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Formulation and Quality Assessment of Value-added Karonda (*Carissa congesta* Linn) Squash

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Karonda fruits are abundant in ascorbic acid, pectin, citric acid, calcium and phosphorous, making them a highly nutritious choice. When ripe, these fruits have a delightful sub-acidic sweetness and a distinct aroma. They can be enjoyed as a dessert on their own or used to create delectable value-added products like jelly, sauce, Carissa cream, or jellied salad. For those seeking refreshing beverages, nectar, squash and syrup can be prepared from the ripe karonda fruits. To enhance the beverage's taste and health benefits, nine treatments were devised, incorporating sugar and herbs such as Cardamom and Clove. Different levels of Cardamom and Clove were added as herbal additives and compared to a control group. To ensure quality, the prepared beverages were stored in 250 ml transparent pre-sterilized glass bottles and subjected to a heat treatment at 96°C for 20 minutes. The treated Squash samples were evaluated immediately after preparation and at 60, 120 days and up to 4 months of storage for physiochemical analysis and sensory evaluation. The herbal treatments outperformed the control regarding Total Soluble Solids (TSS), Acidity, ascorbic acid and Iron content. Particularly, treatment T5 (40% TSS + 30% Juice + 2.0% Cardamom extract) exhibited the highest mean TSS (40.13%), Ascorbic acid content (4.23%) and Iron (0.928mg/100g). Additionally, the sensory evaluation, which considered Color, Texture, Flavor and Taste, yielded the highest score of 8.42 in T5 (40% TSS + 30% Juice + 2.0% Cardamom extract).

Keywords: Karonda; cardamom; clove; squash; iron.

