Processing and the nutritional contents of canned and fresh pigeon peas (Cajanus cajan (L.))

Orlando Parsi-Ros, Edelmiro J. Rodriguez-Sosa, José Cruz-Cay and Magaly E. Cintrón-Muñoz

ABSTRACT
Two portions of pigeon peas, Cajanus cajan (L.), were processed with and without the application of steam blanching, blanching with water immersion and exhausting to determine the nutritional contents of the pigeon peas after each treatment.

The results obtained from the comparison of the nutritional content of the peas imply the possibility of the loss or retention of some of the nutrients. Steam blanching could be the cause of the nutritional loss of Na, K, and Fe, and blanching with water immersion could be the cause of the loss of K, Ca and Mg and could be a determinant factor for the retention of Fe. Exhausting could be the cause of the loss of K, Ca, Mg, Fe and vitamin B₂.

INTRODUCTION
Since the middle of this century, Puerto Rico has evolved from a society highly dependent on agriculture to one that is highly urban and industrial. Hence, processing of foods is now a vital part of the Island’s way of life.

Processing affects appearance, flavor, texture and nutritional value of foods. Some of the changes which occur during processing are desirable; however, undesirable changes also occur. One such change of great concern is the loss of nutrients (4, 9, 15, 17, 18).

Most of the highly nutritious foods, including many vegetables are highly perishable. Without adequate processing, the quality and nutritious value of these products are lost. Processing may lead to an inevitable loss in certain nutrients. Today, it is well known that nutrients are sensitive to heat, oxygen, light, trace metals, pH or a combination of these factors (3, 6, 14, 16, 19, 23). Foods, when processed, are submitted to one or more of these factors. Although food processing in general could

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affect all nutrients, the most widely studied nutrients are the vitamins
(5, 10, 13, 20).

In the past, nutrient composition of food products was largely disre­
garded by many processors. Since the publication in 1973 of the Nutrition
Labeling Regulations by the Food and Drug Administration, and more
recently with the enactment of the Food Labeling Act, concern for the
nutritional content of foods greatly increased among food processors and
the general public. This processor awareness, prompted by the federal
government and by the consumer’s interest, emphasizes the importance
of obtaining information about nutrient retention or losses during proces­
sing and storage so that optimum quality can be obtained in the processed
products.

In Puerto Rico, there are some 350 food and related manufacturing
plants processing a variety of foodstuffs (1). More than two-thirds of
these plants are of local origin; the others are subsidiaries of U.S. firms
and of foreign based companies. Although some of these plants are large,
with enough resources, the great majority of them are medium size and
small family type, with scarce resources to provide for any research or
analytical work. Thus, nutrient data on the different processing steps
and storage are lacking.

Puerto Rico harvested 100,000 hundredweight of pigeon peas in 1982-
83, 36,000 hundredweight of which was processed for local use. In 1983-
84, there was an increase in the harvest and in the processing of 105,000
hundredweight and 42,000 hundredweight, respectively (7, 8).

Much data on nutrient composition of foods available in the literature
were obtained many years ago. Since that time, there have been many
changes in the industrial processes and sometimes in the raw materials.
These 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, soils and climatic conditions, and maturity
at harvest (12).

With few exceptions (2), no information is readily available on most
of the foods processed in Puerto Rico. Data are, therefore, urgently
needed on the nutrient content of raw as well as processed foods pro­
duced in Puerto Rico.

Adequate nutritional data are especially needed on many of the prod­
ucts such as pigeon peas, beans, green bananas, sweet potatoes, snack
items, juices, nectars and meats processed in Puerto Rico. Information
on the destruction of nutritional value during processing and storage
must be obtained to minimize nutrient losses. As long as nutrition re­
mains a problem prevalent in large areas of the world, the nutrient reten­
tion in processed foodstuffs cannot be neglected.
This research was done to obtain nutritional data on pigeon peas, Cajanus cajan (L.), harvested in Puerto Rico and processed with different treatments such as steam blanching, blanching with water immersion and exhausting.

**MATERIALS AND METHODS**

One hundred fifteen pounds of pigeon peas, harvested in southern Puerto Rico, was processed at the Food Technology Laboratory in Rio Piedras, Puerto Rico.

The objectives were: 1) The processing of two portions of pigeon peas with and without the application of different treatments and the determination of their nutritional contents after each treatment; 2) the determination of the nutritional contents of the canned pigeon peas during a storage period of 0- to 6-months.

