TECHNICAL REPORT

70-29-FL

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AD 702 959

MAXIMUM VARIETY FROM FEEDING UNIT OF LOW WEIGHT AND BULK

by

James Blodgett

The Pillsbury Company

Minneapolis, Minnesota 55414

Contract No: DAAG 17-68-C-0148

November 1969

UNITED STATES ARMY

NATICK LABORATORIES

Natick, Massachusetts 01760

U.S. ARMY MATERIEL COMMAND

Food Laboratory

FL-103

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FOREWORD

A previous report, FL-64 (1), October 1967 (AD 662060), described the development of components and demonstrated the feasibility of a novel feeding system based on reversibly compressed, dehydrated food bars and cubes of concentrated sauces and seasonings. Bars and cubes weighing a total of 10 pounds were efficiently packed in a box of 408 cubic inches. By hydrating and mixing bars and cubes in prescribed combinations, 32 familiar meal items were prepared in servings averaging [illegible]00Kcal. From the standpoints of calories per unit volume and the variety of familiar foods potentially available, this bar and cube feeding module offers a unique advantage over any system heretofore described. Examination of rehydrated items prepared from this module suggested the need for improving the acceptability of a number of these items. The current investigation is primarily directed to this objective.

In addition, it was also apparent that measures should be taken to eliminate or reduce the mechanical breakage and attrition of the bars and cubes in the packed module. As a consequence effort was also directed to the development and application of edible coatings and their effectiveness for the purpose indicated.

In assessing the circumstances surrounding the projected use of the referenced feeding module, recognition was given to the possibility that stresses may preclude diversion of time or attention from the preparation of meal items by rehydration and mixing of bars and cubes. For such contingencies, effort was also directed toward the development of food bars which could be eaten as a bar without rehydration, or, as time permitted, could also be rehydrated to yield a familiar food.

The experimental effort described herein was performed at the Research and Development Laboratories of The Pillsbury Company, Minneapolis 55414 under Contract Number DAAG 17-68-C-0148. Funds were provided by the National Aeronautics and Space Administration under customer order number R-22-015-004. Dr. Jack R. Durst and Mr. Morris H. Katz served as Principal Investigators. They were assisted by Mr. James C. Blodgett. Project Officer and Alternate Project Officer for the U.S. Army Natick Laboratories were Dr. Maxwell C. Brockmann and Mrs. Mary V. Klicka, respectively.

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Abstract

This project was originated to: 1) improve organoleptic acceptability and performance of the meal items developed during the course of work on NLABS contract number DA19-129-AMC-860(N), 2) develop 5 dual function food bars and 3) develop a coating material(s) and methods of application to prevent fragmentation of the components.

Information is presented for the preparation of 7 improved food bara and 11 improved adjunct cubes which, when combined in defined combinations, yield 32 familiar meal items.

Five dual function food bars were also prepared. Dual function bars may be consumed "as ia" or hydrated to yield a familiar food item.

Two coatings were prepared which, when applied to the food bars and adjunct cubes, prevent attrition and fragmentation during handling.

Meal items prepared from the above coated components which had been stored for four montha at 38 degrees C. in N_2 filled cans were found acceptable when evaluated by a 30-man panel.

Hedonic ratings for the prepared meal items before and after storage with data on microbiclogical and moisture changes during storage and data to indicate coating effectiveness are also given.

INTRODUCTION

The objectives of this project are threefold: 1) improved organoleptic acceptability and performance of the meal items formulated during the course of work on NLABS contract number DA-19-129-AMC-860(1)(N), 2) development of five dual function food bars; that is, bars which have a high degree of acceptability when eaten as is or after hydration, and 3) development of a coating material(s) and application system to prevent attrition and fragmentation of the above components during storage and handling.

In the above contract it was demonstrated that from a system comprised of 10 types of food bars and 12 adjunct cubes, a total of 45 different meal items could be prepared, each meal item yielding approximately 600 calories. In addition, the food bars and adjunct cubes were prepared so that the system had a caloric density of 2.57 Kcal per cc and was microbiologically stable and organoleptically acceptable when stored 13 weeks at 38 degrees C. in foil pouches.

It was felt that the system could be optimized by improving acceptability through formulation and the development of a suitable coating material to prevent attrition and fragmentation during storage and handling.

To this end the following 7 bars were formulated to have improved acceptability: beef, pork, chicken, turkey, potato, rice, and mixed vegetable.

The bars were prepared from freeze dried foods with materials added to improve performance in the compressed state, in storage, during hydration and increase acceptability when consumed.

The adjunct cubes are prepared from seasonings and additive materials designed to aid compaction and improve performance during storage and hydration and increase the acceptability of the hydrated food bar.

The adjunct cubes developed were barbecue sauce, dark brown gravy, light brown gravy, poultry gravy, cheese sauce, white sauce, sour cream, tomato sauce, salad dressing (mayonnaise type), bacon pieces and onion sauce.

Because a system of this type would probably be used during periods which may include stressful situations which would make preparation of the meal items difficult, it was felt advantageous to develop 5 food bars which may be consumed "as is" with a good degree of acceptability or alternatively rehydrated to yield a familiar food item. The food bars developed as dual function types were beef in barbecue sauce, beef and barley soup, chili (beanless), orange, and lemon.

Design Objectives for Compressed Food Components

A. Composition

1. Servings shall average 625 Kcal.

2. Additives to adjust physical, chemical, nutritional or acceptance characteristics not to exceed 20% by weight of the component.

3. Coatings not to increase volume by more than 5% nor weight hy more than 4%.

4. Coating materiel not to contain more than 50% fat by weight on a dry weight basis.

5. Maximum of 10 different rehydratable bars and 15 different cubes may be hydrated in prescribed combinations to yield 32 familiar food items.

B. Physical

1. Coated bars and cubes sufficient for preparation of the 32 food items must pack in a rectangular container of less than 7000 cm^3.

2. Coatings must prevent fragmentation and attrition in handling and transport.

3. Coatings shall not alter normal flavor of the meal items nor be detrimental to acceptance ratings, rehydration and mastication.

4. Surfaces of components shall not become sticky when exposed to 75% relative humidity for 2 hours at room temperature.

5. All components shall rehydrate to an acceptable level within 20 minutes in 55 degree C. or room temperature water, depending on the item.

C. Tests and Evaluation

1. Quantitative tests to determine effectiveness of coating.

2. Coated components shall show no chemical, physical or microbiological deterioration which jeopardizes wholesomeness, acceptability, nutritional quality or ease of preparation for consumption after storage for four months at 38 degrees C.

3. Acceptability after storage for four months at 38 degrees C. shall be determined by a 30-man panel. To be acceptable, each item must receive a rating of 6 or above on a 9-point hedonic scale by 20 or more members of the panel.

EXPERIMENTAL

I. Rehydratable Bars

As the requirements of the contract encompassing improved levels of acceptability for hydrated food items are essentially an extension of previously developed items (1), the technology developed during the course of that work was used for the recent investigation. Therefore, the approximate composition was known for types and quantities of nutrient materiels and structural ingredients necessary to fabricate an acceptable bar.

Selected as a binder was Matrix B_2 which had been used with excellent results in previous work (2) (3).

Based on this background, the major tasks were to determine the flavor components required and those which should be deleted to improve the acceptability and performance of the hydrated food bar.

Selection was made of those items developed previously (1) which had the highest hedonic rating initially and those which, not withstanding, a low score, had a potential for improvement to acceptable standards with minimal reformulation.

The food bars were prepared using the formulas developed earlier (1) and the deficiencies were determined by comparison to commercially available and acceptable products and to products prepared according to recipes in several cookbooks (4) (5) (6). In cases for which standards did not exist, the bars were formulated to be as acceptable as possible while staying within those constraints which would allow the material to be fabricated into a suitable food bar. In all cases the acceptability of the food bar wes improved by an appreciable amount. Only those formulations found acceptable were reported.

Acceptability was determined by the principal investigators and two of their technical support personnel.

Bars were compressed on a modified Denison 10-ton hydraulic press.

A. Preparation of Matrix B_2

1. Formula

Formula	Dry	Typical Quantity (lbs)
Sodium Caseinate, Land-O-Lakes, Edible Canadian	19.2	38.4
Water (For Sodium Caseinate Solution)		153.6
Sucrose, Granulated	7.0	14.0
Durkex 500 Oil, Durkee Co.	47.1	94.2
Starch	10.0	20.0
Lactose USP, Foremost Dairies	16.7	33.4
Water (For Lactose Make-up)		33.4

2. Procedure

a. Make up 20% sodium caseinate solution, using a Schnell-kutter or similar high speed mixer.

b. Pass to make-up tank and raise temperature to 130 degrees F.

c. Add sucrose to the sodium caseinate solution and mix until dissolved.

d. Slurry the starch in the Durkex 500 oil at 145 degrees F. and pass to make-up tank. Mix with sodium caseinate solution by passing through an Oakes mixer. Check for stable dispersion by dispersing 2 - 4 drops of the mixture in about 200 mls of hot (140 degree F.) tap water. If no oil droplets are present on the surface of the solution, the dispersion is stable.

e. Dissolve the lactose in an equal weight of water. Add to the stable dispersion and mix.

f. Recirculate the completed dispersion through an Oakes mixer.

g. Pass to surge tank and spray dry at 2000 psi with an outlet temperature of 263 - 270 degrees F. using a No. 67 orifice and a No. 17 core.

3. Results

The product is a white, free flowing powder of the following composition:

Protein	16.8%
Fat	47.7%
Moisture	2.2%
Carbohydrate	32.5% (by diff.)
Ash	0.8%
Calories	6.3/g

Microbiological Data

Standard Plate Count/G	6,000
Coliform Colonies/G	3 MPN
E. Coli./G	3 MPN
Fecal Streptococci/G	3 MPN
Salmonella	Negative
Staphylococci	Negative
Yeasts & Molds/G	50 MPN

B. Beef Bar

1. Formula

	%
Beef, Diced, Freeze Dried, Wilson & Co.	55.1020
Matrix B_2, Binding Matrix	20.0000
Matrix B_2. Creaming Agent	10.0000
Caramel Color, Powdered	0.3000
Black Pepper, Ground	0.3000
Powdered Butter, 60% Butterfat	10.0000
White Pepper, Ground	0.0075
Onion Powder	0.8800
Garlic Powder	0.0020
Disodium Inosinate and Guanylate	0.0075

Formula	%
Monosodium Glutamate	0.7435
Salt	1.7200
Citric Acid, Anhydrous	0.0125
Hydrolyzed Vegetable Protein	0.8500
Celery Flavor	0.0750
	100.0000

2. Procedure

The powdered ingredients were thoroughly blended, water sprayed on at a level of 3.4 ml/100 g of total solids with continued mixing, then the beef added and gently blended into the mixture. Sixty grams of this material was placed in a 5.1 x 10.1 cm mold and compressed under 1500 psi (on the bar surface) for 1.5 seconds.

3. Results

The resulting 60-gram bar measured approximately 5.2 x 10.3 x 1.3 cm, had a displacement volume of about 100 cc as measured by a National Loaf Volume Meter, calculated caloric density of 5.14 Kcal/g and 3.08 Kcal/cc and a bulk density of .6g/cc.

Hydration of the bar required 65 ml of 55 degree C. water.

C. Pork Bar

1. Formula

	%
Pork, 3/8" Dice, Freeze Dried, Wilson & Co.	55.70
Matrix B_2, Binding Matrix	20.00
Matrix B_2, Creaming Agent	20.00
Caramel Color	0.20
White Pepper, Ground	0.01
Celery Flavor	0.10
Onion Powder	0.12
Monosodium Glutamate	1.23

Formula	%
Hydrolyzed Vegetable Protein	0.82
Salt	1.82
	100.00

2. Procedure

The powdered ingredients were throughly blended, water sprayed on at a level of 4.0 ml/100 g with continued mixing, then the pork added and gently blended into the mix. Sixty grams of this material were placed in a 5.1 x 10.1 cm mold and compressed under 1500 psi (on the bar surface) for 1.5 seconds.

