Progress in Palmito (Heart-of-Palm) Processing Research

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c.p. 139, 13.100 Campinas, SP., Brazil

(Received for publication December 12, 1977)

ABSTRACT

Palmito is a gourmet product obtained from the young and tender leaves of certain palm trees. Brazil is the main producer and exporter of canned, acidified palmito. In this paper the main aspects of raw material procurement, processing and packaging are reviewed. Most of the original work was done at the Instituto de Tecnologia de Alimentos (ITAL) in Campinas, Brazil. The palmito is mainly produced from two species of naturally growing palms. There are two main technical problems in palmito processing: discoloration of the naturally white product and safe acidification to inhibit Clostridium botulinum growth. Both problems have been solved adequately in laboratory and pilot plant work. Acceptance and implementation of these technological developments by the small palmito canneries is essential to obtain products acceptable to the international market.

Palmito is a gourmet product obtained from the young and tender leaves of certain palm trees. In some areas of Brazil the fresh palmito can be bought in open markets and even in supermarkets. However, due to the perishable nature of the product, most of the product is presently canned and heat processed. Canning of palmito is done in very primitive plants located in the palm-growing areas. The Instituto de Tecnologia de Alimentos (ITAL) was the first institution to study the raw materials and processing techniques (3,5,15). However, it was only recently that an intensive program was initiated on various aspects of palmito processing: types of raw materials, acidification, browning, heat processing, packaging. In this paper the most significant findings will be discussed.

PRODUCERS AND CONSUMERS

The world production and consumption of canned palmito was recently surveyed by Renesto (13). Presently Brazil and Paraguay are the main producing countries. In 1975 Paraguay exported 2464 tons while Brazil exported 7012 tons.

Most of the product of Paraguay is exported to Argentina while France consumes approximately 70% of the Brazilian export. The volumes exported to the United States were quite variable during the last years. In 1974 it amounted to 841 tons and in 1975 to 571 tons.

In addition to the export, palmito is a valued product for Brazilian dishes. No reliable statistics on the domestic consumption of palmito are available. However, the available data indicate that approximately two-thirds of the canned palmito is consumed in Brazil.

Due to the great demand for canned palmito and the scarcity of the raw material, the export price has increased steadily from US$ 508.00 per ton in 1965 to US$ 1,294.00 per ton in 1975.

RAW MATERIALS

Palmito from the following species of palms has been processed successfully:

<table>
<thead>
<tr>
<th>Common name</th>
<th>Scientific name</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Juçara</td>
<td>Euterpe edulis Mart.</td>
<td>(4, 9)</td>
</tr>
<tr>
<td>Açaí</td>
<td>Euterpe oleracea</td>
<td>(9)</td>
</tr>
<tr>
<td>Indaiá</td>
<td>Atalea dubia</td>
<td>(9)</td>
</tr>
<tr>
<td>Babacu</td>
<td>Orbignya oleifera Burret</td>
<td>(3)</td>
</tr>
<tr>
<td>Guaráoba</td>
<td>Syagrus oleracea</td>
<td>(9)</td>
</tr>
<tr>
<td>(bitter palmito)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bacuri</td>
<td>Scheelea phalerata</td>
<td>(9)</td>
</tr>
</tbody>
</table>

In addition there exist several species of palms in Brazil and in other countries, some of which may not even have been studied adequately botanically. Some of these can possibly be economical sources of palmito.

There is considerable interest in the processing of the babacu palm which is also a major source of palm oil in Brazil. The babacu can be found as the predominant feature of the vegetation of 10 million hectares in the central and northern part of the country (3).

Presently only the palmitos of the Juçara and Açaí palms are processed in large amounts. There are small areas along the coast of Brazil where the giant palmito (Indaiá-palm) is processed.

The geographic distribution of the two main palmito producing palms in Brazil is shown on Fig. 1. Until
recently the Jucara palm (*Euterpe edulis*), found in the south, was the main source of palmito. Since 1973 more palmito is being exported through the northern ports (Belém) than through the southern ports (mainly Santos) of Brazil. This is due to the abundant supply of palmito from the Acai palm (*Euterpe oleracea*) in the north while the Juçara in the south is getting depleted.

