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TR-77/008

STUDY TECHNIQUES FOR CONTROLLING FLAVOR INTENSITY IN COMPRESSED FOODS
Phase II

June 1976

UNITED STATES ARMY
NATICK RESEARCH and DEVELOPMENT COMMAND
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FOOD RESEARCH	RATIONS	COMPRESSION	CONSUMPTION
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20 ABSTRACT (Continue on reverse side if necessary and identify by block number)

The purpose of the study was to develop dual purpose compressed food bars which could be eaten as is or rehydrated to a familiar food item. During Phase II of the study, procedures for encapsulation of flavoring components were developed to control the flavor intensities of four food bars when consumed dry and to provide full flavor intensity when rehydrated. The four food bars developed during this phase were: Mushroom Soup, Curried Chicken, Beef with Onion Gravy, and Lemonade. These four food items were found to have essentially equal flavor intensities whether consumed dry or rehydrated.

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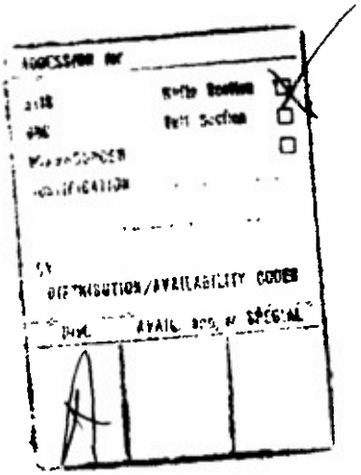
PREFACE

This report is a continuation of the investigation, the initial phase of which was published as Technical Report #75-49-FEL by the US Army Natick Research and Development Command, formerly the US Army Natick Laboratories. The advantage of dual purpose food bars for the combat soldier and to his logistic support was noted in the previous report. Such bars would provide an acceptable and immediate supply of food under conditions which preclude diversion of attention to food preparation. However, when circumstances permit, dual purpose bars could be rehydrated to yield a variety of familiar and highly acceptable meal items. Preliminary observations have revealed that many food bars which are acceptably flavored for consumption after rehydration have a flavor intensity unacceptable for direct consumption.

The preceding report demonstrated the feasibility of controlling the flavor intensity at an acceptable level in dual purpose bars representing barbecued pork and chili with beans. In this report the investigation is extended to include cream of mushroom soup, curried chicken, beef with onion gravy, and lemonade. Each bar represents a requirement to control a different type of intense flavor, such as salt, single or multiple "hot" seasonings, dehydrated onion, acid, and essential oil.

This experimental program was performed at Swift & Company, Research & Development Center, Oak Brook, Illinois 60521 with funds provided under Project Number 1G762713AO34, titled: Food Processing and Preservation Techniques. Dr. Robert L. Pavey served as Principal Investigator. Dr. Maxwell C. Brockmann and Justin M. Tuomy served as Project Officer and Alternate Project Officer, respectively, for the U.S. Army Natick Research and Development Command.



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STUDY TECHNIQUES FOR CONTROLLING FLAVOR INTENSITY IN COMPRESSED FOODS (PHASE II)

INTRODUCTION

A. Objectives

The objective of this investigation was to develop and demonstrate one or more mechanisms for assuring an acceptable flavor in dehydrated compressed food bars, when consumed as a bar and when consumed after hydration as a familiar food or beverage. Effort was to be directed specifically to bars having a high sensory impact from sodium chloride, organic acids, ground or soluble spices and seasonings. Bars used in this study were to yield the following items on rehydration.

a. Cream of Mushroom Soup

b. Curried Chicken

c. Beef with Onion Gravy

d. Lemonade

This investigation was performed in two (2) phases: Phase I was to evaluate and test commercially available encapsulated flavoring materials, and Phase II was to develop and test encapsulation of flavor materials applicable to products listed above which could not be prepared with commercially available materials available to Phase I.

During Phase I of this effort two bars, Chili with Beans and Barbecued Pork were completed and reported as Technical Report 75-49-FEL. This report is for Phase II of this investigation.

B. Specific Requirements

All components and processes used in the preparation of the above food bars were to conform to current FDA regulations, and all flavor components were to be an integral part of the bar. Bars representing products normally served hot were to be hydrated with water at 75°-85°C, while those normally consumed at room temperature or below were to be hydrated in water having a maximum temperature of 25°C. A maximum of 20 minutes, with mild agitation, was allowed for hydration.

Additives used for flavor control were not to exceed 5 percent of the dry weight of the bar and were not to adversely affect the texture, color, or mastication characteristics.

Bars were to have adequate cohesion to withstand normal handling without breakage, a minimum density of 0.8 gram per cubic centimeter, a minimum thickness of 1.2 centimeters, and a minimum weight of 12 grams. The dry bars were to be readily sheared by the incisors and were to be masticated and swallowed without difficulty. The hydrated products were to have an appearance and texture normal to their respective identities.

Bars were to undergo a storage at 40°C for three months sealed in containers impermeable to oxygen and moisture.