3. Results

The resulting 60 g bar measured approximately 5.2 x 10.3 x 1.3 cm, had a displacement volume of about 95 cc as measured by a National Loaf Volume Meter, calculated caloric densities of 5.75 Kcal/g and 3.63 Kcal/cc and a bulk density of .63 g/cc.

Hydration of the bar required 73 ml of 55 degree C. water.

D. Chicken Bar

1. Formula

	%
Chicken, Diced 3/8", Freeze Dried, Wilson & Co.	56.1
Matrix B_2, Binding Matrix	20.0
Matrix B_2, Creaming Agent	20.0
Caramel Color	0.1
Hydrolyzed Vegetable Protein	0.7
Salt	1.385
Yellow Color Premix	1.0
Monosodium Glutamate	0.6
Celery Flavor	0.05
White Pepper	0.005
Onion Powder	0.06
	100.000

2. Procedure

All ingredients except the chicken were sifted and thoroughly blended. Water was sprayed on at a level of 4.0 ml/100 g while mixing was continued. The chicken pieces were then gently blended into this mixture. Sixty grams of this material were placed in a 5.1 x 10.1 cm mold and compressed at 1500 psi (on the bar surface) for 1.5 seconds.

3. Results

The resulting 60 gram bar meaaured approximately 5.2 x 10.3 x 1.4 cm, had a displacement volume of about 100 cc as measured by a National Loaf Volume Meter, calculated caloric densities of 5.3 Kcal/g and 3.18 Kcal/cc and a bulk density of .6 g/cc.

Hydration of the bar required 83 ml of 55 degree C. water.

E. Turkey Bar

1. Formula

	%
Turkey, Diced 3/8", Freeze Dried, Wilson & Co.	56.1
Matrix B_2, Binding Matrix	20.0
Matrix B_2, Creaming Agent	20.0
Caramel Color	0.1
Hydrolyzed Vegetable Protein	0.7
Salt	1.385
Yellow Color Premix	1.0
Monosodium Glutamate	0.6
Celery Flavor	0.05
White Pepper	0.005
Onion Powder	0.06
	100.000

2. Procedure

All ingredients except the turkey were sifted and thoroughly blended. Water was sprayed on at a level of 4.0 ml/100 g while mixing was continued. The turkey pieces were gently blended into the mixture. Sixty grams of this material were placed in a 5.1 x 10.1 cm mold and compressed at 1500 psi (on the bar surface) for 1.5 seconds.

3. Results

The resulting 60 gram bar measured approximately 5.2 x 10.3 x 1.4 cm, had a displacement volume of about 100 cc as measured by a National Loaf Volume Meter, calculated caloric densities of 5.4 Kcal/g and 3.24 Kcal/cc and a bulk density of .6 g/cc.

Hydration of the bar required 83 ml of 55 degree C. water.

F. Shrimp Bar

1. Formula

Formula	%
Shrimp. Tiny Pacific, Freeze Dried, CVC	62.9
Matrix B_2, Binding Matrix	20.0
Matrix B_2, Creaming Agent	15.0
White Pepper	0.03
Monosodium Glutamate	0.1
Onion Powder	0.13
FD&C Yellow No. 5	0.0022
Sugar	0.55
Salt	1.0864
Celery Flavor	0.0144
Piquant Flavor	0.17
Butter Flavor	0.017
	100.0000

2. Procedure

All of the ingredients except the shrimp were sifted and blended. Water was sprayed on at a level of 3.0 ml/100 g with continued mixing. The shrimp was then added and the whole blended very gently. Sixty-five grams of the mixture was placed in a 5.1 x 10.1 cm mold and compressed at 1200 psi (on the bar surface) for 1 second

3. Results

The resulting sixty-five gram bar measured approximately 5.2 x 10.3 x 1.8 cm, had a displacement volume of approximately 120 cc as measured by a National Loaf Volume Meter, calculated caloric densities of 4.8 Kcal/g and 2.6 Kcal/cc and a bulk density of .54 g/cc.

Hydration of the bar required 130 ml of 55 degree C. water.

G. Mashed Potato Bar

1. Formula

	%
Dehydrated Potato Flakes	67.1
Non-fat Dry Milk Solids	8.0
Spray Dried Butter	15.0
Salt	2.892
Matrix B_2	7.0
Artificial Butter Flavor	0.008
	100.000

2. Procedure

The salt, dry milk, matrix and butter flavor were sifted; the spray dried butter and potato flakes added and the whole blended until homogenous. Water was sprayed on at a level of 3.0 ml/100 g with continued mixing. Seventy grams of this mixture was placed in a 5.1 x 10.1 cm mold and compressed at 1500 psi (on the bar surface) for 1 second.

3. Results

The resulting seventy gram bar measured approximately 5.2 x 10.3 x 1.5 cm, had a displacement volume of approximately 105 cc, calculated caloric densities of 4.24 Kcal/g and 2.8 Kcal/cc and a bulk density of .66 g/cc.

Hydration of the bar required 230 ml of 55 degree C. water. The hydrated product was much more acceptable if whipped lightly with a fork after all of the water had been absorbed.

H. Vegetable Bar

1. Formula

	%
Corn, Freeze Dried	38.0
Peas, Freeze Dried	12.0
Matrix B_2, Binding Matrix	20.0
Matrix B_2, Creaming Agent	20.0

Formula	%
Salt	2.91
White Pepper	0.062
Monosodium Glutamate	0.254
Onion Powder	0.3
FD&C Yellow No. 5	0.0052
Sugar	1.249
Celery Flavor	0.0324
Piquant Flavor	0.15
Matrix B_2, Flavor	5.00
Butter Flavor	0.0374
	100.0000

2. Procedure

All ingredients except the corn and peas were sifted and thoroughly blended. Water was sprayed on at a level of 4.0 ml/100 g with continued mixing. The corn and peas were then very gently blended into the mixture. Sixty-five grams of the resulting material was placed in a 5.1 x 10.1 cm mold and compressed under 1250 psi (on the bar surface) for 2 seconds.

3. Results

The resulting sixty-five gram bar measured approximately 5.2 x 10.3 x 1.4 cm, had a displacement volume of about 103 cc, calculated caloric densities of 4.6 Kcal/g and 2.9 Kcal/cc and a bulk density of .63 g/cc.

Hydration of the bar required 90 ml of 55 degree C. water.

I. Rice Bar

1. Formula

Formula	%
Rice, Freeze Dried, Short Grain	80.0
Matrix B_2	10.0
Powdered Butter, 60% Butterfat	10.0
	100.0

2. Procedure

The B_2 and powdered butter were thoroughly blended, then water sprayed on at a level of 4.0 ml/100 g of total mix. The rice was then gently blended into the mixture. Sixty-five grams of this material were placed in a 5.1 x 10.1 cm mold and compressed under 1200 psi (on the bar surface) for 2 second.

3. Results

The resulting sixty-five gram bar measured 5.3 x 10.1 x 2.2 cm, had a displacement volume of about 120 cc as measured by a National Loaf Volume Meter, calculated caloric densities of 4.5 Kcal/g and 2.44 Kcal/cc and a bulk density of .54 g/cc.

Hydration required 130 ml of 55 degree C. water. The hydrated product is similar to cooked rice in a milk and butter sauce.

II. Rehydratable Cubes

The same procedure was used to formulate and improve the cubes as was used for the bars.

The adjunct cubes were formed using a Komage press. This press compresses the material by mechanical pressure alone so no pressure readings were obtained. The press was adjusted by trial and error to yield a 1.75 cm (5.3 cc) cube which was crushable under moderate finger pressure. This usually necessitated three to six trials.

A. Poultry Gravy Cube

1. Formula	%
Onion Powder	0.635
White Pepper	0.152
Salt	6.52
Monosodium Glutamate	5.01
Celery Flavor	0.0787
FD&C Yellow No. 5	0.0153
FD&C Yellow No. 6	0.0038
Caramel Color	0.0238
Cardoman Flavor	0.106
Hydrolyzed Vegetable Protein	4.0

Formula	%
Sugar	0.9854
Spray Dried Chicken Fat	7.5
Starch, Redisol 412, Morningstar Prods., Pregelatinized, High Viscosity	7.49
Starch, Pregelatinized, Low Viscosity	47.7
Sodium Alginate, High Viscosity	4.44
Flour	11.34
Matrix B_2	4.00
	100.0000

2. Procedure

The ingredients were sifted, then thoroughly blended. Water was then sprayed on at a level of 4.0 ml/100 g with continued mixing. Each cube was formed by placing 6.2 g of this material in a 1.75 x 1.75 cm mold and compressing to a 1.75 cm height.

3. Results

Each 6.2 gram cube had calculated caloric densities of 2.88 Kcal/g and 3.37 Kcal/cc and a bulk density of 1.17 g/cc.

Hydration of each cube required 42 ml of 55 degree C. water. The hydrated cube has a chicken gravy flavor, texture and appearance.

B. Light Brown Gravy Cube

1. Formula	%
Onion Powder	3.76
White Pepper	0.12
Garlic Powder	0.13
Salt	6.29
Monosodium Glutamate	3.92
Caramel Color	0.4
Hydrolyzed Vegetable Protein	14.13

Formula	%
Paprika	0.2
Starch, Pregelatinized, Low Viscosity	53.47
Starch, Pregelatinized, High Viscosity	8.53
Sodium Alginate, High Viscosity	5.05
Titanium Dioxide, N.F.	0.15
Matrix B_2	3.85
	100.00

2. Procedure

All ingredients were sifted, then thoroughly blended. While mixing continued, water was sprayed on at a level of 3.0 ml/ 100 g.

Each cube was formed by placing 5.2 g of this material in a 1.75 x 1.75 cm mold and compressing to a height of 1.75 cm.

3. Results

Each 5.2 gram cube had calculated caloric densities of 2.7 Kcal/g and 2.65 Kcal/cc and a bulk density of .98 g/cc.

Hydration of each cube required 55 ml of 55 degree C. water and yielded a product similar to a commercial packaged dry gravy when prepared according to package instructions.

C. Dark Brown Gravy Cube

1. Formula

Formula	%
Monosodium Glutamate	3.74
Caramel Color	0.64
Paprika	0.035
Citric Acid	0.35
Salt	7.427
Onion Powder	4.5
Garlic Powder	0.144

Formula	%
White Pepper	0.13
Disodium Inosinate and Guanylate	0.208
Hydrolyzed Vegetable Protein	11.636
Starch, Pregelatinized, High Viscosity	8.9
Starch, Pregelatinized, Low Viscosity	53.05
Sodium Alginate, High Viscosity	5.23
Titanium Dioxide N.F.	0.16
Matrix B_2	3.85
	100.000

2. Procedure

The above ingredients were sifted, then thoroughly blended. Water was added by spraying it on at a level of 3.0 ml/100 g while mixing continued.

Cubes were formed by placing approximately 5.2 g of the material in a 1.75 x 1.75 cm mold and compressing to a height of 1.75 cm.

3. Results

Each 5.2 gram cube had calculated caloric densities of 2.7 Kcal/g and 2.65 Kcal/cc and a bulk density of .98 g/cc.

Hydration of each cube required 55 ml of 55 degree C. water and gave a product comparing favorably with products made with commercial dry gravy mixes.

