ANALYSES SHOWING THE COMPOSITION OF THE DIFFERENT GRADES OF COMMERCIAL PACK PEAS

By JOHN C. DIGGS

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Knowledge that the maturity of the pea is an important factor in its composition led to an investigation of the different grades of canned peas put out by an Indiana packing concern. Work on peas has been conducted chiefly by chemists who obtained their samples from the open market. The non-uniformity of methods used in grading and packing seriously interfered with any careful work in determining the exact effect of size and age upon the composition of the pea. Data at hand give information regarding the composition as to the size of the canned pea: none, however, are available showing changes in composition that may result with the maturing of the pea; A noticeable fact shown by the work of chemists is the utter unreliability of the label as a guide to the composition of the product. This work may, in a measure, assist in the establishment of standards of composition for each of the grades of canned peas.

The work of McElroy and Bigelow of some twenty years ago gives us¹ some analyses made of a large number of samples, of both American and foreign origin. No information is given as to system of grading as to maturity—if any system did exist. Dubois² in 1910 made the analyses of more than one hundred samples of canned peas. He draws conclusions regarding composition as to size but has no data for determining the effect of age upon composition. Street,³ the same year, published results of one hundred and eleven samples but, without the history of the samples and method used in grading and sizing, based all tabulations on label statements.

Different systems of sizing and grading employed in various plants and the overlapping of one grade into the next tend to reduce the results of different grades to an average rather than differentiate between them. Since the samples were raised in different parts of the country, the matter of soil, rainfall and climate would be interfering factors.

Consequently, it was thought that if the common analytical factors were determined on the product put out by a single plant where uniform methods were used in sizing and grading, where the same variety of peas were packed, and one system used in packing and processing, there might prove to be a definite relation between the composition and the grade of the pea. While it has been shown² that the ratios existing between the organic plant constituents are different for different sizes of peas, no literature has been published showing the relations existing among the various inorganic plant factors for these samples. In view of this fact analyses were made showing the calcium, magnesium and phosphoric acid content of each grade of pea. A table has been calculated showing to some degree the composition of the ash of each grade.

¹ U. S. Department of Agriculture, Bureau of Chemistry, *Circ.* 54.

² U. S. Department of Agriculture, Bureau of Chemistry, *Bull.* 13.

³ Conn. Agr. Exp. Station Report, 1910. U. S. Dept. of Agriculture, Bur. of Chemistry, *Bull.* 137.

In undertaking this work, eleven samples of canned peas were obtained from a local packing concern, ten of these representing three brands and several grades of each brand and the eleventh being a sample of so-called "soaked peas."

THE PACKING PROCESS

The peas used in this pack were grown in central Indiana within a radius of ten miles of the packing plant. The soil in this section is uniform, consequently that factor does not influence any particular grade. The season of packing usually extends from June 10th to July 15th.

The peas are mowed, loaded on wagons and hauled to the vining and thrashing machines. The hulled peas are passed through a squirrel cage washer into a grading tank of dilute brine (sp. gr. 1.07). The younger peas float in this solution and are removed by an elevator to a bin for subsequent grading as to size. This quality of pea is used for the Polk's Best Brand. The peas which have sunk to the bottom are carried by an elevator into a strong brine grading tank (sp. gr. 1.11). This brings about another grading, some floating and some going to the bottom. Those floating are made into the Greenwood Brand; those sinking, the harder and the more mature peas, into the May Day.

Each of these three classes of peas is made up of large and small sizes. It is desirable that the peas of a can be of uniform size. In factory practice each class is separated into five sizes. Beginning with the largest and going to the smallest, the names assigned to these five sizes are Marrow Fat, Early June, Sifted June, Extra Sifted June and Petit Pois. These trade names apply only to the size of the pea and have nothing to do with the season of packing. The grading is accomplished by means of perforated cylinders through which the peas pass.

After proper sizing the peas are blanched. The blancher is a continuous washer in which the peas are held in hot water for a certain period. In blanching two results are accomplished: (1) The outside mucous coat is removed from the pea and with it some of the green coloring matter so that the liquor of the can may be clear; (2) and to force water into the pea so that it may be tender. The time for blanching depends entirely upon the maturity of the pea. Blanching is not done "by rule of thumb" but by competent workmen who very carefully determine when the peas have taken up the right amount of water, when the right amount of color has been removed, etc. In general the time varies from two to five minutes.

