ABSTRACT OF THESIS

THE ASCORBIC ACID CONTENT OF FROZEN PEAS COOKED IN A PRESSURE SAUCEPAN AT DIFFERENT ALTITUDES

Submitted by

Louisa McClure

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Augus

ABSTRACT OF THESIS

Vegetables furnish appreciable amounts of ascorbic acid in the American diet. Since ascorbic acid is water soluble and heat labile, it is important to determine methods of cooking which best preserve it.

Cooking in a pressure saucepan has shown to be one effective method. Directions for use of the pressure cooker do not suggest changes to be used for time or for pressure at various altitudes. Therefore, the object of this experiment was to determine the ascorbic acid content and palatability of peas cooked at different altitudes for varying lengths of time at selected pressures.

Alaska peas were chosen for the experiment, and after quick freezing and blanching they were placed in No. 10 cans and stored at -10 degrees Fahrenheit.

They were cooked in a pressure saucepan under the following conditions: altitude 0 feet, 5,000 feet and 10,000 feet for no minutes and for one minute cooking time at five and at fifteen pounds pressure as registered by the pressure saucepan. The cooking was carried out in the altitude laboratory.

Flavor and tenderness as an index of palatability were scored by four judges. The penetrometer was used to obtain an objective measure of tenderness. A modified Loeffler and Ponting method was used for chemical analysis of the ascorbic acid.

The average ascorbic acid content of the cooked peas was 20.3 milligrams per 100 grams of peas. The difference in ascorbic acid content of samples cooked under the different conditions of altitude, pressure and time amounted to no more than 3 milligrams.

The data for ascorbic acid was analyzed statistically according to analysis of variance. The results of the experiment indicated a negative effect of altitude, pressure and time. The interaction between them was also negative. A large residual variance of (24.34) overshadowed any effect altitude, pressure or time differences had on ascorbic acid content.

Palatability tests for flavor and tenderness scored by laboratory assistants ranged from 3.1 to 4.6 and 3.0 to 4.3 respectively. These were judged on a possible maximum score of five. Differences between each group were small and were probably not significant.

Penetrometer readings used to determine "doneness" appeared to vary somewhat for altitude,

time and pressure, but the individual variation within any sample was great.

According to these criteria altitude would not affect directions given for the use of the pressure saucepan in cooking frozen peas.

COLORADO AGRICULTURAL AND MECHANICAL COLLEGE

August 1946

I HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER MY SUPERVISION BY LOUISA McCLURE

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BE ACCEPTED AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE

MAJORING IN NUTRITION

CREDITS

Elizabeth Dyar
In Charge of Thesis

APPROVED Flora L Slocum
Head of Department

Examination Satisfactory

Committee on Final Examination

Flora L Slocum

W E Ely

Elizabeth Dyar

Eugenia B Clark

W E Lacey Boyd
Dean of the Graduate School

Permission to publish this thesis or any part of it must be obtained from the Dean of the Graduate School.

T H E S I S

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Louisa McClure

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INTRODUCTION

During the last few years many experiments have been conducted to determine the retention of ascorbic acid in cooked vegetables. Since ascorbic acid is heat labile and water soluble, the method of cooking influences the amount of ascorbic acid in the vegetables. Several experiments have compared the losses of ascorbic acid caused by cooking vegetables in various containers for different lengths of time. However, there is little information concerning the ascorbic acid retention in vegetables cooked in a pressure saucepan. Moreover, time tables set up for the use of the pressure saucepan at the present time do not state the length of time or the amount of pressure to be used at different altitudes. The pressure saucepans most commonly used in America provide one or more levels of pressure, but no information has been obtained concerning the actual effects of the pressure on the ascorbic acid retention in the vegetables.

Since ascorbic acid is highly essential to the normal functioning of the human system, and is not synthesized or stored in the body, (King 1936), the daily diet must meet the need for this substance.

Ascorbic acid is known to exist in considerable amounts in fresh vegetables. Many of them are made more edible by cooking, so it would seem advisable to know and to utilize the best methods of preserving the amount present.

Therefore, the object of this experiment was to determine the ascorbic acid content and palatability of a typical vegetable cooked at different altitudes at different pan pressures for varying lengths of time.

The effect of time of cooking on the palatability and ascorbic acid retention was to be determined in frozen peas cooked at different pressures at the same altitude. This process was to be repeated for the same pressure at different altitudes.

The experiment was designed to yield information on the effect of altitude on pressures recommended for the use of the pressure saucepan, and it is hoped that it will help to determine the best method of cooking in a pressure saucepan at different altitudes.

REVIEW OF LITERATURE

The literature in this field indicates that much work has been done to study the loss of ascorbic acid under a variety of conditions. Extensive experiments have been carried on by people in different localities throughout the world, so the review below is limited to the work relating more directly to this experiment.

