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Quality Evaluation of Deep-Fat Fried Peas

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QUALITY EVALUATION OF DEEP-FAT FRIED PEAS

by

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Wattana Sathiraswasti

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INTRODUCTION

Dehydration is perhaps the oldest method of preserving fruits and vegetables. However, it is still an important method of preservation. During World War II, efforts were geared to investigate the possibilities of such newer dehydrated foods as powdered eggs, tomatoes, and potato granules. Since then many new products are flooding the market every year. The use of dehydrated products has increased primarily because they usually require less space and have longer shelf life, and at the same time they have much more concentrated nutritive value than fresh, canned, or frozen foods. Hence, they can easily be adopted for military rations. Because of their ease of handling and transportation they may serve as a snack and picnic food (10, 22).

Dehydration of fruits and vegetables by deep-fat frying is comparatively a new method. A deep-fat fried product does not only have a longer shelf life but also an additional nutritional ingredient--fat.

For most of the countries of Asia, it seems to the author that the preservation of fruits and vegetables by deep-fat frying is rather appropriate and adequate because it is a simple and cheap method and at the same time the deep-fat fried product such as peas[1] is rich in protein and carbohydrate and by addition of fat it can be used as a nutritious food by large masses of vegetarians.

The over-mature peas of size 6 bring substantially less income to

1. Pisum sativum

the farmers than those of size groups 1-3 or 4 because 1-3 or 4 are usually the choice peas for canning and freezing. However, by deep-fat frying of peas of size 5 and 6, they could be better utilized. This means additional income to farmers who grow peas for the canning industry (26).

The investigations presented in this thesis comprise the evaluation of certain objective methods such as size distribution, shear-press, specific gravity, refractive index, and starch grain character (size, shape, and hylum) in relation to the harvest time and the quality (organoleptic appraisal, color, protein, and fat) of the deep-fat fried peas.

REVIEW OF LITERATURE

Size distribution

Pollard, Wilcox, and Peterson (19) stated that the percentage of sieve grades varied with maturity of peas. In Early Perfection peas of grade 1 and 2 (size groups 1-3 and 4) decreased rather rapidly with an increase in maturity. Perfection variety showed less variation in grade 2 (size group 4). In both varieties the percentage of grade 3 (size groups 5-6) showed a marked increase with an advance in maturity. Salunkhe, Pollard, and Taylor (26) separated peas in different sieve size groups in a manner similar to that described by Pollard, Wilcox, and Peterson (19).

Specific gravity

Hoover and Dennison (9) studied the correlation of stages of maturity with certain physical measurements in the southern pea and found that the specific gravity of both blanched and unblanched peas increased with maturity.

Lee, Whitecomb, and Hening (14) made a critical examination of objective methods for maturity assessments in frozen peas and they reported that the specific gravity and alcohol insoluble solids methods were the most reliable of the objective tests used on processed peas.

Salunkhe, Wittwer, Wheeler, and Dexter (27) showed the direct correlation between specific gravity and color of potato chips.

Sharma (30) reported that the higher the percentage of small starch grains the lower the specific gravity of the potato tuber.

Shear-press

Kramer and Aamlid (11) demonstrated the feasibility of shear-press

as an instrument to measure the quality of foods. The shear-press was equal in precision and accuracy to the tenderometer and superior to the texturemeter.

Reeve (21) showed the relationship between the penetrometer values and the texture changes (toughening) in the seed coat of peas.

Lynch and Mitchel (15), Mitchell and Lynch (16) studied the physical measurements of quality in canning peas. The tenderometer and maturometer were used in determining the maturity of peas. The tenderometer and maturometer readings had a satisfactory correlation with the alcohol insoluble solids. The content of alcohol insoluble solids was confirmed as a suitable maturity index for canning peas.

Pollard, Wilcox, and Peterson (19) indicated that the yield of shelled peas increased as the peas advanced in maturity above a tenderometer value of 85. They also found that the unit increase was greater below a tenderometer value of 102 than it was above this point.

Salunkhe, Pollard, and Taylor (26) reported that the shear-press and tenderometer values increased as the size of peas increased. The shear-press values were more precise than the tenderometer values.

Sayre (28) and Kramer, Scott, and Guyer (12) found there was a high positive correlation between tenderometer values, contents of alcohol insoluble solids, and the quality of peas.

Refractive index

Scott, Belkengren, and Ritchell (29) reported that the refractometer is a valuable time and labor saver in grading raw sweet corn for processing.

Hoover and Dennison (9) stated that the refractive index of the first three stages of development of the peas did not appear to be affected by maturity but there was a significant increase in the last

three stages of maturity.

Henry, Wilcox, Pollard, Salunkhe, and Lindquist (8) reported that the refractive index of expressed juice required the least amount of time in determining the maturity of sweet corn for processing.

Salunkhe, Pollard, and Taylor (26) found that the soluble solids determined by a refractometer were less in peas of sizes 1-3 and 6 than in sizes 4 and 5.

Rahman (20) reported that the refractive index increased as beans advanced in maturity.

Microscopic examination of starch grains

Barham, Wagoner, Williams, and Reed (4) found that the varietal and environmental factors in some manner influence the structure of the starch granules.

Salunkhe and Pollard (24) reported that the hylum[1] of the starch grain became larger and more ramified as the maturity advanced. When the hyla of most of the starch grains began to thicken along with their ramifications, it was the proper time to harvest the lima beans without much loss in yield and quality. Salunkhe and Pollard (23) also demonstrated by microscopic observation of starch grains of potatoes that the prominency of the lamellae and of the hyla of the starch grains was correlated with specific gravity and maturity of the tubers or tuber parts. The lamellae and hyla of starch grains of tubers having high specific gravity were more distinct than those of having low specific

1. According to many botany texts, the word hilum means the mark at the point of attachment of an ovule to its funicle forming the eye, as of a bean. In addition, the word hilum had another meaning, i.e., the nucleus of a starch grain. To differentiate the meanings of the same word, Salunkhe and Pollard coined a word, "hylum", to mean the latter. In this thesis, hereafter, the word hylum (plural--hyla) will be employed to designate the nucleus of a starch grain.

gravity. In another study, they (25) found that starch grains in lima beans became larger in size, more regular in shape, and had progressively more prominent hyla and lamellae as the maturity of lima beans advanced.

Sharma (30) studied starch grain sizes and specific gravity of potato varieties. He found that the proportion of the four sizes of starch grains (large above 75 microns, medium between 75-50 microns, small between 50-25 microns, and very small less than 25 microns) in a potato tuber was related to specific gravity. That is, the higher the percentage of large starch grains the higher the specific gravity of the potato tuber.

Salunkhe, Pollard, and Taylor (26) examined the characters of starch grains of peas. They stated that starch grains increased in size, became more irregular in outer demarkations, and developed a more ramified hylum as the peas advanced in maturity.

Sjastrom (32) presented a series of photomicrographs to demonstrate the changes which took place in the configuration of the granules. The similarities and differences between various kinds of starches were also indicated.

Thornburg (33) investigated the formation of starch granules in corn endosperm with the electron microscope. He reported that the surface of starch granules were remarkedly smooth. The granules from different genera had distinctly different surface characters. The origin, shapes, lamellae, and central cavities of corn starch granules were also studied.

Deep-fat frying

Kelley and Baum (10) explained the preparation of tasty vegetable products by deep-fat frying. Beets, carrots, parsnips, peas, and lima beans were used in the experiment. Temperatures for frying were from

275° to 300° F. Various methods of preparation of the deep-fat fried vegetables were discussed.

Salunkhe (22) studied the quality of deep-fat fried products of certain fruits and vegetables. Samples were fried at a temperature of 320° F. The quality of the products was related to the selection of the variety, crop maturity, and kind of fat used for frying.

Nutritive value

Alexander, Sallee, and Taylor (3) found the variations in chemical composition of raw and canned peas. They found that there was a wide variation in the composition of raw canning peas. They also reported that there was a slight decrease in the concentration of protein, carbohydrate, calcium, and magnesium during the canning procedure.

Fincke, Little, Redelings, and Perkins (7) made studies of the thiamine content of frozen peas. After the peas had been cooked for a short time in a small amount of water, they found no significant difference in the thiamine content of fresh and cooked peas.

Kelley and Baum (10) prepared tasty vegetables by deep-fat frying. The average content of both oil and protein were also explained in the report.

