

# The Effects of Iodized Salt in Processed Fruits and Vegetables\*

NAKAJI KOJIMA AND H. D. BROWN  
The Ohio State University, Columbus, Ohio

(Manuscript received June 28, 1954)

6362

Endemic goiter is prevalent in many parts of the world (1) in spite of the fact that Boussingault (1824) and Charin (1850) concluded that a deficiency of environmental iodine was definitely associated with the occurrence of goiter (2) and the further fact that endemic goiter is considered to be the easiest known disease to prevent (4, 5, 6, 7, 8). Even in the United States, where considerable publicity has been given to the use of iodized salt for the prevention of the disease, the incidence of simple goiter may be as high as 1.4% among children in the goiter belt (3). Failure to utilize iodized salt is probably a factor in this situation; a survey by means of telephone calls and personal visits revealed, for example, that only 50% of the salt sold in Columbus, Ohio, is iodized salt. Since the general use of iodized salt in widely used processed foods would appear to be an additional safeguard against endemic goiter, a study of its effects on processed foods warrants further investigation.

This paper presents the results of tests designed to evaluate the effects of added iodine on the quality including the palatability of some processed vegetables and fruit. Iodates  $KIO_3$  (the Department of Health, Education, and Welfare does not permit the use of  $KIO_3$  in salt) were included to learn whether or not this supposedly more stable form of iodine could be used in place of the usual KI. Cuprous iodide was also tested in a limited way to see if this relatively insoluble form (a type desired for use with livestock) had any deleterious effect on Vitamin C.

## EXPERIMENTAL PROCEDURE

**Tomato juice. Preparation of Solutions:** Eleven stock solutions, each containing 259.2 g. (amount which supplies salt at rate of 60 grains per No. 2 can of tomato juice) of NaCl and, in addition, the chemicals noted below were prepared and made up to one liter with distilled water the night prior to use. All chemicals were of c.p. quality. To secure iodine equal to that in commercial iodized salt 0.026 g. of KI and 0.034 g. of  $KIO_3$  were used in each liter. Concentrations of 0.26 g. of KI were also used. Sodium nitrate or  $NaNO_3$  at the rate of 3.866 g. per liter to give a concentration of 0.01% in the tomato juice.

**Processing techniques.** Tomatoes of the Rutgers variety were washed, trimmed, cored, and extracted twice in a Langsenkamp laboratory model extractor. The second extractions were combined. The mixture was then pumped through a Walker Wallace heat exchanger where it was held for  $2\frac{1}{2}$  minutes at  $240^\circ F$ . The flash sterilized tomato juice flowed directly into No. 2 fruit enamel cans which had previously received 15 ml. of one of the prepared chemical solutions. The uniformly filled cans were then sealed in an atmosphere of steam to insure a higher vacuum. The canned juices were kept at room temperature for about 3 months before the products were evaluated.

\* A contribution of the Department of Horticulture and the Institute of Nutrition and Food Technology of The Ohio State University. Financed by contributions from the Chilean Iodine Educational Bureau, Inc. and Kelym Smith.

**Cabbage. Fermentation.** The Bugner variety was harvested early in October and wilted for a few days at room temperature. The outer leaves and core were removed by hand, and the leaves were shredded by a laboratory model kraut cutter. Fifteen pounds of the shredded cabbage were weighed and packed very tightly into glazed crocks. In packing, sufficient salt was added to give a concentration of 2.5%. At the same time, 15 ml. of distilled water were added to the controls. For the iodized and iodated salt batches, 0.0205 g. of KI and 0.0265 g. of  $KIO_3$  were added in solution. This is an amount equivalent to that secured by using iodized salt containing 0.012% KI.

During the fermentation, the acidity was checked every 3 days. All lots were allowed to ferment for thirty-one days at room temperature. At the end of the fermentation, samples (10 ounces per sample) of each lot of kraut were packed in polyethylene bags. These samples were stored at  $35^\circ F$ . for 2 days before being evaluated by the panel. The rest of the kraut was canned.

