TECHNICAL REPORT

68-53-FL

AD

EFFECT OF PROCESSING CONDITIONS IN THE QUALITY OF COOKED, SLICED, FREEZE-DRIED BEEF

by

J. M. Tuomy, R. L. Stentz & R. L. Helmer

Project Refererence 156-24101-D553

April 1968

UNITED STATES ARMY
NATICK LABORATORIES
Natick, Massachusetts 01760

U.S. ARMY MATERIEL COMMAND

Food Laboratory

FL-70

68

AD____________

TECHNICAL REPORT

68-53-FL

EFFECT OF PROCESSING CONDITIONS IN THE QUALITY OF COOKED, SLICED, FREEZE-DRIED BEEF

by

J. M. Tuomy, R. L. Stentz and R. L. Helmer

Project reference:
156-24101-D553

Series: FL-70

April 1968

Food Laboratory
U. S. ARMY NATICK LABORATORIES
Natick, Massachusetts 01760

FOREWORD

Freeze-dried foods are being used in operational rations in increasing amounts. In addition, "convenience" foods are receiving increased attention for use in all Armed Forces feeding situations, and freeze-dried foods have important convenience properties which cannot be ignored. However, freeze-drying is a comparatively new method of food preservation and its quality control parameters are not completely understood or evaluated. As a result, the quality of the products procured for the military is not always as high as is desirable.

This study was undertaken in order to determine the effects of certain process variables in cooked, sliced, dehydrated beef. This product is an important ingredient in menus composed of freeze-dried foods. Although some work has been done in its processing variables, definitive information is lacking. This work was performed under project 156-24101-D553, Food Processing and Preservation Techniques.

FERDINAND P. MEHRLICH, Ph.D.
Director
Food Laboratory

APPROVED:

DALE H. SIELING, Ph.D.
Scientific Director

FELIX J. GERACE
Brigadier General, USA
Commanding

TABLE OF CONTENTS

LIST OF TABLES

ABSTRACT

The effects of temperature reached in cooking, freezer age before drying, platen temperature, dryer pressure, and time of storage at 100° F on the flavor, odor, and texture of cooked, sliced, freeze-dried beef were studied. All of the variables significantly affected the organoleptic properties of the dried beef and the overall effect of freeze-drying was a decrease in acceptability. Several significant statistical interactions were found but, in general, their direction was the same as found for the main effects.

Higher cooking temperature and dryer pressure within the ranges studied were found to result in higher organoleptic ratings. Freezer age before drying adversely affected the ratings. Differences in platen temperature resulted in almost no effect between 100 and 150° F, but in a significant decrease in ratings from 150 to 200° F. As expected, time of storage at 100° F resulted in decreased ratings. Significant statistical interactions were found between storage X dehydrator pressure and storage X dehydrator temperature. The interaction of storage X cooking temperature was not significant.

This study emphasizes the fact that processing conditions for a product such as cooked, sliced, freeze-dried beef must be carefully controlled to maintain product quality.

INTRODUCTION

Freeze-dried cooked beef is a basic ingredient in many of the new or contemplated operational rations designed for use by the Armed Forces. While the beef has been very favorably received by troops, unexplained differences in quality have been found between production lots and between producers.

It has been recognized that freeze-dried meats are less tender than their fresh-frozen counterparts (Bird. 1965; Miller & May. 1965). However, Tuomy et al. (1962a) in investigating the effect of cooking temperature on the tenderness of cooked sliced beef, found that higher temperature and longer cooking time resulted in a more uniformly tender product. It was postulated that this tenderness would carry over to the freeze-dried product. Tuomy et al. (1968) found that the cooking cycle would have to be specifically designed to obtain satisfactory tenderness in freeze-dried turkey.

Present military specifications for freeze-dried meats limit the freezer storage time between cooking and freeze-drying to 20 days. This time has been considered necessary to fit production scheduling and shipment of the cooked meat to freeze-drying plants.

Chang et al. (1961) showed that the lipids of sliced roast beef oxidize at a very rapid rate when exposed to air in a refrigerator or at room temperature. Oxidation was much slower when the product was frozen, but still took place at a perceptible rate. Tappel et al. (1957) went so far as to recommend the removal of all visible fat in cooked beef to be freeze-dried in order to minimize deterioration due to fat oxidation during cooking and subsequent handling. Miller and May. (1965) found that the freezer storage time, before freeze-drying, has a significant effect on the texture of freeze-dried chicken meat.

Tuomy et al. (1962b) studied the effects of platen temperature, dehydrator pressure, and evaporative freezing on the quality of cooked, sliced beef. This work indicated that the platen temperature by itself had no effect on tenderness and flavor, but did interact with chamber pressure and evaporative freezing. Lower chamber pressures resulted in more tender product, but when the product was conventionally frozen rather than evaporatively frozen, the difference in organoleptic scores at the two pressures used was not significant.

