EFFECT OF BLANCHING ON RETENTION OF ASCORBIC ACID AND THIAMINE IN PEAS

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Previous investigations concerned with the retention of water soluble vitamins in vegetables have shown that the principal loss of nutrients occurs during blanching. This loss has been shown to be due primarily to the leaching of water soluble nutrients. Some loss of ascorbic acid has been attributed to oxidation as well as to leaching.

Data obtained by this laboratory (1) on the retention of ascorbic acid in peas show an average retention after blanching of 78 per cent with a standard deviation of ± 6 per cent, and after processing of 74 per cent with a standard deviation of ± 7 per cent. Similar values for thiamine were as follows: after blanching 90 ± 8 per cent and after processing 57 ± 9 per cent. From 24 to 26 retention experiments were performed at five canneries and the results were expressed on the basis of salt-free solids.

Blanching studies conducted by Pennsylvania State College in cooperation with representatives of the National Canners Association and the American Can Company (2), and by Wagner, Strong and Elvehjem of the University of Wisconsin (3), showed that the general consequence of increasing the blanching temperature on ascorbic acid retention was less severe than when the duration of blanch was increased. The results of the Penn. State and Wisconsin studies indicate the possibility of increasing the retention of water soluble nutrients, particularly ascorbic acid, by increasing the temperature of the blanch and decreasing the time of blanching.

It was the primary purpose of the present investigation to determine whether this principle could be applied to the commercial blanching of peas in such a way as to improve the nutritional value of canned peas without sacrifice of quality.

[1] This is the thirty-fifth of a series of papers sponsored by the National Canners Association-Can Manufacturers Institute dealing with the general subject "Nutritive Value of Canned Foods."

It has been reported that canning peas without blanching results in the maximum retention of water soluble nutrients. Although this procedure has also been reported to be unsatisfactory from a quality standpoint, it was thought to be worth while to reinvestigate the possibilities of this method of canning. Since young tender peas require less severe blanching than the more mature peas, it was thought to be advisable to use fancy peas for the experiment. One criticism of the procedure of canning unblanched peas is the inability to wash the peas satisfactorily with cold water. An experiment was performed in which a portion of the same lot of peas canned without blanching was washed thoroughly in warm water (120° F.) prior to canning. It was hoped that the warm water wash would be less severe from the standpoint of leaching than a blanch at a higher temperature.

Experimental

Experiments were conducted at a commercial pea cannery located in the Pacific Northwest. With the exception of the first series of blanching experiments, all the studies were made on commercial blanchers currently in use at the cannery.

Samples of raw peas from a particular load were taken after washing and grading for size. All of the peas were of the Mardelah variety. None of the peas were quality graded by the brine flotation process. Samples representing the same lot of peas were taken as they emerged from the blancher, and cans representing this same lot of peas were taken after commercial filling, brining, and closing. The cans were marked with identifying codes and processed for 18 minutes at 252° F. in vertical retorts.

At each sampling point 200 grams of peas were blended with an equal weight of 6 per cent metaphosphoric, 1 per cent oxalic acid mixture, and the determination of ascorbic acid was completed according to the method previously used by this laboratory for peas (1).

Samples for thiamine were prepared by blending 200 grams of peas with an equal weight of 0.2 N sulfuric acid in a Waring Blendor. During the blending 2 ml. of chloroform was added and the contents of the Blendor cup transferred to a pint Mason jar. Five ml. of toluene was placed on the surface of the liquid and the jars held under refrigeration until they could be analyzed. Samples for moisture and alcohol insoluble solids were prepared by accurately weighing 12 oz. of peas into a No. 2 can, filling the can with hot water, closing, and processing. Upon opening these cans, the net weight was determined and the ratio of peas to total contents calculated.

Thiamine and salt-free solids were determined by the methods previously described (1). Alcohol insoluble solids were determined on the samples prepared for moisture determination after blending the entire can contents. A 20-gram sample was extracted with 200 ml. of 80 per cent alcohol according to the official A.O.A.C. procedure (4).

A summary of the experiments performed in these studies is shown in Table I. In the first series of experiments No. 3 sieve size peas were taken from the size grader. These represented fancy peas with a tenderometer reading of about 80. A portion of the peas was filled into No. 2 cans without blanching, using a 12.5 oz. fill (Code P1). These cans were filled with hot brine, closed, and processed in a commercial retort. A second portion was washed for 3 minutes in water at 120° F. (Code P2), after which the peas were drained, filled, and treated as above. A third portion was blanched for 3 minutes at 190° F. by immersion in a tank of hot water and treated as above (Code P3).