The report of the experimental work with peas has been organized under the following headings:

I. The ascorbic acid content of peas.

II. General conditions for ascorbic acid retention.

III. The effects of blanching, freezing, storing, and cooking on ascorbic acid retention.

IV. Tests for palatability of cooked peas.

I. The ascorbic acid content of peas

Bessey and King (1933) found a sample of fresh peas to contain 16 milligrams of ascorbic acid per 100 grams, one of canned peas (not comparable with fresh) five milligrams per 100 grams, and cooked peas 6 milligrams per 100 grams of peas.

According to many workers peas differ greatly in ascorbic content (from 11 to four milligrams per 100 grams) depending on variety. The small seeded varieties

proved to have a greater concentration of ascorbic acid than the large seeded kinds; while in any variety the ascorbic acid content varied inversely with maturity and size (Mack, Tressler, and King, 1936). The latter observation was confirmed by Olliver (1938) and by Todhunter and Sparling (1938).

On the other hand Morgan, Mackinney, and Cailleau (1945) found that mature peas had a higher ascorbic acid value than the immature peas, but the final product of the immature lot retained 50 per cent more of the vitamin through dehydration, regardless of blanching.

II. General conditions for maximum ascorbic acid retention

King and Tressler (1940) listed conditions which favor maximun retention of vitamin C. These were:

1. Low temperature and maximum acidity.
2. Keeping agitation and injury of tissues at a minimum.
3. Avoiding exposure to sunlight.
4. Adequate blanching to destroy enzymes, but not excessive.
5. Control of harvesting conditions.
6. Avoiding destruction by certain types of bacteria.
7. Avoiding contamination with copper.
8. Preventing unnecessary exposure to air.

III. The effects of blanching, freezing, storing and cooking on ascorbic acid retention

From 30 to 37 per cent of ascorbic acid was lost during preparation for freezing, which included blanching, according to Todhunter and Robbins (1941). Lee and Whitcombe (1945) found the loss to be from 10 to 19 per cent during processing (including blanching).

Todhunter and Sparling (1938) reported no difference in the ascorbic acid retention of peas during blanching in steam or in boiling water for one minute. Blanching in hard water (pH 8.6) caused a greater loss of ascorbic acid than in other types of water used, according to Lee and Whitcombe (1945).

Fenton (1940) observed that preparation for cooking involved crushing, grinding or bruising the raw vegetables, and therefore increased the loss of ascorbic acid.

Fenton and Tressler (1938) found that commercially frozen peas contained 62 per cent of the ascorbic acid present in fresh peas. Harris, Mapson and Wang (1942) observed a loss of over 50 per cent of the ascorbic acid in blanching and freezing peas. No significant differences in ascorbic acid content, appearance or palatability were found from different rates of freezing peas studied by Lee, Gortner, and Whitcombe (1946).

According to Jenkins, Tressler and Fitzgerald (1938), peas maintained a constant ascorbic acid content when held in storage at -18 degrees Centigrade for five months if they were adequately blanched. The most rapid loss of ascorbic acid occurred during cooling and washing.

Fellers and Stepat (1935) observed a loss of 68.7 per cent of the ascorbic acid when frozen peas were allowed to thaw from two to 6 hours. No loss of ascorbic acid was noted by Fenton and Tressler (1938) in thawing peas for 16 hours at 40 degrees Fahrenheit, nor in holding frozen peas at 80 degrees Fahrenheit for one to five hours. They attributed the loss which Fellers and Stepat reported to insufficient blanching.

Fenton, Tressler and King (1936) studied the vitamin C content of peas cooked for various lengths of time. They found that the greatest loss occurred during the first two minutes of cooking while the water was returning to the boiling point. When cooked the peas contained from 42 to 53 per cent of the original amount and had lost 40 to 48 per cent to the cooking water.

After cooking frozen peas, Fenton and Tressler (1938) found that 59 per cent of the ascorbic acid was left in the peas, 36 per cent was in the cooking water and five per cent was destroyed.

Burrell and Ebright (1940) reported that 43.1 per cent of the ascorbic acid was lost if the cooking water was discarded, and 21.6 per cent was lost if the water was used.

In cooking either fresh or frozen Thomas Laxton peas Todhunter and Robbins (1941) observed the loss of ascorbic acid in the cooking water to be proportional to the amount of water used.

McIntosh, Tressler and Fenton (1940) studied the effect of different cooking utensils on ascorbic acid retention. Frozen peas were cooked in a covered aluminum stewpan, two different steamers, a pressure saucepan and a pressure cooker. The cooked vegetable contained from 70 to 80 per cent of the ascorbic acid and 13 to 30 per cent was found in the cooking water. The peas cooked in the pressure saucepan retained the greatest amount of the ascorbic acid.

In a similar study McIntosh, Tressler and Fenton (1942) cooked frozen peas in utensils of aluminum, enamel, pyrex and stainless steel. The loss of ascorbic acid was independent of the composition of the cooking vessel. When a covered enamel pan was used the cooked peas retained 11 per cent more ascorbic acid than when boiled in the same pan uncovered.

