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EFFECT OF FREEZE-DRYING CONDITIONS ON THE QUALITY OF RAW PORK

by

C.L. Brown, H.W. Shafer
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February 1972

UNITED STATES ARMY
NATICK LABORATORIES
Natick, Massachusetts 01760

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FOREWORD

Freeze-dried raw pork chops are purchased by the Armed Services for the B-ration and for special purposes. Complaints have been received from the field indicating the chops were considered tougher than they should be.

Freeze-dried meats are generally considered to be tougher than the equivalent fresh or frozen meats. More information is needed as to why this is so and how to overcome it. There have been some indications that freeze-drying parameters may significantly affect tenderness as well as other quality factors. This study is part of a series of studies aimed at improving the quality of freeze-dried meats.

The work was performed under project 1J662713 A034, Military Food Service and Subsistence Technology.

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TABLES

ABSTRACT

Raw pork chops were freeze-dried using platen temperatures of 100, 125, 150 and 175°F with radiant heat and dehydrator pressures of 0.5, 1.0, 1.5 and 2.0 mm of mercury. The dried products were canned under atmospheric pressure and stored at 40, 70 and 100°F with withdrawals at 2, 4, 8 and 16 weeks. Oxygen uptake, rehydration ratios and the differences between the penetrometer readings on the raw chop and the same chop after processing, storage and cooking were determined.

Analysis of variance indicated that the dehydrator pressure x platen temperature interaction and either the pressure or the temperature had statistically significant effects on the oxygen uptake, rehydration ratios and tenderness (penetrometer values). In general, these effects were small in comparison with those resulting from storage temperature and time. However, they must be considered in the overall quality of freeze-dried raw pork. Except for the rehydration ratio, the direction of the better quality was with lower dehydrator pressures and platen temperatures.

INTRODUCTION

Freeze-dried meat is, in general, tougher than the equivalent fresh or frozen meat cooked in the same way under the same conditions. Tuomy and Helmer (1967) showed that freeze-dried pork was significantly tougher than fresh frozen although there were wide variations between loins with somewhat more than one-third of the loins becoming more tender upon freeze-drying. This same report showed a statistically significant decrease in flavor due to freeze-drying. Processing conditions are known to have considerable effect on the final quality of freeze-dried meats. Cooking temperatures and times can make considerable differences in the final tenderness of pork (Tuomy & Lechnir, 1964) and the platen temperature used in drying can significantly affect tenderness, flavor and the onset of the browning reaction in freeze-dried pork (Tuomy and Felder, 1964). Drying chamber pressure has been shown to have a significant effect on the tenderness of beef (Tuomy et al, 1962).

There are other quality factors besides tenderness and flavor which must be considered in connection with freeze-dried pork even though they are related to some degree with tenderness. Storage stability is one of the most important military considerations, and as part of the stability, susceptibility to oxygen uptake. There have been some indications that freeze-drying conditions affect storage stability and oxygen uptake. Tuomy et al (1971) showed that platen temperature and dryer pressure affect the rehydration ratio and oxygen uptake of cooked spaghetti with meat sauce.

Freeze-dried raw pork chops are procured by the Armed Forces primarily for use in the B-ration. Complaints have been received from the field that some users think the product does not rehydrate as rapidly as it should and that it is tough. In order to shed light on this problem several studies are underway including one on methods and conditions of rehydration and cooking. This study has been concerned with the effect of drying conditions (dryer pressure and platen temperature) on quality aspects of freeze-dried pork chops.

EXPERIMENTAL METHODS

Fresh bone-in pork loins weighing from 12 to 14 lbs. were obtained from Midwestern sources. All loins were trimmed to remove excess fat. The excised longissimus dorsi muscle was shaped by stuffing into a $3\frac{1}{2}$ in-diameter artificial casing. The stuffed loin was frozen in a -30°F blast freezer and sawed into 3/8 in. thick pork chops. The chops were then cut into $2\frac{1}{2}$-in diameter circles with a drill press and cutter.