This study was conducted in order to obtain more detailed information regarding the quality parameters of cooked, sliced, freeze-dried beef.

EXPERIMENTAL METHODS

The semi-membranosus muscles from fresh U. S. Grade Good rounds were used for this study. The muscles were placed in spring-loaded metal forms, 4 X 4 inches in cross section, and cooked to the desired internal temperature as determined by thermocouples placed in the centers of the muscles. Six-pound steam was used as the cooking medium. After completion of the cooking process, the meat was chilled overnight in a 40° F cooler and sliced 1/4-inch thick.

In Phase I of the study, which was designed to investigate the effect of freezer storage of the cooked beef before freeze-drying, twenty-four muscles were used. Internal temperatures to which the muscles were cooked were 140, 155, 170, and 185° F, with six muscles cooked to each temperature. The six muscles were separated at random into three groups of two muscles each to provide three replications. Each group was sliced, and the slices randomly segregated into four portions.

The first portion was evaluated in the chilled state by a technological panel. The second portion was frozen immediately, freeze-dried, and evaluated. Freeze-drying was accomplished at a plate temperature of 110°F. For evaluation, the product was rehydrated in hot water (210°F) for 20 minutes, drained, and chilled overnight to 40°F. The remaining portions were stored 30 and 60 days, respectively, freeze-dried, and evaluated.

A second run was made in this phase in which six semi-membranosus muscles were cooked to an internal temperature of 170°F. The muscles were chilled and sliced with the slices being randomly segregated into three portions. One portion each was stored at -10, 0, and +10°F. Withdrawals were made every week for 5 weeks, the product freeze-dried and evaluated by the technological panel.

In Phase II of the study, a 3 X 3 X 3 X 4 full factorial analysis was run in which the variables were internal temperature reached in cooking (140, 155, 170, 185° F); dehydrator pressure (0.5, 1.5, and 2.5 mm); platen temperature (100, 150, and 200° F); and storage time of the dehydrated product at 100° F (0, 30, and 60 days). A total of 108 muscles were used in this phase of the study. The freeze-dried slices were placed in cans and evacuated to 29 inches of mercury for storage. Slices were rehydrated, stored overnight and evaluated as in Phase I.

The taste panel consisted of 10 experienced technologists who rated the cooked beef for flavor, odor, and texture on a 9-point scale with the highest number indicating the most desirable quality. No more than four samples were served at each session.

RESULTS AND DISCUSSION

Analysis of the Phase I results shows that flavor, odor, and texture scores for the freeze-dried, cooked, sliced beef were lower than the scores for the same beef not freeze-dried ($P < .01$). This confirms the results reported by Bird (1965).

Analysis of variance results for cooking temperature and frozen storage before freeze-drying are shown in Table I. Cooking temperature was significant for texture with higher temperatures resulting in improved scores, but the effect on flavor and odor was not significant. Frozen storage time before freeze-drying resulted in a significant decrease in the flavor, odor, and texture scores as the time was increased. Interactions of time and temperature ($P < .05$) were found for flavor and texture. In both cases, the direction of the interactions was toward improved scores with increased cooking temperature and decreased storage time.

In the second part of Phase I, the panel scores for flavor, odor, and texture were slightly higher for the lower temperature storage, but statistical analysis of the results did not indicate a significant difference. Time in storage before freeze-drying, however, was significant for all storage temperatures, and it is believed that if the storage period had been extended, significant differences related to storage temperatures would have been found.

Holding the cooked beef in frozen storage before freeze-drying is an important consideration since many freeze-drying plants are not equipped to fabricate and cook meats. Thus, the cooked meat must be obtained from processors, and holding times due to shipping and production scheduling can be excessive. Present specifications for freeze-dried meats stipulate a maximum of 20 days between the start of freezing and the start of freeze-drying. This requirement was set as short as possible, yet still long enough to be consistent with the capabilities of industry. Considering the results of this study, every effort should be made to obtain shorter times.

Analysis of variance results for Phase II are shown in Table 2. All the main factors were significant at the 1 percent level for flavor, odor, and texture, with higher panel scores resulting from increased cooking temperatures, increased dehydrator pressures, decreased dehydrator temperatures, and decreased storage times. All the interactions were in the same direction as the main effects.

In this Phase, the cooking temperature was found to have a significant effect on flavor and odor although it did not in Phase I. However, examination of the panel scores obtained when conditions were similar to those in effect in Phase I, show that there was very little actual difference under these conditions.

Although dehydrator temperature resulted in a significant effect on flavor, odor, and texture, examination of the results showed that most of the effect occurred with platen temperatures above 150° F. Between 100 and 150° F, there was little difference.

TABLE I. Analysis of variance results for freeze-dried product in Phase I. Product was stored at +10° F before freeze-drying.

