6-1963

Relationship of aging to the shelling and quality of Southern peas, Vigna sinensis

Joe Dennis Fox

To the Graduate Council:

I am submitting herewith a thesis written by Joe Dennis Fox entitled "Relationship of aging to the shelling and quality of Southern peas, Vigna sinensis." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Food Science and Technology.

Melvin R. Johnston, Major Professor

We have read this thesis and recommend its acceptance:

Ivon E. McCarty

Accepted for the Council:
Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

May 23, 1963

To the Graduate Council:

I am submitting herewith a thesis written by Joe D. Fox entitled "Relationship of Aging to the Shelling and Quality of Southern Peas, Vigna sinensis." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Food Technology.

Melvin R. Johnston
Major Professor

We have read this thesis and recommend its acceptance:

I. E. McCarty

C. A. Buehler

Accepted for the Council:

Hilton A. Smith
Dean of the Graduate School

RELATIONSHIP OF AGING TO THE SHELLING AND QUALITY OF SOUTHERN PEAS, *VIGNA SINENSIS*

A Thesis

Presented to

The Graduate Council of

The University of Tennessee

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

---

by

Joe Dennis Fox

June 1963

28
33

ACKNOWLEDGEMENT

Sincere appreciation is expressed by the Author to Dr. Melvin R. Johnston, Major Professor, and Professor Ivon E. McCarty for their valuable guidance and criticism in the development and preparation of this thesis.

Acknowledgement is made to Dr. James O. Andes for his suggestions in the preparation of the histological material.

Appreciation is also expressed to Dr. Henry A. Fribourg for his assistance in the operation of the IBM 1620 computor.

Due acknowledgement is made to Mrs. Kathleen McCook for conducting the taste panels and to the panel members who so conscientiously served on the taste panel.

The Author wishes to express sincere thanks to the Winter Garden Freezer Company for their financial support of this work.

Sincere thanks is also expressed to my wife and children for their help and encouragement during the preparation of this thesis.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

INTRODUCTION

Food processors in Tennessee pack over half of the 50 million pounds of Southern peas processed in the Southeastern states each year. These peas account for almost 11 per cent of the total vegetables packed in the Southeastern states and are exceeded in volume only by green beans and tomatoes. Over two-thirds of the Southern peas are packed in the green pea stage of maturity (27). To be processed in the green pea stage, Southern peas are harvested by hand and hauled to the processor by truck. A major problem at this stage of handling, however, is that the peas that have been picked only a few hours do not shell easily enough to permit mechanical shelling. Processors have found that mechanical hullers can be used if the peas are allowed to age for 24 or more hours. Aging is easily accomplished by either leaving the peas on trucks or loading them onto large wagons furnished by the processor. During the aging period, heat from respiration of the peas and bacterial action causes the product temperature to increase several degrees above the ambient temperature (24).

Due to the excessively high temperatures and prolonged storage period usually encountered during this aging period, there is a high degree of probability that the quality of the peas is affected considerably. Furthermore, the storage of over 100 tons of peas for 24 hours presents economic and logistic problems. Also more and more economic pressure is being applied on the food industry to convert to continuous flow operations. However, until some means of effecting increased shellout percentages of freshly harvested peas is evolved, continuous flow of Southern peas from field to package cannot be realized.

With these factors in mind, this study was made in an attempt to:

(1) determine if aging exerts any influence on percentage shellout.

(2) study the effect of aging on certain specific quality factors.

(3) study certain morphological changes of the Southern pea pod.

LITERATURE REVIEW

Shelling

Only one reference could be found in the literature that referred to the yield of Southern peas as related to mechanical shelling. Brittingham (4) studied the differences in shellout of Southern peas as influenced by varieties and methods of shelling. He obtained maximum percentage shellout by shelling a small sample of Southern peas by hand. The percentage shellout by machine was obtained by shelling 10 pounds of peas in a small mechanical huller. He found that varietal differences affected both the maximum percentage shellout and the percentage shellout by machine. When shelled within one hour after picking, machine shelling resulted in 8.5 per cent to 47.4 per cent loss in yield over hand shelling, depending on the variety. He attributed the difference in yield between machine and hand shelling to ease with which the pods broke transversely rather than split along the longitudinal suture. The varieties in which the pods broke transversely rather than split along the longitudinal suture had the highest loss in percentage shellout.

Hoover (14) found that the maturity of the peas exerted a profound effect on the maximum percentage shellout of hand shelled Southern peas. The percentage shellout increased from 25.6 per cent to 75.7 per cent as the peas matured.

Harris (10) and Heaton (12) have indicated that they practiced storing Southern peas in a cooler overnight at approximately 35°F to increase the apparent percentage shellout. However, these workers stated that their information was based on observations and that no organized research has been conducted in this area.

Composition

Hoover (14) studied the chemical and physical changes in the Southern pea at 6 levels of maturity. He found that the percentage moisture decreased from about 84 per cent at the green snap stage to as low as 50 per cent in the mature seed. He also found that the alcohol insoluble solids increased from about 13 per cent in the green snap stage to approximately 37 per cent in the mature seed on a fresh weight basis. Furthermore, the amount of ascorbic acid decreased from 23 mg per 100 g in the green snap stage to 6.5 mg per 100 g of mature peas. Wade et al. (26) reported similar results from his study of the composition of Southern peas at 5 levels of maturity.

Jenkins (15), dealing with a more practical problem, studied the post-harvest changes in refrigerated and non-refrigerated Southern peas and found that the non-refrigerated peas lost considerably more ascorbic acid and reducing sugars than did the refrigerated peas. He found the relative ascorbic acid content to be a good index of food value and quality of Southern peas. By using the relative decrease in ascorbic acid, he found that peas held 2 days in open shade at normal summer temperatures decreased in quality enough to be undesirable for canners, food store operators, and consumers. Peas refrigerated for 2 days decreased only slightly in quality, if any at all.

Olson (19), in a related study, showed that ascorbic acid decreased in frozen foods as the storage temperature was increased. He also showed that chlorophyll decreased as the storage temperature increased and suggested that these tests may be used as a measure of quality loss.

Shepherd (22), in an associated study, showed that when vegetables are stored at different freezer temperatures, the storage life of the product decreased by a semilogarithmic factor as the temperature increased. Green beans and peas had a storage life of 10 months at 0°F but only 3 months at 10°F. According to the chart presented by Shepherd, 5 months storage at 10°F would be equivalent to about 2 years at 0°F. He also found that the color of both strawberries and green beans deteriorated as the storage temperature or time was increased. For some products, especially vegetables, the color changed at a faster rate than the flavor.

Morphology

The legume has 2 lines of dehiscence, one through the union of the carpel margin, and the other along the median vascular bundle. Cell division may precede the dehiscence. The break then occurs through the band of thin-walled cells in the dehiscence region. The shape of the cells and character of the micellar structure of walls have also been related to dehiscence (6). Holden (13), moreover, found that the cells in areas of dehiscence contain large amounts of hemicellulose and pectic substances. Preceding dehiscence, there is a softening of the cell walls and of the middle lamella which results from a change in the hemicellulose of the cell walls and in the pectic substances of the middle lamella during ripening.

Sensory Testing

In recent years, sensory testing has become an intgral part of practically every research problem involving a food product. Boggs and Hanson (3) presented an excellent review and evaluation of sensory tests involving differences in flavor, texture, or other components of quality. They concluded that in order to obtain high accuracy, experiments should be designed to: (1) minimize within sample variation; (2) limit the number of samples and the characteristics of each that are to be judged in one period; (3) submit at one time all samples for which comparative data are desired; (4) relate experimental samples with control samples; (5) mask all characteristics except the one under consideration; (6) eliminate samples of strong odor and flavor when possible; (7) judge sufficient replications to show that trends can be repeated or replicate sufficiently so that the data can be analyzed statistically.

Sather and Calvin (21), dealing with another aspect of sensory testing, evaluated the effect of the number of judgements made at each setting on the ability of the judges to discriminate between samples. They found that when mild foods such as green beans, hamburger, or peaches were evaluated, up to 20 samples could be included in one test period with no decrease in the judges' ability to discriminate flavor preferences among samples.

Gridgeman (9), studying the methodology of sensory testing, made a comparative study of three common experimental designs used for the detection of small differences in foods. The three designs included were paired tests (which sample is preferred?), the duo-trio tests (which of two coded samples is identical with the third or standard sample?), and the triangle test (which of the three aliquots is odd?). The results of the experiment suggest that paired tests and triangle tests are normally about equally significant and appreciably superior to duo-trio tests. Byer and Abrams (2), however, found that for certain foods, the paired tests were superior to the triangle test.

Kramer and Ditman (16), similarly, found that a simplified variables was superior to an attributes method such as the triangular taste test in detecting flavor differences. Moreover, the simplified variables test requires substantially fewer tastings, and at the same time provides additional information on the direction and importance of the differences.

Two studies indicate that a constantly utilized criteria is necessary for accuracy in sensory testing. In his work with wines, for example, Filipello (7) found that if no immediate comparison was available, the judge's memory provided a poor measure of standards of quality. Tilgner (25), in a more general study, reports that accuracy in quality scoring could be substantially improved if objective standards were available to the grader for ready reference in restandardization.

Specific examples of the application of sensory testing are given by Buch and associates and by Fry. Buch *et al*. (5), in an organoleptic evaluation of applesauce, used a type of paired comparison test in which a control was given an arbitrary score of 5 and all other samples were scored on a 10 to 1 scale as referenced to the control.

Fry (8) has used a similar type of paired comparison test on potatoes. She gave the control a value of zero and instructed the panel members to grade the other samples as follows:

1 - slightly different,

2 - moderately different,

3 - extremely different, as referenced to the control.

MATERIALS AND METHODS

Two varieties of Southern peas were used in this work. The purple hull blackeye and the purple hull crowder peas were used for all treatments.

During the summer of 1961, several trial experiments were conducted in an effort to determine if the application of artificial heat would increase the shellout of Southern peas after a short period of treatment. The treatments were as follows: dry heat (90°C) for 10, 20, 30, and 90 minutes; steam for 1, 2, and 3 minutes; direct flame from a gas burner for 1, 2, and 3 minutes; pressure-vacuum treatment; and sweated and laid out. The peas were shelled in a junior pea huller which will be discussed below.

Peas used in this study were grown during the spring of 1962. Two plantings each of purple hull blackeye and purple hull crowder peas were made on May 9 and May 31 respectively. Each planting contained one-fourth acre of each variety of Southern peas giving a total of 1 acre of peas. The plantings were made on the University of Tennessee Cherokee farm on a first bottom near Ft. Loudon lake. The peas were fertilized with 500 pounds of 6-12-12 fertilizer per acre at the time of planting. Weeds were controlled by cultivation and irrigation was used when needed. Additional peas, grown under almost identical environmental conditions, were obtained from a grower in Sevier county. The first peas were picked on July 23, and all treatments had been picked and shelled by August 17, 1962.

Southern peas are usually processed after the pods develop a deep reddish-purple color but before the peas lose their light green color and become hard. As soon as the peas reach this stage of maturity, they were picked by hand into bushel baskets and immediately moved into the Food Technology building for processing. The maximum length of time between picking and processing was about 2 hours.

The peas were dumped from the bushel baskets onto a concrete floor and thoroughly mixed to insure homogeneity. From the composite sample of peas, lots of 10 pounds each were weighed. One 10 pound sample was shelled immediately for control. The peas to be left lying out were placed into loose piles on racks in the processing room. The peas to be sweated were packed into 15 quart corrugated boxes measuring 8-1/2 X 8-1/2 X 13-1/2 inches. A thermocouple was placed in the center of the boxes and their tops closed with masking tape but were not vapor proofed. The peas were stored in the processing room for designated periods prior to shelling. Each variety was replicated as follows:

Blackeye Peas

Replicates I and II	Picked July 23, 1962.
Replicate III	Picked July 30, 1962.
Replicate IV	Picked August 12, 1962.

