Processing and storage and the nutritional contents of pigeon peas [*Cajanus cajan* (L.)][1]

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ABSTRACT

Two portions of pigeon peas were processed with and without steam blanching, blanching by water immersion, and exhausting. The nutritional contents of the canned pigeon peas were determined during a storage period from 0 month to 6 months at ambient temperature. The results obtained imply that none of the treatments contributed significantly to the loss or to the retention of protein, P, K, Ca, Mg, Na, total fats and ash. It was not possible to determine the effect of the treatments on the contents of Mn and Fe because these minerals did not remain stable during storage.

INTRODUCTION

A great amount of the data available on nutrient composition of foods was obtained many years ago. Since that time, there have been many changes in the industrial processes and sometimes in the raw materials. These innovations could have resulted in an altered nutrient content. Furthermore, it is well known that raw foods may vary widely in their composition because of genetic variations, soil and climatic conditions and maturity at harvest.

Changes in the nutrient composition of fresh produce can occur between the time of harvesting and processing (2). Thus, Gleim et al. (8) and Ingalls et al. (10) showed that 20%, 40%, more than 40% and 50% of the ascorbic acid content of green beans, spinach, asparagus, and broccoli were lost in 24 hr at 70° F (21.1° C). No similar information was found from tropical products cultivated in Puerto Rico.

Of the various methods for preserving foods (freezing, dehydration and thermal processes) the latter causes the greatest nutrient losses.

Lund et al. (16) studied the effect of thermal processing on nutrient changes in foods. They showed extreme variations in the effect of canning processes on vegetable nutrients. Vitamin A losses range from 0 in tomatoes to more than 83% in corn. The magnitude of the losses obviously reflects the sensitivity of nutrients to food microenvironment and process severity.

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Vitamin B_6 has good stability in most foods. In vegetables, canning destroys between 20 to 30% (2). In meats, retention ranges from 45 to 80% (3). In general, canning causes greater vitamin losses than freezing for both fruits and vegetables (6).

Bluestein and Labuzza (4) and Labuzza (14) reviewed the effects of moisture removal on nutrients. Generally, those nutrients that are heat labile and sensitive to oxidation (vitamin A and C, for example) were investigated. During drying, as well as in other processes, the nutrient microenvironment is important for their retention (14, 15).

Karel (11) showed losses from 0 to 30% in vitamin B_6 and from 20 to 30% in pantothenic acid in fish freeze-drying.

Under most processing conditions, the protein and mineral contents of foods remain fairly stable (5). Heating of proteins, however, can cause loss of nutritive value because of the highly reactive nature of some of the aminoacids with reactive functional groups, such as lysine and methionine (14).

Kramer (13) reviewed nutrient storage retention. Nutritional quality of foods depends not only on the nutrient content immediately after processing, but also on the changes that occur during storage. It was also recognized that fluctuations in storage temperature may be a major contributor to frozen food deterioration (12).

Dvorak (5) found that freeze-dried beef stored in bottles at room temperature for 4 years lost about 32% lysine, 40% tryptophan, 12% leucine, and 12% methionine.

A revision of the literature determined that there has been little research on the retention and losses of the nutritional value of processed and stored foods of Puerto Rico (1).

Asenjo (2) studied the content of vitamins in canned fruit juices and nectars processed in Puerto Rico, but he did not determine the effect of storage and various steps of the process on the stability of the vitamins.

The investigation herein reported was done to obtain nutritional data on pigeon peas, *Cajanus cajan* (L.), harvested in Puerto Rico that were canned after processing with steam blanching, blanching by water immersion, and exhausting.

MATERIALS AND METHODS

Pigeon peas used in this research work were harvested in the south coast of Puerto Rico. Processing was conducted at the Food Technology Laboratory.

The pods were separated into two portions, A and B. Portion A was passed directly to the hulling machine without the application of steam blanching; portion B was steam blanched and then hulled.

The pigeon peas from each portion were transferred to a picking table where undesirable particles and dried or rotten peas were discarded.