**Canning.** After weights were removed from the kraut, the discolored upper layer of kraut was thrown away. The remaining kraut was transferred to a cheesecloth, and the juice extracted by a slight pressure.

The acidity of the juice was determined and adjusted to one percent by the addition of a calculated amount of distilled water. Salt concentration was determined on the adjusted juice chemically and by salometer readings. The salt concentrations were found to be the same, and therefore, no adjustment was made. The adjusted juice was brought to boiling.

The kraut was steamed at  $214^\circ F$ . for 5 minutes, weighed and packed into plain tin cans. Kraut juice at  $210^\circ F$ . was used to cover the kraut in the cans.

The canned lots were exhausted for 5 minutes in steam, sealed and processed at  $214^\circ F$ . for 15 minutes. The processed kraut was cooled immediately in running water. After being cooled down to room temperature, the lots were stored at room temperature for about 2 months before the evaluations.

**Green beans.** The freshly harvested Hyscore green beans were washed in a spray rotary washer, inspected on a moving belt for defects, and graded into sizes No. 5 and No. 6 ( $\frac{3}{16}$  in. or more in thickness). They were then cut into pieces  $1\frac{1}{2}$  to 2 inches in length.

The cut beans were blanched at  $212^\circ F$ . in steam for 5 minutes, cooled immediately in running water, drained, and 0.66 lbs. weighed into No. 2 cans, with 30 grains (1.944 g.) of either plain or iodized salt\* added. Boiling distilled water was added to the packed cans to fill but not to overflowing. They were exhausted for four minutes in steam. Upon emerging from the exhaust box, the cans were sealed and processed at  $240^\circ F$ . for 20 minutes. After processing, they were immediately cooled by circulating cold water and stored at room temperature for about three months.

**Yellow sweet corn.** The Golden Cross Bantam ears were harvested and brought into the processing laboratory immediately; they were husked by a FMC (Food Machinery Co.) husker. The defects were removed, and whole kernels were cut by a FMC No. 2 Universal corn cutter. The kernels were washed by a high pressure spray rotary washer and blanched in steam for three minutes. After being cooled in cold water 13.5 oz. of kernels were packed in No. 2 C-enamel cans with 30 grains of either plain salt or iodized salt. A boiling sugar solution, which contained 3.5 pounds of sugar in 10 gals. of water, was then added.

\* The iodized salt used (Morton's) contains a maximum of 112 p.p.m. of KI.



The corn was exhausted for 3 minutes, sealed by a closing machine in a head of steam, processed at 250° F. for 30 minutes, and cooled immediately in running water; it was stored at room temperature for about 3 months.

Pickled olives. The pitted pickled olives from Spain were stuffed with pieces of red pimientos. The olives were washed and packed at the Kroger Company's plant, Cincinnati, Ohio, in a brine solution in glass jars. The following formula was used:

Salt.....	350 pounds
Lactic acid (50%).....	67.5 pounds
Water to make.....	570 gals.

For the iodized salt brine 0.0335 g. of KI was dissolved in a gallon of the above brine, to give 0.02% of KI. For iodated salt brine, 0.0502 g. of KIO<sub>3</sub> (equivalent amount of 0.0335 g. of KI cited above) was dissolved in a gallon of the brine.

The pickled olives were packed in the above three kinds of brines in glass bottles and sealed while the head space was steam filled. The bottled olives were stored at room temperature for about 2 months.

Flavor evaluation. *Numerical Scoring.*\* The flavors of canned tomato juices and bulk and canned kraut were scored from one to 10 (10 being the best) by the experienced panel. A control sample was known to the judges, and they were told to check the other samples against it. An identical unknown sample was also included to check the judges. The judging on a group of samples was repeated at different intervals.

*Triangle Test.*† Triangle tests were also conducted to see whether there is any detectable differences between the controls and iodized or iodated salt-treated samples.