Factor	Flavor	Odor	Texture
Cooking Temperature	N.S.	N.S.	**
Storage Time before Freeze-Drying	**	**	**
Temperature X Time	*	N.S.	*

* $P < .05$
** $P < .01$
N.S. not significant

Table II. Analysis of variance results for Phase II.

Factor	Flavor	Odor	Texture
Cooking Temperature	**	**	**
Dehydrator Pressure	**	**	**
Dehydrator Temperature	**	**	**
Storage Time	**	**	**
Cooking Temp X Dehy. Press	N.S.	N.S.	*
Cooking Temp X Dehy. Temp	N.S.	**	N.S.
Cooking Temp X Storage Time	N.S.	N.S.	N.S.
Dehy Press X Dehy. Temp	**	**	**
Dehy Press X Storage Time	*	**	*
Dehy Temp X Storage Time	**	**	**

* $P < .05$
** $P < .01$
N.S. not significant

REFERENCES

1. Bird, K. 1965. Palatability of freeze-dried meats. Food Technol. 19, 737.

2. Chang, Pi-Yu, M. T. Younathan, and B. M. Watts. 1961. Lipid oxidation in pre-cooked beef preserved by refrigeration, freezing, and irradiation. Food Technol. 15, 168.

3. Miller, W. O. and K. N. May. 1965. Tenderness of chicken as affected by rate of freezing, storage time and temperature, and freeze-drying. Food Technol. 19, 1171.

4. Tappel, A. L., R. Martin, and E. Plocker. 1957. Preparation, properties and storage stability of pre-cooked, freeze-dried meats, poultry and sea foods. Food Technol. 11, 599.

5. Tuomy, J. M., Lechnir, and T. Miller. 1962a. Effect of temperature on the tenderness of cooked beef. (Quartermaster Food and Container Institute) Report No. 28-62, AD282973.

6. Tuomy, J. M., R. J. Lechnir, and T. Miller. 1962b. Effect of dehydration variables on the quality of freeze-dried cooked sliced beef. (Quartermaster Food and Container Institute) Report No. 14-62, AD277937.

7. Tuomy, J. M., H. T. Schlup, and R. L. Helmer. 1968. Effect of cooking temperature and time on the tenderness of pre-cooked, freeze-dried turkey white meat. Presented before 28th Annual Meeting, Institute of Food Technologists.

Unclassified
Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY *(Corporate author)* US Army Natick Laboratories Natick, Massachusetts 01760	2a. REPORT SECURITY CLASSIFICATION Unclassified 2b. GROUP

3. REPORT TITLE

Effect of Processing Conditions in the Quality of Cooked, Sliced, Freeze-Dried Beef.

4. DESCRIPTIVE NOTES *(Type of report and inclusive dates)*

5. AUTHOR(S) *(First name, middle initial, last name)*

J. M. Tuomy, R. L. Stentz, and R. L. Helmer

6. REPORT DATE April 1968	7a. TOTAL NO. OF PAGES 6	7b. NO. OF REFS 7
8a. CONTRACT OR GRANT NO.	9a. ORIGINATOR'S REPORT NUMBER(S) 68-53-FL	
b. PROJECT NO. 156-24101-D553 c. d.	9b. OTHER REPORT NO(S) *(Any other numbers that may be assigned this report)* FL-70	

10. DISTRIBUTION STATEMENT

This document has been approved for public release and sale; its distribution is unlimited.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY US Army Natick Laboratories Natick, Massachusetts 01760

13. ABSTRACT The effects of temperature reached in cooking, freezer age before drying, platen temperature, dryer pressure, and time of storage at 100° F on the flavor, odor and texture of cooked, sliced, freeze-dried beef were studied. All of the variables significantly affected the organoleptic properties of the dried beef and the overall effect of freeze-drying was a decrease in acceptability. Several significant statistical interactions were found but, in general, their direction was the same as found for the main effects.

Higher cooking temperature and dryer pressure within the ranges studied were found to result in higher organoleptic ratings. Freezer age before drying adversely affected the ratings. Differences in platen temperature resulted in almost no effect between 100 and 150° F, but in a significant decrease in ratings from 150 to 200° F. As expected, time of storage at 100° F resulted in decreased ratings. Significant statistical interactions were found between storage X dehydrator pressure and storage X dehydrator temperature. The interaction of storage X cooking temperature was not significant.

This study emphasizes the fact that processing conditions for a product such as cooked, sliced, freeze-dried beef must be carefully controlled to maintain product quality.

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

Unclassified
Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Cooking	6					
Temperature	6					
Freezing			6			
Time			6			
Drying					6	
Pressure					6	
Storage	6		6			
Odor	7		7		7	
Flavor	7		7		7	
Texture	7		7		7	
Freeze-dried foods	7		7		7	
Beef	7		7		7	