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Mass Transfer and Quality Attributes of Osmodehydrated Malabar Tamarind (*Garcinia gummi-gutta*)

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ABSTRACT

Osmodehydration process for *G. gummi-gutta* (Malabar tamarind) fruit was optimized for the osmotic variables *viz*., osmotic solution concentration and immersion time. The fruit slices of 2 cm^3 size were osmosed in two different concentrations of sucrose (50^{0}Brix and 70^{0}Brix) for 24, 36 and 48 hr immersion time. The effect of osmodehydration on mass transfer characters, biochemical and sensory parameters of the fruits were studied. The results showed that mass transfer characters were increased with osmotic concentration and immersion time. The osmotic pre-treatment of *G. gummi-gutta* with 70^0 Brix sucrose for 48 hr recorded superior quality dehydrated fruits in terms of biochemical and sensory parameters with consumer acceptability. The osmodehydrated fruits exhibited a storage stability of three months with better retention of nutritional and sensory qualities.

Key Words: *Garcinia gummi-gutta,* Osmodehydration, Malabar tamarind, Solid gain.

INTRODUCTION

Garcinia gummi-gutta, popularly known as Malabar tamarind of the family Clusiaceae is native to South Asia and grown in Kerala as a homestead tree. It is used in traditional medicines and is a rich source of hydroxy citric acid (HCA), a much valued antiobesity phytochemical. The phytochemical studies revealed that the fruit also contain xanthones, benzophenones and amino acids with high antioxidant potential (Semwal *et al,* 2015). The sour taste due to high organic acid content of *Garcinia gummi-gutta* fruits is a limiting factor for the development of value added processed products.

Osmodehydration facilitates processing of fruits and vegetables with retention of initial fruit characteristics like colour, aroma, texture and nutritional composition (Chavan, 2012). It is considered as one of the effective pre-treatment method to overcome drawbacks of normal hot air drying and improved the retention of vital bioactive and physicochemical properties in the fruit (Obajemihi *et al,* 2023). Gopakumar and Kavitha (2014) explored processing of Malabar tamarind using sugar and salt where osmotic pressure preservation method was found beneficial for the development of value added products. Hossain *et al* (2021) reported that pre-treatment of *Garcinia pedunculata* slices pretreated with sucrose helped to retain ascorbic acid, and antioxidant activity whereas fructose pretreated samples exhibited maximum B vitamins, total phenolic content and total flavonoid content. The present study aimed to explore the possibility of osmodehydration of *Garcinia gummi-gutta* fruit and to standardize the protocol for osmodehydrated Malabar tamarind rind with consumer acceptability

MATERIALS AND METHODS

Ripe Malabar tamarind fruits with uniform yellow colour were harvested from the Instructional Farm, College of Agriculture Vellayani,

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Table 1. Effect of osmotic concentrations and immersion time on mass transfer characters of *G.gummi-gutta*

Osmotic concentration	Weight reduction (%)			
	Immersion time (hours)			
	T_1 (24)	T_2 (36)	T_3 (48)	Mean (C)
C_1 (50^0 Brix)	18.93	21.93	23.90	21.59^b
C_2 (70^0Brix)	22.94	27.56	29.00	26.50^a
Mean (T)	20.94^c	24.75^b	26.45^a	
CD (0.05)	C-0.808 T -0.989 C X T- NS			
SE (± m)	C -0.259 T -0.318 C X T - 0.449			
	Solid gain (%)			
	Immersion time (hours)			
	T_1 (24)	T_2 (36)	T_3 (48)	Mean (C)
C_1 (50^0 Brix)	19.30	24.06	26.67	23.34^a
C_2 (70^0Brix)	25.32	27.51	29.55	27.46^a
Mean (T)	22.31^c	25.79^b	28.11^a	
CD (0.05)	C- 0.712 T- 0.873 C X T-1.234			
SE(±m)	C-0.229T - 0.280 C X T-0.396			
	Water loss (%)			
	Immersion time (hours)			
	T_1 (24)	T_2 (36)	T_3 (48)	Mean (C)
C_1 (50^0 Brix)	22.31	25.79	28.11	25.40^b
C_2 (70^0Brix)	41.32	44.55	49.10	44.99^a
Mean (T)	37.66^c	40.44^b	45.95^a	
CD (0.05)	C- 0.597 T- 0.73 C X T-1.034			
SE(±m)	C- 0.192 T- 0.235 C X T- 0.332			

Thiruvananthapuram, Kerala Agricultural University for preparation of osmodehydrated product. The collected fruits were washed thoroughly and after separating the seeds, rind was made into $2cm^3$sized slices. The slices were steam blanched and were subjected to osmodehydration with sucrose as osmotic medium at different levels of osmotic concentration and immersion time. The concentration of osmotic medium was 50^oBrix (C_1) and 70^oBrix (C_2) diffusing solution (sucrose) for an immersion time of 24 hr (T_1) 36 hr (T_2) and 48 hr (T_3) and the ratio of fruits to osmotic solution was maintained as 1:2. After osmotic pre-treatments, the rind was removed from the solution, drained and analyzed for mass transfer characters. The osmosed *G. gummi-gutta* rinds were further dehydrated using cabinet drier at 50^oC till the product attained a moisture content of 15-18 per cent. The storage stability of osmodehydrated rind was analysed for a period of three months and biochemical and sensory parameters were analysed at monthly interval.