Ascorbic acid retention was observed to be 58 per cent when peas were cooked in a pressure saucepan, 48 per cent in a waterless cooker, and 46 per cent

in an open kettle.

Halliday and Noble (1946) recommended the use of a pressure saucepan to shorten cooking time of green vegetables and to preserve the color and flavor. For green vegetables the amount of water used should be the minimum required to preserve the color and to prevent a bad flavor, providing the water used is slightly alkaline (pH 8.2) before boiling. According to the time table for boiling vegetables (Halliday and Noble, 1946), one-fourth cup of water should be used to boil fresh peas in a pressure saucepan from three-fourths to one and one-fourth minutes after the weight is placed on the cooker.

It has been recommended by Chaney and Ahlborn (1943) that fresh vegetables be placed in actively boiling water when cooking them. Since ascorbic acid is one of the most labile of all known vitamins, air should be excluded during cooking and storing for greatest preservation. (Sherman, 1946).

Briant, MacKenzie, and Fenton (1946) made studies of the ascorbic acid retention of peas and green beans cooked after ten months of storage in a temperature of -10 degrees Fahrenheit. They reported that steamed peas showed the lowest retention of ascorbic acid. The average ascorbic acid content of a 100 gram portion of freshly cooked peas was 7.4 and ranged from 3.1 to 6.8 milligrams.

IV. Tests of palatability

Laboratory experts showed that both flavor and tenderness were subject to rapid loss as a result of delay between vining and freezing. A judging panel found that approximately a 100 pound test on the tenderometer was the dividing line between highest quality and second grade peas (Schwartze, Rundle, Boggs and Campbell, 1942).

Although numerous reports have been recorded on the outstanding results of cooking and handling peas on ascorbic acid retention, no efforts have been made to determine the effects of altitude and pressure on the ascorbic acid retention of peas cooked in a pressure saucepan.

MATERIALS AND METHODS

I. Preliminary experiments

Variables to be investigated were established after carrying on several preliminary experiments. After studying the results on palatability and ascorbic acid retention of frozen peas, the variables decided upon were time, pressure, and altitude. All factors such as initial treatment, etc., entering into the experiment were constant except the altitude, time and pressure in pounds as measured on the saucepan.

II. Equipment

In order to simulate different altitudes, a specially constructed laboratory was used. This altitude chamber was a cylindrically shaped room equipped with the essentials for cooking and baking. (See Appendix A.) Pressure comparable to that of sea level or any interval of altitude up to 18,000 feet can be maintained inside the chamber. For details of construction of this chamber see Peterson (1930).

A portable two plate electric stove was used throughout the experiment.

The four quart size pressure saucepan was equipped with a safety valve and a gravity type pressure

gauge. The saucepan was entirely constructed of aluminum except for the handles which were hard rubber.

All equipment was identical for each series of operations.

III. Preparation of samples

Peas were chosen since they could be sampled more easily than other suitable vegetables. In early July five bushels of Alaska peas were pulled from the ground and the pods picked from the vines in the shade. The same afternoon the peas were washed and blanched on paper-lined trays for a time previously shown necessary with equipment used at this altitude of 5000 feet. After rapid cooling, the peas were removed to trays of quick freezing units where they were thoroughly frozen. No. 10 cans were filled with peas and stored in a cold room (-10 degrees Fahrenheit) for the night. Early the following morning, the peas were thoroughly mixed (in the cold room) to provide a uniform sample for the experiment. Approximately 1800 grams of peas were then sealed in each can, and stored in the cold room. It was assumed that the ascorbic acid content of the stored peas would remain constant for the short length of time of the study (Jenkins, Tressler, and Fitzgerald, 1938).

IV. Cooking procedure

A definite plan of work was followed to insure

uniformity and to facilitate the procedures of cooking and testing for ascorbic acid. With all preliminary plans completed, the cans were opened (one each day) beginning the week following the storage in the cold room. As each can was opened it was immediately placed on ice in a larger can with a tight fitting lid. All other necessary equipment such as thermometer, metaphosphoric acid, and washed gauze for wrapping samples, was carried to the altitude chamber on a tray. The same electric burner was used for cooking the peas throughout the experiment.

When the desired atmospheric pressure had been obtained in the chamber, the cooking was started.

Samples of peas were weighed out in 200 gram portions just previous to cooking. A small piece of washed cheese cloth was used to enclose 50 grams of the 200 gram sample for the ascorbic acid test. Then both samples were dropped into 90 grams of boiling water, and a maximum thermometer was placed on top of them. The lid was adjusted immediately. The automatic pressure gauge was adjusted as soon as a constant flow of steam issued from the steam vent in the lid.

The cooking was timed according to the directions for use of the saucepan. When the cooking time had elapsed the saucepan was partially immersed in cold water for 30 seconds. By removing the pressure gauge the remaining steam was allowed to escape and the lid

could be removed.