The following tabulation shows the percentage of ripe peas in each portion.

	Portion A	*Portion B*
Green	740	649
Ripe	113	102
Total	853	751
Ripe %	13.2	13.6

Blanching of dehulled pigeon peas of each portion was performed by water immersion at 185° F (85° C) for 5 min. They were then cooled by tap water spraying in a rotary washer.

The peas were transferred in 10 oz portions to No. 303 enameled cans. A 1% boiling brine solution was used for canning. The brine was prepared with commercial salt without iodine.

The cans from each portion (A and B) were separated into two groups. One group of each portion was passed through an exhausting tunnel (19, 20), sealed and identified. The other group from each portion was passed without exhausting to the can sealing machine and identified.

The last treatment of the process was completed with the commercial sterilization in an autoclave (15 min, 250° F and 15 lb/in^2) followed by water cooling.

Figure 1 shows the flow chart of the different treatments. To obtain samples for determining the nutritional contents of the peas, we opened the cans, discarded the liquid portion and transferred the solid portion to plastic bags which were heat-sealed and stored in a freezer.

All the samples were analyzed in duplicate to determine the content of nitrogen, protein, K, Ca, Na, P, Mg, Mn, Fe, vitamin B_2, total fats and ash.

The nitrogen content was determined according to the micro-Kjeldahl method A.O.A.C. (18). The protein content was obtained by multiplying the nitrogen content by 6.25. The Mg, K, Na and Ca contents were determined by flame photometry with a Perkin Elmer, UV-Vis Spectrophotometer[3].

The P content was determined according to the method of Fiske and Subarrow (7) with the Technicon Auto Analyzer. The Mn and Fe content was determined with a Perkin Elmer, UV-Vis Spectrophotometer. The vitamin B_2 content was determined with the fluorometric method of vitamin assays (17). The total fat and ash contents were determined according to the A.O.A.C. (18).

[3]Trade names in this publication are used only to provide specific information. Mention of a trade name does not constitute a warranty of equipment or materials by the Agricultural Experiment Station of the University of Puerto Rico, nor is this mention a statement of preference over other equipment or materials.

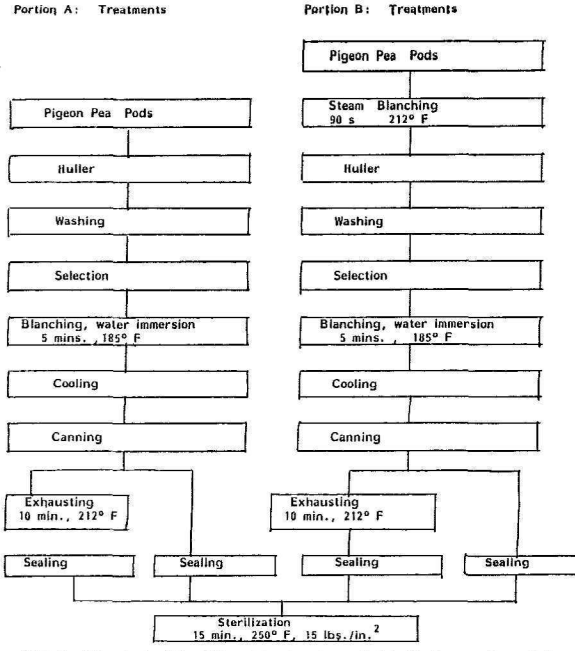

FIG. 1.—Flowchart of the different treatments applied to the two portions of pigeon peas.

The results of the analyses of the nutritional contents were statistically analyzed to determine the possibility of a significant difference between the nutritional content of the pigeon peas from the different processing treatments.

RESULTS

Tables 1 to 4 show the nutritional contents of the stored canned pigeon peas.