Determination of mass transfer characters

The mass transfer characters viz., solid gain (SG), water loss (WL) and weight reduction (WR) of the osmosed fruit rinds were calculated based on the following equations

$$\text{Solid Gain (SG)(\%)} = \frac{St - Si}{mi} \times 100$$

Table 2. Biochemical parameters of osmodehydrated *G.gummi-gutta*

Osmotic treatment	TSS(^{0}Brix)	Titratable acidity (%)	HCA (%)	Total sugar (%)	Reducing sugar (%)	Antioxidant activity (%)
C_1T_1 (50^{o}Brix, 24 h)	28.95^f	3.14^a	2.90^a	36.21^f	11.77^f	78.38^a
C_1T_2 (50^{o}Brix,36 h)	34.73^e	2.26^b	2.20^b	40.38^e	13.84^e	76.22^b
C_1T_3 (50^{o}Brix, 48 h)	38.59^c	1.78^c	1.55^c	42.63^c	15.83^c	74.02^{cd}
C_2T_1 (70^{o}Brix, 24 h)	36.34^d	1.83^c	1.59^c	41.25^d	15.03^d	75.05^{bc}
C_2T_2 (70^{o}Brix, 36 h)	39.63^b	1.67^d	1.44^d	45.04^b	16.82^b	72.41^d
C_2T_3 (70^{o}Brix, 48 h)	46.93^a	1.54^e	1.28^e	48.04^a	17.48^a	67.12^e
CD (0.05)	1.029	0.113	0.101	0.825	0.474	1.913

Where, St = dry mass at time t, Si = Initial dry mass (of fresh) and mi = initial mass of wet sample (Kowalski and Mierzwa, 2011).

$$\text{Water Loss (WL)(\%)} = \frac{(Wo - Wt) + (St - So)}{Wo} \times 100$$

W_o = Initial weight of rind; W_t = Weight of rind after osmotic dehydration ; S_0 = Initial dry mass of rind; S_t = Dry mass of rind after osmotic dehydration (Sridevi and Genitha, 2012)

$$\text{Weight Reduction (WR)(\%)} = \frac{Mo - M}{Mo} \times 100$$

Mo = Initial mass of rind prior to osmosis (g); M = Mass of rind after osmosis (g) (Yadav *et al* 2012)

Titratable acidity, total sugar and reducing sugar content were estimated using titration methods as described by Ranganna (1986). Antioxidant activity of the samples was determined using 2, 2- diphenyl-1-picrylhydrazyl (DPPH) radical scavenging assay and the effect was obtained as per cent from the following equation (Shen *et al,* 2010).

$$\text{Antioxidant activity (\%)} = \frac{(A_0 - A_1)}{A_0} \times 100$$

A_0 – Absorbance of DPPH solution without sample; A_1 – Absorbance of the test sample after 30 min

Hydroxy citric acid (HCA) in fruits was analyzed by the procedure described by Patel and Buch (2019). The method was based on colour complex formation by HCA in presence of metavanadate and absorbance was recorded at 485 nm using spectrophotometer. Sensory quality attributes of products (taste, colour, flavour, texture and overall acceptability) were evaluated using a 9-point Hedonics scale by a semi trained panel of 30 members and the scores were statistically analysed using Kruskall-Wallis chi-square test.

RESULTS AND DISCUSSION

Mass transfer Characters of *G.gummi-gutta* during osmotic process

Mass transfer characters of osmodehydrated *G.gummi-gutta* rind were significantly influenced by osmotic concentrations and immersion time (Table 1). Osmodehydrated rind at 50^{0}Brix showed the lowest solid gain of 23.34 per cent and the highest solid gain (27.46 %) was observed for 70^{0}Brix osmotic concentration. Among the immersion time, 48 hr recorded the highest solid gain of 28.11 per cent followed by 36 hr (T_2) with 25.79 per cent of solid gain. Maximum water loss (49.10 %) was observed for rind osmosed in 70^{0}Brix, 48 hr (C_2T_3), while minimum water loss (22.31 %) was in treatment with osmotic concentration of 50^{0}Brix for immersion time of 24 hr. The fruit slices osmosed in 70^{0}Brix for 48 hr (C_2T_3) recorded maximum weight reduction of 29.00 per cent and the minimum weight reduction of 18.93 per cent was observed for C_1T_1 (50 ^{0}Brix, 24 hr).The results are in confirmation with the findings of Phisut (2012) and the higher osmotic concentration led to higher water loss and solid gain of the osmosed fruits. A similar trend of increase in mass transfer characters with increase in immersion time and diffusing solution concentrations were noticed in banana (Archana and Lekshmi, 2019) and bilimbi (Aparna *et al,* 2022).

