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INSTANT PUDDING AND PIE FILLING

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NATICK RESEARCH and DEVELOPMENT COMMAND
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) For many years, the Military Services were using less than satisfactory cooked-type dessert powders. For convenience and cost effectiveness, these were to be substituted with instant dessert powders. The first prototypes of instant products did not set properly when reconstituted and could not be cut and removed from a pie without the filling falling apart. Finally, after many years of experimentation, new dessert powders were developed by NARADCOM capable of setting to a pudding or a pie filling using skim milk (reconstituted			

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20. Abstract (cont'd)

nonfat dry milk) combined with a new type of starch plus the right combination of sugar, setting agents, powdered shortening and sodium caseinate. The new instant dessert powders when reconstituted simulate the texture and flavor of their cooked-type counterparts prepared with homogenized milk. Specifically, these dessert powders contain (a) setting agents such as tetrasodium pyrophosphate, disodium phosphate or calcium acetate, (b) waxy-maize pre-gelatinized starch, (c) powdered shortening having a high vegetable oil or partially hydrogenated vegetable oil content, (d) firming agent with milk protein base such as sodium caseinate and (e) other ingredients such as flavoring, coloring agents, salt and other desirable agents for modifying the taste and appearance of the pie fillings.

The formulation of three more uniform, high quality dessert powders for use by the Military Services has now been achieved. These products can be prepared with skim milk in place of homogenized milk, have a lower caloric content than the cooked-type powders, and effect considerable cost savings.

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FOREWORD

This project was undertaken in response to a request by the Armed Forces Product Evaluation Committee to develop instant dessert powders to replace cooked-type dessert powders. This project was funded through O&MA 728012.19000.

As a result of this project, three dessert powders — chocolate, vanilla and butterscotch flavors — were developed by NARADCOM, successfully production-tested, and subsequently procured through contracts. These formulations are contained in Military Specification, MIL-D-35033D, Dessert Powder, Instant, Starch.

The authors acknowledge with thanks the assistance of the following persons: Mr. Norman Harris, FEL/NARADCOM, Mr. Gerald Darsch, FEL/NARADCOM, Dr. Walter Ballinger, Department of Horticultural Science, North Carolina State University, NC, Dr. Martin S. Peterson, Editorial Consultant, NARADCOM.

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INSTANT PUDDING AND PIE FILLING

INTRODUCTION

The recurrent problem, unsatisfactory instant dessert powders, dates back almost twenty years. Briefly, the efforts to solve the problem are as follows:

In 1954 a meeting of the Research and Development Advisory Committee on Desserts met at the Quartermaster Food and Container Institute for the Armed Forces (QMF&CI). Representatives of related industries were invited to discuss the feasibility of developing instant dessert powders. These would be used by the Armed Forces as a replacement for cooked-type dessert powders. The advantage of instant powders is that they require no cooking. Participating in this meeting were Corn Products, Standard Brands, American Maize, and the General Foods Corporation.

During the decade, 1954 to 1964, the QMF&CI evaluated many types of dessert powders. These evaluations narrowed down to algin-based dessert powders. Kraft Foods had developed algin-based powders without nonfat dry milk solids whereas Kelco Foods had developed algin-based powders with nonfat dry milk solids included. A deviation from the specification MIL-D-35033A, Dessert Powder, Instant, Starch was prepared incorporating both types of algin-based mixes.¹

In 1965 the Joint Army-Air Force Master Menu Board evaluated and approved the algin-based dessert powders containing non-milk solids. However, during field tests of the algin-based dessert powders, these products were not accepted by the user services. The algin-based pudding had a very smooth, almost velvety type texture atypical of starch-based puddings but because of its soft texture was unsuitable for pie filling.

In 1967 a new Purchase Description, LP/P DES 2-67, Dessert Powders, Instant, Starch was developed.² The formulation developed by the National Starch Company, was based on a combination of starches, a modified pre-gelatinized cornstarch, Koset, together with a modified pre-gelatinized tapioca starch with suitable buffering and setting agents. These were production-tested on 30, 31 August 1967 at the Lester Lawrence Company, Elk Grove, Illinois. The samples from the production test were evaluated by sensory panels. They were found to be unacceptable based on judgements for texture, flavor, and color.

