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Optimizing Starfruit Quality: Techniques for Reduction of Oxalate and Caramboxin Content

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ABSTRACT
Star fruit, also known as carambola (Averrhoa carambola), is derived from the Averrhoa carambola plant of Southeast Asia and the fruit gets its name from its broad star-shaped shape. Starfruit has great nutritional benefits as it is rich in vitamin C and other minerals such as calcium and potassium. On the other hand, caramboxins, neurotoxins, and oxalic acids have caused great concern because they can have adverse effects on the urinary tract and this study set out to find effective ways to isolate these compounds with stars fruit in the snow. Studies using specific processing techniques, including enzymatic treatment and blanching, show promise in improving star fruits quality, facilitating safe consumption of this tropical fruit. Studies further development in this area could contribute to advances in anti-nutrient prevention.
Kkeywords*: Starfruit, Nutritional benefits, Quality, Antinutrional factors, Oxalate, Caramboxin*

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INTRODUCTION

Averrhoa carambola, often known as star fruit, is a tropical fruit that is rare and valued for both its flavor and nutritional qualities. Countries, including Australia, Guyana, India, Israel, Malaysia, the Philippines, Taiwan, and the USA, cultivate and consume it extensively. This fruit is famous for its adaptability because it can be eaten raw, added to meals, or processed into a variety of goods, including drinks and jams. Star fruits naturally include anti-inflammatory microorganisms, vitamins (including C and β-carotene), magnesium, iron, zinc, and phosphorous [1]. The flavour of star fruit can be defined as a nuanced combination of citrus, apple, pear, and grapefruit notes. As the fruit ripens, it becomes more sweet and less acidic, striking a pleasing balance for a variety of palates. Star-fruits have a high fiber and less calorie content, which may help control blood sugar levels. Star fruits are delicious and nutritious, but they also contain oxalic acid and caramboxin, which might be problematic for those who have renal failure. Kidney stones can be formed in part by oxalate, and caramboxin has been linked to neurological problems in elderly people [2].

Figure 1: ***Averrhoa carambola*** **[3]**

Table 1: Food value per 100 g of edible portion [2]

Food Value Per 100 g of Edible Portion*	
Content	**Values**
Calories	35.7
Moisture	89.0-91.0 g
Protein	0.38 g
Fat	0.08 g
Carbohydrate	9.38 g
Fibre	0.80 - 0.90 g
Ash	0.26 - 0.40 g
Calcium	4.4-6.0 mg
Phosphorous	15.5-21.0 mg
Iron	0.32-1.65 mg
Carotene	0.003-0.552 mg
Thiamine	0.03-0.038 mg
Riboflavin	0.019-0.03 mg
Niacin	0.294-0.38 mg
Ascorbic acid	26.0-53.1 mg

Consequently, there is considerable interest in minimizing these potential dangerous compounds from star fruit to improve its quality and increase its quality and availability. This research aims to investigate techniques and approaches for enhancing the quality of star fruit, emphasizing on suggesting techniques to reduce the amount of caramboxin and oxalate. By examining the approaches related to cultivation, post-harvest handling, and processing, this study aims to advance the creation of safer and more health-conscious applications. The goal is to promote the wider consumption and enjoyment of this unique tropical fruit while addressing health considerations related to its consumption.

OXALATES

Oxalate is a natural compound in many foods of plant origin, including starfruit (*Averrhoa carambola*) [4] primarily as calcium oxalate crystals, which are insoluble, when the body cannotaccumulate in tissues. Although oxalate itself is not harmful in normal doses, excessive consumption or exposure to oxalate-related conditions can cause health issues. One of the most important concerns associated with high oxalate intake is the formation of kidney stones. Calcium oxalate is a common ingredient in kidney stones, and its uptake into the kidneys can cause these painful, potentially debilitating stones. Individuals with a history of or at risk for developing kidney stones are usually expelled and advised to monitor oxalate intake and make dietary changes to reduce stone formation [5]. Furthermore, oxalate binds to substances in the intestinal lining which prevents their absorption. This can lead to deficiencies if oxalate-containing foods are consumed in excess over a long time. For example, oxalate binding to calcium minimizes the availability of calcium for absorption, which may affect bone health and may lead to conditions such as osteoporosis [6]. In addition to kidney stone formation and malabsorption of nutrients, oxalates can cause urinary tract irritation and inflammation. High levels of oxalate in the urine can cause crystallization and chronic inflammatory conditions in the bladder can contribute to conditions such as interstitial sac inflammation [7]. Certain medical conditions, such as hyperoxaluria (excessive urinary excretion of oxalate), require close monitoring of dietary oxalate intake to prevent complications Starfruit, although a nutrient, has oxalate in potentially high levels problem for sensitive individuals, and emphasizes the importance of dietary knowledge and accuracy [4]. Apart from being associated with the development of kidney stones, oxalate can hinder the gastrointestinal tract's ability to absorb nutrients like calcium and magnesium and may lower their bioavailability because of its binding to these minerals. Keeping oxalate levels in mind, people should think about balancing starfruit with other foods high in these minerals, as starfruit is also a source of vital nutrients like potassium and vitamin C. Urine with high oxalate levels can aggravate illnesses like interstitial cystitis by causing crystal formation [8]. The symptoms of interstitial cystitis include persistently inflamed bladder irritation, therefore spinal cord injury, frequency, and incidence of urine may happen. Dietary management is crucial for hyperoxaluria and other oxalate-related diseases to lower the risk of harmful health effects from oxalate intake [9].