The 50 gram sample was immediately dropped into a beaker containing 200 grams of one per cent metaphosphoric acid. The temperature of the maximum therometer was recorded and preparations made for the next cooking. The remaining 150 grams of peas were removed to paper cups for palatability and penetrometer tests. The saucepan was thoroughly rinsed after each cooking to prepare it for the next sample. The pressures, times and altitudes at which samples were cooked were randomized.

V. Procedure for testing for ascorbic acid.

The 50 gram samples of peas in metaphosphoric acid were tightly covered with wax paper immediately after cooking and were analyzed as soon as the series of cookings for the day was completed.

A modified Ponting and Loeffler (1942) method was used for estimating the ascorbic acid. The Waring Blendor was used for disintegration. The whole sample was thoroughly blended for five minutes, and poured into a funnel fitted with folded filter paper. Filtration was allowed to proceed until between 10 and 15 milliliters of extract had passed through the filter. This was discarded and a portion from the balance filtered was made up to volume. Samples were taken from this for reading by means of a spectrophotometer

using a wave length of 520 mu and PC-4 filter with a standard solution of sodium 2-6 dichlorobenzenoneindophenol.

Moisture determinations were made from each No. 10 can of peas. Weighed samples of 10 grams were placed in tared moisture cups for dehydration. A drying oven was set at 70 degrees Centigrade and the samples were dried to constant weight.

The palatability of the peas was tested by four judges after each cooking. Their judgment of flavor and tenderness was recorded on score-cards, a sample of which is attached (Appendix B). A penetrometer was also used to test tenderness. Ten peas from each sample were tested using a 10 gram weight. The numbers were averaged to give a general indication of the doneness of the peas.

RESULTS

The ascorbic acid content of the peas cooked in a pressure saucepan was calculated as an average for each of the 12 groups of samples making up the 96 cookings. The results are recorded in Table 1. Averages were also calculated for the palatability and penetrometer tests, and recorded in Table 1.

Calculations were made on the ascorbic acid readings to equalize the moisture content of the samples. Results expressed in this way on the same moisture basis differed little from the results as determined. This was to be expected because of the consistency of the moisture content of different groups.

The maximum temperatures reached during the cooking of each group of samples are recorded in Table 2.

Cooked peas in the experiment were found to contain an average ascorbic acid content of 20.3 milligrams per 100 grams of frozen peas. Since this amount will supply about 28 per cent of the recommended day's allowance for an adult, (National Research Council 1943) it is evident that cooked frozen peas may furnish a major source of the ascorbic acid in our diet.

Table 1.--THE EFFECT OF ALTITUDE, TIME, AND PAN PRESSURE ON THE QUALITY OF FROZEN PEAS COOKED IN A PRESSURE SAUCEPAN.

Altitude	Pan Pressure	Time	Cooking Trials	Quality				
				Ascorbic Acid Content		Penetrometer Reading	Flavor	Subjective Tenderness
				As Determined	calc. to 7.4% Moisture			
ft.	lbs.	min.*	no.	mg./100 gm	mg./100 gm	lbs.	score	score
0	5	0	8	20.7	21.1	19.4	4.2	4.1
	5	1	8	20.7	21.2	22.6	3.9	4.0
	15	0	8	19.5	20.3	22.1	3.6	3.7
	15	1	8	20.3	21.0	29.8	3.1	3.0
5,000	5	0	8	21.5	21.7	17.2	4.5	3.9
	5	1	8	21.3	21.2	17.0	3.8	4.1
	15	0	8	20.2	20.3	21.9	4.2	4.1
	15	1	8	19.7	19.5	28.7	3.2	3.3
10,000	5	0	8	20.5	20.2	18.5	3.8	3.7
	5	1	8	20.0	19.8	20.8	4.0	4.3
	15	0	8	20.7	20.6	24.1	4.6	4.1
	15	1	8	18.5	18.0	24.6	3.9	4.0

*0 minutes time--cooking stopped when pressure is reached.

1 minute time--cooking stopped 1 minute after pressure is reached.

Table 2.--MAXIMUM TEMPERATURES RECORDED DURING COOKING IN PRESSURE SAUCEPAN.

Altitude	Pan Pressure	Time of Cooking	Cooking Trials	Maximum Temperature Fahrenheit	
				Average	Range
ft.	lbs.	min.	no.		
0	5	0	8	226.1°	224°-227°
	5	1	8	222.3	222 -227
	15	0	8	242.3	232 -246
	15	1	8	242.5	240.-248
5,000	5	0	8	219.3°	215°-222°
	5	1	8	221.3	220 -225
	15	0	8	240.0	238 -241
	15	1	8	242.1	241 -243
10,000	5	0	8	214.0°	211°-218°
	5	1	8	214.3	213 -217
	15	0	8	231.0	212 -235
	15	1	8	235.3	231 -236

The difference in ascorbic acid content of samples cooked under the different conditions of altitude, pressure and time amounted to no more than three milligrams. These differences, as discussed below, were found not to be significant.

