

Effect of physicochemical methods on tannin removal, vitamin C, polyphenol, and antioxidant activity in cashew apple juice (*Anacardium occidentale* L.)

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Abstract

Cashew apples, which are a by-product of the harvesting and processing of cashew nuts, contain 5 to 10 times more vitamin C than oranges, lemons, and pineapples. The composition of cashew apples has been shown to help prevent certain cancers, cardiovascular diseases, and scurvy. However, the presence of astringent tannins in the fruit has hindered its use and commercialization. This study investigated and evaluated the potential for tannin removal using physicochemical methods to develop an optimal solution. Six different methods were used to examine their tannin removal effectiveness. The highest efficiency (92.02%) was achieved by combining steaming with gelatin. This was followed by a combination of NaCl and polyvinyl pyrrolidone (PVP) (77.05%) and NaCl with gelatin (75.07%). Steaming at 120°C for 6 min resulted in a 74.81% removal rate. Blanching in brine with a 2% NaCl concentration at 90°C for 2 min yielded a 61.97% tannin removal rate. The lowest efficiency (58.99%) was obtained with the use of a 0.1% PVP adsorbent. This study serves as a foundation for developing products for the cashew industry, providing new economic opportunities for farmers by utilizing by-products that have previously been discarded.

1. Introduction

The cashew apple tree, scientific name *Anacardium occidentale* L., is a crop that grows and develops well in countries in the sub-equatorial region, where the temperature and humidity are high, such as India, Brazil, Thailand, Indonesia, the Philippines, and other continents like Africa, Central America (Das and Arora, 2017). In Vietnam, cashew trees are grown in the South-Central region, the Central Highlands, and the Southeast. Cashew trees are a perennial plant, and the fruit of the tree is formed from the flower stalk. The growth period of the fruit and the seed lasts from 3 to 4 months, and they are usually harvested between May and June each year. The pseudo-fruit is considered the main agricultural waste in the cashew industry (Talasila and Shaik, 2015). It is a unique type of fruit with the seed on the outside. The fruit has a bitter taste, tightens the tongue, and is

difficult to use and process, making up 90% of the total weight of the fruit and seed (Talasila and Shaik, 2015). In 2020, Viet Nam estimated that 1.9 million tons of cashew apples would be discarded (data derived from the General Department of Vietnam Customs 2020). The nutritional content of the fruit is notable, with vitamin C levels 5 to 6 times higher than those of citrus fruits (Lagnika *et al.*, 2019; Dao *et al.*, 2021), 104 – 121 mg/100g (Assunção and Mercadante, 2003), 2.93±0.13 mg/gDW, total polyphenol content (TPC) for 11.23±0.2 mgGAE/gDW (Dao *et al.*, 2022). In addition, other nutrients calculated per 100 g include protein (0.2 g), fat (0.1 g), fiber (3.2 g), carbohydrate components (11.1 g), minerals (0.8 g), calcium (10 mg), and other ingredients such as Fe, Riboflavin, Thiamine, Niacin, Phosphorus, Carotene (Kella Coordinator *et al.*, 2017). Beyond its excellent nutritional content, the cashew apple's free

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radical scavenging ability contributes to preventing the risk of cancer, cardiovascular disease, and scurvy in humans. However, alongside the high nutrient value of cashew apple juice is the presence of tannins, which cause an acrid taste and hinder product processing and commercialization. Tannin in the fruit accounts for about 3.36 ± 0.09 mg/gDW (Dao *et al.*, 2022), about 0.2 - 0.4% (Dao *et al.*, 2021). Excessive intake of tannins in the human body can have potentially carcinogenic effects (Deshpande *et al.*, 1986). Therefore, removing tannins before product formation is a crucial step in the processing of cashew apples.