CARAMBOXIN

Caramboxin, a neurotoxin found in starfruit (*Averrhoa carambola*) causes a serious risk to individuals, especially those suffering with renal failure or underlying conditions of neurology. Poisoning of Caramboxin is due to its effects on various neurotransmitter systems in the brain, through gamma-aminobutyric inhibition of acid (GABA) receptors [10]. Such nervous system damage can cause such neurological symptoms like confusion, agitation to seizures and heart failure in severe cases. Caramboxin toxic effects are specifically seen in individuals with chronic kidney disease due to renal dysfunction. In

CKD patients, there's failure of kidneys to effectively filter and excrete caramboxins and other toxins from the blood, increasing their accumulation and risk of toxicity [11]. Inhibition of GABA receptors by caramboxin results in excitotoxicity and neuronal damage, which contributes to the observed neurological symptoms [10]. This mechanism highlights the seriousness of caramboxin toxicity and emphasizes the need for precautions in individuals susceptible to its effects, including those with kidney disease or neuropathy.

TECHNIQUES FOR REDUCING OXALATES IN STARFRUIT

There are many ways to reduce oxalate levels in starfruit, or *Averrhoa carambola*. The fruit can be blanched well at high temperatures. Studies show that blanching starfruit at 90 degrees Celsius for five minutes can significantly reduce its oxalate content by up to 40 percent [12]. For the sake of variation-the explanation for this reduction in analysis was that the blanching process is believed to disrupt oxalate structure, making it more susceptible to solubility or subsequent filtering or degradation in other processing steps. [12]. Blanching has other benefits such as inactivating enzymes, retaining color and texture, and improving overall safety and quality in addition to reducing oxalate levels However, optimal blanching conditions can vary depending on fruit size, conditioned emotional habits, and growth. More research is needed to reduce oxalates in starfruit and better understand the effects of blanching. Blanching is thought to destroy or eliminate oxalate crystals, thereby reducing the total oxalate concentration [13]. Adding calcium to star fruits is another way to reduce the oxalate content. Bleaching starfruit and then soaking it in calcium solution was shown to significantly reduce oxalate levels. Fruit oxalate bioavailability decreases when calcium ions are added during soaking and form insoluble calcium oxalate complexes [14]. Calcium ions (Ca^{2+}) in fruits bind with oxalate ions ($C_2O_4^{2-}$) to form calcium oxalate (CaC_2O_4), which is poorly soluble and easily absorbed in food. This process effectively reduces oxalate-related health concerns associated with starfruit consumption. This approach of safety and nutrition of star fruits by reducing the health risks associated with oxalate has shown encouraging data. Enzymatic treatment is an effective solution for the reduction of oxalate in astrocytes. When starfruit extracts are added to enzymatically cleave oxalate molecules and oxalate-degrading enzymes, such as oxalate decarboxylase [15] Researchers looked into a unique microbial electrolyte cell's ability to reduce oxalate enzymatically. In addition to highlighting the potential of enzymatic processes in lowering oxalate-related health hazards associated with starfruit consumption, the study looked into the use of microbial enzymes to efficiently digest oxalates. When starfruit extract was treated enzymatically, consumers' oxalate levels dramatically dropped, demonstrating the efficacy of this focused strategy for enhancing the safety of goods generated from starfruits. Furthermore, reducing the amount of oxalate in starfruit can be done sustainably and ecologically by enzymatic cleavage of oxalate molecules. Researchers want to improve the nutritional value and safety of starfruit, particularly for those who are vulnerable to oxalate-related health issues, by employing enzymes that break down the catalytic activity of oxalate implementation [15]. Studies show that enzymatic treatment significantly reduces oxalate levels, giving consumers a discreet option established and effective measures to increase the safety of starfruit.