The treatments were blanching with steam (90 sec., 212° F) of pigeon pea pods; blanching the peas with water immersion (5 min., 185° F) and exhausting the peas (10 min., 212° F) in No. 303 cans without the lids with a brine solution of 2% NaCl as shown in Figure 1.

The pigeon pea pods were divided into two portions, A and B, 56 lb. each. Portion A was passed directly to the huller machine without the application of steam blanching, and portion B was treated with steam blanching before dehulling.

Samples were obtained after each procedure and placed in plastic bags that were heated, sealed, and transferred to a freezer. All the samples of pigeon peas obtained during the different treatments of the process were handled the same way.

The pigeon peas from each portion were transferred to a picking table, where undesirable particles and dry or rotten peas were discarded. We counted green and ripe pigeon peas to determine the percentage of ripe peas of each portion as shown in the following tabulation.

<table>
<thead>
<tr>
<th></th>
<th>Portion A</th>
<th>Portion B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green</td>
<td>740</td>
<td>649</td>
</tr>
<tr>
<td>Ripe</td>
<td>113</td>
<td>102</td>
</tr>
<tr>
<td>Total</td>
<td>853</td>
<td>751</td>
</tr>
<tr>
<td>Ripe %</td>
<td>13.2</td>
<td>13.6</td>
</tr>
</tbody>
</table>

We blanched with water immersion and then water cooled the chosen peas of portions A and B, and put the samples in plastic bags.

Ten-oz. portions were transferred to No. 303 enameled cans with a boiling 2% brine solution. The brine was prepared with tap water and commercial salt without iodine.

The cans from each portion were divided into two groups. One group of each portion was passed through an exhausting tunnel (24, 25), sealed
and labeled. The other group from each portion was passed without exhaustsing to the can sealing machine and labeled.

The last treatment of the process was completed with the commercial sterilization in an autoclave (15 min., 250° F and 15 lb/in²) followed by water cooling.

To determine the effect of the exhausting treatment the labeled cans were opened, the water was discarded and the peas were transferred to plastic bags.

All the samples were analyzed in duplicate to determine their protein, N, K, Ca, Na, P, Mg, Mn, Fe, vitamin B₉ contents, total fats and ash.
The nitrogen content was determined according to the micro-Kjeldahl method A.O.A.C. (22). The protein content was obtained by multiplying the nitrogen content by 6.25. The Mg, K, Na and Ca content was determined by flame photometry with a Perkin Elmer, UV-Vis Spectrophotometer.

The P content was determined according to the method of Fiske and Subbarow (20) with a Technicon Auto Analyzer (11).

The Mn and Fe content was determined according to the method of Perch Seywell and Cunningham with a Perkin Elmer, UV-Vis Spectrophotometer.

The vitamin B<sub>2</sub> content was determined with the fluorometric methods of Vitamin Assays (21).

The total fat and ash contents were determined according to A.O.A.C. (22).

The results of the analyses of the nutritional contents were statistically analyzed for the possibility of a significant difference among the nutritional contents of the pigeon peas obtained from the different processing treatments.

RESULTS

Table 1 summarizes the nutritional contents of pigeon peas before and after steam blanching the pods.

The analyses of variance indicate that the nutritional contents of K, Na and Fe have a significant difference (P=0.05) between application and nonapplication of the treatments.

The results imply that the treatment contributes to the loss of K, Na and Fe and does not contribute significantly to the loss or retention of the other nutrients.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Protein</th>
<th>P</th>
<th>K</th>
<th>Na</th>
<th>Ca</th>
<th>Mg</th>
<th>Mn</th>
<th>Fe</th>
<th>Ash</th>
<th>Fats</th>
<th>Vit. B&lt;sub&gt;2&lt;/sub&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>A&lt;sup&gt;1&lt;/sup&gt;</td>
<td>19.99</td>
<td>0.39</td>
<td>1.95</td>
<td>0.02</td>
<td>0.11</td>
<td>0.22</td>
<td>10.00</td>
<td>97.50</td>
<td>4.96</td>
<td>1.79</td>
<td>1.53</td>
</tr>
<tr>
<td>B&lt;sup&gt;2&lt;/sup&gt;</td>
<td>19.88</td>
<td>0.39</td>
<td>1.85</td>
<td>0.03</td>
<td>0.10</td>
<td>0.21</td>
<td>6.50</td>
<td>57.00</td>
<td>4.31</td>
<td>2.11</td>
<td>1.77</td>
</tr>
</tbody>
</table>

<sup>1</sup> Processed without steam blanching.

