TECHNICAL REPORT
FD-10

EVALUATION OF FREEZE-DRIED CHICKEN: EFFECTS OF COOKING AND DEBONING METHODS ON COSTS AND QUALITY

by

F. E. Wells

MIDWEST RESEARCH INSTITUTE
Kansas City, Missouri

Contract No. DA 19-129-AMC-116(N)

May 1965

U. S. Army Materiel Command
U. S. ARMY NATICK LABORATORIES
Natick, Massachusetts

DDC AVAILABILITY NOTICE

DISPOSITION INSTRUCTIONS

AD

TECHNICAL REPORT
FD-10

EVALUATION OF FREEZE-DRIED CHICKEN: EFFECTS OF COOKING AND DEBONING METHODS ON COSTS AND QUALITY

by

F. E. Wells

MIDWEST RESEARCH INSTITUTE
Kansas City, Missouri

Contract No. DA 19-129-AMC-116(N)

Project Reference:
7-84-06-033

May 19

U. S. Army Materiel Command
U. S. ARMY NATICK LABORATORIES
Natick, Massachusetts

FOREWORD

Freeze dehydration of meat items is one key to producing light weight, palatable rations for the Armed Services. Field tests of experimental operational rations containing freeze dried products have shown very good acceptance, but the cost factor has been a major deterrent to final approval of these rations. In the case of freeze dried cooked chicken, one of the cost factors has been the specification requirement for raw boning of the chicken rather than cooked boning as a microbiological safety factor. In Armed Service usage, the chicken frequently will not receive any heat treatment so that the cooking during processing is the last sterilization or pasteurization accomplished and subsequent contamination must be held to a minimum. If cooked boning is to be considered, it must be determined whether or not the freeze dried chicken prepared from it under normal plant conditions is microbiologically safe and what specification safeguards must be instituted.

The work covered in this report, performed by the Midwest Research Institute under Contract No. DA19-129-AMC-116(N), was designed to obtain general information regarding the microbiological results of cooked and raw boning chicken under plant conditions and to obtain a preliminary cost comparison between the two methods. The investigator was F. E. Wells.

The U. S. Army Natick Laboratories Project Officer was J. M. Tuomy and the Alternate Project Officer was M. C. Brockmann, both of the Animal Products Branch, Food Division.

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

APPROVED:

DALE H. SIELING, Ph.D.
Scientific Director

W. W. VAUGHAN
Brigadier General, USA
Commanding

TABLE OF CONTENTS

List of Tables

TABLE OF CONTENTS (Concluded)

List of Tables (Concluded)

ABSTRACT

Effects of three deboning techniques with three classes of poultry were studied. Evaluations were based upon cost of production, contaminati by bacteria and organoleptic tests for quality of the dried meat.

The results indicate there is reason to recommend a deboning procedu- where carcasses are fully cooked before deboning. Fowl appear to give bet meat yields than fryers or roasters.

A method for bacteriological examination is described. Cautions cc - cerning sanitation in relation to deboning methods are noted.

SUMMARY

The effects of three methods of deboning poultry in the making of freeze-dehydrated meat on microbiology, yields, and costs were studied. The three deboning methods were:

1. Raw deboning followed by complete cooking of the meat.

2. Complete cooking of whole birds followed by deboning.

3. A partial cooking of whole birds followed by deboning, followed by complete cooking.

Three classes of poultry, fryers, roasters and fowl, were evaluated.

Poultry class and deboning methods were found to influence the yields of cooked, deboned and freeze-dried meats.

Fowl deboned by first cooking the carcass was found to give higher yields of both cooked and dried meat than the other two classes of poultry by any of the deboning techniques. Roasters and fryers appeared to give somewhat better yields (for their respective classes) when deboned by the technique of partially cooking the carcasses, deboning when cool, and then fully cooking the meat. The advantage of this particular method for roasters and fryers appears to be related to fat content and the degree of fat loss during the process. Fat in the dry meat appears, by analysis, to be higher in roaster and fryer prepared by partially cooking prior to deboning than by any other deboning method. Fowl, on the other hand, giving a higher yield by fully cooking prior to deboning, had a higher fat content in the meat prepared by that method.

Bacteriology

The numbers of bacteria found on the freeze-dehydrated meat appeared to be related to the contamination resulting from deboning. Although an agar plate count did not indicate unacceptably high numbers of bacteria to be present on any of the dry meats, those prepared by full cooking of carcasses prior to deboning consistently had the higher

total counts. Coliforms were not present on the dry meat, nor were *Salmonella*.

The differences among the total counts on all dried products were not great. However, the tendency for the meat prepared by fully cooking prior to deboning to be higher indicated that strict adherence to plant sanitation practices must be followed when this method is used. Organoleptic evaluation of the dried meats indicated that all classes of poultry yielded a tough product when deboning was done following a partial cook. With the other two deboning methods, fryers produced tender rehydrated meat, roaster and fowl yielded tough products.

Moisture uptake as a percentage of original water in the cooked meat did not appear to correlate well with tenderness and juiciness.

Freeze-dried meat could be produced more cheaply from fowl (by all deboning methods) than by the other poultry classes studied. For all classes, fully cooking prior to deboning was the most economical of the deboning techniques used.

I. INTRODUCTION

Deboning of poultry meat is an operation in the manufacture of freeze-dehydrated products that can have a great influence upon the bacteriological quality of the dry product as well as upon the cost of producing the dried meat. The following report presents the information developed from a study initiated to evaluate the effects of three methods of deboning on freeze-dried meat prepared from three classes of poultry. The primary objective of this study was the development of information by which a recommendation could be made for a particular weight class of bird and a deboning and cooking sequence which would yield freeze-dried meat having an acceptable quality and which could be produced with maximum efficiency.