Since the production test, a new dessert powder was developed in cooperation with the General Foods Corporation. The formulations were essentially the same as designated in LP/P DES 2-67; however, modifications were made, such as lowering the starch levels, use of diglycerides and vegetable oil as well as suitable modified pre-gelatinized starches. Based on

¹ Military Specification MIL-D-35033A, Dessert Powder Starch, Instant, 7 March 1962.

² Limited Purchase Description, LP/P DES 2-67, Dessert Powder, Starch, Instant, 2 February 1967.

sensory technical panel evaluations, the dessert powders were rated highly acceptable. Nevertheless these products were not accepted because of the proprietary nature of the formulations. In this regard, Defense Personnel Support Center, Philadelphia, Pennsylvania, the buying arm of the Military Services, reminded users that a "sole source" product could not be purchased under normal procurement policy. Therefore, a new study was undertaken by this laboratory to develop a formula for instant dessert powders. To the requirements for these instant dessert powders was added, as previously stated, another requirement; namely, that the same dessert powder must be capable of being used as a pudding as well as a pie filling.

Up to a year and a half ago, until this new dessert powder was developed, the Services had used less than satisfactory cooked-type dessert powders. The 42-day Master Menu Program recommends the use of dessert powders 50 percent of the time for puddings and 50 percent of the time for pie fillings. These cooked-type mixes worked fairly well for puddings, but when skim milk was used for pie fillings, the texture became extremely soft, and syneresis occurred on standing. Vanilla pie filling was often transparent and resembled lemon pie filling. To correct this situation, Food Service personnel were using almost twice the amount of mix, and in some cases added whipped topping or homogenized milk to produce an acceptable appearance and texture. Homogenized milk, however, is authorized only for beverage purposes in the military feeding system.

EXPERIMENTAL PROCEDURES

The representative commercial dessert powders, both instant and cooked-type, were purchased from the local food chains for evaluations. These were prepared following label directions to see whether these dessert powders will perform as puddings or pie fillings using skim milk rather than homogenized milk. These representative commercial dessert powders were compared with the instant dessert powders developed in-house. Furthermore, the commercial dessert powders were prepared using homogenized milk in accordance with directions on the package, whereas the in-house (NARADCOM) dessert powders were prepared using skim milk. All samples were evaluated as pie fillings by an expert panel of 12 food technologists. Attributes such as color, odor, flavor, texture, and appearance were judged. Subjects were instructed to rate the fillings according to a 9-point quality scale: 1 to 9 (1 = extremely poor; 9 = excellent) Pilgrim & Peryam.³ All tests were conducted in a laboratory area specifically designed for sensory testing.

Dessert powders were further evaluated to determine the degree of viscosity by means of a simple spread test. A series of circles was drawn on a sheet of paper placed on a plywood board for support. Circles 3-7/8 inch in diameter were drawn, simulating the dimensions of No. 2 cans. A series of concentric circles (5 in number) at 1/8-inch increments were drawn, beginning with the innermost circles. A frosted acetate film was placed over these circles

³F. J. Pilgrim and D. R. Peryam. "Sensory Testing Methods. A Manual" T.R. 25-48, QMF&CI, Chicago, IL, 1948.

and held securely with tape. Molds were designed, based on No. 2½ cans, which had been sliced with a bandsaw to 1 inch in height, open at both ends. The molds were superimposed on the innermost circle underneath the frosted acetate film. Molds were securely held in place with tape. The molds were then filled to the brim with pie fillings and chilled 1 hour in a 40°F (4.8°C) cooler. Molds were then removed using a sharp knife. The degree of flow of the pie filling was measured taking the average of four readings at 70°F ± 10°F (22°F ± 5.5°C).