*Dilution Tests.* Six samples of tomato juice containing increasing amounts of iodine were served. Judges were asked to check the first sample in the series in which they detected an off-flavor.

Color determination. Panel grading of color was used only in the case of bulk kraut, where the subjective numerical scoring by the judges was used to evaluate color differences between the treatments.

*The Hunter Color Difference Meter.* Differences in color of the tomato juices and the canned sauerkraut were measured by the Hunter instrument. A small aperture with a small area illumination with "L" scale was used for the tomato juice. A large aperture and large area illumination with "Rd" scale was used for evaluating the color of sauerkraut.

*Subjective Texture and Color Evaluations.* The flavor and odor evaluations of the canned tomato juices and sauerkraut were scored numerically from one to 10. Texture was also evaluated numerically in the same way on the same score card for sauerkraut.

*Ascorbic acid determination.* Ascorbic acid contents of the tomato juices and the fresh and canned green beans were determined by the indophenol titration method of the A. O. A. C. with the following modifications: One percent oxalic acid was used in place of one percent metaphosphoric acid. Homogenization was eliminated in the case of tomato juice, and instead the weighed juices were transferred into 200-ml. volumetric flasks with the oxalic acid, mixed well, made up to volume, mixed again, and filtered.

## RESULTS AND DISCUSSION

*Flavor evaluation. Canned Tomato Juice.* The average scores of treated tomato juice are shown in Table 1.

Table 2 shows the results of analysis of variance.

As seen from Table 2, the judges could not find a significant difference in the flavor of the canned tomato juices due to the addition of iodized or iodated salt. Even ten times as much KI or I<sub>2</sub> failed to produce any distinguishable off-flavor.

In both numerical scoring and triangle tests, the containers used for tomato juices were 10 ml. clean glass beakers; for other samples, shallow white china dishes of about 5 inches in diameter were used.

TABLE 1

Average scores of 16 judgments of flavor of canned tomato juices

Chemicals added	Average score
Control.....	8.3
KI.....	7.4
KI <sub>2</sub> .....	8.0
KI and NaNO <sub>2</sub> .....	7.6
KI and NaNO <sub>3</sub> .....	7.7
KIO <sub>3</sub> and NaNO <sub>2</sub> .....	7.1
KIO <sub>3</sub> and NaNO <sub>3</sub> .....	7.7
KI × 10 and NaNO <sub>2</sub> .....	7.8
KI × 10 and NaNO <sub>3</sub> .....	7.4
I <sub>2</sub> .....	7.6
I <sub>2</sub> × 10.....	7.0

TABLE 2

Analysis of variance of flavor evaluation of canned tomato juice

Source	DF	SS	MS	F	F (0.05)	F (0.01)
Treatments.....	11	20.552	1.87	1.53	1.84	2.36
Judges.....	15	292.365	19.49	15.97**	1.73	2.16
Error.....	165	201.198	1.22			

\*\* Highly significant difference.

The effect of iodized salt in the presence of considerable amounts of nitrite or nitrate on tomato juice flavor seems to be negligible.

Color evaluation. The "a" and "b" readings on the Hunter Color Difference Meter were repeated 3 times. The resulting "a/b" ratios were combined and the average values are shown in Table 3.

TABLE 3

The "a/b ratios" of tomato juice (three replicates)

Treatment	Replicates			Average
	1	2	3	
Control.....	1.65	1.78	1.71	1.71
KI.....	1.63	1.78	1.72	1.71
KIO <sub>3</sub> .....	1.63	1.74	1.76	1.71
KI and NaNO <sub>2</sub> .....	1.71	1.87	1.81	1.76**
KI and NaNO <sub>3</sub> .....	1.56	1.78	1.74	1.69
KIO <sub>3</sub> and NaNO <sub>2</sub> .....	1.69	1.78	1.74	1.73
KIO <sub>3</sub> and NaNO <sub>3</sub> .....	1.63	1.78	1.74	1.71
KI × 10 and NaNO <sub>2</sub> .....	1.66	1.78	1.76	1.73
KI × 10 and NaNO <sub>3</sub> .....	1.55	1.78	1.76	1.69
I <sub>2</sub> .....	1.66	1.81	1.81	1.76
I <sub>2</sub> × 10.....	1.68	1.81	1.81	1.76

\*\* Significantly different from the control at 5% level (L.S.D. 5% = 0.97; 1% = 0.096).

