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TECHNICAL REPORT
74-24-FL

EFFECT OF FREEZE-THAW CYCLE ON MEAL, READY-TO-EAT, INDIVIDUAL 1966 PROTOTYPE

by

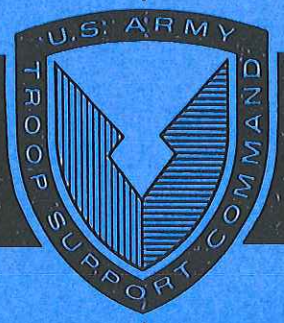
Jessie W. McNutt

and

Frances H. Lee

February 1974

UNITED STATES ARMY
NATICK LABORATORIES
Natick, Massachusetts 01760



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TECHNICAL REPORT

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EFFECT OF FREEZE-THAW CYCLE ON MEAL, READY-TO-EAT, INDIVIDUAL 1966 PROTOTYPE

by

Jessie W. McNutt
Frances H. Lee

Project reference:
1G764713D548

Series: FL-183

January 1973

Food Laboratory
U.S. Army Natick Laboratories
Natick, Massachusetts 01760

FOREWORD

The Meal, Ready-to-Eat, Individual is a complete meal type ration for one individual. It provides individual meals containing food components which are ready-to-eat and highly acceptable when consumed under conditions precluding preparation, except reconstituting of beverages. When completely developed, this Meal, Ready-to-Eat, Individual is scheduled to replace the Meal, Combat, Individual and therefore, will be used in combat for and under all circumstances where planned resupply is established but where it is impractical to provide for large or small group feeding. Packaging is light weight and suitable for use in lieu of mess gear. In fact, all components of the various menus of the 1966 Prototype described herein were packaged in appropriate laminate of flexible materials.

This study was undertaken to provide quality data on foods which have undergone prescribed freezing and thawing conditions, as it is a military requirement that these foods be able to withstand repeated freezing and thawing involving exposure, in the shipping cases to temperatures as high as 125°F. (52°C.) for as long as 2 hours per day and as low as −65°F. (−54°C.) without significant loss of nutritional adequacy, acceptability and utility. This study determined the effect of freeze-thawing cycling on the quality (color, odor, flavor, texture and appearance) of this 1966 Prototype, Meal, Ready-to-Eat, Individual.

Appreciation is expressed to Mary Klicka, Ration Design Specialist, Joel Sidel, formerly of Pioneering Research Laboratory, and Margaret Branagan, Food Laboratory, for their valuable assistance.

This work was conducted under Project No. 1G764713D548, Military Subsistence Systems as was Technical Report 69-86 FL, "Effect of Freeze Thaw Cycling on the Vitamin Content of the Meal, Ready-to-Eat, Individual, by M. H. Thomas, *et al.*

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ABSTRACT

The effect of freezing and thawing on the 1966 Prototype of the Meal, Ready-to-Eat, Individual, was studied to determine if there were changes in 39 food items in the ration. Using six controlled freezing and thawing cycles, it was found that there was little change in ratings due to freezing and thawing when compared to control samples stored at 40°F. (4°C.). A decline in quality of chicken a la king was noted after second cycle and after fourth cycle in beef stew.

INTRODUCTION

This study was undertaken to evaluate 39 food items from the Meal, Ready-to-Eat, Individual, which were subjected to controlled freezing and thawing conditions.

Each food item was packed in polyester-foil-polyolefin (heat sealable) laminated bags or pouches. Meat and bakery items had an additional paperboard folder or carton overwrap. The foods were combined in 14 different menus (meals), each designed to provide a nutritionally balanced, 1135 calorie, acceptable combination (Table 1). The menu combination was packed in a carton measuring 4 3/4 x 2 1/2 x 7 1/4 inches (12.1 x 6.4 x 18.4 centimeters).

The fourteen menus included heat-processed foods such as meats, beans in tomato sauce, and pineapple; freeze-dehydrated foods such as pork sausage patties, beef patties, apricots, peaches and strawberries; baked dessert items; bread rolls; crackers; cereal bars; cheese spread, jelly and peanut butter; plastic spoons and accessory packets containing coffee, cream, sugar, salt and all standard non-food accessory items included with MCI.