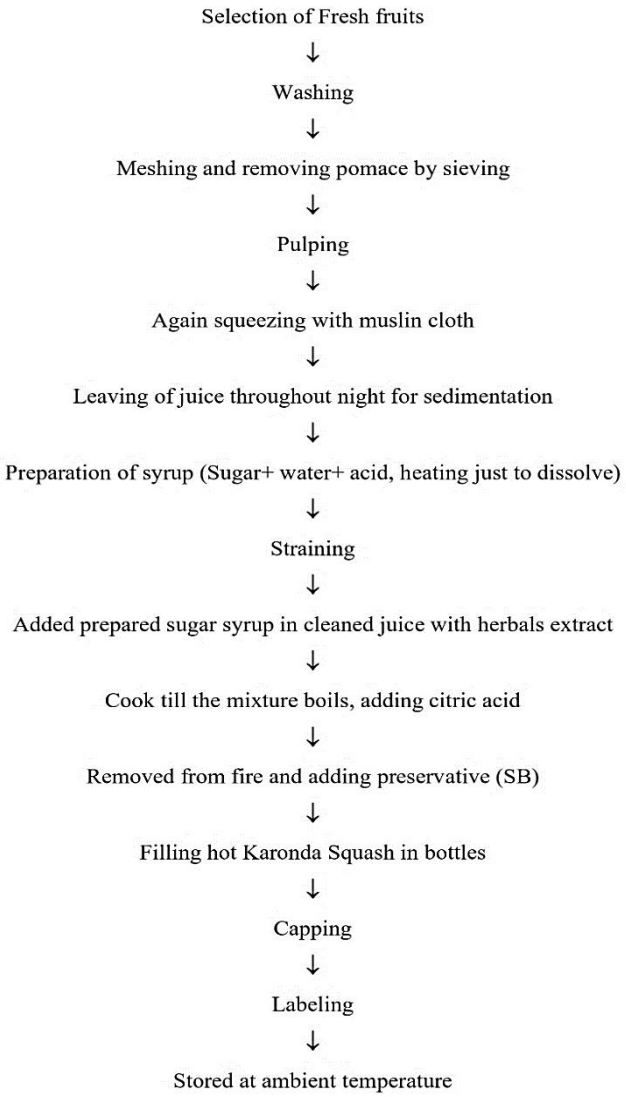
1. INTRODUCTION

Karonda (*Carissa congesta* Linn.), a fruit indigenous to India, belongs to the order Contorate and the family Apocynaceae. It is often referred to as "Dongarchi Kali Maina" in the Konkan region, endearingly recognized as a "poor man's food." Acting as a protective hedge plant, its thorny branches and dense foliage produce valuable fruits. Karonda is remarkably resilient, thriving in various soil types, especially sandy or rocky soils, in both tropical and subtropical climates. “The karonda fruit possesses astringent and antiscorbutic properties, making it beneficial for remedying biliousness and serving as a cure for anemia. Additionally, traditional uses include its efficacy in treating conditions such as scabies, intestinal worms, pruritus and biliousness and it is also valued as an anthelmintic. In terms of nutritional content, the protein levels in green and maroon karonda fruit vary, ranging from 0.74 to 2.25 percent” [1]. “Furthermore, [2] recorded a noteworthy iron content of 39.1 mg/100g in karonda fruits. When fully ripe, the karonda fruits exhibit a delightful sub-acidic sweetness and emit a unique aroma. They can be savored as a dessert or used to create value-added products such as jelly, sauce, Carissa cream, or jellied salad. Moreover, the ripe karonda fruits lend themselves well to the preparation of different beverages like nectar, squash and syrup, further enriching their culinary versatility”. Cloves, derived from the flower buds of the *Syzygium aromaticum* tree, are a versatile spice available in both whole and ground forms. Their uses span various culinary delights, from seasoning pot roasts to adding delightful warmth to hot beverages, cookies and cakes. The clove tree, an evergreen, grows to an impressive height of about 8 to 12 meters (25 to 40 feet). Its leaves, speckled with glands, are small, simple and arranged opposite each other. Typically, these trees are propagated from seeds and thrive in shaded areas. Flowering typically begins around the fifth year, with a mature tree capable of yielding up to 34 kg (75 pounds) of dried buds annually. Harvesting occurs twice a year, in late summer and winter, followed by sun-drying of the buds. Cloves themselves vary in length, ranging from approximately 13 to 19 mm (0.5 to 0.75 inches). Apart from their culinary uses, clove has been traditionally associated with various medicinal applications, including relieving toothache, alleviating pain during dental procedures, combating dental plaque, easing hangovers and aiding digestion, among others. “However, it's important to note that while these uses are common, there is currently no substantial scientific evidence to support their effectiveness” [3]. In South Asia, green cardamom finds widespread use in treating various dental and gum infections, as well as being effective in preventing and alleviating throat issues, lung congestion and pulmonary tuberculosis. Additionally, it is applied to soothe inflammation of the eyelids and aid in digestive disorders. Notably, it has been historically utilized to break up kidney stones and gallstones and was believed to be an antidote for venom from both snakes and scorpions. Cardamom serves a dual purpose as both a spice and a component

of traditional medicine in several systems, including traditional Chinese medicine in China, Japan and Korea, as well as Ayurveda in India [4]. Green cardamom powder is commonly employed as a spice in sweet dishes and is a traditional flavoring agent for coffee and tea [5].

2. MATERIALS AND METHODS

The Karonda Squash beverage was developed at the Department of Postharvest Technology, College of Horticulture, BUAT, Banda- 210001 (U.P.) India. To create the beverage, fully ripened, mature, fresh and sound Karonda fruits were obtained from the Fruit Science Department, while herbals like Cardamom and Clove, sugar, preservatives, utensils and gas were sourced from the Postharvest Department. The development involved nine treatment combinations, each with different proportions of sugar and herb extracts (Cardamom and Clove), as follows: T_1 - 40% TSS + 30% Juice T_2 - 40% TSS + 30% Juice + 0.5% Cardamom extract T_3 - 40% TSS + 30% Juice + 1.0% Cardamom extract T_4 - 40% TSS + 30% Juice + 1.5% Cardamom extract T_5 - 40% TSS + 30% Juice + 2.0% Cardamom extract T_6 - 40% TSS + 30% Juice + 0.5% Clove extract T_7 - 40% TSS + 30% Juice + 1.0% Clove extract T_8 - 40% TSS + 30% Juice + 1.5% Clove extract T_9 - 40% TSS + 30% Juice + 2.0% Clove extract. The preparation process involved blending all the prepared juices, Na-Benzoate, sugar and other ingredients in a