Though there was a highly significant difference in "a/b" ratio between the treatment receiving (KI + NaNO<sub>2</sub>) and the control, it is important to note that the average score of the treated lots is higher than that of the control.

Iodized salt thus did not adversely affect the color of tomato juice.

Odor. Odor of the canned tomato juices was evaluated subjectively from 1 to 10.

Table 4 shows the average scores of the seven judges. It shows that the judges could not detect any significant difference in odor between the treatments.

Ascorbic acid. Ascorbic acid determinations on the 11 treatments were also repeated 3 times.

Table 5 shows the average values of the 3 determinations of ascorbic acid for the 11 lots of canned tomato juice.

From Table 5 it can be seen that 3 nitrite treatments had but half the reduced ascorbic acid content of other treatments including the controls.



**Tests with Cuprous Iodide.** Relatively insoluble cuprous iodide was added to 2 samples of tomato juice at the rate of 0.01%. One lot was agitated for 5 minutes with a Waring blender and the other by pouring the juice 40 times from one tin can to another. The check and CuI treated lots agitated by pouring, both contained

TABLE 4

The average scores of seven judges evaluating odor of the eleven treatments of canned tomato juices

Treatment	Average score of judges
Known control	8.50
Unknown control	8.50
KI	8.50
KIO <sub>2</sub>	8.63
KI and NaNO <sub>2</sub>	8.63
KI and NaNO <sub>3</sub>	8.50
KIO <sub>2</sub> and NaNO <sub>2</sub>	8.50
KIO <sub>2</sub> and NaNO <sub>3</sub>	8.63
KI × 10 and NaNO <sub>2</sub>	8.50
KI × 10 and NaNO <sub>3</sub>	8.63
I <sub>2</sub>	8.50
I <sub>2</sub> × 10	8.63

TABLE 5

The average values of three ascorbic acid determinations of the canned tomato juices

Treatment	Average amount of reduced ascorbic acid (mg./100 grams)
Control	23.50
KI	24.00
KIO <sub>2</sub>	23.40
KI and NaNO <sub>2</sub>	23.33
KI and NaNO <sub>3</sub>	10.44**
KIO <sub>2</sub> and NaNO <sub>2</sub>	23.93
KIO <sub>2</sub> and NaNO <sub>3</sub>	9.73**
KI × 10 and NaNO <sub>2</sub>	23.46
KI × 10 and NaNO <sub>3</sub>	10.63**
I <sub>2</sub>	23.46
I <sub>2</sub> × 10	24.00

\*\* Highly significant differences (L. S. D. 5% = 5.35; 1% = 7.27).

21.5 mg. ascorbic acid per 100 g. and the check agitated by the Waring blender contained 18.4 and the CuI treated lot 18.0 mg. ascorbic acid per 100 g.

**Triangle test.** Canned tomato juice containing a commercial salt and another containing a commercial iodized salt were subjected to a triangle test to see whether the judges could distinguish between iodized and non-iodized tomato juices.

On two occasions the 8 judges were given 3 samples of tomato juices, 2 of which were identical. They were asked to identify the identical two, and the number of correct answers were interpreted statistically to see if there were any significant difference between the 2 treatments. The table prepared by Rosseler *et al.* (10) was used to analyze the data.

The 2 judgments were combined, and the results in Table 6 show clearly that the judges could not detect any difference between iodized and non-iodized salt-

TABLE 6

Analysis of the results of triangle taste tests on iodized and non-iodized canned tomato juices

No. of tastings	No. of correct answers	No. of correct answers necessary to establish significant difference	
		P.05	P.01
2		10	11

treated tomato juices. If there were difference in any of the qualities which can be detected subjectively, i.e., flavor, odor, and color, they should have been detected by the panel.