METHODS AND MATERIALS

For testing, three food items were selected from 13 menus (see Table 1). Menu 1 was not tested because previous experience indicated that freeze-dried pork sausage patties would give results similar to freeze-dried beef patties (Menu 4). Items evaluated are described in Table 2.

Storage

Test cycle, as follows, was repeated up to six times:

a. Freezing at approximately −65°F. (−54°C.) 16 hours

b. Thawing at room temperature (approximately 70°F.) (21°C.) 24 hours

c. Holding at 125°F. (51°C.) for 2 hours

d. Cooling at room temperature

Prior to and after the test cycle, samples were held in 40°F. (4°C.) storage as were the Control samples.

Quality Evaluations

The cycled foods were then evaluated by an expert panel of 10 food technologists using a 9-point quality scale (Figure I). For each evaluation test, the panel was drawn from a pool of 16 technologists.

The three items from each menu, stored at 6 cycles and under control, were evaluated at one time, giving 21 samples for each test. Preparation of food items is indicated in Table 2. One serving portion of each food was examined by panel members to determine any physical differences and smaller portions were served for subjective evaluations.

RESULTS AND DISCUSSION

Averages of rating scores by the panel are shown in Table 3. A treatment by subject design was used for statistical analysis of data. Only seven food items showed any statistically significant changes at the .05 level of probability.

a. Foods showing significant changes

(1) **Barbecue Beef.** The average decrease in rating between control sample and cycle 6 (six freeze-thaw cycles) was not statistically significant, but there was a significant difference between the control and cycle 4. Comments by the testers indicated that changes in rating were due to a variation in the product, rather than freezing and thawing; e.g., cycle 4 was "like ground meat" and cycle 2 had a 'spicier sauce".

Four testers found no change in rating throughout the cycles, and seven testers rated cycle 6 as high as the control sample. Comments from the testers showed that there was softening of texture beginning with cycle 1, and some breakdown of the sauce.

(2) **Beef Stew.** The average decrease in ratings between the control sample and cycle 6 was gradual and was statistically significant for cycles 4, 5, and 6. Some changes were noted in cycle 1, such as slight separation in the sauce, softening of potatoes, lima beans and carrots. These changes were noted in all of the cycles, with cycle 6 showing darkening potatoes, some free liquid, more softness of vegetables and softening of the meat.

(3) **Bread Roll.** The average decrease in rating between control sample and cycle 6 was not statistically significant, but there was a significant change between control and cycle 3 and cycle 4.

Five of the testers gave no change in the rating throughout the seven samples, but the item rated low at the start. Comments from technologists were that changes in rating were due to variation in the product and not from the freezing and thawing. Five of the seven average ratings were below a rating of 5.0.

(4) **Chicken a la King.** Changes occurring in this product were significant statistically in cycles 2, 4, 5 and 6. Comments indicate the breakdown of the sauce began in cycle 1, with a softening in texture in cycle 2.

(5) **Chicken Loaf.** There was a significant decrease in rating between control and cycle 5, but no significance between control and cycle 6. Thus, it would seem that this significance was not due entirely to freezing and thawing.

Two testers noted a variety in the spiciness, which probably indicates a variation in the product. Other comments showed that the product became grainy beginning at cycle 2. Cycles 5 and 6 became softer.

(6) **Orange Cereal Bar.** There was a slight but significant decrease in rating between control and cycle 2, 4, 5 and 6. Seven testers showed no change in ratings of the different samples, but the item rated low at the start.

(7) **Sausage Links.** There was a statistically significant decrease between control and cycle 6, but samples from the other cycles received ratings of the same order of magnitude as the cycle 6 sample.

Six testers noted no change in rating through the samples, though comments noted a softening of texture with cycle 1 and more apparent in subsequent cycles.

b. Foods not showing statistically significant changes, but were of interest

(1) **Beans with Tomato Sauce.** Beans with tomato sauce increased slightly in rating due to the freeze-thaw cycling. The rating increase probably was due to a softening of the texture in the beans.