Flow Chart 1. Flow chart of karonda squash preparation

high-speed blender, following the details outlined in Table 1. The resulting beverage was then carefully bottled in pre-sterilized glass bottles of 250 ml capacity. After bottling, all juice samples underwent heat treatment at 96°C for 20 minutes. Subsequently, the samples were cooled, labeled and stored at 4°C. Evaluation of the treated Squash samples was conducted immediately after preparation and then at regular intervals of 60, 120 days and so on, up to a storage period of 4 months. "This evaluation encompassed both physiochemical analysis and sensory evaluation. Total soluble solids were determined using a Hand refractometer, while titratable acidity was estimated using the method suggested by" [6]. "Ascorbic acid content was measured using the 2, 6-dichlorophenol indophenol dry method of" [7]. "The collected data were statistically analyzed using the standard procedure given by [8] using Completely Randomized Design (CRD)".

Table 1. Formulation of Karonda squash

Ingredients	Concentration (w/w)
Juice	Karonda (30%)
Water	70%
Na-Benzoate	0.1%
Sugar (TSS)	40%

The karonda squash with herbals (Cardamom and Clove) in different proportions were prepared and evaluated for organoleptic traits.

3. RESULTS AND DISCUSSION

3.1 Total Soluble Solids (TSS) °Brix

Table 2 provides data on the total soluble solids (TSS) for all the treatments of Karonda Squash. It was observed that the TSS content of the beverage increased as the storage duration extended. Over the 4-month storage period, the TSS level rose from an initial value of 40.01 °Brix to 40.26 °Brix. The impact of different treatments on TSS changes was found to be significant. Among the treatments, the control group (T_1) recorded the lowest mean TSS of 40.10 °Brix, while treatment T_5 (40% TSS + 30% Juice + 2.0% Cardamom extract) showed the highest mean TSS of 40.13 °Brix. Overall, the treatments with cardamom extracts were more effective in increasing the TSS levels compared to the treatments with clove extracts. Across all treatments, clove was found to be inferior in enhancing the TSS level of Karonda Squash. Furthermore, the higher the level of herb used in the treatment, the higher the TSS value obtained. The gradual increase in TSS during storage can be attributed to the hydrolysis process, wherein polysaccharides are converted into sugars. Additionally, the reduction in moisture content during storage might have contributed to the rise in TSS levels. "Similar findings were reported by [9] in their studies on lime juice" and "the results were consistent with previous research conducted by [10] on canning and storage of oranges and canned peaches". "The TSS content of Karonda Squash increased with storage duration, with treatments involving cardamom extracts proving more effective in enhancing TSS levels compared to clove treatments. The findings suggest that the choice of herbal extracts in the treatments can influence the TSS content of the beverage and the gradual increase in TSS during storage is likely due to hydrolysis and moisture reduction processes" [11]. The study adds to the existing body of research on similar beverages and highlights the importance of herbal extracts in enhancing the TSS levels of Karonda Squash during storage.