The following examples illustrate the preparation and use of each of the three types of instant dessert powder compositions:

Example 1

A vanilla flavored instant dessert powder was prepared by thoroughly mixing the ingredients listed in the following table in the proportion given in terms of percent by weight:

Ingredient	Percent by Weight
Sugar (Baker's Special)	71.89
Dextrose, powdered	3.0
Tetrasodium pyrophosphate, anhydrous	1.2
Disodium phosphate, anhydrous	0.9
Salt	1.1
Vanilla flavor, pure	0.15
Artificial vanilla flavor	0.05
Food starch-modified, pre-gelatinized	16.3475
Yellow coloring #5	0.01
Yellow coloring #6	0.0025
Titanium dioxide	0.20
Powdered vegetable shortening	5.0
Sodium caseinate	0.15

The above instant dessert powder was converted into a pie filling and pies as follows:

Sufficient vanilla flavored pie filling was prepared to make fourteen 9-inch pies. Nine quarts of reconstituted skim milk were prepared by mixing 1 lb, 13 oz (803 g) of nonfat dry milk solids with 8.5 qt (8043 ml) of cold water. Then, using a wire whip, 6.25 lb (2835 g) of the vanilla-flavored dessert powder was added to the reconstituted skim milk and whipped for 15 seconds at low speed, then for 2 minutes at medium speed until the pie filling was smooth. About 3 cups of the mixed pie filling was poured into each fourteen 9-inch baked pie shells. The pies were chilled for 40 minutes to set the pie fillings. Some of the pies

were then cut into 6 slices each and served immediately. The remaining pies were placed in a refrigerator and held for 3 hours, then cut into 6 slices each and served.

Example 2

A butterscotch-flavored instant dessert powder was prepared by thoroughly mixing the ingredients listed in the following table in the proportions given in terms of percent by weight:

Ingredient	Percent by Weight
Sugar (Baker's Special)	70.75
Dextrose, powdered	2.95
Tetrasodium pyrophosphate, anhydrous	1.28
Disodium phosphate, anhydrous	0.88
Salt	1.08
Butterscotch flavor	1.47
Food starch-modified, pre-gelatinized	15.72
Butterscotch shade	0.08
Titanium dioxide	0.39
Powdered vegetable shortening	4.91
Sodium caseinate	0.49

The above instant dessert powder was converted into a pie filling and pies in the same manner and proportions as in the case of the vanilla flavored dessert powder of Example 1. These were chilled, sliced and served in the same manner as in Example 1.

Example 3

A chocolate flavored instant dessert powder was prepared by thoroughly mixing the ingredients listed in the following table in the proportions given in terms of percent by weight:

Ingredient	Percent by Weight
Sugar (Baker's Special)	56.80
Dextrose, powdered	7.07
Tetrasodium pyrophosphate, anhydrous	2.24
Calcium acetate, anhydrous	1.15
Salt	0.57
Cocoa	12.46
Chocolate flavor enhancer	0.04
Artificial vanilla flavor	0.10
Food starch-modified, pre-gelatinized	14.32
Powdered vegetable shortening	4.77
Sodium caseinate	0.48

The above instant dessert powder was converted into a pie filling and pies in the following manner:

Sufficient chocolate pie filling was prepared to make 9-inch pies. Seven quarts of reconstituted skim milk was prepared by mixing 1 lb 7 oz (652 g) of nonfat dry milk solids with 6.5 qt (6151 ml) of cold water. Then, using a wire whip, 5 lb (2268 g) of the chocolate dessert powder was added to the reconstituted skim milk and whipped for 15 seconds at low speed, then for 2 minutes at medium speed until the pie filling was smooth. About 3 cups of the mixed pie filling was poured into each of eleven 9-inch baked pie shells and the pies were chilled for 40 minutes to set the pie fillings. These were chilled, sliced, and served in same manner as in Examples 1 and 2.

RESULTS AND DISCUSSION

Dessert powders were developed in-house by FEL (NARADCOM), see Examples 1, 2 and 3. The puddings and pie fillings prepared with skim milk were rated as equal to pie fillings made with whole milk (Table 1). The pies and slices were easily lifted and served without the pie fillings running or breaking. No syneresis was evident. These pie fillings have a creamy texture, quite acceptable in all cases.