The raw frozen chops were equilibrated to 40°F and a portion of them penetrated according to the procedures of Hinnergardt and Tuomy (1960). The chops were wrapped in freezer paper then placed on 39 x 22 x 1 inch trays, 80 chops per tray, and frozen in a -30°F blast freezer for at least three hours. The pork chops were freeze-dried at the dryer platen temperatures of 100, 125, 150 and 175°F. for each drying pressure of 0.5, 1.0, 1.5, and 2.0 mm. Dehydration was to less than 2 percent moisture with radiant heat.

The dried pork chops were placed in 300 x 200 cans, 30 grams per can including one penetrated chop, and sealed under atmospheric pressure. The canned product was stored at 40, 70 and 100°F. Three cans from each storage temperature were withdrawn at 2, 4, 8, 12 and 16 weeks for evaluation. Identity of the penetrated chop in each can was maintained.

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 allowed to equilibrate overnight to room temperature.

Total headspace volume in the can was determined by compressing 30 grams of non-penetrated product in a laboratory press at 5000 lbs. per sq. inch for 10 seconds. The volume of the resulting bar was subtracted from the total volume of the can.

The freeze-dried pork chops were weighed, rehydrated with 80°F water for 20 minutes, drained, and equilibrated overnight to 40°F. The chops were then reweighed and cooked in an electric fry pan at 400°F, 1 minute per side, with 10 ml of corn oil per six chops. The fried pork chops were cooled to 40°F, weighed and penetrated.

RESULTS AND DISCUSSION

Tables 1 through 7 give the data obtained for oxygen uptake, penetrometer readings and rehydration ratio. Table 8 gives the analysis of variance results along with the components of variance expressed as percent of the total variance found in the study.

Table 1 shows the average oxygen uptakes in ml at each withdrawal. Table 8 indicates that very little of the oxygen uptake observed was due to anything but storage temperature and time in storage. Previous studies on similar products have shown these factors to have large effects on oxygen uptake. Dehydrator pressure was shown to have a significant effect as were some of the interactions containing dehydrator vacuum or pressure, but they actually comprised such a small part of the total variance observed that they are of minor importance. However, the direction of the lowest oxygen uptake was toward the lowest dehydrator pressure which is usually considered to produce the higher quality products.

Average penetrometer readings are shown in Tables 2, 3, and 4. Analysis of variance shown in Table 8 was calculated using the difference between the reading on the raw (unprocessed) chop and the same chops processed and cooked. This procedure was adopted in an attempt to rule out as much raw material difference as possible. The percent of variance for the remainder or error factor in Table 8 is rather high (44.1 percent) considering that previous work with the penetrometer has indicated that 10-20 percent would be more in line. It is postulated that variances in the cooking method may account for this. The dehydrator pressure and the pressure x temperature interaction factors account for 30.2 percent of the variance observed. The direction of pressure is toward a more tender product with the lower pressures. The direction of the pressure x temperature interaction is toward a more tender product with the lower pressures and temperatures. Both lower platen temperature and lower dehydrator pressure are usually considered to result in an overall better freeze-dried product. Table 8 also indicates that the storage temperature has a statistically significant effect on tenderness. The direction is toward a more tender product with the lower storage temperatures.

The rehydration ratio was calculated in two ways. The first, the customary way, is the rehydrated ratio in which the rehydrated weight is divided by the dry weight. The second is the cooked ratio in which the cooked weight is divided by the dehydrated weight. Tables 5, 6 and 7 give both ratios. Table 8 shows that there is considerable difference in the effects of the variables on these two figures. One of the most obvious is the remainder or error factor which, for the cooked ratio, shows a component of variance three times larger than that for the rehydrated ratio. This indicates that there are factors other than those under observation which play a big part in the final moisture content of the cooked product. Since the cooked ratio is of more practical interest than the rehydrated ratio it is suggested that cooking studies could reveal variances of more importance than those found in this study.

The freeze-drying variables (vacuum and platen temperature) both have statistically significant effects on the rehydrated ratio. Further analysis showed that the lowest vacuum and the highest platen temperature give the best rehydration. The storage temperature also had a significant effect and in this case the lower temperatures gave the highest rehydration. Tuomy and Felder (1964) showed that the platen temperature should be kept as low as possible to optimize flavor which would rule out raising the temperature for the small (even though statistically significant) increase in rehydration brought about by higher platen temperatures.