3.2 Acidity

Acidity plays a crucial role in determining the tartness and overall acceptability of Karonda Squash. It is responsible for imparting the characteristic sourness to the beverage, which contributes to its unique flavor. The primary acid responsible for this sourness in Karonda juice is Antiscorbutic, which adds to the distinctive taste of the Squash. The acidity data for various treatments of Karonda Squash can be found in Table 2, showing notable differences between the treated samples and the control in terms of acidity levels. Among the treatments, T_9 (40% TSS + 30% Juice + 2.0% Clove extract) exhibited the highest mean acidity of 0.87%, while T_5 (40% TSS + 30% Juice + 2.0% Cardamom extract) showed the lowest acidity of 0.82%. "The higher acidity in the aspartame-treated sample (T_9) can be attributed to the acidic nature of aspartame. During the storage period of 120 days, there was a gradual decrease in acidity observed across all treatments. This decrease in acidity during storage was likely linked to the degradation of sugars in the herbs used in the beverage" [12]. "The acidity is a key factor influencing the acceptability of Karonda Squash due to its tartness and characteristic sourness. The different treatments resulted in varying levels of acidity, with higher acidity in the aspartame-treated sample" [13]. As the beverage was stored, the acidity levels gradually decreased

due to the degradation of sugars in the herbs. The study emphasizes the importance of acidity in shaping the flavor profile of Karonda Squash and highlights how different treatments and storage conditions can impact this essential aspect of the beverage.

3.3 Ascorbic Acid

In the investigation of various treatments for Karonda Squash, only marginal differences in ascorbic acid contents were observed. However, these treated samples showed noticeable variations compared to the control samples, as indicated in Table 2. Through rigorous statistical analysis, the researchers found high significance concerning the storage period, as the ascorbic acid contents experienced significant declines at all storage intervals. These reductions in ascorbic acid were attributed to the combined impact of processing, storage time and light exposure. The treatment that yielded the highest mean ascorbic acid content (04.23%) was T_5, involving a combination of 40% TSS, 30% Juice and 2.0% Cardamom extract. Not far behind, T_4 (40% TSS, 30% Juice and 1.5% Cardamom extract) demonstrated a mean of 04.20%. Conversely, the control group (T_1) exhibited the lowest mean of 04.06%. "Regarding the degradation process of ascorbic acid, both aerobic and anaerobic pathways may play a role in juice or squash. It suggests that oxygen exposure and the absence of oxygen could contribute to the breakdown of ascorbic acid during storage" [14]. "Moreover, this study's findings align with previous research conducted by [15] who reported a similar decreasing trend in ascorbic acid contents in various fruit beverages over time".

3.4 Iron

Iron is essential for maintaining the shelf stability of Karonda Squash, significantly affecting both its flavor and processing requirements. The data presented in Table 2 highlights variations in the iron content among different treatments, including the control and value-added ones. Among the treatments, T_5 (40% TSS + 30% Juice + 2.0% Cardamom extract) exhibited the highest mean iron content of 0.928 mg/100g, closely followed by T_4 (40% TSS + 30% Juice + 1.5% Cardamom extract) with 0.927 mg/100g. In comparison, the control group (T_1) showed the lowest iron content of 0.923 mg/100g. Furthermore, the storage intervals also influenced the iron content of Karonda Squash. "As the beverage was stored for longer periods, there was a noticeable decline in iron content, particularly in the acidic region. This suggests that the storage time has an impact on the iron levels in the beverage" [16]. Iron is not only essential for maintaining shelf stability but also has implications for flavor and processing considerations in Karonda Squash. The study shows that different treatments and storage intervals can lead to variations in iron content, which may affect the overall quality and nutritional value of the beverage.

"Similar findings of decreasing iron content over time were also reported by [17] confirming the trend observed in this study".