From the results of the analyses of variance (table 1) it was determined that the contents of 1) protein; 2) P; 3) Na; 4) Ca; 5) Mg; 6) Mn;

TABLE 1.—*The nutritional contents of stored canned pigeon peas processed without steam blanching, with blanching by water immersion and without exhausting*

Months	Contents										
	Pro.	P	K	Na	Ca	Mg	Mn	Fe	Ash	Fat	B_2
	%	%	%	%	%	%	p/m	p/m	%	%	μg/g
0	20.12	0.27	0.94	1.21	0.13	0.14	13.00	63.00	5.03	2.47	0.76
1	21.06	0.28	0.89	1.23	0.13	0.13	7.00	36.00	5.15	2.41	0.72
2	21.87	0.26	0.92	1.24	0.12	0.15	13.50	44.00	5.09	2.60	0.73
3	20.99	0.26	0.96	1.20	0.12	0.17	11.00	48.00	5.08	2.35	1.05
4	21.49	0.27	0.92	1.31	0.12	0.15	14.50	43.00	5.08	2.34	1.15
5	20.99	0.29	0.89	1.16	0.12	0.12	10.00	44.00	5.07	2.37	0.90

TABLE 2.—*The nutritional contents of stored canned pigeon peas processed without steam blanching, with blanching by water immersion and with exhausting*

Months	Contents										
	Pro	P	K	Na	Ca	Mg	Mn	Fe	Ash	Fat	B_2
	%	%	%	%	%	%	p/m	p/m	%	%	μg/g
0	20.49	0.28	0.93	1.21	0.13	0.15	11.00	48.00	4.99	2.31	0.83
1	17.50	0.27	0.94	1.38	0.13	0.19	17.00	63.00	5.35	2.80	0.71
2	20.68	0.29	0.95	1.32	0.13	0.18	10.00	76.50	5.33	2.53	0.67
3	20.49	0.27	0.97	1.37	0.13	0.18	13.50	44.50	5.32	2.51	0.73
4	20.99	0.28	0.97	1.34	0.13	0.15	11.00	76.50	5.56	2.34	0.81
5	20.87	0.27	0.99	1.38	0.12	0.18	16.50	63.00	5.20	2.55	0.72
6	20.99	0.26	0.87	1.40	0.18	0.17	30.00	77.00	5.29	2.39	0.98

TABLE 3.—*The nutritional contents of stored canned pigeon peas processed with steam blanching, with blanching by water immersion and without exhausting*

Months	Contents										
	Pro	P	K	Na	Ca	Mg	Mn	Fe	Ash	Fat	B_2
	%	%	%	%	%	%	p/m	p/m	%	%	μg/g
0	19.50	0.28	0.76	1.23	0.11	0.16	10.00	90.00	4.91	2.69	0.77
1	19.37	0.26	0.73	1.08	0.11	0.15	10.00	78.00	4.45	2.44	0.69
2	20.99	0.28	0.78	1.19	0.10	0.13	11.00	35.00	4.70	2.41	0.60
3	20.99	0.28	0.74	1.16	0.11	0.17	9.00	61.00	4.48	2.61	0.60
4	20.68	0.27	0.79	1.21	0.11	0.15	9.00	65.00	4.97	2.27	0.68
5	21.24	0.29	0.81	1.18	0.11	0.15	15.00	50.00	4.72	2.34	0.72
6	22.00	0.27	0.80	1.49	0.17	0.16	25.00	67.00	5.53	2.61	0.71

TABLE 4.—*The nutritional contents of stored canned pigeon peas processed with steam blanching, with blanching by water immersion and with exhausting*

Months	Contents										
	Pro	P	K	Na	Ca	Mg	Mn	Fe	Ash	Fat	B_2
	%	%	%	%	%	%	p/m	p/m	%	%	μg/g
0	21.81	0.29	0.73	1.19	0.11	0.12	12.50	45.50	4.82	2.51	0.61
1	21.8	0.29	0.74	1.24	0.10	0.12	10.00	39.00	4.69	2.26	0.58
2	21.81	0.31	0.76	1.30	0.11	0.12	15.00	30.00	5.02	2.41	0.65
3	21.50	0.27	0.81	1.25	0.10	0.23	12.00	44.00	4.96	2.65	0.65
4	19.50	0.26	0.43	1.23	0.10	0.16	14.00	44.50	4.90	2.65	0.66
5	21.13	0.24	0.42	1.21	0.10	0.15	9.50	59.00	4.90	2.24	0.67
6	20.74	0.27	0.78	1.38	0.17	0.14	26.50	86.00	5.44	2.82	0.63