Previous studies have successfully applied methods using proteins, polysaccharides, and various conditions to affect tannin properties. In these studies, mainly targeting high tannin separation efficiency. A previous study revealed that the removal efficiency was 69.35% when using 0.375 g/L gelatin in the process of removing tannins. Other methods using 0.5 g/L chitosan, 0.375 g/L casein, 0.125 g/L albumin, and 0.375 g/L xanthan gum achieved yields ranging from 57 to 71% (Erkan-Koç *et al.*, 2015). In the report of Dedehou *et al.* (2015) used starch from cassava and rice showed efficiency ranges from 57 to 66%. Meanwhile, Emelike and Ebere (2016) study took advantage of the ability to hydrolyze tannins in hot water, achieving a very high efficiency of 96.2%. However, the use of 50 g/kg gelatin in their study yielded a relatively low efficiency of 30.43%. A common drawback of the previous methods is the amount of time required to remove the tannins. A previous study indicated that all methods required up to 16 h, and systematic processing conditions for tannins were necessary. Continuous cooling to lower the temperature to 2 - 4°C was also needed. Despite the high separation efficiency, the practical application on a large scale was not feasible due to the high operating costs of the continuous cooling system and the low product yield. The raw materials required more than half a day of pre-testing, and methods using cassava or rice starch required at least 3 to 5 h to complete tannin processing (Erkan-Koç *et al.*, 2015). A previous report used hot water blanching for 20 min, but while separation efficiency was very high, prolonged exposure to hot water likely resulted in a significant reduction in the nutritional content of the raw materials (Emelike and Ebere, 2016). A common issue in previous studies is the lack of assessment of the nutritional content and biological activities after tannin treatment. Based on previous reports on the effects of time, temperature conditions on polyphenols (Devic *et al.*, 2010), vitamin C (Igwe mmarr *et al.*, 2013), and antioxidant activity (Ilyia Arina and Harisun, 2019), it seems that these processing conditions significantly influence the nutritional content of the raw materials. To address the

shortcomings of previous methods and studies, we conducted this study to synthesize and investigate alternative conditions for tannin reduction methods and propose a highly efficient and economically feasible de-tanning process. Additionally, suitable methods can be applied on an industrial scale.

2. Materials and methods

2.1 Samples

Cashew apples (*Anacardium occidentale* L.) 50 days after flowering, with a height and diameter of 5 - 6 cm, from Binh Phuoc province (coordinates 11°45'N, longitude 106°55'E), were transported to the laboratory, classified, washed, dried, and then pressed to obtain juice by a pressing machine. At the same time, a quantity of whole cashew apples was also stored along with the cashew apple juice at a temperature of -10°C. Before conducting the experimental treatment, the juice was thawed and brought to room temperature (25 - 30°C). Defrosting was carried out prior to testing.

2.2 Chemicals and agents

The chemicals used, such as NaCl (Purity 58,44%), Folin-Denis reagent, Folin-Ciocalteu reagent, Methanol (Purity 99.5%), Na₂CO₃ (Purity 99.5%), H₂SO₄, 2,4-Dinitrophenylhydrazine (Purity 99%), 1,1-Diphenyl-2-picrylhydrazyl (Purity 97%), were purchased from Sigma.

2.3 Tannin removal processes

The undamaged cashew apples were cleaned using clean water that meets food processing standards. Then, the whole cashew apples and cashew apple juice were stored under conditions of -10°C for preservation. The testing process was conducted immediately after the juice and whole cashew apples were thawed at room temperature until the average temperature of the juice reached at least 27°C. The tannin removal process was carried out with the assistance of various treatment conditions. The thawed whole cashew apples were blanched in water containing NaCl (75 - 90°C), with additional concentrations ranging from 1 to 4%, and the thermal impact lasted between 2 and 8 min. Another tannin removal process involved steaming whole cashew apples at temperatures between 100 and 130°C for 2 to 8 min. After steaming and blanching, the cashew apples were rapidly cooled in a cold-water tank at 25°C. Their juice was used to determine the component content.

A tannin removal process without heat was conducted by filtering through a cloth with a pore size of 50 µm. Then, polyvinyl pyrrolidone (PVP) was added to the juice at concentrations ranging from 0.05 to 0.30%.

The mixture was stirred vigorously for 1 min and stabilized under dark conditions for 20 min. Afterwards, the mixture was filtered again using a new cloth with a 50 µm pore size. The filtrate was used to determine the component content.

