GreenariA
Go Green, Learn Green
An Agricultural Monthly e-Magazine
Volume 03, Issue 06, 2025
ISSN: 2584-153X
Article ID: G-25-0604

FROM ORCHARD WASTE TO REFRESHING SIP: TACKLING TANNINS IN CASHEW APPLE JUICE

Kamalraj R[1]*, Umamaheswara Rao K[2], Prasanna Kumar B[3] and Aruna Kumari K[4]
[1]M.Sc (Horticulture), Dr.Y.S.R Horticultural University, COH- Venkataramannagudem
[2]Senior Scientist, Dr.Y.S.R Horticultural University, CRS- Bapatla
[3]Controller of Examinations, Dr.Y.S.R Horticultural University, Venkataramannagudem
[4]Assistant Professor, Dr.Y.S.R Horticultural University, COH- Venkataramannagudem
*Corresponding Author Mail ID: kamalhortz@gmail.com

Introduction

Every year, tens of millions of tonnes of cashew apples go unharvested or rot in orchards, despite representing up to 90% of the fruit's biomass. These nutrient-packed pseudo-fruits, rich in vitamin C, antioxidants, and dietary fiber, could enhance food security and create revenue streams. Yet, their bitter, astringent bite is due to tannins, naturally occurring compounds that dry the mouth and make even fresh-pressed juice nearly undrinkable. As a result, the vast majority of cashew apples are left to decompose on the ground, leading to significant post-harvest loss and missed opportunities for farmers and processors alike. Finding effective yet simple methods to remove tannins is therefore crucial, not just to improve taste and clarity, but to transform this "waste" into a marketable, nutritious product that benefits both producers and consumers. This article explores various natural methods for tannin reduction, focusing on their efficacy, nutritional impact, and practical applications.

Natural Agents for Tannin Reduction

1. **Cassava Starch**

Cassava starch, derived from the root of the cassava plant (*Manihot esculenta*), is a natural polysaccharide known for its high purity and neutral taste. In the context of cashew apple juice, cassava starch acts as a clarifying agent by binding with tannins, facilitating their removal through flocculation. This process not only reduces astringency but also improves the juice's visual clarity.

Process Flowchart

Prepare 5% w/v starch solution (cassava) or
Prepare 5% w/v starch solution (rice)
↓
Add cassava: 6.2 mL/L or rice: 10 mL/L to juice
↓
Incubate at 30 °C:
i) Cassava: 300 min
ii) Rice: 193 min
↓
Allow flocculation and sedimentation
↓
Filter clarified juice
↓
Outcome:
i) Cassava: ~34% tannin reduction, 93.8% clarity
ii) Rice: ~42% tannin reduction, 94.8% clarity

Studies have demonstrated the efficacy of cassava starch in tannin reduction. Dèdéhou *et al.* (2015) found that adding 6.2 mL of a 5% w/v cassava starch solution per liter of juice for 300 minutes decreased tannin content by 34.2% and achieved a visual clarity of 93.75%. Talasila *et al*. (2012) reported that sago starch, a commercial preparation of cassava starch, at 2 g/kg juice, was more effective in mitigating tannins than polyvinylpyrrolidone (PVP) at 1.4 g/kg and gelatin at 4 g/kg juice.

2. Bajra (Pearl Millet) Flour

Bajra flour, rich in starch and iron, has been tested for its tannin-reducing properties. At a 2% concentration, it reduced tannin levels by

24.0%, with a juice recovery rate of 80.5% . This method offers an additional option for tannin reduction, especially in regions where bajra is readily available.