To get an idea how much iodine must be present to impart a detectable off-flavor to the tomato juices, a concentration test was conducted on the canned tomato juice to which increased amounts of iodine were added.

Eight judges participated in the test, and the results are shown in Table 7.

TABLE 7

The results of concentration tests on different concentrations of iodine in canned tomato juices

Concentration of I <sub>2</sub> in canned tomato juice (p.p.m.)	No. of tasters who detected an off-flavor
0.000	0
0.625	0
2.500	0
6.250	0
12.500	1*
25.000	2

\* The judge stated that he tasted this as slightly different from the preceding concentrations but would not call it off-flavor.

The iodine concentration of canned tomato juice, in which iodized salt is used, is about 0.5 p.p.m. From the Table 7, therefore, it may be said that even at the level of 12.5 p.p.m. (25 times as much iodine as in ordinary iodized tomato juice), iodine failed to impart any appreciable off-flavor to tomato juice.

**Bulk and Canned Sauerkraut.** The results of the acid determinations made every 3 days while the cabbage was fermenting are shown in Table 8.

TABLE 8

Acidity produced by sauerkraut fermentation treated with iodized and iodated salts (acidity expressed as percent lactic acid)

Treatment	Days of fermentation								
	7	10	13	16	19	22	25	28	31
Control-1	0.88	1.20	1.40	1.52	1.44	1.48	1.52	1.60	1.68
Control-2	0.84	1.01	1.32	1.43	1.56	1.69	1.65	1.70	1.71
Iodized-1	0.77	1.05	1.19	1.30	1.38	1.50	1.60	1.65	1.70
Iodated-2	0.78	1.00	1.16	1.33	1.31	1.36	1.60	1.68	1.75
Iodated	0.88	1.21	1.45	1.56	1.64	1.68	1.72	1.73	1.78

The data indicate no appreciable effects from the use of iodized or iodated salts on the acid formation during kraut fermentation.

**Flavor evaluation.** *Bulk Kraut.* Since the total acidities of the 2 control samples were slightly different it was deemed essential to evaluate each by taste panels. The results are shown in Table 9.

TABLE 9

The average scores of eight judges evaluating flavor of bulk kraut using Control-1 as a check

Treatment	Average scores of eight judges
Control-1 (known)	7.60
Control-1 (unknown)	6.60
Control-2	6.90
Iodized-1	7.00
Iodized-2	6.70
Iodated	7.30



The judges failed to detect any significant differences between samples.

**Canned Kraut.** The differences in flavors of the canned kraut were evaluated subjectively after two months' storage at room temperature. The results obtained show that in both cases, using control-1 or control-2 as a check, no significant difference in flavor could be detected between the lots of canned kraut. In other words, the use of iodized or iodated salt in sauerkraut failed to produce any significant detectable off-flavors.

**Bulk Kraut.** Color differences between the lots of bulk kraut were scored subjectively. The judges could not detect any difference in color due to the presence of iodized or iodated salts.

**Canned Kraut.** In the case of canned kraut, "a" readings on "R<sub>1</sub>" scale of the Hunter Color Difference Meter were taken as objective measures of color. The "a" values were exactly the same for all the lots, i.e., 58. It is safe to conclude that iodized or iodated salts can be used without producing any changes in kraut color.

**Bulk Kraut.** The textures of both bulk and canned kraut were scored subjectively from 1 to 10. The average scores of judges are given in Table 10.

TABLE 10  
The average scores of eight judges scoring texture of bulk kraut using Control-2 as a check

Treatment	Average scores
Control-2 (known)	8.20
Control-2 (unknown)	7.60
Control-1	6.60
Iodized-1	7.60
Iodized-2	7.70
Iodated	8.00

It may be concluded that the judges could not detect any significant effects of iodized or iodated salt on the texture of bulk kraut.

