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Identify Effective Methods for Reducing Tannin Content in Cashew Apple Juice Using Different Clarifying Agents

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ABSTRACT

Cashew apple and its juice are used in various value-added products, such as fruit juice, syrup, canned fruit, jam, jelly, wine, vinegar, candy, and beverages. However, there has not yet been any research conducted on cashew apple syrup. Cashew apple juice contains tannins, which cause astringency and dark coloration, leading to a final product that loses both its texture and taste. Therefore, selecting appropriate processing cashew apple juice involves using different clarifying agents, including T0 (no clarifying agent), T1 (Tapioca starch), T2 (corn starch), T3 (gelatin), T4 (rice starch), and T5 (rice gruel) has been studied with the aim of analyzing its physico-chemical composition. Physico-Chemical analyses revealed significant differences among treatments in total soluble solids (4.05–6.60 °Brix), total acidity (0.42–0.61%), vitamin C content (103.84–111.63 mg/100 mL), tannin content (39.50–95.90 mg TAE/100 mL), phenolic content (116.04–182.74 mg GAE/100 mL), and turbidity (0.01–1.49 AU), while pH values (4.00–4.15) remained statistically non-significant. The results of the study revealed that using rice gruel as a clarifying agent is an effective treatment in removing tannins from fresh cashew apple juice and results in greater clarity compared to other treatments.

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Introduction

Cashew apple (*Anacardium occidentale* L.) is an industrial crop extensively cultivated in the lowland and sloping regions of the Kingdom of Cambodia, areas that rarely experience flooding. Cambodia is among the largest producers of cashew apples. The fruit is characterized by its soft, fibrous pulp, absence of a central seed, unique flavor, and favorable nutritional profile [1]. It contains approximately 280 mg of vitamin C per 100 g and about 10% sugar [2]. Additionally, cashew apples contain high levels of minerals, phenolic compounds, and vitamin C, contributing to various health benefits [3]. However, the fruit also contains a significant number of tannins around 90 mg per 100 g which can cause astringency when consumed fresh, making it necessary to reduce or remove them [4]. Furthermore, immature cashew apples have a high-water content and possess a distinct flavor and aroma compared to other fruits [5].

Cashew apples can be processed into a variety of products, such as beverages, vinegar, wine, and syrups, while also being suitable for fresh consumption. Processed products include pure cashew apple juice, blended juices with other fruits (such as lemon, pineapple, orange, mango, papaya), wine, candy, jam, jelly, and fermentation [6]. Moreover, cashew apples are rich in carbohydrates, minerals, vitamins, amino acids, phenolic compounds, organic acids,

antioxidants, and carotenoids components that are not only beneficial for health but also serve as an important energy source [7-9].

Tannins are phenolic compounds and classified into two main groups: condensed tannins and hydrolysable tannins. The tanning content of fruit juice can vary between studied due to factors such as cultivar, extraction from different parts of the fruits, stages of maturity, processing condition, the composition for the juice, viscosity, and presence of the flavors affect the compounds in the juice. Tannins are considered nutritionally undesirable. Therefore, the removal of tannins from cashew juice to produce a beverage this fruit is indispensable. There are three methods to reduce tannin in cashew apple juice: physical, chemical, and enzymatic methods.

The processing of cashew apples into new products is a value-added approach that helps reduce post-harvest losses while enhancing nutritional value, particularly due to their abundance of essential minerals such as calcium, phosphorus, and iron [10]. Nevertheless, the quality of the raw material is crucial to ensure that cashew apple products meet consumer expectations in terms of freshness, color, aroma, and packaging. Therefore, the topic “identify effective methods for reducing tannin content in cashew apple juice using different clarifying agents” has been brought up for study.

Materials and Methods

Table 1: Distribution of Experimental Treatments

Treatment	Clarifying agent (5%)	Unit (ml)	Time (min)	Cashew apple juice (ml)	parameters
T ₀	0	0	0	350	- pH - TSS - Total acidity - Vitamin C - Phenolic content - Turbidity - Tanin
T ₁	Tapioca starch	1:7	45	350	
T ₂	Corn starch	1:7	45	350	
T ₃	Rice starch	1:7	45	350	
T ₄	Gelatin	1:7	45	350	
T ₅	Rice gruel	1:7	45	350	

Note: A 1:7 ratio means that one part of the clarifying solution is used for every seven parts of cashew apple juice.