When the cooked rehydration ratios are reviewed it is evident that even though there were some statistically significant differences caused by the experimental variables, the changes were so small that their practical effects on the product as eaten could be ignored until such time as more information is obtained on what is causing the larger differences not accounted for in this study.

In general, this study has shown that the dehydrator variables (pressure and platen temperature) have statistically significant effects on the variables studies. Generally, these effects are small in comparison to the effects caused by storage temperature and time, but nevertheless must be considered in the overall quality picture of freeze-dried raw pork. It is indicated that lower platen temperatures and pressures would result in a better product. It is also indicated that additional studies on factors such as cooking methods are needed.

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Table 1. Average oxygen uptake in ml. at each withdrawal of 30 grams product stored at 40, 70, and 100°F.

Platen Temp.. °F	Dehy Pressure in HG	Storage Time - Weeks 2			4			8			12			16		
		Storage Temperature - 0° 40	70	100	40	70	100	40	70	100	40	70	100	40	70	100
100	0.5	1.4	1.7	3.5	1.7	2.6	7.4	2.6	4.5	12.8	4.4	5.1	15.7	4.1	7.3	22.1
	1.0	0.6	1.9	5.7	1.5	3.1	8.9	2.2	4.8	14.8	2.5	5.9	18.3	3.7	6.8	20.0
	1.5	1.5	2.1	6.2	1.0	2.9	9.7	2.2	4.7	14.0	2.3	5.7	18.1	3.1	8.9	22.4
	2.0	0.7	1.7	5.5	1.8	3.1	9.4	1.6	5.3	15.4	2.4	5.8	17.6	5.4	8.5	20.8
125	0.5	1.2	1.8	4.6	1.5	2.6	8.1	4.3	5.4	11.5	2.3	5.5	14.7	3.1	5.4	20.0
	1.0	1.2	2.2	5.1	1.8	3.2	8.8	3.7	5.5	13.1	5.7	8.4	20.9	3.2	7.0	19.8
	1.5	0.6	2.2	4.9	1.2	3.0	8.3	2.9	5.1	14.9	2.9	5.5	16.7	4.4	7.7	20.7
	2.0	1.6	2.7	5.8	2.4	3.0	9.5	1.9	4.4	13.0	4.0	6.6	18.2	3.2	6.5	19.2
150	0.5	2.5	4.4	9.1	2.0	4.1	8.2	2.8	5.1	13.6	6.5	10.6	26.4	4.4	10.6	20.4
	1.0	1.8	2.9	6.6	1.9	4.7	10.3	2.4	5.1	14.3	5.0	8.4	17.9	4.2	8.5	22.7
	1.5	1.2	2.7	6.4	2.8	4.4	10.3	4.2	5.8	16.0	3.9	7.3	18.0	4.3	7.9	22.8
	2.0	2.4	3.2	6.9	2.9	4.0	9.9	3.1	5.5	14.3	3.4	6.5	16.1	4.6	7.8	21.9
175	0.5	2.5	4.2	9.8	2.5	4.2	9.8	4.0	6.0	14.9	5.6	7.6	16.3	6.4	9.1	20.9
	1.0	1.7	3.7	8.9	3.6	6.1	12.6	3.7	7.4	11.2	4.5	10.0	21.7	8.3	12.8	30.4
	1.5	1.6	3.5	8.8	2.6	4.8	12.1	3.4	7.3	18.2	7.2	9.3	22.1	5.1	8.7	25.1
	2.0	2.7	4.3	9.3	3.4	5.7	5.3	3.8	7.1	16.9	6.4	9.9	19.9	7.6	12.9	30.3

Table 2. Average penetrometer readings at each withdrawal of products stored at 40°F. 1/