II. EXPERIMENTAL

A. Examination of Dried Meats

1. Sample Preparation

The carcasses of fresh poultry meats have a low "interior" bacterial count. Practically all the contamination is on the exterior surfaces. Meat handled in "further processing" such as deboning and cubing for freeze-dehydration would be expected to become more contaminated but again the contamination would be essentially external. Surface sampling techniques are practical and efficient for enumeration of bacteria on these products. Meat which is dried cannot be examined accurately by surface sampling methods, freeze-dried meat in particular.

Two methods of sampling were investigated specifically for use with freeze-dried poultry. One is routinely used for dry meat products; the other is not. The first method consisted of preparing a slurry of the meat in water by use of a Waring Blendor or some similar homogenizer. The second method consisted of grinding the meat dry in the Blendor and then preparing dilutions from the powder.

2. Preparation of Dilutions

It is generally assumed that in low dilutions of meat, or other dry products, rapid decline of bacterial numbers does not occur.

Increasing dilution does cause reductions. The nature of the diluent is partly responsible for the reduction with increased dilution. To evaluate the most effective dilution media we studied the following factors:

1. Distilled water at 34°F.
2. Distilled water at 75°F.
3. Distilled water at 110°F.
4. Aqueous solution of peptone (0.1 per cent) at 34°F.
5. Aqueous solution of peptone (0.1 per cent) at 75°F.
6. Aqueous solution of peptone (0.1 per cent) at 110°F.
7. Phosphate buffer (pH 7.0) at 34°F.
8. Phosphate buffer (pH 7.0) at 75°F.
9. Phosphate buffer (pH 7.0) at 110°F.

3. <u>Plating Media</u>

Only violet red bile agar was used for the determination of coliforms. For determination of total aerobic bacteria two media were compared, trypticase soy agar and plate count agar.

4. <u>Incubation Times and Temperatures</u>

Incubation of the poured plates for total aerobic counts was done at 75°F and 90°F. In addition to these, 37°F was used for incubation of the coliform plates.

5. <u>Examination of Fresh Meats</u>

In the second plant run the bacteriological changes related to processing were followed throughout the deboning operation on fowl. Surface contamination was evaluated by swabbing 1 sq. cm. of surface using an aluminum template and a cotton swab. Platings for total aerobic counts were made using trypticase soy agar (BBL). Examination of the meat for Salmonella was made by streaking the swabbings of 1 sq. cm. of surface on previously solidified brilliant green agar.

B. Preparation of Freeze-Dehydrated Meat

All poultry used in this investigation was processed in the Dardanelle, Arkansas, plant of Arkansas Valley Industry, Inc. (A.V.I.). All the birds used in the tests were placed on the evisceration line with the poultry being slaughtered commercially during the normal operation of the plant. The test birds were put through all unit processes of normal operation (i.e., killing, scalding, picking, evisceration, inspection, chilling, etc.). An end product comparable in bacteriological quality to that normally produced by the plant was achieved by this method. At the chilling stage the test birds were separated from the regular production birds. Further processing was done in the kitchens of the A.V.I. plant.

Three deboning techniques were used to produce meat for freeze-dehydration:

Group I - Raw deboned.

Group II - Deboned following a complete cook.

Group III - Deboned following a partial cook.

1. Plant Run No. 1

a. Group I. Raw deboned:

(1) Deboning: The carcasses were skinned and boned prior to cooking. The head, feet, giblets, viscera, bones, cartilage, connective tissue, blood clots, skin, bruised meat and meat of the neck, back and wing were excluded. After deboning, the meat was mixed to insure an even distribution of light and dark portions. The deboned meat was held in a room maintained at 30°F between any processing steps separated by more than 30 min. time.

(2) Cooking: The deboned chicken meat was stuffed into casings and cooked in boiling water (212°F). Fryers and roasters were cooked to an internal temperature of 160°F. Fowl were cooked to

an internal temperature of 180°F. Immediately after the end point of cook was reached, the kettles were drained of hot water and refilled with cold. The cooked meat was allowed to cool until the internal temperature had fallen to 120°F, the casings were then removed from the cooling water, opened, and the meat placed on pans to drain. No attempt was made to collect the meat juices although such a reclamation would have economic benefit in commercial operations.

When the meat had drained well, it was placed in a 30°F chill-room for cooling. After cooling to 40°F, the meat was cut into pieces approximately 1 x 1 x 3/8 in. Normally this operation would be done with a dicing machine. On the days our tests were made, the dicing machine was inoperable. The diced meat was frozen in a blast freezer at -40°F.

(3) <u>Frozen storage</u>: The cooked, diced, frozen meat was kept in heavy Mylar bags in a freezer maintained at -40°F. All meat was packed in dry ice and transported by truck to Kansas City. Upon arrival in Kansas City checks for temperature changes in the product were made and the meat then placed at -40°F and held until dried.

(4) <u>Freeze-dehydration</u>: The meat was placed in the dehydrator and refrigerated at -50°F for 2 hr. prior to commencing the dehydration process. This additional freeze was given in order to assure a uniform temperature in the meat. The following conditions were used for the drying: plate temperature, 140°F; pressure 5-10 μ ; condenser temperature, -90°F; maximum temperature of product, 120°F.

b. <u>Group II. Deboned following complete cooking</u>:

(1) <u>Cooking</u>: The entire poultry carcass was cooked in boiling water (212°F). Fryers and roasters were cooked to an internal temperature of 160°F, fowl to an internal temperature of 180°F. After the cooking end point was reached, the kettles were drained and refilled with tap water. When the birds had cooled to an internal temperature of 120°F they were removed from the cookers and placed on trays, in racks, to cool.

(2) <u>Deboning</u>: Cooling was accomplished in a chill-room maintained at 30°F. The skin and meat of the neck, back and wings were

not used. After deboning, the meat was cut to pieces approximately 1 x 1 x 3/8 in. A mixture of light and dark meat was made to obtain uniform distribution of the two types of flesh.

(3) Frozen storage: Conditions were the same as for the previously described raw deboned meat.