D. Bacon Cube

1. Formula

	%
Bacon, Wilson's Bits-O-Bacon, Refried	60.0
Matrix B_2, Binding Matrix	20.0
Matrix B_2, Creaming Agent	15.0
Starch, Binasol 15	5.0
	100.0

2. Procedure

The bacon was fried until crisp and dry when removed from the pan and blotted between peper towels. There was a 35% weight loss from frying. If insufficient fat was cooked off, the compressed cubes lacked structural integrity. When cool, the bacon was mixed with the other ingredients until a homogeneous mixture was obtained. Mixing was continued as water was sprayed on at a level of 4.0 ml/100 g.

Cubes were formed by placing about 6.4 g of mix in a 1.75 x 1.75 cm mold and compressing to a 1.75 cm height.

3. Results

Each 6.4 gram cube had calculated caloric densities of 6 Kcal/g and 7.3 Kcal/cc and a bulk density of 1.2 g/cc.

This item is to add visual, textural and flavor appeal to the meat salad items.

E. Cheese Cube

1. Formula	%
White Pepper	0.15
Citric Acid	0.73
Onion Powder	0.73
Garlic Powder	0.29
FD&C Yellow No. 5	0.018
FD&C Yellow No. 6	0.018
Hydrolyzed Vegetable Protein	5.06
Starch, Pregelatinized, High Viscosity	13.27
Spray Dried Romano Cheese	62.6
Celery Flavor	0.36
Imitation Butter Flavor	0.73
Mustard Flavor	0.22
Red Pepper	0.06
Sucrose	9.764
Salt	6.0
	100.000

2. Procedure

All ingredients were sifted and then thoroughly blended. Water was sprayed on at a level of 4.0 ml/100 g while mixing was continued.

Each cube was formed by placing 6.2 g of mix in a 1.75 x 1.75 mold and compressing to a height of 1.75 cm.

3. Results

Each 6.2 gram cube had calculated caloric densities of 4.4 Kcal/g and 5.1 Kcal/cc and a bulk density of 1.17 g/cc.

Hydration of each cube required 19 ml of 55 degree C. water and yielded a good cheese sauce product.

F. Barbecue Sauce Cube

1. Formula	%
Onion Powder	0.119
Celery Flavor	0.07
Paprika	0.14
Red Pepper	1.05
Cinnamon	0.035
Allspice	0.035
Salt	11.2
Sugar	26.845
Sodium Diacetate	8.4
Smoked Yeast	6.3
Tomato Powder	14.0
FD&C Red No. 2	0.0042
FD&C Red No. 3	0.0063
FD&C Yellow No. 6	0.0105
Citric Acid	1.4
Caramel Color	0.385

Formula	%
Starch, Pregelatinized, High Viscosity	10.0
Starch, Pregelatinized, Low Viscosity	20.0
	100.0000

2. Procedure

All ingredients were sifted and thoroughly blended. Water was sprayed on at a level of 2.5 ml/100 g with continuous mixing.

Cubes were formed by placing 6.2 g of the material in a 1.75 x 1.75 cm mold and compressing to a 1.75 cm height.

3. Results

Each 6.2 g cube had calculated caloric densities of 3 Kcal/g and 3.4 Kcal/cc and a bulk density of 1.17 g/cc.

Hydration of each cube required 26 ml of 55 degree C. water and yielded a very good barbecue sauce with a mild, tangy, sweet flavor.

G. Tomato Sauce Cube

1. Formula

Formula	%
Tomato Flakes	46.0
Starch, Pregelatinized, High Viscosity	5.0
Starch, Pregelatinized, Low Viscosity	23.0
Salt	9.0
White Pepper	0.2
Sugar	15.0
Onion Powder	0.2
Garlic Powder	0.1
Citric Acid	1.5
	100.0

2. Procedure

All ingredients except the tomato flakes were sifted and thoroughly blended. The tomato flakes were then added and the mixture again blended until uniform. Water was sprayed on at a level of 2.5 ml/100 g as mixing continued.

Cubes were formed by placing 5.1 grams of the above mix in a 1.75 x 1.75 cm mold and compressing to a 1.75 cm height.

3. Results

Each 5.1 g cube had calculated caloric densities of 3.2 Kcal/g and 3.1 Kcal/cc and a bulk density of .96 g/cc.

Hydration of each cube required 25 ml of 55 degree C. water and yielded a good tomato sauce type of product.

H. Sour Cream Cube

1. Formula

Formula	%
Sour Cream, Spray Dried	70.0
Salt	1.5
White Pepper	0.1
Starch, Pregelatinized, Low Viscosity	17.4
Starch, Pregelatinized, High Viscosity	6.0
Flour	5.0
	100.0

2. Procedure

All ingredients were sifted and thoroughly blended. Water was sprayed on at a level of 4.0 ml/100 g as mixing was continued.

Each cube was formed by placing 4.7 g of the mixture in a 1.75 x 1.75 cm mold and compressing to a height of 1.75 cm.

3. Results

The 4.7 g cubes formed had calculated caloric densities of 5.6 Kcal/g and 5 Kcal/cc and a bulk density of .89 g/cc.

Hydration of each cube required 9 ml of 55 degree C. water and gave a sauce suitable for use in a stroganoff dish.

I. Sea Food Sauce Cube

1. Formula

Formula	%
Onion Powder	0.083
Celery Flavor	0.048
Paprika	0.097
Red Pepper	0.48
Salt	6.24
Sugar	43.526
Sodium Diacetate	3.82
Tomato Flakes	12.0
FD&C Red No. 2	0.004
FD&C Red No. 3	0.006
FD&C Yellow No. 6	0.01
Citric Acid	0.966
Caramel Color	0.28
Mustard Flavor	1.44
Starch, Pregelatinized, Low Viscosity	18.0
Starch, Pregelatinized, High Viscosity	8.0
Onion, Minced, Dehydrated	5.0
	100.000

2. Procedure

All ingredients except the onion and tomato flakes were sifted and blended. These items were then added and the whole mixed until uniform. As mixing continued, water was sprayed on at a level of 2.5 ml/100 g.

Cubes were formed by placing 5.8 g of the above material in a 1.75 x 1.75 cm mold and compressing to a 1.75 cm height.

3. Results

The 5.8 g cubes formed had calculated caloric densities of 3.2 Kcal/g and 3.5 Kcal/cc and a bulk density of 1.1 g/cc.

Hydration of each cube required 14 ml of 55 degree C. water and yielded a good tomato sauce product.

J. Onion Sauce Cube

1. Formula

	%
Onion Powder, Toasted	5.00
Minced. Dehydrated Onion	25.00
Salt	34.80
White Pepper, Ground	1.00
Matrix B_2	10.00
Starch, Pregelatinized	24.20

2. Procedure

All ingredients were thoroughly blended, then water sprayed on at a level of 4.0 ml/100 g with continued mixing.

Cubes were formed by placing 5.9 g of the mixture in a 1.75 x 1.75 cm die and compressing to a height of 1.75 cm.

3. Results

The 5.9 g cubes formed had calculated caloric densities of 2.57 Kcal/g and 2.83 Kcal/cc and a bulk density of 1.1 g/cc.

Hydration of each cube required 7 ml of 55 degree C. water.

K. Salad Dressing Cube

1. Formula

	%
Powdered Shortening, 60% Hydrogenated Vegetable Fat	24.00
Salt	5.50
Dried Whole Egg	5.00
Mustard Flavor	0.40

Formula	%
Sodium Diacetate	2.10
Powdered Butter, 60% Butterfat	20.00
Apple Flavor, Imitation	0.02
Lemon Flavor	0.02
Starch, Gelatinized	16.54
Citric Acid, Anhydrous	1.30
Sugar, Powdered	21.00
Flour, All Purpose	4.00
Union, Powdered	0.04
Garlic, Powdered	0.01
Allspice	0.03
White Pepper, Ground	0.02
Celery Flavor	0.02
	100.00

2. Procedure

All ingredients were sifted, then blended until uniform. Water was sprayed on this mix at a level of 3.0 ml/100 g as mixing continued.

Cubes were formed by placing 5.0 g of the mixture in a 1.75 x 1.75 cm mold and compressing to a height of 1.75 cm.

3. Results

Each 5.0 g cube had calculated caloric densities of 4.8 Kcal/g and 4.5 Kcal/cc and a bulk density of .95 g/cc.

Hydration of each cube required 7 - 8 ml of 55 degree C. water and yielded a product similar in texture and flavor to mayonnaibe type salad dressing.

I.. White Sauce Cube

1. Formula

	%
Instant Non-fat Dry Milk Solids	10.00
Matrix B_2	14.00
Powdered Butter, 60% Butterfat	37.00
White Pepper, Ground	0.06
Salt	2.50
Starch, Gelatinized	31.94
Flour, All Purpose	3.00
Citric Acid, Anhydrous	0.10
Onion Powder, Toasted	0.10
Sodium Alginate, High Viscosity	1.30
	100.00

2. Procedure

All ingredients except the powdered butter were sifted and thoroughly blended. The dry butter was added and the whole blended until uniform. Mixing was continued while water was sprayed on at a level of 3.0 ml/100 g.

Cubes were formed by placing 5.0 g of the mixture in a 1.75 x 1.75 cm mold and compressing to a 1.75 cm height.

3. Results

Each 5.0 g cube had calculated caloric densities of 5.2 Kcal/g and 4,9 Kcal/cc and a bulk density of .95 g /cc.

Hydration of each cube required 15 ml of 55 degree C. water and gave a satisfactory white sauce.

III. Dual Function Bars

A dual function bar, because of its intended use, is often a compromise in performance and acceptability. It must perform adequately and be organoleptically acceptable when eaten "as is" or when hydrated. Hydration involves dilution of the bar so that a flavor level acceptable in a bar eaten "as is" may be too low when it is consumed in the hydrated form. Conversely, since many bars are hydrated with warm water (55 degree C.), the elevated temperature helps to volatilize some flavor components, making them much more apparent in the hydrated form, even though dilution has occurred, than in the dry form.

This problem was approached by selecting five food bars from among those covered in this report and the reports of previous food bar research efforts (1) (2) (3). The five selected were: chili, orange drink, beef and barley soup, barbecue beef, and shrimp creole.

Selection of these five was made on the basis that an organoleptic acceptance problem did exist which could realistically be successfully solved.

The bars were reformulated to optimize the flavor level in the hydrated product. The dry mixes were then compressed into bars and evaluated "as is". Evaluation indicated the following:

Chili -- excess saltiness, acidity and spice

Orange Drink -- excess acidity

Beef and Barley Soup -- excess saltiness

Barbecued Beef -- excess saltiness, acidity, and spice

Shrimp Creole -- excess pepper

After a number of formulation changes, the shrimp creole bar was deleted because a bar could not be produced which was acceptable in the dry form due to the dry mouth feel. This bar was replaced with a lemon bar similar in concept to the orange bar.

To prevent flavor resolution of the problem components, it was decided to evaluate delayed solubility and thermal release mechanisms.

The delayed solubility systems consisted of partially encapsulating an ingredient in a hydrocolloid which was less soluble than the component, in this case gum arabic, to prevent the rapid solution or dispersion of that component.

The thermal release systems employ a fat as the encapsulating material. The fats have a melting point of approximately 46 - 52 degrees C. The melting of the fat releases the ingredient so it may dissolve or disperse and stimulate the olfactory and gustatory receptors.

A. Delayed Solubility System

Citric Acid Encapsulated With Gum Arabic

A solution of 1 part citric acid and 1 part gum arabic to 3 parts water was prepared by mixing the materials at high speed in a Waring Blendor. The solution was spray dried, using a Bowen Laboratory Spray Dryer.

The spray dried material appeared to have a wide range of particle sizes so the material was sifted through a U.S. No. 12 stainless steel sieve and the finer powder used in compounding.