Instant dessert powders that satisfy the rigorous requirements set by the Armed Forces Product Evaluation Committee were developed using the Edisonian approach of trial and error. Following are some of the procedures used. First, a patent search dealing with pudding

compositions was reviewed. US Patent No. 2,801,924 relates preparation of instant pudding using the combination of alkali pyrophosphate alkali orthophosphate.⁴ US Patent No. 2,808,337 relates to edible puddings or gels and an alginate composition in making same.⁵ US Patent 2,829,978 relates to pudding composition capable of forming a pudding simply by mixing powders with milk and water and without cooking.⁶ This patent discloses the use of nonfat dry milk; however, this patent is related to puddings rather than pie fillings. None of the above patents describes development of suitable firm and creamy pie fillings using skim milk that can be used interchangeably as puddings or pie fillings.

After reviewing the patents, the next step was to search for setting agents (phosphate and calcium salts) and a pie filling thickener. Although there are many setting agents such as tetrasodium pyrophosphate ($\text{Na}_4\text{P}_2\text{O}_7$), calcium acetate ($\text{Ca}(\text{C}_2\text{H}_3\text{O}_2)_2 \cdot \text{H}_2\text{O}$) sodium orthophosphate ($\text{Na}_2\text{HPO}_4 \cdot 7\text{H}_2\text{O}$), monocalcium phosphate ($\text{Ca}(\text{H}_2\text{PO}_4)_2$), dibasic calcium phosphate ($\text{CaHPO}_4 \cdot 2\text{H}_2\text{O}$), and carrageenan, these were finally reduced to two systems: (1) TSPP (tetrasodium pyrophosphate) and DSP (disodium phosphate) as a setting salts for vanilla and butterscotch dessert powders; (2) TSPP (tetrasodium pyrophosphate) and calcium acetate for chocolate dessert powders. Although the exact mechanism of setting is not too clear, setting of puddings and pie fillings is the coagulating effect of setting agents (TSPP, DSP, and calcium acetate) with milk protein in the skim milk. Calcium ions in the skim milk also react with sodium caseinate to form calcium caseinate.

The next step was to find a pie filling thickener for preparation of puddings and pie fillings. A series of modified starches were tested together with two systems specified above. These ingredients were supplemented by adding various flavoring materials, colorings, sugar, salt and other desirable agents for modifying the taste and appearance of the pie filling. The starches found most effective were NuCol-Staley 4227 (pre-gelatinized modified cornstarch) and H-50 (Steinhall pre-gelatinized modified tapioca starches) in combination. Tapioca was used because of its bland taste and short texture. This combination was used in a ratio of 10 percent H-50 and 5 percent NuCol in the formulation for chocolate dessert powders. This ratio was also used in butterscotch and vanilla dessert powders. The above ratio of starches gave better texture to the puddings and pie fillings. The texture of the products was satisfactory using this combination; however, this formulation cannot be used as H-50 starches have been discontinued by the manufacturer.

Since the H-50 was no longer available, other sources of starch were investigated. These starches were: Redisol 2, Redisol 412, Starco 400. All of these are manufactured by the

⁴US Patent No. 2,801,924. 6 August 1957. Pudding Composition and Process of Producing the same.

⁵US Patent No. 2,808,337. 1 October 1957, Alginate Composition for Making Milk Puddings and Process for Making the Same.

⁶US Patent No. 2,829,978. 8 April 1958, Pudding Compositions and Method of Making a Pudding.

Staley Company. Each one of these performed well in instant pudding mixes, but none matched the combination of NuCol and H-50. Finally, after additional experimental work, a new starch developed by the National Starch Company 78-1820 (Pureflo F) was selected. This starch simulated more closely than the others the texture and mouthfeel of the NuCol and H-50 combination. Pureflo F is derived from waxy maize and has branched type chain molecules instead of straight chain molecules, e.g., short texture instead of long texture. The level of starch was established at 15 percent for chocolate and 16 percent for vanilla and butterscotch flavored dessert powders.