Process Flowchart

Choose powder:

i) Soybean meal 2%

ii) Potato powder 2%

iii) Bajra flour 2%

↓

Add powder to juice

Refrigerate mix (if soybean): 4 °C, 4 hrs

Room temperature mix: 2 hrs+

↓

Stir gently to mix

↓

Allow sedimentation (~4 hrs)

↓

Filter juice

↓

Outcome:

i) Soybean: 34.3% tannin reduction, 89.5% yield

ii) Potato: 28.6% tannin reduction, 84.5% yield

iii) Bajra: 24.0% tannin reduction, 80.5% yield

3. Defatted Soybean Meal

Defatted soybean meal has emerged as an effective and cost-efficient agent for tannin reduction. At a concentration of 2% and incubated at 4°C for 4 hours, it reduced tannin levels by approximately 34.3%, with a juice recovery rate of 89.5%. This method not only decreases astringency but also preserves the juice's nutritional content.

4. Dried Potato Powder

Dried potato powder serves as another natural clarifying agent. When added at a concentration of 2%, it achieved a 28.6% reduction in tannin content, with a juice recovery rate of 84.5%. This approach is particularly beneficial for small-scale producers due to its accessibility and affordability.

Plant-Based Coagulants

1. Moringa Seed Powder

Moringa oleifera seed powder has demonstrated promising results in tannin reduction. At a concentration of 10 g/L, it reduced tannin content by 80%, along with significant reductions in lignin, pectin, and starch levels. The mechanism involves the positively charged proteins in moringa seeds binding to negatively charged tannins, facilitating their removal through flocculation.

2. **Taro Powder**

Taro (*Colocasia esculenta*) powder emerged as a highly effective natural clarifier for cashew apple juice. When just 0.5 g of finely milled taro powder was added to 100 mL of juice and left to settle at room temperature for 1.5 hours, tannin levels dropped by an impressive 76.1 %, while visual clarity improved by 58.1 %. The starch- and protein-rich composition of taro likely facilitates rapid binding and coagulation of tannin molecules, leading to quick flocculation and sedimentation.

3. Dried Okra Pod Powder

Dried okra pod powder has been identified as an effective bio-coagulant. Under optimal conditions (0.3% concentration and 0.5-hour settling time), it achieved a 48.9% reduction in tannin content, with minimal loss of ascorbic acid, total sugars, and antioxidant activity. This method also resulted in high sensory scores, indicating its potential for consumer acceptance.

Process Flowchart

Choose coagulant:

i) Moringa seed: 10 g/L

ii) Okra pod powder: 0.3%

↓

Add to juice and stir

Settle time:

i) Moringa: 1–2 hr

ii) Okra: 30 min

↓

Allow flocculation → sedimentation

↓

Filter juice

↓

Outcome:

i) Moringa: 80% tannin reduction, >90% vitamin C retention

ii) Okra pod: 48.9% tannin reduction, high sensory rating

4. Water chestnut Powder

Water chestnut (*Eleocharis dulcis*) powder was also evaluated under identical conditions—0.3 g per 100 mL juice, 1.5 hours at room temperature. This treatment resulted in a 65.4 % reduction in tannin content and a 59.4 % enhancement in juice clarity.

Process Flowchart

Prepare:

i) Taro powder: 0.5 g per 100 mL juice

ii) Water chestnut: 0.3 g per 100 mL juice

↓

Mix thoroughly

Allow settle: 1.5 hr (ambient temperature)

↓

Decant or filter juice

↓

Outcome:

i) Taro: 76.1% tannin ↓, 58.1% clarity ↑

ii) Water chestnut: 65.4% ↓, 59.4% clarity ↑

Enzymatic Treatments

Enzymatic methods offer targeted approaches for tannin degradation. The application of tannase enzyme at a concentration of 0.5% resulted in a significant reduction in tannin content, enhancing juice clarity and shelf life. However, enzymatic treatments may lead to a decrease in certain nutrients, such as vitamin C, sugars, and polyphenols, necessitating a balance between tannin reduction and nutrient preservation.