B. Thermal Release Systems

1. Citric Acid Encapsulated With Fat

A molten mixture of citric acid in fat was prepared by heating 1 part Durkee's KLX Flakes to 100 degrees C. and 3 parts anhydrous citric acid to approximately 55 degrees C. and blending in a Waring Blendor bowl (heated to about 65 degrees C.). This molten mixture was spread 1/16" - 3/16" thick on polyethylene and allowed to cool. The solidifed mixture was broken into pieces smaller than an inch in diameter. These were chilled two hours in powdered dry ice and ground with the dry ice in the Waring Blendor. The carbon dioxide was allowed to vaporize and the resulting powder sifted when at room temperature, using a U.S. No. 12 stainless steel sieve. The fines were collected and used.

2. Salt Encapsulated With Fat

This material, salt encapsulated with hydrogenated vegetable oil, is a product of Presco Food Products, Inc., Flemington, New Jersey (Experimental Salt No. 7308).

3. Thermal Release Barbecue Flavor

Barbecue TRF (thermal release flavor) was supplied by Gentry Corporation, Paramus, New Jersey.

C. Formulations of Dual Function Bars

1. Orange

a. Formula

	%
Citric Acid/Gum Arabic 1/1 Encapsulation	5.5200
Corn Syrup Solids	16.8300
Ascorbic Acid	1.2600
Orange Flavor	0.1900
Sugar, Granulated	76.1760
FD&C Yellow No. 5	0.0178
FD&C Yellow No. 6	0.0062
	100.0000

b. Procedure

The dry ingredients were thoroughly blended using a Hobart N-50 mixer. A premix of the colors and about 20% of the sugar was made to facilitate dispersion of the color material. After thoroughly mixing the ingredients, water was sprayed on at a level of 0.5 ml/100 g and 60 g of the mixture immediately placed in a 5.1 x 10.1 cm mold and pressed at 750 psi (on the bar surface) with 1 second dwell time.

c. Results

The resulting 60 g bar measured 5.2 x 10.3 x 1.2 cm, had a volume of 68 cc, caloric densities of 3.5 Kcal/g and 3.1 Kcal/cc and a bulk density of .88 g/cc.

When consumed "as is" the bar tasted like slightly tart orange candy. Hydration of each bar required 420 ml of 22 degree C. water and yielded an excellent orange flavored drink.

2. Lemon Bar

a. Formula

	%
Sugar, Granulated	88.16
Citric Acid Encapsulated with Gum Arabic	11.00
Ascorbic Acid, Powdered	0.14
Lemon Juice Flavor	0.60
Yellow Color	0.10
	100.00

b. Procedure

The dry ingredients were thoroughly blended using an N-50 Hobart mixer. After the ingredients were mixed, water was sprayed in at a level of 0.5 ml/100 g of solids with continued mixing and 60 g of the mixture placed in a 5.1 x 10.1 cm mold and pressed at 750 psi (on the bar surface)with a 1 second dwell.

c. Results

The resulting 60 g bar measured 5.1 x 10.2 x 1.15 cm, had a volume of 62 cc, caloric densities of 3.4 Kcal/g and 3.3 Kcal/cc and a bulk density of .97 g/cc.

When consumed "as is" the flavor resembled that of "lemon drops" candy. Hydration of each ber required 420 ml of 22 degree C. water and gave a good lemonade drink.

3. Chili

a. Formula

Ingredient	%
Matrix B_2, Binding Agent	20.0
Matrix B_2, Creaming Agent	11.0
Onion Powder	0.7
Beef, Ground, Freeze Dried	32.0
Tomato Crystals	3.0
Paprika	1.3
Citric Acid, Thermal Release in Matrix of Hydrogenated Vegetable Fat, 75% Acid	0.8
Chili Powder, Mild	6.5
Dextrose	7.3
Starch	13.0
Salt, Thermel Release in Matrix of Hydrogenated Vegetable Fat, 85% Salt, Presco Food Products Inc.	4.1
Caramel Color	0.3
	100.0

b. Procedure

The powdered and granulated ingredients were thoroughly blended using a Hobart A-200 mixer. Blending was continued as water was sprayed into the mixture at a level of 3 ml per 100 g of mix. The beef was then gently blended into the mix. The mixture was immediately compressed into 5 x 10.1 x 1.3 cm bars weighing 60 grams each. Pressure was 750 psi and the dwell 1 second.

c. Results

The resulting bar had a displacement volume of 71 cc, calculated caloric densities of 4.7 Kcal/g and 4 Kcal/cc and a buik density of .85 g/cc.

When consumed "as is" the bar had a mild chili flavor conveying the impression of some type of unfamiliar snack item. Each bar required 120 ml of 55 degree C. water for hydration and the result was a good, mild flavored chili type product.

4. Beef and Barley

a. Formula

	%
Barley, Cooked and Freeze Dried	48.0
Beef Bouillon Flavor, Low Salt	7.2
Matrix B_2	17.0
Beef, Cooked, Diced, Freeze Dried, Wilson & Co.	14.0
Pepper, Ground Black	0.5
Celery Seed, Ground	0.25
Dextrose	2.4
Monosodium Glutamate	0.5
Parsley, Freeze Dried	0.25
Salt, Thermal Release in a Matrix of Hydrogenated Vegetable Fat, 85% Salt, Presco Food Products, Inc.	9.7
Onion Powder	0.15
Garlic Powder	0.05
	100.00

b. Procedure

All of the ingredients except the barley and beef were thoroughly mixed by use of a Hobart A-200 mixer. The beef and barley were then gently blended with the mixture and mixing continued as water was sprayed in at a level of 4 ml/100 g. The mixture was immediately pressed into 60 g bars at 1500 psi (on the bar surface) with a dwell of 2 seconds, using a 5.1 x 10.1 cm mold.

c. Results

The resulting bar measured 5.2 x 10.3 x 1.7 cm, had a displacement volume of approximately 102 cc, calculated caloric densities of 4.7 Kcal/g, 2.8 Kcal/cc and a bulk density of .59 g/cc.

When consumed "as is," this food bar resembled a puffed food product seasoned with bouillon and spice. The salt level was quite acceptable.

Hydration of each bar with 340 ml of 55 degree C. water yielded an excellent, rich beef and barley soup similar to Scotch broth.

5. Barbecued Ground Beef

a. Formula

Formula	%
Sugar, Powdered	10.1814
Caramel Color, Powdered	0.1870
FD&C Red No. 2	0.0019
FD&C Red No. 3	0.0029
FD&C Yellow No. 6	0.0048
Barbecue Flavor, Fat Based, Thermal Release Flavor, Gentry Corp.	17.2000
Vinegar, Spray Dried in Vegetable Gum	6.0000
Citric Acid, Encapsulated, 75% Acid, 25% Hydrogenated Vegetable Fat	0.6820
Salt, Thermal Release in Matrix of Hydrogenated Vegetable Fat	4.7400
Beef, 3/16" Grind, Freeze Dried, Wilson & Co.	35.0000
Matrix B_2, Binding Matrix	20.0000
Matrix B_2, Creaming Agent	5.0000
Tomato Crystals	1.0000
	100.0000

b. Procedure

The powdered and granulated ingredients were thoroughly blended. Blending was continued as water was sprayed into the mixture at a level of 3 mls of water/100 g of mix. The beef was then gently mixed in and the material compressed into 5 x 10.1 x 1.3 cm bars at 1000 psi (on the bar surface) with a dwell of 1.5 seconds.

c. Results

The resulting bar had a displacement volume of 65 cc, calculated caloric densities of 5.2 Kcal/g and 4.8 Kcal/cc and a bulk density of .92 g/cc.

When consumed "as is" the bar had a mild barbecue flavor. Hydration of each bar required 90 ml of 55 degree C. water and gave a very good robust barbecue beef product.

IV. Coating

It was determined that a suitable coating material for this application should demonstrate the following qualities:

A. Bland or tasteless when eaten as is or when dispersed or hydrated.

B. Slightly flexible.

C. Readily soluble or dispersible in water at 22 - 55 degrees C.

D. Easily applied.

E. Resistant to exposure to 75% relative humidity at 20 - 72 degrees C. for two hours.

F. Possess some nutritional value.

G. Not objectionable in appearance when on the component and when dispersed.

In addition, it was required that the coating contribute no more than 5% of the volume nor 4% by weight to the finished bar.

A number of coating materials were subjectively evaluated including zein, edible shellac, gelatin, fats and acetylated monoglycerides. They were found unsuitable.

Additional information on coatings for food bars was obtained from work performed by Archer Daniels Midland Co. (7) From the description of a wide variety of coating materials and formulations in this report, it was determined that none could be used satisfactorily with the component and dual function systems. It was then decided to investigate the possibility of using Matrix B_2 as a coating material.

Coatings of this material were easily prepared by dispersing 8 parts of B_2 in 17 parts of water at room temperature. The coating was best applied by spray. After a 5 - 10 minute wait to allow the coating to level (become smooth), the bars were dried for 1.5 - 2 hours at 50 - 60 degrees C. in an air circulating oven. The coating was then virtually transparent, smooth and slightly glossy. The coating did not impede hydration of the components if they were well broken up before adding water. (Bars will not hydrate completely in 20 minutes even without the coating if not well fragmented.) Hydrated components differed only slightly in appearance from the non-coated counterpart and not at all in flavor.

It was found that the B_2 coating was unsuitable for use with the orange and lemon bars as the low pH of the drinks prepared from the bars caused precipitation of the protein portion of the coating material.

The following formula was prepared to eliminate the problem.

Coating C_2	%
Hydrogenated Vegetable Fat (60%) in Vegetable Gum With Added Antioxidants, Spray Dried	83.0
Starch, Low Viscosity	17.0
	100.0

The coating solution was prepared by dispersing the ingredients in warm (approximately 55 degree C.) water at a solids level of 42%. The coating was best applied by spray at a solution temperature of 55 degree C. The coated bars were then dried in an air-circulating oven at 55 degree C. for 4 hours to remove the moisture. Some "oiling out" of the coating was evident during the drying procedure but was not apparent after the bars had cooled to room temperature. This coating does not have the nutritional advantage of the protein in the B_2, but functions much better in this application than the B_2 coating and forms the cloud or gives the opacity associated with a beverage of this type.

TESTS AND EVALUATIONS

A. Coating

To determine the effectiveness of the coatings, the coated components (bars and cubes), along with uncoated controls, were subjected to vibration, impact and stickiness tests. Stickiness was determined by placing the component in an atmosphere with a relative humidity of 73 - 76% at 23 degrees C. for two hours and then checking for adhesion by use of a Universal Testing Machine, Type TTC (Instron Corp.).

To determine adhesion a smooth circular stainless steel anvil with an area of 4.9 cm^2 was placed against the coated surface with a load in excess of 80 g/cm^2 for 30 - 40 seconds. The anvil wae then withdrawn and the adhesion noted. Although the sensitivity of this test was 1 g/cm^2 not a single deflection was found in 300 trials.

As a standard, Scotch brand double coated adhesive tape no. 665 (Minnesota Mining & Manufacturing Co.) was treated in a like manner. The adhesion shown by this product was 34.8 ± 8.4 g/cm^2.

Subjective evaluation of stickiness, by pressing the foreganger against the bar or pressing two bars together and separating, failed to reveal any adhesion.