In Figure 1, the general effect of altitude is illustrated; in Figure 2, the general effect of pressure, and in Figure 3, the general effect of time is illustrated. It will be noted that there appear to be slight variations with altitude, pressure or time, but the differences are not significant when analyzed statistically.

The palatability tests for flavor and tenderness show average values from 3.1 to 4.6 and from 3.0 to 4.3 respectively. These are judged on a possible maximum score of five.

Since a tenderometer for testing "doneness" of the peas was not available, a penetrometer was used to estimate their resistance to pressure. The penetrometer readings appeared to vary somewhat for altitude, time and pressure as seen in the average readings in Table 1; but the individual variation within any sample was great.

Statistical treatment was given to the ascorbic acid content of the samples as analyzed. The experiment was designed to permit a complete analysis of variance of the data. The variance was first

Figure 1.

Effect of altitude on the ascorbic acid content of peas.

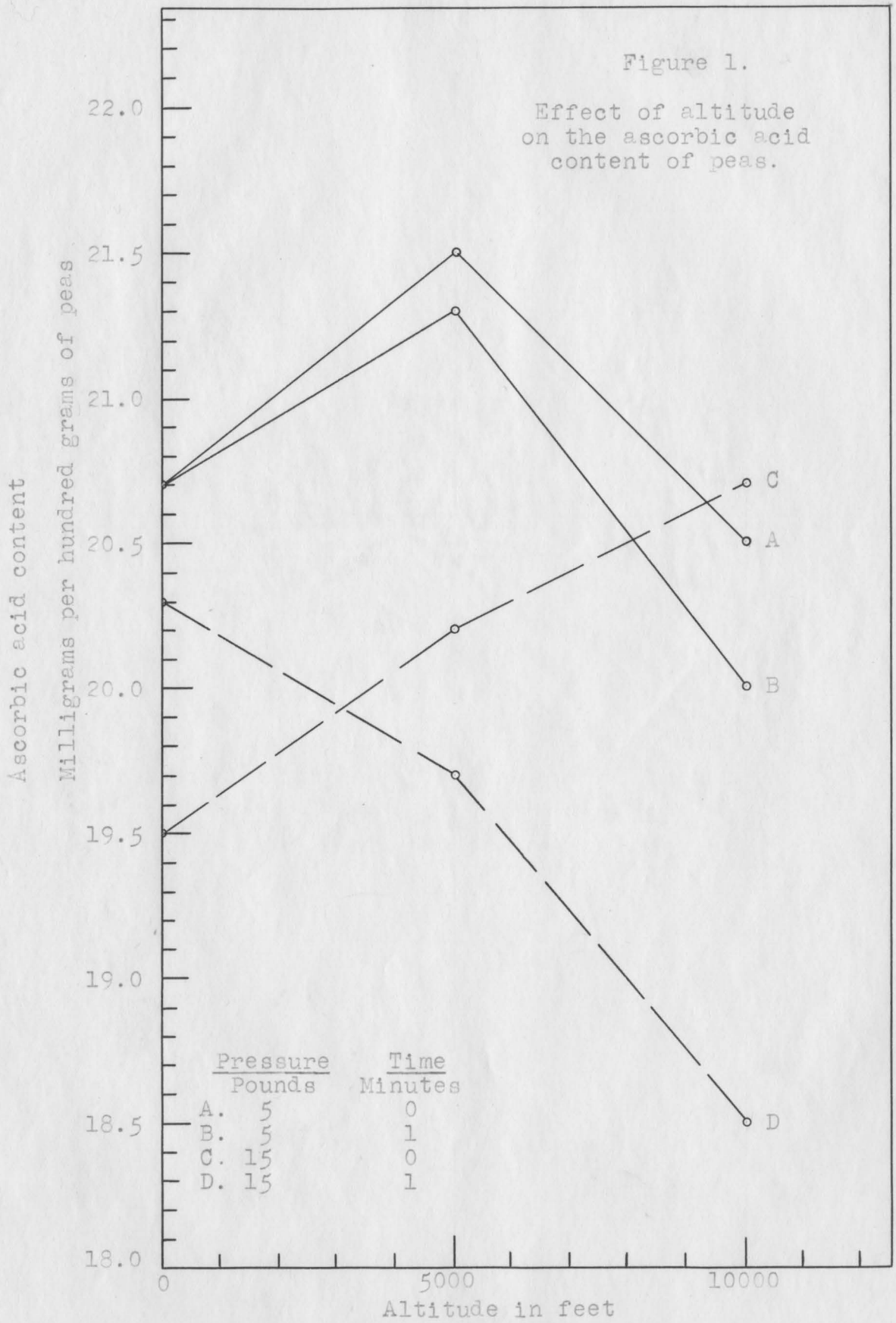


Figure 2.