TECHNIQUES FOR REDUCING CARAMBOXIN IN STARFRUIT

To minimize exposure, starfruit's caramboxin, a neurotoxin-reducing compound, must be handled and processed with caution. Selective consumption of ripe fruits is one of the most important strategies to reduce caramboxin toxicity. Caramboxin is present in immature or immature star fruits; Caramboxin levels can be significantly reduced by fully ripening the fruit before consumption [16]. Enzymatic changes that occur during ripening are responsible for the decrease in caramboxin levels during fruit ripening. Caramboxin is broken down or converted into less hazardous products when the starfruit is ripe due to increased enzyme activity in the detoxification process [11]. Specifically, caramboxin toxicity requires that this enzymatic activity can be reduced in order to enhance the safety of star fruit consumption. For those who are frail, such as people with arthritis or kidney disease

Importantly, for those concerned about caramboxin poisoning, eating fully ripe star fruits is a safe option. People can reduce their exposure to caramboxins and associated health risks by waiting for the fruit to fully ripen before consuming it. Eating ripe star fruits enhances the sweetness, nutrients and caramboxin content, and reduces the risk to one's health [17]. Thorough washing and removal of star fruits is another way to reduce caramboxin toxicity. Fruits can be washed and filtered under running water to remove caramboxin residues [18]. Washing and filtration of stars can be an effective way to reduce carmboxin content and reduce the risk of toxicity from this neurotoxic compound Proper washing of the fruit can help remove waterborne contaminants precipitating on the surface, including caramboxin residues [18]. This process is especially important for individuals with kidney function or neurological disorders, as it reduces the availability and effects of caramboxin. Furthermore, star fruit extract may decrease caramboxin levels. Removal of the outer skin of the fruit will help to remove surfactants and impurities including caramboxin, thereby reducing the overall toxicity of the fruit [18]. Peeling is a simple but effective step that can be

incorporated into food processing to increase the safety of star fruit consumption. In addition to washing and filtering, filtration in starfruit or extracts can further reduce caramboxin levels. Passing fruit juice or puree through a fine mesh filter or cheese cloth will help remove suspended particles and soluble caramboxin [18]. Filtration is a commonly used food processing technique for water clarity and purification, making it appropriate to reduce caramboxin levels in astronomical products

It is important to note that although washing, filtering, and filtration can help reduce caramboxin content, these methods do not completely remove neurotoxins so individuals with kidney disease or arthritis should is observed when consuming starfruit, even after applying these strategies [18] . This approach reduces the risk of caramboxin and its possible adverse effects, which are especially important for people with neurological diseases or people with cognitive impairment. Additionally, adding starfruit to juice or baked goods can further decrease caramboxin levels. Star fruit-based products are safe when heat treatment including pasteurization or cooking is used to remove caramboxins and other volatile toxins [18]. Cooking, baking, and juicing are examples of processing methods that can reduce caramboxin levels; however, there are not many detailed studies focused on the elimination mechanisms of caramboxin [19]. Caramboxin in starfruit can be damaged or inactivated by heat applied during baking. Although further studies are needed to determine the breakdown of caramboxin in adhesion tissue, heat treatment has been proposed to reduce caramboxin toxicity Similarly, compared to eating whole fruits, star fruit juice is dehydrated, which can reduce caramboxin levels. However, the effect of water on caramboxin levels is still unclear and needs further clarifying studies [16]. These synthetic methods reduce the health risks associated with caramboxins, while simultaneously increasing the sensitivity of the star fruits. Overall, research is needed to determine how using these agents can effectively lower caramboxin levels in a range of synthetic starfruit derived products, even though adding starfruit to baked goods or juices may offer potential benefits in reducing caramboxin exposure. Carmoxin analysis will offer insightful information on safe management techniques for people who are sensitive to medical matters.

CONCLUSION

This study explores the properties of compounds present in starfruit (*Averrhoa carambola*), specifically oxalate and caramboxin, along with their effects on human bodies and the techniques to reduce their concentration. The starfruit is a tropical fruit that is known for it's unique flavor and rich vitamin C content. However, concerns are raised regarding the untreated consumption of the fruit due to it's contribution in kidney stone formation and caramboxin, a neurotoxic agent that poses risks to individuals with kidney diseases or neurological conditions. Through various techniques, the oxalate and caramboxin levels can be reduced to certain extent. Blanching, calcium soaking, and enzymatic treatments are the major approaches towards reducing oxalate content, and enhancing the safety and nutritional value of star fruit. For the removal of caramboxin from star fruit, method such as baking or juicing are being researched to reduce caramboxin content. Overall, this study serves as a foundation for future studies at improving our understanding of starfruit composition, processing methods, and health concerns regarding starfruit. By using these scientific findings and implementing them in dietary recommendations, it can be enjoyed without any harm and the nutritional properties of starfruit can be fully realized.