A sequential combination of blanching and the non-thermal tannin removal process (PVP), under previously determined optimal conditions, resulted in juice with lower tannin content. This juice was used to determine the component content. Another combination involved blanching under optimal conditions and adding gelatin at a concentration of 2 g/L. The mixture was stirred vigorously for 1 min and stabilized under dark conditions for 20 min. Then, the mixture was filtered using a cloth with a pore size of 50 µm. The filtrate was used to determine the component content. A similar process combined steaming under the previously determined optimal conditions with the addition of gelatin at 2 g/L. The filtrate from this process was also used to determine the component content.

2.4 Determination of total tannin content

The total tannin content was determined using the Folin-Denis method. Approximately 30 g of the sample solution was centrifuged at 4000 rpm for 15 min. The supernatant was collected and diluted to the appropriate concentration. Then, 1 mL of the diluted sample was aspirated, and 0.5 mL of 1N Folin-Denis reagent was added, followed by 1 mL of saturated Na₂CO₃. The solution was then made up to 10 mL with distilled water. Shake well and measure the absorbance of the blue complex formed at 775 nm for up to 30 min. The blank was prepared in the same way, replacing the sample solution with distilled water (Salau *et al.*, 2015).

2.5 Determination of total polyphenol content

The determination of total polyphenol content (TPC) was performed as described by Tran *et al.* (2021). After centrifuging at 4000 rpm for 15 min, the supernatant from the cashew apple juice was collected. Each 1 mL aliquot of extract was aspirated into a test tube wrapped in aluminum foil. Then, 5 mL of 10% Folin – Ciocalteu reagent was added to the tube. After waiting for 5 min, 4 mL of 7.5% Na₂CO₃ was added to prevent atmospheric oxidation of the extracted phenols. The sample was left in the dark for 1 hour at room temperature. The absorbance was measured at 765 nm using a UV-VIS spectrophotometer.

2.6 Determination of total ascorbic acid

The determination of total ascorbic acid (TAA) was performed as described by Kapur *et al.* (2012). A 5 g sample (apple cashew juice) was mixed with 25 mL of a

meta-phosphoric acid acetic acid solution in a 50 mL volumetric flask. The mixture was gently shaken to homogenize the solution, then made up to 50 mL. The solution was centrifuged at 4000 rpm for 15 min, and the supernatant was collected to obtain the extract. A 4 mL aliquot of the centrifuged sample solution was aspirated, and 0.23 mL of 3% bromine solution and 0.13 mL of 10% thiourea were added to remove excess bromine. Finally, 1 mL of 2,4-Dinitrophenylhydrazine (DNPH) solution was added to form osazone. The solution was kept at 37°C for 3 h in a thermostatic bath, then cooled for 30 min. After cooling, 5 mL of 85% H₂SO₄ was added, the solution was stirred well, and the absorbance was measured at 521 nm. The blank was prepared in a similar manner, with distilled water replacing the sample solution.

2.7 Determination of DPPH antioxidant activity

The DPPH antioxidant activity was conducted according to the method description of Brand-Williams (Quy *et al.*, 2022). The sample extract was diluted to the appropriate concentration range, and 0.5 mL of the diluted extract was transferred into a test tube. Then, 1.5 mL of DPPH solution was added to the test tube, which was incubated in the dark for 30 min. The optical absorbance was measured at 517 nm using a UV-Vis spectrophotometer.

3. Results and discussion

3.1 Effect of conditions during blanching on the ability to remove tannin

Tannin compounds in food are often bound to proteins. The use of the hot water blanching primarily removes hydrolyzed tannins, such as gallotannin, but not condensed tannins, which remain unhydrolyzed. This is because condensed tannins are polymers linked by C-C bonds (Aguilar *et al.*, 2007). Increasing the ionic concentration in the blanching water helps separate condensed tannins such as procyanidins from proteins, facilitating the oxidation of procyanidins into anthocyanidins (Aguilar *et al.*, 2007). In this study, NaCl was added to the blanching water to increase the ionic concentration and enhance the removal of condensed tannins. As shown in Figure 1, up to 54.17% of the total tannin content in fruit juice was removed when 1% NaCl was added. When the NaCl concentration was increased to 2%, total tannin content removal efficiency rose to 63.43%. Hydrolyzed tannins are polyesters formed from polyols and gallic acid; the nature of the esters is easily hydrolyzed in acidic, primary media under the catalysis of heat (Belmares *et al.*, 2004). Therefore, the hydrolyzed tannins are converted to gallic acid and polyol, which dissolve in the blanching medium.

