

TECHNICAL REPORT

69-55-FL

**EFFECT OF PROCESSING CONDITIONS ON COOKED,
FREEZE-DRIED SPAGHETTI WITH MEAT SAUCE**

AD

by

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January 1969

UNITED STATES ARMY
NATICK LABORATORIES
Natick, Massachusetts 01760



Food Laboratory

FL-85

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FOREWORD

Freeze-dried foods are being used in operational rations in increasing amounts. In addition, it can be expected that the use of "convenience" foods will be increased in all Armed Forces feeding situations. Freeze-dried foods have important convenience properties which make them logical products for such use. 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 Armed Forces is not always as high as is desirable.

This study was undertaken in order to determine the effects of certain variables on cooked, freeze-dried Spaghetti with Meat Sauce. This product is one of the main components in the Food Packet, Long Range Patrol and is scheduled for inclusion in other operational rations. It is more susceptible to oxidative deterioration than some of the other combination meat items. Although some work has been done on determining the effect of processing variables on its quality, definitive information is lacking.

The work was performed under project 1J6-62708-D553, Food Processing and Preservation Techniques.

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ABSTRACT

The effects of refrigerated holding before freezing, time in freezer before freeze-drying, dryer platen temperature, dryer pressure, and storage at 100°F on the flavor, odor, texture, and color of cooked, freeze-dried Spaghetti with Meat Sauce were studied. All of the variables significantly affected the organoleptic properties of the dried product. Several significant statistical interactions were found.

The interaction storage in freezer x dryer pressure was significant at the 1 percent level with the highest organoleptic ratings being obtained for zero freezer time and lowest pressure, and the lowest ratings at zero freezer storage and highest pressure. This interaction should be studied further.

Oxygen uptake analysis during storage of the product at 100°F showed statistically significant effects caused by dryer pressure and platen temperature and their interactions. This is another area requiring further study.

INTRODUCTION

Freeze-dried Spaghetti with Meat Sauce is one of the components of the Food Packet, Long Range Patrol (LRP). It is a representative of the newer type freeze-dried combination foods which are freeze-dried as completed foods rather than combined as previously dried foods. Although considerable work has been done in delineating raw material and processing factors and their effects on end product quality of freeze-dried foods, the variation in foods is so large that results from a study of one freeze-dried food can be only generally applied to another food or class of foods.

Holding of cooked food products either under refrigeration or in the freezer has been shown to have deleterious effects. Chng *et al.* (1961) showed that the lipids of sliced roast beef oxidize at a very rapid rate when exposed to air either in a refrigerator or at room temperature. Oxidation was much slower when the product was frozen, but still took place at a perceptible rate. Miller and May (1965) found that the freezer storage time before freeze-drying had a significant effect on the texture of freeze-dried chicken. Tappel *et al.* (1957) recommended that all visible fat be removed from cooked beef before freeze-drying in order to minimize deterioration due to fat oxidation during cooking and subsequent handling. Tuomy *et al.* (1968) studied the effect of processing conditions on the quality of cooked, sliced, freeze-dried beef and found that freezer storage before freeze-drying had an adverse effect on the flavor, odor, and texture of the beef. This study also showed that the dehydrator pressure and platen temperature had significant effects on the product quality.

The present military purchase document for the LRP does not put a limit on the time between preparing the product and putting it in the freezer. Twenty days is permitted for holding the frozen product before freeze-drying. The maximum dehydrator pressure permitted is 1.5 mm and the maximum platen temperature permitted is 155°F. These requirements were set arbitrarily and have resulted in procurements of quite satisfactory products. However, not enough is known about the effects of deviations from the requirements, therefore, this study was undertaken to gain further insight into these effects.

EXPERIMENTAL METHODS

The Spaghetti with Meat Sauce was made in accordance with Interim Purchase Description IP/DES S-36-6, Food Packet, Long Range Patrol, dated 20 April 1966. The study was designed as a full factorial with the factors being aged at 40°F before freezing (0 and 1 week); time in freezer before freeze-drying (0, 3 and 6 weeks); dryer platen temperature (100, 125, 150, 175, and 200°F); drying pressure (0.5 and 2.5 mm); and storage at 100°F (0 and 4 weeks).

The cooked product was spread on trays in 5-lb increments measuring 11 x 21 in with two of these slabs constituting one sample.

Trays containing samples for storage at 40°F were wrapped with paper. Samples for freeze-drying were frozen in a -30°F blast freezer before freeze-drying. The temperature of the frozen storage was 0°F with the product wrapped in freezer paper. Dehydration was to less than 2 percent moisture with radiant heat, and the vacuum on the chamber was broken with nitrogen. The dry product was packaged in No. 2 1/2 cans, 125 grams per can, 26 inches of mercury vacuum.

Taste panel evaluation was made by a 10-member technological panel rating the product on a 9-point scale for flavor, odor, color, and texture where the highest number was the most acceptable. The product was rehydrated with 180°F water for 5 minutes for the panel. The same panel members were used for each evaluation.

Headspace gas analysis was performed by chromatographic means in accordance with the procedure outlined by Bishov and Henick (1966). Prior to analysis the cans were brought to atmospheric pressure with nitrogen and allowed to equilibrate overnight. Sample size was 250-500 *ml*. Experience would indicate an anticipated error for the method of approximately ± 0.25 percent. Five cans were analyzed for each variable and the results averaged for reporting purposes.