Crowder Peas

Replicate I	Picked August 8, 1962.
Replicates II and III	Picked August 14, 1962.
Replicate IV	Picked August 15, 1962.

Each replicate was treated in the following manner:

Blackeye Peas

Sweated 18, 24, and 40 hours.

Laid Out 18, 24, and 40 hours.

Crowder Peas

Sweated 21, 28, and 44 hours.

Laid Out 21, 28, and 44 hours.

After treatment, the peas were again weighed and the weight recorded.

Samples of 2 or 3 pods were randomly selected from each treatment for histological studies. Pods at different stages of maturity had been taken earlier in the field to be used for comparison. All pods were cut into three-fourth inch lengths and immediately placed in a solution of the following mixture:

5 ml Formalin

5 ml Glacial acetic acid

90 ml 80 per cent Ethyl alcohol.

The samples were left in the above killing solution until histological studies could be made.

The temperature of the peas being sweated was taken at random intervals along with the ambient temperature. The temperature measurement was made with a thermocouple-direct reading potentiometer.

All peas were shelled in a Dixie huller with a beater speed of 450 RPM and a screen diameter of one-half inch (Fig. I). The peas were fed into the huller within a period of 30 seconds and the huller operated for another 30 seconds. Only the peas that had been removed during the 1 minute period of operation were used in the experiment.

The peas were first gathered up and cleaned by allowing them to fall in front of a fan which removed most of the pieces of hull and other trash. The peas were further cleaned by hand and weighed. After the peas were weighed, a 12 to 16 ounce sample was removed and placed in a polyethylene bag and frozen at -20°F. After being frozen, the peas were stored at 0°F until moisture and alcohol insoluble solids could be determined. Another 50 g of peas were placed in a 7 per cent metaphosphoric acid solution for the ascorbic acid determination.

The blackeye peas were washed in cold water, then blanched in steam for 4 minutes. The crowder peas were blanched in boiling water for 3 minutes after they were washed. All peas were cooled under cold water, drained, and placed in waxed paperboard boxes of 350 g each. The boxes were overwrapped with waxed paper and the peas frozen at -20°F. After the peas were frozen, they were stored at 10°F until needed for organoleptic tests.

The ascorbic acid was determined according to a modification of the procedure of Loeffler and Ponting (17). The modification was as follows: 50 g of peas were placed in 50 ml of 7 per cent metaphosphoric acid. The peas were blended in an Osterizer for 2 minutes and refrigerated at 32°F for 5 minutes to lower the pressure inside the jar. Three hundred ml of distilled water were added to the sample, and the sample was again osterized for 1 minute at low speed. The solids were allowed to settle for 20 minutes and the solution filtered through Whatman number 1

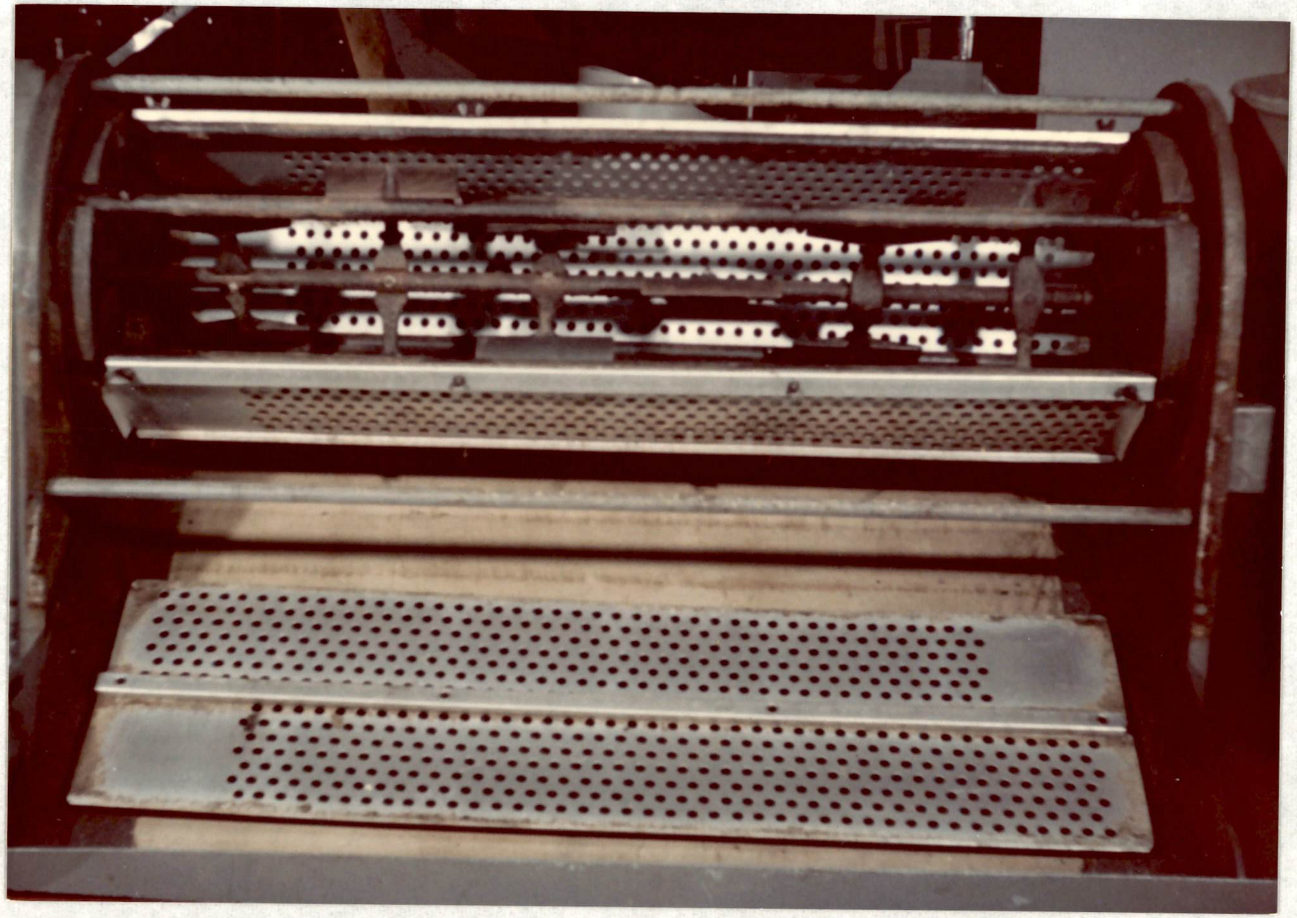


PLATE I

BEATER ASSEMBLY OF THE DIXIE HULLER

filter paper. The first 25 ml were discarded and the next 10 ml collected. A 1 ml aliquot was used for the assay.

During the months of January and February, 1963, peas for moisture and alcohol insoluble solids were ground in a hammer mill through a 0.066 inch sieve while still frozen at 0°F. After grinding, the peas were placed in bottles, sealed, removed from the freezer, and thawed to room temperature. The peas were mixed and triplicate 10 g samples removed for moisture determination. The samples were placed in small uncovered tins, predryed for 12 hours at 70°C, covered with a lid and placed in a vacuum oven at 70°C and 29 inches vacuum and dried to a constant weight as recommended by the National Canners Association Laboratory Manual (18). The tins were placed in a desiccator, cooled, and immediately weighed.

Peas for alcohol insoluble solids determination were taken from the thawed samples mentioned above. Twenty g were weighed in duplicate, placed in a reflux beaker with 300 ml of 80 per cent ethyl alcohol and refluxed for 30 minutes. The hot sample was filtered through a Whatman number 1 filter paper and dried in an uncovered tin at 100°C for 2 hours (1). The tins were covered before being removed from the oven and placed in a desiccator to cool prior to being weighed.

During the months of January through March, 1963, peas were removed from the killing solution and cut into short lengths containing one pea ovule each. The sections were dehydrated and infiltrated with paraffin by using dioxane as the dehydrating agent and solvent. The samples were embedded in paraffin and cut into slices 15 to 20 microns in thickness. The tissue slices were attached to slides with egg albumin and stained with a general stain, hemalum, as recommended by Sass (20).

The peas for organoleptic evaluation were removed from the freezer during the months of February and March, 1963. The samples were allowed to thaw for a few minutes before being opened and coded. Members of the taste panel were asked to evaluate the peas for color prior to cooking. After evaluation for color, 350 g of peas were placed in three-fourth cup of boiling water containing 0.7 per cent sodium chloride. The water was again brought to a boil and the peas simmered for 30 minutes. After the peas were cooked, they were placed in custard dishes and served to the panel while warm. Evaluations were made on color before cooking, and flavor, color, and texture after cooking, according to the following scale:

plus 3 - much better than the control.

plus 2 - better than the control.

plus 1 - slightly better than the control.

zero - same as the control.

minus 1 - slightly worse than the control.

minus 2 - worse than the control.

minus 3 - much worse than the control.

The panel members were instructed to rate the samples on color and flavor according to their own personal preference as related to the control. Texture was rated on the degree of starchiness or hardness in relation to the control with excessive hardness or starchiness being undesirable. All treatments of each replicate were judged at one time giving seven different samples to each judge at each sitting (21). Color evaluations and the flavor and texture evaluations were made on separate score sheets in an attempt to minimize prejudice between the factors. Each panel member was given a glass of water for rinsing his mouth at his convenience. The taste panel consisted of staff members and technicians working in the Food Technology building.

In addition to the taste panels' evaluation of the color of the uncooked peas, their color was also evaluated on the Hunter Color and Color Difference Meter using the white standard number D25-230.

Where applicable, the data was statistically analyzed using the analysis of variance and/or Duncan's multiple range test. The analysis of variance was conducted according to the methods of Snedecor (23) and the Duncan's multiple range was conducted on a 1620 computer according to the tables in Biometrics (11).

EXPERIMENTAL RESULTS

Physical Measurements

Preliminary Results

Since no previous research has been conducted on the effect of various treatments on the shellout of Southern peas, several preliminary experiments were conducted. Southern peas were given a variety of treatments in an effort to find a starting point for the research. Table I shows the results of these experiments.

In experiments where high temperatures were used, such as 90°C dry heat, steam, or flame, the percentage shellout was less than the control. The samples with the most severe heating had the greatest decrease in yield while peas with less severe heating decreased only slightly in yield. For example, peas heated for 90 minutes at 90°C gave a yield of approximately half that of the control. Furthermore, heating at high temperatures even for short periods of time, still gave yields slightly lower than the controls.

Another treatment, 15 pounds pressure decreased to 27 inches of vacuum in less than 30 seconds, was used to loosen the pod and thus increase the shellout of peas. The results of this treatment showed that no differences in percentage shellout occurred between control and treated peas.

Finally, some of the peas were sweated in a closed container and some were laid out in the open room. The yield of the peas from the closed container showed an increase of 53 per cent after being sweated

TABLE I

THE INFLUENCE OF VARIOUS TREATMENTS ON THE SHELLOUT OF SOUTHERN PEAS

Treatment		Total Shellout in Ounces						
		1	2	3	4	5	6	7
Control		56	68	90	48	54	52	38
Heat 90°C	10 min.		66	84				
	20 min.		58	87				
	30 min.	50	54	79	40	50	51	
	90 min.	29						
Steam	1 min.				44			
	2 min.			90	36			
	3 min.				36	48	50	
Flame	30 sec.	49						
	60 sec.			82				
	90 sec.		60					
Pressure-vacuum		56	68					
L.O.	18 hrs.							40
	24 hrs.					64	62	38
S.W.	18 hrs.							44
	24 hrs.							42
	48 hrs.					74	80	

for 48 hours. There was almost a 20 per cent increase in yield of peas from the 24 hour laid out treatment.

After the results of the preliminary experiments were studied, it was decided to discontinue those treatments using artificial heating. The two treatments that had given increased shellout of peas were to be studied in more detail.