(4) Freeze-dehydration: Conditions were the same as previously described.

c. Group III. Deboned following a partial cook:

(1) Cooking: All poultry was cooked in boiling water at 212°F. All three classes of poultry were given a partial cook to 140°F internal temperature (temperature recorded at deepest part of breast against the keel bone). After deboning, the fryers and roasters were cooked to 160°F, internal temperature, and the fowl to 180°F internal temperature.

(2) Deboning: Deboning was done following a partial cook to 140°F and cooling to 40°F. The meat was deboned, placed in Mylar tubing, and then completely cooked, as described above, to 160°F or 180°F internal temperature depending on poultry class.

(3) Frozen storage: Conditions were the same as previously described.

(4) Freeze-dehydration: Conditions were the same as previously described.

2. Plant Run No. 2

a. Deboning: The techniques described for deboning in plant Run No. 1 were followed in plant Run No. 2.

b. Cooking: The end point of cook was changed from that used in plant Run No. 1. Evaluation of the cooked meat and the dried meat of the first trials indicated some of the meat to be inadequately cooked. All meat cooked in casings, i.e., raw deboned and meat partially cooked prior to deboning, was cooked to an internal temperature of 170°F. The carcasses of fryers and roasters cooked whole (for deboning following cook) were also cooked to an internal temperature of 170°F; fowl were cooked to 180°F internal temperature.

c. Frozen storage: All cooked, deboned meat was frozen to -40°F in a blast-freezer over a 14-hr. period. For shipment to Kansas City, the frozen rolls were placed in insulated containers or heavy cardboard boxes and were packed with dry ice. Upon arrival in Kansas City, examination of the product indicated that the frozen state had been preserved. The meats were then immediately placed in a freezer at Midwest Research Institute.

d. Freeze dehydration: Representative samples of each experimental unit were prepared for drying in the following manner:

The frozen rolls of chicken meat were rapidly sawed on a band saw into slices 1/2 in. thick. These slices were placed onto cold trays and the trays loaded onto the freezing plates of the freeze-dehydrator and the temperature of the meat reduced to -50°F in 1-1/2 hr. With the exception of some slight surface thawing due to sawing, the meat remained frozen during preparation.

All other drying conditions were the same as described for meat processed in plant Run No. 1.

C. Chemical Analysis

Chemical analyses of the dried products were made for protein, fat, fiber, moisture, and carbohydrate (by difference). The analyses were made by recommended methods of the Association of Official Agricultural Chemists.

Caloric values were calculated.

D. Organoleptic Evaluation

Flavor, tenderness and general acceptability were evaluated by taste panel testing. These organoleptic tests were used on dried meat rehydrated according to directions in Quartermaster Corps Interim Purchase Description for Chicken Pieces, Precooked, Dehydrated (IP-DES, CS-5-1, 15 May 1961).

Rehydratability was evaluated following the above procedure (IP-DES, CS-5-1) and by using distilled water at room temperature as the rehydrating medium.

Using the first method, weighed dry meat was allowed to rehydrate 15 min. in salted hot water. Then it was drained for 5 min. on stainless steel screens. The rehydrated meat was weighed and the amount of water resorbed was calculated.

The second method was similar to the first with the exception that the weighed, dried meat was soaked in distilled water for 30 min. at room temperature.

E. Cost Analysis

The analysis of costs for production of meat from any particular class of poultry by any one of the deboning methods will have relevancy only when applied in the broadest terms.

The yield of a given amount of dry meat from a given amount of chilled meat will be applicable to most operations. The total costs of producing that meat will, however, be influenced by other variables which cannot be fully evaluated. Reclamation and sale of by-products such as broth, meat scraps, fat, etc., would have a decided bearing on cost of production. It may be assumed that not all producers of freeze-dried meat will attempt this recovery and even if we knew to what extent such recoveries would be made, the differences in size and efficiency of drying operations would not allow us to do more than generalize.

The costs we present in this report are related to factors which we feel will be uniform regardless of plant size and efficiency; i.e., if one is to use fryers as meat sources, which will be the most costly deboning procedure; if one uses heavier birds, which deboning method will be most efficient?

F. Meat Yields

Meat yields for cooked and dry meat in relation to chilled carcass weight are based upon a 65 per cent moisture in cooked meat and a 2 per cent moisture in the dry. Adjustments were made where actual values differed from these bases.

III. RESULTS AND DISCUSSION

A. Bacteriology: Methods

1. Sample Preparation

One of the problems in surveying meats for bacterial contamination is that slurries made of the meat are difficult to pipette uniforml Another complicating factor is that the contamination of noncomminuted meat is external, i.e., on the surface - when large pieces of meat are used as sample and the results are based on weight, a distorted pictur of the degree of contamination may result. To produce a more uniform sample one could choose large aliquots, homogenize these with diluent and subsample or one could first homogenize large dry aliquots and sub sample them for counts.

A comparison of these two methods indicated that the dry grinding of the meat prior to preparation of dilution gave the most consistent results. The results of these comparisons are presented in Table I.

TABLE I

EFFECT OF METHOD OF SAMPLE PREPARATION ON BACTERIAL COUNTS OF FREEZE-DRIED POULTRY MEAT

Replication	Method of Preparing Sample: Homogenized with Diluent in Waring Blendor - No. Bacteria/g 1 x 10^{-2}	Method of Preparing Sample: Ground Dry in Waring Blen Subsampled for Dilution No. Bacteria/g 1 x 10^{-2}
1	96	130
2	25	145
3	121	111
4	136	131
5	31	141

2. Dilution Media

The bacteria present on poultry meat, which has been freeze-dehydrated, has been under variable temperature stress. Two things related to this stress were considered to be possible limiting factors of growth: a greater nutritional demand of the cells, and suspension in a diluent at such a temperature that lethal stress was applied to the cells. To determine these effects, three different diluting fluids were used at three temperatures. The results obtained on freeze-dried poultry meat are presented in Table II.

