Physicochemical, microbiological and sensory characteristics of cashew nut butter made from different kernel grades-quality

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A B S T R A C T

This work aimed at evaluating the influence of cashew nut kernel grades and qualities in the characteristics of butter obtained by grinding kernels (89.9 g/100 g) with sugar (8.0 g/100 g), salt (0.1 g/100 g) and soy lecithin (2.0 g/100 g). Kernels and butter were analyzed for physical chemical characteristics (water activity, acid value, pH, moisture, ash, protein and fat contents) and microbiological quality (total and fecal coliforms, Escherichia coli, Salmonella sp., Staphylococcus, mesophilic count, yeast and mold). Minor differences were observed among the different grades and qualities. Nut kernels and corresponding butter showed high nutritive food value containing 18.3–26.9 g/100 g of protein and 35.7–52.6 g/100 g of oil. Fecal coliforms, E. coli, Salmonella sp. or coagulase positive Staphylococcus, were not detected. Sensory acceptability and sensory profile of the butter were also performed. Fourteen sensory descriptors were developed: appearance (caramel color, shiny, visual graininess and visual thickness), aroma (nutty, roasted and rancidity), flavor (nutty, sweet, salty, roasted and rancidity) and texture (consistency and graininess). Although all scores of sensory acceptability were among the acceptance range of the scale, the descriptive analysis found the butter made from B (butts), S (splits) and P (pieces) kernel grades to be of better quality.

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1. Introduction

The cashew tree (Anacardium occidentale L.) is native from Brazil and the nut that is botanically defined as a fruit is composed of a kernel, which represents about 20–25 g/100 g of the nut weight, peel and shell (Ogunwolu, Henshaw, Mock, Santros, & Awonorin, 2009).

Cashew kernels are very popular due to their desirable sensory and nutritional attributes. Cashew kernels are a good source of proteins (20–24 g/100 g), carbohydrates (23–25 g/100 g) and fats (40–57 g/100 g) (Nascimento, Naozuka, & Oliveira, 2010; Ogunwolu et al., 2009; Yang, 2009). Moreover, scientific investigations have demonstrated that nut kernels have beneficial effects on health, particularly on chronic diseases such as hypertension and obesity, coronary heart disease, and diabetes. The high content of unsaturated fatty acids of nut kernels is one of the most determinant factors against cardiovascular disease and obesity (Mexis & Kontominas, 2009; Oliete et al., 2008; Yang, 2009; Yang, Liu, & Halim, 2009).

The cashew culture has a large socioeconomic importance for the Northeastern region of Brazil and the nut is the main economic product of the tree (IBGE, 2009). In the region there are about 770,000 ha planted with cashew trees which produces 217,000 tons of nuts per year (SINDICAJU, 2011).

Commercial processing of cashew nuts involves a number of steps such as roasting, shelling, peeling, grading and packing that yields about 40 g/100 g of broken kernels. Different grades of broken kernels are obtained, which are usually classified by size and color, and their commercial value is much lower than that of the whole kernel. However, broken kernels have high nutritional value and can be used as an ingredient in the formulation of other products such as nut butter (Lima & Bruno, 2007; Nagaraja, 2003). Moreover, as the technology involved in the butter production is simple, it can be used by small producers in order to improve their income.

Therefore, the objectives of this study are, first, to determine the physicochemical and microbiological characteristics of different commercial grades and qualities of raw cashew nut kernels and, second, to evaluate physicochemical, microbiological and sensory properties of butter obtained from different kernels aiming to obtain an alternative way to use the broken kernels.

2. Materials and methods

2.1. Cashew nut kernels

Six grades of cashew nut kernels of two qualities, first and third, were tested making 12 samples. Kernels were obtained from
Table 1