Temperature of Peas During Treatment

Blackeye peas. The temperature was taken at random intervals of the sweating peas and of the room. These data, solid line for peas and broken line for room temperature, are plotted in Figure 1. In each replicate, the temperature increased very rapidly for approximately 7 hours when a maximum temperature was reached then decreased to near ambient at the end of the treatment. The highest temperature, 105.7°F, was recorded in replications I and II, and the lowest temperature, 91.3°F, was recorded in replication III. Ambient temperature fluctuated between 77°F and 86°F during the treatment period.

Crowder peas. The heating curves of crowder peas were very similar to blackeye peas (Figure 2). The temperature of the product increased rapidly to a maximum of 98°F in 8 hours followed by a gradual decrease for about 16 hours. Data of replications II and III indicate a secondary heating period of about 10 hours before decreasing to near ambient. Replication IV had the highest temperature with a maximum of 98°F. Replications II and III was lowest with 91.5°F. The temperature of the treatment room ranged between 75°F and 84°F for the treatment

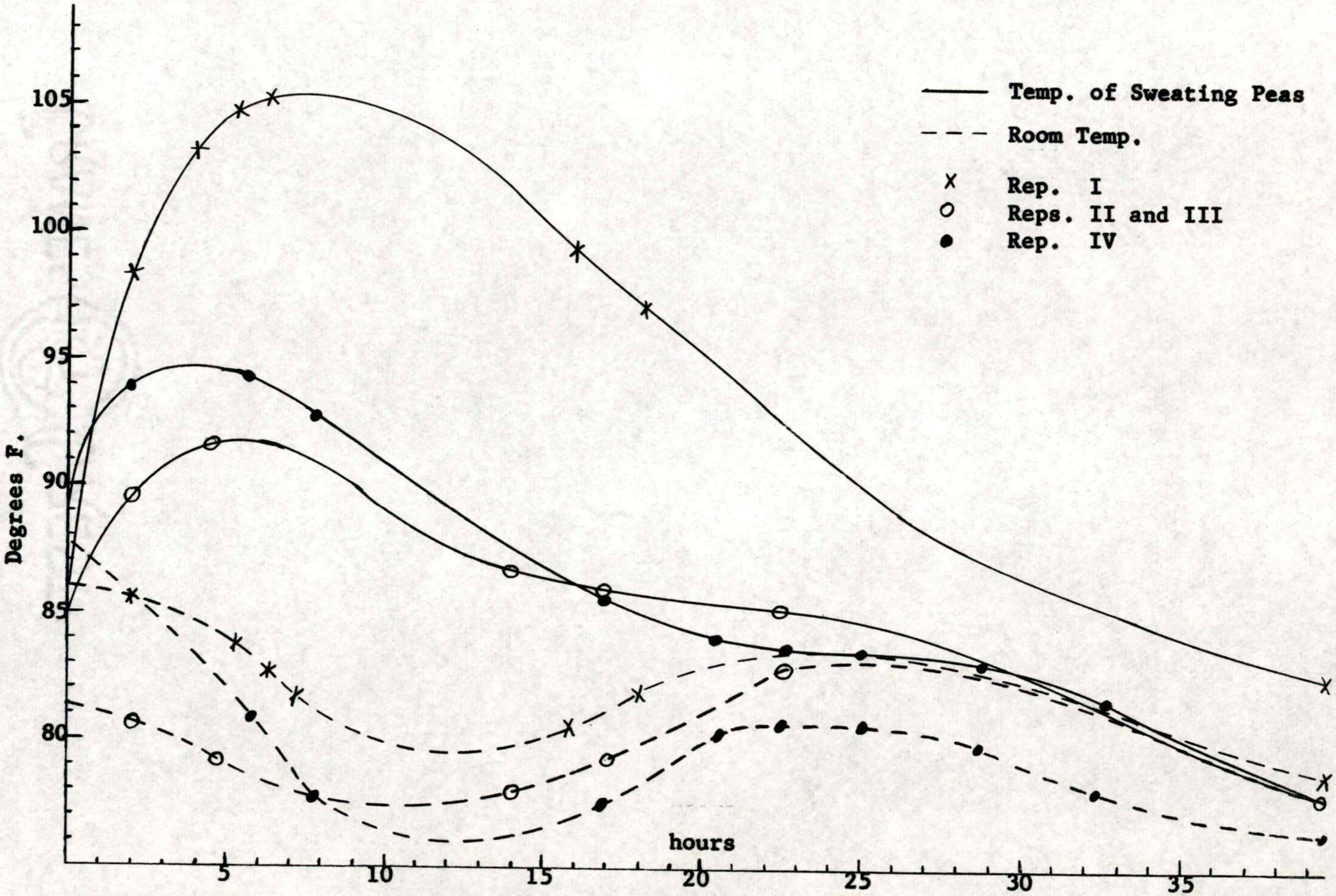


FIGURE 1

TEMPERATURE OF THE ROOM AND OF BLACKEYE PEAS DURING SWEATING

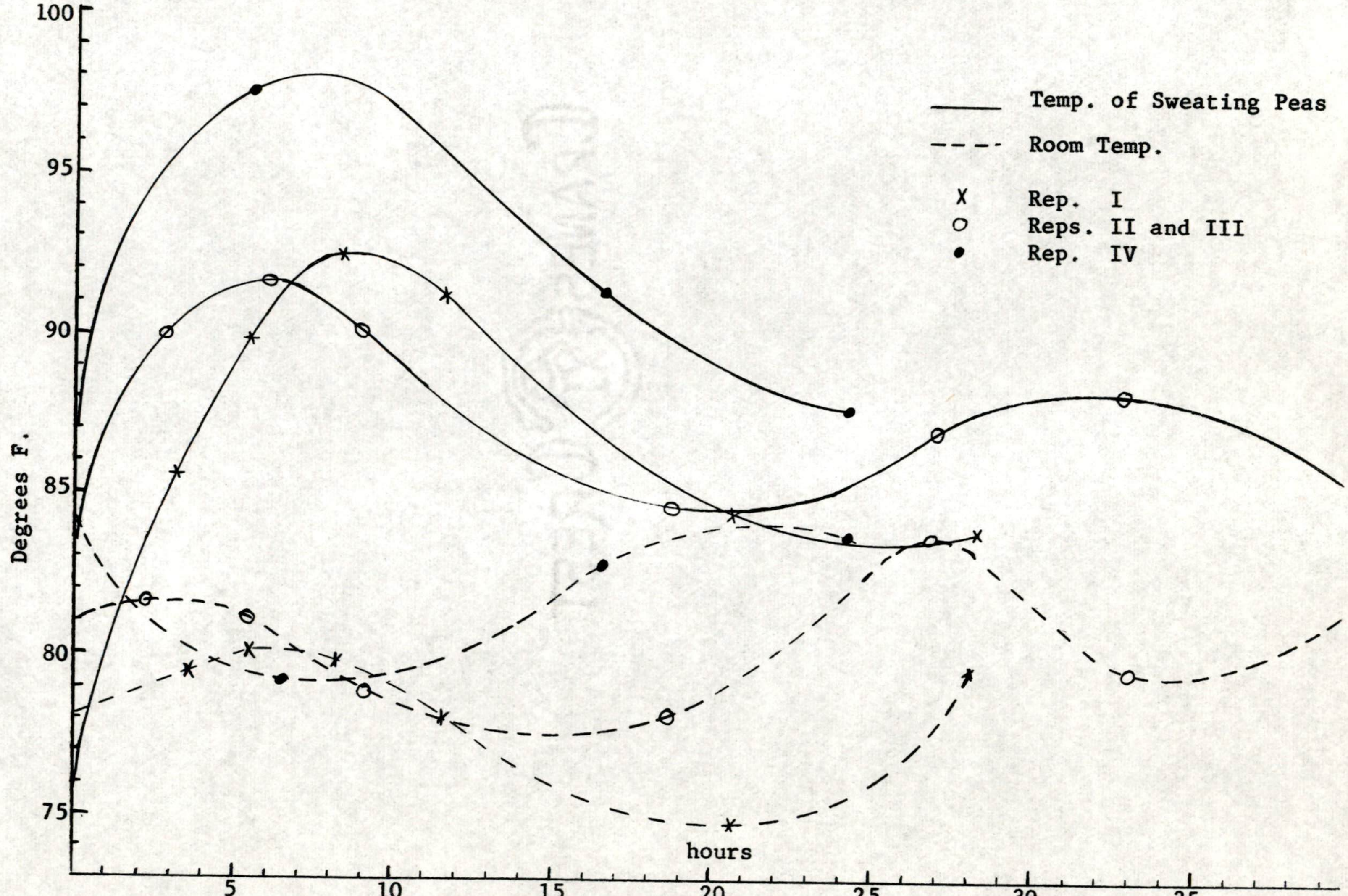


FIGURE 2

TEMPERATURE OF THE ROOM AND OF CROWDER PEAS DURING SWEATING period.

Weight Loss of Unshelled Peas

Blackeye peas. Both treatment and duration of treatment affected the loss in weight of the unshelled peas. Table II shows that peas laid out lost considerably more weight than the peas sweated in an enclosed container. Peas laid out 18 hours lost 17.25 ounces or a decrease in weight of 10.78 per cent; whereas those laid out 40 hours lost 36.5 ounces or 22.81 per cent of the original weight. The maximum weight loss in sweated peas occurred in those sweated 40 hours. In this sample, the weight loss was 13.25 ounces or a decrease of 8.28 per cent. All treatments were significantly different except sweated 18 and 24 hours at the 0.05 level of probability. The 0.05 level of probability was used in all the statistical analysis of this experiment.

Crowder peas. There was little difference between the weight loss of crowder and blackeye peas. The maximum weight loss occurred in the peas which were laid out. The peas laid out 44 hours lost 32.25 ounces or 20.15 per cent decrease in weight (Table III). The peas sweated 44 hours lost only 12.25 ounces or a loss of 7.65 per cent. There was a significant difference between all treatments except peas sweated 21 and 28 hours.

Shellout

Blackeye peas. The aging treatments resulted in an increase in shellout over the control. Table IV shows that lying out 40 hours

TABLE II

THE INFLUENCE OF VARIOUS TREATMENTS
ON THE WEIGHT LOSS OF UNSHELLED BLACKEYE PEAS

	Weight Loss in Ounces						
Replicate	Cont.	SW 18	SW 24	SW 40	LO 18	LO 24	LO 40
1	0	9	12	13	18	24	34
2	0	9	12	14	20	24	36
3	0	6	7	12	16	26	40
4	0	7	9	14	15	26	36
Total	0	31	40	53	69	100	146
Mean	0	7.75	10	13.25	17.25	25	36.50
Aver. % Decrease	0	4.84	6.25	8.28	10.78	15.62	22.81
Statistical significance .05 level		________	________				

Summary of Analysis of Variance

Source	D.F.	M.S.	F. Ratio
Total	27		
Replication	3	2.03	.61
Treatment	6	579.81	176.77 **
Remainder	18	3.28	

TABLE III

THE INFLUENCE OF VARIOUS TREATMENTS ON THE WEIGHT LOSS OF UNSHELLED CROWDER PEAS

	Weight Loss in Ounces						
Replicate	Cont.	SW 21	SW 28	SW 44	LO 21	LO 28	LO 44
1	0	9	11	13	19	29	38
2	0	6	6	13	15	18	29
3	0	7	8	11	13.5	17	28
4	0	7	10	12	15	20	34
Total	0	29	35	49	62.5	84	129
Mean	0	7.25	8.75	12.25	15.62	21.00	32.25
Aver. % Decrease	0	4.53	5.46	7.65	9.76	13.12	20.15
Statistical significance .05 level		————	————				

Summary of Analysis of Variance

Source	D.F.	M.S.	F. Ratio
Total	27		
Replication	3	35.29	7.24 **
Treatment	6	437.85	89.90 **
Remainder	18	4.87	

resulted in the least increase in shellout (11 per cent) over the control. Sweating 24 hours, however, gave an increase of 29.47 per cent over the control. There were large differences between the shellout in ounces of the peas from the various treatments. However, when the weight of the peas was corrected for differences in moisture, the differentials were greatly reduced. After these corrections, peas laid out 18 hours had the lowest shellout (74.6 ounces), and the peas sweated 24 hours exhibited the largest shellout (77.9 ounces), when the control was excluded. Thus there was a maximum difference of only 3.3 ounces between treatments.