**Canned Kraut.** The texture of the canned kraut was also evaluated subjectively. Table 11 shows the average scores of the judges using different controls as a check on texture of the canned kraut.

TABLE 11  
The average scores of eight judges scoring texture of canned kraut using Control-1 as a check

Treatment	Average scores
Control-1 (known)	7.63
Control-1 (unknown)	7.38
Control-2	7.63
Iodized-1	8.00
Iodized-2	7.63
Iodated	7.88

From this and other data, we can conclude that neither iodized nor iodated salt induced any deterioration in the texture of canned kraut.

**Odor evaluation.** The judges scored odor subjectively.

The results in Table 12 show that the judges could not detect any different or undesirable odor due to the use of iodized or iodated salts in canned sauerkraut.

**Canned Green Beans.** Since only two lots of canned green beans were prepared, i.e., with iodized salt and

plain salt, the triangle test was used to detect differences in flavor, texture, odor, or color. The results of the 2 triangle tests were combined and are shown in Table 13.

These results show that there was no difference in flavor, color, texture, or odor which may have been utilized in identifying the duplicates.

**Ascorbic acid.** The amounts of reduced ascorbic acid found in the beans in 6 different cans are shown in Table 14.

TABLE 12  
The average scores of eight judges scoring odor of canned kraut using Control-1 as a check

Treatment	Average scores
Control-1 (known)	8.00
Control-2 (unknown)	8.00
Control-2	7.75
Iodized-1	7.38
Iodized-2	7.63
Iodated	7.75

TABLE 13  
Results of triangle test of canned green beans stored for three months at room temperature

No. of judgments	No. of correct answers	No. of correct answers necessary to establish significant difference	
		5%	1%
14	1	9	10

TABLE 14  
The amount of ascorbic acid in canned green beans after three months' storage at room temperature (expressed in mg./100 g. of juice)

Replicate	Control	Iodized salt
1	4.75	4.75
2	5.13	4.94
3	4.81	4.90
Average	4.89	4.86

Without resorting to analysis of variance, it is obvious that the results show no effect of iodized salt on the ascorbic acid content of canned green beans.

**Canned Yellow Corn.** Triangle tests failed to find any detectable differences in flavor or color between iodized and plain salted, canned, yellow, whole kernel corn.

TABLE 15  
Result of two triangle tests using different treatments as duplicate in canned whole kernel yellow corn stored for three months at room temperature

No. of judgments	No. of correct answers	No. of correct answers necessary to establish significant difference	
		5%	1%
16	5	10	11

**Pickled Olives.** Since pickled olives were treated three ways, i.e., plain-salted, iodized-salted, and iodate-salted, 4 judgments were made. The results of the triangle tests are shown in Tables 16 and 17.

TABLE 16  
Result of triangle test on iodized-salted and plain-salted olives

No. of judgments	No. of correct answers	No. of correct answers necessary to establish significant difference	
		5%	1%
15	4	9	10



TABLE 17

Result of triangle test on iodated-salted and plain-salted olives

No. of judgments	No. of correct answers	No. of correct answers necessary to establish significant difference	
		5%	1%
15	4	9	10

The results again show that the judges could not find any detectable differences between plain-salted and iodized-salted or iodated-salted bottled pickled olives.

#### CONCLUSIONS

In conclusion, the results obtained in this work all show no detectable deterioration in quality due to use of iodated or iodized salt in canned tomato juice, bulk and canned sauerkraut, canned green beans, canned whole kernel yellow corn, and bottled pickled olives.

Since the products tested were representative of processed fruits and vegetables which contained considerable amounts of salt, it may be concluded that as far as processed fruits and vegetables are concerned, there will be no fear of deterioration of the quality of products due to the use of iodized salt instead of plain salt.

Therefore, it would seem wise to use iodized salt in processing vegetables and fruits to reduce the incidence of goiter. It might even be wise to state on the label that

iodized salt had been added as an additional safeguard to health.