By varying the amount of starch, it was possible to control the degree of firmness, but this did not solve the texture problem. Increasing the level of starch will result in a firm but pasty product, thus sacrificing the more desirable creamy texture. The evaluation of the commercial dessert powders showed that none of them, whether the cooked or instant type, will set as pie filling using skim milk (reconstituted nonfat dry milk solids with water). The difference between nonfat dry milk solids and whole milk solids is due to the difference in milk fat. According to the Standards for the Dry Milk Industry, Bulletin 916, the approximate fat content in nonfat dry milk is 0.7%, whereas in dry whole milk, it is 2.675%.⁷ With this in mind, several shortenings were secured for evaluation. The powdered shortenings available commercially were powdered or dehydrated vegetable oil, or partially hydrogenated vegetable oil containing approximately 72.5 to 77.5 percent of the vegetable oil, or partially hydrogenated vegetable oil, or mixture of such oils as desired. They may be prepared by spray drying a mixture of the oil with other material for example, a coating agent such as sodium caseinate, corn syrup solids, soy protein isolate, or with other permissible adjuvants. Among the powdered shortenings that have been found to work well in dry pie filling formulations are "Beatreme 3458" and NDX-112V", both manufactured by the Beatrice Food Company. These powdered shortenings impart a desirable and acceptable "creamy" texture comparable to the creamy texture obtained when dry pie filling composition of the prior art is mixed with whole milk. In order to impart firmness to a creamy filling, a selective use of a firming agent, e.g., sodium caseinate was used. Under refrigeration, the calcium ion from skim milk together with phosphate salts acted as a coagulation or gelatin accelerator to cause the mix to set. Sodium caseinate reacted with calcium ion to form calcium caseinate thus supplement setting.

The newly developed instant dessert powders prepared as pie fillings showed no significant difference in sensory characteristics as compared with the commercial counterparts (Table 1). In fact, the following commercial pie fillings showed significantly lower acceptability: one of the commercial cooked type vanilla pie filling and two of butterscotch pie fillings (a cooked and instant type).

The NARADCOM developed instant dessert powders were further compared with their commercial counterparts for degree of spread, measured in increments of 0.3 cm (1/8 in.) (Table 2). After 2 hours at room temperature (72°F ± 10°F), all fillings maintained a fairly firm texture with one exception: one commercial instant butterscotch pie filling coded "E" showed a greater spread than the other pie fillings. "E" sample spread 0.9 cm (3/8 in.). The

⁷Standard for Grades for the Dry Milk Industries Including Methods of Analysis, Bulletin 916, American Dry Milk Institute, Inc., Chicago, IL (1965)

range of spread of pie fillings was 0.3 cm (1/8 in.) to 0.6 cm (1/4 in.) at room temperature after 2 hours of setting at room temperature. This may be considered an acceptable range of spread without refrigeration; however 0.9 cm (3/8 in.) spread may be considered borderline in texture.

A value engineering study was initiated to determine the cost saving in substituting the new instant chocolate and vanilla dessert powders in place of the old conventional cooked type. This study took into consideration the 42-day Master Menu programs where dessert powder was used 50% of the time for puddings and 50% of the time for pie fillings. This study showed a tangible saving of \$60,000 per year in substituting the instant powders. In addition, elimination of cooking requirements, thus reducing the labor and energy cost, provides an appreciable, but difficult to estimate, saving.

CONCLUSION

NARADCOM developed and tested instant dessert powders meet the stipulated requirements of the Armed Forces Product Evaluation Committee. The new instant dessert powders, when prepared as puddings and pie fillings, were shown to be at least comparable in quality to commercial products even though skim milk was used in place of homogenized milk. A significant cost saving can be realized by use of skim milk in place of homogenized milk.

REFERENCES

1. Military Specification MIL-D-35033A, Dessert Powder Starch, Instant, 7 March 1962.
2. Limited Purchase Description, LP/P DES 2-67, Dessert Powder, Starch, Instant, 2 February 1967.
3. F. J. Pilgrim and D. R. Peryam. "Sensory Testing Methods. A Manual" T.R. 25-48, QMF&CI, Chicago, IL, 1948.
4. US Patent No. 2,801,924. 6 August 1957. Pudding Composition and Process of Producing the Same.
5. US Patent No. 2,808,337. 1 October 1957, Alginate Composition for Making Milk Puddings and Process for Making the Same.
6. US Patent No. 2,829,978. 8 April 1958, Pudding Compositions and Method of Making a Pudding.
7. Standard for Grades for the Dry Milk Industries Including Methods of Analysis, Bulletin 916, American Dry Milk Institute, Inc., Chicago, IL, 1965.