(2) **Others.** There was some variation within the cycles, but not significant over the six freeze-thaw cycles tested as shown in the averages of potato pattie, chocolate with almonds, chocolate covered brownies, peaches and apricots (some testers rated apricots and some rated peaches).

CONCLUSIONS

There was little change in the ratings of food due to the freeze-thaw cycles. Beef Stew and Chicken a la King seemed to be the most affected with a breakdown of the sauce and softening texture in the vegetables, beginning with the first freeze-thaw cycle. The average ratings of these showed that the quality remained at fair or above throughout all of the cycles.

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(2) Manual on Sensory Testing Methods STP434, American Society for Testing and Materials: Philadelphia, PA, 1968.

Table 1

Meal, Ready-to-Eat, Individual Menus*

Menu 1 a

1 — Chicken loaf
Peaches
2 — Apricot cereal bar
Bread roll
Jelly
3 — Chocolate bar with almonds
Coffee
Cream substitute
Sugar

Menu 2

4 — Bacon
5 — Beans with tomato sauce
Apricots
Bread roll
Cheese spread
6 — Cookies, chocolate covered
Coffee
Cream substitute
Sugar

Menu 3

7 — Ham and chicken loaf
Bread roll
8 — Peanut butter
9 — Chocolate nut roll
Peaches
Coffee
Cream substitute
Sugar
Catsup

Menu 4 a

10 — Beef loaf
Beans with tomato sauce
11 — Bread roll
Peanut butter
12 — Raisin nut cake
Coffee
Cream substitute
Sugar

Menu 5

13 — Barbecue beef
Potato pattie
Bread roll
Peanut butter
14 — Strawberries
15 — Fudge bar
Coffee
Cream substitute
Sugar

Menu 6

16 — Chicken a la King
Crackers
Cheese spread
17 — Date pudding
18 — Vanilla cream bar
Fruit tablets
Coffee
Cream substitute
Sugar

Menu 7

19 — Ground beef in pickle flavored sauce
Potato pattie
Bread roll
20 — Cheese spread
Cookies, chocolate covered
21 — Fruit tablet
Coffee
Cream substitute
Sugar

Menu 8

22 — Beef Stew
23 — Crackers
Peanut butter
24 — Pound cake
Orange cereal bar
Coffee
Cream substitute
Sugar

*Numbered items — foods which were tested.

Table 1

Meal, Ready-to-Eat, Individual Menus* (cont'd)

Menu 9

25 – Frankfurters
Bread roll
Jelly
26 – Chocolate covered brownies
27 – Coffee
Cream substitute
Sugar
Catsup mix

Menu 10

28 – Sausage links
29 – Orange cereal bar
Bread roll
Cheese spread
30 – Peaches and apricots
Coffee
Cream substitute
Sugar
Catsup mix

Menu 11

31 – Beef steak
Bread roll
32 – Jelly
33 – Fruitcake
Chocolate bar with almonds
Coffee
Cream substitute
Sugar
Catsup mix

Menu 12

Chicken loaf
34 – Potato pattie
Bread roll
Jelly
35 – Cocoa
36 – Orange nut roll
Coffee
Cream substitute
Sugar
Catsup mix

Menu 4

37 – Beef patties
38 – Soup and gravy base, beef
Beans with tomato sauce
Bread roll
Cheese spread
Cocoa
Peaches
Coffee
Cream substitute
Sugar
39 – Catsup mix

Menu 1 (Not Used)

**Pineapple
**Pork sausage patties
Apricot cereal bar
Bread roll
Jelly
Chocolate with almonds
Coffee
**Cream substitute
Sugar
Catsup mix

*Numbered items – foods which were tested.
**Foods which were not tested.

Table 2

Preparation of Food Items For Serving

Three portions of each item were cut into smaller samples to serve the ten panelists.

MEATS

Bacon, prefried
Barbecued beef
Beef loaf
Beef patties, freeze dried
Beef steak
Beef stew
Chicken a la King
Chicken loaf
Frankfurters
Ground beef in pickle sauce
Ham and chicken loaf
Sausage links

METHOD OF SERVING

Plastic trays, having seven compartments were used.
Compartments were labeled c, 1, 2, 3, 4, 5, 6.
Foods were served at room temperature.

