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Standardization of Process Variables for the Development of Osmo-dehydrated Coconut Haustorium

A.K. Archana[1], P.R. Geetha Lekshmi[1]

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ABSTRACT

Background: Coconut (*Cocos nucifera* L.) is considered a highly valuable and beneficial perennial crop in our country. The basal portion of the coconut embryo enlarges during germination and forms a spongy structure, haustorium, which is an excellent source of essential nutrients. Since consumer preference is shifting towards healthy food and processed coconut products have immense scope in this sector, the study was conducted to standardize the process variables for osmo-dehydration of coconut haustorium and to evaluate the nutritional qualities of the osmo-dehydrated product.

Methods: The present study involved the development of osmo-dehydrated coconut haustorium by standardizing the process variables, *viz*., osmotic solution concentration and immersion time. Mass transfer, physical, biochemical and sensory parameters were analysed to evaluate the nutritional qualities and consumer acceptance.

Result: The results on biochemical properties revealed that an increase in concentration and time of immersion increased TSS, total sugar, reducing sugar, ash and mineral content. The process variables were standardized for the development of osmo-dehydrated coconut haustorium with optimum mass transfer characters, better nutritional qualities and consumer acceptance, which has application in the food industry.

Key words: Coconut haustorium, Flavonoids, Nutrition, Osmo-dehydration, Phenols, Water loss.

INTRODUCTION

Coconut (*Cocos nucifera* L.) is a versatile and economically important crop mostly utilized in tropical regions of the world for culinary purposes. Coconut is considered as an oil seed as well as food crop. It provides various edible parts like coconut meat/ kernel, tender coconut, coconut water, coconut sap *etc*. which are rich in essential nutrients, vitamins and minerals. Coconut products are used in food, pharmaceutical and cosmetic industries and are important in international trade. Coconut haustorium also known as 'coconut apple', a product from coconut with immense health benefits, is functionally the cotyledon during the germination of coconut (Tonpe *et al*., 2014). The embryo near the germinating pore in coconut enlarges to form a spongy structure called haustorium which fills the entire water cavity and mobilizes nutrients from endosperm to nourish the germinating embryo. Coconut haustorium has been proven to have an array of health benefits, including low caloric intake and high content of proteins, fibre and enzymes that support a number of physiological chemical reactions and metabolic processes, thereby promoting coronary health and facilitating digestion (Mohan *et al*., 2018).

Coconut haustorium is a nutritious tropical delicacy rich in antioxidants and various phytoconstituents that possess strong antibacterial and anti-inflammatory activities which can boost our immune system. Even though haustorium is rich in bioactive compounds, its value addition remains underscored (Rakesh *et al*., 2021). Dehydration is the oldest and most effective food processing method and osmotic dehydration is a pre-treatment process that improves product quality. The development of value-added products from coconut haustorium by enhanced dehydration through osmotic process improves its nutritional quality, palatability and shelf life. Osmotic dehydration is a pretreatment process, which depends upon the phenomenon of diffusion of moisture from food materials by immersing in a hypertonic solution (Tortoe, 2010). It is usually followed by other drying methods such as air drying, deep fat frying, freeze drying, *etc*. to produce better quality final product. Choosing the optimal osmotic process parameters is very important for product quality and mass exchange efficiency (Ciurzynska *et al*., 2016). Therefore, the present study was conducted to standardize the process variables *viz*. solution concentration and immersion time, for the development of osmo-dehydrated coconut haustorium. The osmo-dehydrated coconut haustorium can be used as a snack food or components of breakfast cereals for direct usage and also in confectionaries.

[1]Department of Postharvest Management, College of Agriculture, Vellayani-695 522, Thiruvananthapuram, Kerala, India.