Pollard, Wilcox, and Peterson (19) found that the vitamin C content of fresh peas gradually decreased when maturity increased.

Wilcox and Morrell (34) reported that the percent retention of ascorbic acid in the blanched, canned, and frozen peas did not vary greatly with increasing maturity until tenderometer values of the peas went over 125. The carotene content of frozen and canned peas decreased as the maturity of the peas increased above a tenderometer value of 114. However, the thiamine content was not increased significantly as the maturity increased.

Salunkhe, Pollard, and Taylor (26) explained the utilization of over-mature peas by deep-fat frying. The over-mature peas were fried at 300° F. The nutritive values of such peas and potato chips were compared and they found that the deep-fat fried peas were superior in nutritive value to the potato chips.

Color and color difference

The Hunter color and color difference meter (1) was designed for the rapid and precise measurement of color and color differences. However, Henry, Wilcox, Pollard, Salunkhe, and Lindquist (8) did not recommend it for determining the color change in corn because of variability of color of kernels on a single ear.

MATERIALS AND METHODS

Four varieties of peas, Giant Stride, Little Marvel, New Era, and Victory Freezer, were planted on the Terry Experimental Farm, Logan, Utah, on approximately 1/3 acre on May 2, 1957. A randomized block design with four replications was used in the experiment. Each plot consisted of five rows. Each row was 40 feet long. The weeding and irrigation were done as often as needed. The crop showed a full and vigorous growth one month after seeding. Little Marvel had small size pods and when about 1½ feet high, started to bloom first and was followed by New Era which had medium size pods and grew to a height of 2½ feet. Victory Freezer resembled New Era in the pod size and vine growth. Giant Stride was slightly taller and relatively larger than New Era and Victory Freezer. All four varieties showed comparatively high resistance to diseases and insects during the growing season. At the stage of full bloom, dusting with 25 percent D.D.T. wettable powder was given to protect against pea-weevil.

Peas were harvested at three different intervals. The time interval between harvest was not uniform but was determined by the maturity of peas. The harvest date began July 8 and ended on July 29, 1957. Each harvest was done in the early morning or in the late evening. The first and second harvest of each variety included two rows of the plot and for the third harvest one row was used. The pods from each plot of each variety were mixed before vining. After vining by a machine, the shelled peas were weighed to determine the total shelled yield.

Plan of harvest

Variety	1st Harvest	2nd Harvest	3rd Harvest
Giant Stride	July 26	July 28	July 29
Little Marvel	July 8	July 9	July 10
New Era	July 13	July 17	July 21
Victory Freezer	July 19	July 22	July 24

Subsequent to each harvest, the shelled peas were utilized for the following studies:

1. Objective measures for the maturity of peas.
2. Development of the deep-fat frying technique.
3. Determination of nutritive value and color changes in deep-fat fried peas.
4. Organoleptic appraisal of deep-fat fried peas.

Objective measures for the maturity of peas

Certain objective measures were conducted to find out the maturity of peas on the different harvest dates and to correlate them with the quality of the deep-fat fried peas. The following methods were studied.

Size distribution. The shelled peas were classified into four different size groups as follows: Peas of size 1-3 were designated as the ones which were screened through a sieve 5/16 inches. Peas of size 4 were designated as the peas which were screened through a sieve 6/16 inches but were held on a 5/16 inches sieve. Peas of size group 5 were designated as the peas which screened through a sieve 7/16 inches but were held on a 6/16 inches sieve. Peas of size 6 were designated as the peas which were held on a 7/16 inches sieve.

Specific gravity. The specific gravity determination of peas was conducted according to the method described by Lee (13). In the determination of specific gravity, a triple bean balance was used. An empty wire basket was hooked to the lower part of the weighing pan by means of

three thin copper wires. The whole basket was placed in water inside a container. Peas were blanched in boiling water for two minutes prior to the determination of the specific gravity. This induced the peas to sink more readily. One hundred grams of blanched peas were weighed in air and put into the basket to be weighed in water. The weight loss in water was compared with the weight in air and the specific gravity was calculated according to the following equation:

$$\text{Specific gravity} = \frac{\text{weight of peas in air}}{\text{weight loss of peas in water}} \times 100$$

Shear-press. The tenderness of peas was measured by the Shear-press instrument (figure 1) built by Bridge Food Machinery Company, Philadelphia 35, Pennsylvania. This instrument works on the principle of hydraulic force.

Prior to the determination of shear-press values, the test-cell and the plunger plates were thoroughly washed with water and dried with a cheese cloth. The speed of the test cylinder was set at $7\frac{1}{2}$ on the flow control valve. One hundred grams of peas were used for each reading. The maximum pressure employed against the resistance of peas was recorded. The readings were made in duplicate.

Refractive index. Expressed juice of the peas from the Shear-press instrument was utilized in determining the percent of soluble solids, mostly sugars, by the Abbe-type refractometer. The surface of the measuring prism was entirely covered with a few drops of pea juice. The temperature of prisms was maintained at 68° F. by means of a water bath which was connected with the refractometer (figure 2). Refractometer readings were recorded in duplicate.

Microscopic examination of starch grains. Random samples of peas from each size group were thoroughly cleaned with water after removing

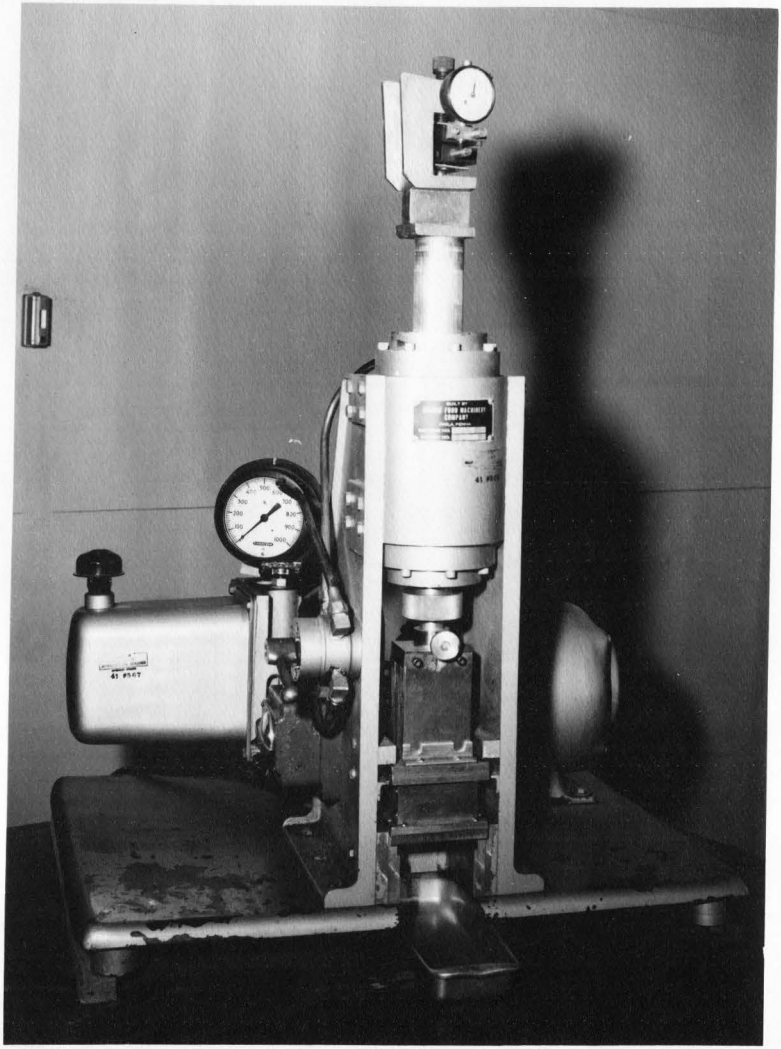

Figure 1. Shear-press instrument

Figure 2. Abbe type refractometer with temperature control attachment

the shriveled peas. Peas of each size group were preserved in 95 percent ethyl alcohol. The slurries of these samples were prepared with a Waring blender.