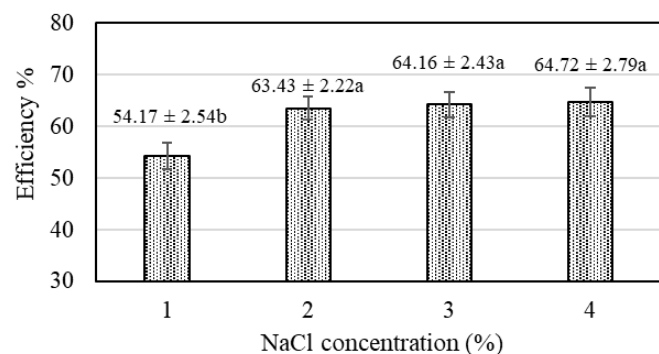


Figure 1. Effect of NaCl concentration on the ability to remove tannin. Values are presented as mean±SD. Values with different superscripts are statistically significantly different ($p < 0.05$).

Furthermore, the addition of NaCl enhances the separation of condensed tannins from protein. At higher NaCl concentrations, more condensed tannins are separated from protein, and this process is facilitated by oxidation in the environmental conditions and the washing away of tannins via osmosis. Some previous studies have shown the effect of NaCl in reducing the interaction of condensed tannins and proteins (De Freitas *et al.*, 2003). Additionally, hot water treatment has been shown to increase the hydrolysis efficiency of tannins (Dao *et al.*, 2021). However, when the NaCl concentration was increased from 2 to 4%, no statistically significant difference was observed ($p < 0.05$) (Figure 1). This can be explained by the fact that, under typical blanching conditions, the short blanching time and the whole fruit structure prevent sufficient Cl^- ions from penetrating deeply enough to react with and separate tannins from proteins in the core of the cashew apples. Therefore, increasing the concentration from 2 to 4% did not result in a significant change.

Time is a key determinant of tannin separation efficiency. Blanching for too short a time leads to unsatisfactory tannin separation, negatively affecting the sensory qualities of the product. Conversely, blanching for too long results in the degradation of key components in apple cashews, such as vitamin C, polyphenols, and biological activities, due to oxidation and decomposition (Kwak *et al.*, 2017). Therefore, a minimum blanching time of 2 min was selected, and the time was increased up to 8 min. After 2 min of blanching, the TTC removal efficiency reached 42.34%. This efficiency increased with longer blanching times, reaching 55.04% at 5 min and 60.32% at 6 min. No significant statistical difference was observed between 6 min and 8 min of blanching ($p < 0.05$) (Figure 2). The tannins that can be removed in 6 min seem to have reached the maximum level. Further penetration into the core of the material would require either higher pressure or a significantly longer time. Increasing blanching time beyond this point led to minimal changes in TTC, which is consistent with the

report of Sigit Amanto *et al.* (2019), where 19% of tea tannins were degraded after 10 min of heating.

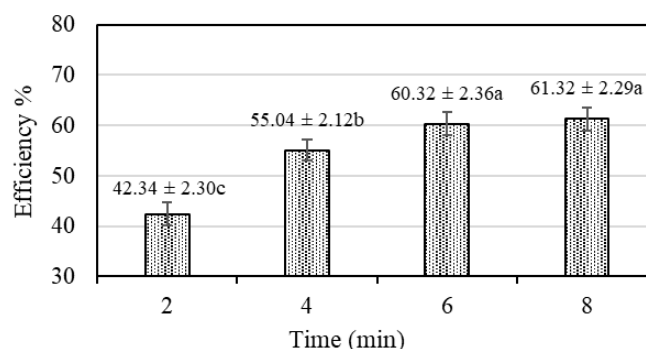


Figure 2. Effect of blanching time on the ability to remove tannin. Values are presented as mean±SD. Values with different superscripts are statistically significantly different ($p < 0.05$).