7) Fe; and 8) ash show a significant difference at the 5% probability level between the respective storage times: 1) 0-2, 2-4, 5, 4-5; 2) 0-5, 2-4, 5, 4-5; 3) 0-5, 1-5, 2-5, 3-5, 4-5; 4) 0-5, 1-5, 2-5, 3-5, 4-5 5) 0-3, 1-3, 2-3, 3-4, 5; 6) 0-5, 1-5, 2-5, 3-5, 4-5; 7) 1-5, 2-5, 3-5, 4-5; and 8) 0-5, 1-5, 2-5, 3-5, 4-5.

The results imply that the processing of the pigeon peas without steam blanching, blanching by water immersion and without exhausting resulted in a loss in the content of Fe during 0 month and 1 month, followed by the retention of its contents for the remainder of the storage period. During the entire storage time there was a retention of the other nutrients.

The analyses of variance in table 3 show that in 1) P; 2) K; 3) Na; 4) Ca; 5) Mg; 6) Mn; 7) Fe; 8) ash; 9) total fats; and 10) vitamin B_2 there was a significant difference at the 5% probability level between the respective storage times: 1) 0-6, 1-3, 2-4, 5, 6, 4-6; 2) 0-3 4, 5, 6, 3-6, 4-6, 5-6; 3) 0-1, 2, 3, 4, 5, 6, 1-2, 2-5, 6, 4-6; 4) 0-6, 1-6, 2-6, 3-6, 4-6, 5-6; 5) 0-1, 2, 3, 5, 6, 1-4, 2-4, 3-4, 4-5, 6; 6) 0-1, 5, 6, 1-2, 4, 6, 2-5, 6, 3-6, 4-5, 6, 5-6; 7) 0-1, 2, 3, 4, 5, 6, 1-2, 3, 4, 6, 4-5, 5-6; 8) 0-1, 2, 3, 3, 4, 6, 4-5; 9) 0-1, 2, 3, 5, 1-2, 3, 4, 5, 6; and 10) 0-2, 6, 2-6, 6, 1-6, 2-6, 3-6, 4-6, 5-6.

The results imply that the processing of the pigeon peas without steam blanching, blanching by water immersion and with exhausting resulted in a retention of the content of Mn during 0 month to 4 months followed by a gain during 5 months to 6 months. During the entire storage period there was a retention of the other nutrients.

The analyses of variance in table 3 show that in the contents of protein, P, K, Na, Ca, Mg, Mn, Fe, ashes, total fats and vitamin B_2 there was a significant difference at the 5% probability level between the respective storage times: 1) 0-6, 1, 5, 6; 2) 0-1, 1, 2, 3, 5, 5-6; 3) 0-5, 1-2, 4, 5, 6, 2-3, 3-4, 5, 6; 4) 0-1, 2, 3, 4, 5, 6, 1-2, 3, 4, 5, 6, 3-4, 5, 6, 4-5, 6, 5-6; 5) 0-2, 6, 1-2, 6, 3-5, 7, 4-5, 5-6; 6) 0-1, 5, 6, 1-2, 4, 6, 2-5, 6, 3-6, 4-5, 6, 5-6, 7) 0-1, 2, 3, 4, 5, 6, 1-2, 3, 4, 6, 4-5, 5-6; 8) 0-1, 2, 3, 3, 4, 6, 4-5; 9) 0-1, 2, 3, 5, 1-2, 3, 4, 5, 6; 10) 0-4, 5, 3-4, 4-6; and 11) 0-1, 3, 4, 1-3, 2-3, 3-4, 5-6.