Figure 1. *Approximate geographic distribution of two palmito producing palms.*

Presently all the palmito harvested is from natural seeding. It is only recently that some companies have replanted some of the palms, mainly of the Jucara species, along the southern coast of Brazil. The oldest plantations are now approximately 7 years old and should be ready for harvesting. Unfortunately the commercial plantations of palmito-producing palms have not been very successful due to lack of basic knowledge involving the following: preparation of the seeds and seedlings, type of shading required, spacing between plants, and time between successive harvests.

Figure 2 shows a typical Juçara palm in its natural habitat. This plant may be 6 to 12 years old. Figure 3 shows the upper part of the palm, from where the palmito is obtained. The edible part starts just above the stem and ends where the tissue becomes hard and fibrous due to its transformation into adult leaves. Roughly one-third of the length shown in Fig. 3 is edible. While the outside diameter of the section is typically 10 to 20 cm, the inner edible part has typically a diameter of 3 to 6 cm.

Figure 4 shows a typical young plant of the Açaí palm. Unlike the Juçara palm, the açaí plant grows in a cluster of shoots of different ages. If only the older shoots are harvested, the plant continues its growth and the adult palmitos can be harvested at regular intervals. Due to lack of information and control, frequently the whole plant is harvested at once. In this case the Açaí plant may die.

Figure 2. *Juçara palm* (*Euterpe edulis*) *in its natural habitat.*

Figure 3. *Palmito — containing region of the Juçara palm* (*Euterpe edulis*).
The Júcará plant, having only one stalk, is always killed when the palmito is harvested. New plants have to grow from seeds. Due to the intensive harvesting in the southern part of Brazil, the factories processing Júcará palmito are being transferred to the Amazon region where they now process Acaí palmito.

The palmitos of the Júcará and Acaí palms are quite similar. No special mention of the species is made on the labels of the canned product. Usually the diameter of the palmito from the Júcará palm is larger than that of the Acaí palm.

Present Brazilian Government regulations require that no palmitos with less than 2.5 cm diameter be canned. These regulations were made to prevent the harvest of palms before the adult stage. However, harvesting is done by poorly qualified personnel and therefore many small palmitos are brought to the factories.

After cutting the palm, the harvester cuts the edible part which usually has a length of 40 to 60 cm. Next he removes the outer shells (sheaths) but leaves several nonedible layers for protection of the palmito during transportation. A typical bundle of product at this stage is shown in Fig. 5. In the southern part of Brazil the raw material is frequently transported by mules while in the Amazon, transportation is mainly by boat. The time from harvest to delivery at the factory sometimes takes 1 week, causing extensive product loss and quality deterioration. Depending on the moisture conditions, dehydration or microbial spoilage occurs, starting from the ends.

Immersion of the ends into a disinfectant solution after cutting could help maintain the quality of the product but is difficult to implement under present conditions.

### CHEMICAL COMPOSITION

The chemical composition of the Júcará and Acaí is given in Table 1 (14). The differences between the two palms may in part be due to the differences in their ages, since the Acaí palmito is frequently harvested at an earlier age. It can be seen that no important nutritional value can be claimed for palmito. Just like asparagus, the palmito is consumed for its pleasant flavor and texture.

<table>
<thead>
<tr>
<th>Component</th>
<th>Júcará</th>
<th>Acaí</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein (%)</td>
<td>2.42</td>
<td>1.72</td>
</tr>
<tr>
<td>Ash (%)</td>
<td>1.43</td>
<td>0.83</td>
</tr>
<tr>
<td>Crude fiber (%)</td>
<td>0.89</td>
<td>0.27</td>
</tr>
<tr>
<td>Fat (%)</td>
<td>0.33</td>
<td>0.08</td>
</tr>
<tr>
<td>Total sugars (%)</td>
<td>0.86</td>
<td>0.70</td>
</tr>
<tr>
<td>Reducing sugars (%)</td>
<td>0.49</td>
<td>0.30</td>
</tr>
<tr>
<td>Tannins (%)</td>
<td>0.06</td>
<td>0.06</td>
</tr>
<tr>
<td>Vitamin C (mg/100 g)</td>
<td>1.8</td>
<td>1.4</td>
</tr>
</tbody>
</table>

### PROCESSING

The traditional processing of palmito is summarized in Fig. 6. The preliminary peeling is usually done outside the factory. Up to 50% of the weight is eliminated at this stage. The process is manual and is illustrated in Fig. 7. The final peeling has to be done more carefully to avoid damage to the soft inner tissues. The fully peeled palmito is shown on the right side of Fig. 8. Then the peeled palmito stem is cut with a knife into pieces slightly shorter than the can height, starting from the lower end.