Corresponding Author: A.K. Archana, Department of Postharvest Management, College of Agriculture, Vellayani-695 522, Thiruvananthapuram, Kerala, India.
Email: archana-2019-22-021@student.kau.in

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MATERIALS AND METHODS

The optimally matured coconut haustorium, which filled the entire cavity of germinating coconut were extracted and cut into cubes of 2 cm^3 size. The coconut haustorium cubes were exposed to osmotic dehydration process through wet infusion dehydration with sucrose as humectant. The sucrose solution as osmotic agent were prepared at three different concentrations *viz*. 40°Brix (C_1), 50°Brix (C_2) and 60°Brix (C_3) and 0.1% citric acid, 0.1% potassium metabisulphite and 0.2% ascorbic acid were added to the osmotic solution. The osmosis process of haustorium cubes was done at three different durations of 60 minutes (I_1), 120 minutes (I_2) and 180 minutes (I_3). After the osmotic process, haustorium slices were analysed for mass transfer characters *viz*., solid gain, water loss, water loss to solid gain and percentage weight reduction and were dehydrated at 50°C using a cross-flow cabinet dryer till its moisture content reached 15 to 20%. Dehydrated haustorium without osmosis was taken as control and all the osmo dehydrated products and the control sample were analysed for physical, biochemical and sensory parameters which is necessary to understand its nutritional components for food applications.

Mass transfer characters

The dry mass of the fresh cubes and the dry mass after osmosis were recorded together with the fresh weight and weight after osmosis. Water loss was computed using the method outlined by Sridevi and Genitha (2012).

$$WL\ (\%) = \frac{(W_o - W_t) + (S_t - S_o)}{W_o} \times 100$$

W_o= Initial weight of haustorium cubes.
W_t= Weight of haustorium cubes after osmotic dehydration.
S_0= Initial dry mass of haustorium cubes.
S_t= Dry mass of haustorium cubes after osmotic dehydration.

The solid gain of osmosed haustorium cubes was determined according to Kowalski and Mierzwa (2011).

$$SG\ (\%) = \frac{S_t - S_i}{m_i} \times 100$$

Where:
S_t= Dry mass at time t.
S_i= Initial dry mass (of fresh).
m_i= Initial mass of the wet sample.

Water loss to solid gain is expressed as the ratio of calculated value of water loss and solid gain.

$$\frac{WL}{SG} = \frac{\%\ \text{Water loss}}{\%\ \text{Solid gain}}$$

The weight reduction in percentage was computed following the procedure described by Yadav *et al*. (2012).

$$WR\ (\%) = \frac{M_o - M}{M_o} \times 100$$

M_o= Initial mass of fruit slices before osmosis (g).
M= Mass of fruit slices after osmosis (g).

Physical characters

Physical parameters of osmo-dehydrated haustorium cubes, *viz*. yield and rehydration ratio were analyzed based on the standard methods defined by Yadav *et al*. (2012).

The weight of osmodehydrated product obtained from a known quantity of fresh coconut haustorium cubes was recorded and the yield was calculated using the formula.

$$\text{Yield}\ (\%) = \frac{\text{Weight of dehydrated haustorium}}{\text{Weight of fresh haustorium}} \times 100$$

Five grams of dehydrated haustorium sample was added to 100 ml of water, boiled for 3 minutes, filtered and the sample was weighed. The rehydration ratio was calculated using the formula.

$$\text{Rehydration ratio} = \frac{\text{Weight of rehydrated sample}}{\text{Weight of dried sample}}$$

Biochemical characters

The starch content using Anthrone method, titrable acidity, total and reducing sugars, ascorbic acid, total ash, peroxide value and free fatty acid content of osmo-dehydrated coconut haustorium was estimated as per the method described by Ranganna (1986) and the protein content was estimated by following Bradford's colourimetric method (Kruger, 2009). The moisture content (%) was estimated using a moisture analyzer (Essae and MAX 50) based on thermogravimetric method. The total soluble solids were recorded by Atago-0 to 53% digital refractometer. The 2, 2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging assay was used to measure the antioxidant activity (Sharma and Bhat, 2009). Total phenol, total flavonoids and crude fibre were calculated following the procedure by Sadasivam and Manickam (1996) and the carotenoids by spectrophotometry (Saini *et al*., 2015). The total mineral content of osmo-dehydrated haustorium were estimated using the method by Luten *et al*. (1996).

Sensory quality

Sensory attributes of osmo-dehydrated haustorium were analyzed using the hedonic rating by 30 semi-trained panels (Ranganna, 1986). The data on mass transfer characters were statistically analysed using completely randomized design (CRD) with two factors and three levels and the data on physical and biochemical characters of osmo-dehydrated coconut haustorium were examined using completely randomized design. The sensory score was evaluated using Kruskall-Wallis chi-square test (Shamrez *et al*., 2013).