Experiments P5, P6, P7 and P8 were performed during commercial canning operations without modification of the blanching treatment. Since both rotary and tubular blanchers were being used, an attempt was made to obtain comparative retention values using the two types of equipment. Codes P5 and P6 represent two different lots of peas, whereas Codes P7 and P8 represent the same lot of peas blanched simultaneously in the two blanchers. All of the peas were of extra standard quality. The rotary blanching time was 4 minutes, whereas the time required for the peas to pass through the tubular blancher was estimated at 4½ minutes. Some uncertainty existed as to the exact time required for the peas to pass through the tubular blancher, since it was not possible to time its operation at the time these experiments were conducted; however, tests performed several days previously

had indicated a blanching time of 4½ minutes.

Experiments P9 and P10 were performed on a single lot of peas, using the same rotary blancher. The peas were extra standard in quality, and a mixture of No. 5 and 6 sieve sizes. Approximately half of the lot was run through the blancher using the commercial blanch of 5 minutes at 190° F. The speed of rotation was then quickly changed to give a blanching time of 1½ minutes and the thermostat was set at 205° F. The blancher was allowed to operate for several minutes after it had come up to temperature and then a sample of blanched peas was taken for analysis and the remaining peas run into a hopper and canned separately. The total time of operation at this temperature was approximately 10 minutes. The commercially blanched peas were canned in No. 2 cans and the peas blanched at the high temperature were canned in No. 303 cans.

Experiments P11 and P12 were performed in a similar manner except that fancy peas of No. 2, 3 and 4 sieve sizes were used and the commercial blanch was 4½ minutes at 190° F. instead of 5 minutes. In this experiment both lots of peas were canned in No. 2 cans.

Twelve processed cans were set aside from each blanching treatment. The remainder of the cans were put back into commercial stock.

All of the processed samples were analyzed for ascorbic acid from 24 to 48 hours after processing. Samples for thiamine and moisture were prepared from additional cans of the same codes after shipping to the San Francisco laboratory.

At the time the ascorbic acid analyses were performed additional cans were cut for quality examination. These samples were tested by the cannery superintendent and the chief quality control man.

Results

Effect of Elimination of Blanch.— All of the analytical results are shown in the accompanying table. It is seen in Code P1 that canning peas without blanching resulted in a remarkably high retention of ascorbic acid. Washing the peas in warm water resulted in retention intermediate between the blanched and the unblanched peas. It is probable that a somewhat higher than usual rate of loss occurred between washing or blanching and processing as a result of unavoidable delays in filling and closing these samples. This delay was occasioned by the necessity of hand filling and brining the cans. Approximately 30 minutes elapsed in performing these operations. These delays probably have tended to accentuate the differences between the blanched and the unblanched peas; however, the retention obtained in the unblanched peas was markedly higher than any retention ever obtained after commercial blanching.

The quality of both the unblanched and warm water washed samples was judged unsatisfactory for the following reasons:

1. Sufficient air was present in the peas to cause buckling of the cans during processing.
2. The brine of the unblanched peas was markedly cloudy and a considerable amount of starchy material had sloughed off the peas into the brine.
3. The flavor of the unblanched peas was slightly bitter or "viney" as compared with that of the blanched peas.

The warm water wash apparently was entirely ineffective in improving the quality of the peas from the standpoint of any of the factors listed above.

The excessive air might have been eliminated by adding brine at a higher temperature, by exhausting the cans, or by vacuum closure. A somewhat better flavor might have been obtained by more rapid inactivation of the enzymes in the peas. It is doubtful whether the cloudy brine could be eliminated by any known method not involving water blanching, since steam blanching has also been reported to be objectionable in this respect. In spite of the markedly higher retention of nutrients obtained on the unblanched peas, it would appear that this procedure is unsatisfactory from the standpoint of quality.

Rotary vs. Tubular Blanchers.— The results of experiments P5, P6, P7 and P8 indicate that a slightly higher retention of ascorbic acid was being obtained in the rotary blancher than in the tubular blancher. It is not

Summary

1. Fancy No. 3 sieve peas were canned unblanched, after washing for three minutes in water at 120° F. and after blanching three minutes at 190° F. Retentions of ascorbic acid after processing were 96, 80 and 53 per cent, respectively, on the basis of dry solids, and 92, 69 and 43 per cent, respectively, on the basis of alcohol insoluble solids. The quality of the unblanched peas and the peas washed with warm water was unsatisfactory.