At the completion of this storage period, the bars were to receive an average sensory panel rating of 5 or more using a 9-point hedonic scale. After hydration, stored products were to receive an average sensory panel rating of 6 or more, based on a 9-point hedonic scale.

EXPERIMENTAL PROCEDURES AND RESULTS

A Preparation of Prototype Products

Formulation and processing procedures were developed for each of the four specified products to be evaluated in this study.

1. Ingredient Preparation:

All ingredients were used in their natural state or in freeze-dried form. Meats were pre-cooked, diced, frozen, and freeze-dried. Rice was pre-cooked, washed, drained, frozen and freeze-dried. Sauces and gravies were prepared as cooked materials, freeze-dried and chopped. The mushroom soup ingredients were all used as procured in their dry state. Lemonade bars were prepared from dry commercial lemonade mix (Wylers).

Freeze drying was accomplished using conventional methods with a maximum platen temperature of 25°C. After drying, all products were vacuum sealed in metal cans until used in product preparation.

2. Formulation:

The formula components were evaluated, and those found to contribute the strongest flavor characteristics were treated with various materials for the purpose of inhibiting their flavor intensity, when consumed from the dry state. Flavor intensity evaluations were made through the use of Flavor Profile Panel Analysis, which identifies intensities of individual flavor characteristics. Materials selected for this purpose were those which would release the full flavor potential when rehydrated. The material and procedure variables studied for each of the four food bars are discussed as follows:

a. Cream of Mushroom Soup

Commercial canned cream of mushroom soup was used as a starting formula. This soup was strained of mushrooms and each component was then freeze-dried. When compressed into bars, this material was found to be very dark in color, very hard to break, and extremely difficult to hydrate The addition of 10% and 20% cracker meal was not sufficient to soften the bars for proper hydration. It was found necessary to replace 50% of the mushroom soup material with a blend of other materials to permit proper hydration. This resulted in a formula for the mushroom soup bar as shown in Table 1.

TABLE I

Formula For Control Mushroom Soup Bar

Ingredients	%
Mushroom Soup Base, Dry	45.0
Instant Non-Dairy Creamer (Carnation)	21.8
Pre-gelatinized Starch (Instant Clearjel)	11.0
Cracker Meal	8.1
Chicken Soup Base (Lipton)	4.1
Mushrooms, Dehydrated	10.0
Total	100.0

Blending the above ingredients provided a formula which, when compressed, would hydrate within the maximum specified time limit. This bar was used as an initial Control reference.

This Control bar was subjected to a Flavor Profile Descriptive Analysis in order to determine the flavor intensity difference between dehydrated and rehydrated forms of consumption. The results of this evaluation are shown in Table II.

Interpretation of Flavor Profile intensity ratings is as follows:

)(= just detectable intensity
1 = slight
2 = moderate
3 = strong
↑ = increasing intensity level
↓ = decreasing intensity level, a dissipating aroma, etc.
a,b,c = sequence of individual aroma/flavor note detection

The first attempt to control this flavor intensity difference was to evaluate the procedure of adding an all-purpose shortening (Vream) as was found beneficial for the Chili and the Barbeque Pork items in Phase I. This shortening has a melting point of 42 to 44°C and should retain flavors at body temperature but release them when heated during hydration. This material was blended with the total soup base component, with the exclusion of the mushrooms, at 2, 4, and 8 percent of the total formula.

These test products were prepared and subjected to Flavor Profile evaluation. The results of this analysis are shown in Table III.

TABLE II

Flavor Profile Descriptive Analysis

Mushroom Soup Bars - Control

Flavor Character	Dehydrated	Rehydrated
Hydrolysate/MSG	1 - 2 (a)	- - -
Salt	2 - 3 (b)	1 - 2 (e)
NFDM/Milky/Casein	1 - 2 (c)	1 - 2 (b)
Creamy Sweet	1 - 2 (d)	1 - 2 (a)
Mushroom	1 - 2 (e)	1 - 2 (c)
Onion/Green Herb Complex	1 - 2 (f)	)(- 1↑ (d)
Powdery/Dehydrated	)(- 1↑ (g)	1 (f)
Milky Sour	- - -	1 (g)
Aftertastes:	Creamy sweet, salt, cardboard, mushroom, green herbs, onion	Sour, cream, sweet, salt, mushroom, onion, green herbs
Mouthfeelings:	Creamy, chunky, salivation, chewy mushrooms, undissolved clumps, metallic tooth edging	Chewy mushroom particles, MSG-salivation, sticks to teeth, salt particles