The palmito cutter evaluates the hardness of the tissue by the cutting force required. Usually, as the upper end (towards the leaves in the palm) is approached, the outer
After cutting, the damaged tissues show rapid enzymatic browning in the presence of oxygen. Therefore the pieces are usually immersed in a sodium chloride brine with citric acid (0.5 to 0.8% salt) and which may also contain sulfur dioxide. Usually some browning takes place at this stage but most of the browning occurs during the exhaustion. This process is slow and at this time the tissue oxygen is expelled through the damaged tissues at the cut surfaces. Some browning also occurs between the sheaths of the palmito. The discoloration is typically bluish-gray rather than brown.

Since the palmito is an acidified product (2), thermal processing is usually done in a boiling water bath. If the product is not well exhausted, additional browning may occur during heat processing.

Some experiments have been done on the heat processing of palmito at its natural pH of approximately 6.0. A pink discoloration of the product was observed when a retort temperature of 121°C was employed, even for well-exhausted cans. However, there is no special interest in producing a low-acid canned palmito since it is usually consumed in salads.

**IMPROVED PROCESSING**

The main technological problem encountered in processing of palmito is browning. Preliminary work at ITAL indicated that enzymatic browning was particularly fast in the temperature range of 40 to 60°C (16). Contact between the substrate, the oxygen and the enzyme in this temperature range had to be either avoided or reduced to a minimum. Faster heating by rotating the can during heating was tested but was found to be too slow to avoid browning.

Next the possibility of eliminating oxygen from the plant tissue was studied (8). It was found that the tissue contained 11 to 17 cm³ of gas per 100 g. Composition of the gas was similar to that of air. This gas could be removed readily by applying vacuum to the palmito pieces immersed in the acid brine for 10 to 30 sec.

Based on these laboratory experiments on deaeration of the tissue, pilot plant experiments were done using commercially available equipment (7). The palmito was cut, immersed in 3% NaCl +0.85% citric acid brine and transferred to the cans. It was covered by cold canning brine of adequate acidity (citric acid). Then the cans were sealed in a vacuum closer (120 mm Hg residual pressure for 15 sec). The product in 300 × 406 cans was heat-processed for 40 min in boiling water.

The canned palmito was compared with a similar product in which gas (oxygen) removal was done by the traditional method (thermal deaeration or exhaustion). Both processes gave a final can vacuum of approximately 15 inches of mercury. Figure 9 shows the two products obtained. It can be seen that the thermally deaerated product is distinctly brown at the surfaces while the vacuum-seamed product is white. It must be mentioned that....
that thermal deaeration employed in this experiment was relatively fast. Under commercial processing conditions by the traditional method, browning is frequently much stronger.

Browning and poor vacuum are usually related. Some manufacturers make almost no exhaustion since they fear browning during this process. However, in this case browning occurs during heat processing. The improved process always gives adequate vacuum and a product without any discoloration.

Control of the drained weight for palmito is quite difficult, especially in small cans, since the individual pieces are relatively large. The problem becomes even more difficult if uniformity of length and diameter is sought. In addition, small variations of the drained weight may occur during storage. Paschoalino and Berhardt (7) found a 4% decrease in the weight of the palmito canned in a 2.5% NaCl +0.85% citric acid brine after 30 days of storage (very close to equilibrium). This decrease may be larger for more concentrated brines.

The packaging problems presently encountered are the consequence of the primitive conditions under which palmito is processed. Rusty cans result from cooling in water contaminated with canning brine. Inside corrosion of the cans is rarely a problem unless SO₂ is used in the canning brine. Plain tin cans are to be preferred over lacquered cans. The palmito in lacquered cans is usually slightly darker than the palmito in plain tin cans.