From the blanchers the peas go to the filling machines. These put a certain weight of peas, varying according to size and quality into the can and add the liquor, a salt sugar solution (24 pounds of salt and 24 pounds of sugar to 500 gallons water) sufficient to fill the can. The lid is put on, sealed and the cans sent to the retorts for processing where they are heated at 240° Fahrenheit for 30 minutes.

PHYSICAL EXAMINATION

The contents of each can were poured upon a sieve of $\frac{1}{8}$ inch wire mesh and allowed to drain for one min-

ute. The greatest total weight (Table I) was 612 grams in the sample of "Soaked Peas." The maximum total of the fresh peas was 598 grams and the minimum 581 grams. The maximum weight of drained peas was 421 grams. This sample, 7247 B, undoubtedly had an excess of peas as would be indicated by the condition of the sample, "Peas all broken," "Liquor very turbid." The minimum of drained peas was 322 grams. This can had an excess of liquor. As a rule the small grades of peas were accompanied by the larger per cent of liquor.

a number of samples might be run simultaneously. However, the samples assumed a dark color upon drying, especially those in which the starch content was low. The dried substance proved to be hygroscopic and caused trouble in weighing. All of this would indicate that when time permitted, it would be advisable to determine the liquors without drying which, of course, means that the sample must to a certain extent, be handled individually. In many cases on account of the small amount of liquor obtained, it was impossible to make all of the desired determina-

TABLE I—PHYSICAL EXAMINATION OF CANNED PEAS

					Peas and liquor						
Label on can			Appearance of contents		Contents in grams			%		Gravity	
Sample	Brand	Grade	Peas	Liquor	Drained			peas	Liquor	Peas	Liquor
					Total	peas	Liquor				
7246 B	May Day	Marrow Fat	Peas all broken	Liquor very turbid	581	388.5	192.5	66.9	33.1	1.065	1.033
7247 B	May Day	Early June	Peas all broken	Liquor very turbid	594	421	173	70.9	29.1	1.123	1.028
7248 B	May Day	Sifted June	Slightly sprouted and broken	Turbid	590	322	268	54.6	45.4	1.106	1.0135
7252 B	Greenwood	Early June	Large and broken	Somewhat turbid	598	370	228	61.9	38.1	1.099	1.025
7253 B	Greenwood	Sifted June	Small and slightly broken	Somewhat turbid	596	386	210	64.8	35.2	1.090	1.0277
7254 B	Greenwood	Extra Sifted June	Nearly all slightly broken	Slightly turbid	598	379	219	63.3	36.7	1.063	1.0244
7249 B	Polk's Best	Early June	Slightly sprouted and broken	Somewhat turbid	598	391	207	65.4	34.6	1.112	1.026
7250 B	Polk's Best	Sifted June	Slightly sprouted and broken	Somewhat turbid	586	370	216	63.0	37.0	1.072	1.0178
7251 B	Polk's Best	Extra sifted June	Small—not much broken	Nearly clear	595	360	235	60.5	39.5	...	1.0218
7255 B	Polk's Best	Petit-Pois	Peas small—badly broken	Nearly clear	594	351	243	59.1	40.9	1.075	1.0208
7256 B	Everybody's	Soaked Peas	Large and all broken	Liquor muddy	61	408	204	66.7	33.3	1.120	1.034

The appearance of the drained peas and liquor was quite variable. We would have expected the smaller and better grades of peas to have been less broken since they required less blanching. This, however, was not always the case. The liquor of the more mature peas showed a greater tendency to be turbid, due to the longer time required for blanching and the greater tendency of these peas to swell and burst.

tions and to check some inconsistent results. In general, the methods of analysis used were those of *Bull. 107*, Bureau of Chemistry. In order to run a number of samples simultaneously, it was necessary to dry a large quantity of the drained peas and pulverize the dry sample until all would pass through a forty mesh sieve. From this dried material the samples for subsequent determinations were weighed out.