PLATEN TEMP °F	DEHY. PRESSURE MN HG	STORAGE TIME - WEEKS: INITIAL RAW	INITIAL COOKED	2 RAW	2 COOKED	4 RAW	4 COOKED	8 RAW	8 COOKED	12 RAW	12 COOKED	16 RAW	16 COOKED
100	0.5	21.55	59.83	21.39	38.44	24.44	36.50	27.61	32.21	22.89	33.97	22.83	42.00
	1.0	30.11	42.22	36.44	43.17	28.00	35.28	24.83	32.72	28.44	37.29	24.00	36.33
	1.5	24.05	57.06	24.17	42.50	26.12	37.89	27.73	40.78	31.67	42.28	34.79	43.39
	2.0	31.06	42.56	30.39	34.11	29.44	42.39	29.22	39.73	29.61	49.56	30.00	40.57
125	0.5	30.17	46.61	29.11	42.78	27.33	50.89	37.17	44.11	25.39	35.83	25.89	35.77
	1.0	31.50	48.06	23.33	41.53	26.30	46.70	23.67	37.83	20.03	34.37	32.53	55.60
	1.5	26.00	36.89	21.00	31.28	28.17	34.11	25.72	38.61	25.94	42.63	22.17	35.93
	2.0	37.94	45.39	24.06	47.62	28.89	58.11	21.72	51.06	37.94	51.78	22.72	46.44
150	0.5	25.28	44.44	25.72	40.84	27.72	40.33	20.17	54.39	25.33	59.23	24.67	40.18
	1.0	19.67	26.12	14.06	24.39	17.50	27.00	20.11	32.33	20.83	33.50	24.28	29.07
	2.5	41.83	50.63	28.78	42.33	29.67	40.61	31.61	45.22	23.17	53.33	31.89	72.47
	2.0	22.56	76.11	23.67	44.83	39.39	50.61	28.50	52.67	33.61	48.06	22.72	34.27
	0.5	24.17	40.11	24.72	44.50	22.44	40.28	20.89	37.72	23.39	39.33	25.06	29.67
	1.0	21.33	29.72	24.39	41.17	24.50	36.27	23.83	39.50	24.50	39.00	23.22	36.73
	1.5	26.84	40.94	24.83	35.67	25.22	36.72	23.72	40.39	21.67	45.89	21.76	32.50
	2.0	17.83	36.06	20.28	45.55	18.67	33.00	21.61	47.00	26.00	51.29	27.47	40.27

1/ Values for raw chops were obtained before any processing and those for the cooked chops were on the same chops after dehydration, rehydration and cooking.

Table 3. Average penetrometer readings in pounds at each withdrawal of products stored at 70°F. 1/

Platen Temp. °F.	Dehy Pressure MM Hg	STORAGE TIME - WEEKS: INITIAL Raw	INITIAL Cooked	2 Raw	2 Cooked	4 Raw	4 Cooked	8 Raw	8 Cooked	12 Raw	12 Cooked	16 Raw	16 Cooked
100	0.5	21.55	59.83	21.83	40.94	21.64	40.28	17.89	33.20	25.89	50.50	20.94	32.33
	1.0	30.11	42.22	27.61	22.06	30.06	41.89	26.17	45.00	27.44	31.28	21.50	27.83
	1.5	24.05	57.06	28.56	39.28	39.78	38.67	36.89	46.06	29.67	46.72	37.50	45.94
	2.0	31.06	42.56	26.00	32.78	35.67	42.44	31.50	40.06	27.44	38.11	30.72	43.83
125	0.5	30.17	46.61	25.28	42.00	20.00	43.78	30.67	39.22	26.33	42.50	28.22	47.53
	1.0	31.50	48.06	21.53	46.44	32.60	50.23	20.73	34.13	31.53	39.83	27.17	34.80
	1.5	26.00	36.89	29.78	41.94	26.83	39.44	33.33	45.83	22.67	39.39	29.89	38.23
	2.0	37.94	45.39	24.06	47.62	28.89	58.11	21.72	51.06	37.94	51.78	22.72	46.44
150	0.5	25.28	44.44	31.06	46.56	37.00	46.56	30.56	45.67	25.06	44.23	34.56	49.83
	1.0	19.67	26.12	25.56	34.72	19.78	31.17	25.83	39.67	27.44	50.22	26.94	39.50
	1.5	41.83	50.63	36.39	43.72	18.67	40.28	15.72	39.94	18.67	39.67	26.56	56.10
	2.0	22.56	76.11	27.78	57.06	33.06	69.22	38.44	54.39	27.22	44.28	31.56	67.20
175	0.5	24.17	40.11	29.28	46.06	25.39	41.00	29.06	41.17	25.17	37.67	28.28	44.10
	1.0	21.33	29.72	29.50	44.17	26.78	35.94	22.44	34.89	23.94	40.06	22.33	34.67
	1.5	26.84	40.94	25.83	44.67	23.22	38.89	28.50	44.44	24.94	43.50	26.56	37.50
	2.0	17.83	36.06	28.06	39.00	20.44	40.39	29.00	50.39	31.50	53.94	30.11	44.90