Biochemical qualities of osmodehydrated *G.gummi-gutta*

Biochemical evaluation of osmodehydrated Malabar tamarind (Table 2) revealed that the fruit rind osmosed in 70 ^{0}Brix for 48 hr recorded the highest Total Soluble Solids of 46.93^{0}Brix, total sugar (48.04 %) and reducing sugar (17.48 %) with the lowest tritratable acidity of 1.54 per cent followed by rind osmosed in 70^{0}Brix for 36 hr. Highest HCA content of 2.90 per cent was observed for the fruit osmosed in 50^{0}Brix for 24 hr and the lowest (1.28 %) was recorded for 70 ^{0}Brix for 48 hr. With the increase in immersion time and concentration of osmotic medium, acidity decreased and is supported by the findings of Turkiewicz *et al* (2020) who confirmed that osmodehydration process reduced organic acids in Japanese quince by 77 per cent compared to fresh fruit. The highest antioxidant activity of 78.38% was observed for the osmodehydrated product prepared by immersing at 50^{0}Brix for 24 hr and with increase osmotic solution concentration and immersion time, acidity and antioxidant activity of the osomdehydrated Malabar tamarind fruits decreased. This might be due to higher leaching of soluble components during osmotic diffusion process as reported by Phisut *et al* (2013).

Sensory analysis of osmodehydrated *G.gummi-gutta*

Sensory parameters *viz.,* taste, colour (golden yellow to light brown), flavour, texture and overall acceptability (Fig 1.) for osmodehydrated malabar tamarind fruits revealed that the highest mean score for taste (8.60) was recorded for osmodehydrated fruit in 70^{0}Brix for 36 hr followed by C_2T_3 (70^0 Brix, 48 hr) with 8.47 and C_1T_3 (50^0 Brix, 48 hr) recorded a mean score of 8.17. On analyzing colour of the osmodehydrated products, the highest mean score (8.53) was for fruit osmosed in 70^0 Brix for 48 hr whereas the highest score for flavour (8.60) was recorded by the osmodehydrated fruit with the osmotic pre-treatment of 70^0 Brix for 36 hr. Landim *et al* (2016) confirmed that osmotic pretreatment protected the colour of fruits and vegetables. The highest mean score for overall acceptability (8.63) was recorded for 70^{0}Brix, 36 hr (C_2T_2) followed by 70^0 Brix, 48 hr (C_2T_3) with a mean score of 8.40. Osmodehydration process helped to retain initial fruit characteristics *viz*., colour, aroma, texture and nutritional composition, and product stability (Ramya and Jain, 2017).

Changes in Biochemical parameters of osmodehydrated *G.gummi-gutta* during storage

The osmodehydrated *G. gummi-gutta* fruits were stored for a period of 3 months to assess the storage stability of the products (Fig 2). During storage, the TSS, total and reducing sugar content of osmodehydrated fruit slices were significantly increased. Results were in accordance with the findings of Sagar and Kumar (2009) in mango. Katsoufi *et al (*2017) confirmed that increased total sugar concentration made the fruit tissue more brittle and less tough. Acidity of the dehydrated fruits significantly increased during storage and the osmodehydrated slices in 70^{0}Brix for 36 hr recorded an acidity of 1.72 per cent, 1.75 per cent and 1.79 per cent after 1st, 2ndand 3rd month of storage respectively. Osmodehydrated fruits in 70^{0}Brix for 36 hr recorded an antioxidant activity of 70.61 per cent after one month of storage, 70.20 per cent after second month and 68.63 per cent after third month of storage which showed a decreasing trend during storage. The sensory scores for all osmodehydrated fruit samples recorded a decreasing trend during storage and were acceptable even after three months of storage. Similar result was reported by Aparna *et al* (2018) for osmo-dehydrated bilimbi during storage.