Chemical Treatments

1. Polyvinylpyrrolidone

Polyvinylpyrrolidone (PVP), and its insoluble form PVPP, are synthetic clarifiers commonly used to reduce tannin content in cashew apple juice. At concentrations of 2–4 g/L, PVP has been shown to decrease tannins by approximately 32–35%, comparable to gelatin but slightly less effective than starch alternatives like sago. The mechanism involves hydrogen bonding and chelation between PVP's groups and tannin phenolic hydroxyls, resulting in stable complexes that precipitate and can be removed via filtration or decanting. Despite its effectiveness, PVP is more expensive than natural starches, and concerns over residual synthetic polymer and cost often drive processor preference toward plant-based or natural clarifiers.

2. Gelatin

Gelatin, a protein-based clarifying agent, has been studied for its ability to reduce tannin content. At a concentration of 0.2 g/L and incubated for 2 hours at room temperature, it reduced tannin levels significantly. However, the use of gelatin may raise concerns regarding its animal origin, prompting interest in alternative plant-based agents.

Process Flowchart

Prepare:

i) Gelatin: 0.67% w/v (standard)

ii) Gelatin: 5% w/v (intense)

iii) PVP: 4 g/L

↓

Add to juice and mix (0.67% → 15 min, 5% → 30 min)

↓

Allow flocculation/sedimentation

↓

Filter juice

↓

Outcome:

i) 0.67% gelatin: significant tannin reduction

ii) 5% gelatin: ~99% condensed tannin removal

iii) PVP: ~32% removal; higher cost, synthetic

Physical Methods

1. Steaming and blanching

Steaming and blanching are simple and effective pre-treatment methods often applied to whole cashew apples to reduce tannin levels and astringency before juicing. For instance, steaming apples at moderate pressure (0.4 N/m²) for 5–15 minutes, or blanching in warm saltwater (40–50 °C for 15 minutes), can significantly degrade surface-bound tannins in the skin and flesh, making the fruit noticeably less astringent. Studies comparing thermal methods—like hot-water immersion for 20 minutes—have shown up to 96% reduction in tannin content, alongside improved clarity and sensory appeal. However, it's worth noting that these heat treatments can also lead to some loss of heat-sensitive nutrients, such as vitamin C and phenolic antioxidants, which may leach out or degrade as a result of the process.

2. Microfiltration

Microfiltration is a gentle, non-thermal process ideal for clarifying cashew apple juice while preserving its fresh flavor and high nutrient content. In a common setup, juice is first lightly clarified usually by centrifugation then passed through a 0.2–0.3 µm membrane under mild pressure or using cross-flow (tangential) filtration. This method can remove 88–100% of tannins, almost entirely eliminate turbidity, and retain 87–94% of the vital vitamin C and soluble solids. The clarified juice also maintains a pleasant aroma and color, comparable to fresh juice despite slight changes to volatile compounds. The main challenge is controlling membrane fouling manageable through simple pretreatments like centrifugation, mild enzymes, or periodic cleaning

Method	Dosage & Conditions	Tannin ↓ (%)	Clarity ↑ (%)	Juice Yield	Nutritional Impact	Reference
Cassava Starch	5% w/v (6.2 mL/L), 30 °C for 300 min	34.2%	≈93.8%	—	High, clean-label	Dèdéhou et al. (2015)
Rice Starch	5% w/v (10 mL/L), 30 °C for 193 min	42.1%	≈94.8%	—	High, clean-label	Dèdéhou et al. (2015)
Sago Starch	2 g/L	~42–43%	~94%	—	High, clean-label	Talasila et al. (2012)
Defatted Soybean Meal	2%, 4 °C, 4 hrs	34.3%	—	89.5%	High, plant-based	Dagadkhair et al. (2018)
Dried Potato Powder	2%, ambient, ~4 hrs	28.6%	—	84.5%	Moderate	Dagadkhair et al. (2018)
Bajra Flour	2%, ambient, ~4 hrs	24.0%	—	80.5%	Moderate; adds iron	Dagadkhair et al. (2018)
Gelatin	0.67% w/v, 15 min or 5% w/v, 30 min	50–99%	High	—	High; animal-derived	Prommajak et al. (2018); Nguyen et al. (2023)
PVP	2–4 g/L	~32–42%	High	—	Moderate; synthetic	Hanh et al. (2024)
Moringa Seed Powder	10 g/L, 1 hr	80%	—	—	High; nutrient-preserving	Ugwuoke et al. (2020)
Dried Okra Pod Powder	0.3%, 30 min	48.9%	—	—	High; nutrient-preserving	Dagadkhair et al. (2018)
Tannase Enzyme	0.079–0.085%, 39–46 °C for 85–89 min	64–69%	High	—	Moderate; some nutrient loss	Abdullah et al. (2020)