DEFECTS OF PROCESSED PALMITO

From experience of the authors and surveys by the Ministry of Foreign Relations (6) and by Renesto and Vieira (13), the following appear to be the most common defects of the product presently produced in Brazil: (a) inadequate acidification, (b) hard pieces and too soft pieces, (c) browning, (d) poor vacuum, (e) poor control of drained weight, and (f) packaging problems such as rusty cans, loose labels, and weak cardboard boxes.

From Table 2 it can be seen that extremely wide variations of key control factors can be observed between manufacturers. Slightly smaller variations can be observed within products of the same manufacturer.

TABLE 2. Typical values for 21 No. 21/2 cans of palmito from southern Brazil (13).

<table>
<thead>
<tr>
<th>Determination</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>4.3</td>
<td>4.8</td>
<td>4.5</td>
</tr>
<tr>
<td>Vacuum (in Hg)</td>
<td>0.0</td>
<td>9.0</td>
<td>3.2</td>
</tr>
<tr>
<td>Headspace (mm)</td>
<td>8</td>
<td>20</td>
<td>11.6</td>
</tr>
<tr>
<td>Total weight (g)</td>
<td>885</td>
<td>968</td>
<td>945</td>
</tr>
<tr>
<td>Drained weight (g)</td>
<td>395</td>
<td>587</td>
<td>486</td>
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Proper acidification of the palmito is a very important factor for safety of the product. This subject will be treated separately.

Inclusion of hard pieces results from poorly trained personnel and poor quality control. Some producers think that longer cooking will render these pieces softer. Although this is true, the additional cooking does not destroy the fibers. In addition, the regular raw material becomes too soft when overcooked, losing its distinctive character. The delicate flavor of the palmito is also affected by excessive cooking. For this reason the processing time in the improved method was reduced to 40 min from 80 min in the traditional process.

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of the palmito. These differences were found to be quite consistent and were observed for all the five species studied (9). The reasons for this behavior are not fully established. It could be due to higher concentrations of free amino-acids and salts in the younger tissue of the lower end and a higher fiber (inert) content of the upper end.

Figure 11. Titration curves of different parts of the palmito (9).

The variation of the buffer capacity along the palmito brings an unexpected complexity to the commercial acidification process. Clearly, three alternatives are available. (a) Use enough acid brine for the lower end of palmito; cans containing only upper end will be quite sour; range of variation of pH will be about 0.4 pH-unit. (b) Carefully mix pieces from upper and lower end into the same can; use brine of intermediate acid concentration; this procedure is the most recommended one. (c) Separate product into "lower end" and "upper end"; use different brines.

While the first alternative is the only safe one for primitive processing conditions, the last method would be recommended for well controlled operations. In present commercial practice the product is frequently divided into two groups, since the lower end is the softer, higher quality part. Unfortunately this requirement is included in this category. Fortunately this requirement is virtually not enforced and some palmito canners are now starting to implement satisfactory acidification

Figure 10. Titration curves of palmito with different acids (4).

the Jucara palmito with different acids. Not surprisingly, hydrochloric acid lowers the pH to 4.3 with the smallest amount of acid. Unfortunately this acid is not allowed for food products in most countries. The authors see no reason for this restriction since the amount of chloride from the salt is approximately 10 times larger than that from the acid.

Citric and lactic acid showed very similar acidification curves. Approximately 0.3 g of acid per 100 g of palmito are required to lower the pH to 4.6. Therefore, this amount has to be present in a can to obtain a pH of 4.6. The acid concentration of the brine depends on the product-to-brine ratio. If this ratio is not controlled closely, considerable variations in the pH can occur.

The great variability of the equilibrium pH of canned palmito prepared with the same brine and with the same product-to-brine ratio always intrigued the authors. A search for the source of this variability showed that the different parts of the palmito had remarkably different buffer capacities. From Fig. 11 it can be seen that 0.35% citric acid was required to reach pH 4.3 for the upper part (towards the leaves) of the palmito. For pieces from the lower end, 0.67% acid was required. Pieces between the extremities gave intermediate results. The same canning brine which gives a very safe pH of 4.3 for the upper part, would yield an unsafe product of pH 4.65 if used in a can containing only pieces from the lower end...
procedures.