3.5 Colour/Appearance

Table 3 depicts the impact of different treatments on the color and appearance of Karonda Squash. Among the treatments, T_5 (40% TSS + 30% Juice + 2.0% Cardamom extract) received the highest mean score of 8.29, indicating it was ranked the highest in terms of color and appearance. On the other hand, T_1 (Control) received the lowest score of 5.90, indicating its color and appearance characteristics were ranked the lowest. The study found that storage significantly influenced the perception of color in the colored beverages. The highest scores for color and appearance were observed when the beverage was freshly prepared in T_5 (40% TSS + 30% Juice + 2.0% Cardamom extract). However, as the storage period increased, there was a slight decline in the color and appearance scores of the beverage. The treatments had varying effects on the color and appearance of Karonda Squash, with T_5 showing the highest scores and T_1 showing the lowest. "Additionally, storage time played a significant role in the color perception of the beverage, with a slight decline in color and appearance scores observed as the storage period increased" [18]. "These findings are consistent with previous research by [19] which also reported a similar loss in color during the storage of beverage samples".

3.6 Texture/ Body

The treatments had a significant impact on the texture and body of Karonda Squash. T_5 (40% TSS + 30% Juice + 2.0% Cardamom extract) received the highest mean score of 8.37, indicating it had the maximum score for texture and body. It was closely followed by T_4 (40% TSS + 30% Juice + 1.5% Cardamom extract)

with a score of 7.90. Conversely, the control group (T_1) received a lower mean score of 6.44, indicating that it had the lowest texture and body perception. The flavor perception of the diet beverage showed significant variation at different storage levels. The freshly prepared T_5 (40% TSS + 30% Juice + 2.0% Cardamom extract) received the highest texture and body score of 8.69. However, as the storage period increased, there was a slight decline in the texture and body score of the beverage (as shown in Table 3). This gradual loss in texture and body scores over the storage period was attributed to changes in volatile compounds in the product. The treatments significantly influenced the texture and body of Karonda Squash, with T_5 and T_4 demonstrating better scores compared to the control group (T_1). "Moreover, the storage time had an impact on the texture and body perception, with a slight decline in scores observed over time, likely due to changes in volatile compounds in the beverage. Similar texture and body deterioration in beverage products were also reported by [20] further supporting the findings of this study".

3.7 Flavor/ Taste

In the organoleptic evaluation of Karonda Squash, flavor and taste are crucial factors, ranking high in importance after color and texture. The statistical analysis revealed that both treatment and storage significantly affected the flavor and taste of the beverage. T_5 (40% TSS + 30% Juice + 2.0% Cardamom extract) obtained the highest mean score of 8.61, indicating it had the most favorable flavor and taste among the samples. Following closely was T_4 (40% TSS + 30% Juice + 1.5% Cardamom extract) with a mean score of 8.33 and T_3 (40% TSS + 30% Juice + 1.0% Cardamom extract) scored 8.11, all outperforming the treated samples as shown in Table 3. Notably, Karonda Squash without herbs received lower scores compared to the samples where herbal combinations were used, highlighting the positive impact of herbs on flavor and taste. Moreover, the flavor and taste of the squash underwent significant variation at various storage levels. The highest scores for flavor and taste (8.87) were observed in freshly prepared T_5 (40% TSS + 30% Juice + 2.0% Cardamom extract). "However, as the storage period increased, there was a slight decline in the flavor and taste scores, as indicated in Table 3. This gradual loss in flavor and taste over the storage period was attributed to changes in volatile compounds present in the Karonda Squash Beverages, as reported by" [21]. The differences and loss in flavor and taste may be influenced by factors such as storage time, temperature and duration. "The flavor and taste are essential aspects of Karonda Squash evaluation and treatment and storage significantly affect these attributes. Samples with herbal combinations tended to perform better than those without herbs. The gradual decline in flavor and taste scores during storage is likely due to changes in volatile compounds" [22]. "These findings emphasize the importance of storage conditions and duration in maintaining the desirable flavor and taste of Karonda Squash. These findings are consistent with similar research reported by [23] further supporting the impact of storage on the flavor and taste of the beverage".