The values in this table are averages obtained by combining the counts made on trypticase soy and plate count agar plates.

TABLE II

EFFECT OF TYPE OF DILUENT ON RECOVERY OF BACTERIA FROM FREEZE-DEHYDRATED POULTRY MEAT

Diluent Temperature (°F)	Kind of Diluent		
	Distilled Water (No./g)	0.1% Peptone (No./g)	Phosphate Buffer pH 7.0 (No./g)
34	18,050	15,000	16,050
75	31,800	36,300	29,800
110	1,440	1,270	1,450

The difference in recovery did not appear to be great but it must be remembered that the numbers obtained per gram on these samples were not high and because of this, much dilution of the samples was not necessary. In those cases where great dilution of sample is necessary, the indications are that the diluent prepared from 0.1 per cent peptone will yield higher numbers than either distilled water or phosphate buffer.

3. Diluent Temperature

With materials such as dehydrated meat it appeared reasonable to assume that temperature of the dilution medium would influence the degree of recovery of bacteria.

The reasons for these assumptions are related to the possibility of bacterial entrapment in fats and the possibility that release of the trapped cells would not be effected by the diluent at temperature below the melting point of the fatty material.

To bracket temperature effects, diluents were used at three temperatures: 34°F, 75°F, and 110°F. The effect of these conditions - recovery of bacteria from freeze-dried poultry meat is given in Table III. There appears to be little doubt that 75°F gives far better results than either 34°F or 110°F.

TABLE III

EFFECT OF DILUENT TEMPERATURE AND TYPE OF PLATING MEDIUM ON RECOVERY OF BACTERIA FROM FREEZE-DEHYDRATED POULTRY MEAT

Diluent Temperature (°F)	Plating Media	
	Trypticase Soy Agar (No./g)	Plate Count (No./g)
34	800	700
75	14,000	10,000
110	1,300	3,100

The low recovery at 110°F may be partly explained by the loss of freeze-injured cells being brought to such a high metabolic rate, so rapidly that physiological imbalances are intensified and repair cannot be achieved. The increase in metabolic rate at 75°F would be slower, so it is conceivable that physiological imbalances can be stabilized or physical damages repaired before loss of cell sap occurs. The lower recovery at 34°F may also be related to metabolism. In this case, however, the rates of repair may be so low as to be inadequate to prevent leaching of cell sap or too low to allow the cell to overcome metabolic imbalance.

A similar comparison of diluent temperature effects was made using dried beef as the sample. The results with beef are presented in Table IV.

TABLE IV

EFFECT OF DILUENT TEMPERATURE AND TYPE OF PLATING MEDIUM ON RECOVERY OF BACTERIA FROM COOKED, DEHYDRATED BEEF

Diluent Temperature (°F)	Plating Media: Trypticase Soy Agar (No./g)	Plating Media: Plate Count Agar (No./g)
34	168,000	224,000
75	430,000	405,000
110	8,500	22,000

The trends noted with poultry meat were also found with beef: poorest recovery bacteria was at 110°F, intermediate values were obtained at 34°F and the best results were obtained at 75°F.

4. Incubation Temperature

Early indications were that an incubation temperature of near 30°C gave better results than an incubation temperature near 20°C. Subsequent tests, however, showed that the lower incubation temperature did give higher counts if incubation was continued for five days. The difference in counts obtained on freeze-dried poultry meat are summarized in Table V.

TABLE V

EFFECT OF INCUBATION TEMPERATURE ON TOTAL AEROBIC PLATE COUNTS OF FREEZE-DRIED POULTRY MEAT

Incubation Temperature	Total Aerobic Bacteria by Plate Count (No./g)
20°C (5 days)	425,000
30°C (3 days)	216,000
37°C (2 days)	68,000

B. Bacteriology: Analysis of Freeze-Dried Poultry Meat

The methods of analysis were evaluated through the use of freeze-dried meat prepared in the laboratory. The results of these tests suggested the following procedure would be applicable to the evaluation of deboning and cooking techniques to be used in this study:

1. Diluent: 0.1 per cent peptone.

2. Diluent temperature: 25°C.

3. Plating agar: trypticase soy or plate count agar.

4. Incubation temperature: 20°C.

5. Incubation time: five days.

6. Sample preparation: dry grind the freeze-dehydrated meat in a sterile, dry Waring Blendor and choose the material to be ground in such a manner as to have a representative sample of light and dark meat fat, etc. Prepare dilutions from aliquots of the dry material.

Using the above procedure, the effect of the three deboning techniques on bacteriological quality of freeze-dried poultry were evaluated, Table VI. The results of both commercial trials are presented as well as an average value for the two. Plant Run No. 1 was made using an end point of cook at 160°F, and by dicing the meat prior to freezing. Plant Run No. 2 was made using an end point of cook at 170°F and by dicing the meat after it was frozen.

The average number of bacteria per gram indicates that raw deboning yields a dry product with a lower level of contamination than does deboning by the other two methods. The highest numbers of bacteria were found on the meat which was fully cooked and then deboned.

Although the counts on meat prepared by all methods were low, the percentage of difference between the high and the low is great: the lowest result is only about 7 per cent of the high. The number of bacteria on the meat deboned by partially cooking, deboning and then fully cooking were nearer those of the meat raw deboned than of the meat fully cooked and deboned. Within each group there was little difference due to difference in poultry class; i.e., fryer, roaster, or fowl, Table VI.