OTHER ITEMS USING TRAYS

Beans with tomato sauce
Peanut butter

CEREAL, BAKERY PRODUCTS, CANDIES AND POTATO PATTIE

Apricot cereal bar
Orange cereal bar

Served on sheets of paper labeled c, 1, 2, 3, 4, 5, 6.

Bread roll
Crackers
Chocolate covered brownies
Chocolate nut roll
Cookies, chocolate covered
Date pudding

Table 2

Preparation of Food Items For Serving (cont'd)

MEATS	METHOD OF SERVING
Fruit cake	
Orange nut roll	
Pound cake	
Raisin nut cake	
Chocolate bar with almonds	
Fruit tablet	
Fudge bar	
Vanilla cream bar	
Potato pattie	
FRUITS	
Strawberries	Served in individual paper souffle cups, not rehydrated.
Peaches and apricots	
SPREADS AND CATSUP	
Catsup	Served in individual one-ounce paper portion cups.
Cheese spread (kneaded in the package before serving)	
Jelly	
LIQUIDS	
Cocoa	Served hot at the food counter where panelists served themselves in china mugs.
Coffee	
Soup and gravy base, beef	

Table 3

Averages of Overall Quality Ratings[1] by 10 Food Technologists
On 39 Different Foods From Meal, Ready-to-Eat, Individual (1966 Prototype)
Control Through Six Freeze-Thaw Cycles

Menu	Meat & Protein Foods	Control	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 5	Cycle 6
2	Bacon, prefried	6.9	6.9	6.9	6.9	6.5	6.5	6.5
5	Barbecued beef	7.1	6.9	7.0	6.8	6.3*	6.7	6.6
4a	Beef loaf	6.3	6.3	6.2	6.2	6.1	6.2	6.2
4	Beef patties, freeze dried	6.3	6.3	6.3	6.4	6.1	5.9	6.2
11	Beef steak	7.1	7.1	7.1	7.0	7.0	6.9	6.9
8	Beef stew	6.9	6.4	6.1	6.0	5.8*	5.6*	5.6*
6	Chicken a la King	6.8	6.5	5.9*	6.2	5.7*	5.9*	5.9*
1a	Chicken loaf	7.1	6.9	6.8	6.9	6.6	6.4*	6.5
9	Frankfurters	6.7	6.6	6.4	6.3	6.2	6.0	6.0
7	Ground beef in pickle sauce	6.6	6.6	6.6	6.6	6.6	6.6	6.6
3	Ham and chicken loaf	6.6	6.7	6.7	6.7	6.6	6.6	6.6
10	Sausage links	6.4	6.1	5.7	5.8	6.0	5.8	5.6*
2	Beans with tomato sauce	6.8	6.7	7.0	6.8	7.0	6.9	7.1
3	Peanut butter	7.3	7.2	7.2	7.1	7.1	7.0	7.0

[1] Overall Quality Ratings are based upon color, odor, flavor, texture and appearance of each food.
*Indicates foods showing statistically significant changes between Control Rating and Freeze-Thaw Cycle.

Table 3

Averages of Overall Quality Ratings[1] by 10 Food Technologists On 39 Different Foods From Meal, Ready-to-Eat, Individual (1966 Prototype) Control Through Six Freeze-Thaw Cycles (cont'd)

Menu	Candies, Fruits, Spreads Catsup and Beverages	Control	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 5	Cycle 6
1a	Chocolate bar with almonds	7.4	6.5	6.8	6.8	6.6	6.6	6.4
7	Fruit tablet	7.4	7.3	7.3	7.2	7.2	7.2	7.2
5	Chocolate fudge bar	7.3	7.4	7.4	7.3	7.2	7.2	7.1
6	Vanilla cream bar	6.4	6.5	6.5	6.4	6.5	6.6	6.6
5	Strawberries	7.3	7.4	7.4	7.3	7.3	7.3	7.3
10	Peaches and apricots	7.1	7.0	6.2	6.3	6.5	6.3	6.3
4	Catsup mix	6.1	6.1	6.3	6.2	6.1	6.2	6.2
7	Cheese spread	6.6	6.1	6.3	6.2	6.2	6.2	6.2
11	Jelly	7.0	6.8	7.0	6.8	6.7	6.7	7.1
12	Cocoa	7.2	7.3	7.1	7.2	7.3	7.3	7.1
9	Coffee	5.3	5.3	5.2	5.1	5.1	5.0	4.8
4	Soup and gravy base, beef	6.2	6.2	6.3	6.3	6.2	6.1	6.3

[1] Overall Quality Ratings are based upon color, odor, flavor, texture and appearance of each food.