RESULTS AND DISCUSSION

Mass transfer characters of osmo-dehydrated coconut haustorium

The coconut haustorium cubes osmosed in 60°Brix solution for 180 minutes, recorded the highest water loss (25.31%) (Table 1). The water loss of haustorium cubes increased with osmotic concentration, which was recorded

as 4.78%, 9.21% and 21.97% for 40°Brix, 50°Brix and 60°Brix respectively. The water loss for the 60, 120 and 180 minutes immersion times was 9.46%, 11.66% and 14.85%, respectively. Patil *et al.* (2018) confirmed increased water loss with an increase in osmotic concentration and immersion time during osmo-dehydration studies in orange segments. Water loss increased as osmotic concentration and treatment time increased, supporting the results of the present study (Aparna *et al*., 2022).

Solid gain increased with an increase in concentration, where 60°Brix recorded the highest solid gain of 12.40%. Osmo-dehydration of haustorium cubes using sucrose solution of 60°Brix for 180 minutes observed maximum solid gain (15.08%). The solid gain increased as solution concentration and immersion period increased in osmo-dehydrated sweet potato (Singh *et al*., 2014) and osmo-dehydrated mangoes (Zongo *et al*., 2023). Solution concentration of 40°Brix recorded the lowest water loss to solid gain ratio of 0.87, which increased to 1.26 for 50°Brix and 1.80 for 60°Brix concentration. Among the immersion time, 180 minutes recorded the highest water loss to solid gain ratio (1.43) and the highest weight reduction (2.80%). Weight reduction increased with an increase in solution concentration, where 60°Brix recorded the highest reduction in weight (3.88%) and the coconut haustorium osmo-dehydrated at 60°Brix and 180 minutes recorded the highest weight reduction of 4.70%. The highest water loss with increase in osmotic solution concentration and immersion time resulted in highest weight reduction of osmo-dehydrated product as described by Tortoe (2010). Increased weight reduction with an increase in solution concentration and immersion time was reported in osmo-dehydrated Red Banana (Archana and Lekshmi, 2019).

Physical characters of osmo-dehydrated coconut haustorium

The highest yield (37.70%) was noticed for the osmotic treatment 60°Brix and 180 minutes and the lowest yield (25.24%) was recorded for 40°Brix and 60 minutes (Table 2). Osmo-dehydration studies for bilimbi (Aparna *et al*., 2022) confirmed that higher concentration with increased immersion time resulted in higher yield which might be

Table 1: Mass transfer characters of osmo-dehydrated coconut haustorium influenced by osmotic concentration and immersion time.

Osmotic concentrations	Water loss (%)			
	I_1	I_2	I_3	Mean (C)
C_1	2.22^{g}	5.44^{f}	6.68^{f}	4.78^{c}
C_2	6.77^{f}	8.31^{e}	12.55^{d}	9.21^{b}
C_3	19.38^{c}	21.22^{b}	25.31^{a}	21.97^{a}
Mean (I)	9.46^{c}	11.66^{b}	14.85^{a}	
SE(±m)	C-0.269	I-0.269	C × I-0.466	
CD (0.05)	C-0.799	I-0.799	C × I-1.383	
		Solid gain (%)		
C_1	5.17^{e}	5.54^{de}	5.66^{de}	5.46^{c}
C_2	5.94^{de}	6.76^{d}	8.97^{c}	7.22^{b}
C_3	10.03^{c}	12.07^{b}	15.08^{a}	12.40^{a}
Mean (I)	7.05^{c}	8.13^{b}	9.91^{a}	
SE(±m)	C-0.297	I-0.297	C × I-0.514	
CD (0.05)	C-0.882	I-0.882	C × I -1.528	
		Water loss to solid gain		
C_1	0.44^{f}	0.99^{e}	1.18^{cde}	0.87^{c}
C_2	1.16^{de}	1.23^{cd}	1.41^{c}	1.26^{b}
C_3	1.94^{a}	1.77^{ab}	1.70^{b}	1.80^{a}
Mean (I)	1.18^{b}	1.33^{a}	1.43^{a}	
SE(±m)	C-0.046	I-0.046	C × I-0.079	
CD (0.05)	C-0.136	I-0.136	C × I-0.235	
		Percentage weight reduction (%)		
C_1	0.91^{f}	1.20^{f}	1.40^{ef}	1.17^{c}
C_2	1.91^{de}	2.08^{d}	2.29^{d}	2.09^{b}
C_3	3.18^{c}	3.77^{b}	4.70^{a}	3.88^{a}
Mean (I)	2.00^{c}	2.34^{b}	2.80^{a}	
SE(±m)	C-0.101	I-0.101	C × I-0.175	
CD (0.05)	C-0.3	I-0.3	C × I-0.52	

C_1- 40°Brix; C_2- 50°Brix; C_3- 60°Brix; I_1- 60 minutes; I_2- 120 minutes; I_3- 180 minutes.

due to increased pressure gradients that boosted solid gain and yield.