<sup>2</sup> Processed with steam blanching.

*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.*
Table 2 summarizes the nutritional contents of the pigeon peas processed and not processed with steam blanching of the pods after blanching with water immersion.

According to the results of the analyses of variance it was determined that between the two treatments the contents of K, Ca, Mg and Fe have a significant difference (P=0.05).

These results imply that blanching of the pods contributes to the nutritional loss of K, Ca and Mg and to the retention of Fe.

Table 3 summarizes the nutritional contents of pigeon peas before and after exhausting of the canned pigeon peas in the brine solution.

From the analyses of variance, it was inferred that the contents of K, Na, Ca, Mg, Fe, ash and vitamin B_2 have a significant difference of 5% among the respective treatments: 1) 1-3, 4, 2-3, 4; 2) 1-2, 2-3, 4; 3) 2-3, 4; 4) 1-2, 2-4; 5) 1-2, 3, 2-4, 3-4; 6) 1-2, 3, 2-3, 4; and 7) 1-2, 3, 4, 2-3, 4.

The results imply that exhausting contributes to the nutritional loss of K, Ca, Mg, Fe and vitamin B_2, and that processing without exhausting contributes to the retention of Mg, Fe and vitamin B_2.

### Table 2. The nutritional contents of pigeon peas processed with treatments A and B

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Protein</th>
<th>P</th>
<th>K</th>
<th>Na</th>
<th>Ca</th>
<th>Mg</th>
<th>Mn</th>
<th>Fe</th>
<th>Ash</th>
<th>Fats</th>
<th>Vit. B_2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>p/m</td>
<td>p/m</td>
<td>%</td>
<td>%</td>
<td>µg/g</td>
</tr>
<tr>
<td>A&lt;sup&gt;1&lt;/sup&gt;</td>
<td>19.87</td>
<td>0.35</td>
<td>1.46</td>
<td>0.04</td>
<td>0.14</td>
<td>0.21</td>
<td>7.50</td>
<td>64.50</td>
<td>3.82</td>
<td>2.29</td>
<td>1.17</td>
</tr>
<tr>
<td>B&lt;sup&gt;2&lt;/sup&gt;</td>
<td>19.18</td>
<td>0.35</td>
<td>1.28</td>
<td>0.05</td>
<td>0.12</td>
<td>0.14</td>
<td>8.00</td>
<td>72.50</td>
<td>3.20</td>
<td>2.32</td>
<td>1.76</td>
</tr>
</tbody>
</table>

<sup>1</sup> Treatment of blanching with water immersion and without steam blanching.  
<sup>2</sup> Treatment of blanching with water immersion and with steam blanching.

### Table 3. The nutritional contents of pigeon peas processed with treatments I, II, III and IV

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Protein</th>
<th>P</th>
<th>K</th>
<th>Na</th>
<th>Ca</th>
<th>Mg</th>
<th>Mn</th>
<th>Fe</th>
<th>Ash</th>
<th>Fats</th>
<th>Vit. B_2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>p/m</td>
<td>p/m</td>
<td>%</td>
<td>%</td>
<td>µg/g</td>
</tr>
<tr>
<td>I&lt;sup&gt;1&lt;/sup&gt;</td>
<td>19.24</td>
<td>0.32</td>
<td>1.32</td>
<td>1.91</td>
<td>0.15</td>
<td>0.26</td>
<td>12.50</td>
<td>65.50</td>
<td>7.65</td>
<td>2.21</td>
<td>0.68</td>
</tr>
<tr>
<td>II&lt;sup&gt;2&lt;/sup&gt;</td>
<td>18.87</td>
<td>0.31</td>
<td>1.27</td>
<td>1.83</td>
<td>0.14</td>
<td>0.22</td>
<td>10.00</td>
<td>65.50</td>
<td>7.20</td>
<td>2.32</td>
<td>0.66</td>
</tr>
<tr>
<td>III&lt;sup&gt;3&lt;/sup&gt;</td>
<td>18.75</td>
<td>0.32</td>
<td>1.16</td>
<td>1.92</td>
<td>0.13</td>
<td>0.29</td>
<td>10.50</td>
<td>65.50</td>
<td>7.14</td>
<td>2.42</td>
<td>0.80</td>
</tr>
<tr>
<td>IV&lt;sup&gt;4&lt;/sup&gt;</td>
<td>18.68</td>
<td>0.33</td>
<td>1.11</td>
<td>1.66</td>
<td>0.12</td>
<td>0.26</td>
<td>10.00</td>
<td>63.50</td>
<td>6.44</td>
<td>2.10</td>
<td>0.65</td>
</tr>
</tbody>
</table>