TABLE III

Flavor Profile Descriptive Analysis

Mushroom Soup Bar - Shortening Test

Flavor Character	4% Shortening		8% Shortening	
	Dehy.	Rehy.	Dehy.	Rehy.
Hydrolysate/MSG	1 - 2 (a)	- - -	2 (a)	- - -
Salt	2 - 3 (b)	1 - 2 (e)	2 - 3 (b)	1 - 2 (e)
NFDM/Milky/Casein	2 (c)	1 - 2 (b)	2 (c)	1 - 2 (b)
Creamy Sweet	1 - 2 (d)	1 - 2 (a)	1 (d)	1 - 2 (a)
Mushroom	1 - 2 (e)	1 - 2 (c)	1 - 2 (e)	1 - 2 (c)
Onion/Green Herb	1 - 2 (f)	)(- 1+ (d)	1+ (f)	)(- 1 (d)
Powdery/Dehy.	1 (h)	1 (f)	1 (g)	1 (f)
Milky Sour	1 (g)	- - -	- - -	- - -
Aftertastes:	Creamy, salt, cardboard, mushroom, green herbs, onion	Sour, cream, sweet, salt, mushroom onion, green herbs	Same as 4% - plus sweet, and sour	Same as 4%
Mouthfeelings:	Creamy, chunky, salivation, soft & chewy mushrooms, me' llic tooth edging	Chewy mushroom particles, MSG-salivation, sticks to teeth, salt burn	Same as 4% - plus chewy/ mushy mushrooms, undissolved clumps & poor hydration	Same as 4%

They were found unacceptable in that too much salt flavor was released in the mouth. This is apparently due to the broad range of the solid fat index (SFI) of this type of shortening. It was found that the addition of shortening did greatly improve the softness of the bar, which aided its eating and rehydration characteristics.

It was then our approach to find a material which was very slowly dissolved in the mouth. The U.S. Army Natick Space Food Coating material was selected for this purpose and was prepared from the following formula.

TABLE IV

Caseinate Coating Material

Ingredients	%
Durtex 500 Oil	9.7
Sodium Caseinate	9.7
Glycerine	2.8
Gelatin - 275 Bloom	2.2
Water	75.6
Total	100.0

This coating material was applied to the mushroom soup base material with the added chicken soup base material at 10% and 20% levels. These ingredients make up approximately 50% of the total formula, resulting in a 5% and 10% caseinate coating level in the final product. This material, after blending with the soup base, was freeze-dried and chopped prior to blending with the remaining components in preparation of bars. This freeze drying resulted in an additive level of 1.25% and 2.5% respectively, due to the coating material being 75.6% water.

The bars prepared with the caseinate coating were submitted for Flavor Profile evaluation. Results of these analyses are shown in Table V.

This coating material was found effective in inhibiting or masking the intense salt flavor of this product when consumed dry, however, it also resulted in producing a very hard bar which was very difficult to break and rehydrate. This was especially true after 2 months storage at 38°C, at which time this variable was abandoned.

TABLE V

Flavor Profile Descriptive Analysis

Mushroom Soup Bar - Caseinate Coating

Flavor Character	1.25% Caseinate		2.5% Caseinate	
	Dehy.	Rehy.	Dehy.	Rehy.
Hydrolysate/MSG	1 - 2 (b)	- - -	1 - 2 (b)	- - -
Starch (Crackers)	1 (a)	1 - 2 (a)	1 (a)	1 (a)
Salt	2 (d)	1 - 2 (d)	1 - 2 (d)	1 - 2 (d)
Casein	1 - 2 (e)	1 - 2 (e)	2 (e)	2 (e)
Creamy Sweet	1 - 2 (c)	1 - 2 (e)	1 - 2 (c)	1 - 2 (b)
Mushroom	1 - 2 (f)	1 - 2 (f)	1 (f)	1 - 2 (c)
Onion/Green Herb	)(- 1 (g)	)(- 1 (h)	)(- 1 (h)	)(- 1 (f)
Powdery/Dehy.	)(- 1 (h)	- - -	- - -	- - -
Milky Sour	)(- 1+ (i)	)(- 1 (g)	1 (g)	)(- 1 (g)
Aftertastes:	Bitter,sour,cream, salt,mushroom,onion,green herbs	Casein, creamy sweet,mushroom, green herbs	Same as 1.25% - plus sweet	Same as 1.25% plus metallic and onion
Mouthfeelings:	Metallic tooth edging, chewy, mushroom particles,MSG-salivation,sticks to teeth, creamy/ fatty coating	Creamy, chunky, salivation,chewy mushrooms,undissolved clumps, tooth edging, mouth burn, viscous	Same as 1.25%	Same as 1.25% but no undissolved clumps

The next effort was to evaluate other potential solutions to this problem. After considerable review and discussion, it was decided to explore the use of a specialty fat with a very narrow plastic range and a melting point slightly above body temperature. The fat selected for this purpose was Swift's Tem Wip, which has a sharp melting point of 40° to 42°C. This material was evaluated at 8% and 16% of the total formula but added only to the ingredients other than the mushrooms. This fat was found to be more acceptable than the all-purpose shortening (Vream), but still not sufficient to mask the salt intensity to the degree desired.

From the above studies it was observed that the addition of fats aided hydration and eating characteristics, but had little effect on flavor intensity. The addition of the caseinate coating material was effective in reducing the salt, but had a very detrimental effect on the eating and hydrating characteristics. Therefore, it was decided to evaluate the two approaches in combination. The caseinate coating was applied to the 50% of the formula which contained the high salt at 10% and 20% levels (equivalent to 2.5 and 5.0% dry matter). This resulted in an additive level of 1.25% and 2.50% respectively, in the final product, on a dry weight basis. These levels were then prepared into bars containing 16% fat (Tem Wip), and evaluated.