TABLE II—PERCENTAGE COMPOSITION OF CANNED PEAS

Original basis						Water-free basis					
Sample	Water	Proteid N $\times 6.25$	Crude starch	Sugar	NaCl	P ₂ O ₅	Proteid N $\times 6.25$	Crude starch	Sugar	NaCl	P ₂ O ₅
7246 B	78.52	4.56	11.94	1.15	0.40	0.167	21.23	55.8	5.35	1.86	0.777
7247 B	80.77	4.64	8.22	1.13	0.60	0.145	24.1	42.6	5.87	3.12	0.754
7248 B	84.55	3.31	8.11	0.71	0.40	0.106	21.4	52.5	4.59	2.59	0.686
7252 B	82.29	3.79	8.05	...	...	...	27.8	51.0	...	...	...
7253 B	82.90	...	6.50	...	...	...	...	38.0	...	...	...
7254 B	85.92	2.96	5.16	...	...	...	21.0	36.6	...	...	...
7249 B	81.65	4.55	9.18	1.97	0.53	0.131	24.8	50.0	10.68	2.34	0.713
7250 B	86.32	3.09	6.09	1.46	0.34	0.118	22.7	41.5	10.66	2.48	0.862
7251 B	88.06	2.85	3.30	...	...	...	23.9	27.6	...	...	...
7255 B	89.61	2.34	2.73	...	...	...	22.5	26.2	...	...	...
7256 B	78.96	3.95	9.87	1.32	0.73	0.165	18.7	47.0	6.27	3.47	0.784

In a general way the gravity of the drained peas was practically the same as that of the fresh peas used in each brand. Samples 7254 B and 7246 B were exceptions to this rule. The gravity of the liquors was practically the same for all, the samples 7248 B and 7250 B having the minimum gravity. The salt and sugar content of these samples help explain this discrepancy.

PERCENTAGE COMPOSITION

The chemical analyses were made on the liquor and drained peas independently. Considerable difficulty was encountered in working on the liquor. Owing to the fact that it would quickly ferment, it was necessary to evaporate it to dryness in order that

TABLE III—PERCENTAGE COMPOSITION OF PEA LIQUOR

Original basis						Water-free basis					
Sample	Water	Proteid N $\times 6.25$	Sugar	Crude starch	Salt	P ₂ O ₅	Proteid N $\times 6.25$	Sugar	Crude starch	Salt	P ₂ O ₅
7246 B	92.9	2.11	1.68	1.95	0.55	0.086	29.78	23.7	27.5	7.8	1.22
7247 B	93.23	1.98	1.10	1.33	0.79	0.080	29.21	16.33	19.58	11.61	1.19
7248 B	96.54	1.06	0.77	0.76	0.54	0.048	30.65	22.27	21.89	15.68	1.39
7252 B	94.62	1.51	...	0.46	...	...	25.83	...	7.89	...	...
7253 B	93.87	...	...	0.56	...	...	...	...	9.06	...	...
7254 B	94.66	1.37	...	0.16	...	...	25.59	...	3.00	...	...
7249 B	93.61	2.06	3.11	1.85	0.78	0.073	32.22	48.66	28.93	12.17	1.15
7250 B	95.42	1.38	1.52	0.58	0.54	0.071	30.07	33.15	12.72	11.71	1.55
7251 B	95.22	1.53	...	0.04	...	...	32.38	...	0.93	...	...
7255 B	95.02	1.41	...	0.11	...	...	28.27	...	2.35	...	...
7256 B	91.80	1.70	1.7	1.85	0.93	0.123	20.71	20.7	22.6	11.3	1.51

Tables III and IVA and B have been prepared showing the percentage composition of the drained peas and liquors on both the original and water-free basis. The composition on a water basis in a measure eliminates the abnormal figures that may result from varying amounts of liquor added. Table II has been calculated on the basis of the peas and liquor as they occur in the can. This table has also been reduced to a water-free basis.

The composition of the different samples varies quite as much as do the analyses made by Street and Dubois. However, all determinations come within the limits found by these authors.