<table>
<thead>
<tr>
<th>Grade</th>
<th>pH</th>
<th>Water activity</th>
<th>Acid value (g/100 g)</th>
<th>Moisture (g/100 g)</th>
<th>Ash (g/100 g)</th>
<th>Protein (g/100 g)</th>
<th>Fat (g/100 g)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1st</td>
<td>3rd</td>
<td>1st</td>
<td>3rd</td>
<td>1st</td>
<td>3rd</td>
<td>1st</td>
</tr>
<tr>
<td>S</td>
<td>6.3aA</td>
<td>5.9aB</td>
<td>1.40A</td>
<td>0.44B</td>
<td>1.67B</td>
<td>2.76B</td>
<td>2.8aB</td>
</tr>
<tr>
<td>B</td>
<td>6.3aA</td>
<td>6.3aB</td>
<td>0.390A</td>
<td>0.40A</td>
<td>0.20A</td>
<td>0.26A</td>
<td>3.4aB</td>
</tr>
<tr>
<td>P</td>
<td>6.3aA</td>
<td>6.3aB</td>
<td>0.369A</td>
<td>0.454aA</td>
<td>1.60aB</td>
<td>2.09aB</td>
<td>3.1aB</td>
</tr>
<tr>
<td>SP</td>
<td>6.0aA</td>
<td>6.4aB</td>
<td>0.453A</td>
<td>0.501A</td>
<td>1.58aB</td>
<td>2.12aB</td>
<td>3.3aB</td>
</tr>
<tr>
<td>SSP</td>
<td>6.4aA</td>
<td>6.1aB</td>
<td>0.431A</td>
<td>0.543A</td>
<td>1.70aB</td>
<td>3.50aB</td>
<td>3.0aB</td>
</tr>
<tr>
<td>G</td>
<td>6.2aA</td>
<td>6.2aB</td>
<td>0.452A</td>
<td>0.508aA</td>
<td>1.86aB</td>
<td>2.73A</td>
<td>3.5B</td>
</tr>
</tbody>
</table>

Table 2

<table>
<thead>
<tr>
<th>Grade</th>
<th>pH</th>
<th>Water activity</th>
<th>Acid value (g/100 g)</th>
<th>Moisture (g/100 g)</th>
<th>Ash (g/100 g)</th>
<th>Protein (g/100 g)</th>
<th>Fat (g/100 g)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1st</td>
<td>3rd</td>
<td>1st</td>
<td>3rd</td>
<td>1st</td>
<td>3rd</td>
<td>1st</td>
</tr>
<tr>
<td>S</td>
<td>6.2aA</td>
<td>5.9aB</td>
<td>0.362A</td>
<td>0.314B</td>
<td>1.41B</td>
<td>1.79aB</td>
<td>0.3aB</td>
</tr>
<tr>
<td>B</td>
<td>6.2aA</td>
<td>6.2aB</td>
<td>0.352A</td>
<td>0.312B</td>
<td>1.31A</td>
<td>1.35aA</td>
<td>1.9aB</td>
</tr>
<tr>
<td>P</td>
<td>6.1aA</td>
<td>6.2aB</td>
<td>0.313A</td>
<td>0.304A</td>
<td>1.56aB</td>
<td>1.48aB</td>
<td>0.8aB</td>
</tr>
<tr>
<td>SP</td>
<td>6.2aA</td>
<td>6.1aB</td>
<td>0.342A</td>
<td>0.425A</td>
<td>1.38aA</td>
<td>1.45aA</td>
<td>1.4aB</td>
</tr>
<tr>
<td>SSP</td>
<td>6.2aA</td>
<td>6.0aB</td>
<td>0.358A</td>
<td>0.408A</td>
<td>1.31A</td>
<td>2.18aA</td>
<td>1.1B</td>
</tr>
<tr>
<td>G</td>
<td>6.2aA</td>
<td>6.1aB</td>
<td>0.379B</td>
<td>0.439A</td>
<td>1.57A</td>
<td>1.96aA</td>
<td>1.4B</td>
</tr>
</tbody>
</table>

In the column, means with different small letters are statistically different (p < 0.05).
In the row, for each analysis, means with different capital letters are statistically different (p < 0.05).
samples (Meilgaard, Civille, & Carr, 1999). The tests were performed in individual acclimatized booths (24 °C).

### 2.6. Quantitative descriptive sensory analysis

Cashew nut kernel butter samples were evaluated by a trained panel using descriptive sensory profiling (Lawless & Heymann, 1998; Stone, Sidel, Oliver, Woolsey, & Singleton, 1974). The panel consisted of 10 trained assessors screened for their sensory ability by basic tastes and odor detection tests, as well as their ability to describe and discriminate food products.

The generation of descriptors followed the Grid Method, suggested by Moskowitz (1983), where pairs of samples were offered to the panelists so as to define the terms which describe similarities and differences between the samples in relation to appearance, aroma, flavor and texture attributes. Samples comprised butter obtained from recent processed whole cashew nut kernels and butter obtained from SP (first quality) cashew nut kernels. The panelists, under the supervision of a moderator, selected the descriptors which better characterized the samples.