There is a significant difference between the control and all other treatments except laid out 40 hours. There were also differences between peas laid out 40 hours and all sweated peas. However, after the yields were corrected to a constant moisture content, the only significant difference in yield was between the control and all other treatments.

Crowder peas. There was a slight difference between the shellout of blackeye and crowder peas. Lying out 21 hours gave the least increase in shellout with a yield of 57.5 ounces or an increase of 13 per cent over the control (Table V). The greatest increase in shellout occurred in the peas sweated 44 hours. These peas gave a yield of 74.5 ounces or an increase of 46.79 per cent over the control. Yet, when the yields of peas were corrected for differences in moisture, no change occurred in the ranking of the yields.

Analysis of the data indicates there are significant differences

TABLE IV

THE INFLUENCE OF VARIOUS TREATMENTS ON THE SHELLOUT OF BLACKEYE PEAS

	Total Shellout of Peas in Ounces						
Replicate	Cont.	LO 40	LO 24	LO 18	SW 40	SW 18	SW 24
1	66.0	77.0	77.0	78.5	84.0	83.0	85.5
2	67.5	74.0	80.0	84.0	83.0	87.5	85.0
3	68.0	72.0	77.0	77.0	83.0	80.0	83.0
4	44.0	52.0	59.0	59.0	62.0	63.0	64.5
Total	245.5	275.0	293.0	298.5	312.0	313.5	318.0
Mean	61.4	68.75	73.25	74.6	78.0	78.4	79.5
Statistical significance .05 level							

Summary of Analysis of Variance

Source	D.F.	M.S.	F. Ratio
Total	27		
Replication	3	172.52	5.71 **
Treatment	6	213.43	7.06 **
Remainder	18	30.21	

TABLE V

THE INFLUENCE OF VARIOUS TREATMENTS ON
THE SHELLOUT OF CROWDER PEAS

	Total Shellout of Peas in Ounces						
Replicate	Cont.	LO 21	LO 28	LO 44	SW 21	SW 28	SW 44
1	48.0	51.0	52.0	56.0	58.0	64.0	72.0
2	53.0	54.0	56.0	61.0	61.0	66.0	73.0
3	49.0	56.0	54.0	61.5	59.0	65.0	73.0
4	53.0	69.0	70.0	69.0	71.0	73.0	80.0
Total	203.0	230.0	232.0	247.5	249.0	268.0	298.0
Mean	50.75	57.50	58.0	61.87	62.25	67.0	74.5
Statistical significance .05 level		————	————				
			————	————			
				————	————		

Summary of Analysis of Variance

Source	D.F.	M.S.	F. Ratio
Total	27		
Replication	3	192.58	29.90 **
Treatment	6	228.99	35.55 **
Remainder	18	6.44	

between all samples except: laid out 21 and 28 hours, laid out 28 and 44 hours, and laid out 44 and sweated 21 hours. The statistical significance was not affected when the yield was corrected for moisture differences.

Composition

Moisture Content

Blackeye peas. The various treatments exhibited a slight effect on the moisture content of the peas. The moisture content of the blackeye peas ranged from 49.05 per cent for the peas laid out 40 hours to 54.94 per cent for peas sweated 24 hours (Table VI). Statistical analysis of the data shows a significant difference between samples laid out 40 hours and all others except those laid out 24 hours. Also, those laid out 24 hours and all other samples except peas laid out 18 and 40 hours were significantly different.

Crowder peas. The effect of the several treatments on the moisture content of crowder peas was very similar to that of blackeye peas. Table VII shows that moisture ranged from 62.83 per cent for peas laid out 44 hours to 65.85 per cent for the peas sweated 44 hours. The moisture content of peas laid out 44 hours and 28 hours was significantly less than any other treatment. The peas sweated 44 hours contained significantly more moisture than any of the other treatments except the control.

TABLE VI

THE INFLUENCE OF VARIOUS TREATMENTS ON THE PERCENTAGE WATER IN BLACKEYE PEAS

	Percentage Water in Peas						
Replicate	LO 40	LO 24	LO 18	Cont.	SW 40	SW 19	SW 24
1	49.13	50.77	52.25	53.59	51.00	54.36	55.16
2	48.63	51.46	51.00	52.51	53.97	52.78	50.47
3	46.17	49.90	52.70	54.67	55.11	55.79	55.14
4	52.28	52.27	56.39	55.63	57.06	56.82	59.01
Total	196.21	204.40	212.34	216.40	217.14	219.75	219.78
Mean	49.05	51.10	53.08	54.10	54.28	54.93	54.94
Statistical	———	———					
significance		———	———				
.05 level			———	———	———	———	———

Summary of Analysis of Variance

Source	D.F.	M.S.	F. Ratio
Total	27		
Replication	3	22.29	9.60 **
Treatment	6	19.70	8.49 **
Remainder	18	2.32	

TABLE VII

THE INFLUENCE OF VARIOUS TREATMENTS ON THE PERCENTAGE WATER IN CROWDER PEAS

	Percentage Water in Peas						
Replicate	LO 44	LO 28	LO 21	SW 21	SW 28	Cont.	SW 44
1	63.86	64.65	65.86	66.64	67.15	67.17	67.73
2	64.75	63.99	67.31	66.25	66.01	65.99	68.46
3	65.92	65.96	66.44	66.90	66.27	67.40	67.84
4	56.80	57.36	58.14	58.13	59.50	59.10	59.37
Total	251.33	251.96	257.75	257.92	258.93	259.66	263.40
Mean	62.83	62.99	64.43	64.48	64.73	64.91	65.85
Statistical significance .05 level	________	________					
			________	________	________	________	
						________	________

Summary of Analysis of Variance

Source	D.F.	M.S.	F. Ratio
Total	27		
Replication	3	111.6	214.61 **
Treatment	6	4.34	8.40 **
Remainder	18	.5166	

TABLE VIII

THE INFLUENCE OF VARIOUS TREATMENTS ON THE PERCENTAGE ALCOHOL INSOLUBLE SOLIDS IN BLACKEYE PEAS

	Percentage Alcohol Insoluble Solids, Fresh Weight						
Replicate	SW 24	SW 18	SW 40	Cont.	LO 18	LO 24	LO 40
1	38.13	38.59	42.09	40.28	39.69	42.67	43.94
2	41.94	39.97	38.81	40.51	41.35	41.07	43.99
3	38.55	38.47	38.97	38.76	40.84	43.62	46.90
4	35.58	37.35	37.40	38.19	38.12	41.58	41.54
Total	154.20	154.38	157.27	157.74	160.00	168.94	176.37
Mean	38.55	38.59	39.31	39.43	40.00	42.23	44.09
Statistical significance .05 level	————	————	————	————	————	————	————

Summary of Analysis of Variance

Source	D.F.	M.S.	F. Ratio
Total	27		
Replication	3	9.99	5.28 *
Treatment	6	17.26	9.13 **
Remainder	18	1.89	

TABLE IX

THE INFLUENCE OF VARIOUS TREATMENTS ON THE PERCENTAGE ALCOHOL INSOLUBLE SOLIDS IN CROWDER PEAS

	Percentage Alcohol Insoluble Solids, Fresh Weight						
Replicate	SW 44	Cont.	SW 21	SW 28	LO 44	LO 28	LO 21
1	27.25	27.86	28.96	28.97	30.89	31.29	29.44
2	28.18	29.22	27.57	28.87	30.31	31.08	31.27
3	26.68	29.42	29.24	28.89	32.27	31.20	31.76
4	34.96	36.47	37.25	38.01	36.87	37.68	39.35
Totals	117.07	122.97	123.02	124.74	130.34	131.25	131.82
Means	29.26	30.74	30.75	31.18	32.58	32.81	32.95
Statistical significance 0.05 level		________	________	________			
					________	________	________

Summary of Analysis of Variance

Source	D.F.	M.S.	F. Ratio
Total	27		
Replication	3	103.61	130.4 **
Treatment	6	7.48	9.4 **
Remainder	18	.795	

Alcohol Insoluble Solids

Blackeye peas. The various treatments had little affect on alcohol insoluble solids of blackeye peas (Table VIII). The only significant difference was between peas laid out 24 and 40 hours and the other treatments. However, when the percentage alcohol insoluble solids was corrected for moisture differences, there was only 1 per cent difference between all treatments.

Crowder peas. Different treatments had slightly greater influence on the alcohol insoluble solids of crowder peas than on blackeye peas. Percentage alcohol insoluble solids in crowder peas ranged from 29.26 per cent in peas sweated 44 hours to 32.95 per cent in peas laid out 21 hours (Table IX). There was a significant difference between the percentage alcohol insoluble solids in the peas laid out 21, 28, and 44 hours and those receiving other treatments. Peas sweated 44 hours had a significantly lower percentage alcohol insoluble solids than all other treatments. When the percentage alcohol insoluble solids was corrected for differences in moisture, the differences were small.

Ascorbic Acid

Blackeye peas. The ascorbic acid content of blackeye peas decreased considerably during the treatment period. Thirty-six per cent of the ascorbic acid was destroyed when the peas were laid out 18 hours, and one-half the ascorbic acid was lost when peas were sweated 18 hours. After 40 hours of either lying out or sweating, over 70 per cent of the

TABLE X

THE INFLUENCE OF VARIOUS TREATMENTS ON THE ASCORBIC ACID CONTENT OF BLACKEYE PEAS

	Milligrams of Ascorbic Acid per 100 grams Peas						
Replicate	SW 40	LO 40	SW 24	SW 18	LO 24	LO 18	Cont.
1	4.8	6.6	9.3	11.5	11.6	13.5	20.4
2	4.9	5.8	9.2	10.1	11.0	13.3	24.5
3	10.0	8.7	9.5	9.0	9.6	12.2	14.3
4	1.7	2.2	9.0	9.3	9.2	11.6	20.8
Total	21.4	23.3	37.0	39.9	41.4	50.6	80.0
Mean	5.35	5.82	9.25	10.0	10.35	12.7	20.0
Statistical significance .05 level	———	———					
		———	———				
			———	———	———	———	

Summary of Analysis of Variance

Source	D.F.	M.S.	F. Ratio
Total	26		
Replication	3	40.07	6.68 **
Treatment	6	79.91	13.34 **
Remainder	17	5.99	

TABLE XI

THE INFLUENCE OF VARIOUS TREATMENTS ON THE ASCORBIC ACID CONTENT OF CROWDER PEAS

	Milligrams of Ascorbic Acid per 100 grams Peas						
Replicate	LO 44	SW 44	SW 28	SW 21	LO 21	LO 28	Cont.
1	18.39	17.38	18.95	22.47	24.18	22.08	28.34
2	8.86	12.33	19.08	17.65	20.22	18.17	25.16
3	10.22	13.03	17.99	17.09	17.07	19.21	25.54
4	8.54	7.40	9.32	11.04	9.25	12.27	24.81
Total	46.01	50.14	65.34	68.25	70.72	71.73	103.85
Mean	11.50	12.53	16.33	17.06	17.68	17.93	25.96
Statistical significance .05 level	______	______					
			______	______	______	______	

Summary of Analysis of Variance

Source	D.F.	M.S.	F. Ratio
Total	27		
Replication	3	114.54	25.06 **
Treatment	6	88.17	19.29 **
Remainder	18	4.57	

ascorbic acid was destroyed. Table X shows the effect of the various treatments on ascorbic acid content.