2. Retention experiments were performed on commercially blanched peas using rotary and tubular blanchers. The average retention of ascorbic acid after processing was 72 per cent when results were calculated on the basis of dry solids (excluding added sugar and salt) and 63 per cent when results were calculated on the basis of alcohol insoluble solids. Slightly higher retentions of ascorbic acid were obtained on extra standard peas blanched in a rotary blancher for four minutes at 190° F. than were obtained on peas blanched in a tubular blancher for four and a half minutes at the same temperature.

3. Retention values were obtained on extra standard peas blanched five minutes at 190° F. and for one and a half minutes at 205° F. and on fancy peas blanched four and a half minutes at 190° F. and for one and a half minutes at 205° F. in rotary blanchers. Approximately 5 per cent higher retention of ascorbic acid was obtained on the extra standard peas and approximately 10 per cent higher retention was obtained on the fancy peas blanched at the higher temperature and shorter time. The quality of the peas blanched by the two procedures was indistinguishable except for the slightly greener color of the fancy peas blanched at the higher temperature.

4. In general the retention of thiamine during blanching paralleled the retention of ascorbic acid, although differences between the different blanching treatments were not as pronounced. The data indicate that blanching procedures giving maximum retention of ascorbic acid can also be expected to give maximum retention of thiamine, provided processing conditions remain constant.

5. Retention values calculated on the basis of alcohol insoluble solids were lower in every instance than those calculated on the basis of total dry solids. As a result of the leaching of alcohol soluble solids from the peas during blanching, the ratio of total to alcohol insoluble solids in every instance was higher on the raw peas than on the corresponding peas after blanching and after processing. Either method of calculation appears to be satisfactory in comparing the results obtained by different blanching treatments; however, retention values calculated on the basis of alcohol insoluble solids appear to represent more nearly the actual retention obtained.

TABLE I

Retention of Ascorbic Acid and Thiamine in Sweet Peas of the Mardelah Variety

Code	Sample	Ascorbic Acid* mg./100 gms.	Thiamine*	A Salt-free Solids %	B Alcohol-insol. Solids %	Ratio A/B	Retention, Basis of Dry Solids Ascor. Acid %	Retention, Basis of Dry Solids Thiamine %	Retention, Basis of A. I. S. Ascor. Acid %	Retention, Basis of A. I. S. Thiamine %
P1	Raw, No. 3 sieve	33.4	0.206	17.9	7.5	2.39	100	100	100	100
	Processed, not blanched	20.5	0.092	11.5	5.0	2.30	96	70	92	67
P2	Washed, 3 min., 120° F.	30.0	—	16.6	7.4	2.24	97	—	92	—
	Processed	15.7	0.087	10.5	5.1	2.06	80	72	69	62
P3	Blanched, 3 min., 190° F.	23.2	—	16.9	8.4	2.01	74	—	62	—
	Processed	10.6	0.093	10.8	5.5	1.96	53	75	43	62
P5	Raw, Nos. 4, 5 sieve	28.2	—	19.9	14.0	1.42	100	—	100	—
	Rotary blanch, 4 min., 190° F.	22.6	—	18.9	15.8	1.20	84	—	71	—
	Processed	11.4	—	10.1	9.2	1.10	80	—	62	—
P6	Raw, Nos. 4, 5 sieve	28.4	0.243	23.6	13.3	1.77	100	100	100	100
	Tubular blanch, 4½ min., 190° F.	19.4	0.225	21.2	14.3	1.48	76	103	63	86
	Processed	10.8	0.090	13.6	8.8	1.55	66	64	58	56
P7	Raw, Nos. 4, 5 sieve	28.1	0.302	23.4	13.9	1.68	100	100	100	100
	Rotary blanch, 4', 190° F.	22.8	0.233	22.8	14.0	1.63	83	79	81	77
	Processed	11.0	0.107	12.5	8.2	1.52	73	66	66	60
P8	Tubular blanch, 4½', 190° F.	22.1	0.233	23.6	15.6	1.51	78	77	70	69
	Processed	10.9	0.104	13.3	9.0	1.48	68	61	60	53
P9	Raw, extra std. Nos. 5, 6	31.2	0.274	23.3	14.2	1.64	100	100	100	100
	Blanched, 5 min., 190° F.	20.1	0.226	21.9	13.5	1.62	69	87	68	87
	Processed	10.9	0.106	12.6	8.5	1.48	65	71	58	65
P10	Blanched 1½', 205° F.	23.3	0.272	24.2	14.9	1.62	72	95	71	95
	Processed	12.1	0.108	13.2	8.7	1.52	68	69	63	64
P11	Raw, fancy, Nos. 2, 3, 4	38.3	—	20.1	9.7	2.07	100	—	100	—
	Blanched, 4½', 190° F.	23.0	0.194	17.6	9.0	1.96	69	—	65	—
	Processed	12.5	0.097	10.3	5.7	1.81	64	—	55	—
P12	Blanched, 1½', 205° F.	30.2	0.200	18.0	9.0	2.00	88	—	85	—
	Processed	14.9	0.093	10.3	5.7	1.81	76	—	66	—