For vibration and impact tests, a wooden box with inside dimensions of 10.5 x 10.5 x 20 cms was constructed. Five to six bars of a type or 10 cubes were placed in the box for each test. The bars were placed in the box on edge and parallel to one another. Space for one bar was left unfilled to provide adequate room for movement of the bars within the box. For the vibration test, the box was filled and placed on the platform of a vibration tester (Gaynes Engineering Co., Chicago, Illinois). The test was conducted at 240 rpm for 5 minutes. The impact test consisted of placing the box on the platform of an impact tester and allowing it to impact against the stop 5 times from the 4 ft level for each type of component. The impact tester used was a type 400 (L.A.B. Corp., Skaneateles, New York). Results are given in Table I.

Table I: Effectiveness of Coatings in Preventing Fragmentation and Fracture of Food Components

Component	Test*	Coated: % Fragmentation a*	Coated: % Fracture b*	Uncoated: % Fragmentation a*	Uncoated: % Fracture b*
Beef Bar	V	0	0	4.3	8.4
Beef Bar	I	0	0	5.2	23.1
Pork Bar	V	0	0	2.1	0
Pork Bar	I	0	0	2.5	0
Chicken Bar	V	0.47	0	100.	-
Chicken Bar	I	0.65	0	-	-
Turkey Bar	V	0	0	4.1	6.5
Turkey Bar	I	0.35	0	10.2	5.7
Shrimp Bar	V	0	0	0	0
Shrimp Bar	I	0	0	0.4	0
Vegetable Bar	V	0	0	0.63	0
Vegetable Bar	I	0	0	0.1	0
Potato Bar	V	0	0	2.7	0
Potato Bar	I	0	0	8.3	0
Rice Bar	V	2.5	0	7.8	0
Rice Bar	I	1.08	0	3.2	7.1
Lemon Bar	V	0	0	7.2	0
Lemon Bar	I	0	0	14.5	29.6
Orange Bar	V	0	0	2.35	0
Orange Bar	I	0	0	2.3	0
Beef & Barley Soup	V	0.28	0	13.2	0
Beef & Barley Soup	I	0	0	16.0	3.0
BBQ Bar	V	0	0	0	0
BBQ Bar	I	0	0	0	0
Chili Bar	V	0	0	3.5	0
Chili Bar	I	0	0	16.0	3.0

* Symbols explained at end of Table I

TABLE I (cont'd)

Component	Test*	Coated % Fragmentation a*	Coated % Fracture b*	Uncoated % Fragmentation a*	Uncoated % Fracture b*
Dark Brown Gravy Cube	V	0	0	43.0	0
Dark Brown Gravy Cube	I	0.4	0	24.1	3.3
Light Brown Gravy Cube	V	0.63	0	14.8	3.9
Light Brown Gravy Cube	I	0.47	0	12.5	3.6
Poultry Gravy Cube	V	0.6	0	9.4	3.7
Poultry Gravy Cube	I	0.3	0	6.8	4.5
Cheese Cube	V	0	0	1.85	0
Cheese Cube	I	0	0	13.3	3.9
Barbecue Cube	V	0	0	0.3	0
Barbecue Cube	I	0	0	0	0
Tomato Cube	V	0	0	2.0	0
Tomato Cube	I	0	0	0.5	0
Sea Food Sauce Cube	V	0	0	0.7	0
Sea Food Sauce Cube	I	0	0	3.57	1.5
Sour Cream Sauce	V	0	0	0.9	0
Sour Cream Sauce	I	0	0	1.5	0
Onion Cube	V	0.2	0	7.0	14.8
Onion Cube	I	0.2	0	7.3	0
White Sauce Cube	V	0	0	0.34	0
White Sauce Cube	I	0	0	0.34	0

*Symbols explained at end of Table I

TABLE I (cont'd)

		Coated		Uncoated	
Component	Test*	% Fragmentation a*	% Fracture b*	% Fragmentation a*	% Fracture b*
Salad Dressing Cube	V	0	0	0	0
Salad Dressing Cube	I	0	0	0	0
Bacon Cube	V	0	0	0.32	0
Bacon Cube	I	0	0	0.48	0

*Symbols--

V - Vibration -- 240 rpm for 5 minutes

I - Impact -- 4 ft for 5 cycles

a -- Fragmentation determined by dividing the original weight of the components into the total weight of those pieces broken off which individually weigh less than 10% of the original component weight and multiplying by 100.

b -- Fracture determined by dividing the original weight of the components into the total weight of those pieces which individually weighed more than 10% of the original component and multiplying by 100

The data given in Table I clearly indicate that the coatings do prevent fracture and fragmentation of the components when subjected to defined vibration and impact tests.

To ensure that the coatings did not exceed 4% by weight or increase the volume of the components by more than 5%, controls were weighed and the volume determined and then placed at random among the components as they were coated. After drying, the weight and volume were again determined. The differences were calculated as percentages (Table II).

TABLE II: WEIGHT AND VOLUME CHANGES ASSOCIATED WITH COATING THE COMPONENTS

Component	% Weight Change	% Volume Change c*
Beef Bar	4.0	-7.9
Pork Bar	1.1	-3.0
Chicken Bar	1.5	-4.0
Turkey Bar	1.1	-4.0
Shrimp Bar	1.2	2.0
Vegetable Bar	2.7	-3.8
Potato Bar	1.2	2.0
Rice Bar	3.6	4.5
Lemon Bar	3.1	0
Orange Bar	3.3	0
Beef & Barley Bar	2.6	3.5
Chili Bar	2.25	-8.4
Barbecue Bar	2.5	-4.6
Dark Brown Gravy Cube	2.9	-9.5
Light Brown Gravy Cube	2.18	-5.0
Poultry Gravy Cube	2.08	0
Barbecue Cube	2.85	-5.0
Cheese Cube	1.15	-10.0
Tomato Cube	3.1	-5.25
White Sauce Cube	3.3	0
Onion Cube	2.96	-1.[illegible]
Sour Cream Cube	3.84	-2.2
Sea Food Sauce Cube	3.55	0

*Symbol explained at end of Table II

TABLE II. (cont'd)

Component	% Weight Change	% Volume Change c*
Salad Dressing Cube	2.37	-1.6
Bacon Cube	2.43	0

*Symbol

c -- By National Loaf Volume Meter

The data in Tables I and II indicate that it was unnecessary to exceed 4% by weight of coating to prevent fracture and fragmentation. An unexpected result of the coating process was an apparent shrink in most of the components. Possibly this is due to the proteinaceous portion of the coating. It is also interesting to note that of the four components showing an increase in volume after coating three of them contained significant amounts of cooked, dried, starchy materials; e.g. barley, rice and potato. The explanation for these varied results is not apparent.

An additional benefit of coating the components was the increased caloric content of each. The dry coating has a higher caloric density (6.3 Kcal/g) than any of the components, thus increasing the caloric density of the components slightly.

Table III gives the Kcal increase of each component due to the coating.

Table III: CALORIC GAIN OF COMPONENTS DUE TO COATING

Component	Grams Coating	Additional Kcal
Beef Bar	2.4	15.1
Pork Bar	.66	4.1
Chicken Bar	.9	5.7
Turkey Bar	.66	4.1
Shrimp Bar	.72	4.5
Vegetable Bar	1.75	11.0
Rice Bar	2.34	14.7

TABLE III. (cont'd)

Component	Crams Coating	Additional Kcal
Potato Bar	.84	5.3
Lemon Bar	1.86	9.3
Orange Bar	1.98	9.9
Beef & Barley Bar	1.56	9.8
Chili Bar	1.35	8.5
Barbecue Bar	1.5	9.5
BBQ Cube	0.18	1.1
Cheese Cube	0.07	0.4
Dark Brown Gravy Cube	0.15	0.9
Light Brown Gravy Cube	0.11	0.7
Poultry Gravy Cube	0.13	0.8
Tomato Cube	0.16	1.0
Sea Food Sauce Cube	0.2	1.3
White Sauce Food Cube	0.16	1.0
Sour Cream Cube	0.18	1.1
Onion Cube	0.17	1.1
Bacon Cube	0.16	1.0
Salad Dressing Cube	0.12	0.8

B. <u>Component Moisture Before and After Storage at 38 degrees C. For Four Months</u>

Moisture determinations were made by breaking up the bar or compacted adjunct in an Osterizer, weighing a sample and placing it in a vacuum oven set at 70 degrees C. for 16 hours, then reweighing to determine moisture loss. The data is given in Table IV.

TABLE IV: COMPONENT MOISTURE BEFORE AND AFTER STORAGE AT 38 DEGREES C. FOR FOUR MONTHS IN N_2 FILLED CANS

Component	% Moisture Before	% Moisture After
Beef Bar	5.18	2.95
Pork Bar	4.34	4.05
Chicken Bar	3.65	6.26
Turkey Bar	4.25	3.52
Shrimp Bar	4.38	5.20
Potato Bar	5.43	5.29
Vegetable Bar	5.09	6.30
Rice Bar	3.95	4.01
Lemon Bar	0.55	0.84
Orange Bar	1.09	1.24
Chili Bar	3.79	5.90
Barbecue Bar	4.07	5.12
Beef & Barley Bar	4.74	6.11
Dark Brown Gravy Cube	3.71	3.70
Light Brown Gravy Cube	4.21	4.50
Poultry Gravy Cube	3.62	3.67
Bacon Cube	2.94	5.36
Barbecue Cube	4.77	3.70
Cheese Cube	5.27	6.14
Onion Cube	2.72	3.15
Salad Dressing Cube	1.60	2.30
Sea Food Sauce Cube	3.41	3.79

TABLE IV. (cont'd)

Component	% Moisture Before	After
Sour Cream Cube	2.49	5.04
Tomato Sauce Cube	3.53	4.45
White Sauce Cube	2.40	2.18

C. <u>Microbiological Levels of Components Before and After Storage at 38 degrees C. for Four Months</u>

Procedures used for the determination were those specified in the "Microbiological Requirements for Spacefood Prototypes", Addendum No. 1B, 30 December 1966, U.S. Army Natick Laboratories, Natick, Massachusetts. Results are given in Table V.

Table V: <u>MICROBIOLOGICAL LEVELS OF COMPONENTS BEFORE AND AFTER STORAGE AT 38 DEGREES C. FOR FOUR MONTHS IN N_2 FILLED CANS</u>

Component	Before					After				
	TPC	Coli-forms	E. Coli.	Staph.	Strep.	TPC	Coli-forms	E. Coli.	Staph.	Strep.
Beef Bar	1.6×10^5	23	N	N	360	1.5×10^5	N	N	N	< 3
Pork Bar	5.8×10^4	9	N	N	< 300	$2. \times 10^4$	N	N	N	< 3
Turkey Bar	10^4	< 3	N	N	240	$2. \times 10^4$	N	N	N	460
Chicken Bar	1.5×10^3	43	N	N	460	2.5×10^4	N	N	N	460
Vegetable Bar	9.1×10^3	23	N	N	23	9.5×10^3	N	N	N	< 3
Potato Bar	3.9×10^3	< 3	N	N	43	3.5×10^3	N	N	N	< 3
Shrimp Bar	3.9×10^3	< 3	N	N	23	3.5×10^3	N	N	N	4
Rice Bar	8.5×10^3	< 3	N	N	1100	$8. \times 10^3$	N	N	N	43
Chili Bar	1.4×10^5	23	N	N	460	2.1×10^5	N	N	N	< 3
Barbecue Bar	6.6×10^4	< 3	N	N	23	1.8×10^4	N	N	N	< 3

N = negative

TABLE V (cont'd)

Component	Before					After				
	TPC	Coliforms	E. Coli.	Staph.	Strep.	TPC	Coliforms	E. Coli.	Strep.	Staph.
Beef & Barley Bar	1.4×10^5	9	N	N	43	$2. \times 10^5$	N	N	N	< 3
Lemon Bar	900.	< 3	N	N	< 3	200.	N	N	N	< 3
Orange Bar	700.	< 3	N	N	< 3	50.	N	N	N	< 3
Poultry Gravy Cube	10^4	21	N	N	1100	$6. \times 10^3$	N	N	N	1100
Light Brown Gravy Cube	2.8×10^5	23	N	N	1100	5.7×10^4	N	N	N	1100
Dark Brown Gravy Cube	$6. \times 10^4$	23	N	N	4	$7. \times 10^3$	N	N	N	1100
Barbecue Sauce Cube	2.5×10^4	< 3	N	N	1100	1.1×10^4	N	N	N	< 3
Cheese Cube	$9. \times 10^3$	< 3	N	N	1100	1.2×10^4	N	N	N	43
White Sauce Cube	1.3×10^3	< 3	N	N	460	3.5×10^3	N	N	N	< 3
Sour Cream Cube	4.6×10^3	< 3	N	N	1100	$5. \times 10^3$	N	N	N	< 3
Onion Cube	1.5×10^5	4	N	N	1100	1.8×10^4	N	N	N	15
Bacon Cube	$7. \times 10^3$	< 3	N	N	1100	4.5×10^3	N	N	N	1100
Sea Food Sauce Cube	9.8×10^4	4	N	N	1100	2.2×10^4	N	N	N	1100
Salad Dressing Cube	6.5×10^3	9	N	N	240	500.	N	N	N	9
Tomato Cube	7.5×10^3	< 3	N	N	43	1.1×10^3	N	N	N	< 3

N = negative

Previous experience with systems of this type has been that no significant microbiological deterioration is encountered in storage at 38 degrees C. if moisture is maintained at about 5% or less and often the apparent number of viable organisms is reduced. The data in Table V bear this out.