RESULTS AND DISCUSSION

Analysis of variance results are shown in Table 1. Storage of the prepared product at 40°F before freezing had an adverse effect on flavor, odor, color and texture of the finished dehydrated product. Since the present specification for the LRP contains no restrictions in this area, it is evident that the revision of this specification should contain provisions for limiting such storage. Ordinarily, production scheduling would be such that there would be no holding period between cooking and freezing beyond a few hours. If however, under certain circumstances production personnel might want to hold the cooked product, such holding should be minimized.

Storage in the freezer before freeze-drying resulted in better texture ratings after three and six weeks. With color, better ratings were obtained for product stored zero and three weeks. The effect of storage on flavor and odor was not statistically significant. It should be noted that although the effect of storage on texture and color was statistically significant, the means for the various levels were not very far apart. Present limitation in the specification is 20 days from start of freezing to start of freeze-dehydration and the evidence from this study is not sufficient to make any change. These results are not in complete agreement with the results found with cooked, sliced, freeze dehydrated beef by Tuomy *et al.* (1968). It is postulated that the adverse effects in that study were due to the large areas of meat exposed

to oxidation by slicing, whereas, the Spaghetti with Meat Sauce was stored as a compact slab.

The drying pressure and platen temperature both resulted in significant effects on the flavor, odor, texture and color. The direction of the organoleptic ratings was toward improvement with the lower pressures and the lower platen temperatures. This result was expected and the main interest was in the statistical interactions.

Storage at 100°F after freeze-drying resulted in a significant decrease in flavor, odor, texture and color as was expected. The main interest in this study was not the storage *per se*, but rather the statistical interaction of the other variables with storage.

Further study of the significant interactions showed that generally the interactions followed the direction of the main effects where the main effects were significant. With the storage at 40°F X storage in freezer interaction, the odor rating decreased as both storage times increased. With the storage in freezer X platen temperature interaction, the ratings for flavor and odor decreased as the storage time increased and the platen temperature increased.

The interaction of most interest was storage in freezer X drying pressure which was significant at the 1 percent level for flavor, odor, texture, and color. In this case, the highest ratings were obtained for zero freezer storage and the lowest pressure. The lowest ratings were obtained at zero freezer storage and the highest pressure. Reasons for this interaction are not known at this time but it is expected that further work will be done on it.

Table 2 shows that analysis of variance results for oxygen uptake during the 4-week storage period at 100°F. These results indicate that drying pressure and platen temperature and the interaction of these two variables have statistically significant effects on the oxygen uptake. Estimation of the components of variation in accordance with the method of Hicks (1956) shows that 19 percent of the total variance was due to drying pressure, 17 percent to platen temperature, 58 percent to the drying pressure X platen temperature interaction, and 6 percent to error. Direction of the variation was toward low oxygen uptake with low pressure, high uptake with low temperature and the interaction in the same direction as the main effects. However, this investigation was not directed primarily toward studying oxygen uptake and further work is necessary before definite conclusions can be drawn.

Table 1. Analysis of Variance Results

<u>Factor</u>	<u>Flavor</u>	<u>Odor</u>	<u>Texture</u>	<u>Color</u>
Storage at 40°F	**	**	**	**
Storage in freezer	n.s.	n.s.	**	**
Storage after drying	**	**	**	**
Drying pressure	**	**	**	**
Platen temperature	**	**	**	**
Storage at 40°F X Storage in freezer	n.s.	**	n.s.	**
Storage at 40°F X Storage after drying	n.s.	**	n.s.	n.s.
Storage at 40°F X Drying pressure	n.s.	**	n.s.	n.s.
Storage at 40°F Platen temperature	**	**	**	**
Storage in freezer X Storage after drying	n.s.	n.s.	n.s.	n.s.
Storage in freezer X Drying pressure	**	**	**	**
Storage in freezer X Platen temperature	**	**	**	**
Storage after drying X Drying pressure	**	**	**	**
Storage after drying X Platen temperature	**	**	n.s.	**
Drying pressure X Platen temperature	*	**	n.s.	**

* = $P > 0.05$

** = $P < 0.01$

n.s. = not significant at $P > 0.05$

Table 2. Analysis of Variance Results
for Headspace Oxygen

<u>Factor</u>	
Storage at 40°F	n.s.
Storage in freezer	n.s.
Drying pressure	**
Platen temperature	**
Storage at 40°F X Storage in freezer	n.s.
Storage at 40°F X Drying pressure	n.s.
Storage at 40°F X Platen temperature	n.s.
Storage in freezer X Drying pressure	n.s.
Storage in freezer X Platen temperature	n.s.
Drying pressure X Platen temperature	**

** = $P > 0.01$

n.s. = not significant at $P > 0.05$

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	ROLE	WT	ROLE	WT	ROLE	WT
Freeze drying	8					
Refrigerating	6					
Freezing	6					
Temperature	6					
Pressure	6					
Storage	6					
Flavor	7					
Odors	7					
Texture	7					
Color	7					
Spaghetti	9					
Meat Sauce	9					
Freeze-dried	0					
Cooked	0					
Freeze-dried foods	9					

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