Source of Raw Materials

Cashew apples were collected from Kosal Farms, located in Chi Oak Village, Chi Oak Commune, Kbeng Mean Chey District, Preah Vihear Province. Only well-ripened cashew apples were selected, and those that were overly mature were discarded. The fruits were then transported to the experimental site, washed thoroughly with clean water two to three times to remove any adhering impurities, and drained until dry before being stored in a refrigerator for experimentation.

Method for Tannin Removal from Fresh Cashew Apple Juice

For treatments using tapioca starch, corn starch, rice starch, and gelatin is added to the cashew apple juice and allowed to dissolve and interact for 45 minutes to facilitate clarification. The mixture is then filtered through filter paper, and the filtrate is collected for analysis. In the case of rice gruel, to obtain one liter of gruel, seven liters of clean water and one kilogram of rice are required. Rice is added to the water, and once the water reaches boiling, the heat is reduced. The mixture is maintained for 10 minutes, after which only the liquid portion (rice gruel) is decanted and added to the cashew apple juice. This combined mixture is left to clarify for 45 minutes, then filtered through filter paper for subsequent analysis.

Physio-Chemical Analysis

pH Measurement: pH is measured using a pH meter (Model F-71G, MFG No. B16L0032) that displays the pH value on its screen. **Total Soluble Solids:** These are measured with a refractometer (Model Pal-BX/RI) that provides readings in degrees Brix. **Total Acidity:** Total acidity is determined by titration with 0.1N sodium hydroxide using phenolphthalein as an indicator, following the AOAC method [11]. **Tannin Content:** Tannin is analyzed by adding 0.1% Indigo-Carmine and H₂SO₄, then titrating with a 0.1N KMnO₄ solution, according to the method described by Chandran et al. [12]. **Vitamin C Content:** Vitamin C is determined by preparing a standard solution, then adding 1M HCl and 1% starch, and finally titrating with a 0.01N iodine solution, following the method. **Phenolic Content:** Phenolic content are analyzed by preparing a standard gallic acid solution, adding Folin-Ciocalteu reagent (FCR) and Na₂CO₃, and measuring the absorbance with a spectrophotometer at 760 nm, as described by Queiro et al. [13]. **Turbidity:** Turbidity is measured using a spectrophotometer. After calibration with distilled water (blank), the sample is centrifuged to remove particulates, and the supernatant is placed in a cuvette. The absorbance is then measured at 450 nm, following the AOAC (2000) method [11].

Results and Discussion

Table 2: Physicochemical Composition of Cashew Apple Juice after Tannin Removal

Parameters	T ₀	T ₁	T ₂	T ₃	T ₄	T ₅	P-value
pH	4,00	4,00	4,00	4,00	4,00	4,15	0,983
Total acid (%)	0,61	0,48	0,51	0,42	0,55	0,42	0,006
TSS (°Brix)	6,35	6,60	6,30	5,95	6,15	4,05	0,000
Vitamin C (mg /100m)	111,63	106,44	104,36	104,36	103,84	103,37	0,000
Tanin (mg TAE/100ml)	95,90	58,80	72,30	55,40	45,20	39,50	0,000
Phenolic (mgGAE/100ml)	182,74	173,83	174,00	176,85	129,62	116,04	0,000
Turbidity (AU)	1,49	1,33	1,26	1,26	0,49	0,01	0,000

Note: T₀ indicates no clarifying agent was used; T₁ denotes the use of tapioca starch at a 1:7 ratio; T₂ denotes the use of corn starch at a 1:7 ratio; T₃ denotes the use of rice starch at a 1:7 ratio; T₄ denotes the use of gelatin at a 1:7 ratio; and T₅ denotes the use of rice gruel at a 1:7 ratio

The pH of the cashew apple juice after tannin removal ranged from 4.00 to 4.15. Akyereke et al. reported a pH range of 3.5 to 4.8 for fresh cashew apple juice, while Marc et al. found a range between 4.37 and 4.5. Additionally, Aluko et al. noted that both tannin-removed and fresh cashew apple juice exhibited pH values from 4.0 to 4.4. Thus, the pH levels obtained in this study are consistent with those reported in previous research [14,15].