All treated peas contained significantly less ascorbic acid than the control. Peas laid out 40 hours contained significantly less ascorbic acid than other treatments except samples sweated 24 and 40 hours. Peas sweated 40 hours contained significantly less ascorbic acid than all others except those laid out 40 hours.

Crowder peas. As in blackeye peas, the ascorbic acid content of crowder peas decreased considerably during the treatment period. The ascorbic acid content of crowder peas did not decrease as rapidly as in blackeye peas (Table XI). After 44 hours of treatment, approximately 55 per cent of the ascorbic acid had been lost.

Statistical analysis of the data shows that all treated peas contained significantly less ascorbic acid than the control. The greatest loss occurred in peas laid out and those sweated 44 hours.

Morphology

Several tissue sections were made of Southern pea fruit to observe the development of longitudal sutures in the fruit wall or hull. Plate II illustrates the suture formation through the median vascular bundle. The placenta of a pea ovule may be seen in the lower center of the plate. The suture extends almost through the median vascular bundle, and only thin walled parenchymatous tissue remains below the suture. Plates IIIa and b exhibit in more detail the suture formation through the median vascular bundle. Photomicrographs of a tissue

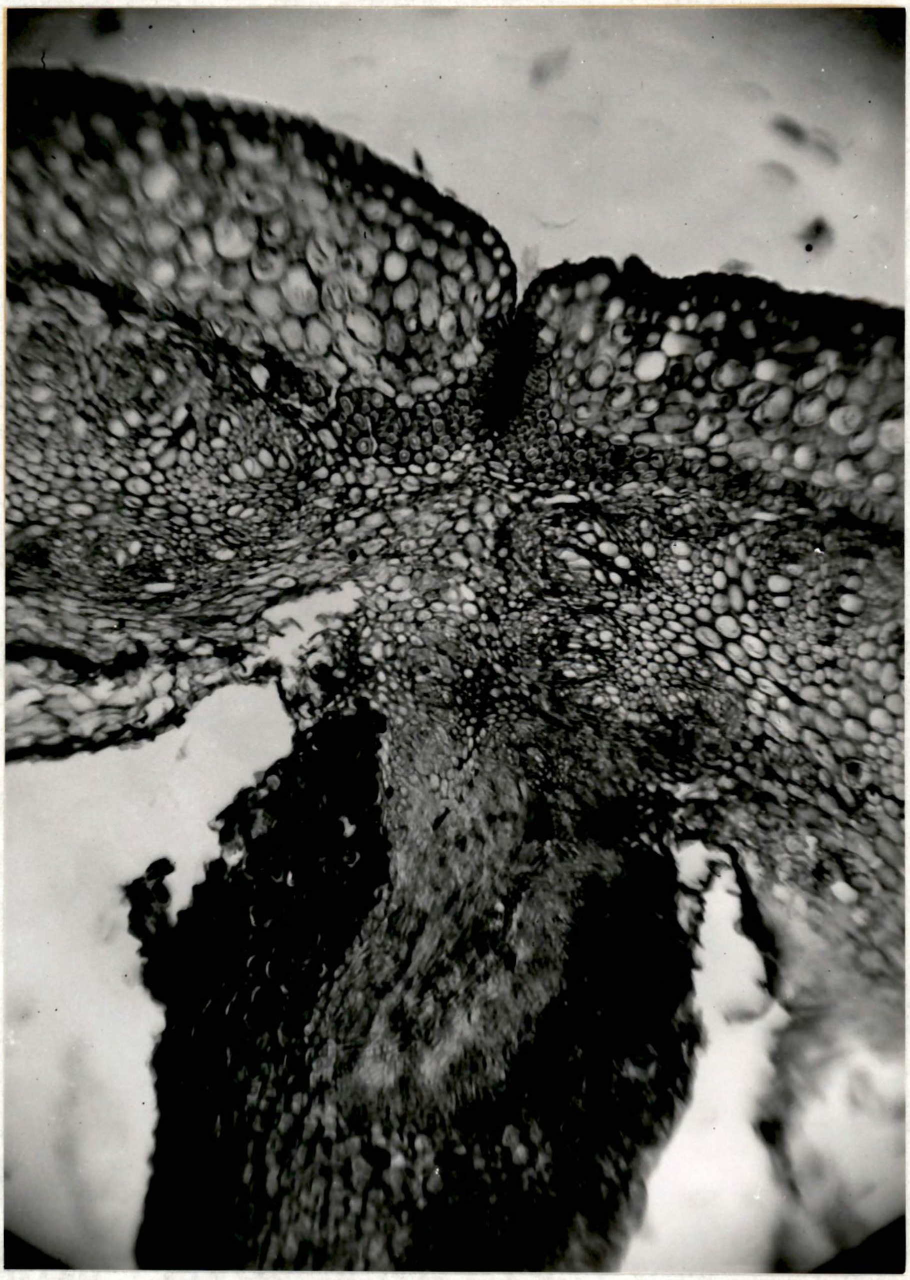
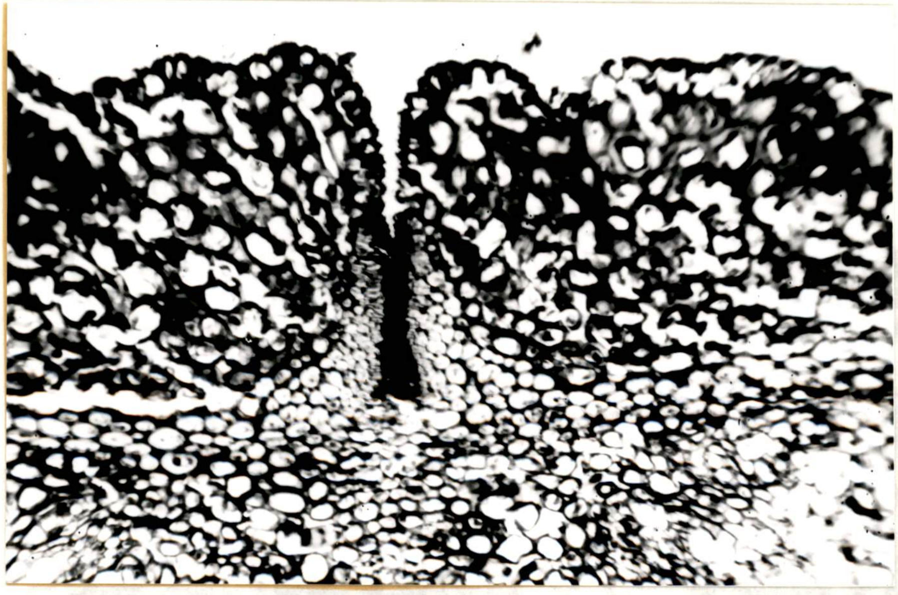
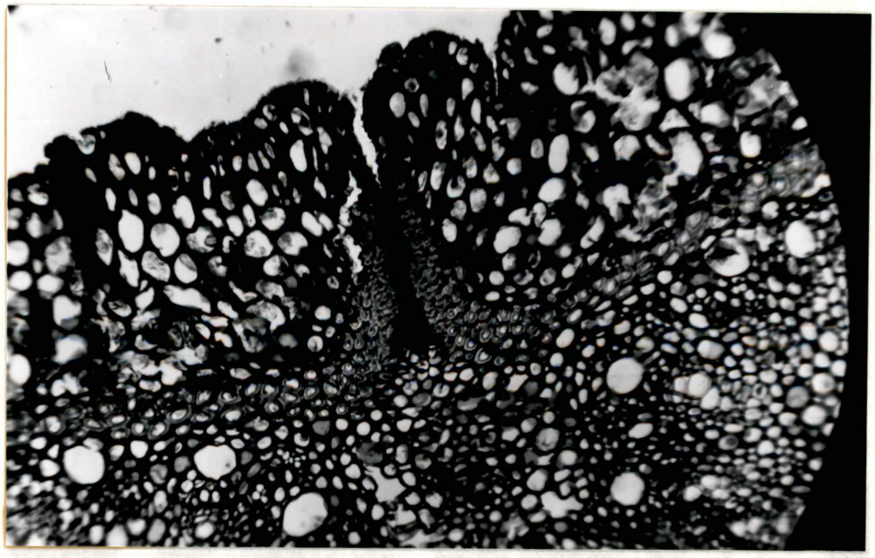


PLATE II

PHOTOMICROGRAPH OF THE MEDIAN VASCULAR BUNDLE REGION SHOWING SUTURE FORMATION AND PEA PLACENTA



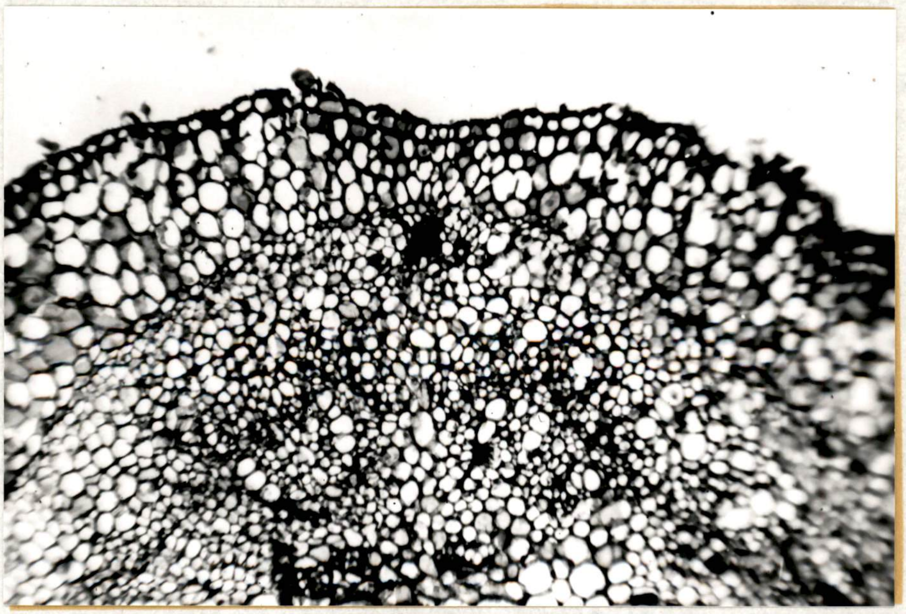
IMMATURE CROWDER PEA
a.



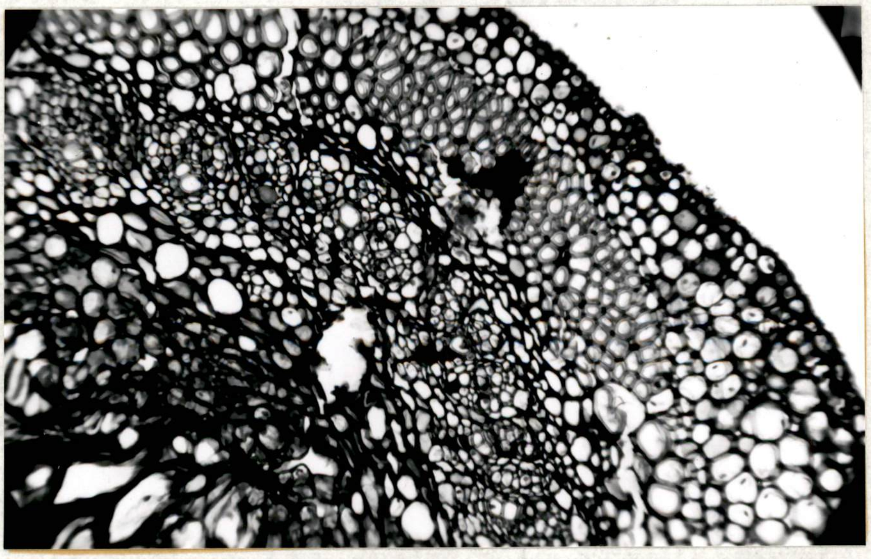
MATURE CROWDER PEA
b.