Pea-slurries were shaken vigorously before microscopic examination of the starch grains to help to disperse uniformly various sizes of starch grains. A drop of stirred slurry from each sample was placed on a slide, a drop of distilled water was added to it, and the slide was covered with a cover slip. The slide was then viewed through a microscope. The size, shape, and hylum of starch grains were observed under the 44 x objective lens and a 10 x ocular. On each slide 10 starch grains chosen at random were measured, and for each sample 20 slides were studied. The size of starch grains in microns was computed by the aid of an eye-piece and a stage micrometer. The shape of starch grains was classified as circular and irregular. Subjective hylum classifications were as follows:

1 = No hylum development

2 = Slight hylum development

3 = Moderate hylum development and small ramifications

4 = Abundant hylum development and large ramifications

A detailed hylum study was conducted by the use of the oil emersion (98 x objective lens and a 10 x ocular lens). The structure of starch grains was drawn with the aid of a camera lucida (figure 3).

Development of the deep-fat frying technique

A 500-gram sample of peas from each size group was fried in a Westinghouse electric pan with a 5000 cc capacity. "Crisco", a hydrogenated vegetable oil, and "Dri-Fri" cocoanut oil were used in this experiment. The preliminary study showed that the deep-fat fried peas

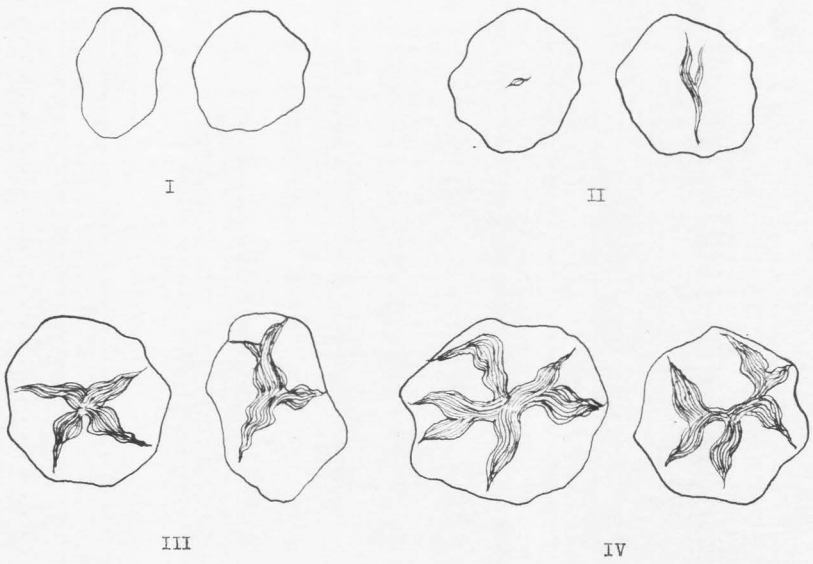

Figure 3. Classification of hyla of starch grains of peas X 980

I. No hylum development
II. Slight hylum development
III. Moderate hylum development
IV. Abundant hylum development

were better in flavor when fried in Dri-Fri than in Crisco. Hence, the Dri-Fri was the only product included in further experiments.

Dri-Fri was heated to 350° F. Each sample (blanched or unblanched) was put in the strainer and dipped in boiling (350° F) oil. A quick dipping technique was developed that caused popping of the peas and resulted in a superior product. The sample in the strainer was well covered before putting it into hot oil. The peas must be promptly dipped into the boiling oil for a few seconds. This process consisted of consecutive dippings until the sizzling of oil had subsided. Much attention was devoted to this stage. The phenomenon of sizzling occurred by the action of extremely hot oil which converted the water from the peas into steam. The cover was then removed, and the peas continued to fry 12-13½ minutes longer. When the bubbles stopped in the oil, the cooking was discontinued.

Determination of nutritive value and color changes in deep-fat fried peas

In evaluating the nutritive values of the deep-fat fried peas, the following chemical analyses were conducted.

Protein. In determining the protein content, the Kjeldahl method for total nitrogen determination was advocated. The percent of total nitrogen was computed and converted into crude protein by multiplying by a factor of 6.25.

Approximately one gram of the ground fried peas was taken for this analysis. By the kjeldahl method, nitrogen in the deep-fat fried peas was converted to ammonium sulfate by digesting with concentrated sulfuric acid. The ammonia in ammonium sulfate was liberated by the addition of strong sodium hydroxide. The liberated ammonia was then condensed into a boric acid solution and finally was titrated with the standard acid.

The percent of total nitrogen was calculated as follows:

$$\text{Percent nitrogen} = \frac{\text{ml. acid used - blank x N equivalent of acid}}{\text{weight of the sample}} \times 100$$

Moisture. A known weight of ground deep-fat fried pea sample from each size group was dehydrated in a drying oven at 158° F for 24 hours, then transferred to a vacuum oven at 158° F at 20 pounds reduced pressure for 48 hours. The samples were kept in dessicators before weighing. Percent of moisture was computed as follows:

$$\text{Percent moisture} = \frac{\text{weight of wet sample - weight of dry sample}}{\text{weight of the wet sample}} \times 100$$

Fat. Fat was determined by the Ether Extraction method. Approximately one gram of each sample of the oven-dried fried peas was taken. Purified ether was used in the experiment. The percent of the crude fat was calculated as follows:

$$\text{Percent crude fat} = \frac{\text{weight of fat}}{\text{weight of the wet sample}} \times 100$$

The weight of fat obtained from the increased weight of the glass container was checked against the decreased weight of the alundum (extraction thimble). The ether from the fat extraction process was completely removed before weighing the vessels.

Color and color difference. Color of the ground deep-fat fried peas was determined by the Hunter color and color difference meter (figure 4). The kitchen green panel, a color standard (Rd 34.0, a - 12.2, b 15.3), was employed for the standardization of the readings. The Rd color scale was set in the experiment. The ground peas were put in a clean petri-dish and color reflectance was measured. Rd, a, and b values were recorded in quadruplicate on each sample. They were interpreted as follows:

Rd value--luminous reflectance

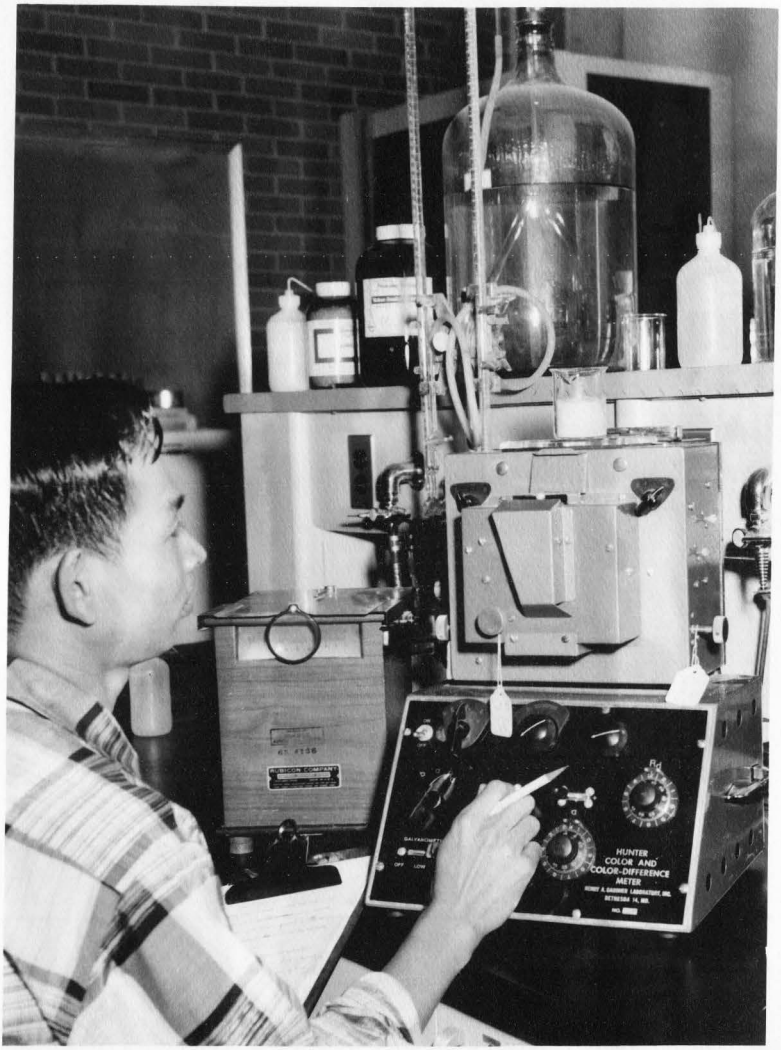

Figure 4. Hunter color and color difference meter with galvanometer attachment

a minus value--greeness

b plus value--yellowness

Organoleptic appraisal of deep-fat fried peas

Organoleptic appraisal was conducted with the cooperation of the Food and Nutrition Department to determine the acceptibility of deep-fat fried peas. A well-trained panel of 10 judges consisted of staff members and students, five men and five women, of the Departments of Food and Nutrition and Horticulture. The Hedonic scale (18) was employed by the judges to express their reaction to the samples (table 1). A score of 9 indicated an extreme like for the sample and a score of 1 indicated an extreme dislike. A sample receiving a score of 5 or higher was considered to be acceptable.