An additional problem for safe acidification involves the rate of diffusion of the acid of the brine into the low-acid food. Quast et al. (10) found that 33 days after canning there was still a small difference between the average pH of the product and the pH in the center of the palmito pieces. Similar results were obtained by Ferreira (1) for palmitos of different species of palms. Figure 13 shows in cross-section the pH distribution in a piece of palmito of 5-cm diameter and 10-cm length, 8 days after canning. It can be seen that in this case after 8 days the pH in the center was still sufficiently high for growth of Clostridium botulinum. Of course, it is very unlikely that spores of C. botulinum would be present at the center of a piece of palmito. Since the question of safety under conditions of acidification by diffusion has not been solved for other foods, the best that can be done is to acidify to a specified equilibrium (average) pH. It must be mentioned that the pH of the brine containing 0.5% citric acid is approximately 2.5. Two days after processing the pH of the brine was 3.8 to 4.0, while the average pH of the palmito was 4.3 (1). In this case the average pH of the can contents was 4.1.

With the purpose of accelerating the acidification, palmito pieces were immersed into 5% citric acid solutions and vacuum was applied to deaerate the product. It was hoped that breaking of the vacuum would cause acid penetration. However, this procedure did not give significant acidification in the interior of the product.

Palmito stems with freshly cut lower ends were placed into solutions containing acid. The regular biological transport of the fluid did not take place, probably because there was no evaporation on the other end as it occurs when there are leaves on the upper end.

ACKNOWLEDGMENT


REFERENCES

1. Ferreira, V. L. P. 1975. Comparação físico-químico-sensorial do palmito de três espécies de palmeira. (Comparison of the physical, chemical and sensory properties of the palmito of three species of palms). Final report, project 46,5/75., Instituto de Tecnologia de Alimentos, Campinas, Brazil.
Whey Land Application
Safe, Benefits Crops

Whey, the liquid by-product of the cheese-making process, can be an excellent source of nutrients for crop plants, according to University of Wisconsin-Madison soil scientists Arthur E. Peterson and William G. Walker. In addition, it can be applied to the soil in relatively large amounts without posing a threat to the environment.

Peterson told the American Chemical Society meeting in Chicago Aug. 31 that studies on whey application to fields indicate the material provides all the nitrogen, phosphorus and potassium needed by growing crops, and that phosphorus in whey, considered the most serious potential pollutant substance, remains in the root zone even after many years' application without inhibiting plant growth.

Dried whey has found several uses as human food—in cake and bread mixes, puddings, etc.—and as a high protein addition to animal feeds. But the drying equipment is expensive, impractical for small cheese plants, which must find other suitable ways to dispose of liquid whey.

State environmental protection regulations prohibit disposal of whey in waterways. Disposal into municipal sewage treatments facilities is costly and wastes nutrients.

Many plants are turning to nearby land disposal of whey, Peterson said, saving energy needed to transport the material.

Peterson said corn yields in test plots increased dramatically with applications of 4 and 8 acre-inches (an acre-inch is 28,000 gallons) of whey. Per acre yields were 100 bushels higher with 4 acre-inches and 110 bushels higher with 8 acre-inches in the first year of tests after fall and spring applications. Average increases for four years of tests (including two poor corn years) were 56 bushels with 4 inches and 70 bushels with 8 inches. Yields begin to fall off somewhat with heavier applications, Peterson noted.

Corn plant leaves in whey-treated plots were "a deep, dark green," Peterson reported, "indicating an abundance of nitrogen throughout the growing season."

An acre-inch of whey contains about 320 pounds of nitrogen, 100 pounds of phosphorus and 400 pounds of potassium. Phosphorus and potassium build up in the soil, sometimes moving below the principal root zone. But tests of groundwater quality indicate no threat from phosphorus. Peterson says the reason is that the soil serves "as a sink, preventing downward movement of appreciable amounts of phosphorus."

Potassium moves deeper into the soil than phosphorus and could eventually enter the groundwater, Peterson said, but not in amounts to make it a serious pollutant.

For the many small cheese factories around the nation, the most satisfactory application method is truck spreading on crops needing nitrogen, such as grasses and corn, but not on alfalfa, Peterson said.

Cranberry Juice used for food coloring

Cranberry juice concentrate probably will be used as a replacement for red dyes in food colorings. It gives a satisfactory coloring for pie fillings, says Mrs. Sally Coble, foods and nutrition specialist with the Texas Agricultural Extension Service, The Texas A&M University System.