The total soluble solids (TSS), the highest value recorded at 6.60 °Brix and the lowest at 4.05 °Brix. In contrast, Aluko et al. reported TSS values between 10.5 °Brix and 14 °Brix, Pascal et al. found values from 9.25 °Brix to 12.63 °Brix, and Dédéhou et al. noted a range from 10.7 °Brix to 14.5 °Brix. Thus, the total soluble solids in this study is lower than that reported in previous studies [15-17].

Total acidity ranged from 0.42% to 0.61%. Akyereke et al. reported total acidity values between 0.3% and 0.48%, while Marc et al. observed values between 0.62% and 0.71%, and Adou et al. found a value of 0.79% [14,18,19]. Thus, total acidity levels obtained in this study are consistent with those reported in previous research.

The vitamin C content ranged from 103.37 mg/100 mL to 111.63 mg/100 mL. In comparison, Akyereke et al. reported vitamin C levels between 200 and 241 mg/100 g, and Salehi et al. recorded a vitamin C content of 279.37 mg/100 g. Thus, the vitamin C content in this study is lower than that reported in previous studies [18,20].

Tannin content, values ranged from 39.50 mg TAE/100 mL to 95.90 mg TAE/100 mL. Kyraleou et al. (2019) found tannin levels between 23.70 mg TAE/100 mL and 87.60 mg TAE/100 mL, and Dagadkhair et al. demonstrated that rice gruel could remove approximately 30-35% of tannins [21,22]. Thus, the Tannin content levels obtained in this study are consistent with those reported in previous research.

Total phenolic content ranged from 116.04 mg GAE/100 mL to 182.74 mg GAE/100 mL. Dao et al. reported a phenolic content of 760 mg GAE/100 mL for fresh cashew apple juice, and Hanh et al. recorded 245.29 mg GAE/100 mL. Thus, the total phenolic content in this study is lower than that reported in previous studies [23,24].

Turbidity, ranged from 0.01 to 1.49 AU. Prommajak et al. reported that the use of gelatin as a clarifying agent could reduce turbidity by 75.5%. Ukonze et al. found that the turbidity of tannin-removed cashew apple juice ranged from 0.04 to 0.32 AU, depending on the clarifying agent used (gelatin, rice gruel, or various powders) [25]. Moreover, Sluiter et al. noted that higher total soluble solids can lead to increased turbidity in the final product [26]. The turbidity levels obtained in this study are consistent with those reported in previous research.

Conclusions and Recommendations

The physicochemical analysis of cashew apple juice after tannin removal, using various clarifying agents (corn starch, tapioca starch, rice starch, gelatin, rice gruel, and no clarifying agent), revealed that these treatments significantly influence parameters such as total soluble solids, total acidity, vitamin C content, tannin content, total phenolic content, and turbidity, while having no effect on pH. Among the treatments, T5 (rice gruel) using rice gruel as the clarifying agent demonstrated the most favorable results in both tannin removal and turbidity reduction. Particularly the application of rice starch extract for tannin reduction, may serve as a solid foundation for optimizing technological schemes in small- and medium-scale fruit processing enterprises. Specifically, the chemical parameters for treatment T5 (rice gruel) were as follows: a pH of 4.15, total soluble solids of 4.05 °Brix, total acidity of 0.42%, vitamin C content of 103.37 mg/100 mL, tannin content of 39.50 mg TAE/100 mL, total phenolic content of 116.04 mg GAE/100 mL, and turbidity of 0.001 AU. Therefore, rice gruel is the most effective clarifying agent for tannin removal in cashew apple juice processing.

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