#### LITERATURE CITED

1. Anonymous. Goiter a world-wide disease. (Fact No. 375 from pamphlet of the Iodine Educational Bureau, Stone House, Bishopsgate, London, 1946.)
2. Anonymous. Environmental iodine deficiency. (Fact No. 305 and Fact No. 340, *ibid.*, Iodine Educational Bureau, Stone House, Bishopsgate, London, 1946.)
3. Anonymous. Michigan Dept. of Health, E-1, 1953.
4. KIMBALL, O. P. The efficiency and safety of the prevention of goiter. *J. Am. Med. Assn.*, 82, 1328 (1924) and OLIN, R. M. Iodine deficiency and prevalence of simple goiter in Michigan. Michigan Health Report, 21, 1924.
5. MARINE, D., AND WILLIAMS, W. W. The relation of iodine to the structure of the thyroid gland. *Arch. Int. Med.*, 1, 349 (1908).
6. MARINE, D. The occurrences and physiological nature of glandular hyperplasia of the thyroid. *Johns Hopkins Hospital Bull.*, 18, 359 (1907).
7. MARINE, D., AND LENHART, G. Further observations on the relation of iodine to the structure of the thyroid gland in the sheep, dog, and ox. *Arch. Int. Med.*, 3, 66 (1909).
2. MARINE, D., AND LENHART, C. Further observations and experiments on the so-called thyroid carcinoma of the brook-trout (*Salvelinus fontinalis*) and its relation to endemic goiter. *J. Exp. Med.*, 13, 455 (1911).
9. NICKERSON, D. Color measurement and its application to the grading of agricultural products. U. S. Dept. Agr. *Misc. Publication* 580, 1946.
10. ROESSLER, E. B., WARREN, J., GUYMON, J. F. Significance in triangle taste test. *Food Research*, 13, 6 (1948).

## The Effect of Aureomycin Treatment on the Shelf Life of Fresh Poultry Meat<sup>a</sup>

FRANK ZIEGLER AND W. J. STADELMAN

State College of Washington, Pullman, Washington

Several recent studies report the effect of certain antibiotics in the preservation of canned goods. A few studies have been made to determine the preservative effect of antibiotics on fresh food products.

Tarr, Southcott and Bessett (4) conducted trials in which the preservation effect of fifteen antibiotics on fresh fish was studied. They found that aureomycin, terramycin and chloromycetin were consistently effective in delaying spoilage. Goldberg, Weiser and Deatherage (2) found that these same three antibiotics were the most effective of the six used to preserve fresh beef.

Kohler, Broquist and Miller (3) reported increases in shelf life of eviscerated and cut-up chicken of from 7 to 14 days when the meat was dipped into aureomycin solutions containing from 3 to 30 p.p.m. and then was stored at 40° F. (4.4° C.).

Since aureomycin was considered one of the most effective antibiotics in the studies mentioned above, it was used in this study of shelf life with fresh chicken fryers.

#### EXPERIMENTAL METHODS

This study consisted of an experiment made up of three replicates which were not conducted simultaneously. Each replicate consisted of twelve fryers. The birds were dressed in the college poultry plant which is equipped with a Greenbriar Rotomatic Scalding and Greenbriar picker. Scalding was done in 128° F. (53.3° C.) water for forty seconds. The dressed birds were cooled for two hours in water containing melting ice, after which they were eviscerated and cut into halves. Four experimental treatments were applied on a half bird basis. The basic design was plan 11.1 of Cochran and Cox (1), which is a balanced incomplete block design with the treatments in blocks of two and each treatment repeated three times. The possible replicate grouping was not utilized in the present instance. Each bird, being halved, formed a block of two treatments and thus possible bird to bird differences were removed from the treatment comparisons. Three runs of twelve fryers were utilized with the basic design being repeated within each run. Thus,

<sup>a</sup> Scientific paper No. 1358, Washington Agricultural Experiment Station, Pullman; project No. 1079.