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Changes in Cashew Apple Juice Flavor after Tangential Microfiltration Process

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Abstract

Cashew is a highly nutritive fruit native to Brazil, but the high astringency of its integral juice limits its acceptability and consumption. Using tangential microfiltration process it is already possible to reduce up to 97% of the tannin present in the cashew juice. Making use of this same technology, the present work studied the changes in the volatile composition caused by this process, monitored by sensory evaluation. Cashew juice was obtained from the processing of cashew apples in an expeller extractor. The juice was clarified in a microfiltration pilot scale plant. Volatile compounds were extracted through vacuum evaporation, trapped into a polymer membrane and analyzed by GC-MS. Difference-from-control sensory test was applied to verify aroma sensitive changes between the integral and clarified juice. Cashew juice clarification by tangential microfiltration provoked a few alterations on the juice's volatile profile, but these changes did not impair the characteristic cashew aroma in the clarified juice.

Keywords: Annacardium occidentale L; Pseudofruit; Peduncle; Volatile compounds; Sensory analysis

Introduction

Cashew tree (Anacardium occidentale L.) is a tropical plant native to Brazil, dispersed throughout its territory. Its economic importance is due to the cashew nut, appreciated all over the world, reflected in high number of direct and indirect jobs and significant income generation. In the semi-arid region, the social importance is even greater, because rural jobs are generated in the between-harvest of traditional crops such as maize, beans and cotton, thus reducing rural exodus [1]. The cashew apple (hypertrophied peduncle)is highly nutritive, with high levels of vitamin C (126 to 372 mg/100 mL), reducing sugars, organic acids, minerals and amino acids, carotenoids and phenolic compounds [2-9]. It can be consumed as fresh fruit, but also presents good characteristics for juice industrialization, due to its fleshy pulp, soft peel, no seeds and strong exotic flavor. However, its high astringency is the main issue that limits its acceptability and consumption, mainly in the external market [10].

Clarification has been used to remove tannins and astringency in cashew juice. The clarified juice obtained by pulp flocculation with gelatin has excellent sensory properties, but is a semi-artisanal process. Studies using enzymatic maceration with Pectinex Ultra SP-L and microfiltration in tubular ceramic membranes of different pore sizes demonstrated that the reduction of the tannin content in the clarified juice was up to 97% (average) [11,12]. However, the flavor of the products was not yet evaluated. The present work investigates how microfiltration affects the volatile compounds, determining the volatile profile and the cashew-like aroma of the pulpy juice and the clarified juice.

Material and Methods

Juice preparation

Cashew juice was obtained from a pool of dwarf cashew apples from different clones cultivated under irrigation at Embrapa Experimental Farm in Paraipaba (Ceará). Fresh juice was obtained in pilot scale by an expeller extractor (Incomap, Brazil) and then micro filtered in cross flow system with a 0.2-μm pore size tubular ceramic membrane (Membralox-Pal, Germany). The integral juice (pulpy) and the clarified juice (permeate) were stored at −18°C for further analyses.

Chromatographic analysis

Volatile compounds from the headspace of the cashew apple juices (300 g added by NaCl 30%

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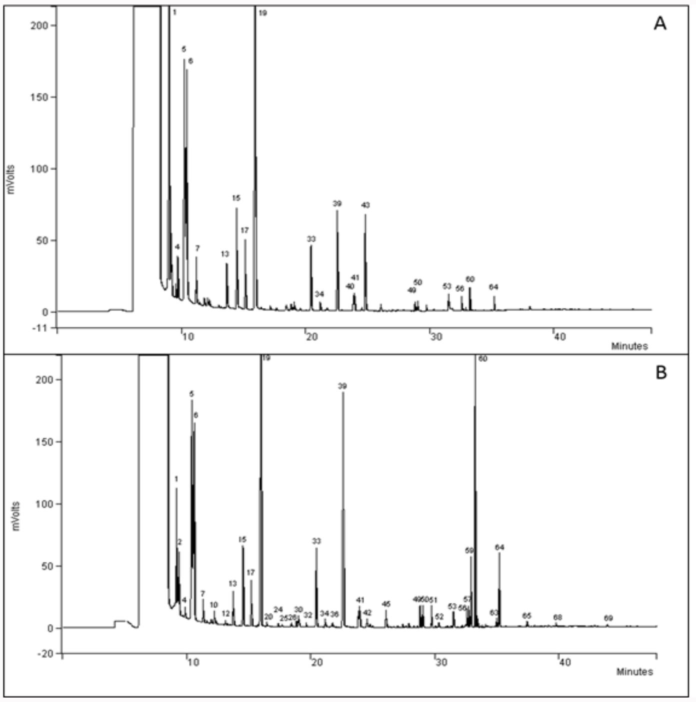