Table 3

Averages of Overall Quality Ratings[1] by 10 Food Technologists
On 39 Different Foods From Meal, Ready-to-Eat, Individual (1966 Prototype)
Control Through Six Freeze-Thaw Cycles

Menu	Cereal, Bakery Products, Potato Pattie	Control	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 5	Cycle 6
1a	Apricot cereal bar	5.8	6.1	5.7	6.0	5.8	5.8	5.8
10	Orange cereal bar	6.0	5.8	5.6*	5.7	5.6*	5.6*	5.6*
4a	Bread roll	5.2	5.0	4.9	4.7	4.6	4.7	4.9
8	Crackers	7.1	6.9	6.9	7.0	7.0	7.0	6.9
9	Chocolate covered brownies	5.9	6.0	5.9	6.0	5.4	5.6	5.7
3	Chocolate nut roll	5.6	5.6	5.6	5.6	5.6	5.6	5.6
2	Cookies, chocolate covered	7.1	7.2	7.3	7.1	7.1	7.1	7.1
6	Date pudding	6.1	6.1	6.1	6.1	6.0	6.1	6.1
11	Fruit cake	6.9	6.8	6.8	6.8	6.3	6.6	6.6
12	Orange nut roll	6.6	6.5	6.6	6.6	6.6	6.5	6.5
8	Pound cake	5.6	5.5	5.5	5.6	5.5	5.5	5.5
4a	Raisin nut cake	5.9	6.1	5.7	5.9	5.8	5.8	5.9
12	Potato pattie	6.8	6.3	6.6	6.6	6.6	6.8	6.7

[1] Overall Quality Ratings are based upon color, odor, flavor, texture and appearance of each food.
*Indicates foods showing statistically significant changes between Control Rating and Freeze-Thaw Cycle.

Figure I

RATING SHEET

Test Number_____

Meal, Ready-to-Eat, Individual
Multiple Discrimination Test

Menu_____

Name_____

Extremely Poor	Very Poor	Poor	Below Fair	Fair	Below Good	Good	Very Good	Excellent
1	2	3	Above[4] Poor	5	Above[6] Fair	7	8	9

Using the above scale, rate the overall quality of each of the products. There will be seven ratings for each food.

Sample_____ Sample_____ Sample_____

Cycle	Rating	Comment	Cycle	Rating	Comment	Cycle	Rating	Comment
C								
1								
2								
3								
4								
5								
6								

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER FL-183	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE *(and Subtitle)* Effect of Freeze-Thaw Cycle on Meal, Ready-to-Eat, Individual, 1966 Prototype		5. TYPE OF REPORT & PERIOD COVERED Final 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Jessie W. McNutt and Frances H. Lee		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Experimental Kitchens Division Food Laboratory US Army Natick Laboratories, Natick, MA		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 1G764713D548
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Natick Laboratories Natick, MA		12. REPORT DATE February 1974 13. NUMBER OF PAGES 22
14. MONITORING AGENCY NAME & ADDRESS*(if different from Controlling Office)*		15. SECURITY CLASS. *(of this report)* Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

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20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

The effect of freezing and thawing on the 1966 Prototype of the Meal, Ready-to-Eat, Individual, was studied to determine if there were changes in 39 food items in the ration. Using six controlled freezing and thawing cycles, it was found that there was little change in ratings due to freezing and thawing when compared to control samples stored at 40°F. (4°C.). A decline in quality of chicken a la king was noted after second cycle and after fourth cycle in beef stew.

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	Role	WT	Role	WT
Meal, Ready-To-Eat, Individual	9		7	
Military Rations	9		7	
Chicken A La King	9		7	
Stew	9		7	
Beef Stew	9		7	
Freezing			6	
Thawing			6	