Some components contained populations of viable organisms which were higher than desired and previously experienced. Suspect ingredients were examined individually in an attempt to ascertain the cause, but the results were inconclusive. The most likely sources of contamination are the spices and seasonings and the spray dried matrix. Although examination of the matrix did not bear this out, the occurrence of aggregates containing large microbial populations is quite possible. Spices are notorious for harboring large populations of microorganisms unless properly treated. Prior experience has shown that by using a proper program of microbiological control, the level of microorganisms in a system of this type can be maintained at low levels.

D. Sensory Evaluation

Sensory evaluation of the meal items was carried out both before and after storage at 38 degrees C. for four months. (Table VI). The components were packed in N_2 filled cans for storage. The food items were evaluated before storage to preclude storage of unacceptable items and to establish a base line to detect deterioration of the items during storage.

A meal item was considered acceptable if it received a rating of 6 or above on a 9-point hedonic scale by 20 or more of the 30 panel members.

To select taste test panel members, a survey was conducted at The Pillsbury Company Research and Development Laboratories in Minneapolis to determine those male employees with previous military experience. They were then used as primary panel members. Because an insufficient number of people had had military experience and due to availability difficulties, secondary panel members were selected. These were males with no previous military experience. The use of female employees as panel members was kept to an absolute minimum.

To realistically evaluate the food items, it was felt necessary that the panel members have some empathy with the projected use of foodstuffs of this type. Therefore, it was attempted to "concept position" the panel members through the use of special taste test rating sheets. Examples are show in Appendix 1 and 2.

Table VI. HEDONIC RATINGS OF MEAL ITEMS BEFORE AND AFTER STORAGE FOR FOUR MONTHS AT 38 DEGREES C. IN N_2 FILLED CANS

Meal Item P*	Before		After	
	Responses of 6 or above	Mean x* Rating	Responses of 6 or above	Mean x* Rating
Beef in Gravy	22	6.43	27	6.76
Beef with Potatoes and Gravy	27	6.8	24	6.7

*Symbols explained at end of Table VI.

TABLE VI. (cont'd)

Meal Item p*	Before		After	
	Responses of 6 or above	Mean x* Rating	Responses of 6 or above	Mean x* Rating
Beef & Vegetables	25	6.53	24	6.16
Barbecued Beef	24	6.7	25	6.83
Beef Stew	20	6.1	20	5.93
Beef, Rice & Gravy	26	6.83	27	6.93
Beef in Tomato Sauce	24	5.9	24	6.3
Beef with Cheese Sauce	23	6.03	20	6.1
Beef Stroganoff	25	7.07	21	6.23
Pork in Gravy	24	6.93	25	6.64
Pork, Potatoes & Gravy	28	7.1	23	6.2
Pork & Vegetables	19	5.93	20	5.8
Barbecued Pork	22	6.66	18	5.93
Pork, Rice & Gravy	25	6.30	20	5.9
Pork in Tomato Sauce	20	6.26	19	6.1
Pork Stroganoff	22	6.36	21	6.43
Chicken & Gravy	20	6.33	21	6.1
Chicken, Potatoes & Gravy	25	6.96	28	7.0
Barbecued Chicken	23	6.36	21	5.8
Chicken, Rice & Gravy	26	6.73	23	6.53
Chicken Salad	24	6.2	23	6.03

*Symbols explained at end of Table VI.

TABLE VI (cont'd)

Meal Item [p*]	Before: Responses of 6 or above	Before: Mean x* Rating	After: Responses of 6 or above	After: Mean x* Rating
Chicken ala King	25	6.74	24	6.9
Chicken Stroganoff	23	6.3	23	6.43
Turkey, Potatoes & Gravy	26	6.8	24	6.43
Turkey & Gravy	20	5.88	19	5.73
Turkey & Vegetables	20	6.1	21	6.3
Barbecued Turkey	22	6.13	21	6.1
Turkey, Rice & Gravy	20	5.6	20	5.73
Turkey Salad	27	6.83	26	6.7
Turkey Stroganoff	25	6.7	25	6.23
Turkey ala King	23	6.5	21	6.53
Shrimp & Rice	19	5.6	d	d
Shrimp Newberg	24	6.6	d	d
Shrimp with Sea Food Sauce	20	6.1	d	d
Potato Soup	26	6.73	19	6.2
Cream de Carne	28	6.66	27	6.36
		Dual Function Bars		
Orange Drink	25	6.96	21	5.9
Orange Candy[e*]	26	6.4	20	5.3
L[illegible]n Drink	28	7.1	28	6.4
Lemon Candy [e*]	30	6.86	26	6.7
Beef & Barley Soup	28	7.46	23	6.43

*Symbols explained at end of Table VI.

TABLE VI (cont'd)

Meal Item p*	Before		After	
	Responses of 6 or above	Mean x* Rating	Responses of 6 or above	Mean x* Rating
Beef & Barley Bar e*	22	5.83	19	5.2
Chili	25	6.7	25	6.83
Chili Bar e*	23	5.83	21	5.73
Barbecue Beef	23	6.5	22	5.9
Barbecue Beef Bar e*	23	6.1	21	5.3

*Symbols

d -- Shrimp failed storage due to excessive browning.

e -- Bar consumed as is; required a rating of 5 or above by 20 or more panel members.

p -- See Appendix 3 for composition.

x -- Mean of all responses

Subjective evaluation of appearance and odor of the components after storage was carried out by the three investigators to supplement panel evaluation of the meal items. Results are shown in Table VII.

Table VII:. ORGANOLEPTIC EVALUATION OF MEAL ITEMS AFTER STORAGE FOR FOUR MONTHS AT 38 DEGREES C, N_2 PACKED

Component	Appearance	Odor
Beef Bar	Excellent - normal	Slightly stale
Pork Bar	Fair - slight browning	Slightly stale
Chicken Bar	Good - normal	Slightly stale
Turkey Bar	Fair - slight browning	Slightly stale
Shrimp Bar	Poor - heavy browning	Very poor - hydrolyzed
Vegetable Bar	Fair - slight browning	Normal

TABLE VII (cont'd)

Component	Appearance	Odor
Mashed Potato Bar	Fair - slight browning	Of dried milk
Rice Bar	Excellent - normal	Slightly stale
Lemon Bar	Fair - slight browning	Lemon candy
Orange Bar	Excellent - normal	Orange candy
Beef & Barley Soup	Good - very sl browning	Of HVP, normal
Barbecue Bar	Good - very sl browning	Barbecue
Chili Bar	Good - very sl browning	Chili
Sea Food Sauce Cube	Excellent - no change	Normal
Barbecue Cube	Excellent - no change	Normal
Sour Cream Cube	Good - very sl browning	Normal
Onion Cube	Excellent - no change	Normal
Poultry Gravy Cube	Excellent - no change	Normal
Tomato Sauce Cube	Excellent - no change	Normal
Dark Brown Gravy Cube	Excellent - no change	Normal
Bacon Cube	Excellent - no change	Normal
White Sauce Cube	Excellent - no change	Normal
Light Brown Gravy Cube	Excellent - no change	Normal
Cheese Sauce Cube	Fair - some browning	Strong, bitter cheese
Salad Dressing Cube	Excellent - no change	Normal

DISCUSSION

Fabrication of the rehydratable food components from readily available ingredients was by compression technique using a water activated binder. The difficulties encountered were resolved satisfactorily.

Controlled release flavor ingredients were produced from commercially available materials and were manufactured with little difficulty or obtained from commercial sources; therefore, the commercial use of these items is facilitated.

The coating materials used were either available commercially or could be easily manufactured. Preparation of the coating material involved making a suitable solution in water using a high shear mixer such as a Waring Blendor.

Application was by use of a conventional pressurized paint spray gun. The coatings could thus be applied on a production line basis as the components moved through a battery of spray heads.

The coating was dried by placing the components in a laboratory model circulating oven (Reco, Model C425A) similar in design to commercial food product dryers.

An unexpected result of application of the coating to the component was a reduction in volume of some of the components. (Mean volume change of -3.1% for all components.) The reason for this was not apparent. Possibly during the drying procedure, the cohesiveness of the coating was sufficient so that as the volume of the coating diminished as water was removed, a reduction of bar volume occurred rather than a stretching or discontinuity of the film occurring. Possibly this phenomena could be an aid for volume reduction in systems of this type.

The coatings markedly reduced fragmentation and fracture as demonstrated by the quantitative tests. This was reinforced by observation during handling of the bars in production. About 300 bars and 500 cubes of each type were produced.

A total of thirty-four meal items was prepared using combinations of seven food bars (shrimp failed storage) and eleven adjunct cubes (See Fig. 3). Twenty-eight of these received a rating of 6 or above on a 9-point hedonic scale by twenty or more members of the 30-man panel. Of the remaining six, 5 received a rating of 6 or above by 19 members of the panel while the remaining one received a rating of 6 or above by 18 of the panel members.

It was felt that these results indicated that the basic acceptability and stability of the system was very good as 88% of the meal items were given a rating of 6 or above on a 9-point hedonic scale by better than 66% of the panel members.

All meal items prepared from the dual function bars met the design criteria of receiving a rating of 6 or above on a 9-point hedonic scale by 20 or more of the panel members.

When consumed "as is" the dual function bars met the design criteria of receiving a rating of 6 or above on a 9-point hedonic scale by 20 or more of the panel members and therefore also met the design criteria.

In the course of work on the dual function bars, formulations identical to the final formulations but without encapsulating the flavor materials, were pressed into bars. The orange, lemon, and beef and barley bars were impossible to consume because of high acid and salt levels respectively. The barbecue and chili bars were rendered much more acceptable in the dry form by encapsulation of a portion of the flavor materials.

Over-all microbiological counts were higher than desired and previously experienced. It was not possible to implicate any single source. Microbiological deterioration in storage was not significant as indicated by counts of viable organisms. In general, microbiological populations were lower at the conclusion of storage than the pre-storage levels.

No problems were encountered in placing the components for the 32 meal items in a box 12" x 8.25" x 4.3", which is equivalent to 426 in^3 or 6986 cc. In addition, it was possible to pack 4 of the dual function bars with the components for the 32 meal items (Figures 1 and 2). The orange, lemon, and beef and barley bars were packed leaving sufficient room for either the chili or barbecue beef bar.