3.8 Overall Acceptability

The treatment significantly influenced the overall acceptability of Karonda Squash. However, higher levels of herbal additions did not result in the highest acceptability due to deviations from the standard color, texture and flavor of the beverage, especially after 4 months of storage. The best overall acceptability score (8.42) was recorded in T_5 (40% TSS + 30% Juice + 2.0% Cardamom extract), closely followed by T_4 (40% TSS + 30% Juice + 1.5% Cardamom extract) with a score of 7.78. "Surprisingly, even the control group did not perform better in comparison to the samples with different levels of herbs. No specific pattern was observed concerning the overall acceptability with the different treatments. Storage duration also had an impact on the overall acceptability of the beverage" [24]. "Initially, the overall acceptability score was 8.66, but it reduced to 8.19 after 4 months of storage. Despite this decline, all sensory parameters remained in an acceptable region even after 120 days of storage. In conclusion, the study indicates that herbals can be effectively used as an alternative source of value addition in Karonda Squash" [25]. "However, higher levels of herbal additions may affect the standard attributes of the beverage, leading to lower overall acceptability scores, especially during extended storage" [26]. Nevertheless, even after 4 months of storage, the sensory parameters remained within an acceptable range.

Table 2. Effect of treatments on physiochemical properties of Karonda Squash

Treatment	TSS (°Brix)				Acidity (%)				Ascorbic Acid (%)				Iron (mg/100g)			
	Months after storage			Mean	Months after storage			Mean	Months after storage			Mean	Months after storage			Mean
	0	2	4		0	2	4		0	2	4		0	2	4	
T_1	40.03	40.09	40.17	40.10	0.92	0.87	0.79	0.86	4.66	4.14	3.37	4.06	0.927	0.924	0.918	0.923
T_2	40.04	40.10	40.19	40.11	0.91	0.85	0.77	0.84	4.71	4.23	3.56	4.17	0.928	0.926	0.920	0.925
T_3	40.02	40.09	40.20	40.10	0.91	0.84	0.76	0.84	4.72	4.24	3.60	4.19	0.929	0.927	0.922	0.926
T_4	40.01	40.09	40.22	40.11	0.90	0.84	0.74	0.83	4.72	4.26	3.62	4.20	0.930	0.928	0.923	0.927
T_5	40.02	40.09	40.24	40.13	0.90	0.84	0.74	0.82	4.73	4.30	3.67	4.23	0.931	0.929	0.925	0.928
T_6	40.03	40.09	40.21	40.11	0.92	0.87	0.80	0.86	4.68	4.17	3.41	4.09	0.928	0.926	0.920	0.925
T_7	40.02	40.08	40.21	40.10	0.93	0.87	0.80	0.87	4.70	4.18	3.43	4.10	0.928	0.926	0.920	0.925
T_8	40.00	40.08	40.21	40.10	0.94	0.88	0.79	0.87	4.70	4.19	3.45	4.11	0.928	0.926	0.920	0.925
T_9	40.01	40.09	40.22	40.11	0.94	0.88	0.78	0.87	4.70	4.20	3.48	4.13	0.929	0.927	0.921	0.926
S. Ed. (±)	0.09	0.08	0.34		0.03	0.02	0.03		0.08	0.12	0.06		0.005	0.008	0.007	
C.D. at 5%	0.20	0.17	0.69		0.06	0.05	0.07		0.19	0.24	0.15		0.011	0.019	0.016	