TABLE VI

BACTERIOLOGY OF FREEZE-DRIED POULTRY MEAT PRODUCED UNDER COMMERCIAL CONDITIONS

	Plant Run	Total Plate Count (No./g)	Coliforms	Salmonella
Group I (Raw, deboned)				
Fryers	1	500	< 10	-
	2	200	< 10	Neg.
	Avg.	350	< 10	Neg.
Roasters	1	250	< 10	-
	2	1,100	< 10	Neg.
	Avg.	675	< 10	Neg.
Fowl	1	600	< 10	-
	2	2,250	< 10	Neg.
	Avg.	1,425	< 10	Neg.
Average for Group	All	816	< 10	Neg.
Group II (Fully cooked, deboned)				
Fryers	1	10,000	< 10	-
	2	1,400	< 10	Neg.
	Avg.	5,700	< 10	Neg.
Roasters	1	12,650	< 10	-
	2	6,400	< 10	Neg.
	Avg.	9,525	< 10	Neg.
Fowl	1	29,000	< 10	-
	2	7,500	< 10	Neg.
	Avg.	18,250	< 10	Neg.
Average for Group	All	11,158	< 10	Neg.

TABLE VI (Concluded)

	Plant Run	Total Plate Count (No./g)	Coliforms	Salmonell
Group III (Partially cooked deboned)				
Fryers	1	800	< 10	-
	2	600	< 10	Neg.
	Avg.	700	< 10	Neg.
Roasters	1	1,600	< 10	-
	2	1,650	< 10	Neg.
	Avg.	1,625	< 10	Neg.
Fowl	1	900	< 10	-
	2	4,600	< 10	Neg.
	Avg.	2,750	< 10	Neg.
Average for Group	All	1,692	< 10	Neg.

None of the meats had more than 10 coliforms per gram and no *Salmonella* could be detected on any samples.

A product of satisfactory bacteriological quality can be made by using any of the deboning techniques tested. However, should there be an indifferent attitude in regard to sanitation by a processor, deboning after cook would yield a dry product likely to be bacteriologically unacceptable.

Meat yields: The results of deboning on meat yields are given separately for plant runs Nos. 1 and 2 as well as averages for the two runs (Tables VII, VIII, and IX).

TABLE VII

EFFECT OF DEBONING METHODS ON YIELDS OF COOKED AND FREEZE-DRIED POULTRY MEATS

Deboning Method	Plant Run No. 1 Lb. Chilled Meat Per Lb. Cooked*	Plant Run No. 1 Lb. Chilled Meat Per Lb. Dry**
Group I (Raw, deboned)		
Fryer	4.0	11.8
Roaster	3.7	10.6
Fowl	3.6	10.4
Group II (Fully cooked, deboned)		
Fryer	4.1	11.7
Roaster	3.6	10.3
Fowl	3.3	9.5
Group III (Partially cooked, deboned)		
Fryer	3.6	10.2
Roaster	3.4	9.8
Fowl	3.4	9.7

* Cooked meat values based on 65 per cent water.

** Dry meat values based on 2 per cent water.

TABLE VIII

EFFECT OF DEBONING METHODS ON YIELDS OF COOKED AND FREEZE-DRIED POULTRY MEATS

Deboning Method	Plant Run No. 2 Lb. Chilled Meat Per Lb. Cooked*	 Lb. Chilled M Per Lb. Dr**
Group I (Raw, deboned)		
Fryer	4.4	12.9
Roaster	3.1	8.9
Fowl	3.3	9.6
Group II (Fully cooked, deboned)		
Fryer	3.9	11.3
Roaster	3.7	10.6
Fowl	3.2	9.0
Group III (Partially cooked, deboned)		
Fryer	3.6	11.2
Roaster	3.6	10.2
Fowl	3.5	9.3

* Cooked meat values based on 65 per cent water.

** Dry meat values based on 2 per cent water.

TABLE IX

EFFECT OF DEBONING METHODS ON YIELDS OF COOKED AND FREEZE-DRIED POULTRY MEATS

Deboning Method	Averages Runs Nos. 1 and 2: Lb. Chilled Meat Per Lb. Cooked*	Lb. Chilled Meat Per Lb. Dry**
Group I (Raw, deboned)		
Fryers	4.2	12.4
Roasters	3.4	9.8
Fowl	3.5	10.0
Group II (Fully cooked, deboned)		
Fryers	4.0	11.5
Roasters	3.7	10.5
Fowl	3.3	9.3
Group III (Partially cooked, deboned)		
Fryers	3.6	10.7
Roasters	3.5	10.0
Fowl	3.4	9.8

* Cooked meat values based on 65 per cent water.

** Dry meat values based on 2 per cent water.

The yields of cooked meat and freeze-dried meat, as a return on chilled carcass weight, are based upon a 65 per cent water content for cooked meat and 2 per cent water content for the dehydrated.

When the meat was raw deboned, fowl gave a better yield than did the other two classes of poultry, i.e., fryers and roasters. Three and six-tenths pounds of fowl (chilled carcass weight) were required to produce 1 lb. of cooked meat by the raw debone technique. Three and seven-tenths pounds of roaster were required to yield 1 lb. cooked, and 4 lb. of fryers were needed to yield an equivalent weight. The same ranking holds for the amount of chilled meat to yield 1 lb. of freeze-dried products: fowl gave better yield than roasters or fryer .

Fowl also gave the highest yield of cooked meat when the carcasses were fully cooked prior to deboning. For every pound of cooked meat produced, 3.3 lb. of chilled fowl were required. For roasters, 3.6 lb. were required to yield 1 lb. of cooked meat and for fryers 4.1 lb. were necessary.

The difference in the yield of freeze-dried meat between fowl and roasters was greater with the full-cook method than with the raw debone method. Fowl again gave the highest yield. Fryers gave the poorest yield.

There was less difference among the three classes with the partial cook-debone method than with either raw-deboning or cooked-deboning. Fowl and roaster classes appeared to give identical yields of cooked meat for each pound of chilled. The yield with fryers was slightly less but the difference was not as great as with the other two methods.