The comparison between the fried products from previously blanched and unblanched peas was made to determine the difference in the quality and flavor of the final products.

Data obtained in these investigations were analyzed for statistical significance (17).

Table 1. Organoleptic appraisal ballot

Name _____ Date _____

Score	Sample_____	Sample_____	Sample_____	Sample_____
9	Like Extremely	Like Extremely	Like Extremely	Like Extremely
8	Like Very Much	Like Very Much	Like Very Much	Like Very Much
7	Like Moderately	Like Moderately	Like Moderately	Like Moderately
6	Like Slightly	Like Slightly	Like Slightly	Like Slightly
5	Neither Like Nor Dislike	Neither Like Nor Dislike	Neither Like Nor Dislike	Neither Like Nor Dislike
4	Dislike Slightly	Dislike Slightly	Dislike Slightly	Dislike Slightly
3	Dislike Moderately	Dislike Moderately	Dislike Moderately	Dislike Moderately
2	Dislike Very Much	Dislike Very Much	Dislike Very Much	Dislike Very Much
1	Dislike Extremely	Dislike Extremely	Dislike Extremely	Dislike Extremely
	Comments	Comments	Comments	Comments

Directions: Completely encircle the category which best describes your reaction to the sample written above the column. Then, under Comments give your reasons for rating the sample as you did. (I.e., Flavor too strong, etc.)

RESULTS AND DISCUSSION

Size distribution

Table 2 shows that the varieties and harvest dates did not have significant effect on the distribution of peas in four size groups. Giant Stride, Little Marvel, and Victory Freezer showed noticeable increase in the percent of the distribution of peas in size groups 1-3 to 6 of the three harvest dates. New Era showed a variability in the distribution of peas in size groups at the three harvest dates. However, the percent of peas in size group 6 was the highest in the third harvest. In this case, it could be assumed that the yield of shelled peas increased as the harvesting was advanced. This confirms the findings of Rahman (20) on lima beans and of Pollard, Wilcox, and Peterson (19) on canning peas.

Shear-press

Table 3 indicates the variability in shear-press values in different sizes, harvest dates, and varieties. In the varieties there was a variation noted in the average Shear-press values. In each case the peas of different size groups markedly influenced the Shear-press values. That is, peas of size 6 showed higher Shear-press values than those of 1-3, 4, and 5 size groups. In general, Shear-press values of peas which were harvested at the late maturity were higher than of the early maturity.

Refractive index

It is evident from table 4 that the refractive index values (percent soluble solids) of peas were significantly influenced by the size

Table 2. Effect of harvest dates on the percent distribution of peas in four size groups of four varieties, planted on May 2, 1957

Varieties	Harvest dates	Percent distribution			
		Size groups			
		1-3	4	5	6
		percent	percent	percent	percent
Giant Stride	July 26	2.45	12.83	19.60	65.12
	July 28	2.78	8.39	22.70	66.13
	July 29	1.61	5.44	23.36	69.59
Little Marvel	July 8	19.57	20.37	27.78	32.28
	July 9	16.34	23.11	23.71	36.84
	July 10	13.62	18.79	19.67	47.93
New Era	July 13	45.51	38.38	9.99	6.12
	July 17	21.83	21.78	22.89	33.50
	July 21	6.81	16.49	41.41	35.29
Victory Freezer	July 19	10.77	11.86	16.77	60.60
	July 22	4.17	5.64	17.44	72.74
	July 24	4.57	7.56	18.90	68.97
Average		12.50	15.89	22.02	49.59

Analysis of variance indicates a highly significant difference between size groups of peas.

Least significant difference between size groups, 5% level, 7.42; 1% level, 10.17.

Table 3. Effect of harvest dates and sizes of peas on the shear-press values obtained on peas of four varieties, planted on May 2, 1957

Varieties	Harvest dates	Shear-press values				
		Size groups				Average
		1-3	4	5	6	
		values	values	values	values	values
Giant Stride	July 26	700.0	850.0	985.0	1090.0	906.3
	July 28	930.0	1017.5	1075.0	1120.0	1035.6
	July 29	780.0	890.0	1082.5	1132.5	971.3
						971.0
Little Marvel	July 8	547.5	630.0	740.0	787.5	676.3
	July 9	585.0	640.0	772.5	912.5	727.5
	July 10	552.4	670.0	780.0	902.5	726.3
						710.0
New Era	July 13	537.5	615.0	720.0	770.0	660.6
	July 17	485.0	652.5	775.0	875.0	696.9
	July 21	595.0	830.0	1010.0	1175.0	902.5
						753.3
Victory Freezer	July 19	542.5	587.5	730.0	987.5	711.9
	July 22	572.5	615.0	790.0	1065.0	760.6
	July 24	570.0	632.5	790.0	1127.5	780.0
						750.8
Average		569.0	719.2	854.2	995.4	796.3
Average		Harvest I		Harvest II	Harvest III	
		738.8		805.1	845.0	

Analysis of variance indicates a highly significant difference between size groups, harvest dates, and varieties.

Least significant difference between size groups and varieties 5% level, 37.8; 1% level, 51.8.

Least significant difference between harvest dates 5% level, 32.7; 1% level, 44.9.

Table 4. Effect of harvest dates and sizes of peas on the refractive index values (percent soluble solids) of juice of peas of four varieties, planted on May 2, 1957

Varieties	Harvest dates	Refractive index values				
		Size groups				Average
		1-3	4	5	6	
		values	values	values	values	values
Giant Stride	July 26	13.90	14.30	13.25	12.13	13.40
	July 28	13.30	15.35	13.75	11.88	13.57
	July 29	11.90	14.60	13.13	12.40	13.01
						13.32
Little Marvel	July 8	15.00	15.45	15.35	15.30	15.01
	July 9	14.55	15.25	14.75	13.45	14.50
	July 10	14.20	14.90	13.90	13.10	14.03
						14.60
New Era	July 13	15.60	17.00	16.35	15.60	16.14
	July 17	15.25	15.00	13.50	12.50	14.06
	July 21	14.38	15.65	13.35	12.55	13.98
						14.73
Victory Freezer	July 19	13.20	13.90	13.90	11.70	13.18
	July 22	14.25	15.25	14.75	11.50	13.94
	July 24	14.00	15.25	14.13	10.00	13.35
						13.49
Average		14.13	15.16	14.18	12.68	14.03
Average		Harvest I 14.50		Harvest II 14.02		Harvest III 13.59

Analysis of variance indicates a highly significant difference between size groups and varieties but only significant difference (5% level) between harvest dates.

Least significant difference between size groups and varieties 5% level, 0.79; 1% level, 1.08.

Least significant difference between harvest dates 5% level, 0.68; 1% level, 0.93.

groups of peas and varieties but slightly by harvest dates. In all four varieties the refractive index values decreased as the size of peas increased from size group 4. The data show that the highest refractive index values were in peas of size 4. That is, the sweetest peas were from the sieve size 4. This is in agreement with the previous work on peas by Salunkhe, Pollard, and Taylor (26).

Generally, in the processing industry the peas of size 1-3 fetch a higher price to the grower than those from size 4. This is because the peas of size 1-3 are more tender than the peas of size 4. However, peas of size 4 contain more sugars than the peas of size 1-3, 5, or 6 (table 4). Hence, they have a better flavor than the peas of size 1-3, 5, or 6. It is, therefore, recommended that the grower should receive an equal amount of money for his peas of size 1-3 (tender) and 4 (sweet). This can be confirmed with shear-press and refractometer readings. It is also recommended that the peas of size 1-3 and 4 may be utilized for canning and freezing, peas of size 5 may be soaked overnight and may be canned as second grade peas, and the peas of size 6 (starchy) can be utilized by deep-fat frying. By adopting this practice, the grower will receive a better share of the consumer's dollar from the processor than he receives today.