Effect of pressure on the ascorbic acid content of peas.

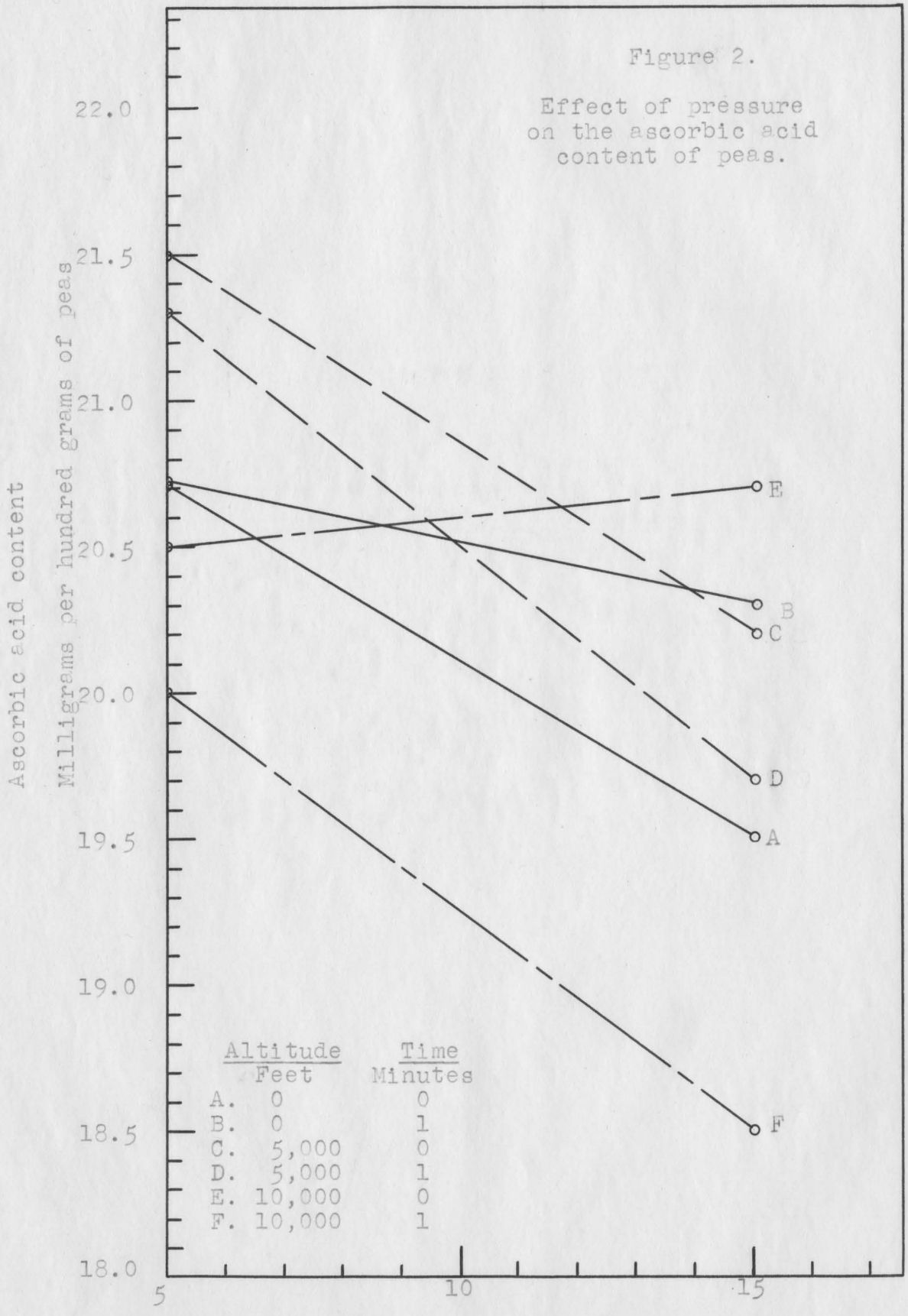
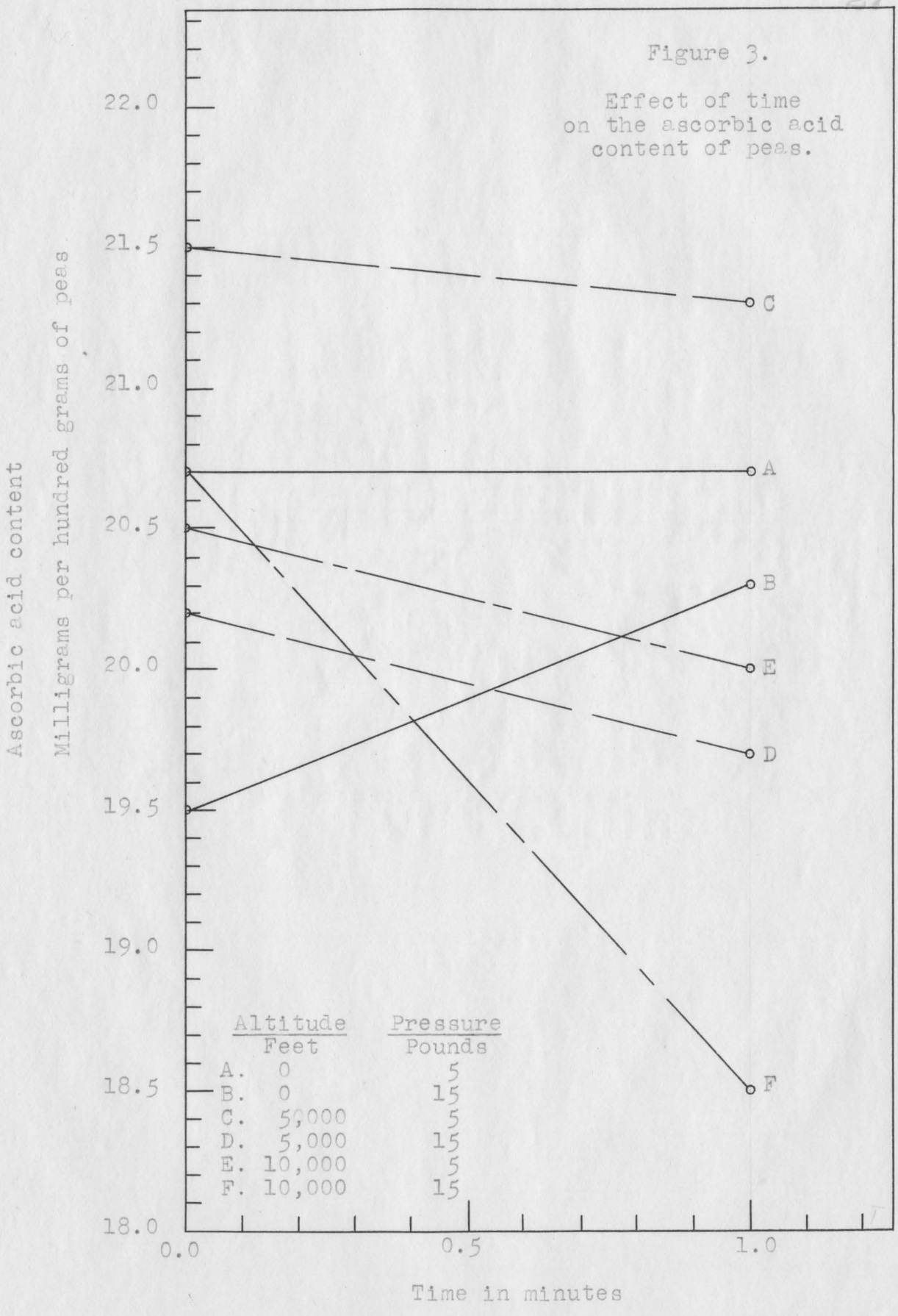