According to the information given at the factory

the salt sugar solution used in all grades was 24 pounds sugar and 24 pounds salt to 500 gallons of water. This would mean that the liquor contained 0.57 per cent each of salt and sugar. This figure is hard to reconcile with the percentage of salt and sugar found in the pea liquor and canned peas. The maximum percentage of salt found in the liquor was 0.79 per cent in Sample 7247 B. The drained peas taken from the same can showed 0.52 per cent of salt, a figure by no means the highest in this table. The samples of liquor having the minimum salt content were 7248 B and 7250 B, each of which had 0.54 per cent. The drained peas from these cans had 0.32 per cent and 0.23 per cent, respectively, these figures being the smallest in the table. This would indicate a difference in the strength of the salt solutions used. This assists in explaining the low gravity of the liquor of these samples.

TABLE IVa—PERCENTAGE COMPOSITION OF DRAINED PEAS, ORIGINAL BASIS

Sample	Water	Ether extract	Crude fiber	Proteid N X 6.25	Sugar	Crude starch	Salt	Total ash	Salt-free ash	CaO	MgO	P ₂ O ₅
7246 B.....	71.4	0.56	1.77	5.92	0.89	16.93	0.34	1.04	0.70	0.047	0.038	0.208
7247 B.....	75.81	0.38	1.74	5.74	1.14	16.93	0.34	1.04	0.70	0.047	0.038	0.208
7248 B.....	74.57	0.49	2.06	5.19	0.66	11.04	0.52	1.10	0.58	0.053	0.033	0.172
7252 B.....	74.69	0.49	1.98	5.21	1.22	14.21	0.32	0.85	0.53	0.078	0.049	0.158
7253 B.....	76.94	0.47	1.62	5.10	1.39	12.74	0.64	1.27	0.63	0.053	0.038	0.179
7254 B.....	80.85	0.53	1.74	3.89	1.31	9.72	0.65	1.26	0.61	0.060	0.021	0.165
7249 B.....	75.32	0.50	2.00	5.88	1.33	8.06	0.92	1.33	0.41	0.061	0.040	0.128
7250 B.....	80.96	0.50	1.99	4.10	1.44	13.06	0.41	0.97	0.56	0.047	0.054	0.166
7251 B.....	83.35	0.39	1.92	3.73	1.62	8.86	0.23	0.67	0.44	0.047	0.035	0.147
7255 B.....	85.85	0.42	1.54	3.16	1.85	5.42	0.43	0.96	0.53	0.049	0.032	0.131
7256 B.....	72.85	0.55	1.90	5.09	1.11	4.56	0.58	0.95	0.47	0.031	0.036	0.142
						13.98	0.66	0.32	0.66	0.057	0.037	0.185

The highest sugar content of the liquor was in Sample 7249 B, being 3.11 per cent. The corresponding sample of drained peas had 1.33 per cent sugar, one of the highest of this table. The minimum sugar content was in liquor Sample 7248 B where it was 0.77 per cent. The corresponding drained peas sample had 0.66 per cent, the minimum of that table. Sample 7248 B especially seems to be deficient in these added constituents. We have no explanation of this save that the liquor is probably not made up according to formula. It has been suggested that selective absorption may play a part in determining the location of the salt and sugar added. This, however, is a field for further study.

TABLE IVb—WATER-FREE BASIS

Sample	Ether extract	Crude fiber	Proteid N X 6.25	Sugar	Crude starch	Salt	Total ash	Salt-free ash	CaO	MgO	P ₂ O ₅
7246 B 1.96	6.18	20.7	3.1	59.2	1.16	3.65	2.49	0.17	0.134	0.730	
7247 B 1.59	7.18	23.71	4.7	45.65	2.19	4.55	2.36	0.22	0.142	0.714	
7248 B 1.94	8.09	20.41	2.61	55.87	1.29	3.34	2.05	0.35	0.198	0.639	
7252 B 1.93	7.84	20.58	4.81	48.16	2.55	5.02	2.47	0.21	0.157	0.716	
7253 B 2.03	8.03	22.11	6.01	42.14	2.82	5.48	2.66	0.26	0.093	0.675	
7254 B 2.77	9.08	20.33	6.83	42.07	4.86	6.85	2.09	0.32	0.203	0.640	
7249 B 2.07	8.09	23.83	5.35	52.91	1.66	3.94	2.28	0.19	0.223	0.667	
7250 B 2.64	10.43	21.54	7.54	46.52	1.20	3.54	2.34	0.25	0.178	0.738	
7251 B 2.32	11.55	22.41	9.68	32.53	3.22	5.75	2.53	0.29	0.188	0.784	
7255 B 2.94	10.91	22.36	13.10	32.24	4.13	6.69	2.56	0.21	0.223	0.854	
7256 B 2.03	6.92	18.51	4.02	50.85	2.40	4.79	2.39	0.21	0.157	0.756	