<sup>1</sup> Processed without steam blanching, with water immersion and without exhausting.  
<sup>2</sup> Processed without steam blanching, blanching with water immersion and with exhausting.  
<sup>3</sup> Processed with steam blanching, blanching with water immersion and without exhausting.  
<sup>4</sup> Processed with steam blanching, blanching with water immersion and with exhausting.
Tables 4 and 5 summarize the nutritional contents of the two portions of pigeon peas indicated in the flowchart after the application of the respective treatments throughout the process.

The results of the analyses of variance in table 4 indicate that the contents of 1) P, 2) K, 3) Na, 4) Ca, 5) Mg, 6) Mn, 7) Fe, 8) ash, 9) total fats and 10) vitamin B₂ show a significant difference at the 5% probability level among the respective treatments: 1) 1-2, 3, 4, 2-3, 4; 2) 1-2, 3, 4, 2-3, 4; 3) 1-3, 4, 2-3, 4, 2-3, 4, 3-4; 4) 1-2, 3, 4, 2-3, 3-4; 5) 1-3, 2-3, 3-4; 1-2, 3, 2-3, 4, 3-4; 7) 1-2, 3, 4; 8) 1-2, 3, 4, 1-2, 3, 4; 8) 1-2, 3, 4, 2-3, 4; 9) 1-2, 3, 4 and 10) 1-2, 3, 4, 2-3, 4.

**Table 4.**—Nutritional contents of pigeon peas from portion A processed with treatments A, B, C and D

<table>
<thead>
<tr>
<th>Nutrients</th>
<th>A¹</th>
<th>B²</th>
<th>C³</th>
<th>D⁴</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proteins %</td>
<td>19.99</td>
<td>19.44</td>
<td>19.21</td>
<td>18.87</td>
</tr>
<tr>
<td>P %</td>
<td>0.39</td>
<td>0.35</td>
<td>0.32</td>
<td>0.31</td>
</tr>
<tr>
<td>K %</td>
<td>1.95</td>
<td>1.46</td>
<td>1.32</td>
<td>1.27</td>
</tr>
<tr>
<td>Na</td>
<td>0.02</td>
<td>1.04</td>
<td>1.91</td>
<td>1.83</td>
</tr>
<tr>
<td>Ca %</td>
<td>0.11</td>
<td>0.14</td>
<td>0.15</td>
<td>0.14</td>
</tr>
<tr>
<td>Mg %</td>
<td>0.22</td>
<td>0.21</td>
<td>0.26</td>
<td>0.22</td>
</tr>
<tr>
<td>Mn p/m</td>
<td>10.00</td>
<td>7.50</td>
<td>12.50</td>
<td>10.00</td>
</tr>
<tr>
<td>Fe p/m</td>
<td>97.50</td>
<td>64.50</td>
<td>66.50</td>
<td>65.60</td>
</tr>
<tr>
<td>Ash %</td>
<td>4.96</td>
<td>3.92</td>
<td>7.65</td>
<td>7.20</td>
</tr>
<tr>
<td>Fats %</td>
<td>1.79</td>
<td>2.29</td>
<td>2.21</td>
<td>2.32</td>
</tr>
<tr>
<td>Vitamin B₂ µg/g</td>
<td>1.53</td>
<td>1.17</td>
<td>0.68</td>
<td>0.66</td>
</tr>
</tbody>
</table>

¹ Processed without steam blanching.
² Processed with blanching in water immersion.
³ Processed without exhausting.
⁴ Processed with exhausting.