The test bars were prepared and submitted to Flavor Profile analysis, with the results shown in Table VI.

This evaluation showed that the higher levels of caseinate in formulas containing 16% fat met the objectives of flavor control, hardness of bars, and rehydration. Therefore, the 1.25% caseinate bars were submitted to the prescribed storage evaluation. For purposes of this contract, the addition of the fat is considered as an improvement of the original control product and not for the purposes of flavor intensity control. The flavor intensity control is provided by the caseinate coating at 1.25% level.

b. Curried Chicken:

The curried chicken formula was prepared by our Executive Chef, in separate parts: sauce, chicken, and rice. The formulas for these components were as follows:

TABLE VI

Flavor Profile Descriptive Analysis

Mushroom Soup Bars - Casein/Sp. Fat Test

Flavor Character	1.25% Caseinate 16% Tem Wip		2.5% Caseinate 16% Tem Wip	
	Dehy.	Rehy.	Dehy.	Rehy.
Hydrolysate/MSG	1 - 2 (a)	- - -	1 - 2 (a)	- - -
Salt	2 (b)	1 - 2 (d)	2 (b)	1 - 2 (d)
NFDM/Casein	1 - 2↑ (c)	1 - 2 (b)	2 (d)	2 (b)
Creamy Sweet	1 - 2 (d)	1 - 2 (a)	1 - 2 (c)	1 - 2 (a)
Mushroom	2 (f)	2 (c)	1 - 2 (e)	1 - 2 (c)
Onion/Green Herb	1↑ (g)	)(- 1 (e)	)(- 1 (f)	)(- 1 (f)
Milky Sour	1 (e)	1↑ (g)	)(- 1↑ (g)	)(- 1 (g)
Powdery/Dehy.	1 (f)	- - -	)(- 1 (h)	- - -
Aftertastes:	Creamy, sweet, salt, chalky, cardboard, mushroom, green herbs, onion	Sour, cream, sweet, salt, mushroom, onion, green herbs	Same as 1.25%	Same as 1.25%
Mouthfeelings:	Creamy, chunky, salivation, chewy mushroom, metallic tooth edging, mouth burn	Metallic tooth edging, chewy mushroom particles, MSG-salivation, sticks to teeth, salt burn, salt particles	Same as 1.25%	Same as 1.25%

TABLE VII

Curry Sauce Formula

Ingredients	%
Apple Sauce	12.18
Non Fat Dry Milk	8.12
Shortening (Vream)	3.17
Chicken Base (Lipton's)	3.04
Curry Powder (McCormick)	2.54
Hard Wheat Flour	2.18
Onion Juice	2.02
Salt	1.02
Waxy Maize Starch	.73
White Pepper	.011
Bay Leaf, Ground	.004
Water	64.985
Total	100.000

This curry sauce was prepared as a fully-cooked component, frozen, and then freeze-dried. Swift Premium chicken rolls, white meat without skin added (fully cooked), were sliced and diced 2.5 cm x 2.5 cm x 2.5 cm, frozen and freeze-dried for use as the meat portion. Rice was cooked in two parts water by bringing to a boil, followed by baking 25 minutes in a 125°C oven, frozen and freeze-dried.

The above dried components were blended in the following proportions for preparation of the control bars.

TABLE VIII

Curried Chicken Formula

Component	%
Chicken, Diced, Freeze-Dried	70
Curry Sauce, Freeze-Dried	20
Rice, Freeze-Dried	10
Total	100.0

Evaluation of the Control bars established that the curry sauce component required flavor intensity control as is shown in Table IX.

Therefore, our efforts were concentrated on this curry sauce component.

TABLE IX

Flavor Profile Descriptive Analysis

Curried Chicken Bar - Control

Flavor Character	Control	
	Dehydrated	Rehydrated
Curry Spice Blend	2↑ (a)	2 (a)
Cumin/Sage	1 (b)	1 - 2 (b)
Ginger/Cloves	)(- 1 (c)	- - -
Red Pepper	1 - 2↑ (d)	)(- 1↑ (c)
Salt	1 - 2↑ (e)	2 (f)
Chicken	1 (f)	1 (g)
Onion (Dehy.)	)(- 1 (g)	)(- 1 (e)
Sweet Curry	1 (h)	1 - 2 (d)
Sour	)(- 1 (i)	)(- 1 (h)
Rice, Dehydrated	1 (j)	1 (i)
Aftertastes:	Pepper, cloves, onion, curry, cumin, cardboard, HVP, salt	Salt, sweet, pepper, curry, cloves, onion, cumin, rice
Mouthfeelings:	Pepper burn, salivation, hard rice, slow hydration, sticks to teeth, numbing (cloves), throat irritation, spice burn	Salivation, chewy rice, numbing (cloves), pepper/curry burn, mealy texture, mouth irritation, not rehydrated well (rice)

Our first attempt in controlling the flavor intensity of this item was to evaluate the use of an all-purpose shortening (Vream) at 10% and 20% of the curry sauce component. This resulted in a 2% and 4% level in the total product since the curry sauce makes up 20% of the total formula. Both levels of the all-purpose shortening caused a slower flavor release in the dry bar as compared to the control. The flavor intensity, however, did build up to excessive levels with time. These analyses are shown in Table X. The shortening was effective in diminishing the salt intensity in this product, contrary to its effect in mushroom soup, but was not effective in reducing the pepper intensity.