* Actual values, wet basis.

known, however, whether this slight difference was caused by the slightly greater length of time the peas remained in the tubular blancher or whether the difference was due to some inherent difference in the two types of blanchers. Unfortunately, is was not possible in these experiments to obtain exactly the same blanching times in the two blanchers, nor was it possible to determine in either case exactly what the actual time of blanching was at the time the experiments were performed. It is possible that the difference in blanching time was somewhat greater than expected.

Comparison of Commercial Blanches with Short High Temperature Blanch.—A temperature of 205° F. was selected as the highest that was commercially feasible with the type of blancher selected for this experiment. Although the minimum possible time of blanching with this particular rotary blancher was about one minute, it was thought that a 1½-minute blanch would be more satisfactory from a quality standpoint.

The data show that for both the extra standard and the fancy peas appreciably better retention of ascorbic acid was obtained with the shorter blanch. The difference was slightly greater with the fancy peas than with the extra standard. This was to be expected since, although the commercial blanch for the extra standard peas was slightly longer than for the fancy peas, the smaller peas have a greater surface per given weight, are more tender, and consequently would be expected to lose a higher proportion of soluble solids by leaching than the larger, more mature peas.

It is believed that the improvement in retention shown in these experiments is near the ultimate that could be obtained in this cannery employing commercial blanching equipment.

Neither the cannery superintendent nor the quality control man could distinguish between the two lots of extra standard peas. The superintendent selected the fancy peas given the short blanch as the peas which were blanched the least, his judgment being based primarily on the slightly greener color of the shorter blanched peas. Neither person objected to the short blanched peas in any way.

It would appear that the high temperature blanch was not exactly equivalent in blanching effect to the regular blanch. The advantages in retention, therefore, were not due solely to the shorter time permitted by the higher temperature, but also to the overall lighter blanch. Further experiments should be directed towards determining how light a blanch, irrespective of temperature, is feasible in blanching peas of various degrees of maturity, and also determining the relative blanching times at different temperatures which give exactly equivalent blanching effects.

Retention of Thiamine.—The retention of thiamine, in general, parallels the retention of ascorbic acid; however, the differences between the various blanching treatments are less clearly marked and, in most instances, probably are within experimental error. Since the greatest loss of thiamine occurs during processing, slight differences in blanching losses are obscured in the thiamine retention of the final canned product. The data indicate that procedures giving the maximum retention of ascorbic acid would also give maximum thiamine retention, provided that processing conditions were identical.

Method of Calculating Results.—Results were calculated both on the basis of dry solids and on the basis of alcohol insoluble solids. Added salt and sugar were subtracted from the total solids of the processed samples. The ratio of total to alcohol insoluble solids is shown in the table.

In every instance retention results calculated on the basis of dry solids were higher than those calculated on the basis of alcohol insoluble solids. The reason for this becomes apparent upon examination of the ratios of total to alcohol insoluble solids. In every instance a higher ratio was obtained on the raw than on the blanched peas. This would indicate that alcohol soluble solids were leached out in the blanch to a greater extent than alcohol insoluble solids. Apparently the sugars and water soluble constituents were leached to a greater extent than starch. The amount of decrease of this ratio appears to be roughly proportional to the amount of leaching that occurs during blanching. The results are particularly striking in the series of experiments P1, P2 and P3.

The higher ratio of total to alcohol insoluble solids in the fancy peas than in the extra standards indicates a higher ratio of sugar to starch.

It would appear that alcohol insoluble solids provides a truer basis for calculation of retention values than does total dry solids. Retention results calculated by the two methods parallel each other very closely, however, and from the standpoint of determining the relative effectiveness of different blanching treatments, either method appears to be equally satisfactory.

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