Specific gravity

Table 5 shows that the specific gravity of peas of different sizes was highly influenced by size groups, varieties, and harvest dates. This concurs with the investigations of Sharma and Thompson (31), Briant, Personius, and Cassell (5), Burton (6), Sharma (30), and Akeley and Stevenson (2) on potatoes and of Hoover and Dennison (9) on southern peas.

Table 5. Effect of harvest dates and sizes of peas on the specific gravity of peas of four varieties, planted on May 2, 1957

Varieties	Harvest dates	Specific gravity				
		Size groups				Average
		1-3	4	5	6	
		sp.gr.	sp.gr.	sp.gr.	sp.gr.	sp.gr.
Giant Stride	July 26	1.0504	1.0672	1.0742	1.0798	1.0697
	July 28	1.0427	1.0587	1.0710	1.0723	1.0612
	July 29	1.0500	1.0706	1.0741	1.0772	1.0740
						1.0657
Little Marvel	July 8	1.0025	1.0095	1.0147	1.0151	1.0105
	July 9	1.0487	1.0537	1.0600	1.0632	1.0564
	July 10	1.0460	1.0521	1.0632	1.0661	1.0569
						1.0412
New Era	July 13	1.0504	1.0515	1.0526	1.0550	1.0524
	July 17	1.0533	1.0537	1.0576	1.0624	1.0568
	July 21	1.0487	1.0485	1.0528	1.0615	1.0529
						1.0540
Victory Freezer	July 19	1.0506	1.0543	1.0554	1.0594	1.0550
	July 22	1.0311	1.0515	1.0598	1.0622	1.0512
	July 24	1.0454	1.0576	1.0598	1.0700	1.0582
						1.0548
Average		1.0433	1.0524	1.0579	1.0620	1.0539
Average		Harvest I 1.0460		Harvest II 1.0564		Harvest III 1.0590

Analysis of variance indicates a highly significant difference between size groups, harvest dates, and varieties.

Least significant difference between size groups and varieties 5% level, 0.0013; 1% level, 0.0037.

Least significant difference between harvest dates 5% level, 0.0011; 1% level, 0.0032.

Starch grain characters

Starch grain size. Table 6 shows that the size of starch grains (in microns) was increased as peas increased in size. Harvest dates and varieties showed no effect on the size of starch grains. From the data it could be concluded that as the peas increased in size the percent of large starch grains increased.

Starch grain shape. It is evident from table 7 that the varieties of peas differ in shape of starch grains, but harvest dates and size groups of the peas showed no significant variations. The circular shape of starch grains was quite common. In addition the rectangular and the polygonal shapes were noticed in the minority.

Structural development of hylum. It can be concluded from table 8 that as the peas increased in size the structural development and ramifications of hylum increased. Peas of size 6 had a high percent of starch grains with higher structural hylum development and ramifications than peas of other sizes (figures 5 and 6). This may be the result of the progressive dehydration of peas as they mature (24).

Deep-fat frying

Table 9 indicates that the immersion temperature should be set at 350° F. If the temperature were below 350° F, it influenced the popping action (breaking of testa) of the peas. The exit temperature should be kept at the appropriate level, depending upon the pea sizes. If the temperature were allowed to increase beyond the designated temperature, the peas burned. The time required for frying, which depends upon sizes of peas, should be maintained appropriate for the entire cooking period. Otherwise, the flavor would also be altered. The amount of weight loss by the peas was inversely related to the size of peas. However, the small peas retained more moisture and showed greater loss of weight.

Table 6. Effect of harvest dates and sizes of peas on the size of starch grains (in microns) of peas of four varieties, planted on May 2, 1957

Varieties	Harvest dates	Starch grain size				Average
		Size groups				
		1-3	4	5	6	
		microns	microns	microns	microns	
Giant Stride	July 26	14.00	17.03	19.62	21.17	17.96
	July 28	9.72	13.57	16.52	20.02	14.96
	July 29	10.04	14.47	16.96	20.34	15.45
						16.12
Little Marvel	July 8	9.61	11.70	17.89	18.43	14.41
	July 9	7.52	11.02	17.82	19.98	14.09
	July 10	8.87	14.58	15.52	18.18	14.29
						14.26
New Era	July 13	7.49	14.29	17.68	22.10	15.39
	July 17	8.50	14.58	15.48	18.04	14.15
	July 21	9.43	14.26	16.20	22.10	15.50
						15.01
Victory Freezer	July 19	6.91	12.31	16.78	20.38	14.10
	July 22	9.40	12.64	16.42	17.82	14.07
	July 24	10.80	12.49	15.62	16.61	14.38
						14.18
Average		9.36	13.58	16.88	19.77	14.90
Average		Harvest I 15.46		Harvest II 14.32		Harvest III 14.90

Analysis of variance indicates a highly significant difference between size groups and no significant difference between varieties nor between harvest dates.

Least significant difference between size groups and varieties 5% level, 1.75; 1% level, 2.40.

Table 7. Effect of harvest dates and sizes of peas on the shape of starch grains of peas of four varieties, planted on May 2, 1957

Varieties	Harvest dates	Percent starch grain shapes									
		Size groups								Average	
		1-3		4		5		6			
		Circular	Irregular	Circular	Irregular	Circular	Irregular	Circular	Irregular	Circular	Irregular
		%	%	%	%	%	%	%	%	%	%
Giant Stride	July 26	56	44	50	50	58	42	48	52	53	47
	July 28	59	41	49	51	50	50	39	61	49	51
	July 29	71	29	72	28	61	39	49	51	63	37
										55	45
Little Marvel	July 8	44	56	48	52	45	55	44	56	45	55
	July 9	62	38	45	55	54	46	53	47	54	46
	July 10	49	51	41	59	48	52	57	43	49	51
										49	51
New Era	July 13	42	58	44	56	50	50	60	40	49	51
	July 17	49	51	47	53	59	41	56	44	53	47
	July 21	63	37	40	60	62	38	52	48	54	46
										52	48
Victory Freezer	July 19	66	34	64	36	58	42	66	34	64	36
	July 22	62	38	60	40	45	55	63	37	58	42
	July 24	57	43	72	28	53	47	56	44	60	40
										60	40
Average		57	43	53	47	54	46	54	46	54	46
Average		Harvest I		Harvest II		Harvest III					
	Circular	53		53		56					
	Irregular	47		47		44					

Analysis of variance, within shape classes, indicates a highly significant difference between varieties but no significant difference between size groups nor harvest dates.

Least significant difference between varieties 5% level, 6; 1% level 8.

Table 8. Effect of harvest dates and sizes of peas on the structural development of hylum of starch grains of peas of four varieties, planted on May 2, 1957

Varieties	Harvest dates	Percent starch grains in size groups												Average			
		1-3				4				5				6			
		Hylum classes*				Hylum classes				Hylum classes				Hylum classes			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
		%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
Giant Stride	July 26	50	19	12	19	48	12	21	19	13	13	23	51	6	11	25	58	29	14	20	37
	July 28	80	6	7	7	52	21	12	15	22	16	23	39	15	10	22	53	42	13	16	29
	July 29	46	39	8	7	35	22	27	16	28	14	31	27	19	59	9	13	32	34	19	16
																		35	20	18	27
Little Marvel	July 8	100	0	0	0	96	4	0	0	25	38	15	22	14	18	14	54	59	15	7	19
	July 9	100	0	0	0	77	10	6	7	44	12	24	20	11	19	24	46	58	10	14	18
	July 10	96	3	1	0	56	23	11	10	28	30	16	26	15	22	25	38	49	20	13	19
																		55	15	11	19
New Era	July 13	91	9	0	0	55	31	10	4	6	25	33	36	4	13	29	54	39	20	18	24
	July 17	96	0	1	3	44	25	15	16	36	14	19	31	24	9	28	39	50	12	16	22
	July 21	69	21	3	7	53	13	15	19	25	23	19	33	11	12	13	64	40	17	13	31
																		43	16	15	26
Victory Freezer	July 19	72	12	11	5	65	10	10	15	38	13	21	28	17	16	22	45	48	13	16	23
	July 22	76	16	7	1	46	21	18	15	19	29	34	18	12	14	27	47	38	20	22	20
	July 24	72	12	11	5	65	10	10	15	38	13	21	28	17	16	22	45	48	13	16	23
																		45	16	18	22
Average		79	11	5	5	58	17	13	12	27	20	23	30	14	18	22	46	44	17	16	23
Average		Harvest I				Harvest II				Harvest III							
Hylum class 1		44				47				42							
Hylum class 2		15				14				21							
Hylum class 3		15				17				15							
Hylum class 4		26				22				22							

* 1 = no hylum development; 2 = slight hylum development; 3 = moderate hylum development; 4 = abundant hylum development.