The next approach for the curry sauce was to evaluate the use of caseinate coating at 10% level in the curry sauce portion, which is 0.5% of the total formula on a dry matter basis. This treatment also included the addition of Tem Wip Specialty fat at 20% of the curry sauce component, or 4% of the total formula. The addition of the caseinate coating was found to be effective in reducing the pepper flavor intensity. The profile results are shown in Table XI. This treatment was prepared for storage evaluation using 0.5% caseinate coating and 3% (15% of the curry spice component) Specialty fat (Tem Wip).

c. Beef with Onion Gravy

The onion gravy for this item was prepared by our Executive Chef, using the following formula:

TABLE XII

Onion Gravy Formula

Ingredients	%
Onions, Chopped	18.0
Tomato Paste	4.10
Hard Wheat Flour	3.41
Beef Base	2.98
Celery Juice	2.46
Shortening (Vream)	2.36
Carrot Juice	1.23
Onion Juice	1.23
Waxy Maize Starch	0.79
Garlic Juice	0.16
Monosodium Glutamate	0.10
Black Pepper	0.025
Caramel Color	0.025
Water	63.130
Total	100.000

TABLE X

Flavor Profile Descriptive Analysis

Curried Chicken Bars - Shortening Test

Flavor Character	2% Shortening		4% Shortening	
	Dehy.	Rehy.	Dehy.	Rehy.
Curry Spice Blend	1 - 2↑ (a)	2 (a)	1 - 2↑ (a)	1 - 2 (a)
Cumin/Sage	1 (b)	1 - 2 (b)	1 (b)	1 - 2 (b)
Ginger/Cloves	)(- 1 (c)	- - -	)(- 1 (c)	- - -
Pepper	1 - 2↑ (d)	1↑ (c)	1 - 2↑ (d)	1↑ (c)
Salt	1↑ (e)	1 - 2↑ (f)	1↑ (e)	1 - 2 (f)
Chicken	)(- 1 (f)	1 (g)	)(- 1 (f)	1 (g)
Onion (Dehy.)	)(- 1 (g)	1 (e)	)(- 1 (g)	1 (e)
Sweet (Curry)	1 (h)	1 - 2 (d)	1 (h)	1 (d)
Sour	)(- 1 (i)	)(- 1 (h)	)(- 1 (i)	)(- 1 (h)
Rice, Dehydrated	1 (j)	1 (i)	1 (j)	1 (i)
	Slow flavor release		Slow flavor release	
Aftertastes:	Pepper,cloves,onion,curry,cumin, cardboard, HVP, salt, sour	Salt,sweet,pepper, curry,cloves,onion,cumin,rice	Same as 2%	Same as 2%
Mouthfeelings:	Pepper burn,salivation,hard rice, slow hydration, sticks to teeth, numbing (cloves), throat irritation, spice burn	Salivation,chewy rice, numbing (cloves),pepper, curry burn,mouth irritation, not rehydrated well (rice)	Same as 2%	Same as 2%

TABLE XI

Flavor Profile Descriptive Analysis

Curried Chicken Bar - Caseinate Coating

Flavor Character	2% Caseinate 4% Specialty Fat	
	Dehydrated	Rehydrated
Curry Spice Blend	2+ (a)	1 - 2 (a)
Cumin/Sage	1 (b)	1 - 2 (b)
Ginger/Cloves	1 (c)	
Pepper	1+ (d)	1 (c)
Salt	1 - 2 (e)	1 - 2 (f)
Chicken	1 (f)	1 (g)
Onion (Dehydrated)	)(- 1 (g)	)(- 1 (e)
Sweet (Curry)	1 (h)	1 - 2 (d)
Sour	)(- 1 (i)	1 (h)
Rice, Dehydrated	1 (j)	1 (i)
	Slow flavor release	
Aftertastes:	Pepper,cloves,onion, curry,cumin,cardboard, HVP,salt,sour	Salt,sweet,cumin, pepper,curry,rice, cloves,onion,sour
Mouthfeelings:	Pepper burn, salivation, crisp hard rice, slow hydration, numbing (cloves), sticks to teeth, throat irritation, creamy/fatty mouthcoating	Salivation,chewy rice, numbing (cloves), pepper/curry burn, mouth irritation, not rehydrated well (rice)

The above onion gravy was prepared as a cooked gravy, frozen, and freeze-dried. The meat used was boneless rib eye, which was braised for 20 minutes in a 260°C oven. This meat was then chilled in a -2°C cooler overnight, diced 0.5 cm x 2.5 cm x 2.5 cm, frozen and freeze-dried.