PLATE III

PHOTOMICROGRAPH OF THE MEDIAN VASCULAR BUNDLE REGION OF AN IMMATURE AND A MATURE CROWDER PEA



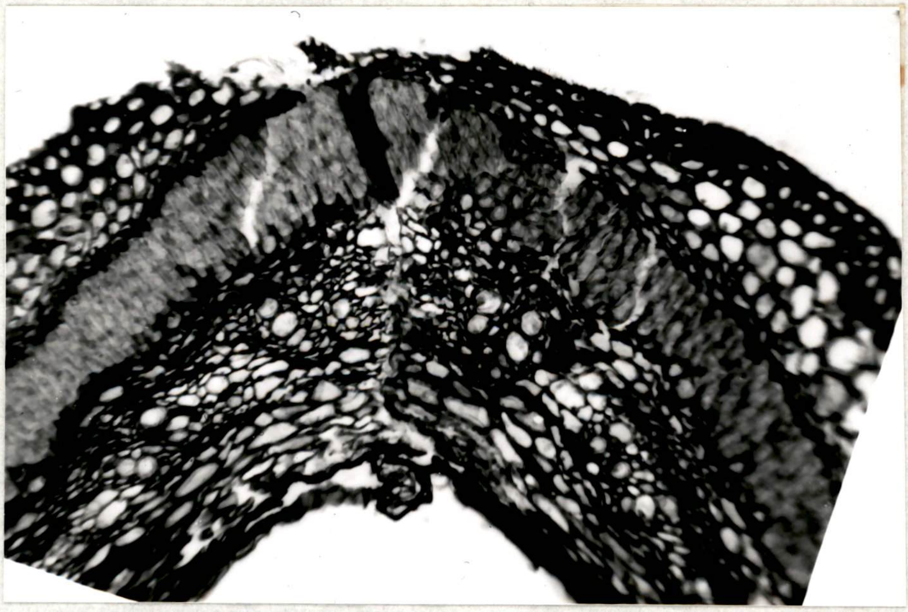
IMMATURE BLACKEYE PEA
a.



MATURE BLACKEYE PEA
b.

PLATE IV

PHOTOMICROGRAPH OF THE CARPEL MARGIN UNION IN AN IMMATURE AND A MATURE BLACKEYE PEA



CARPEL MARGIN UNION
a.

MEDIAN VASCULAR BUNDLE REGION
b.

PLATE V

PHOTOMICROGRAPH OF THE MEDIAN VASCULAR BUNDLE REGION AND CARPEL MARGIN UNION OF A MATURE BLACKEYE PEA SWEATED 40 HOURS section from a green immature and a mature crowder pea hull are presented in Plates IIIa and b respectively. The cells around the suture have much thicker walls in the mature hull than in the immature hull. Plates IVa and b illustrate the suture formation through the union of the carpel margin. A section of an immature and mature blackeye pea hull is shown on Plates IVa and b respectively. The mature blackeye pea hull, like the mature crowder pea hull, has thicker cell walls near the suture than immature pea hull.

Plates Va and b depicts sections from mature blackeye pea hulls sweated 40 hours. Plate Va exhibits the union of the carpel margin, and Plate Vb illustrates the region of the union of the carpel margin. The adhesive material of the median suture is holding the hull together (Plate Vb). Sections of fruit walls from all treatments were prepared and examined, and only the above were illustrated as typical examples.

Sensory Factors

Objective Color

Blackeye peas. The various treatments affect the color, especially the greenness, of blackeye peas. Table XII illustrates the effect of the various treatments on the greenness-redness color factor of blackeye peas. The color value ranged from -2.2 (green) for the control to -0.32 (less green) for the peas sweated 40 hours. The control contained more green color than peas from other treatments. Peas laid out 18 and 24 hours were not significantly different;

TABLE XII

THE INFLUENCE OF VARIOUS TREATMENTS ON THE GREENNESS-REDNESS COLOR FACTOR OF BLACKEYE PEAS

	"a" Units of Hunter Color Difference Meter						
Replicate	Cont.	LO 18	LO 24	LO 40	SW 18	SW 24	SW 40
1	-2.3	-2.1	-1.7	-0.9	-0.6	-0.5	-0.1
2	-1.9	-1.3	-2.0	-1.4	-0.8	-0.5	0.1
3	-1.9	-0.9	-0.8	-0.6	-0.9	-0.6	-0.6
4	-2.7	-1.9	-1.5	-0.8	-1.0	-0.7	-0.7
Total	-8.8	-6.2	-6.0	-3.7	-3.3	-2.3	-1.3
Mean	-2.2	-1.55	-1.5	-0.92	-0.82	-0.57	-0.32
Statistical significance .05 level		———— (LO 18 – LO 24)					
				———— (LO 40 – SW 24)			
					———— (SW 18 – SW 40)		

Summary of Analysis of Variance

Source	D.F.	M.S.	F. Ratio
Total	27		
Replication	3	.22	1.66
Treatment	6	1.69	12.78
Remainder	18	0.1322	

TABLE XIII

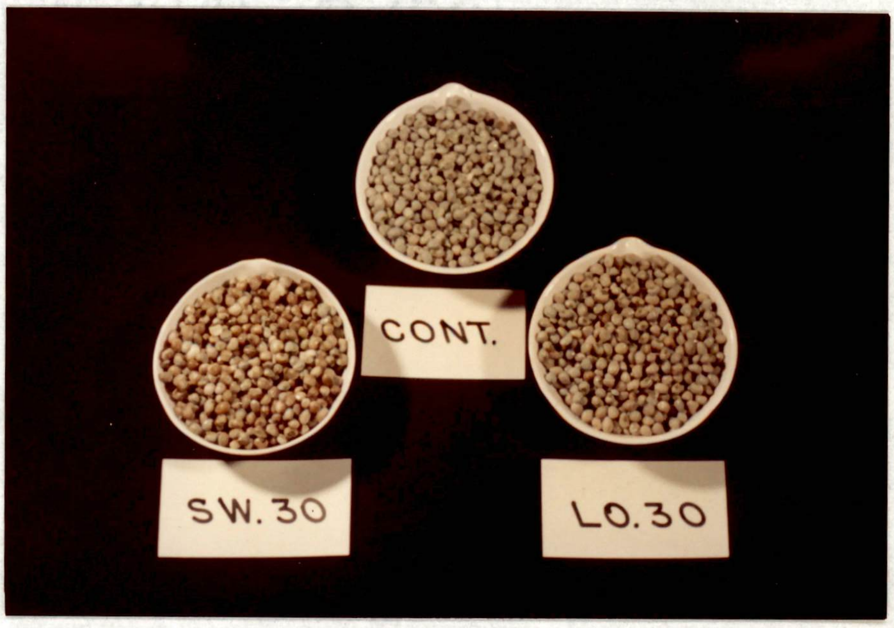
THE INFLUENCE OF VARIOUS TREATMENTS ON THE GREENNESS-REDNESS COLOR FACTOR OF CROWDER PEAS

Replicate	"a" Units of Hunter Color Difference Meter						
	Cont.	LO 44	LO 21	LO 28	SW 21	SW 28	SW 44
1	-3.1	-1.2	-0.8	-0.6	0.1	2.1	2.0
2	-3.0	-0.8	-0.4	0.5	-0.4	-0.2	-0.8
3	-1.9	-0.4	-0.3	0.2	0.8	0.9	-0.3
4	0.9	1.9	1.9	1.1	2.7	1.9	4.1
Total	-7.1	-0.5	0.4	1.2	3.2	4.7	5.0
Mean	-1.77	-0.12	0.1	0.3	0.8	1.17	1.25
Statistical significance .05 level		______	______	______	______	______	______

Summary of Analysis of Variance

Source	D.F.	M.S.	F. Ratio
Total	27		
Replication	3	5.41	7.11 **
Treatment	6	8.56	11.26 **
Remainder	18	.76	

BLACKEYE PEA
a.



CROWDER PEAS
b.

PLATE VI

COLOR PHOTOGRAPH SHOWING THE EFFECT OF VARIOUS TREATMENTS ON THE COLOR OF BLACKEYE AND CROWDER PEAS however, those treatments contained significantly more green color than the other treatments except the control. Peas sweated 40 hours contained significantly less green color than any of the other treatments except those sweated 18 and 24 hours.

Plate VIa depicts the actual color of the peas laid out 24 hours, sweated 24 hours, and the control. The samples were taken from replication I. The control contained the most green color, and peas sweated 24 hours contained the least.

Crowder peas. The color changes of the crowder and blackeye peas were very similar. Table XIII shows that the greenness-redness color change of the peas ranged from -1.77 (green) for the control to 1.25 (red) for the peas sweated 44 hours. Analysis of the data indicates a significant difference between the color of the control and all other treatments.

Plate VIb illustrates the color of peas laid out 30 hours, sweated 30 hours, and the control. These peas also were taken from replication I. Peas from the control are very green but peas sweated 30 hours possess a slightly reddish color.

Organoleptic Color Before Cooking

Blackeye peas. The various treatments exhibited considerable effect on the color of uncooked blackeye peas as evaluated by organoleptic means (Table XIV). The scores for all treatments were below that of the control. Laid out treatment seemed to have less detrimental effect on the color than sweated treatments. Analysis of the data

TABLE XIV

EFFECT OF VARIOUS TREATMENTS ON THE ORGANOLEPTIC EVALUATION OF COLOR OF UNCOOKED BLACKEYE PEAS

	Average Score of 4 Replications						
Individual	Cont.	LO 24	LO 18	LO 40	SW 24	SW 18	SW 40
1	0.0	-1.0	-1.2	-2.2	-2.0	-2.2	-3.0
2	0.0	-0.7	-0.7	-1.2	-1.0	-1.2	-1.2
3	0.0	0.5	0.0	-0.7	-1.0	-1.0	-1.2
4	0.0	-0.7	-1.5	-0.7	-1.7	-1.7	-2.2
5	0.0	-1.0	-0.5	-1.5	-1.7	-1.2	-2.2
6	0.0	-0.2	-1.0	-0.7	-1.2	-1.5	-2.0
7	0.0	-0.5	-0.5	-0.7	-1.0	-1.5	-1.2
8	0.0	-1.0	-0.7	-1.7	-1.7	-2.2	-2.7
9	0.0	0.5	0.5	0.5	0.0	-0.2	-1.7
Total	0.0	-4.75	-5.75	-9.25	-11.5	-13.0	-17.75
Mean	0.0	-0.5	-0.6	-1.0	-1.3	-1.4	-2.0
Statistical significance 0.05 level		———	———				
			———	———			
				———	———	———	

Summary of Analysis of Variance

Source	D.F.	M.S.	F. Ratio
Total	251		
Treatment	6	15.75	14.38 **
Replication	3	1.40	.91
Individual	8	6.77	10.25 **
T X R	18	2.48	7.35 **
T X I	48	.57	1.70 **
R X I	24	.83	2.46 **
T X R X I	144	.33	

TABLE XV

EFFECT OF VARIOUS TREATMENTS ON THE ORGANOLEPTIC EVALUATION OF COLOR OF UNCOOKED CROWDER PEAS

	Average Score of 4 Replications						
Individual	Cont.	LO 21	LO 44	LO 28	SW 21	SW 44	SW 28
1	0.0	-1.2	-1.5	-1.7	-2.0	-2.0	-2.0
2	0.0	0.3	-0.5	0.5	0.3	-0.2	-0.7
3	0.0	-0.2	-0.2	-1.0	-1.2	-1.5	-1.7
4	0.0	-1.0	-1.0	-1.5	-1.5	-1.0	-1.5
5	0.0	0.0	-0.7	-0.5	-1.0	-1.7	-1.2
6	0.0	-1.2	-1.5	-1.5	-1.2	-2.0	-2.2
7	0.0	-0.5	-0.5	-0.5	-1.0	-1.5	-1.2
8	0.0	-1.0	-1.2	-1.0	-1.2	-1.5	-2.0
9	0.0	0.0	-0.2	-0.5	-1.0	-0.5	-1.0
Total	0.0	-4.8	-7.3	-7.7	-9.8	-11.9	-13.5
Mean	0.0	-0.6	-0.8	-0.9	-1.1	-1.3	-1.5
Statistical significance 0.05 level	______	______					
		______	______	______	______	______	
			______	______	______	______	______

