from snacks then being served in the school lunch program. They were instructed to evaluate the cookies by checking excellent, good, fair or bad on the form.

Data were tabulated with the help of one of the Iranians who had translated the form and helped administer the test. We were told by Iranian officials that cookies rated fair or better would be accepted by the children.

The percentage of Iranian children who rated the cookie

acceptable ranged from 70 for the spiced filled wafer to 90 for the toffee bar (Table 6). Results of the taste panel tests with Iranian children were very similar to those with United States children.¹⁰

Response of Iranian Govern-

ment officials was positive and enthusiastic. The Governor was confident that a sale had been made and, after the trade mission returned to the United States, initiated a contract between the Mississippi Board of Trustees for

Institutions of Higher Learning and a Mississippi company with experience in international trade. The contract granted exclusive domestic and international distribution rights to that company.

Nutritive Value of the Protein-Fortified Products

The calculated kilocalorie content of the protein-fortified products was 232, 226, 234 and 248 for the toffee bar, the brownie bar, the oatmeal bar and the filled wafer, respectively (Table 7). Calculated protein content ranged from 5.01 grams for the filled wafer to 5.96 grams for the oatmeal bar. All products contained an assortment of essential nutrients--calcium, phosphorus, iron, Vitamin A, Thiamin, riboflavin, niacin, Vitamin C, zinc and magnesium. The filled wafer contained an abundance of Vitamin A because of its sweet potato content.

All products were analyzed for protein and values were slightly higher than those calculated. Amino acid content (except for lysine and methionine) of the oatmeal bar compared favorably with that of whole egg and casein and was considerably higher than that of wheat flour, except for proline.

The protein-fortified brownie bar contained fewer kilocalories, less fat, and more protein than facsimiles with which it was compared--home recipe, commercially frozen, incomplete box mix to which eggs and nuts were to be

added (Table 8). The protein-fortified brownie could be used effectively in diets restricted in saturated fats because its fat content was primarily polyunsaturated soy oil. Carbohydrate content of the protein-fortified brownie was lower than that of most facsimiles and this could be helpful in preventing dental problems, particularly if consumed daily by children.

The protein supplied by a serving of the toffee, brownie and oatmeal bars and the filled sweet potato wafer would provide 20 to 24% of the Daily Recommended

Table 7. FAO recommended nutrient intake of a 7- to 9-year-old child and calculated nutrient content of a 2-oz portion of 4 protein-fortified foods.

Nutrient		FAO Standards for 7-9-year old ¹	Toffee	Brownie	Oatmeal	Filled Wafer
Kilocalories		2,190	231.78	225.97	234.45	247.50
Protein	g	25	5.32	5.34	5.96	5.01
Fat	g		11.76	10.05	10.61	6.50
Carbohydrate	g		29.78	31.10	30.74	34.01
Moisture	%		12.27	14.78	13.91	15.00
Calcium	mg	400-500	56.92	49.90	68.59	87.44
Phosphorus	mg		93.25	100.57	122.84	114.25
Iron	mg	5-10	1.30	1.21	1.42	1.03
Sodium	mg		56.92	83.34	82.72	330.72
Potassium	mg		159.46	160.80	195.65	118.42
Vitamin A	i.u.	1,333	270.36	103.39	102.12	595.96
Thiamin	mg	0.9	0.105	0.12	0.14	0.10
Riboflavin	mg	1.3	0.071	0.12	0.11	0.18
Niacin	mg	14.5	1.24	1.10	0.97	1.58
Vitamin C	mg	20	0.21	0.09	0.15	1.01
Zinc	mg		0.52	0.60	0.77	0.62
Magnesium	mg		32.91	35.63	36.27	38.84

¹Source: The Handbook of Human Nutritional Requirements, published by FAO and WHO, Rome, Italy, 1974.

¹⁰A detailed report of results of the evaluation is contained in MAFES Research Report, Vol. 2, No. 1.

Table 8. Calculated nutrient content of a 2-oz protein-fortified Brownie bar and selected facsimilies.

BROWNIE BARS				
Nutrients	Protein-fortified	Home Recipe ¹	Frozen Commercial ²	Incomplete Box Mix ³
Kilocalories	225.97	269.00	238.00	243.00
Protein g	5.34	2.80	2.78	2.84
Fat g	10.05	17.00	12.00	11.00
Carbohydrate g	31.20	28.00	34.00	36.00
Calcium mg	49.90	23.00	23.00	26.00
Iron mg	1.21	1.13	0.85	1.13
Vitamin A i.u.	103.39	113.00	125.00	57.00
Thiamin mg	0.12	0.11	0.05	0.09
Riboflavin mg	0.12	0.056	0.05	0.06
Niacin mg	1.10	0.28	0.17	0.28
Ascorbic Acid mg	0.09	trace	trace	trace

¹Nutritive Value of Foods, Home and Garden Bulletin No. 72, U.S.D.A., 1971.

²Composition of Foods, Agriculture Handbook No. 8, U.S.D.A., 1963.

³Nutritive Value of American Foods in Common Units, Agriculture Handbook No. 456, U.S.D.A., 1975.

Includes eggs and nuts in calculations.

Allowance for a 7- to 9-year-old child (Table 7). A 2-oz portion of the filled sweet potato wafer would supply about 45% of the daily Vitamin A requirements of children of this age. The protein efficiency ratio (PER) of all protein-fortified products should be conducive to promotion of growth of children.

Cost of Protein-Fortified Product

Based on wholesale prices of ingredients in May-August 1975, the cost of producing a 2-oz portion of the toffee brownie and oatmeal bars and the filled sweet potato wafer was 3.74, 2.31, 3.05 and 4.00 cents, respectively (costs of additives and salt not included). Cost of each product was below the specified 18 cent maximum after adding estimates of labor, packaging and shipping costs.

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In conformity with Title IX of the Educational Amendments of 1972 and Section 504 of the Rehabilitation Act of 1973 Dr. T. K. Martin, Vice President, 610 Allen Hall, P. O. Drawer J, Mississippi State, Mississippi 39762, office telephone number 325-3221, has been designated as the responsible employee to coordinate efforts to carry out responsibilities and make investigation of complaints relating to nondiscrimination.

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