The rehydration ratio showed a declining pattern in the current investigation as osmotic concentration and immersion time increased. The lowest rehydration ratio of 1.03 was recorded at 60°Brix concentration and immersion time of 180 minutes. The larger amount of sugar in the osmosed slice may prevent water absorption due to the preoccupation of the pore spaces, resulting in a reduced rehydration ratio with increased osmotic solution concentration and immersion time (Bakhara *et al*., 2018). Lower rehydration values were reported by Salazar *et al.* (2019) when osmo-dehydration of pineapple was conducted using sucrose solution at 30°Brix, 35°Brix and 40°Brix for an immersion time of 60 minutes, which might be due to the occurrence of a structural protector prior to dehydration. The dehydrated coconut haustorium without osmotic process (control) recorded the highest rehydration ratio of 4.10 indicating the structural distortion of the coconut haustorium while dehydration.

Biochemical characters of osmo-dehydrated coconut haustorium

The starch content in osmo-dehydrated coconut haustorium decreased with the increase in osmotic solution concentration and immersion time (Table 3a). Islam *et al.* (2018) also reported declining trend for starch during the osmo-dehydration of fresh chayotes with increase in osmotic concentration and immersion time. The protein content, ascorbic acid and moisture content were found non-significant for all osmo-dehydrated coconut haustorium. The total soluble solid content in the osmo-dehydrated coconut haustorium increased with increase in concentration and immersion time. The higher sugar/solid gain and pressure gradients as a result of increased osmotic solution concentration might be the cause of total soluble solids

Table 2: Physical characters of osmo-dehydrated coconut haustorium influenced by osmotic concentration and immersion time.

Osmotic treatments	Yield (%)	Rehydration ratio
C_1I_1	25.24^{e}	3.57^{b}
C_1I_2	26.11^{e}	2.83^{c}
C_1I_3	26.26^{e}	2.83^{c}
C_2I_1	27.56^{d}	2.54^{cd}
C_2I_2	28.07^{d}	2.53^{cd}
C_2I_3	31.82^{c}	2.38^{de}
C_3I_1	32.52^{c}	2.05^{ef}
C_3I_2	34.74^{b}	1.84$^{f\ the}$
C_3I_3	37.70^{a}	1.03^{g}
Control (without osmotic drying)	23.02^{f}	4.10^{a}
SE(±m)	0.385	0.12
CD	1.136	0.353

C_1- 40°Brix; C_2- 50°Brix; C_3- 60°Brix.

I_1- 60 minutes; I_2- 120 minutes; I_3- 180 minutes.

Table 3a: Biochemical characters of osmo-dehydrated coconut haustorium influenced by osmotic concentration and immersion time.

Osmotic treatments	Starch (%)	Protein (g 100 g^{-1})	Moisture (%)	TSS (°Brix)	Titrable acidity (%)	Ascorbic acid (mg 100 g^{-1})	Total sugar (%)	Reducing sugar (%)
C_1I_1	17.58^{a}	3.41	16.78	9.53^{fg}	1.60^{b}	55.55	27.17^{d}	10.89^{e}
C_1I_2	17.14^{ab}	3.94	16.68	10.13^{f}	1.55^{bc}	49.99	27.25^{d}	11.21^{de}
C_1I_3	16.53^{bc}	4.12	16.17	11.57^{f}	1.52^{c}	48.99	30.11^{bc}	11.46^{cde}
C_2I_1	16.39^{c}	3.98	16.86	14.30^{e}	1.37^{d}	55.55	28.74^{cd}	11.63^{cde}
C_2I_2	15.92^{cd}	4.07	16.30	18.27^{d}	1.33^{d}	49.99	29.41^{bc}	12.10^{bcd}
C_2I_3	15.31^{de}	4.57	16.14	20.50^{c}	0.85^{e}	43.44	30.38^{bc}	12.51^{bc}
C_3I_1	14.85^{ef}	3.95	16.11	22.10^{c}	0.43^{f}	40.44	30.51^{b}	12.83^{b}
C_3I_2	14.28^{f}	4.25	16.01	28.07^{b}	0.39^{f}	44.44	30.87^{b}	13.16^{b}
C_3I_3	13.08^{g}	4.53	15.59	37.77^{a}	0.29^{g}	44.44	34.02^{a}	16.41^{a}
SE(±m)	0.229	0.406	0.544	0.715	0.019	6.804	0.591	0.364
CD	0.674	NS	NS	2.109	0.055	NS	1.745	1.075