Liquors 7246, 47, 49 and 56 have very high starch content. These same liquors have the highest proteid content of the table. This is in a measure ex-

plained by Table I which shows all of these liquors to be "very turbid." The peas have been over-blanching or over-processed and have burst, allowing the solids including starch and insoluble proteid to become mixed with the liquor. It is also interesting to note that the gravities of these solutions have been increased to the highest of the table. The other factors of these tables vary so greatly that no fair conclusion can be drawn.

Table V shows the average composition according to the maturity of the pea. The Polk's Best Brand was made from the tender and more succulent peas—peas which have a gravity of less than 1.07, the Greenwood was made from the fresh pea harder than the Polk's Best Brand and having a gravity between 1.07 and 1.11, and the May Day from peas which sank in a 1.11 gravity brine. By means of this table (dried peas, original basis) we see the water decreases

from 81.37 per cent in the Polk's Best to 73.92 per cent in the May Day, the oldest peas. On account of the varying factor of water content no conclusion regarding other constituents from this table can be drawn.

According to the water-free basis calculations of the drained peas, the crude fiber decreased with the age of the pea, changing from 10.25 per cent in the youngest to 7.15 per cent in the mature peas. This fact is borne out by Street, who says: "The crude fiber of the immature pea, in which the meaty portion had just begun to develop, is usually higher than in the more mature."¹ Protein decreases slightly, 22.31 per cent to 21.74 per cent, as the pea becomes older. The crude starch increases from 41.05 per cent to 53.57 per cent.

The figures for the sugar content of these brands call for an explanation. Bitting² gives the average sugar content of fresh peas as follows:

Grade	Original basis	Water-free basis
First, corresponds to Polk's Best....	0.88	4.51
Second, corresponds to Greenwood....	0.71	3.26
Third, corresponds to May Day....	0.55	2.16

These figures indicate that the sugar which forms in the pea during the early stage of growth does not keep pace with the other constituents as the pea matures. It has been suggested that the variation of sugar content of the drained peas was due to the sugar content of the liquor.

¹ Loc. cit.² U. S. Dept. of Agriculture, Bureau of Chemistry, Bull. 125.

TABLE Va—PERCENTAGE COMPOSITION OF DRAINED PEAS BASED ON BRAND

Brand	Water	Ether extract	Crude fiber	Proteid N X 6.25	Sugar	ORIGINAL BASIS			Total ash	Salt-free ash	CaO	MgO	P ₂ O ₅
						Crude starch	Salt						
May Day.....	73.92	0.47	1.85	5.61	0.89	14.06	0.39	0.99	0.60	0.059	0.040	0.179	
Greenwood.....	77.49	0.49	1.78	4.73	1.31	10.17	0.74	1.28	0.55	0.058	0.033	0.157	
Polk's Best.....	81.37	0.45	1.86	4.22	1.56	7.97	0.41	0.89	0.47	0.043	0.039	0.146	
WATER-FREE BASIS													
May Day.....		1.83	7.15	21.74	3.14	53.57	1.55	3.85	2.30	0.25	0.158	0.694	
Greenwood.....		2.34	8.31	21.01	5.55	44.12	3.54	5.78	2.41	0.27	0.151	0.677	
Polk's Best.....		2.00	10.25	22.31	8.92	41.05	2.55	4.98	2.43	0.23	0.203	0.761	