With regard to yields by classes among the three deboning methods, the following observation can be made. Partial cooking prior to deboning yielded a greater quantity of cooked meat than did the other systems. Only 3.6 lb. of chilled meat were required to produce 1 lb. cooked meat by this method in comparison to 4.0 lb. for raw deboning a 4.1 lb. for cooked deboning. The only explanation offered for the poo showing of full cooked deboned carcasses is that perhaps there was a sufficient loss of fat during cook to make the difference. With both the raw deboned meat and the partial cooked-deboned, fat may have been retained better because the meat was cooked in sealed pouches and drained only after cooling.

As was true with fryers, the roasters gave better yields with a partial cook prior to deboning than with either of the other techniques. Again this may be a reflection of fat loss. When the yields for the heavier, fatter fowl are examined the full cook-debone method resulted in better production than the partial-cook debone technique. Because the fowl was fatter to begin with they would have lost fat on cooking but much fat would also have been removed by the deboners during the raw deboning, and partial cook-deboning.

The results of the first plant run appeared to show that better yields could be obtained by using the older, heavier class birds, i.e., fowl, and deboning by first cooking the carcasses. Other considerations are not taken into account; i.e., quality, bacteriological contamination, or costs.

A second commercial run was made using more birds than were used in the first. In addition to more birds some changes were made in cooking temperature and in handling of the meat after cooking. The handling changes were made in order to evaluate the bacterial contamination that could be anticipated by such changes in a plant. Table VIII presents the yield data for this production.

Fryers consistently gave poorer yields of cooked and freeze-dried meat. Yield by this class of poultry was lower with raw deboning than with either full-cooked deboned or partial-cooked deboned. Of all three techniques the better yield was obtained by partial cooking prior to deboning.

The yield of cooked and freeze-dried meats from roaster class poultry appeared to be better using the raw debone technique than either cooked deboned or partial cook, deboned methods. How accurate this particular value is may be open to debate. The reason for the better showing of the raw debone technique in this instance cannot be explained. A comparison of the values in Tables VII and VIII for any class in any group would indicate that raw deboned fryer values are the ones showing the most inconsistency. Other values in both trials are close.

The results with fowl were similar to the results of the first run with one exception. The better yield was obtained by using the full cook, debone method. The exception was in the reversal of ranking between raw deboning and partial cook, deboning.

The results of this second trial appear to show, as did Run No. 1, that better yields are obtained using poultry of the fowl class and deboning after first fully cooking. Again this is based on no consideration other than meat yield.

Average yields: The results obtained in the two trials have been combined and the averages for yields are presented in Table IX.

With fryers raw deboning gave less yield of cooked meat per pound of chilled carcass than did either full cook, debone or partial cook, debone. Of the two latter techniques better yield was obtained partially cooking and then deboning. Because the yields of cooked meat are based on a 65 per cent water content the yield of freeze-dried meat would be expected to follow the same pattern. The figures in the table indicate that such is the case.

The average yield for roasters gives the same pattern as the results of the second trial; better yield was obtained by raw deboning. However, the average may be biased by the disparity found in the second trial for roaster yield.

The average values for fowl only show what was found in both trials 1 and 2; the better method is full cook, debone.

Based on average yields, better production can be obtained by using fowl deboned by first fully cooking.

If one must use either fryers or roasters, the better results appear to come by use of partial cooking prior to deboning. In some way the advantages of this system appear to be related to fat of the carcasses.

Protein and fat in freeze-dried meat: The fat content varied widely in the three classes of poultry used in this study. The results of chemical analysis of the dry meat are shown in Table X.

TABLE X

PERCENTAGE OF PROTEIN AND FAT IN FREEZE-DRIED POULTRY MEATS

	Analysis (%)					
	Protein			Fat		
Deboning Method	Run No. 1	Run No. 2	Avg.	Run No. 1	Run No. 2	Avg.
Group I (Raw, deboned)						
Fryers	78.8	76.8	77.8	12.7	14.7	13.7
Roasters	77.9	77.8	77.9	14.2	14.0	14.1
Fowl	78.0	73.2	75.6	20.6	23.5	22.1
Group II (Fully cooked, deboned)						
Fryers	83.6	85.6	84.6	15.1	13.1	14.1
Roasters	82.7	78.3	80.5	12.2	16.8	14.5
Fowl	76.3	69.3	72.8	18.4	26.2	22.3
Group III (Partially cooked, deboned)						
Fryers	82.7	83.4	83.6	16.3	15.4	15.8
Roasters	76.1	81.2	78.7	13.4	18.4	15.9
Fowl	77.9	79.0	77.5	20.6	17.0	18.8

Fat content of the dry meat produced from fryers varied between deboning methods and between the two plant runs. In the first trial, fat in the dry meat increased from raw deboned, to full cook, deboned to partial cook, deboned. This pattern was nearly repeated in the second trial. The exception was in a lower value for one meat deboned after it was fully cooked than for the other methods. The meat of fryers prepared by partial cook before deboning had the higher percentage of fat.

With birds of the roaster class the fat content of the dry meat also varied among the three deboning methods. The average values for this class indicated that fat was lower on meat deboned by partial cooking prior to deboning than by any of the other methods. For roasters, fat was higher for meat prepared by raw deboning and this higher percentage may indicate less fat loss in cooking which may in turn tend to explain the higher meat yield of roasters (Table IX) by the raw debone procedure.

Dry meat of fowl was higher in fat than either roaster or fryer regardless of the deboning method used. All the variability found in fat in the meat cannot be attributed to the method of deboning alone. There is inherent in all the methods a certain uncontrollable factor when poultry such as fowl are used. The interim specification for freeze-dried meat now requires the dry product to have 18 per cent fat or less. To achieve this value, with a fowl or with some heavy roasters, some of the body fat must be removed either prior to or at deboning. There is no way in which this fat removal can be accomplished uniformly. Without removal of some fat, dehydrated meat produced from fowl would not be able to meet the specification. The degree to which the per cent of fat in dry meat of fowl exceeds the maximum can be seen from the figures in Table X.