Descriptors were quantified with a 9 cm non-structured linear scale, anchored on the extremes with terms which expressed their intensities. At this point, a list of definitions of each descriptive term, with the respective physical reference standards, was determined by panel consensus and used to develop the proper descriptive language and calibrate the panel in the use of the intensity scale. After the terminology development phase, the panelists were trained in the evaluation of cashew nut kernel butter. Training consisted of evaluating three butter samples prepared with different grades of nuts by means of the developed ballot in order to describe and quantify appearance, aroma, flavor and texture. The reference standards were presented along with the samples. These tests were performed in an experimental design of balanced complete blocks with three repetitions. Results were submitted to analysis of variance (ANOVA), having the sources of variation being panelists and repetitions in order to check the panelists’ discriminatory ability and repeatability, according to the methodology reported by Damásio and Costell (1991).

After panel validation, butter samples were evaluated in three repetitions, following the experimental design of balanced complete blocks. At this step, only butter samples obtained from first quality kernels (S, B, P, SP, SSP and G) were evaluated. Approximately 20 g of butter were placed in small plastic containers coded with three digit random numbers. In order to eliminate the residual flavor, water and bread were used. The tests were performed in individual acclimatized booths (24 °C).

### 2.7. Statistical analysis

Physicochemical and sensory acceptability data were subjected to ANOVA. Means and standard deviations were calculated, and when F-values were significant (p < 0.05), Tukey test was applied at the 0.05 significance level for the comparison of mean values.

For the descriptive sensory analysis, results were submitted to ANOVA which was applied to individual descriptors separately, using samples and judges as the main effects and the interaction between them as the random effect, in order to get an indication of the signal/noise ratio of the variables. Tukey test was applied (p < 0.05) for the comparison of mean values. For the sensory mapping of the cashew nut kernel butter samples, a Principal Component Analysis (PCA) was carried out.

Statistical analyses were performed using the SAS statistical program for Windows system (SAS, 2001).

### 3. Results and discussion

#### 3.1. Physicochemical characteristics

Physicochemical characteristics of raw cashew nut kernels and butter are presented in Table 1 and Table 2. Although minor differences were observed among grades and qualities, both kernels and butter showed pH close to neutrality (5.9—6.6). However, they were also characterized by low water activity (<0.55) and low moisture content (<4.2 g/100 g), which contributes to prevent microbiological deterioration. It is generally stated

<table>
<thead>
<tr>
<th>Grade</th>
<th>Total coliforms</th>
<th>Fecal coliforms</th>
<th>Escherichia coli</th>
<th>Salmonella sp.</th>
<th>Coagulase positive Staphylococcus aureus</th>
<th>Mesophilic count</th>
<th>Yeast and mold</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>G</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>SP</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>SSP</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

In the column, means with different small letters are statistically different (p < 0.05).

In the row, means with different capital letters are statistically different (p < 0.05).
that there is no microbial growth at water activities below 0.60
(Troller, 1980).

Kernels showed protein content ranging from 20.6 to 26.9 g/100 g and fat contents ranging from 35.7 to 45.9 g/100 g, while butter samples showed protein content ranging from 18.3 to 22.0 g/100 g and fat contents ranging from 43.7 to 52.6 g/100 g. Butter showed smaller water activity, moisture and protein content compared to the corresponding nut kernels due to the sugar that was added during formulation. Results are in good agreement with those of USDA National Nutrient Database for Standard Reference (2010) regarding cashew nut and cashew nut butter proximate composition.

3.2. Microbiological characteristics

Microbiological evaluation of raw cashew nut kernels and corresponding butter are presented in Table 3. The most probable numbers (MPN) of fecal coliforms (including E. coli) were lower than 10 organisms per gram both for cashew nut kernels and butters. Salmonella sp. was absent in 25 g. The enumeration of Coagulase positive S. aureus was lower than 100 CFU/g. These results indicate that nuts had good manufacturing practices, which, associated with the low water activity, guaranteed good microbiological quality for the products. It was observed mesophilic counts, yeast and molds, mainly on SP, SSP and G kernels, which can be attributed to the greater number of manufacturing steps used to obtain those grades. However, the counts were lower than 10³ CFU/g and did not present any health hazard. Quality (first or third) did not influence the microbiological characteristics.

3.3. Sensory acceptability

Hedonic sensory scores (Table 4) were close to like moderately for all formulated butter samples, except for butter made from G grade-third quality nut kernels, which was evaluated as like slightly. All scores were among the acceptance range of the scale, which comprises notes from 6 to 9. Therefore, it can be concluded that butter made from all kernel grades–qualities were accepted by the consumers.

3.4. Quantitative descriptive analysis

The sensory descriptive terms selected for the characterization of cashew nut kernel butter are listed in Table 5, which also presents the definitions and reference samples for each descriptor. Table 6 shows the intensity means of all descriptors for each sample.