1/ Values for raw chops were obtained before any processing and those for the cooked chops were on the same chops after dehydration, rehydration and cooking.

Table 4. Average penetrometer readings at each withdrawal of products stored at 100°F. 1/

Platen Temp. °F.	Dehy Pressure MM Hg.	INITIAL		2		4		8		12		16	
		Raw	Cooked	Raw	Cooked	Raw	Cooked	Raw	Cooked	Raw	Cooked	Raw	Cooked
100	0.5	21.55	59.83	21.60	64.22	21.06	36.72	20.72	36.20	33.56	58.17	25.78	38.53
	1.0	30.11	42.22	26.72	39.44	24.17	46.00	28.11	51.94	26.78	46.06	23.44	44.17
	1.5	20.05	57.06	36.61	45.17	26.94	39.83	49.11	55.72	34.50	78.00	33.17	63.22
	2.0	31.06	42.56	23.61	42.33	27.33	57.39	27.61	56.11	33.56	79.06	35.83	45.27
125	0.5	30.17	46.61	24.89	35.94	17.17	42.22	29.67	41.00	19.56	40.72	23.83	51.37
	1.0	31.50	48.06	28.27	50.43	25.17	54.07	31.77	49.83	25.57	40.57	27.50	42.93
	1.5	26.00	36.89	26.78	38.17	26.11	41.67	29.94	48.89	23.78	46.94	28.44	43.60
	2.0	37.94	45.39	21.39	57.83	24.61	44.62	28.72	60.67	23.78	37.72	21.61	60.78
150	0.5	25.28	44.44	26.17	40.72	29.94	55.39	27.00	49.28	37.67	45.88	30.64	57.03
	1.0	19.67	26.12	27.72	44.44	22.44	39.61	24.11	40.11	27.83	48.89	27.61	46.23
	1.5	41.83	50.63	21.94	36.06	20.33	35.28	33.17	40.50	21.50	26.33	18.78	23.27
	2.0	22.56	76.11	30.37	49.44	22.78	45.09	25.06	65.44	33.17	77.34	24.67	65.40
175	0.5	24.17	40.11	27.50	49.22	31.50	42.11	31.78	46.00	29.28	47.78	27.33	32.83
	1.0	21.33	29.72	25.57	41.78	31.28	48.06	21.78	37.06	27.68	52.83	23.78	53.67
	1.5	26.84	40.94	24.00	42.50	23.39	41.83	28.83	47.06	25.56	47.56	36.44	55.89
	2.0	17.83	36.06	28.28	55.33	29.61	67.22	22.67	45.67	27.39	47.56	19.28	57.03

1/ Values for raw chops were obtained before any processing and those for the cooked chops were on the same chops after dehydration, rehydration and cooking.

Table 5. Rehydration ratios at each withdrawal of product stored at 40°F. Ratios are rehydrated weight or cooked weight divided by dry weight.