Temperature is one factor that significantly affects the product's nutrition, and it also acts as a catalyst for the faster hydrolysis of tannins. In addition to removing tannins, the blanching process was targeted to inactivate the PPO enzymes that cause organoleptic and nutritional losses in food (Latorre *et al.*, 2012). Previous reports have shown that at temperatures above 70°C, polyphenol oxidase (PPO) enzymes are inactivated (Queiroz *et al.*, 2008). Therefore, temperatures greater than 70°C were chosen to carry out the tannin removal process. At 75°C, the ability to separate tannins reached 41.5%, which tended to increase as the temperature continued to rise to 90°C (61.97%) (Figure 3). The higher the temperature, the higher the rate of the hydrolysis reaction, resulting in increased gallic acid content, which creates an H^+ environment. In this environment, condensed tannins are separated from proteins and oxidized due to the influence of heat (Hagerman *et al.*, 1992). At higher temperatures, cells expand, structures are destroyed, and tannin compounds are washed out into the environment.

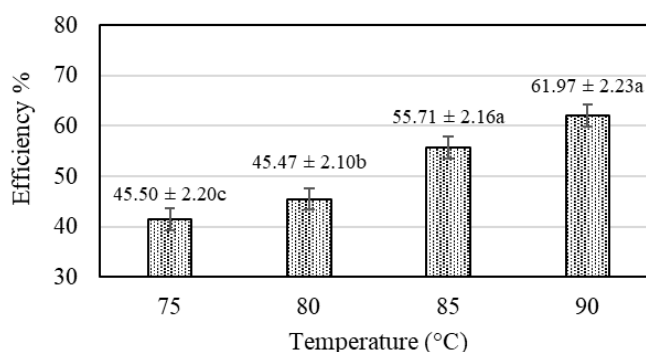


Figure 3. Effect of blanching temperature on the ability to remove tannin. Values are presented as mean±SD. Values with different superscripts are statistically significantly different ($p < 0.05$).

3.2 Effect of temperature and steaming time on the ability to remove tannin

Steaming is one of the methods capable of separating

tannins. Some previous reports have shown that the nutritional content and organoleptic value are well preserved using this method (Das and Arora, 2017). Temperature and time are two essential factors in removing tannins through steaming. The steaming process has a lower heat transfer rate to the center of the material compared to blanching. Therefore, choosing a steaming temperature higher than the blanching temperature is appropriate. At 100°C, 69.13% TTC was removed; the efficiency continued to increase as the temperature was raised to 120°C (75.25%), with no statistical difference observed when the temperature was increased to 130°C (Figure 4). During the steaming process, steam penetrates the inside of the material, performing hydrolysis reactions (Das and Arora, 2017). At high temperatures, the heat and steam transfer to the center of the material more quickly. Therefore, the hydrolysis capacity increases at higher temperatures.

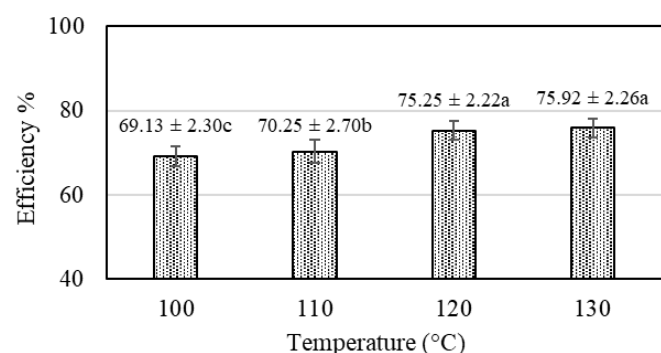


Figure 4. Effect of steaming temperature on the ability to remove tannin. Values are presented as mean±SD. Values with different superscripts are statistically significantly different ($p < 0.05$).

Time is one of the essential factors that determines the nutritional and sensory aspects of the product. Processing for too long can cause the ingredients to soften and lose their distinctive flavor. Additionally, some nutrients may be oxidized or decomposed, leading to suboptimal product quality. The steaming time ranged from 2 to 8 min at high temperatures (Figure 5). The processed product still retains the sensory value at a reasonable level. At 2 min of steaming, 55.84% of the TTC was removed. The TTC removal efficiency increased sharply when the time was extended to 4 min (65.22%), 6 min (74.81%), with no statistically significant difference observed when further increasing the steaming time. Longer steaming times facilitate deeper penetration of water vapor into the material, increasing the contact area and enhancing the hydrolysis of tannins. By 6 - 8 min, the hydrolyzed tannins have likely been completely hydrolyzed, resulting in only a negligible increase in yield. These results are consistent with previous findings that steaming time of 5 to 15 min at 40-50°C significantly reduces TTC (Preethi *et al.*, 2019).