The caloric content of the packed module was thus approximately 23,500 Kcal giving a caloric density of 3.36 Kcal/cc and 55.2 $Kcal/in^3$. Weight of the packed module, excluding the box, was about 4730 grams or approximately 10.5 lbs. The caloric density was thus 4.95 Kcal/gm and the bulk density .68 g/cc.

The module packed with the components for the 32 meal items and 4 of the dual function bars gives the user a large (32) choice of meal items which can be prepared when time allows and 4 additional food bars designed to be consumed "as is" when circumstances do not allow the time or effort for meal preparation. The packed module thus contains enough food in a 0.246 ft^3 volume to sustain a man 6.5 days at a caloric intake of 3,600 calories per day, which is the minimum required by the Surgeon General.

CONCLUSIONS

The results of this study show that it is technically feasible to produce a feeding system of low weight and bulk and high caloric density (4.95 Kcal/g and 3.36 Kcal/cc) which offers the user a large and varied choice of meal items. This system may also incorporate dual function bars to increase its range of application. The results also indicate that such a system can be made stable, with regard to microbial, physical and chemical changes, for extended periods of time.

SUGGESTIONS FOR FUTURE WORK

The acceptance, flexibility and convenience of a system of this type is dependent on the following: 1) high caloric density, 2) meal variety, 3) coatings to prevent attrition, 4) minimal fragmentation of particulate matter during compression, 5) use of moisture mimetic agents and flavor masking materials to increase acceptance of dual function bars, and of course 6) storage stability.

A considerable amount of research has been done by a number of groups in each of these areas, and it now appears that it should be possible to blend the technologies gained into one unified system. Certainly, more effort will be required to arrive at a workable system, but the results should be very valuable.

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Appendix 1

Dual Function Bars

The food bar you are to evaluate is of the dual function type. It may be consumed directly in the compressed form under conditions which do not allow sufficient attention, effort or time for preparation. However, when circumstances permit, these same bars can be hydrated in a canteen cup to yield a familiar food.

When evaluating these foods, bear in mind that this project seeks to provide guidance for the development of food bars for the combat soldier who must carry whatever food he expects to eat on missions lasting as long as eight days, and assume you are under field conditions.

Take only small bites of the compressed dry material, as the hydration water must come from your mouth.

You may sample the item as often as you wish.

Food Item ____________________

Name ____________________ Date ____________

Preference Rating

Over-all Quality

9 Like extremely well ________

8 Like very much ________

7 Like moderately ________

6 Like slightly ________

5 Neither like nor dislike ________

4 Dislike slightly ________

3 Dislike moderately ________

2 Dislike very much ________

1 Dislike extremely ________

Appendix 2

Rehydratable Items

When evaluating these foods bear in mind that this project seeks to provide guidance for the development of food bars for the combat solider who must carry whatever food he expects to eat on missions lasting as long as eight days.

The food item you are evaluating today was prepared from a bar(s) similar to the example bar(s). This light, dense, conveniently carried bar can be easily hydrated in the field by crumbling it into a partial canteen cup of water. When evaluating this item, assume you are under field conditions.

You may sample the item as often as you wish.

Food Item ______________________________

Name ______________________________ Date ______________

Preference Rating

Over-all Quality

9 Like extremely well ________

8 Like very much ________

7 Like moderately ________

6 Like slightly ________

5 Neither like nor dislike ________

4 Dislike slightly ________

3 Dislike moderately ________

2 Dislike very much ________

1 Dislike extremely ________

Appendix 3

TABLE VIII: MEAL ITEMS, THEIR CONSTITUENTS AND CALORIC VALUES

Meal Item	Components	Calculated* Caloric Value Kcal
Beef in Gravy	Beef Bars (2)	646
Beef w/Potatoes & Gravy	Beef Bar (1), Potato Bar (1), Dark Brown Gravy Cubes (2)	655
Beef w/Vegetables	Beef Bar (1), Vegetable Bar (1)	634
Barbecued Beef	Beef Bars (2), BBQ Cubes (3)	703
Beef Stew	Beef Bar (1), Vegetable Bar (1), Dark Brown Gravy Cube (1)	649
Beef, Rice & Gravy	Beef Bar (1), Rice Bar (1), Dark Brown Gravy Cube (1)	646
Beef in Tomato Sauce	Beef Bars (2), Tomato Cubes (4)	714
Beef w/Cheese Sauce	Beef Bars (2), Cheese Cubes (2)	700
Beef Stroganoff	Beef Bars (2), Sour Cream Cubes Cubes (4), Onion Cube (1)	770
Pork in Gravy	Pork Bars (2)	698
Pork & Vegetables	Pork Bar (1), Vegetable Bar (1)	660
Barbecued Pork	Pork Bar (2), BBQ Cubes (3)	755
Pork, Rice & Gravy	Pork Bar (1), Rice Bar (1), Light Brown Gravy Cube (1)	672
Pork, Potatoes & Gravy	Pork Bar (1), Potato Bar (1), Light Brown Gravy Cube (1)	666
Pork in Tomato Sauce	Pork Bars (2), Tomato Cubes (4)	766
Chicken in Gravy	Chicken Bars (2)	648
Chicken, Potatoes & Gravy	Chicken Bar (1), Potato Bar (1), Poultry Gravy Cube (1)	645
Chicken & Vegetables	Chicken Bar (1), Vegetable Bar (1)	634

*Includes calories contributed by coating

Appendix 3

TABLE VIII (cont'd)

Meal Item	Components	Calculated* Caloric Value Kcal
Barbecued Chicken	Chicken Bars (2), BBQ Cubes (3)	704
Chicken, Rice & Gravy	Chicken Bar (1), Rice Bar (1), Poultry Gravy Cube (1)	652
Chicken Salad	Chicken Bars (2), Salad Dressing Cubes (3), Bacon Cubes (2)	801
Chicken ala King	Chicken Bars (2), White Sauce Cubes (4), Onion Cubes (2)	788
Chicken Stroganoff	Chicken Bars (2), Sour Cream Cubes (4), Onion Cubes (1)	772
Turkey, Potatoes, & Gravy	Turkey Bar (1), Potato Bar (1), Poultry Gravy Cube (1)	648
Turkey in Gravy	Turkey Bars (2)	656
Turkey & Vegetables	Turkey Bar (1), Vegetable Bar (1)	639
Barbecued Turkey	Turkey Bars (2), BBQ Cubes (3)	713
Turkey, Rice & Gravy	Turkey Bar (1), Rice Bar (1), Poultry Gravy Cube (1)	656
Turkey Salad	Turkey Bars (2), Salad Dressing Cubes (3), Bacon Cubes (2)	809
Turkey ala King	Turkey Bars (2), White Sauce Cubes (4), Onion Cubes (2)	796
Turkey Stroganoff	Turkey Bars (2), Sour Cream Cubes (4), Onion Cube (1)	780
Potato Soup	Potato Bars (2), Onion Cubes (6), Bacon Cubes (3)	817
	Average	703

*Includes calories contributed by coating

Appendix 3

TABLE IX: NUTRITIONAL VALUES OF INGREDIENTS USED

Ingredient	Calculated Kcal/g	% Protein	% Fat
*Beef, diced 3/8", Wilson & Co.	4.6	85.	14.5
*Chicken, diced 3/8", Wilson & Co.	4.9	81.1	18.4
*Turkey, diced 3/8", Wilson & Co.	5.1	76	23.5
*Pork, diced 3/8", Wilson & Co.	5.8	61.	38.
*Shrimp, small, Calif. Veg. Concentrates	4.17	79	5.6
-Matrix B_2	6.3		
*Rice, F.D., Calif. Veg. Concentrates	3.95		
*Corn, F.D., Calif. Veg. Concentrates	3.5		
*Peas, F.D., Calif. Veg. Concentrates	3.8		
*Sugar	3.85		
*Corn Syrup Solids	3.4		
*Dehydrated Potato Flakes	3.64		
*Onion Pieces & Powder	3.5		
*Starch	3.7		
-Powdered Butter, Spray Dried	7.2		
*Bacon Bits, Wilson	6.1		
*Tomato Powder	3.5		
*Smoked Yeast	3.1		
-Cheese, Spray Dried	5.6		
*Durkex 500 Oil, The Durkee Co.	8.8		
*Sour Cream, Spray Dried	6.5		
*Sodium Caseinate (Land-O-Lakes)	4.2		

Use of any of the above materials does not constitute an official endorsement or approval.

*Calculated from data contained in "Composition of Foods," Agriculture Handbook No. 8, United States Department of Agriculture, Rev. 1963.

-Values obtained from the manufacturer.

Appendix 3

TABLE X: COMPONENT DATA

BARS: Given below are the amounts of water per 100 g of mix, the pressure on the bar surface, the dwell necessary to fabricate each bar, and the representative weight and calculated caloric content of each type of bar when coated.

Bar Type	mls	psi	sec	gs	Kcal
Diced Beef	3.4	1500	1.5	62.4	323
Diced Pork	4.0	1500	1.5	61	349
Diced Turkey	4.0	1500	1.5	61	328
Diced Chicken	4.0	1500	1.5	61	324
Shrimp	3.0	1200	1.0	66	316
Vegetable	4.0	1250	2.0	67	311
Mashed Potato	3.0	1500	1.0	71	302
Rice	4.0	1500	2.0	67	308
Lemon	0.5	750	1.0	62	213
Orange	0.5	750	1.0	62	220
Beef & Barley	4.0	1500	2.0	61	292
Barbecue Beef	3.0	1000	1.5	61	321
Chili	3.0	750	1.0	61	290

NOTE: The above calculated caloric values include calories derived from the coating.

Appendix 3

TABLE X. (cont'd)

CUBES: Given below are the amounts of water added per 100 g of mix for pressing, and the calculated caloric value and representative weight of each cube when coated.

Cube Type	mls	gs	Kcal
Sea Food Sauce	2.5	6.0	19
Barbecue	2.5	6.4	19
Sour Cream	4.0	4.9	27
Onion	4.0	6.1	16
Poultry Gravy	4.0	6.3	19
Tomato Sauce	2.5	5.3	17
Dark Brown Gravy	3.0	5.3	15
Bacon Pieces	4.0	6.6	39
White Sauce	3.0	5.2	27
Light Brown Gravy	3.0	5.3	15
Cheese Sauce	4.0	6.2	27
Salad Dressing	3.0	5.1	25

NOTE: The above calculated caloric values include calories derived from the coating.