TABLE Vb—PERCENTAGE COMPOSITION OF CANNED PEAS BASED ON BRAND

Brand	Original basis							Water free basis					
	Water	Proteid N X 6.25	Crude starch	Sugar	Salt	P ₂ O ₅		Proteid N X 6.25	Crude starch	Sugar	Salt	P ₂ O ₅	
May Day.....	81.28	4.17	9.42	1.00	0.47	0.139		22.2	50.3	5.27	2.52	0.739	
Greenwood.....	83.70	3.37	6.60	..	..	..		24.4	41.87	..	..	..	
Polk's Best.....	83.91	3.27	5.35	1.71	0.43	0.125		23.49	36.32	10.67	2.41	0.787	

There are two points that lead us to believe this is not the case. *First*, the liquor of the sample 7249 B is abnormally high in sugar, but the drained peas of this can show only a normal amount of sugar. *Secondly* the Polk's Best Brand would before processing have the highest water content and would absorb a smaller amount of liquor upon processing. Therefore, unless selective absorption comes into play, the conditions cannot be laid to the composition of the liquor. The question is one open for study. The salt-free ash is slightly higher in the youngest pea.

Upon comparing the analysis of the sample of "Soaked Peas" with the above averages, it is found that it agrees quite closely with the May Day grade. The reason for this is quite apparent for as far as maturity is concerned these grades lie very close together.

Table VI shows the maximum salt-free ash content of 2.66 per cent and the minimum of 2.05 per cent with an average of 2.38 per cent. The alkalinity of the ash varies from 2.5 to 2.1 cc. N/10 HCl per gram

TABLE VI—ASH OF THE DRAINED PEAS

Sample	Salt-free ash Water-free basis	Alk. of ash (°)	Percentage composition of ash		
			P ₂ O ₅	CaO	MgO
7246 B.....	2.49	2.1	29.3	5.7	5.4
7247 B.....	2.36	2.4	30.1	9.4	5.9
7248 B.....	2.05	2.3	31.1	17.1	9.6
7252 B.....	2.47	2.2	29.0	8.5	6.3
7253 B.....	2.66	2.2	25.3	9.9	4.0
7254 B.....	2.09	2.2	30.5	15.4	8.7
7249 B.....	2.28	2.3	29.2	8.5	9.8
7250 B.....	2.34	2.5	31.5	10.7	7.5
7251 B.....	2.53	2.5	31.0	11.6	7.3
7255 B.....	2.56	..	33.4	8.1	8.6
7256 B.....	2.39	2.4	31.6	8.8	6.5
Maximum.....	2.66	2.5	33.4	17.1	9.8
Minimum.....	2.05	2.1	25.3	5.7	4.0
Average.....	2.38	2.3	30.2	10.0	7.2

(°)Cc. N/10 HCl per gram water-free sample.

dry sample. The phosphoric acid remains fairly constant averaging 25.3 per cent of the total ash. The CaO varies from 5.7 per cent to three times that amount. The MgO ranges from 4.0 per cent to 9.8 per cent of the total ash. There seems to be no relation between the ash or any of its constituents and the maturity of the pea.

SUMMARY

The investigation has shown that in a pack of peas put up by a single concern where the conditions are as nearly uniform as it is possible to make them in factory work, great variations of results in individual samples are found. A large number of samples are desirable for conclusive results.

There is considerable variation in the proportion of liquor and peas in the different grades of the product. The composition of the liquor of the canned pea is largely determined by the blanching and processing, and as the more mature peas require a longer period, we may expect to find this grade with turbid liquors of high starch and proteid content.

The young immature dried peas contain 18 per cent more water than the oldest grade.

The crude fiber decreases from 10.25 per cent to 7.15 per cent on the drained peas, water-free basis.

The per cent of sugar seems to decrease with maturity. The reason is not apparent and should be a field for further study.

The part played by selective absorption in determining the location of added constituents is one requiring further study. The change in ash is very slight. The composition of the ash seems to remain the same throughout the growth of the pea.

(Credit is due to C. F. Coffin, Jr., for much of the analytical work reported in this paper.)

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ON THE VALUATION OF LIME-SULFUR AS AN INSECTICIDE

By HERMAN V. TARTAR

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At the present time, the object of the examinations made of samples of commercial lime-sulfur solution in different chemical laboratories throughout the country, is to ascertain data regarding composition. In many cases, simply the total lime content, total sulfur content and specific gravity are ascertained. Oftentimes, however, quantitative determinations are also made of the different forms of sulfur in combina-