Figure 1: Chromatograms of cashew juice volatile compounds: (A) integral juice, (B) Clarified juice by microfiltration.

w/w) were swept by vacuum (70 mmHg) to a Porapak Q polymer trap (80 mesh to 100 mesh) (Waters, Milford, MA, USA), according to the methodology described by Garruti et al [13]. After 2h, the traps were eluted with 300 µL pure acetone, generating an extract.

The volatile compounds extraction was validated by a difference-from-control sensorytest. A trained panel evaluatedhow much the cashew-like aroma of the extract wassimilar to the fresh cashew juice aroma (see Sensory Analysis) [14].

Volatile compounds were separated on a CP-Wax 52 CB (Varian, Walnut Creek, CA, USA) bonded phase fused silica capillary column (20 m length, 0.1 mm id, 0.2 µm film thickness) in a Varian gas chromatograph model 3380. The injector was stein the split less mode at 200°C and the Flame Ionization Detector (FID) at 250°C. Hydrogen was the carrier gas at a flow rate of 1.5 mL min^{-1}. The oven temperature program started at 30°C, held for 7 min, programmed to 90°C (3°C min^{-1}) and then to 200°C (10°C min^{-1}). The injected volume was 1.0 µL.

Identification was done by GC-MS in a Shimadzu gas chromatograph model GC-2010 coupled to a Shimadzu QP-2010 mass spectrometer (GC/MS, Kyoto, Japan) at an ionization voltage of 70 eV and 1 scan s^{-1} scan range. Column and oven conditions were the same as those used for the chromatographic analysis. Helium was the carrier gas at a flow rate of 1.5 mL min^{-1}. Additionally, the experimental Retention Index (RI) was determined with a homologue mixture of n-alkanes (C8–C22) and compared with the ones reported in literature [15,16].

Sensory evaluation

Members of a trained sensory panel (4 woman, 4 men)evaluated the cashew-like aroma of the two samples of cashew juice: integral juice (pulpy) and clarified juice (microfiltered), using the same difference-from-control test used for the extracts. Each subject was given a labeled control sample and one or more test samples. Within the test samples, the control was also presented as a blind-control. Then, they were asked to rate the size of the difference between the test sample and the control, on a 9-cm line scale. Samples were served in glass cups coded with three digits numbers and capped with a watch glass. The analyses were performed in individual cabins, under red lights and in a series of three replicates, making 24 observations. Results were submitted to Anova and Dunnett tests for mean comparison (α =0.05).

Results and Discussion

The juice clarified by microfiltration showed a richer volatile profile than the integral juice. Figure 1 shows the chromatograms of the integral juice and the clarified juice, while Figure 2 summarizes the changes of the most important odor-active compounds in relation to the integral juice. In this figure, the zero point refers to the peak area in the chromatogram of the integral juice, and the scale refers to the variation, in percentage, of the peak area of each compound in the clarified juice. Compounds were divided into three groups, according to their role in the cashew aroma, based on olfactometric studies reported in a previous work [13]:

Group 1: key-odor compounds with cashew-like aroma

Group 2: contributor compounds with sweet, fruity, floral and green odors

Group 3: contributor compounds with unpleasant, stinky odors

In the clarified juice, allkey-odor compounds (Group 1) showed no relevant changes in relation to the integral cashew juice, varying less than 5%. On the other hand, some contributor compounds with pleasant odor notes (Group 2) were concentrated by the membrane between 7% to 35%: ethyl valerate (peak 29; cashew, sweet), (E)-ethyl-3-hexenoate (peak 47, green), (Z)-3-hexenol (peak 50; green) and benzaldehyde (peak 55; green, fruity). Only ethyl octanoate (peak 52; fruity) decreased almost 20%.