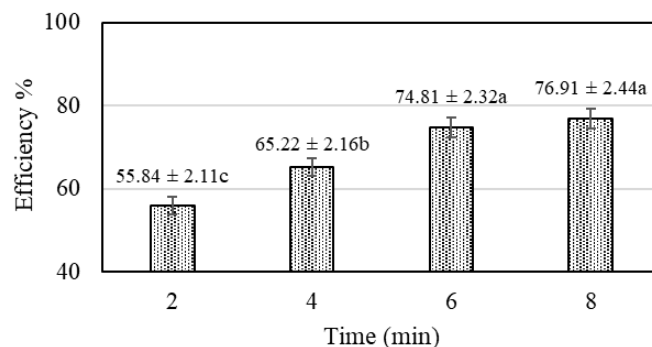


Figure 5. Effect of blanching time on the ability to remove tannin. Values are presented as mean±SD. Values with different superscripts are statistically significantly different ($p < 0.05$).

3.3 Effect of adsorbent polyvinyl pyrrolidone on tannin removal efficiency

PVP is an adsorbent capable of complexing with tannins. The right amount of PVP provides optimal tannin separation efficiency. At the concentration of 0.05% PVP (w/v) removal efficiency reached 53.1%. The TTC removal efficiency continued to increase when the PVP concentration was raised to 0.1% (w/v). However, no statistical difference was observed when adding more PVP ($P < 0.05$). This is because PVP can absorb low molecular weight tannins and phenolic compounds (Bagci, 2014). In this method, PVP was used to remove tannins through a chelation mechanism (Talasila *et al.*, 2012). At a higher concentration of PVP than TTC present in the juice (Figure 6), TTC is precipitated with more PVP, leading to higher separation efficiency and vice versa. Some previous studies have also noted that the addition of 3 - 10 g PVP/L helps to maximize the separation efficiency (Preethi *et al.*, 2019). However, the separation efficiency also depends on the material properties such as hardness, size, maturity, growing area, and initial TTC.

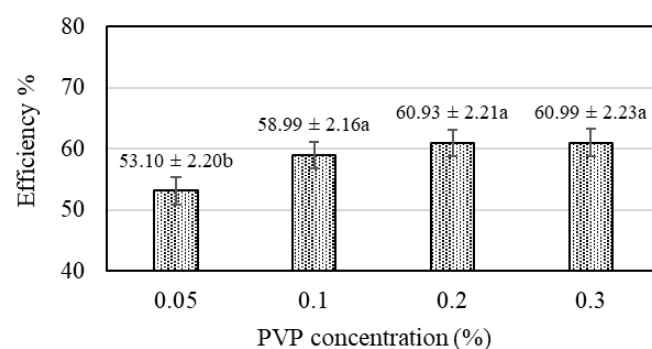


Figure 6. Effect of PVP concentration on the ability to remove tannin. Values are presented as mean±SD. Values with different superscripts are statistically significantly different ($p < 0.05$).

3.4 Effect of the combination method on the ability to remove tannin

The single tannin treatment methods mostly provide a separation efficiency of over 58%. Depending on the purpose of processing cashew apples, methods with varying efficiencies are applied. To diversify methods and improve separation efficiency, this study tested combined methods to evaluate their ability to remove tannins. The combination of methods achieved a relatively high efficiency (> 75%). The combined method of steaming and adding gelatin had the highest efficiency (92.02%), while other methods ranged in efficiency from 75.07 to 77.05%. Figure 7 shows that combined methods with the addition of gelatin increase the efficiency of tannin removal. Gelatin, being a protein, can react with tannins in fruit juice and form a gelatin-tannin complex, which precipitates as flakes (Talasila *et al.*, 2012). Therefore, adding the appropriate amount of gelatin provides the best separation efficiency. A previous study showed the formation of gelatin-tannin complexes during the blanching of cassava roots, with efficiency increasing as temperature and ion concentration were raised (Salau *et al.*, 2015).