Taro Powder	0.5 g/100 mL, ambient, 1.5 hr	76.1%	+58.1%	—	High; fast & low-dose	Singh et al. (2025)
Water Chestnut Powder	0.3 g/100 mL, ambient, 1.5 hr	65.4%	+59.4%	—	High; efficient & quick	Singh et al. (2025)
Microfiltration (centrifuge + MF)	Centrifuge 7,532 rpm/52.6 min; MF at 0.2 µm, 138 kPa	88%	97% turbidity ↓	87%	High; preserves ~87% vitamin C	Abdullah et al. (2022)
Tangential Microfiltration	0.3 µm tubular MF	~100%	—	—	High; retains ~94% vitamin C	Soro et al. (2012)
Hot-Water Treatment (thermal)	20 min immersion in hot water	96.2%	—	—	Moderate; vitamin C loss	Emelike & Ebere (2016)
Chitosan (co-flocculant)	co-applied with gelatin or bentonite	—	—	—	High; non-toxic additive	Common in beverage clarification

Conclusion

Reducing tannin content in cashew apple juice is essential for enhancing its taste and nutritional value. Natural agents like defatted soybean meal, dried potato powder, bajra flour, and plant-based coagulants such as moringa seed powder and dried okra pod powder offer effective, sustainable, and cost-efficient methods for tannin reduction. Enzymatic treatments provide precision in tannin degradation but require careful consideration of nutrient preservation. By selecting appropriate methods tailored to specific needs and resources, producers can improve the quality and marketability of cashew apple juice, catering to consumer preferences for both taste and nutrition.

References

1. Abdullah, A.M. *et al*., 2020. Optimization of tannase enzyme conditions for enzymatic tannin degradation in cashew apple juice. *Food Biotechnology*.
2. Dagadkhair, R., Sasmal, S. & Arora, A., 2018. Comparative evaluation of defatted soybean meal, potato powder and bajra flour as tannin-removal agents in cashew apple juice. ICAR-Directorate of Cashew Research, Puttur.
3. Dèdéhou, E.S.C.A. *et al*., 2015. Optimization of cashew apple juice clarification process by using cassava and rice starch. *Journal of Applied Biosciences*, 95, pp.8989–9002.
4. Emelike, U.C. & Ebere, L.E., 2016. Hot-water immersion for tannin reduction in cashew apple juice. *Post-harvest Processing Review*.
5. Hanh, N.T. *et al*., 2024. De-tanning in cashew apple juice by chemical agents: gelatin, modified cassava starch and PVPP. *Current Research in Nutrition and Food Science*, 12(3).
6. Prommajak, T., Phongthai, S. & Chonhenchob, V., 2018. Optimization of gelatin concentration for tannin removal in cashew apple juice. Chiang Mai University proceedings.
7. Singh, S. *et al*., 2025. Tannin mitigation in cashew apple juice using taro and water chestnut powders as clarifying agents. *Current Research in Nutrition and Food Science*, 13(Special Issue, Phytonutrients, June 2025).
8. Soro, M. *et al*., 2012. Clarification of cashew apple juice by tangential microfiltration: retention of vitamin C. *Membrane Processing in Food Tech*.