C_1- 40°Brix; C_2- 50°Brix; C_3- 60°Brix.

I_1- 60 minutes; I_2- 120 minutes; I_3- 180 minutes.

increase in osmo-dehydrated samples as supported by Shukla *et al.* (2018). The acidity of osmo-dehydrated coconut haustorium decreased with the increase in osmotic concentration and immersion time and the lowest acidity (0.29%) was recorded at 60°Brix and 180 minutes. The acid from fruits might have leached into hypertonic osmotic solution causing the reduction in acidity (Salazar *et al*., 2019). The changes in ascorbic acid content were found to be non-significant as the osmotic solution was added with 0.2% ascorbic acid content anticipating the loss of vitamin C during the osmotic process reported in earlier studies and the variations in ascorbic acid content would likely result from the reasons mentioned above. The maximum total sugar (34.02%) and reducing sugar (16.41%) were noticed at 60°Brix and 180 minutes which suggests that osmo-dehydration resulted in increased sugar due to the rise in osmotic concentration (Aparna *et al*., 2022).

The antioxidant activity, carotenoid, total phenol, total flavonoids and crude fibre were reduced with rise in solution concentration and immersion time (Table 3b). Osmo-dehydration at 60°Brix and 180 minutes observed 78.19% antioxidant activity with 2.65 µg 100 g^{-1} carotenoids, 150.92 mg GAE 100 g^{-1} total phenols and 77.87 µg $QUEg^{-1}$ total flavonoids. The polyphenols may attach to other molecules or undergo structural changes, causing reduction of antioxidant efficacy during drying (Martin-Cabrejas *et al*., 2009). A similar trend of decline in antioxidant activity with increase in concentration and immersion time was reported in papaya (Islam *et al*., 2019). Carotenoid polyene chains become unstable and undergo modifications from oxidation or isomerization which might be the cause of drop in carotenoid content during osmo-dehydration (Salazar *et al*., 2019). Similar findings of decreasing total phenol and total flavonoid during osmo-dehydration were noticed in pineapple (Zzaman *et al*., 2021).

According to Chavan and Amarowicz (2012), products differ in terms of tissue compactness, initial insoluble and soluble solids, intercellular gaps and enzymatic activity. The coconut haustorium is a spongy mass of tissue and the structure is different from that of fruits. The crude fibre content decreased with osmotic concentration and time and noticed 25.65% at 60°Brix and 180 minutes while the changes in peroxide value and free fatty acid were non-significant with increase in concentration and immersion time. Because of increased enzyme activity, the cell wall network varied as the concentration of sugar solution increased, dissolving the pectin components which might be the reason for the decrease in crude fibre content as reported by Shirvan *et al* (2023). The total ash and minerals increased as the immersion time and solution concentration were elevated, with 5.29% total ash and 52.95% total minerals at 60°Brix and 180 minutes. Since osmo-dehydration is the simultaneous process of water and solute diffusion, the increase in ash content may be caused by sugar in the osmotic solution that diffused into the sample as the water migrated out (Krokida and Kouris, 2003). Famurewa *et al.* (2006) confirmed the findings of increased ash content with increase in concentration and immersion time during osmotic dehydration of red bell pepper in sugar solution. The present study results are also in conformity with Odewole and Olaniyan (2016) where a similar pattern of increase in ash content was observed during osmo-dehydration of bell pepper using salt solution of 5%, 10%, 15% and 20% for immersion time of 60 minutes, 90 minutes, 120 minutes and 150 minutes respectively. The increase in ash content is in agreement with the results reported by Olaniyan and Omoleyomi (2013) for osmo-dehydrated okra, Sethi and Kaur (2019) in pineapple. According to Adeyeye *et al.* (2020), the likely mineral composition of every material is estimated by the ash and a moderate concentration of mineral components probably result from the ash content. In the osmo-dehydration of coconut haustorium, an increase in total mineral content was observed which might be due to the increase in ash content of osmo-dehydrated haustorium. Similar trend of increase in total minerals was reported in cabbage by Cvetkovic *et al.* (2019).