Analysis of variance within hylum classes indicates a highly significant difference between certain size groups and between varieties, but no significant difference between harvest dates.

Least significant difference between size groups for hylum class 1 and varieties at 5% level, 8; 1% level, 10. No significant difference between size groups for hylum class 2 and varieties. Least significant difference between size groups for hylum class 3 and varieties at 5% level, 5; 1% level, 6. Least significant difference between size groups for hylum class 4 and varieties at 5% level, 6; 1% level, 8.

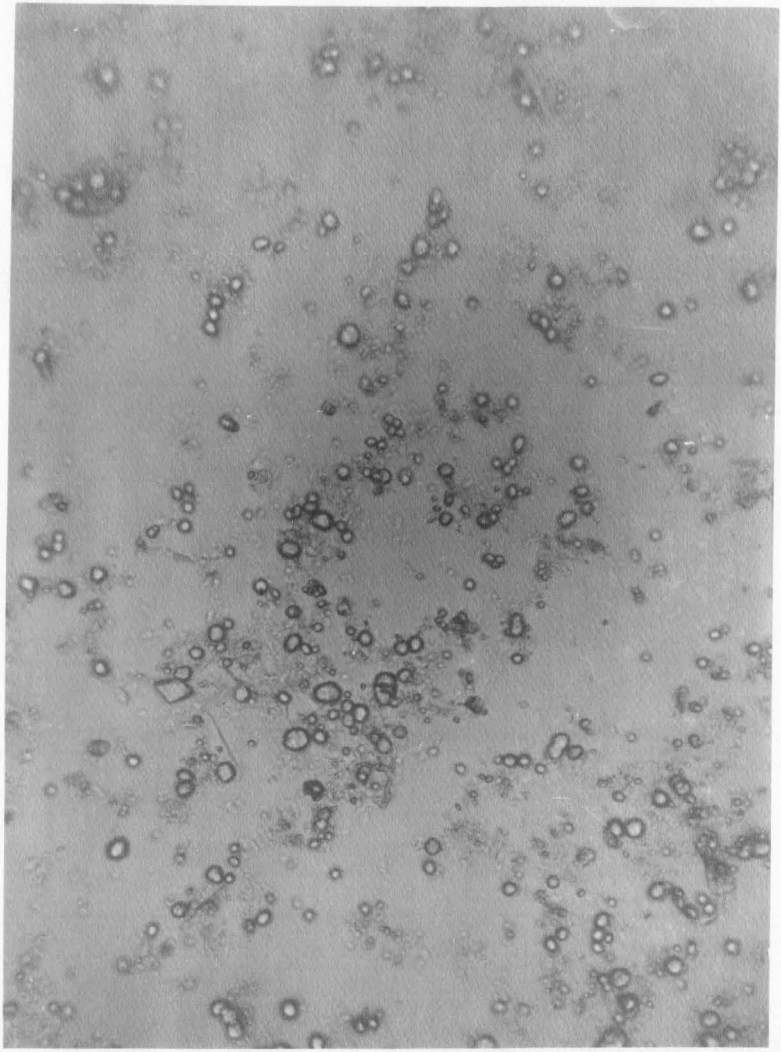

Figure 5. Starch grains of peas of size group 1-3. Compare with figure 6, noting size and shape of starch grains and structural development of hyla.

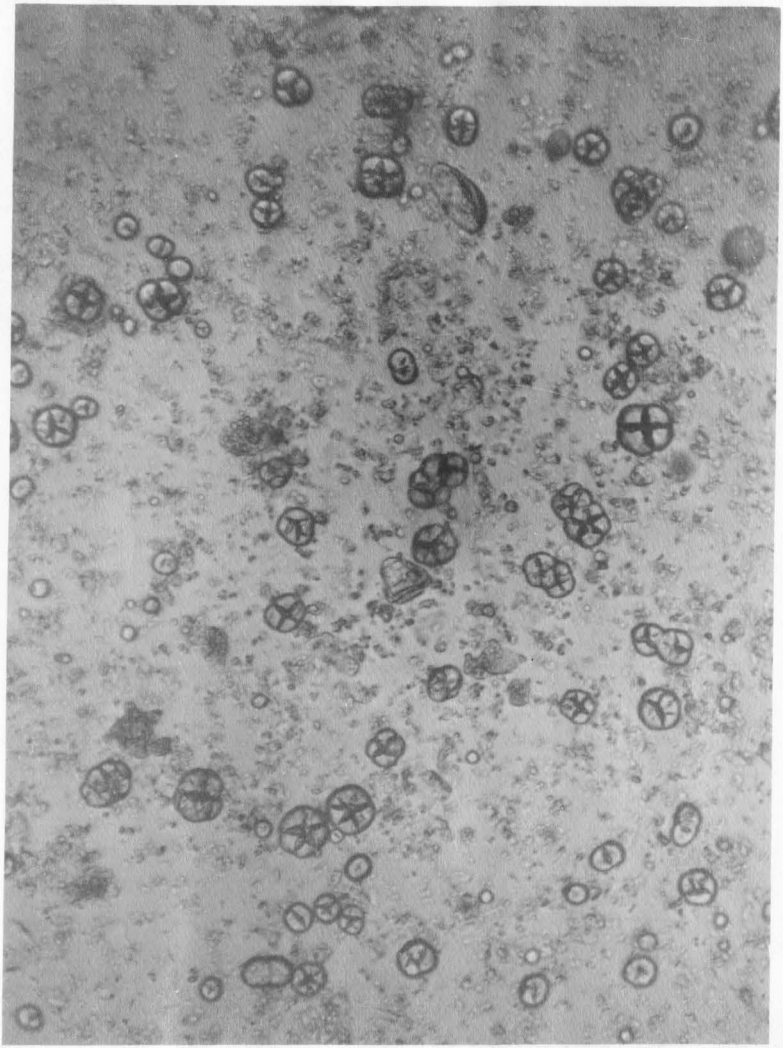

Figure 6. Starch grains of peas of size group 6. Compare with figure 5, noting size and shape of starch grains and structural development of hyla.

Table 9. Temperature changes and time required for frying 500 grams of peas and the weight of fried peas (average of four varieties and three harvest dates)

Size groups	Immersion temperature	Temperature immediately after immersion	Exit temperature	Time required for frying	Weight of fried peas
	°F	°F	°F	minutes	grams
1-3	350	220	280	13.0	120
4	350	220	290	13.5	140
5	350	225	300	14.0	170
6	350	235	310	14.5	180

When peas were fried at the proper condition, they were a tasty and crunchy product.

The previous work on deep-fat frying of peas by Salunkhe, Pollard, and Taylor (26) suggested a temperature of 300° F for frying over-mature peas. Kelley and Baum (10) advised the use of a temperature of 270-300° F for deep-fat processing of carrots, beets, parsnips, peas, and lima beans. The findings of the previous workers did not agree with the findings of the present study in the temperature used. After an extensive experimentation on deep-fat frying of peas by the author, it was found that the popping action of peas depends on the following three main factors:

(1) The immersion temperature must not be less than 350° F. If the temperature were below 350° F, it was not hot enough to break the seed coat of the peas.

(2) The dipping technique as discussed under "Materials and Methods."

(3) The uniform ratio of peas and oil (in this experiment a ratio of 500 grams of peas to 2800 cc of the cocoanut oil was used).

Blanching did not have any significant effect on the popping action of the peas. This agrees with the earlier work of Kelley and Baum (10).

Nutritive value

Differences in protein content between peas of different sizes and varieties were highly significant (table 10). Over-mature peas (size groups 5 and 6) yielded the product of a higher protein content than the immature peas (size groups 1-3 and 4).