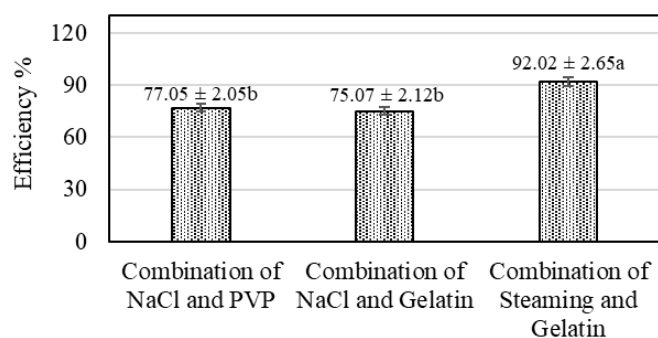


Figure 7. Effect of the combination methods on the ability to remove tannin. Values are presented as mean±SD. Values with different superscripts are statistically significantly different ($p < 0.05$).

3.5 Effect of tannin reduction method on nutritional content and biological activity

Vitamin C (L-ascorbic acid) is lactone-2,3-dienol-L-gluconic acid. It is one of the essential nutrients for the human body and is the primary nutrient in cashew apples. However, vitamin C is very easily degraded by external factors such as temperature, light, and other conditions during processing. In the methods used to remove tannins from cashew apples, TAA decreased compared to the original sample (370.58 mg/100 g) after processing (Figure 8). Using the method of adding PVP sorbent, the remaining TAA is 347.89 mg/100 g. The process of using temperature and brine to hydrolyze tannins retained 314.63 mg/100 g. The condition of the steaming process also affected TAA, with a reduction of

about 18% compared to the original, leaving 304.07 mg/100 g. The results are similar to those reported on vitamin C content being strongly influenced by steaming and blanching at 100°C (Das and Arora, 2017). Although the combined method (steaming + gelatin) provided the optimal effect in terms of TTC removal, TAA was significantly degraded, dropping by 25% compared to the original. This is due to the prolonged processing at high temperatures, which increases the likelihood of TAA being oxidized to dehydroascorbic acid (Furuya *et al.*, 2008). Another study showed that while the effectiveness of the combination method was higher or not significantly increased compared than the single methods, the nutritional content was greatly affected (Prommajak *et al.*, 2018).

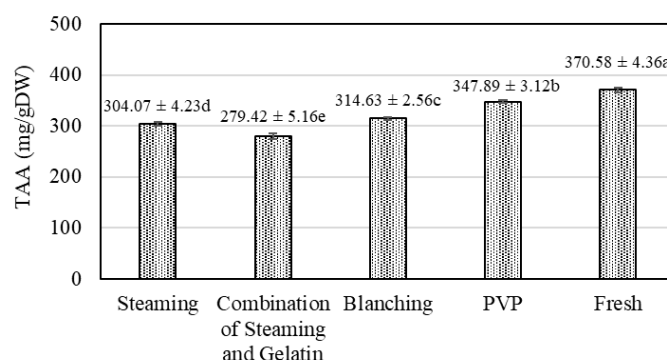


Figure 8. Effect of tannin removal methods on TAA. Values are presented as mean±SD. Values with different superscripts are statistically significantly different ($p < 0.05$).

The antioxidant activity of cashew apple juice was tested using the stable free radical DPPH. Tannin treatment methods affect the antioxidant activity of the juice (Figure 9). The antioxidant activity of the juice before tannin treatment reached 33.56%, and after the treatment by the PVP absorbent method reached 25.81%. At high-temperature treatments (blanching at 90°C, steaming at 120°C), antioxidant activity was significantly reduced. The combined method (Steaming + Gelatin) was most affected, remaining 14.51%. The antioxidants in apple cashews include vitamin C, gallic acid, gallotannins, and anthocyanins (Mphahlele *et al.*,