Figure 3.

Effect of time on the ascorbic acid content of peas.



analyzed to separate the variability of the replicate analysis from that resulting from all other sources combined as seen in Table 3.

Table 3.--PRELIMINARY ANALYSIS.

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Variance
Between samples	2256.76	95	23.76
Between replicate analyses within samples	451.15	288	1.57
TOTAL	2707.91	383	

Before any interpretation of these results was possible the process of complete analysis of the "Between Sample" variance was necessary to measure and remove those parts due to the effects of altitude, pressure and time, as well as their first order interactions; and also that variability introduced by the basis of sample replication (i.e.) cans of peas.

Table 4.--ANALYSIS OF VARIANCE.

Source	Sum of Squares	Degrees of Freedom	Mean Variance	F* Value	Critical Value (F)
Cans	274.94	11	24.99	1.03	(2.12)
Altitude	5.33	2	2.66	.11	(3.10)
Pressure	20.19	1	20.19	.83	(3.95)
Times	4.34	1	4.34	.18	(3.95)
Alt. x Pressure	38.84	2	19.42	.80	(3.10)
Alt. x Times	8.49	2	4.25	.18	(3.10)
Pressure x Times	25.59	1	25.59	1.05	(3.95)
Residual	1829.34	75	24.34		
TOTAL (Between samples)	2256.76	95			

*F value is the statistic which offers a basis for testing the hypothesis that two variances are equal.

The results of the tests and of the statistical calculations are discussed below.

DISCUSSION

The ascorbic acid content of the peas cooked at selected altitudes for different lengths of time and in five and 15 pounds of pressure varied only slightly. The differences between the results of this study and similar studies (Noble and Waddell 1945) made with a pressure saucepan were not entirely comparable. In some cases the ascorbic acid content of cabbage was found to increase with cooking time. However, the same authors indicated that the ascorbic acid retention of cabbage in a steamer, a tightly covered pan and the pressure saucepan did not change consistently with the time of cooking.