Table 11 shows that there was an inverse relationship between the size of peas and the moisture content of the final product. The harvest

Table 10. Effect of harvest dates and sizes of peas on the percent protein content of deep-fat fried peas of four varieties, planted on May 2, 1957

Varieties	Harvest dates	Percent protein				
		Size groups				Average
		1-3	4	5	6	
		percent	percent	percent	percent	percent
Giant Stride	July 26	16.02	16.86	19.60	19.80	18.07
	July 28	17.70	18.72	19.33	21.45	19.30
	July 29	11.67	18.74	21.14	21.18	18.18
						18.52
Little Marvel	July 8	16.19	16.47	17.46	18.76	17.22
	July 9	15.08	17.88	17.93	18.68	17.39
	July 10	17.50	17.55	18.42	19.00	18.11
						17.58
New Era	July 13	17.30	17.94	18.96	20.21	18.60
	July 17	19.73	19.75	19.81	20.22	19.88
	July 21	19.58	19.28	21.25	20.01	20.03
						19.50
Victory Freezer	July 19	19.58	19.61	19.17	19.93	19.57
	July 22	19.20	19.48	19.40	20.02	19.53
	July 24	18.80	19.11	19.46	21.20	19.64
						19.58
Average		17.36	18.45	19.33	20.04	18.79
Average		Harvest I 18.37		Harvest II 19.02		Harvest III 18.99

Analysis of variance indicates a highly significant difference between size groups and varieties but no significant difference between harvest dates.

Least significant difference between size groups and varieties 5% level, 0.90; 1% level, 1.23.

Table 11. Effect of harvest dates and sizes of peas on the percent moisture content in deep-fat fried peas of four varieties, planted on May 2, 1957

Varieties	Harvest dates	Percent moisture				
		Size groups				Average
		1-3	4	5	6	
		percent	percent	percent	percent	percent
Giant Stride	July 26	3.94	3.82	2.87	2.86	3.36
	July 28	3.79	3.15	2.92	2.88	3.19
	July 29	2.69	3.08	3.06	2.67	3.88
						3.14
Little Marvel	July 8	3.52	2.95	2.47	2.75	2.92
	July 9	3.83	3.83	3.26	3.63	3.64
	July 10	4.00	3.26	2.90	2.43	3.15
						3.24
New Era	July 13	3.38	3.20	3.13	2.76	3.12
	July 14	3.67	2.95	2.70	2.71	3.01
	July 15	4.02	3.72	3.60	2.41	3.44
						3.19
Victory Freezer	July 19	4.15	2.95	3.09	2.75	3.24
	July 22	3.97	3.64	3.66	3.15	3.61
	July 24	3.71	3.70	3.20	2.46	3.27
						3.37
Average		3.72	3.35	3.07	2.79	3.23
Average		Harvest I 3.16		Harvest II 3.36		Harvest III 3.18

Analysis of variance indicates a highly significant difference between size groups but no significant difference between harvest dates nor varieties.

Least significant difference between size groups 5% level, 0.20; 1% level, 0.27.

dates and varieties had no effect on the moisture content of the deep-fat fried peas.

It can be seen from table 12 that the fat content of the product was inversely proportional to the size of the peas, but harvest dates and varieties showed no significant variations in the fat content of the product.

Color and color difference

Table 13 shows that the Rd values (luminous reflectance) obtained on ground deep-fat fried peas were highly influenced by the size of the peas. The varietal difference had some effect (at the 5% level), but harvest dates showed no effect on Rd values. The product of small size peas was less shiny (reflection of light) than that of the large size.

It can be seen from table 14 that the size of peas and varieties changed the "a" values (greeness) of the products. Harvest dates failed to show any effect on the "a" values. The fried product made from young peas was greener and browner than the product obtained from over-mature peas.

Table 15 indicates that size groups of peas influenced the "b" values (yellowness) of the product. Varieties of peas had some effect (at the 5% level), but harvest dates had no effect on the "b" values of the product. The deep-fat fried product obtained from the large size peas (5 and 6) was more yellow than those prepared from the smaller size (1-3 and 4) peas.

The color of the product is one of the important factors in the consumer's acceptance. The dark green color of the deep-fat fried peas is not highly appealing. An attempt, therefore, was made to "dip" the deep-fat fried peas in chocolate to mask the color and to add chocolate flavor.

Table 12. Effect of harvest dates and sizes of peas on the percent fat content of deep-fat fried peas of four varieties, planted on May 2, 1957

Varieties	Harvest dates	Percent fat				
		Size groups				Average
		1-3	4	5	6	
		percent	percent	percent	percent	percent
Giant Stride	July 26	33.42	27.38	23.19	22.05	26.51
	July 28	34.68	23.83	23.81	22.30	26.16
	July 29	26.17	23.58	24.07	23.56	24.35
						25.67
Little Marvel	July 8	33.04	31.74	23.95	23.09	27.96
	July 9	35.61	28.13	23.71	24.45	27.98
	July 10	29.75	28.96	26.29	27.61	28.15
						28.03
New Era	July 13	30.72	27.03	28.56	26.59	28.23
	July 17	27.75	24.89	26.37	24.93	25.99
	July 21	29.54	25.73	22.38	24.31	25.49
						26.57
Victory Freezer	July 19	32.53	27.06	30.57	27.54	29.43
	July 22	28.77	26.60	23.87	23.75	25.75
	July 24	31.05	28.55	23.45	22.57	26.41
						27.19
Average		31.09	26.96	25.02	24.40	26.85
Average		Harvest I 28.03		Harvest II 26.47		Harvest III 26.10

Analysis of variance indicates a highly significant difference between size groups but no significant difference between harvest dates nor varieties.

Least significant difference between size groups 5% level, 2.00; 1% level, 2.74.

Table 13. Effect of harvest dates and sizes of peas on the "Rd" values obtained by Hunter color and color difference meter on ground deep-fat fried peas of four varieties, planted on May 2, 1957

Varieties	Harvest dates	"Rd" values				
		Size groups				Average
		1-3	4	5	6	
		values	values	values	values	values
Giant Stride	July 26	10.53	13.38	15.55	16.15	13.90
	July 28	9.93	12.93	17.28	16.13	14.07
	July 29	9.93	11.05	15.13	17.13	13.31
						13.76
Little Marvel	July 8	10.80	10.08	12.78	13.80	11.87
	July 9	10.03	10.03	10.30	15.35	11.43
	July 10	10.93	12.83	11.75	13.00	12.13
						11.86
New Era	July 13	11.63	11.28	12.95	13.25	12.28
	July 17	10.60	12.23	15.78	16.55	18.39
	July 21	11.58	14.40	19.25	13.90	14.78
						13.82
Victory Freezer	July 19	9.90	10.98	12.28	14.80	12.64
	July 22	10.28	11.33	15.50	15.80	13.32
	July 24	10.35	11.15	13.00	18.33	13.20
						12.81
Average		10.54	11.86	14.30	15.35	13.01
Average		Harvest I 12.55		Harvest II 13.13		Harvest III 13.36

Analysis of variance indicates a highly significant difference between size groups and significant difference (5% level) between varieties, but no significant difference between harvest dates.

Least significant difference between size groups and varieties 5% level, 1.40; 1% level, 1.92.

Table 14. Effect of harvest dates and sizes of peas on the "a" values* obtained by Hunter color and color difference meter on ground deep-fat fried peas of four varieties, planted on May 2, 1957

Varieties	Harvest dates	"a" values				
		Size groups				Average
		1-3	4	5	6	
		values	values	values	values	values
Giant Stride	July 26	42.48	39.15	35.53	35.98	38.29
	July 28	43.13	38.28	34.38	35.85	37.91
	July 29	43.45	40.43	36.98	34.63	38.87
						38.36
Little Marvel	July 8	41.50	40.85	38.98	35.48	39.20
	July 9	43.40	42.60	39.33	36.63	40.49
	July 10	41.23	38.45	39.85	39.13	39.67
						39.79
New Era	July 13	40.70	32.23	36.39	35.30	36.13
	July 17	42.58	38.95	36.48	34.85	38.22
	July 21	41.98	38.03	32.73	33.48	36.56
						36.97
Victory Freezer	July 19	43.45	38.40	40.65	36.90	39.85
	July 22	43.60	41.58	35.45	36.05	39.17
	July 24	43.75	42.85	39.00	33.53	39.78
						39.60
Average		42.60	39.32	37.14	35.65	38.68
Average		Harvest I 38.37		Harvest II 38.95		Harvest III 38.72

Analysis of variance indicates a highly significant difference between size groups and varieties but no significant difference between harvest dates.

Least significant difference between size groups and varieties 5% level, 1.86; 1 % level, 2.55.

* Minus values.