Caloric yields: The caloric density of a food is an important consideration in the development of dehydrated military ration. Because of this fact the presentation of some relative yields of calories by meats prepared by different classes of poultry as well as by deboning technique appeared to merit some study. An evaluation of the calories supplied by 100 g. of dried poultry meat would seem to show that the total calories supplied by meat from fryer, roaster or fowl or by any deboning process within a class do not differ greatly (Table XI). There appears to be less than 10 calories per 100-g. difference in fryer meat among the three deboning techniques, less than five among roasters and about 50 among fowl.

Greater differences appear among the poultry classes by deboning methods, however, when calculations are made to show variations in the per cent of calories supplied by fat. Nearly 8 per cent more calories are supplied by fat in fowl meat raw deboned than are supplied by the fat in fryer meat raw deboned. When poultry classes deboned by the full cook technique are compared, 15 per cent more of the calories are supplied by dried fowl meat than are supplied by fryer. With these two classes deboned by the partial cook method, the difference is 7 per cent more for fowl meat.

TABLE XI

CALORIC YIELDS OF FREEZE-DRIED POULTRY

	Calories Per 100 g. Dry	% of Calories From Protein	% of Calories From Fat
Group I			
Fryers	454	68.5	31.5
Roasters	456	68.3	31.7
Fowl	501	60.4	39.6
Group II			
Fryers	454	74.4	25.6
Roasters	453	71.1	28.9
Fowl	452	59.0	41.0
Group III			
Fryers	463	71.8	28.2
Roasters	452	69.6	30.4
Fowl	483	65.0	35.0

It is possible that these differences in values have no real significance although cognizance of the environmental condition under which a military ration is to be used is necessary. In light of this, rations designed for cold climates might be desired in which the percentage of calories supplied by fat is higher. Dehydrated meat prepared from fowl would meet this need better than meat prepared from fryers.

Organoleptic evaluation: Evaluations for flavor, tenderness, juiciness and general acceptability were made by use of a taste panel. The testing was done only on the meat as meat and not as to its potential for use in meat mixtures such as stews, soups, etc. The panel was asked to rate flavor as excellent, good, poor or unacceptable. Ratings were not compared to freshly cooked poultry meat since we were interested in how freeze-dehydrated meat would be accepted based on its own merits; we were not attempting to duplicate the flavor, texture, etc., of fresh cooked meat. Toughness was rated by a chew panel as very tough, tough, slightly tough, tender or very tender. The meat was rated for juiciness as being either juicy or dry. The results of testing freeze-dried meat are given in Table XII. All classes of poultry yielded a dry meat considered to have good flavor when raw deboning was employed. Fryers were considered to be more tender than roasters or fowl. Roasters were tougher than fowl. Fryers and fowls were considered juicy but roasters were considered to be dry. Acceptability of fryers was high and roasters low. Meat from fowl was intermediate. Fully cooking before deboning yielded meat that rated a good flavor in all poultry classes. Again fryers gave a more tender meat. Rehydrated meat from roasters and fowl were both rated tough. Only fowl was rated as a dry meat.

TABLE XII

ORGANOLEPTIC EVALUATION OF FREEZE-DRIED MEATS PREPARED FROM THREE CLASSES OF POULTRY USING THREE DEBONING PROCESSES

	Flavor	Tenderness	Juiciness	Acceptability
Group I (Raw, deboned)				
Fryer	Good	Tender	Juicy	High
Roaster	Good	Tough	Dry	Low
Fowl	Good	Slightly Tough	Juicy	Avg.
Group II (Cooked, deboned)				
Fryer	Good	Tender	Juicy	High
Roaster	Good	Tough	Juicy	Avg.
Fowl	Good	Tough	Dry	Low
Group III (Partially cooked, deboned)				
Fryer	Good	Tough	Juicy	Avg.
Roaster	Good	Tough	Juicy	Avg.
Fowl	Good	Tough	Juicy	Avg.

The flavor of the dried meat made by partial cooking prior to deboning was given a good rating for all three classes. All three classes were considered tough although all three classes were also considered juicy. This apparent discrepancy may be related to the fact that interfiber spaces may resorb water well while the fibers themselves have undergone changes resulting in poor resorption characteristics. In some cases the first few chews resulted in much expressed juice and thereafter continued chewing resulted in an increased awareness of toughness.

Rehydratability: Rehydratability as a term applied to freeze-dried meat may be misleading. In the strictest sense we are measuring the amount of water that can be absorbed by the dried product regardless of where the water is held. This does not imply that the same proportion of water will go into all structures as was there in the original state. The situation is somewhat analogous as to saying we are going to determine the rehydratability of cellulose by determining the water uptake of a cellulose sponge. The two systems are not the same.

We should be careful in attempting to correlate, too closely, uptake of water, juiciness, and tenderness.

From the values given in Table XII and Table XIII such correlations would appear vague. Roasters deboned by the raw deboning technique yielded a dry product that was rated to have good flavor but was dry and tough. The values in Table XII show that this particular product took up a higher percentage of water based on original water in the cooked meat than did either fryers or fowl. Both the latter classes rated higher in tenderness and juiciness than did the roasters. Again dried meat from all three classes deboned by partially cooking the carcass and then removing the meat (Group III) was tough on rehydration. Yet, the per cent uptake of water was higher than water uptake in meat deboned by the other two methods.

TABLE XIV

COST OF PRODUCING 1 LB. OF FREEZE-DEHYDRATED POULTRY MEAT

Deboning Method - Poultry Class	Cost Per Pound Dry Meat
Group I (Raw, deboned)	
Fryers	$5.32
Roasters	3.83
Fowl	3.75
Group II (Fully cooked, deboned)	
Fryers	$3.79
Roasters	3.58
Fowl	3.27
Group III (Partially cooked, deboned)	
Fryers	$4.03
Roasters	3.99
Fowl	3.78

All other things being equal, dried meat made from fowl class poultry deboned by full cooking followed by deboning can be produced cheaper than can meat produced by any other combination investigated in this study. The advantage of the cook before deboning process can be seen also in that the cost of meat of fryers produced in this manner is nearly identical to the costs for fowl deboned by partial cooking and only slightly higher than fowl prepared by raw deboning.