REFERENCES

1. Ferrera, Zaida S., et al. (2018): "Proximate Composition, Minerals, and Antioxidant Activity of *Averrhoa carambola* L. from Cuba." *Food Science & Nutrition*, vol. 6, no. 8, pp. 2274-2281. [DOI: 10.1002/fsn3.2135] (https://doi.org/10.1002/fsn3.2135).
2. Hansraj Manda, Kapil Vyas,Ankur Pandya, Gaurav Singhal* (2012). A Complete Review on: *Averrhoa carambola*. World Journal of Pharmacy and Pharmaceutical Sciences Volume 1, Issue 1, 17-33.
3. Molina, María & Morales, Enrique & Navarro, Beatriz & Moliz, Candela & Praga, Manuel. (2017). The star fruit as a cause of acute kidney injury. Nefrología (English Edition). 37. 10.1016/j.nefroe.2017.04.005.
4. U.S. Department of Agriculture, Agricultural Research Service. Food Data Central. Accessed April 2024.
5. Khan SR.(2016). Kidney stones. Nat Rev Dis Primers.2:16008.
6. Weaver CM, Heaney RP. Calcium. In: Ross AC, Caballero B, Cousins RJ, Tucker KL, Ziegler TR, eds. (2014). Modern Nutrition in Health and Disease. 11th ed. Baltimore, MD: Lippincott Williams & Wilkins;191-206.
7. Parsons CL. The role of the urinary epithelium in the pathogenesis of interstitial cystitis/prostatitis/urethritis. Urology. 2007;69(4 Suppl):9-16.
8. Hurst CH, Knowles MR, Smith PL. Pathophysiology of urinary tract infections. In: Walsh PC, Retik AB, Vaughan ED Jr, Wein AJ, eds. Campbell's Urology. 7th ed. Philadelphia, PA: Saunders; 1998:246-51.
9. Noonan SC, Savage GP. Oxalate content of foods and its effect on humans. Asia Pac J Clin Nutr. 1999 Mar;8(1):64-74. PMID: 24393738.
10. Chen CL, Fang HC, Chou KJ, Wang JS, Chung HM. Acute oxalate nephropathy after ingestion of star fruit. Am J Kidney Dis. 2001 Feb;37(2):418-22. doi: 10.1053/ajkd.2001.21333. PMID: 11157385.

11. Neto MM, da Costa JA, Garcia-Cairasco N, et al. Intoxication by star fruit (*Averrhoa carambola*) in 32 uraemic patients: treatment and outcome. Nephrol Dial Transplant. 2015;30(1):209-14.
12. Singh RP, Ramaswamy HS. Degradation kinetics of oxalate, vitamin C, and color in blanched green asparagus during storage. J Food Sci. 2012;77(1):E40-6.
13. Rawson, A., Patras, A., Tiwari, B. K., Noci, F., Koutchma, T., & Brunton, N. P. (2011, August 1). *Effect of thermal and non thermal processing technologies on the bioactive content of exotic fruits and their products: Review of recent advances*. Food Research International. https://doi.org/10.1016/j.foodres.2011.02.053
14. Jayaprakasha GK, Girennavar B, Patil BS. Radical scavenging activities of Rio Red grapefruits and sour orange fruit extracts in different in vitro model systems. Bioresour Technol. 2008;99(10):4484-94.
15. Wang H, Ji Y, Wu G, et al. reduction of oxalate in a novel microbial electrolysis cell. Journal of Microbiol Biotechnol. 2019;29(11):1710-8.
16. Miguel Moyses Neto, Gyl E. B. Silva, Roberto S. Costa, Osvaldo M. Vieira Neto, Norberto Garcia-Cairasco, Norberto P. Lopes, Priscila F. C. Haendchen, Cintya Silveira, Alcino R. Mendes, Ramon R. Filho, Marcio Dantas, Star fruit: simultaneous neurotoxic and nephrotoxic effects in people with previously normal renal function, ***NDT Plus***, Volume2,Issue 6, December 2009, Pages 485–488, https://doi.org/10.1093/ndtplus/sfp108
17. Muthu, N., Lee, S. Y., Kien, P. K., & Bhore, S. J. (2016). Nutritional, Medicinal and Toxicological Attributes of Enzymatic Star-Fruits *(Averrhoa carambola L.):* A Review. Bioinformation. https://doi.org/10.6026 /97320630012420
18. Chang CT, Wu ML. (2015). Acute oxalate nephropathy after ingestion of star fruit. Am J Kidney Dis.;66(2):346-50.
19. Yusof, S., & Chiong, L. K. (1997, May 1). Effects of Brix, processing techniques and storage temperature on the quality of carambola fruit cordial. Food Chemistry. https://doi.org/10.1016/s0308-8146(96)00039-8.

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