The results imply that the processing of the pigeon peas with steam blanching by water immersion and without exhausting resulted in a higher content of Mn, ash, Ca and Na during 5 to 6 months of storage in the order of Mn, ash, Na and Ca. There was a retention of the other nutrients during the entire storage period.

The analyses of variance in table 4 show that in the contents of protein, P, K, Na, Ca, Mg, Mn, Fe, ash, total fats and vitamin B_2 there was a significant difference at the 5% probability level between the respective storage times: 1) 0-2, 4, 6, 1-4, 3-4, 5, 6; 2) 0-2, 3, 6, 1-2, 3, 4, 6, 2-3, 4, 5, 6, 4-5; 3) 0-3, 4, 5, 1-3, 4, 5; 4) 0-1, 2, 3, 4, 6, 1-2, 6, 2-3, 4, 5, 6,

4-6, 5-6; 5) 0-1, 3, 4, 5, 6, 1-2, 6, 2-3, 4, 5, 6, 3-6, 4-6, 5-6; 6) 0-3, 4, 5, 1-3, 4, 5, 2-3, 4, 5, 6; 7) 0-6, 1-2, 6, 2-5, 6, 4-5, 6, 5-6; 8) 0-2, 5, 6, 1-5, 6, 3-5, 6, 4-5, 6, 5-6; 9) 0-6, 1-6, 4-6; 10) 0-1, 5, 6, 1-3, 4, 6, 2-3, 4, 6, 3-5, 4-5, 5, 6; and 11) 0-5, 1-5.

The results imply that the processing of the pigeon peas with steam blanching, blanching by water immersion and with exhausting resulted in higher contents of Na, Mn, ash and Fe during a 5- to 6-month storage in the order of Fe > Mn > ash > Na.

On the basis of the effects of treatments I, II, III and IV on the nutritional contents of the stored canned pigeon peas, it can be inferred that it is probable that no one of the treatments contributes more than any other to the retention, loss or gain of the nutrients during the storage period. The gain of the nutrients Mn, ash, Ca, Na and Fe can be attributed to causes other than the effects of the treatments.

The contents of Mn and Fe did not remain stable during the entire storage period; therefore, it was not possible to determine the effect of the treatment on these minerals. None of the treatments contributed significantly to the loss or to the retention of the contents of the other nutrients.

RESUMEN

El efecto del procesamiento y del almacenamiento en el contenido nutricional de gandules (*Cajanus cajan* (L.)) cosechados en Puerto Rico

Dos porciones de gandules se desgranaron mecánicamente, una utilizando la escaldadura a vapor de las vainas, 90 segundos (A), y la otra sin escaldar (B). Las muestras desgranadas se escaldaron separadamente sumergiéndolas en agua a 185° F por 5 minutos y envasándolas en salmuera al 1%. Las porciones A y B se subdividieron en dos porciones. Una subporción se pasó por un túnel de vapor para expulsar el oxígeno en la salmuera antes de sellarla y la otra subporción se selló sin aplicarle ese tratamiento. Las muestras se sellaron y se calentaron a 250° F, a 15 libras por pulgada cuadrada por espacio de 5 minutos. Se enfriaron con agua y se almacenaron a temperatura ambiente por seis meses.

Todas las muestras se analizaron en duplicado para determinar el contenido en nitrógeno, proteína, P, K, Ca, Na, Mg, Mn, Fe, vitamina B_2, grasas totales y cenizas.

Los resultados de los análisis de laboratorio se analizaron estadísticamente para determinar la posibilidad de diferencias significativas entre los contenidos nutricionales y el efecto de los tratamientos.

Los resultados obtenidos señalan que ninguno de los tratamientos contribuyó significativamente a la pérdida o a la retención de proteína, P, K, Ca, Na, Mg, grasas totales o cenizas. Los contenidos en Mn y Fe no se mantuvieron estables durante el almacenamiento, por lo que no pudo determinarse su efecto en estos nutrimentos.