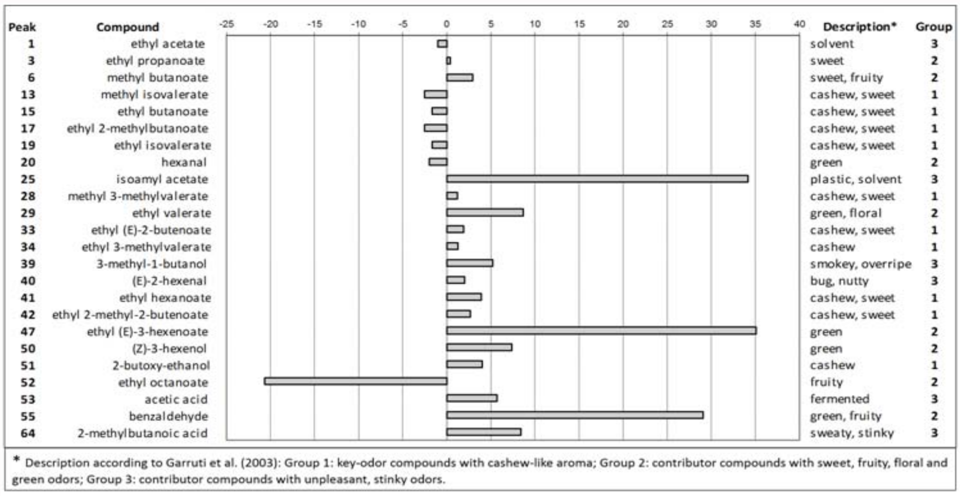

Figure 2: Percentage variation of most important odor-active compounds of cashew juice clarified by microfiltration in relation to the integral cashew juice.

Among the negative-impact compounds, only isoamyl acetate (peak 24; plastic, solvent) and 2-methylbutanoic acid (peak 64; sweaty, stinky) were concentrated in the clarified juice. However, these changes in the volatile profile of cashew juice did not impair the aroma quality of the clarified product since the intensity of cashew-like aroma of the micro filtered juice showed no significant difference in relation to the integral juice ($p>0.05$). Probably the sensory perception due to the increase inunpleasant compounds was compensated by the concentration of those high odoriferous compounds that contribute to the characteristic cashew-like aroma.

An analysis of the volatiles compounds that varied considerably (>5%) in the permeate stream demonstrates a tendency for the concentration of those with higher water solubility and the dilution of those with lower water solubility. Since all the studied compounds are oxygenated, it was expected a major concentration of the volatiles in the permeate [17,18]. This behavior was confirmed with only one exception, the ethyl octanoate, which has the lower solubility and the higher molecular weight among the components with relevant variation in concentration. This fact reflects the hydrophilic, polar and size selective characteristics of the membrane.

During microfiltration processes, a fouling layer of fibers from the pulp and other compounds can be formed at the internal surface of the tubular membranes, and the volatile molecules, which in most cases are non-polar, can be entrapped or adsorbed. This can be considered as one of the main causes for the variation in composition between the permeate and feed stream. It's also possible for the volatiles do adsorb to the membrane itself, although this process would take place only at the very beginning of the microfiltration (until the sites in the membrane were filled), reducing its influence in the processing of the integral juice.

The selective properties of the membrane had influenced over the volatile composition in the permeate stream, however this effect was modest (maximum variation 35%) if compared to the tannin content reduction reported in literature [19,20].

Conclusion

Cashew juice clarification by tangential microfiltration provokes a few alterations on the juice's volatile profile, although these changes do not imply in a significant impact on the cashew characteristic aroma in the clarified juice.

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