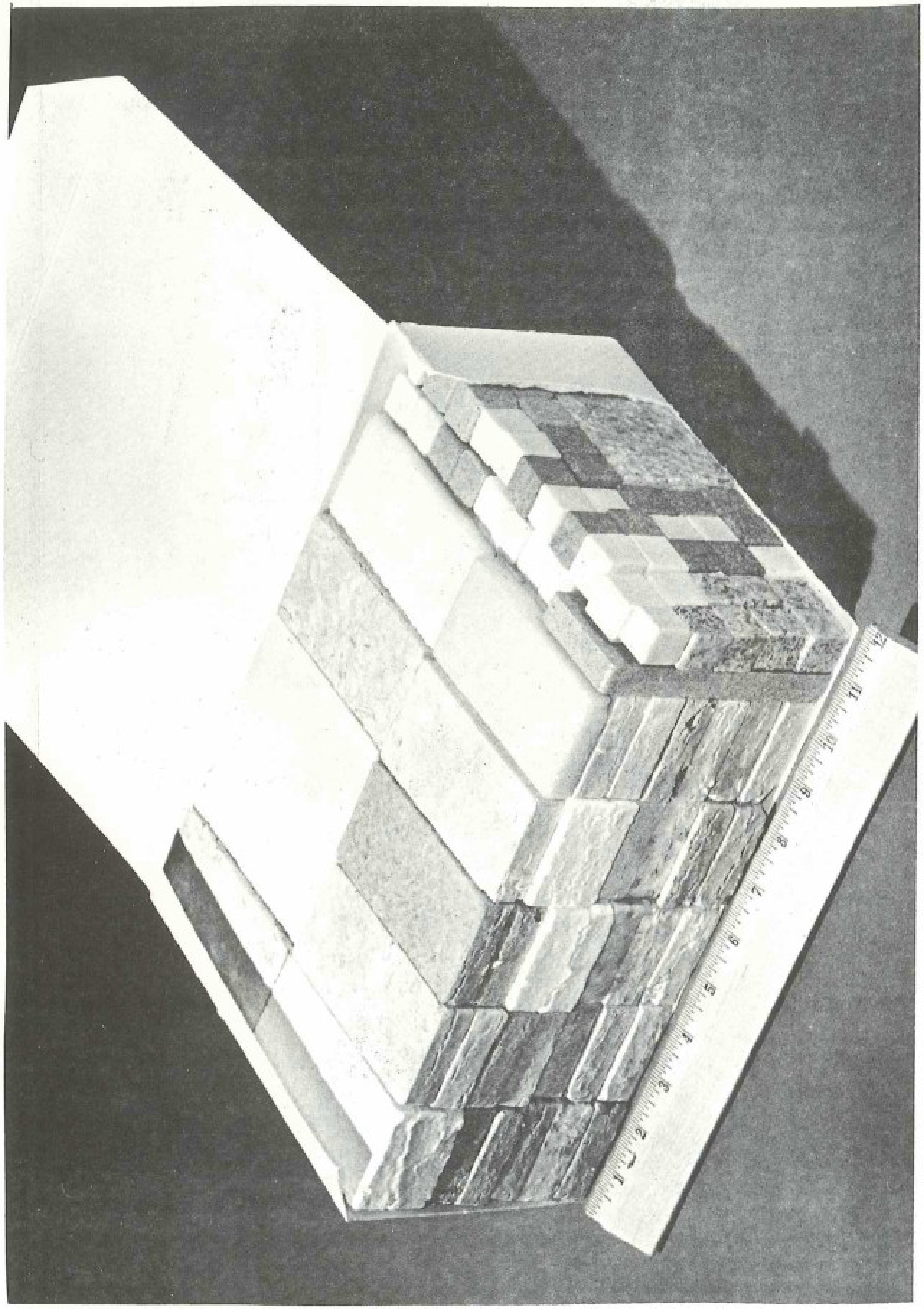

Figure I. Packed Module

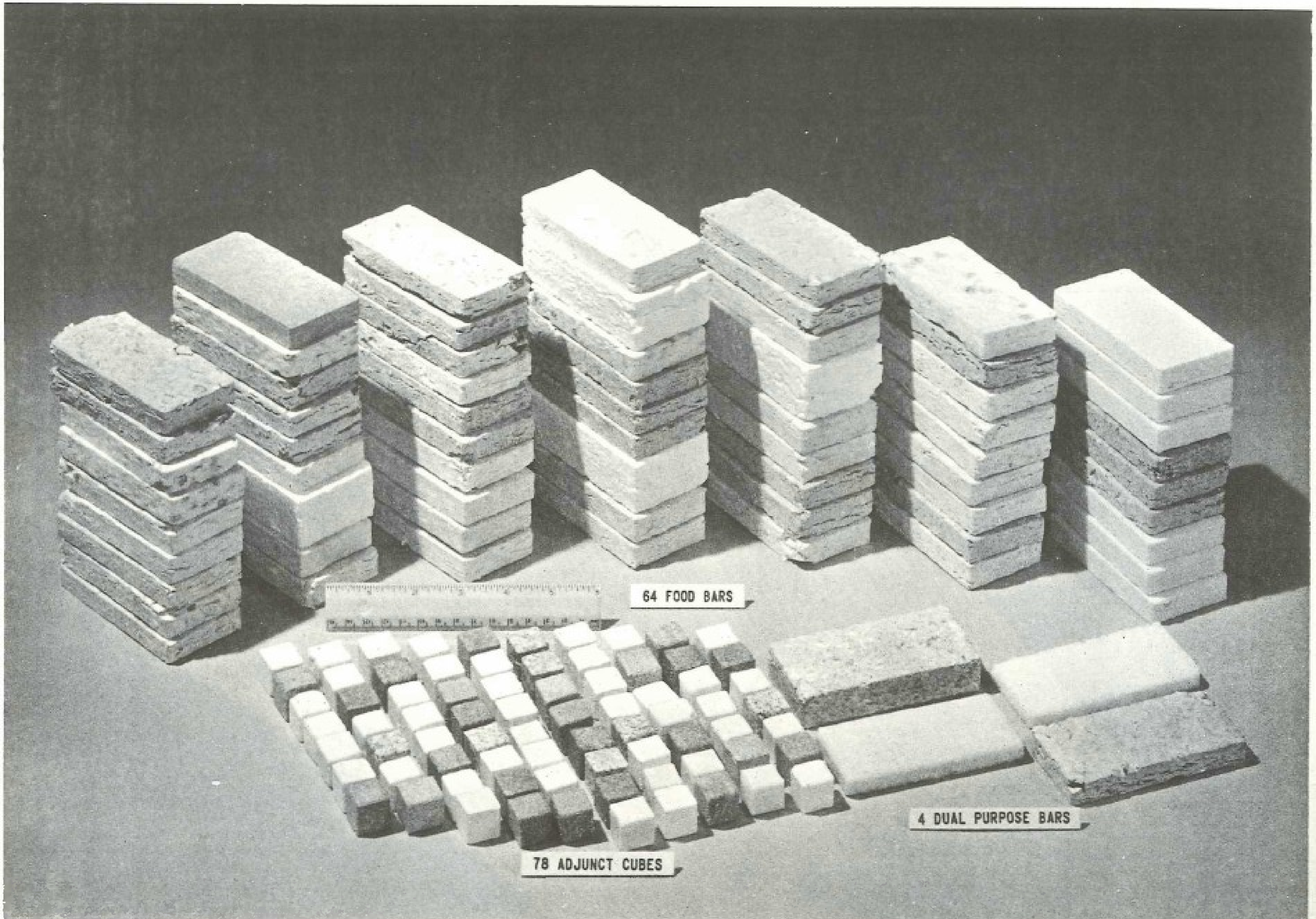

Figure 2. Contents of Module

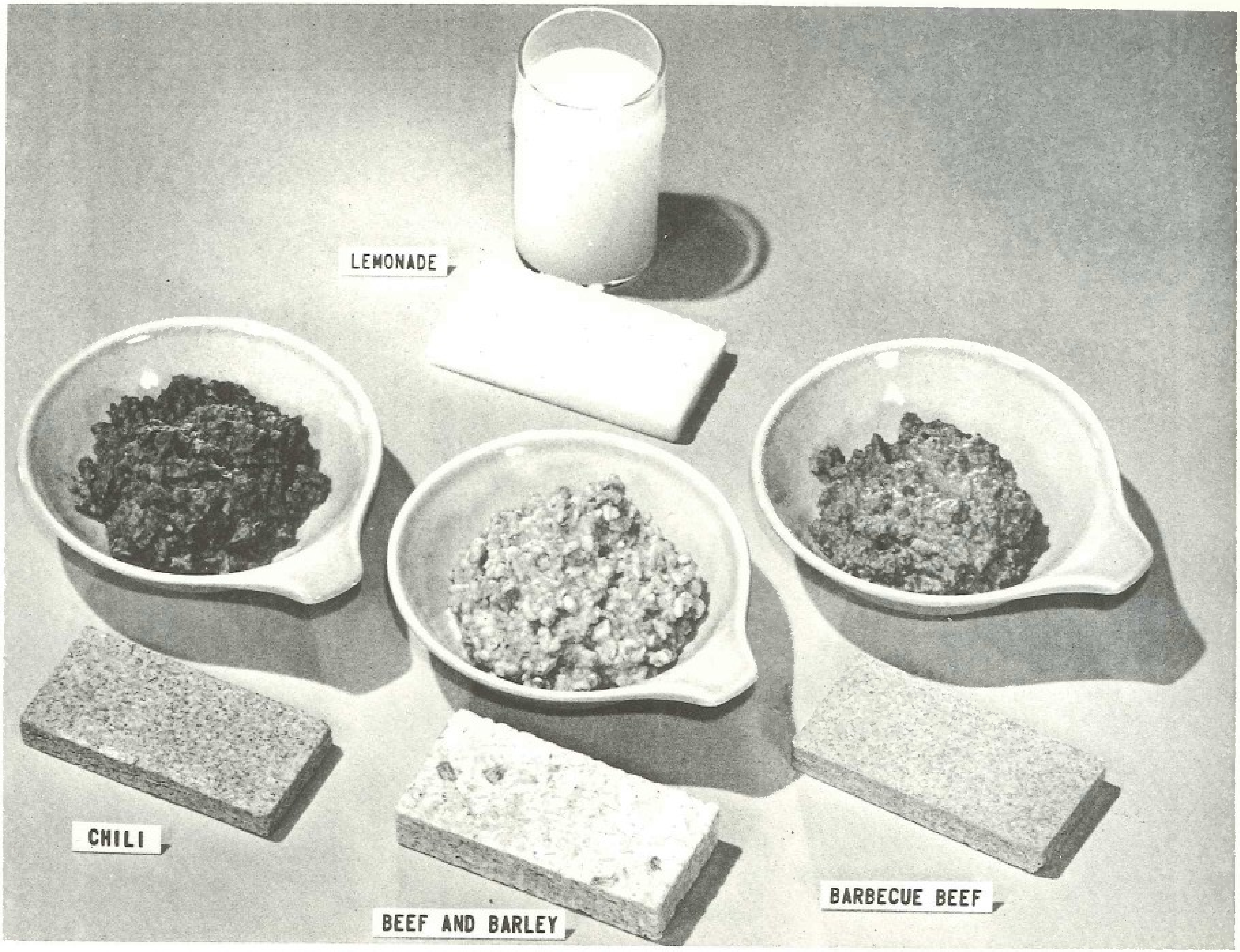

Figure 3. Hydrated Meal Items

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13. ABSTRACT

This project was originated to: 1) improve organoleptic acceptability and performance of the meal items developed during the course of work on NLABS contract number DA 19-129-AMC-860(N), 2) develop 5 dual function food bars and 3) develop a coating material(s) and methods of application to prevent fragmentation of the components.

Information is presented for the preparation of 7 improved food bars and 11 improved adjunct cubes which, when combined in defined combinations, yield 32 familiar meal items.

Five dual function food bars were also prepared. Dual function bars may be consumed "as is" or hydrated to yield a familiar food item.

Two coatings were prepared which, when applied to the food bars and adjunct cubes, prevent attrition and fragmentation during handling.

Meal items prepared from the above coated components which had been stored for four months at 38 degrees C. in N_2 filled cans were found acceptable when evaluated by a 30-man panel.

Hedonic ratings for the prepared meal items before and after storage with data on microbiological and moisture changes during storage and data to indicate coating effectiveness are also given.

DD FORM 1 NOV 65 1473 REPLACES DD FORM 1473, 1 JAN 64, WHICH IS OBSOLETE FOR ARMY USE.

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14. KEY WORDS	LINK A		LINK B		LINK C	
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Coatings	8					
Preparation	8					
Design	8					
Food Bars	9					
Food cubes	9					
Military rations	4					

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