The bar formulation was as follows:

TABLE XIII

Beef With Onion Gravy Formula

Ingredients	%
Meat, Diced, Dried	90
Onion Gravy, Dried	10
Total	100

The preparation and evaluation of the control Beef and Onion Gravy bar demonstrated a high intensity of onion and pepper flavor, when consumed dry. These results are shown in Table XIV.

The use of an all purpose shortening at 10% and 20% of the gravy mix was evaluated. The only effect noted was on the onion sour note, with no apparent effect on the onion and the pepper flavor characteristics. There was a marked improvement in bar texture and rehydration characteristics. These results are shown in Table XV.

The caseinate coating was then tried in conjunction with the Specialty fat (Tem Wip). The caseinate coating was added to the onion gravy mix at 20% level wet weight, resulting in 5% on a dry weight basis for the onion gravy component after freeze-drying. This was then chopped and treated with 20% fat (Tem Wip). These treatments of the gravy portion resulted in a 0.5% caseinate and 2% fat addition to the total formula, since the gravy portion was used at 10% of the total formula. The meat was then sprayed with water until slightly pliable and then blended with the treated gravy mix prior to compression into bars. The bars were freeze-dried and evaluated. These results are shown in Table XVI.

The combined caseinate-fat treatment was effective in reducing the onion flavor and pepper flavor of this bar. Therefore, this treatment was prepared for storage evaluation

TABLE XIV

Flavor Profile Descriptive Analysis

Beef and Onion Gravy Bar - Control

Flavor Character	Dehydrated	Rehydrated
Onion (Dehy.)	2↑ (a)	1 (d)
Beef	1 - 2↑ (b)	1 - 2 (a)
Sour (Onion)	1 - 2↑ (c)	1 (c)
Hydrolysate	- - -	1 (f)
Salt	1↑ (e)	1 - 2↑ (e)
Black Pepper	1↑ (d)	)(- 1↑ (g)
Sweet	)(- 1 (f)	1 (b)
Dehydrated	)(- 1 (g)	1 (h)
Aftertastes:	Onion,salt,sour,sweet, beef	Onion,sour,salt,beef, pepper,sweet
Mouthfeelings:	Salivation,pepper warmth, dry,slow rehydration, sticks to teeth, throat drying	Chunky, salivation, astringent,incompletely rehydrated

TABLE XV

Flavor Profile Descriptive Analysis

Beef and Onion Gravy Bar - Shortening Test

Flavor Character:	1% Shortening		2% Shortening	
	Dehy.	Rehy.	Dehy.	Dehy.
Onion (Dehy.)	2↑ (a)	1 (d)	2↑ (a)	1 (d)
Beef	1 - 2↑ (b)	1 - 2 (a)	1 - 2↑ (b)	1 - 2 (a)
Sour (Onion)	↑ (d)	1 (c)	1↑ (c)	1↑ (c)
Hydrolysate	- - -	)(- 1 (f)	- - -	)(- 1 (f)
Salt	1↑ (c)	1 - 2 (c)	1↑ (e)	1 - 2 (e)
Black Pepper	1 (e)	1 (g)	1 (d)	1↑ (g)
Sweet	)(- 1 (f)	1 (b)	)(- 1 (f)	1 (b)
Dehydrated	)(- 1 (g)	1 (h)	)(- 1 (g)	1 (h)
Aftertastes:	Onion, salt, sour, sweet, beef	Onion, sour, salt, beef, pepper, sweet	Same as 1%	Same as 1%
Mouthfeelings:	Salivation, pepper warmth, firm, dry, slow hydration, sticks to teeth, throat drying	Chunky, salivation, astringent, stringy, incompletely rehydrated, mushy consistency	Salivation, pepper warmth, sticks to teeth, throat drying, soft & crumbly, fatty coating	Same as 1% - but not stringy

TABLE XVI

Flavor Profile Descriptive Analysis

Beef and Onion Gravy Bar - Caseinate Test

Flavor Character	0.5% Caseinate 2% Specialty Fat	
	Dehydrated	Rehydrated
Onion (Dehy.)	1 - 2+ (a)	1+ (b)
Beef	1 - 2 (b)	2 (a)
Sour (Onion)	)(- 1+ (d)	)(- 1 (d)
Hydrolysate	1 (c)	- - -
Salt	1 - 2 (f)	1 - 2 (e)
Black Pepper	)(- 1 (e)	1 (f)
Sweet	)(- 1 (g)	1 (c)
Dehydrated	)(- 1 (h)	1+ (g)
Aftertastes:	Onion, salt, sour, sweet, beef	Onion, salt, sour, sweet, beef, pepper
Mouthfeelings:	Salivation, pepper warmth, creamy, greasy/fatty coating	Salivation, chunky, astringent, completely rehydrated

d. Lemonade Bar

The Control material used for the lemonade bar item was "Wylers" lemonade mix. This bar was prepared by spraying the lemonade mix with water until just barely tacky (about 3% water added) and compressing. The bar was then freeze-dried and evaluated by Flavor Profile. The results of this analysis are shown in Table XVII.