Table 3. Effect of treatments on organoleptic properties of Karonda Squash

Treatment	Colour/Appearance				Texture/ Body				Flavor/ Taste				Overall acceptability			
	Months after storage			Mean	Months after storage			Mean	Months after storage			Mean	Months after storage			Mean
	0	2	4		0	2	4		0	2	4		0	2	4	
T_1	6.16	5.98	5.55	5.90	6.60	6.49	6.24	6.44	7.35	7.20	6.93	7.16	6.70	6.56	6.24	6.50
T_2	6.87	6.73	6.44	6.68	7.22	7.10	6.88	7.07	7.70	7.58	7.40	7.56	7.26	7.14	6.91	7.10
T_3	7.04	6.89	6.62	6.85	7.92	7.77	7.50	7.73	8.25	8.13	7.95	8.11	7.74	7.60	7.36	7.57
T_4	7.23	7.15	6.97	7.12	8.09	7.94	7.67	7.90	8.48	8.35	8.16	8.33	7.93	7.81	7.60	7.78
T_5	8.42	8.30	8.17	8.29	8.69	8.32	8.09	8.37	8.87	8.66	8.31	8.61	8.66	8.43	8.19	8.42
T_6	6.21	6.03	5.61	5.95	6.99	6.84	6.59	6.81	7.55	7.41	7.22	7.39	6.92	6.76	6.47	6.72
T_7	6.33	6.17	6.04	6.18	6.40	6.29	6.15	6.28	6.59	6.44	6.28	6.44	6.44	6.30	6.16	6.30
T_8	6.57	6.23	6.12	6.31	6.69	6.25	6.19	6.38	6.72	6.58	6.21	6.50	6.66	6.35	6.17	6.40
T_9	6.60	6.55	6.25	6.47	7.74	7.59	7.32	7.55	8.00	7.86	7.66	7.84	7.45	7.33	7.08	7.29
S. Ed. (±)	0.77	0.95	0.80		0.98	0.27	0.72		0.99	0.90	0.86		0.74	0.79	0.38	
C.D. at 5%	1.58	1.91	1.60		1.98	0.53	1.47		1.98	1.81	1.74		1.48	1.60	0.177	

4. CONCLUSION

The innovative preparation of beverages from karonda, incorporating sugar and herbs like Cardamom and Clove, has shown promising results. Specifically, the treatment T_5 (40% TSS + 30% Juice + 2.0% Cardamom extract) stands out, exhibiting superior physiochemical properties and sensory appeal during storage. This treatment demonstrated the highest Total Soluble Solids (40.13%), ascorbic acid content (4.23%), and iron content (0.928mg/100g), alongside the best sensory scores for color, texture, flavor, and taste. These findings suggest that incorporating specific herbal additives can significantly enhance the nutritional and sensory qualities of karonda-based beverages, offering a highly beneficial and enjoyable product.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Kumar S, Singh I. Variation in quality traits of karonda (*Carissa congesta* L.) germplasm. South Indian Hort. 1993;41(2): 108-110.
2. Misra P, Rai R. Micro propagation of karonda (*Carissa carandas*) through shoot multiplication. Scientia Horticultura. 2005; 103(2):227-232.
3. Vikram B, Sikarwar PS. Studies on preparation of value added herbal kinnow – aonla beverages (RTS and Squash) during Storage. Int. J. Pure App. Biosci. 2018;6(1):758-765.
4. Alvarez L. Cardamom prices leads to a re-emergence of the green gold. 2008;5(2):9-13.
5. Aubertine C. Cardamom (*Amomum spp*.) in Lao PDR: The hazardous future of an agro forest system product, in Forest products, livelihoods and conservation: Case studies of non-timber forest products systems. Asia, Center for International Forest Research. 2004;2(11):69-75.
6. Ranganna S. Handbook of analysis and quality control for fruits and vegetable products. 2nd Edition. Tata McGraw Hill Publishing Company Ltd. New Delhi; 1997.
7. Johnson BC. Methods of Vitamins Determination, Burgess Pub.Co., Minnea-polis. 1948;98.
8. Panse VG, Sukhantme PV. Statistical method of Agricultural. Indian council of Agricultureal research, New Delhi; 1985.
9. Divate SM, Savale BG, Patil NB, Relekar PP. Study of preparation and standardization of Karonda (*Carissa congesta* L.) crush. The Pharma Innovation Journal. 2020;9(1):176-179.
10. Sharma M, Verma D. Phyto-therapeutic Significance of Karaunda. Bulletin of Environment. Pharmacology and Life Sciences. 2012;1(12):34-36.
11. Wani RA, Pratap VM, Hakeem SA, Amgchuk SS, Dixit A. Shelf life of karonda jam (*Carrisa carandas* L.) under ambient temperature. African Journal of Agricultural Research. 2013;8(21):2447-2449.
12. Dhole RB, Warang OS, Sante PR. Studies of the changes in physico-chemical parameters during growth and development of fruits of karonda cv. Konkan Bold. International Journal of Plant & Soil Science. 2023;35(19):1105-1109.
13. Bajpai R, Vasure N. Role of acidity on processing of different Karonda products (Jam, Jelly, Squash, Candy) during storage periods. Agriculture Update. 2017; 12(8):2277-2281.
14. Virmani R, Virmani T, Singh C, Sorout G, Gupta J. Hidden potential of natural herb *Carissa carandas* (Karonda*).* Research in Pharmacy and Health Sciences. 2017;3(2): 294-302.
15. Marimuthu M, Thirumaran AS. Utilization of jamunjuice, squash and syrup. Beverage and Food World. 2000;27(8):42-46.
16. Sharma D, Maheshwari A, Verma N. Phyto-therapeutic Significance of Karaunda. Bulletin of Environment, Pharmacology and Life Sciences. 2012; 1(12):34-36.
17. Srivastava A, Sarkar PK, Bishnoi SK. Value addition in under-exploited fruits of karonda (*Carissa carandas* L.): An earning opportunity for rural communities in India. Rashtriya Krishi. 2017;12(2):161-163.
18. Singh S, Saxena AK. Studies on effect of cultivars and picking dates on shelf life of jelly prepared from karonda (*Carissa*