Table 15. Effect of harvest dates and sizes of peas on the "b" values obtained by Hunter color and color difference meter on ground deep-fat fried peas of four varieties, planted on May 2, 1957

Varieties	Harvest dates	"b" values				
		Size groups				Average
		1-3	4	5	6	
		values	values	values	values	values
Giant Stride	July 26	20.18	21.93	23.28	23.63	22.26
	July 28	20.88	21.33	24.03	22.73	22.24
	July 29	19.48	20.50	23.05	23.63	21.67
						22.05
Little Marvel	July 8	19.80	19.95	22.10	22.70	21.14
	July 9	18.30	20.00	20.40	22.63	20.33
	July 10	20.18	21.83	22.76	21.90	21.67
						21.05
New Era	July 13	20.68	20.00	21.48	22.05	21.05
	July 17	20.88	21.05	23.68	23.98	22.40
	July 21	20.58	22.75	24.80	22.38	22.63
						22.03
Victory Freezer	July 19	19.48	22.03	21.55	23.13	21.55
	July 22	19.68	20.58	23.50	23.75	21.88
	July 24	19.60	20.30	21.45	24.35	21.43
						21.62
Average		19.98	21.02	22.67	23.07	21.68
Average		Harvest I 21.50		Harvest II 21.71		Harvest III 21.85

Analysis of variance indicates a highly significant difference between size groups and significant difference (5% level) between varieties but no significant difference between harvest dates.

Least significant difference between both size groups and varieties 5% level, 0.78; 1% level, 1.37.

Organoleptic appraisal

Table 16 indicates that the product from the large size peas was better in quality and in flavor than that from small size peas. The quality and flavor of the product depends mainly upon the size and varieties of peas but harvest dates did not show any effect on the quality. The product from the peas of size 5 and 6 of variety Little Marvel was of the best quality.

In general, regardless of varieties and harvest times of peas studied, it may be concluded that the taste quality of deep-fat fried peas seems to be directly correlated with the size, shear-press values, specific gravity, starch grain size, and the structural development of hylum of starch grains of peas (figure 7). However, no correlation between the size of peas and the shape of the starch grain was evidenced.

In general, it may be concluded that the harvest dates studied did not show significant effects on the objective measures for the determination of the potential quality in raw peas as well as the final quality of deep-fat fried peas. This may be attributed to the following two reasons:

(1) The varieties of peas used in this experiment set pods indeterminately.

(2) The interval between harvests may be too short.

The results from the comparison of blanched vs. unblanched deep-fat fried peas did not show any difference in the flavor and quality. The blanching of peas was assumed unnecessary and hence the treatment was discontinued in the further experiments.

Table 16. Effect of harvest dates and sizes of peas on the organoleptic appraisal scores* on deep-fat fried peas of four varieties, planted on May 2, 1957

Varieties	Harvest dates	Organoleptic appraisal scores				
		Size groups				Average
		1-3	4	5	6	
		scores	scores	scores	scores	scores
Giant Stride	July 26	6.7	6.9	7.0	7.4	7.0
	July 28	6.1	6.2	6.8	7.9	6.8
	July 29	6.4	6.8	7.5	7.9	7.2
						7.0
Little Marvel	July 8	6.8	7.1	7.7	8.3	7.5
	July 9	6.9	6.8	7.8	8.3	7.5
	July 10	6.6	7.6	8.4	7.9	7.6
						7.5
New Era	July 13	6.8	7.3	7.6	7.8	7.4
	July 17	7.2	7.6	7.7	7.7	7.6
	July 21	6.6	7.3	7.0	7.1	7.0
						7.3
Victory Freezer	July 19	6.7	7.4	7.1	7.4	7.2
	July 22	6.1	6.0	7.3	7.6	6.8
	July 24	6.1	6.6	7.5	6.8	6.8
						6.9
Average		6.6	7.0	7.4	7.7	7.2
Average		Harvest I 7.3		Harvest II 7.1		Harvest III 7.1

Analysis of variance indicates a highly significant difference between size groups and varieties but no significant difference between harvest dates.

Least significant difference between size groups and varieties 5% level, 0.2; 1% level, 0.3.

* 1 = extreme dislike; 9 = extreme like; 5 or higher = acceptable.

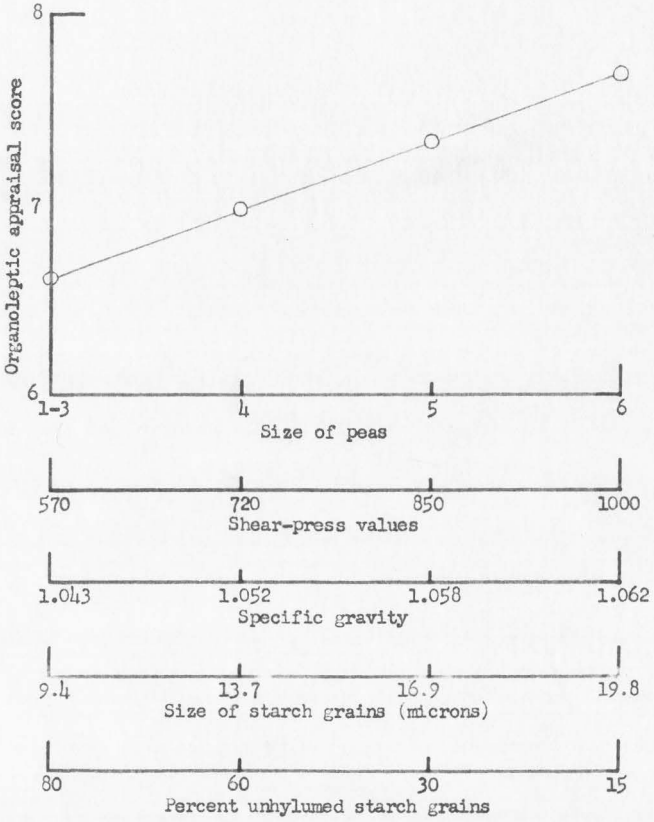

Figure 7. Relationship between organoleptic appraisal score for deep-fat fried peas and size, shear-press value, specific gravity, size of starch grains, and percent unhylumed starch grains of raw peas

SUMMARY AND CONCLUSIONS

Four varieties of peas--Giant Stride, Little Marvel, New Era, and Victory Freezer--were planted at the Terry Experimental Farm, Logan, Utah, on May 2, 1957, and harvested from July 8 to July 29. Various objective tests were made to determine the proper maturity of peas. A process of deep-fat frying was developed for peas. Chemical analyses were conducted to determine the nutritive value of the product. Organoleptic appraisal was arranged to evaluate the quality of the product.

Objective tests

Peas were classified according to size groups before studying the objective tests. The results of these tests may be summarized as follows:

1. The shear-press values increased as the size of peas increased.
2. The specific gravity increased as the size of peas increased.
3. The refractive index increased as the size of peas increased from size group 1-3 to 4 and decreased rapidly as the size of peas increased from size group 4 to 6. Peas of size 4 showed the highest refractive index values.
4. The starch grain size increased as the size of peas increased.
5. Many different shapes of starch grains were noticed.
6. As the size of peas increased, the structural development of the hylum was increased.

Deep-fat frying

Peas were fried in cocoanut oils (Dri-Fri) at 350° F. The proper process for frying consisted of three main factors:

1. Immersion temperature

2. Dipping technique

3. Ratio of peas to oil used.

Quality of deep-fat fried peas

1. The deep-fat fried peas of the large size groups were higher in protein content than those from the small size groups. The protein content of the product ranged from 11.67 to 21.45 percent.

2. The moisture content of the fried peas obtained from the small size peas was higher than that obtained from the large size peas. The moisture content ranged between 2.41-4.15 percent.

3. The fat content of the product showed results similar to the moisture content. It ranged from 22.05 to 36.61 percent.

4. The ground product of the large size peas had more glossiness, less greeness, and more yellowness as compared with the product of the small size peas.

5. The deep-fat fried products from peas of size groups 5 and 6 were generally considered of the best taste quality. The taste quality was compared with various objective methods.

In general, it may be concluded that the harvest dates studied did not show significant effects on the objective measures for the determination of the potential quality in raw peas as well as the final quality of deep-fat fried peas. This may be attributed to the following two reasons:

1. The varieties of peas used in this experiment set pods indeterminately.

2. The interval between harvests may be too short.

Peas of size group 6 received the highest score for flavor and quality when compared with other size groups. In this case we could

assume that over-mature peas yielded the most acceptable flavor and quality deep-fat fried product. The findings of this study could be helpful to the canning industry where the over-mature peas are of little value for processing purposes. If over-mature peas were utilized by deep-fat frying, the processor as well as the growers of peas would benefit from the income.

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