According to the statistical data in Table 4, the large residual variance overshadows any effect that altitude, pressure or time differences may have on ascorbic acid content. It is clear from looking at Table 4, that all results are negative as far as the main effects or interactions between them producing any variation in ascorbic acid content. The critical values of F are based on the use of a five per cent level of significance.

From Table 3, the mean variance within samples (1.57) if compared and tested against the

residual variance (24.34) from Table 4, shows the following result:

	Mean Variance	Degrees of Freedom	F Value	Critical Value (F)
Within samples (between replicate analyses)	1.57	28.8		
Residual (between samples)	24.34	95.0	15.50	1.27

The value F (15.50) is very significant indicating that replicate chemical analyses varied little and were dominated and overshadowed by other variants.

The statistical analyses indicate that the matter of cans from which the samples were taken proved to be a non-significant effect, although perhaps the most important source of variation.

It is difficult to explain the reasons for the large residual variance unless there is some, as yet unrecognized, important source of variation. The statistical data indicated that there were consistent results in ascorbic acid determinations throughout the 12 cans of peas. The variation in the maximum temperatures (Table 2) recorded for the different cooking conditions may account for some variation in the ascorbic acid content of the samples. A more constant reading was recorded for the one minute time of cooking than for the zero time. Occasionally the cooker lid appeared to leak which may have indirectly , through temperature, affected the ascorbic acid content

of the peas. The weight was placed on the cooker when the proper amount of steam was judged to be escaping from the vent and this time may have varied slightly for the successive cookings.

All cookings were systematically randomized to eliminate the effect of any unknown atmospheric condition at 5,000 feet, or other unrecognized factors.

Results of the tests for palatability as judged by flavor and tenderness are recorded in Table 1. According to the judges the flavor of the peas decreased with increased cooking time and with increased pressure at sea level and at 5,000 feet, and increased with cooking time at five pounds pressure at 10,000 feet.

Peas cooked at sea level and at 5,000 feet for zero minutes and five pounds pressure received the highest flavor scores for those altitudes, while those cooked at 15 pounds pressure for zero minutes received the highest score for samples cooked at that altitude. Although these results were not analyzed statistically they serve to indicate possible trends.

From the literature no information was found concerning penetrometer readings for cooked peas. In the absence of a tenderometer, the results of the penetrometer readings recorded in this writing are only comparative in nature. The decision of the judges did not agree with the results of the penetrometer reading in some cases, in that their judgment of tenderness

increased with decreased cooking time and pressure. There was a definite and gradual increase in tenderness as interpreted by the judges with increased cooking time at five pounds pressure at 10,000 feet, but the score was practically the same with cooking time at 15 pounds pressure.

SUMMARY

Vegetables make up a large part of the American diet and furnish appreciable amounts of ascorbic acid. Therefore preserving all the possible amount would seem important from the health as well as from the economic standpoint.

Numerous experiments in the literature indicated that cooking in a pressure saucepan was an effective method of preserving the ascorbic acid in cooked peas.

The directions for use of the pressure cooker do not suggest changes to be used for time or for pressure at various altitudes. Therefore, the object of this experiment was to determine the ascorbic acid content and palatability of peas cooked under varying conditions of altitude, pressure and time.

Groups of 8 samples from a uniform source of supply were cooked in 12 different ways. The 12 ways included were no minutes and one minute cooking time for pressures of five and 15 pounds at three altitudes, zero, 5,000 and 10,000 feet. The ascorbic acid retention was determined on the peas cooked under each of these varying cooking conditions. The data for ascor-

bic acid retention were analyzed statistically according to analysis of variance. From the results of this experiment it may be concluded that altitude, time and pressure did not affect the retention of ascorbic acid. The combined effects of the variables were also negative.

The variation from the use of successive samples for each cooking was not significant. The greatest variation was derived from an unknown source.

The results of the penetrometer and palatability tests, as related factors, probably were not significant because of the variation of individual scores within the same group.

According to the criteria used in this experiment altitude would not affect directions given for the use of the pressure saucepan in cooking frozen peas.

A P P E N D I X

Appendix A.

Photograph of altitude laboratory showing entrance to chamber and equipment for maintaining pressure, temperature and humidity.

Appendix B.

PALATABILITY SCORE FOR VEGETABLES

Vegetable_____ Date_____

Description_____ Judge_____

Quality	Sample number 1	2	3	4	5	6	7	8
Flavor								
Natural vegetable (5)								
Faint vegetable . (4)								
No flavor . . . . (3)								
Off flavor . . . (2)								
Tenderness								
Tender but firm . (5)								
Slightly tender . (4)								
Mushy . . . . . (3)								
Tough . . . . . (2)								
Remarks:								

B I B L I O G R A P H Y

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