This bar was extremely sweet and tart when consumed dry in comparison to when rehydrated. Several alternatives for reducing this sweet/tart flavor were considered, including sugar coating, fat coating, gums and gelatin. Of these alternatives it was decided that the only logical alternative would be the use of gelatin, which would hydrate in cold water without objectionable characteristics. Gelatin (100 bloom) was hydrated in a 30% gelatin concentration, heated until dissolved, then sprayed onto the lemonade while stirring to achieve uniform distribution. The levels selected for study were 7.0, 9.3 and 12.0% of the gelatin solution, resulting in 2.1, 2.8 and 3.6% gelatin respectively, on a dry weight basis. Each of these, and especially the 12% treatment, became quite sticky during this addition. These materials were freeze-dried and rechopped into a coarse powder prior to forming bars. Tasting of these gelatin treated products appeared to greatly diminish the sweet/tart flavor of the original lemonade mix. These bars were prepared and subjected to Profile flavor evaluation. Results are shown in Table XVIII.

Both the lemon sour/tart and the sweetness intensities were diminished with increasing levels of gelatin. The 3.6% gelatin level was considered best in regard to flavor intensity and, therefore, was prepared for storage evaluation.

3. Preparation of Compressed Bars:

Products were compressed in a 4 cm x 6.5 cm die to a thickness controlled by the length of the upper and lower punch length having a cavity of 1.2 cm thickness when pushed to the limits of the upper and lower surfaces of the die assembly. Press pressure was sufficient to push the punch fully into the die. The meat portions of the products were conditioned with moisture prior to compression, to prevent particle fragmentation. At least 30 grams of moisture-conditioned product were compressed in this manner, resulting in a density of at least 0.8 grams per cubic centimeter after drying. The product weight was increased to achieve sufficient cohesion to withstand handling, where necessary. The compressed bars were freeze-dried and then placed in flexible pouches and sealed fol-

TABLE XVII

Flavor Profile Descriptive Analysis

Lemonade Bar - Control

Flavor Character	Dehydrated	Rehydrated
Lemon Sour/Tart	2 - 3 (a)	1 - 2↑ (b)
Sugar Sweet	2↑ (b)	1 - 2 (a)
Artificial Lemon	1 - 2 (c)	1 (c)
Powdery/Dehydrated	)(- 1↑ (d)	)(- 1↑ (d)
Bitter	1↑ (e)	1 (e)
Aftertastes:	Sour, sweet, bitter, artificial lemon	
Mouthfeelings:	Throat irritation (acid), mouth/throat burn, extreme astringency, abrasive, hard bar	Salivation, astringent, mouth tingle, throat irritation (acid), tooth edging, drying

TABLE XVIII

Flavor Profile Descriptive Analysis

Lemonade Bars - Gelatin Treated

Flavor Character	2% Gelatin		2.8% Gelatin		3.6% Gelatin	
	Dehy.	Rehy.	Dehy.	Rehy.	Dehy.	Rehy.
Lemon Sour/Tart	2-3 (a)	1-2↑ (d)	2↑ (a)	1-2 (a)	2 (a)	1-2 (a)
Sugar Sweet	2↑ (b)	2 (a)	2 (b)	1-2↑ (b)	2 (b)	1-2↑ (b)
Artificial Lemon	1-2 (c)	1-2 (c)	1-2 (c)	1 (c)	1 (c)	1 (c)
Powdery, Dehy.	)(-1 (d)	)(-1 (d)	)(-1 (d)	)(-1 (d)	)(-1 (d)	)(-1 (d)
Bitter	1↑ (e)	1↑ (e)	)(-1↑ (e)	)(-1↑ (e)	)(-1 (e)	)(-1 (e)

	Dehydrated (All)	Rehydrated (All)
Aftertastes:	Sour,sweet,bitter (peel),artificial lemon	Sour,powdery,sweet,bitter,artificial lemon,gelatin
Mouthfeelings:	Throat irritation (acid),mouth/throat burn,extreme astringency, abrasive	Salivation,astringent,mouth tingle,throat irritation (acid), gelatinous coating,tooth edging, drying

lowing complete evacuation and nitrogen backfill to approximately 1/2 atmospheric pressure.

4. Storage Evaluation of Test Products:

The four (4) products developed above were placed in 30°C storage for a period of three (3) months, in nitrogen backfilled foil laminated pouches. The results of this storage evaluation are discussed as follows:

a. Rehydration:

The bars were broken into pieces prior to hydration in hot water, 75° to 85°C (except for lemonade - 20°-25°C), according to the amounts shown in Table XIX. After the water was added, mild agitation was applied using a spoon. At the end of 20 minutes, the product was evaluated and found to be hydrated to an acceptable degree.