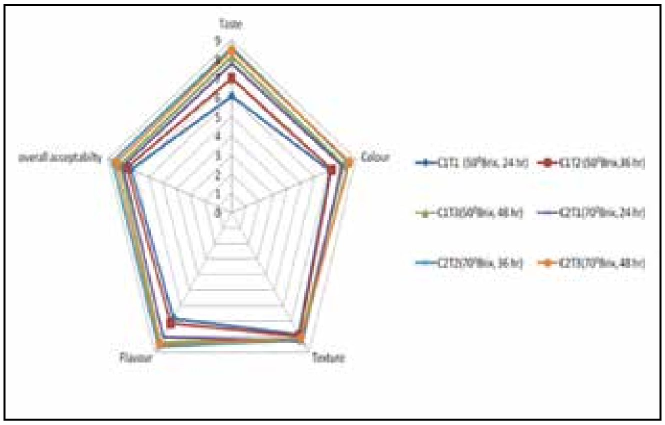

Fig 1. Sensory qualities of osmodehydrated *G.gummi-gutta*

CONCLUSION

The osmodehydration studies of *Garcinia gummi-gutta* fruits revealed that osmotic pre-treatment of Malabar tamarind fruit yielded good quality dehydrated fruits. The osmotic treatment with 70^0 Brix for 36 hr recorded the dehydrated fruits with reduced acidity, favoured the mass transfer properties, and improved consumer acceptability. Storage studies of the osmodehydrated malabar tamarind revealed that TSS, sugars, and acidity increased with storage while antioxidant activity and HCA decreased. The Osmodehydrated *Garcinia* fruit for an immersion time of 36 hr recorded highest acceptability scores at the end of the storage and which can be further utilized for product development studies.

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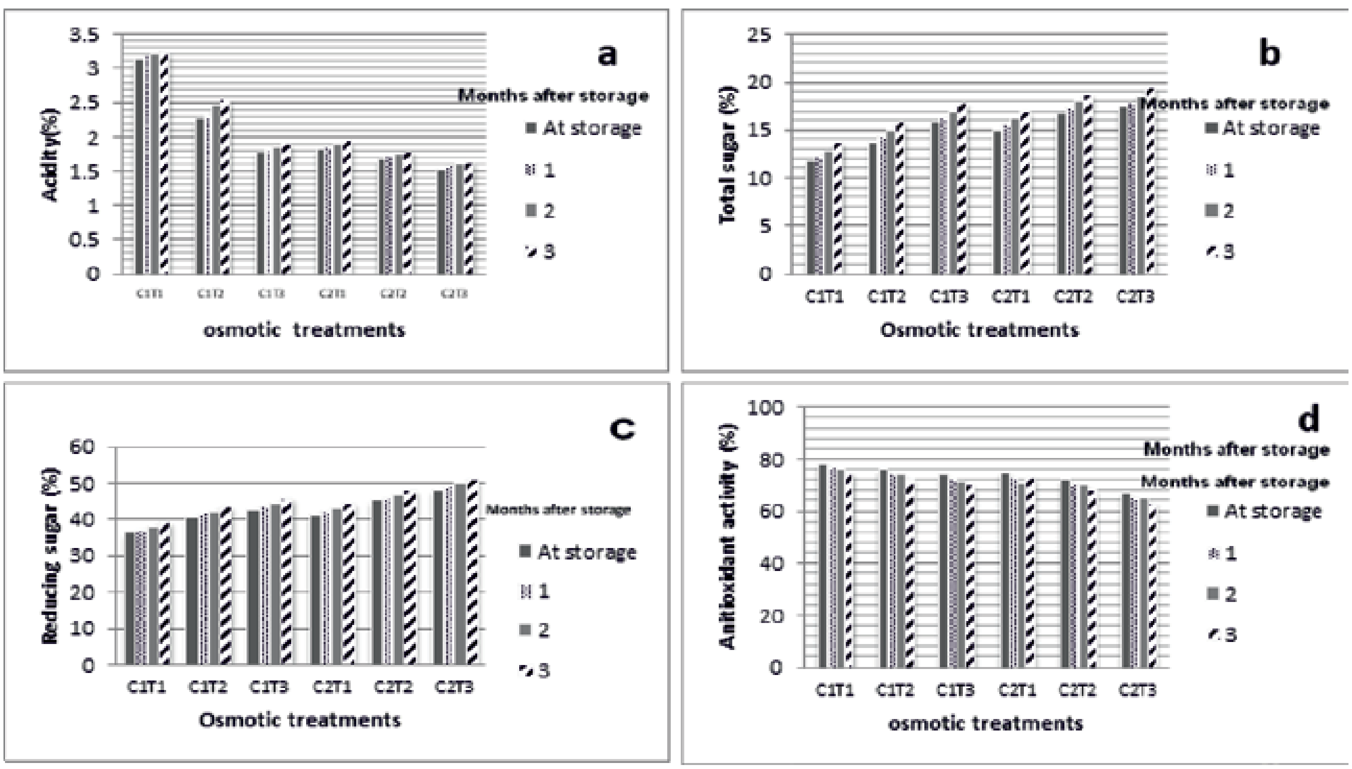

Fig 2. Changes in acidity (a), total sugar (b), reducing sugar(c) and antioxidant activity(d) of osmodehydrated G.gummi-gutta during storage

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