Summary of Analysis of Variance

Source	D.F.	M.S.	F. Ratio
Total	251		
Treatment	6	9.36	4.32 **
Replication	3	1.74	.47
Individual	8	5.64	7.29 **
T X R	18	6.73	18.90 **
T X I	48	.44	1.25
R X I	24	1.42	3.99 **
T X R X I	144	.35	

TABLE XVI

EFFECT OF VARIOUS TREATMENTS ON THE ORGANOLEPTIC EVALUATION OF COLOR OF COOKED BLACKEYE PEAS

	Average Score of 4 Replications						
Individual	Cont.	LO 18	LO 24	SW 18	SW 24	LO 40	SW 40
1	0.0	-1.5	-1.2	-1.7	-1.5	-1.7	-2.2
2	0.0	-0.5	-0.2	-0.5	-0.5	-0.5	-0.5
3	0.0	-0.2	-0.5	-1.0	-1.2	-1.2	-1.2
4	0.0	-0.2	-0.7	-0.7	-0.7	-0.5	-1.0
5	0.0	0.0	0.0	0.0	-0.2	-0.5	-0.7
6	0.0	-0.2	-1.0	-1.2	-1.5	-1.2	-1.7
7	0.0	-0.2	-0.7	-1.2	-0.7	-1.5	-1.2
8	0.0	-0.2	-0.7	-0.7	-1.2	-1.0	-0.7
9	0.0	0.5	0.3	+1.0	1.3	1.0	0.5
Total	0.0	-2.7	-5.0	-6.4	-6.5	-7.2	-9.0
Mean	0.0	-0.3	-0.6	-0.7	-0.7	-0.8	-1.0
Statistical significance 0.05 level	———	———					
		———	———				
			———	———	———	———	
				———	———	———	———

Summary of Analysis of Variance

Source	D.F.	M.S.	F. Ratio
Total	251		
Treatment	6	4.03	6.98 **
Replication	3	1.44	1.11
Individual	8	9.34	9.61 **
T X R	18	.61	1.51
T X I	48	.56	1.37
R X I	24	1.79	4.38 **
T X R X I	144	.40	

TABLE XVII

EFFECT OF VARIOUS TREATMENTS ON THE ORGANOLEPTIC EVALUATION OF COLOR OF COOKED CROWDER PEAS.

	Average Score of 4 Replications						
Individual	Cont.	LO 21	LO 28	LO 44	SW 21	SW 44	SW 28
1	0.0	-1.0	-1.2	-1.5	-1.5	-1.5	-2.0
2	0.0	-0.7	-1.0	-1.0	-1.0	-0.5	-1.0
3	0.0	0.0	-1.7	-0.7	-1.0	-1.7	-1.2
4	0.0	-0.7	-0.5	-1.7	-1.0	-2.0	-1.5
5	0.0	-0.5	-0.3	-0.0	-0.2	-1.0	-1.5
6	0.0	-0.5	-0.5	-1.7	-2.2	-1.5	-1.2
7	0.0	-0.2	0.0	-0.5	-0.2	-0.5	0.0
8	0.0	1.3	1.3	1.8	1.0	1.5	1.0
9	0.0	0.5	0.8	1.0	0.8	1.0	-0.2
Total	0.0	-2.25	-2.75	-4.75	-5.5	-6.25	-7.75
Mean	0.0	-0.2	-0.3	-0.5	-0.6	-0.7	-0.9
Statistical significance 0.05 level							

Summary of Analysis of Variance

Source	D.F.	M.S.	F. Ratio
Total	251		
Treatment	6	3.13	1.64
Replication	3	1.41	.65
Individual	8	18.67	16.52 **
T X R	18	3.75	6.99 **
T X I	48	1.21	2.26 **
R X I	24	.96	1.79 *
T X R X I	144	.53	

TABLE XVIII

EFFECT OF VARIOUS TREATMENTS ON THE ORGANOLEPTIC EVALUATION OF FLAVOR OF COOKED BLACKEYE PEAS

	Average Score of 4 Replications						
Individual	Cont.	LO 24	LO 18	SW 18	SW 24	SW 40	LO 40
1	0.0	-1.0	-1.2	-2.0	-2.0	-2.0	-1.7
2	0.0	0.3	0.0	0.3	0.0	-0.2	-0.5
3	0.0	-0.2	-0.2	-0.5	-0.2	-0.5	-1.0
4	0.0	1.3	0.8	0.0	0.8	-0.5	0.5
5	0.0	0.0	-0.5	1.0	-1.0	-0.5	-1.2
6	0.0	-0.7	-0.7	-1.5	-1.7	-2.0	-2.0
7	0.0	-0.7	-1.0	-1.0	-1.0	-1.0	-1.0
8	0.0	0.5	0.0	0.3	0.5	0.0	-0.2
9	0.0	0.3	0.5	0.8	0.0	0.3	0.0
Total	0.0	-0.5	-2.5	-2.5	-4.75	-6.50	-7.25
Mean	0.0	-0.1	-0.3	-0.3	-0.5	-0.7	-0.8
Statistical significance 0.05 level	———	———	———				
			———	———	———	———	
					———	———	———

Summary of Analysis of Variance

Source	D.F.	M.S.	F. Ratio
Total	251		
Treatment	6	3.51	5.17 **
Replication	3	1.76	2.35
Individual	8	12.04	13.23 **
T X R	18	.29	.50
T X I	48	.82	1.40
R X I	24	1.08	1.85 *
T X R X I	144	.58	

TABLE XIX

EFFECT OF VARIOUS TREATMENTS ON THE ORGANOLEPTIC EVALUATION OF FLAVOR OF COOKED CROWDER PEAS

Individual	Average Score of 4 Replications						
	Cont.	LO 21	SW 28	SW 21	LO 28	SW 44	LO 44
1	0.0	-1.0	-1.2	-0.7	-1.2	-1.2	-2.0
2	0.0	0.0	0.0	0.0	0.0	0.0	-0.2
3	0.0	-0.2	0.0	-0.2	-1.2	-0.7	-1.2
4	0.0	-0.5	0.8	0.0	0.3	0.0	0.5
5	0.0	0.3	-1.2	-0.2	0.5	0.0	-0.7
6	0.0	-1.0	-0.7	-2.0	-2.0	-1.0	-1.7
7	0.0	0.0	-0.7	-0.5	-0.5	-0.7	-0.7
8	0.0	-0.2	0.5	0.0	0.0	-0.5	0.5
9	0.0	1.5	1.0	0.8	0.8	1.0	-0.5
Total	0.0	-1.25	-1.75	-3.0	-3.5	-3.25	-6.25
Mean	0.0	-0.1	-0.2	-0.3	-0.4	-0.4	-0.7
Statistical significance 0.05 level							

Summary of Analysis of Variance

Source	D.F.	M.S.	F. Ratio
Total	251		
Treatment	6	1.77	1.92
Replication	3	.94	.60
Individual	8	9.76	6.95 **
T X R	18	.69	1.28
T X I	48	1.00	1.86 **
R X I	24	2.19	4.06 **
T X R X I	144	.54	

TABLE XX

EFFECT OF VARIOUS TREATMENTS ON THE ORGANOLEPTIC EVALUATION OF TEXTURE OF COOKED BLACKEYE PEAS

	Average Score of 4 Replications						
Individual	Cont.	LO 24	LO 18	SW 18	SW 24	SW 40	LO 40
1	0.0	-1.2	-1.2	-1.5	-2.0	-2.5	-2.5
2	0.0	-0.5	0.3	0.3	0.0	0.0	-0.7
3	0.0	-0.7	-0.5	-1.0	-1.0	-1.0	-1.0
4	0.0	0.8	0.5	0.0	0.5	-0.2	0.5
5	0.0	-0.5	-1.0	0.0	-1.0	-1.5	-1.7
6	0.0	-0.7	-1.0	-2.0	-1.7	-2.0	-2.5
7	0.0	-0.7	-0.7	-1.5	-1.2	-1.2	-2.5
8	0.0	-1.0	-1.5	-0.7	-0.5	-0.5	-1.5
9	0.0	0.3	0.3	0.3	-0.2	0.0	-0.2
Total	0.0	-4.5	-5.0	-6.25	-7.25	-9.0	-12.25
Mean	0.0	-0.5	-0.6	-0.7	-0.8	-1.0	-1.4
Statistical significance 0.05 level		————	————	————	————	————	
						————	————

Summary of Analysis of Variance

Source	D.F.	M.S.	F. Ratio
Total	251		
Treatment	6	6.53	5.86 **
Replication	3	3.46	2.28
Individual	8	11.84	11.54 **
T X R	18	1.75	3.11 **
T X I	48	.87	1.55 *
R X I	24	1.32	2.36 **
T X R X I	144	.56	

TABLE XXI

EFFECT OF VARIOUS TREATMENTS ON THE ORGANOLEPTIC EVALUATION OF TEXTURE OF COOKED CROWDER PEAS

Individual	Average Score of 4 Replications						
	Cont.	SW 28	LO 21	SW 21	LO 44	LO 28	SW 44
1	0.0	-1.0	-1.5	-1.2	-2.0	-1.7	-1.2
2	0.0	-0.5	0.0	-0.2	0.0	-0.2	0.0
3	0.0	-0.2	-0.7	-0.7	-1.0	-1.2	-1.0
4	0.0	0.3	-0.7	-0.2	0.0	0.0	-0.2
5	0.0	-1.2	-0.7	-0.7	-0.5	-0.5	-1.5
6	0.0	-0.5	-1.0	-1.7	-1.5	-2.2	-1.7
7	0.0	-0.7	-0.7	-1.7	-1.5	-1.5	-1.5
8	0.0	0.0	-0.2	-0.5	-0.5	-1.0	-0.7
9	0.0	0.8	1.0	0.8	-0.5	0.8	0.3
Total	0.0	-3.0	-4.5	-6.1	-7.5	-7.5	-7.5
Mean	0.0	-0.4	-0.5	-0.7	-0.8	-0.9	-0.9

Statistical significance 0.05 level: Cont.–SW 28; SW 28–LO 44; LO 21–SW 44 (underlined groups)

Summary of Analysis of Variance

Source	D.F.	M.S.	F. Ratio
Total	251		
Treatment	6	3.76	4.50 **
Replication	3	1.23	2.34 **
Individual	8	9.25	64.09 **
T X R	18	1.06	1.38
T X I	48	.75	.98
R X I	24	1.95	2.56 **
T X R X I	144	.76	

shows a significant difference between all treatments except: laid out 24 and 18 hours, laid out 18 and 40 hours, and laid out 40 hours, sweated 24 and 18 hours.

Crowder peas. The effect of the various treatments on the color of uncooked crowder peas was not as great as the blackeye peas. However, all treatments were given significantly lower scores than the control except laid out 21 hours (Table XV).

Organoleptic Color After Cooking

Blackeye peas. There was an effect of the various treatments on the color after the peas were cooked. Table XVI shows that all treatments were given a score significantly less than the control except laid out 18 hours. There was also a significant difference between laid out 18 hours and all other treatments except laid out 24 hours and control.

Crowder peas. Although the average scores given all treatments were less than the control, there were no significant differences in the color of cooked crowder peas due to the various treatments.

Flavor

Blackeye peas. There was a slight effect of the various treatments on the flavor of blackeye peas. Even though all treatments received an average score less than the control, only peas sweated 24 hours, 40 hours, and laid out 40 hours were significantly less than the control (Table XVIII).

Crowder peas. The average flavor scores of all treatments was less than the control; however, there were no significant differences due to the various treatments.