The ANOVA revealed that the kernel grade significantly influenced (p < 0.05) the perception of most descriptors, except for sweet, salty and rancidity flavors. Considering that in cashew nut butter formulations the same amount of sugar and salt were used, differences in those descriptors were not expected. Thus, the small values observed for rancidity flavor and aroma showed that although the nut kernels used for formulation were broken, they were of good quality.

The PCA, carried out only with those descriptors that presented significant differences by ANOVA, revealed differences among samples (Fig. 1). The first two components (PC1 and PC2) together explained up to 69.3% of the sample variability.

In this plot, descriptors that are close present a high positive correlation among them, while the descriptors in opposite position present a high negative correlation. Thus, the descriptors such as roasted aroma and flavor, rancidity aroma and caramel color presented a higher correlation among one another. Those descriptors are related to the roasting process.

The visual thickness, visual graininess, consistency and graininess were all correlated and associated to the butter samples prepared from SP, SSP and G grades. Those characteristics are

<table>
<thead>
<tr>
<th>Table 5</th>
<th>Sensory descriptors, definitions and references used in descriptive analysis of cashew nut kernel butter.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Descriptor</strong></td>
<td><strong>Definition</strong></td>
</tr>
<tr>
<td><strong>Appearance</strong></td>
<td>Color resembling sugar when submitted to heat (caramelized)</td>
</tr>
<tr>
<td><strong>Shiny</strong></td>
<td>Shining associated with oil surface</td>
</tr>
<tr>
<td><strong>Visual graininess</strong></td>
<td>Small pieces as seen visually</td>
</tr>
<tr>
<td><strong>Visual thickness</strong></td>
<td>Force is needed to remove butter from spoon</td>
</tr>
<tr>
<td><strong>Aroma</strong></td>
<td>Nutty</td>
</tr>
<tr>
<td><strong>Roasted</strong></td>
<td>Aroma associated with the roasting process</td>
</tr>
<tr>
<td><strong>Rancidity</strong></td>
<td>Aroma associated with oxidized oil</td>
</tr>
<tr>
<td><strong>Sweet</strong></td>
<td>Basic taste associated with sugars</td>
</tr>
<tr>
<td><strong>Salting</strong></td>
<td>Basic taste associated with sodium salts</td>
</tr>
<tr>
<td><strong>Roasted</strong></td>
<td>Flavor associated with the roasting process</td>
</tr>
<tr>
<td><strong>Rancidity</strong></td>
<td>Oily flavor associated with oxidized oil</td>
</tr>
<tr>
<td><strong>Texture</strong></td>
<td>Consistency</td>
</tr>
<tr>
<td><strong>Graininess</strong></td>
<td>pieces of cashew nut perceived in the mouth</td>
</tr>
</tbody>
</table>

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related to pieces perceived visually or in the mouth and also to the force necessary to remove the butter from a spoon or between tongue and mouth. Those are undesirable characteristics since for nut butters smooth and creamy texture is important and consumers usually use words related to texture and pleasantness when defining creaminess (Tourrier, Martin, Guichard, Issanchou, & Sulmont-Rosse, 2007). According to Crippen, Hamann, and Young (1989) who studied texture on peanut butter, many people equate texture with quality and deviations from expected texture indicate that something is wrong with the food. Those authors reported that consumer preference ratings for peanut butter decreased with increasing grind size.

The descriptors of shiny, nutty aroma and flavor, which are desirable characteristics, were also correlated and associated with the butter samples prepared with B, P and S grades. Nutty aroma and flavor are desirable because they represent the origin product. Shiny is associated with an oily surface (not dry) which is important in creamy foods such as peanut, butter and others (Giboreau et al., 2007). Shiny is also reported in the literature as brightness. Arvanitoyannis, Mavromatis, Rodiatis, and Goulas (2007) working with landraces of Greek common dry bean found out that smell, brightness and acceptance are the most important factors determining landrace total acceptability, so effort should be directed at improving these attributes in an attempt to satisfy consumer experience.

As a conclusion, the PCA indicated that the butter samples prepared from the B, P and S grades were identified by the trained panel as products of better quality.

4. Conclusions

All kernels and butter showed good microbiological characteristics. Minor physicochemical differences were observed in kernels and corresponding butter obtained from different grade-qualities. Sensory hedonic scores for the butter samples were on the acceptance range of the scale. However, the trained panel identified better characteristics in butter samples prepared from the B, S and P grades, which should be preferably used to prepare commercial butter. For that purpose, the classification step of broken kernels in cashew nut processing can be simplified by placing B, S and P pieces in just one grade. Moreover, cashew nut kernel butter represents a good source of protein and energy and is an alternative for adding value to broken nut kernels.

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References