Table 1. Comparative Mean Technological Ratings^a of Dessert Powders Prepared as Pie Fillings (with Skim Milk instead of Homogenized Milk)

Product	Color	Odor	Flavor	Texture	Appearance
Chocolate Pie Filling					
A. New (Instant) Skim milk ^b	6.9	6.5	5.6	6.3	6.5
B. (Cooked-type) Commercial ^c	6.6	6.6	6.3	6.4	6.5
C. (Cooked-type) Commercial ^c	6.6	6.8	6.0	6.3	6.3
D. (Instant) Commercial ^c	7.0	6.6	5.3	6.2	6.7
E. (Instant) Commercial ^c	5.9 ^d	6.7	5.9	6.2	5.4 ^d
Vanilla Pie Filling					
A. New (Instant) Skim Milk ^b	7.0	6.8	6.5	6.6	6.6
B. (Cooked-type) Commercial ^c	6.8	6.6	6.3	7.0	6.5
C. (Cooked-type) Commercial ^c	6.2	6.4	6.8	6.2 ^d	5.6 ^d
D. (Cooked-type) Commercial ^c	6.8	6.9	6.6	6.7	7.0
Butterscotch Pie Filling					
A. New (Instant) Skim milk ^b	6.7	6.7	6.3	6.6	6.1
B. (Cooked-type) Commercial ^c	7.1	6.9	6.4	6.5	6.4
C. (Cooked-type) Commercial ^c	7.1	6.5	6.8	7.1	6.8
D. (Cooked-type) Commercial ^c	7.0	6.8	6.4	5.5 ^d	5.6 ^d
E. (Instant) Commercial ^c	6.8	7.0	6.3	5.6 ^d	5.4 ^d

^aRating were based on a scale of 1 to 9 (1=extremely poor; 9=excellent).

^bNew instant pie fillings coded "A" were prepared with skim milk (reconstituted nonfat dry milk solids) using direction in MIL-D-35033D.

^cCommercial dessert powders coded "B, C, D, and E" were prepared with homogenized milk.

^dSignificant difference at 5% level of that datum from other data in the column.

Table 2. Apparent Viscosity of Pie Fillings at Room Temperature Within Two Hours of Set as Determined by Degrees of Spread of a 3-7/8 Inch Mold Measured in Increments of 0.3cm (1/8 inch)

Time	Temperature (72° + 10° F)															
	Chocolate Pie Fillings					Vanilla Pie Fillings					Butterscotch Pie Fillings					
	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
30 mins	0	0	0	0	0	0.3	0.15	0.3	0.15		0.15	0.15	0.15	0.3	0.3	
1 hour	0.15	0.15	0.15	0.3	0.3	0.3	0.3	0.3	0.3		0.3	0.15	0.3	0.3	0.45	
1½ hours	0.3	0.3	0.3	0.3	0.3	0.6	0.3	0.3	0.3		0.6	0.45	0.3	0.6	0.6	
2 hours	0.3	0.3	0.3	0.3	0.3	0.6	0.3	0.3	0.3		0.6	0.45	0.3	0.6	0.9	
	*Chocolate Pie Filling					Vanilla Pie Filling					Butterscotch Pie Filling					
	A.	New	(Instant)	B.	Cooked-type	A.	New	(Instant)	B.	Cooked-type	A.	New	(Instant)	B.	Cooked-type	
	C.	Cooked-type	D.	Instant	E.	Instant	C.	Cooked-type	D.	Cooked-type	C.	Cooked-type	D.	Cooked-type	E.	Instant

NOTE: "A" is NARADCOM developed instant dessert powders prepared with skim milk.

"B", "C", "D", and "E" are commercially available dessert powders prepared with homogenized milk.