TABLE XIX

Rehydration of Stored Bars

Type of Bar	Weight of Bar	Grams Water	Temp.
Mushroom Soup	30 gms	142	85°C
Curried Chicken	20 gms	42	85°C
Beef & Onion Gravy	30 gms	42	85°C
Lemonade	20 gms	185	85°C

The mushroom soup had a few lumps which were not fully hydrated, the beef had a few particles of meat not fully hydrated, the curried chicken meat was broken up, and the lemonade had some undissolved particles. All products appeared to have acceptable texture and flavor and were, therefore, subjected to panel acceptability evaluation.

b. Panel Acceptability Evaluation:

1. Objective

To evaluate acceptability of dehydrated, compressed food bars consumed (1) in dehydrated bar form, and (2) as a familiar food or beverage, in rehydrated form.

2. Panel Procedure

Twenty male laboratory personnel, of approximate

25-35 years age, participated in this evaluation series. Panels were conducted over 3 consecutive days. Two bar varieties, rehydrated and dehydrated forms, were evaluated per panel session.

Test criteria included overall appeal, flavor appeal and intensity, and texture/mouthfeel appeal. Appeal (acceptability) ratings were based on a 9-point hedonic system (1.00 = dislike extremely; 9.00 = like extremely); flavor and hardness ratings were quantitative (1.00 = none; 6.00 = very much/extreme).

3. Product Preparation:

Dehydrated Bars - Each bar was cut into 6 gram pieces; two pieces were consumed by each panelist.

Rehydrated Bars - Bars were broken into pieces prior to hydration. Hot water, 75-85°C (except lemonade, 20°-25°C) was added and mild agitation applied. Rehydrated product was allowed to stand (double-boiler water bath) 20 minutes before serving. The following bar-water proportions were used.

TABLE XX

Bar Rehydration

Bar Variety	Weight of Bar	Recommended Water/Bar Proportion	*Actual Amount Added Water/Bar
Lemonade	30 gms	185 gms	185 gms
Mushroom Soup	30 gms	142 gms	142 gms
Beef w/Onion Gravy	30 gms	42 gms	48 gms
Curried Chicken w/Rice	30 gms	42 gms	57 gms

* Additional water added to Beef with Onion Gravy and Curried Chicken varieties to promote "typical" consistency.

An approximate 55°-60°C serving temperature was maintained for rehydrated bars (except lemonade, room temperature); dehydrated counterparts were served at room temperature. Fifty milliliters soup or lemonade and 25 gms curried chicken or beef with gravy sample portions were served.

4. Data Presentation:

The acceptance and quantitative flavor intensity/hardness panel data (mean scores) shown in Table XX were obtained.

Overall/Flavor/Texture-Mouthfeel Appeal 9-point word hedonic rating scale: 1.00 = dislike extremely

TABLE XX

Acceptance, Quantitative Flavor Intensity and Hardness Panel Evaluation Data - 3 Months Storage at 40°C

Bar Variety	Overall Appeal	Flavor Appeal	Flavor Intensity	Texture/ Mouthfeel Appeal	Hardness
Lemonade Bars					
Dehydrated	6.80	7.05	5.00	6.25	3.40
Rehydrated	6.80	6.85	4.50	6.85	-
Mushroom Soup					
Dehydrated	7.40	7.55	4.30	6.80	2.10
Rehydrated	6.65	6.90	3.70	7.35	-
Beef w/Onion Gravy-1					
Dehydrated	6.50	6.70	4.00	6.00	1.85
Rehydrated	7.10	7.05	4.35	6.50	-
Beef w/Onion Gravy-2					
Dehydrated	6.20	6.30	3.75	6.35	2.60
Rehydrated	6.45	6.75	3.70	5.80	-
Curried Chicken w/Rice					
Dehydrated	6.40	6.45	4.55	6.10	2.45
Rehydrated	6.90	6.80	3.90	6.55	-

2.00 = dislike very much, 3.00 = dislike moderately, 4.00 = dislike slightly, 5.00 = neither like/dislike, 6.00 = like slightly, 7.00 = like moderately, 8.00 = like very much, 9.00 = like extremely

Overall Flavor Intensity 6-point quantitative rating scale: 1.00 = none, 2.00 = very little, 3.00 = little, 4.00 = moderate, 5.00 = much, 6.00 = very much.

Degree of Hardness 5-point quantitative rating scale: 1.00 = slight, 2.00 = moderate, 3.00 = much, 4.00 = very much, 5.00 = extreme.

Panel data were not subjected to statistical analyses. According to contract (reference #DAAG17-73-C-0210, Sensory Evaluation specifications (page 5), "Bars stored 3 months at 40°C shall receive an average rating of 5 or more when evaluated by a panel on the basis of a 9-point hedonic scale. After hydration, each item shall receive an average rating of 6 or more based on a 9-point hedonic scale." All bar varieties submitted met these specifications

5. Summary:

The four (4) food bar items requiring flavor intensity control during this phase of the contract were evaluated and methods of flavor intensity control were developed. The Mushroom Soup required a caseinate coating, the Curried Chicken and the Beef with Onion Gravy required a combination caseinate/fat treatment, and the Lemonade bar used a gelatin coating to achieve the desired flavor inhibition, when consumed in the dry state. These materials released the full flavor intensity when hydrated in their respective manner.

The above treated bars were prepared and evaluated after 3 months storage at 40°C and found acceptable.