IV. RECOMMENDATIONS

A. Bacteriological Analysis

The following recommendation is made for bacteriological examination of freeze-dried poultry meat:

1. The diluent should be 0.1 per cent peptone solution.

2. The temperature of the diluent should be at, or close to, 20°C.

3. The plating medium should be either trypticase soy agar (with dextrose) or standard plate count agar.

4. The agar plates should be incubated at 20°C for five days, or if the long incubation time does not fit into an efficient quality control program, 30°C for three days may be used.

5. Samples should be prepared for analysis by first grinding the dry meat and then sub-sampling the ground material. Samples composed of large chunks of meat are not satisfactory until the particle size has been greatly reduced.

B. Deboning Technique

Based upon the results of this study, there is reason to recommend the procedure of fully cooking the meat prior to deboning. However, caution must be exercised; this recommendation can be made only with the expectation that knowledge of the need for first-rate sanitation is known by the processor and that such need is met. Although it would appear that a great reduction in bacterial numbers may occur during freeze-drying, such a factor should not be relied upon for safety.

C. Poultry Class

The use of fowl must be recommended for production of freeze-dried poultry meat based upon the higher yields and lower costs with this class. The fat content can be adjusted to meet the present interim specification of not more than 18 per cent; however, only slightly more fat than this is present in the dry meat prepared from fowl when little attention is given to removal of excess body fat from the carcasses prior to cooking and during deboning.

In view of the more economical production through the use of fowl, perhaps some attention should be given to the substitution of turkey meat for chicken. It could be anticipated that deboning costs would be even lower and yields better with turkeys than with fowl.

APPENDIX A

SOME AVERAGE COSTS FOR PROCESSING COOKED CHICKEN

Raw Cost

	Live Weight	Cost/lb	Amount
Fryers	677	$0.15	$101.55
Roasters	822.5	0.17	139.23
Fowl	777	0.16	124.32

Processing Cost

	Live Weight	Cost/lb	Amount
Fryers	677	0.05	33.85
Roasters	822.5	0.05	41.13
Fowl	777	0.05	38.85

Deboning and Cooking: Labor Costs

		Amount
Deboners	75.5 hr. at $1.28	96.64
	4.0 hr. at $1.92	7.68
Cookers	24.0 hr. at $1.43	34.32
Cook's helper and clean up	10.75 hr. at $1.33	14.30
Supervisory	19.0 hr. at $2.02	38.33
Fringe Benefits		33.48
Packaging Material		22.31
Icing and Refrigeration		21.68
Miscellaneous and Freight Charges		19.75

Poultry Class	Processing	Raw Deboned	Full Cooked, Deboned	Partially Cooked, Deboned
Fryers	Live weight cost	$34.40	$34.55	$33.95
	Evisceration costs	11.52	11.37	10.17
	Deboning and cooking costs	12.20	5.66	9.[illegible]5

Poultry Class	Processing	Raw Deboned	Full Cooked, Deboned	Partially Cooked, Deboned
	Drying at $0.10/lb water	$ 2.52	$ 3.09	$ 2.94
	Yield of dry meat (lb.)	11.37	14.42	14.14
Roasters	Live weight costs	45.89	45.69	50.08
	Evisceration costs	13.34	13.28	14.56
	Deboning and cooking costs	9.60	6.39	9.25
	Drying costs at $0.10/lb water	4.06	3.81	3.93
	Yield of dry meat (lb.)	14.01	19.30	19.52
Fowl	Live weight costs	39.67	40.62	43.37
	Evisceration costs	12.40	12.69	13.55
	Deboning and cooking costs	8.81	5.24	8.98
	Drying costs at $0.10/lb water	3.48	3.67	3.61
	Yield of dry meat (lb.)	17.17	19.05	18.64

AD 619280

U.S. ARMY NATICK LABORATORIES
NATICK, MASSACHUSETTS

IN REPLY REFER TO

To: Distribution List

ADDENDA SHEET

Technical Report FD-10

"Evaluation of freeze-dried chicken: Effects of cooking and deboning methods on costs and quality"

Midwest Research Institute (Contractor)

May 1965

Due to printing error, page 28 was not included in some copies of subject report.

Please insert enclosed page 28 in report, already forwarded.

TABLE XIII

REHYDRATABILITY OF FREEZE-DRIED POULTRY MEAT

Deboning Method and Class of Poultry	% Water Uptake of Freeze-Dried Meat: Based on Actual % Water in Cooked Meat	Based on Calculated Water at 65% in Cooked Meat
Group I (Raw, deboned)		
Fryers	88.9	94.2
Roasters	98.3	97.2
Fowl	86.1	92.4
Group II (Fully cooked, deboned)		
Fryers	87.3	101.[illegible]
Roasters	99.3	102.8
Fowl	79.1	89.[illegible]
Group III (Partially cooked, deboned)		
Fryers	97.2	99.[illegible]
Roasters	102.0	102.3
Fowl	89.0	93.9

Costs: The costs of production presented in this study are based upon the conditions prevailing in this study. Cooking costs are based only upon wages of the personnel doing the cooking. We could not estimate the energy costs. Freeze-drying costs were arbitrary and were calculated upon a figure of $0.10/lb of water removed. Consideration was not given to the reduction in total costs through the reclamation and sale of by-products. The total cost per pound of dried poultry meat was based upon the live weight costs of the poultry classes used, upon the processing costs, upon the labor costs for deboning and cooking and upon the fixed cost of freeze-drying. The cost of producing 1 lb. of freeze-dehydrated poultry based on the factors given above are presented in Table XIV.