Texture

Blackeye peas. The scores given blackeye peas on texture were significantly lower for all treatments than the control (Table XX). Also, peas laid out 40 hours received a significantly lower score than all other treatments except sweated 40 hours.

Crowder peas. The effect of the various treatments on the texture of crowder peas was similar to that of blackeye peas. All treatments received scores significantly lower than the control except sweated 28 hours (Table XXI). Peas laid out 28 and sweated 44 hours received scores significantly lower than the control and sweated 28 hours.

DISCUSSION

Shelling

The preliminary experiments were conducted on the assumption that peas must go through a heating period before they would shell easily and that increased temperatures was responsible for the increased ease with which the pods split along the 2 sutures. It was reasoned that if a long heating period would increase the percentage shellout, then a short heating period at higher temperatures might also increase the dehiscence of the pod. However, the results show treatments of various degrees of artificial heat have a lower percentage shellout than the control, because of excessive wilting of the pods during heat treatment. When placed in the huller, the wilted pods would wrap around the beaters and thus would not be subjected to the beating action. The more severe the heat treatment, the more the pods were wilted, and, therefore, a larger decrease in shellout resulted.

The pressure-vacuum treatment was used on the presumption that pressure inside the pods would equilibrate with the outside pressure in 5 or 10 minutes. Then if the pressure was reduced to a high vacuum in a short period of time the difference in pressure between the inside and outside of the pods would cause them to break open. The results of this experiment indicate that the pressure inside the pods did not equilibrate as fast as was assumed or that it equilibrated much faster than expected. There was no net change in percentage shellout due to the pressure-vacuum treatment.

It was then decided to attempt to duplicate the conditions that occur during the aging period of commercial processing and to compare the percentage shellout of peas that had been allowed to undergo heating with peas aged the same length of time but not allowed to undergo a heating period.

The temperature of the peas that were allowed to heat increased very rapidly during the first few hours and was similar to the temperature rise during commercial processing (24). The maximum temperature reached in the laboratory, however, was probably not so high as that reached in the large piles on trucks and wagons because of the size difference of the lots of peas. The second increase in temperature that occurred in the crowder peas should not be considered characteristic for that variety until further studies are made.

There was considerable weight loss in the peas that were laid out as compared to the peas that were sweated in a closed container. Most of the weight loss in the peas laid out can be attributed to loss of water through transpiration with limited loss due to respiration. However, the small amount of weight loss in the sweated peas is probably due in large part to respiration of the peas and only a small amount due to transpiration.

Both sweating and lying out gave an increase in shellout over the control. In both the blackeye and crowder peas, sweating resulted in a larger yield in ounces than lying out. However, in the blackeye peas, the difference between treatments could be attributed to the differential in moisture content. Some of the differences in yield of the crowder peas could be attributed to a differential in moisture but not all as in the case of blackeye peas.

Crowder peas had a much higher percentage increase in shellout than blackeye peas—46 per cent for the crowder peas and 29 per cent for the blackeye peas. This increase could be the result of differences in maturity and/or variety. The crowder peas were less mature than the blackeye peas as will be discussed below. The control for the crowder peas gave a much lower shellout than the control for the blackeye peas. However, there was much less difference between the two varieties after sweating 40 hours. Due to maturity and possibly varietal differences, the blackeye peas probably gave a higher percentage of the maximum yield in the control than did the crowder peas. After being sweated 40 hours, both varieties probably gave a yield approximately equal to the maximum possible yield.

Composition

The various treatments had a limited influence on the percentage alcohol insoluble solids. Although there was some change in the alcohol insoluble solids when based on the fresh weight, when the percentage alcohol insoluble solids was corrected for differences in moisture there was very little differential between treatments. Only a limited amount of sugar was available in the pea at the time of picking. Very soon after picking, an equilibrium would be established between the alcohol insoluble solids and free sugar in the pea; therefore, little change could occur in the actual amount of alcohol insoluble solids in the peas.

There was a considerable decrease in the moisture of the peas that were laid out long periods of time. This decrease was the result of a high rate of transpiration in the peas that were not subjected to an atmosphere saturated with moisture as in the case of peas being sweated.

There was little difference in the changes in alcohol insoluble solids and moisture between blackeye and crowder peas. However, it should be noted that the percentage alcohol insoluble solids in the blackeye peas was approximately 10 per cent greater than in the crowder peas. Also the percentage moisture was about 10 per cent greater in the crowder peas than in the blackeye peas. Based on work by Hoover (14), this increase would indicate that crowder peas were much less mature than blackeye peas even though an attempt was made to harvest them at the same maturity level.

No change in maturity occurred if the usual measurements (alcohol insoluble solids and moisture) were used in evaluating the maturity change. However, it would be assuming too much to say that no changes occurred in the peas during the aging period. There was a considerable affect of the various treatments on the quality of Southern peas. Ascorbic acid decreased approximately 2 per cent per hour in blackeye peas and almost 1.5 per cent per hour in the crowder peas. If loss of ascorbic acid is used as a measure of quality as recommended by Jenkins (15), there was a substantial loss of quality during the aging period. It may be noted that ascorbic acid did not decrease so fast in crowder peas as in blackeye peas. This difference, as in the case of percentage shellout, is probably due to level of maturity and possibly varietal differences.

There was also a decrease in green color of both blackeye and crowder peas. The loss in green color probably corresponds to a loss in chlorophyl although the chlorophyl content was not measured because of the very low concentrations. According to Olson (19), chlorophyl degradation is a measure of quality. Therefore, indirectly, the loss of green color would indicate a loss in quality of peas during sweating or aging. Although differences in quality measurements between peas being sweated and peas laid out is not significant at the 0.05, there is a tendency for sweated peas to decrease more rapidly in quality than peas laid out.

Morphology

The histological studies show that changes do occur in the area of suture formation during maturing and aging processes. As the pea matures, the cells near the suture become more differentiated and cell walls become thicker. As may be seen from the photomicrographs, there is an area of the suture that contains large amounts of intracellular material, probably hemicellulose and/or pectic substances. According to Holden (13), the middle lamella softens during the ripening period. This softening is probably enzymatic in nature and will continue after the pea is removed from the vine. Hoove (14) has shown that maturation is very rapid while the pea is on the vine. If the middle lamella continues to soften or even increases in softening rate due to the increased temperature of the peas being sweated, then the hull of the peas would have matured an amount equal to or greater than the aging period with respect to dehiscence. The explanation is only a theory since no actual data has been collected on the chemical changes of the suture material during maturation and aging. However, based on knowledge of the product, this theory, attempting to explain why aging and sweating causes an increase in shellout of Southern peas, is the one most acceptable theory available to the author at the present time.

Organoleptic Evaluation

For each quality attribute evaluated, the scores were lower for the various treatments than the control; however, in two instances, there were no significant differences at the 0.05 level. In general, the longer the treatment period, the lower the score given. Therefore, in addition to a loss in quality as measured by chemical means, the long aging periods also caused a decrease in the palatability of the peas. This would indicate that although the aging period caused an increase in the shellout of Southern peas, it was very detrimental to the quality of the pea and it would be undesirable from the standpoint of the consumer.

SUMMARY

A study was made to determine the influence of aging on percentage shellout and certain specific quality factors of Southern peas, and to study certain morphological changes of the Southern pea pod.

Under condition of the experiment reported in this paper it was found that:

(1) Aging did cause an increase in percentage shellout of Southern peas but temperatures above ambient summer temperatures were not required for this increase in shellout.

(2) A considerable loss of quality as determined by chemical methods and quality as measured by organoleptic means occurred during the aging period.

(3) Changes occur in the morphology of the pea pod near the suture and these changes probably influence the increase in percentage shellout.

BIBLIOGRAPHY

Bibliography

1. A.O.A.C. 1945. "Official Methods of Analysis." 6th ed. Assoc. of Official Agr. Chemists. Washington, D. C., p. 35.17.

2. Byer, A. J., and D. Abrams. 1953. A comparison of the triangular and two-sample taste-test methods. Food Technol. 7, 185.

3. Boggs, Mildred M., and Helen L. Hanson. 1949. Analysis of foods by sensory difference test. Advances in Food Research 2, 219.

4. Brittingham, W. H., and John A. Mortensen. 1951. Varietal differences in shellout percentages in the Southern pea, Vigna sinensis. Proc. Am. Soc. Hort. Sci. 58, 257.

5. Buch, L. M., E. C. Dryden, Claude H. Hills, and James R. Oyler. 1956. Organoleptic evaluation of applesauce fortified with essence and citric acid. Food Technol. 10, 560.

6. Esau, K. 1960. "Anatomy of Seed Plants." John Wiley and Sons, Inc., New York, p. 316.

7. Filipello, F. 1957. Organoleptic wine-quality evaluation. II. Preformance of judges. Food Technol. 11, 51.

8. Fry, P. C. 1959. Flavor evaluation of potatoes grown in soils treated with pentochloronitrobenzene. J. Agr. Food Chem. 7, 201.

9. Gridgeman, N. T. 1955. Taste comparisons: two samples or three? Food Technol. 9, 148.

10. Harris, Hubert. 1963. Private communication.

11. Harter, H. L. 1960. Critical values for Duncan's new multiple range test. Biometrics 16, 671.

12. Heaton, E. K. 1963. Private communication.

13. Holden, D. J. 1956. Factors in dehiscence of the flax fruit. Bot. Gaz. 117, 294.

14. Hoover, M. W. 1953. Correlation of certain physical and chemical changes in the Southern pea, Vigna sinensis, with six stages maturity. Ph. D. Thesis. University of Florida Library, Gainesville, Fla.

15. Jenkins, W. F. 1954. Post-harvest changes in refrigerated and non-refrigerated Southern peas. Proc. Am. Soc. Hort. Sci. 64, 327.

16. Kramer, Amihud, and L. P. Ditman. 1956. A simplified variables taste panel method for detecting flavor changes in vegetables treated with pesticides. Food Technol. 10, 155.

17. Loeffler, H. J., and J. D. Ponting. 1942. Ascorbic acid rapid determination in fresh, frozen, or dehydrated fruits and vegetables. Ind. and Eng. Chem. 14, 846.

18. National Canners Association. 1956. A Laboratory Manual for the Canning Industry. 2nd ed. National Canners Association Research Laboratories. Washington, D. C., p. 20.1.

19. Olson, R. L. 1960. Objective tests for frozen food quality. Conference on frozen food quality. U. S. Agr. Research Service ARS-74-21.

20. Sass, J. E. 1958. "Botanical Microtechnique." 3rd ed. Iowa State College Press, Ames, Iowa.

21. Sather, Lois A., and Lyle D. Calvin. 1960. The effect of number of judgments in a test on flavor evaluations for preference. Food Technol. 14, 613.

22. Shepherd, A. D. 1960. Relative stabilities of various frozen foods. Conference on frozen food quality. U. S. Agr. Research Service ARS-74-21.

23. Snedecor, George W. 1956. "Statistical Methods." 5th ed. Iowa State University Press, Ames, Iowa, p. 237.

24. Tankersley, J. O. 1960. Private communication.

25. Tilgner, Damazy J. 1962. Anchored sensory evaluation tests - a status report. Food Technol. 16, 47.

26. Wade, B. L., and Associates. 1951. Composition of Southern peas. South. Coop. Ser. Bul. No. 15.

27. Williams, F. W., and M. B. Allen. 1962. The Southeastern vegetable processing industry: Location and number of plants - composition, volume, and value of pack, 1960. U.S.D.A. Marketing Research Report No. 527.

VITA

The author was born November 3, 1937 in Dallas, Texas. He was graduated from Central High School, Knoxville, Tennessee in 1956. Except for 6 months with the United States Army, he was enrolled at the University of Tennessee from September, 1956 until he received a B.S. degree in Agriculture in August, 1960. On November 1st of the same year he was appointed Assistant in Food Technology and since that time he has been working to complete the requirements for the degree, Master of Science. He was married to Miss Judith Phelps on September 11, 1959 and at the time of this writing, is the father of 3 children.