carandas L.). International Journal Current Microbiology and Applied Sciences. 2019; 8(6):2864-2877.
19. Arif M, Mehnaz K, Jawaid T, Khalid M, Saini KS, Kumar A, Ahmad M. *Carissa carandas* Linn. (Karonda): An exotic minor plant fruit with immense value in nutraceutical and pharmaceutical industries. Asian J. Biomed. Pharmaceu. Sci. 2016;6(58):14-19.
20. Jadhav SB, Joshi GD, Garande VK. Studies on the preparation and storage of karonda (*Carissa carandas* Linn.) fruit products. Beverage and Food World. 2004; 31(5):46-47.
21. Manivasagan S, Rana GS, Joon MS, Godara AK. Study on qualitative changes in pickles prepared from karonda (*Carissa carandas* Linn.) during storage. Haryana J. Hort. Sci. 2007;36(1/2):44-45.
22. Navya DV, Kukanoor L, Naik RK, Gorabal K, Bhat AS, Jalawadi S. Studies on organoleptic qualities and colour (L*a*b*) values of Karonda (*Carissa carandas* L.) blended squash during storage. Journal of Pharmacognosy and Phytochemistry. 2020;9(6):994-997.
23. Chaudhary M, Yadav R, Singh DB. Changes in physico-chemical characteristics of karonda jelly during storage period. Plant Archives. 2007;7(2): 885-887.
24. Jadhav SB, Joshi GD, Garande VK. Storage behavior of ripe karonda fruits as influenced by different storage conditions. Journal of Asian Horticulture. 2006;2(4): 291-293.
25. Mohire RS, Relekar PP, Pujari KH. Studies on standardization of Karonda (*Carissa congesta* L.) Syrup. Advances in Life Sciences. 2016;5(4): 1338-1342.
26. Vikram B, Gangwar S, Belwel A, Mathur R, Kumar P Pushpandra, Kishor B, Kumari D, Sikarwar PS. A review on post-harvest management and value addition of horticultural crops: A source of income generation for the farmers of Bundelkhand, India. Int. J. Environ. Clim. Change. 2023; 13(11):4662-4672.

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