LITERATURE CITED

1. Anonymous, 1974. Shelf-Life of Foods, Food Technol. 28 (8): 45–8.
2. Asenjo, C. F., E. R. de Hernández and M. G. Andino, 1968. Vitamins in Canned Puerto Rican Fruit Juices and Nectars, J. Agric. Univ. P. R. 52 (1): 64–70.
3. Barrat, B., 1973. Nutrition: 2, Effect of Processing Food in Canada 33 (2): 28–31.
4. Bluestein, P. M. and T. P. Labuzza, 1975. Effects of Moisture Removal of Nutrients, Ch. II *In* Nutritional Evaluation of Food Processing, R. S. Harris and E. Karmas, Eds, AVI Publ. Co., Inc., Westport, Conn.
5. Dvorak, Z., 1968. Availability of Essential Amino Acids from Protein II. Food Proteins, J. Sci. Ed. Agric. 19 (2): 77–82.
6. Fenma, O., 1977. Loss of Vitamins in Fresh and Frozen Foods, Food Technol. 31 (12): 32–5, 38.
7. Fiske, S. H. and Y. Subbarrow, 1925. Colorimetric Determination of Phosphorus, Biol. Chem. 66 (2): 375–400.
8. Gleim, E. J., O. K. Tressler and F. Fenton, 1944. Ascorbic Acid, Thiamine, Riboflavin and Carotene Content of Asparagus and Spinach in the Fresh, Stored and Frozen States, Both Before and After Cooking, Food Res. 9: 471–90.
9. Goodard, M. S. and R. H. Mathews, 1979. Current Knowledge of Nutritive Values of Vegetables, Food Technol. 33 (2): 71–3.
10. Ingalls, R., W. D. Brewer, H. L. Tobly, J. Plummer, B. B. Bennett and M. A. Ahlson, 1950. The Nutritive Value of Canned Foods. III. Changes in Riboflavin Content of Vegetables During Storage Prior to Canning, Food Technol. 4: 258–63.
11. Karel, M., 1979. Effect of Storage on Nutrients Retention of Foods, Food Technol. 33 (2): 36–7.
12. Kramer, A., 1979. Effect of Freezing and Frozen Storage on Nutrients Retention of Fruits and Vegetables, Food Technol. 33 (2): 58–61.
13. ——, 1974. Storage Retention of Nutrients, Food Technol. 28 (1): 50–1, 53–6, 58, 60.
14. Labuzza, T. P., 1973. Symposium: Effect of Processing, Storage and Handling on Nutrients Retention in Foods. 2. Effect of Dehydration and Storage, Food Technol. 27 (1): 20–1, 23, 25–6, 51.
15. Luh, B. S., M. Karbasi and B. S. Scheweigert, 1978. Thiamine, Riboflavin, Niacin and Color Retention in Canned Small White and Garbanzo Beans as Affected by Sulfite Treatment, J. Ed. Sci. 43 (2): 431–4.
16. Lund, D. B., 1975. Effects of Heat Processing and Nutrients, Part I. Effects of Blanching, Pasteurization and Sterilization on Nutrients, Ch. 9, *In* "Nutritional Evaluation of Food Processing", R. H. Harris and E. Karmas, Eds. AVI Publ. Co., Inc., Westport, Conn.
17. Methods of Vitamin Assay, 2nd ed, 1951. Interscience Publisher, Inc., New York.
18. Official Methods of Analysis, 1975. Association of Official Agricultural Chemists, 12th ed, Washington, D. C.
19. Sánchez Nieva, F., J. R. Rodríguez and J. R. Benero, 1961. Improved Method of Canning Pigeon Peas, Agric. Exp. Stn. Univ. P. R., Bull. 157.
20. ——, M. A. González and J. R. Benero, 1961. The Effects of Some Processing Variables on the Quality of Canned Pigeon Peas, J. Agric. Univ. P. R. 45 (4): 232–58.