Table 3b: Biochemical characters of osmo-dehydrated coconut haustorium influenced by osmotic concentration and immersion time.

Osmotic treatments	Antioxidant activity (%)	Carotenoids (µg 100 g^{-1})	Total phenol (mg GAE 100 g^{-1})	Total flavonoids (µg QUE g^{-1})	Crude fibre (%)	Peroxide value (meq kg^{-1})	Free fatty acid (mg g^{-1})	Total ash (%)	Total minerals (%)
C_1I_1	88.42^{a}	2.66^{ab}	175.88^{a}	86.60^{a}	26.88^{abcd}	0.22	0.63	1.39^{d}	13.92^{d}
C_1I_2	87.20^{ab}	1.66^{bc}	173.00^{ab}	84.30^{bc}	26.73^{bcd}	0.22	0.63	2.18^{cd}	21.77^{cd}
C_1I_3	86.43^{bc}	1.50^{bc}	170.85^{bc}	85.35^{ab}	26.18^{de}	0.18	0.63	2.80^{bcd}	28.03^{bcd}
C_2I_1	84.67^{c}	3.61^{a}	167.71^{cd}	83.24^{cd}	28.17^{a}	0.23	0.57	3.73^{abc}	37.29^{abc}
C_2I_2	84.44^{c}	2.68^{ab}	164.65^{de}	82.87^{cde}	27.74^{ab}	0.23	0.57	3.83^{abc}	38.31^{abc}
C_2I_3	83.56^{c}	1.17^{bc}	161.63^{ef}	82.34^{de}	27.63^{abc}	0.2	0.61	3.96^{abc}	39.64^{abc}
C_3I_1	81.54^{d}	4.27^{a}	159.10^{fg}	81.37^{ef}	26.33^{cde}	0.25	0.6	4.34^{ab}	43.38^{ab}
C_3I_2	80.95^{d}	2.94^{ab}	154.71^{gh}	79.57^{fg}	26.00^{de}	0.22	0.63	4.91^{a}	49.14^{a}
C_3I_3	78.19^{e}	2.65^{ab}	150.92^{h}	77.87^{g}	25.65^{de}	0.23	0.60	5.29^{a}	52.95^{a}
SE(±m)	0.48	0.604	1.537	0.631	0.471	0.021	0.047	0.704	7.04
CD	1.415	1.783	4.535	1.861	1.389	NS	NS	2.077	20.77

C_1- 40°Brix; C_2- 50°Brix; C_3- 60°Brix; I_1- 60 minutes; I_2- 120 minutes; I_3- 180 minutes.

Sensory qualities of osmo-dehydrated coconut haustorium

The highest mean scores for appearance (8.75), taste (9.00), flavour (8.94), texture (9.00), odour (9.00) (Table 4) and overall acceptability (8.94) (Fig 1) were observed for 60° Brix and 180 minutes. Aparna *et al.* (2018) confirmed improved sensory scores in osmo-dehydrated bilimbi at higher concentrations of 80°Brix and 180 minutes immersion time and the product was found acceptable and microbiologically safe for a period of four months. Sucrose solution as the osmotic agent at higher concentration of 60°Brix in cabinet tray drying exhibited better organoleptic characters with high sensory scores in osmo-dehydrated pineapple slices (Chaudhary *et al.*, 2019). The higher mean score at higher concentrations and immersion time was supported by Aparna and Lekshmi (2023) in malabar tamarind. Dehydrated haustorium without osmotic treatment recorded the highest mean score for colour (8.31). The higher score in dehydrated haustorium without osmosis might be due to the fact that higher sugar concentration caused osmo-dehydrated samples to turn brown during the drying process (Rodrigues *et al.*, 2003).

Based on the mass transfer, physical, biochemical and organoleptic qualities, the osmotic process variables 60° Brix solution concentration and 180 minutes immersion time were standardized for the development of osmo-dehydrated coconut haustorium with improved nutritional characteristics and consumer acceptability.