Platen Temp °F.	Dehy Pressure MM H_6	Storage Time - Weeks									
		2		4		8		12		16	
		Rehy	Cooked	Rehy	Cooked	Rehy	Cooked	Rehy	Cooked	Rehy	Cooked
100	0.5	3.1	2.2	3.5	2.4	3.3	2.3	3.3	2.3	3.3	2.2
	1.0	3.2	2.5	3.2	2.5	2.9	2.3	3.5	2.6	3.3	2.4
	1.5	2.7	2.2	2.9	2.3	3.0	2.2	3.1	2.3	3.3	2.3
	2.0	3.2	2.4	2.8	2.4	3.3	2.1	2.7	2.2	3.0	2.3
125	0.5	3.4	2.4	2.9	2.1	3.3	2.4	3.0	2.3	3.2	2.3
	1.0	3.1	2.2	3.0	2.0	3.3	2.5	3.1	2.2	3.2	2.3
	1.5	3.0	2.3	2.9	2.3	2.9	2.1	3.2	2.1	3.3	2.2
	2.0	3.1	2.4	2.8	2.4	3.3	2.2	3.1	2.3	3.4	2.3
150	0.5	3.0	2.4	3.2	2.4	3.1	2.1	3.7	1.9	3.3	2.2
	1.0	3.0	2.3	3.2	2.2	2.7	2.0	3.3	2.4	3.0	2.2
	1.5	3.1	2.3	3.3	2.4	2.9	2.2	3.0	2.1	3.1	2.3
	2.0	3.2	2.2	2.9	2.3	2.8	2.2	3.6	2.5	3.1	2.3
175	0.5	3.5	2.1	3.2	2.2	3.3	2.3	3.2	2.2	3.3	2.1
	1.0	3.3	2.3	3.0	2.2	3.4	2.0	3.6	2.3	3.1	2.0
	1.5	3.0	2.4	3.4	2.1	3.3	2.2	3.5	2.5	3.5	2.3
	2.0	3.2	2.5	2.6	1.9	3.3	2.0	3.2	2.3	3.3	2.0

Table 6. Rehydration ratios at each withdrawal of product stored at 70°F. Ratios are rehydrated weight or cooked weight divided by dehydrated weight.

Platen Temp °F	Dehy Pressure MM HG	Storage Time - Weeks									
		2		4		8		12		16	
		Rehy	Cooked	Rehy	Cooked	Rehy	Cooked	Rehy	Cooked	Rehy	Cooked
100	0.5	3.2	2.3	3.1	2.3	3.1	2.3	3.1	2.3	3.2	2.4
	1.0	3.3	2.6	3.3	2.5	3.0	2.2	3.5	2.5	3.3	2.5
	1.5	3.0	2.1	3.2	2.4	2.8	2.1	2.5	1.9	3.4	2.3
	2.0	2.9	2.3	2.6	2.3	3.4	2.4	2.6	2.0	3.1	2.3
125	0.5	2.8	2.3	2.8	2.2	3.1	2.3	2.9	2.3	2.9	2.3
	1.0	2.8	2.3	3.2	2.2	3.2	2.5	3.0	2.3	3.1	2.3
	1.5	3.0	2.4	3.1	2.4	3.2	2.2	3.0	2.1	2.9	2.0
	2.0	2.9	2.5	2.6	2.2	3.1	2.2	2.1	2.4	3.1	2.4
150	0.5	3.2	2.5	3.1	2.3	3.2	2.4	3.4	2.0	3.2	2.3
	1.0	3.1	2.3	3.2	2.2	3.0	2.2	3.3	2.3	2.9	2.2
	1.5	3.4	2.5	3.0	2.5	2.7	2.2	3.5	2.2	3.2	2.4
	2.0	3.2	2.6	2.4	2.1	3.3	2.2	3.7	2.4	3.2	2.3
175	0.5	3.4	2.2	3.5	2.4	3.8	2.6	3.5	2.3	3.3	2.1
	1.0	3.2	2.3	3.2	2.2	2.9	2.0	3.5	2.3	3.2	2.2
	1.5	3.4	2.1	3.4	2.4	3.1	2.1	3.5	2.3	3.3	2.2
	2.0	3.0	2.2	3.2	2.4	3.5	2.4	3.4	2.1	3.7	2.3

Table 7. Rehydration ratios at each withdrawal of product stored at 100°F. Ratios are rehydrated weight or cooked weight divided by dehydrated weight.