**Table 5.**—Nutritional contents of pigeon peas from portion B processed with treatments A, B, C and D

<table>
<thead>
<tr>
<th>Contents</th>
<th>Steam blanching</th>
<th>Blanching with water immersion</th>
<th>No exhausting</th>
<th>Exhausting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proteins %</td>
<td>19.68</td>
<td>19.18</td>
<td>18.75</td>
<td>18.68</td>
</tr>
<tr>
<td>P %</td>
<td>0.39</td>
<td>0.35</td>
<td>0.32</td>
<td>0.33</td>
</tr>
<tr>
<td>K %</td>
<td>1.85</td>
<td>1.28</td>
<td>1.16</td>
<td>1.11</td>
</tr>
<tr>
<td>Na %</td>
<td>0.03</td>
<td>0.05</td>
<td>1.92</td>
<td>1.66</td>
</tr>
<tr>
<td>Ca %</td>
<td>0.10</td>
<td>0.12</td>
<td>0.13</td>
<td>0.12</td>
</tr>
<tr>
<td>Mg %</td>
<td>0.21</td>
<td>0.14</td>
<td>0.29</td>
<td>0.26</td>
</tr>
<tr>
<td>Mn p/m</td>
<td>6.50</td>
<td>8.00</td>
<td>10.50</td>
<td>10.00</td>
</tr>
<tr>
<td>Fe p/m</td>
<td>57.00</td>
<td>72.50</td>
<td>65.50</td>
<td>63.50</td>
</tr>
<tr>
<td>Ash %</td>
<td>4.31</td>
<td>3.20</td>
<td>7.14</td>
<td>6.44</td>
</tr>
<tr>
<td>Fats %</td>
<td>2.11</td>
<td>2.32</td>
<td>2.42</td>
<td>2.10</td>
</tr>
<tr>
<td>Vitamin B₂ µg/g</td>
<td>1.77</td>
<td>1.76</td>
<td>0.80</td>
<td>0.65</td>
</tr>
</tbody>
</table>
The results imply that the application of treatments 2, 3 and 4 contributes to the nutritional loss of P, K, Ca, Mg, Mn and Fe; to the gain of Na, and to the retention of ash and total fats.

According to the analyses of variance (table 5) it was determined that the contents of protein, P, K, Na, Ca, Mg, Mn, Fe, ash, total fats and vitamin B<sub>2</sub> show a significant difference at the 5% probability level between the respective treatments: 1) 1-3, 4; 2) 1-2, 3, 4, 2-3; 3) 1-2, 3, 4, 2-3, 4; 4) 1-3, 4, 2-3, 4, 3-4; 5) 1-2, 3, 4; 6) 1-2, 3, 4, 2-3, 4; 7) 1-2, 3, 4; 8) 1-2, 3, 4, 2-3, 4, 3-4; 9) 1-2, 3, 4, 2-3, 4, 3-4; 10) 1-2, 3, 4 and 11) 1-3, 4, 2-3, 4.

The results imply that the application of treatments 1, 2, 3, and 4 do not contribute significantly to the retention or loss of total fats, P and Ca. Treatments 3 and 4 contribute to the addition of Na, Mg and ash, and to the loss of K and vitamin B<sub>2</sub>.

### RESUMEN

El efecto del procesamiento en el contenido nutricional de gandules (*Cajanus cajan*(L.)), enlatados y frescos

Se trataron dos porciones de gandules para determinar su contenido nutricional después de cada tratamiento con y sin escaldadura con vapor de agua, escaldadura por inmersión en agua caliente y expulsión con vapor de agua.

Los análisis de laboratorio y el análisis estadístico sugieren la posibilidad de la pérdida de algunos de los nutrientes. La escaldadura con vapor de agua probablemente puede causar la pérdida de contenido en K, Ca y Mg. Además podría ser un factor determinante de la retención de Fe. La expulsión con vapor de agua probablemente pueda causar la pérdida de K, Ca, Mg, Fe, y la vitamina B<sub>2</sub>.

El contenido nutricional que se obtuvo de los gandules después de aplicarles los tratamientos a las porciones A y B indican la posibilidad de una tendencia a perderse consecutivamente K, Mn, Fe y Ca y a una tendencia a aumentar el contenido en vitamina B<sub>2</sub> en los gandules de la porción B.

### LITERATURE CITED


Ch. 11 In "Nutritional Evaluation of Food Processing", R. S. Harris and E. Karmas, Eds, AVI Publ. Co., Inc., Westport, Conn.