Table 4: Sensory attributes of osmo-dehydrated coconut haustorium influenced by osmotic concentration and immersion time.

Treatments	Mean scores					
	Appearance	Taste	Colour	Flavour	Texture	Odour
C_1I_1	8.00^{ab}	7.31^{ab}	7.31^{a}	7.75^{abc}	7.75^{ab}	7.50^{a}
C_1I_2	8.06^{ab}	7.06^{a}	8.00^{bc}	7.56^{ab}	7.94^{ab}	7.56^{a}
C_1I_3	8.37^{bc}	7.18^{a}	8.25^{b}	7.94^{ac}	7.94^{ab}	7.93^{ac}
C_2I_1	8.00^{ab}	7.56^{ab}	8.13^{b}	7.88^{abc}	8.25^{a}	7.44^{a}
C_2I_2	8.06^{ab}	7.31^{ab}	8.00^{bc}	7.38^{b}	7.56^{b}	7.81^{a}
C_2I_3	8.31^{bc}	7.63^{ab}	7.81^{bc}	7.63^{abc}	7.75^{ab}	7.63^{a}
C_3I_1	8.19^{b}	8.00^{de}	7.75^{abc}	7.75^{abc}	8.06^{a}	8.38^{c}
C_3I_2	8.00^{ab}	8.44^{bd}	7.50^{ac}	8.13^{c}	8.25^{a}	8.38^{c}
C_3I_3	8.75^{c}	9.00^{e}	8.00^{bc}	8.94^{e}	9.00^{d}	9.00^{d}
Control (without osmotic drying)	7.69^{a}	6.25^{c}	8.31^{b}	5.50^{d}	5.38^{c}	5.06^{b}
P value	0.001**	0.000**	0.007**	0.000*	0.000**	0.000**
χ^2	27.43	83.53	22.53	77.35	90.57	100.60

C_1- 40°Brix; C_2- 50°Brix; C_3- 60°Brix; I_1- 60 minutes; I_2- 120 minutes; I_3- 180 minutes.

*Significant at 5% level of significance; (P value less than 0.05).

**Significant at 1% level of significance; (P value less than 0.01).

Like extremely-9; Like very much-8; Like moderately-7; Like slightly-6; Neither like nor dislike-5; Dislike slightly-4; Dislike moderately-3; Dislike very much-2; Dislike extremely-1.

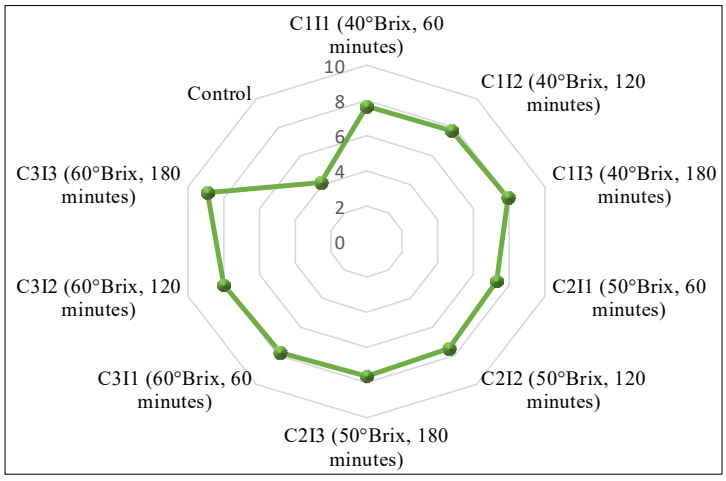

Fig 1: Overall acceptability of osmo-dehydrated coconut haustorium.

CONCLUSION

A growing interest in innovative and nutritionally enhanced foods for preserving human well-being and consumer health is a characteristic of today's society. Coconut haustorium is a great source of vital nutrients and bioactive substances that enhance health benefits. As per the findings of this investigation, osmotic dehydration is among the best and most appropriate ways to extend the shelf life and value of haustorium. The osmo-dehydrated haustorium developed at 60°Brix concentration and 180 minutes immersion time was found nutritionally superior with high consumer acceptance. The study shows light on the usage of coconut haustorium as a snack food with extended shelf life and consumer acceptability due to its unique taste, flavour and its exquisite structure. It has application in food industry for the development of novel and functional foods.

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Conflict of interest

The authors declare no conflict of interest.

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