Platen Temp °F.	Dehy Pressure MM HG.	Storage Time - Weeks									
		2		4		8		12		16	
		Rehy	Cooked	Rehy	Cooked	Rehy	Cooked	Rehy	Cooked	Rehy	Cooked
100	0.5	2.9	2.2	3.4	2.3	3.1	2.2	3.1	2.2	3.0	2.2
	1.0	2.8	2.4	2.6	2.2	2.4	2.0	2.7	2.1	2.6	2.1
	1.5	2.9	2.2	2.8	2.3	2.9	2.1	2.4	2.0	2.8	2.1
	2.0	3.0	2.4	2.2	2.0	3.8	2.3	3.0	1.7	2.7	2.1
125	0.5	3.2	2.4	2.9	2.0	3.2	2.2	2.8	2.1	3.0	2.2
	1.0	3.0	2.3	3.1	2.2	3.5	2.5	3.2	2.3	3.2	2.3
	1.5	3.0	2.3	3.0	2.4	2.9	2.1	2.8	2.0	2.8	2.1
	2.0	2.5	2.2	2.8	2.1	2.8	1.9	2.7	2.1	2.7	2.2
150	0.5	3.2	2.5	3.4	2.3	3.8	2.7	2.9	2.7	3.3	2.6
	1.0	3.0	2.3	3.0	2.2	3.0	2.3	3.2	2.5	2.9	2.2
	1.5	3.6	2.5	3.5	2.4	3.2	2.4	2.7	2.3	3.3	2.4
	2.0	3.2	2.5	3.2	2.4	3.0	2.1	3.1	2.5	3.1	2.4
175	0.5	3.5	2.3	3.5	2.4	3.3	2.5	3.4	2.4	3.4	2.4
	1.0	3.1	2.1	3.1	2.1	3.0	1.9	2.5	2.0	2.4	2.0
	1.5	3.4	2.3	3.3	2.4	2.9	2.0	3.5	2.2	2.7	2.1
	2.0	3.4	2.4	2.7	2.1	3.5	2.3	3.0	2.1	3.2	2.2

Table 8. Analysis of variance results showing the significance and percent of variance.

Factor	O_2 Uptake		Tenderness 1/		Rehydration ratio 2/		Cooked ratio 3/	
	Signif	% of Var	Signif	% of Var	Signif	% of Var	Signif	% of Var
A (pressure)	n.s.	-	xx	15.8	xx	11.3	n.s.	-
B (Platen temp)	xx	2.1	n.s.	-	xx	28.4	xx	2.1
C (Storage time)	xx	20.0	n.s.	-	n.s.	-	xx	2.3
D (Storage temp)	xx	57.7	xx	14.4	xx	8.7	n.s.	
AB	xx	0.4	xx	10.3	n.s.	-	xx	4.4
AC	xx	0.3	n.s.	-	x	14.5	xx	4.0
AD	n.s.	-	x	2.9	n.s.	-	x	2.0
BC	xx	0.8	x	6.6	n.s.	-	n.s.	-
BD	n.s.	-	xx	5.9	x	13.7	xx	6.6
CD	xx	13.2	n.s.	-	n.s.	-	n.s.	-
Remainder	-	5.5	-	44.1	-	23.4	-	78.6

n.s. not significant
x significant at the 5 percent level
xx significant at the 1 percent level

1/ As measured by the difference between the chops penetrated raw and the same chops penetrated after processing, storage and cooking.

2/ Obtained by dividing the weight of the rehydrated chops by the dry weight.

3/ Obtained by dividing the weight of the rehydrated and cooked chops by the dry weight.

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13. ABSTRACT

Raw pork chops were freeze-dried using platen temperatures of 100, 125, 150 and 175°F with radiant heat and dehydrator pressures of 0.5, 1.0, 1.5 and 2.0 inches of mercury. The dried products were canned under atmospheric pressure and stored at 40, 70, and 100°F with withdrawals at 2, 4. 8 and 16 weeks. Oxygen uptake, rehydration ratios and the differences between the penetrometer readings on the raw chop and the same chop after processing, storage and cooking were determined.

Analysis of variance indicated that the dehydrator pressure X platen temperature interaction and either the pressure or the temperature had statistically significant effects on the oxygen uptake, rehydration ratios and tenderness (penetrometer values). In general, these effects were small in comparison with those resulting from storage temperature and time. However, they must be considered in the overall quality of freeze-dried raw pork. Except for the rehydration ratio, the direction of the better quality was with lower dehydrator pressures and platen temperatures.

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