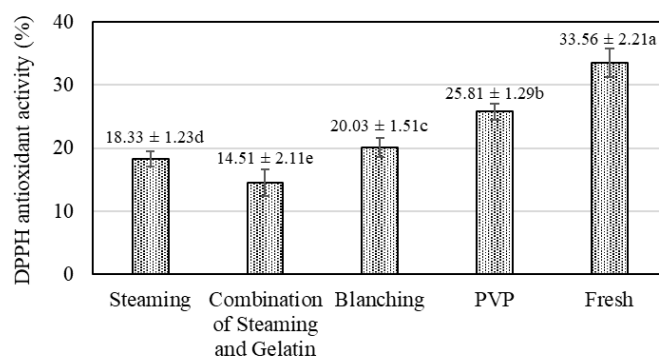


Figure 9. Effect of tannin removal methods on DPPH antioxidant activity. Values are presented as mean±SD. Values with different superscripts are statistically significantly different ($p < 0.05$).

2017). High-temperature treatment and other conditions during tannin processing significantly affect the content of these substances, leading to a reduction in antioxidant activity. Therefore, the DPPH antioxidant activity is correlated with the depletion of vitamin C and polyphenols (Mphahlele *et al.*, 2017).

Polyphenols are organic compounds with high antioxidant and anti-inflammatory properties. Therefore, they can prevent cancer, heart disease, diabetes, and obesity. These are essential compounds in human health protection (Cory *et al.*, 2018). However, the total polyphenol content is strongly influenced by external factors such as temperature, light and processing conditions (Yang *et al.*, 2018). In this study, the combined method (steaming + gelatin) had the greatest impact on TPC, with the remaining content at 542.96 mg GAE/100 mL (Figure 10). This reduction was due to the high-temperature treatment and prolonged processing time, which caused polyphenols to oxidize. Steaming and blanching methods were less affected, with no significant difference from the combined method, though both still showed a significant reduction in TPC compared to the untreated sample. Several previous reports indicated that temperature and time are the main factors affecting TPC (Ghitescu *et al.*, 2015). Another report also showed that some antioxidant groups are destroyed by high-temperature treatment (Liyana-Pathirana and Shahidi, 2005).

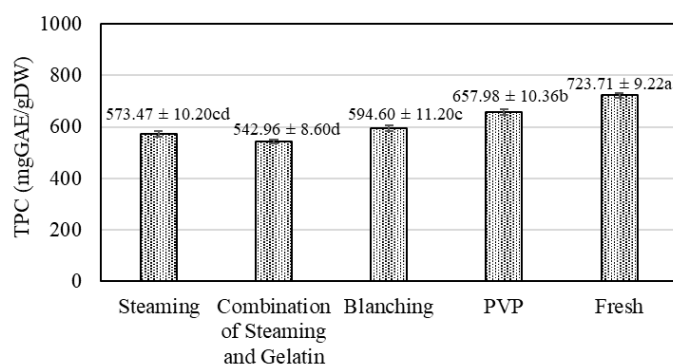


Figure 10. Effect of tannin removal methods on TPC. Values are presented as mean±SD. Values with different superscripts are statistically significantly different ($p < 0.05$).

4. Conclusion

After removing tannins, the combined method (Steaming + Gelatin) had the most influence on all three monitoring parameters. Approximately 19.74% of TAA and 25% of TPC were lost after treatment, and DPPH antioxidant activity was reduced by more than 50%. The method using 0.1% PVP showed the highest values for all three indicators: TPC (657.98 mgGAE/100 mL), TAA (347.89 mg/100 gDW), and DPPH antioxidant activity (25.81%). Next was the blanching method with

TPC (594.60 mgGAE/100 mL), TAA (314.63 mg/100gDW), and DPPH antioxidant activity (20.03%). The high-temperature steaming process had a significant impact on the parameters: TPC (573.47 mgGAE/100 mL), TAA (304.07 mg/100 g), and DPPH antioxidant activity (18.33%). The parameters in this study provide a foundation for developing processing methods for products that require tannin removal from cashew apples and other materials. Additionally, the study results indirectly promote the economic development of cashew-growing areas by creating new products and increasing the diversity of products made from cashew apple by-products for the consumer market.

Conflict of interest

The authors declare no conflict of interest.

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