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Bioscience Research

Print ISSN: 1811-9506 Online ISSN: 2218-3973

Journal by Innovative Scientific Information & Services Network

RESEARCH ARTICLE BIOSCIENCE RESEARCH, 2020 17(4): 3003-3007. **OPEN ACCESS**

Influence of Convective Dehydration on Physico-chemical, Antioxidant and Organoleptic Attributes of Calabash Fruit (*Crescentia cujete* L)

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Calabash (*Crescentiacujete* L) is an underutilized seasonal fruit containing phytochemical constituents with numerous health advantages. The ideal and practical strategy for prolonging the stability of calabash fruit is dehydration. In our research, the pulp of calabash was dehydrated by convective drying for different conditions (8.0/52, 7.5/54, 7.0/56, 6.5/58, 6.0/60 hours/^{o}C). The dried calabash pulp was evaluated on various physico-chemical, antioxidant and organoleptic attributes such as total soluble solid (TSS, ^{o}Brix), moisture content (%), titratable acidity (%), ascorbic acid (mg/100g), rehydration ratio, total phenolic content (TPC, mg GAE/100g), total flavonoid content (TFC, mg CE/100g), free radical scavenging activity (% DPPH), ferric reducing antioxidant power (FRAP, µg/g), color, texture, flavor, taste, overall acceptance. Experimental results revealed that calabash pulp should be dehydrated at 56^{o}C for 7 hours to achieve the best physico-chemical and organoleptic properties. Drying of calabash has been demonstrated to be a cost effective and an appropriate approach to decrease the bulk and to enhance the shelf-life of valuable fruit during preservation.

Keywords: Calabash, drying, physico-chemical, antioxidant, organoleptic, shelf-life, preservation

INTRODUCTION

Calabash (*Crescentiacujete* L) fruit has been used as ornamental and folk medicinal purposes (Gang et al., 2010). It is globular with smooth hard green woody shell (Ejelonu et al., 2011). *Crescentiacujete* fruit is of nutritional value and is notably high in sodium and phosphorus (Ejelonu et al., 2011). The fruit pulp contains crescentic, tartaric, citric, tannic, chlorogenic and hydrocyanic acids (Olaniyi et al., 2018). The major constituents of the essential oil were kaur-16-ene, phytol, trans-pinane and hexadecanal (Olateju et al., 2016). Extracts from *Crescentiacujete* possessed anti-inflammatory, antibacterial, DPPH radical scavenging, antioxidant, cytotoxic, anti-venom, CNS depressant, wound healing activities (Juceni et al., 2007; Akinmoladun et al., 2010; Mahbub et al., 2011; Shastry et al., 2012; Aderibigbe et al., 2013; Das et al., 2014; Parvin et al., 2015; Agarwal and Chauhan, 2015; Campos et al., 2016). In Vietnam, the dried fruit is used in folk medicine to treat diarrhea, stomachache, cold, bronchitis, cough, asthma, and urethritis (Gang et al., 2010). The fruit itself can be mixed with milk, heated, and consumed for treating colds and asthma (Mackenzie et al., 2017). The syrup prepared from the pulp is used as a medicine for relieving disorders of the chest or respiratory tract and also to cure dysentery and stomach ache (Olaniyi et al., 2018). Calabash fruit is highly perishable under ambient environment. Its' necessary to have appropriate solution to extend product shelf-life. Not many studies mentioned to the drying of calabash pulp. Objective of our study focused on the effectiveness of convective drying conditions on the physico-chemical, antioxidant

and sensory characteristics of dried calabash.

MATERIALS AND METHODS

Material

Ripe calabash (*Crescentiacujete* L) fruitswere collected from HauGiang province, Vietnam. After collecting, they must be kept in dry cool box and quickly conveyed to laboratory for experiments. They were subjected to washing and treatment. Fruits were chopped into halves to collect their pulp inside. Pulp was set on stainless trays and dried in different conditions.

Researching method

Calabash pulp was dehydrated by convective dryer under various thermal conditons (8.0/52, 7.5/54, 7.0/56, 6.5/58, 6.0/60 hours/^{o}C). The dried calabash pulp was evaluated on various physico-chemical, antioxidant and organoleptic attributes such as total soluble solid (TSS, ^{o}Brix), moisture content (%), titratable acidity (%), ascorbic acid (mg/100g), rehydration ratio, total phenolic content (TPC, mg GAE/100g), total flavonoid content (TFC, mg CE/100g), free radical scavenging activity (% DPPH),ferric reducing antioxidant power (FRAP, µg/g), color, texture, flavor, taste, overall acceptance.

Physico-chemical and sensory analysis

Total soluble solid (TSS, ^{o}Brix) of fresh and dried samples was evaluated using hand-held refractometer.Moisture content (%) was estimated by comparing the weight of samples before and after drying in oven at 105^{o}C to a constant weight.Titratable acidity (%) was measured by titrating a known volume of the sample against standard0.1 N NaOH solution by using phenolphthalein as an indicator up to the end point of pink color. The titratable acidity was expressed as per cent malic acid (AOAC, 2000). Ascorbic acid content (mg/100g) was determined as per standard method using 2, 6- dichlorophenol indophenol dye after extracting in 3% m-phosphoric acid and titrating with the dye to an end point of pink colour(Ranganna, 1986). Rehydration ratio was expressed as a ratio of water absorbed by the dried sample to the weight of the dried sample.Total phenolic content(TPC, mg GAE/100g) was determined using Folin-Ciocalteu reagent (Hassan and Bakar, 2013). Total flavonoid content(TFC, mg CE/100g) was determined using aluminium chloride colorimetric method (Bakar et al., 2015). Free radical scavenging activity**(**DPPH, %) was conducted according to Bakar et al. (2017). Ferricreducing antioxidant power **(**FRAP, µg/g) assay was performed by procedure of Benzie and Strain (1996). Color, texture, flavor, taste, overall acceptance were evaluated as sensory score by a group of panelists using 9 point-Hedonic scale.

Statistical analysis

The experiments were run in triplicate with three different lots of samples. The data were presented as mean±standard deviation. Statistical analysis was performed by the Statgraphics Centurion version XVI.

RESULTS AND DISCUSSION

Physico-chemical attributes of fresh and dried calabash pulp

Physico-chemical attributes of fresh and dried calabash pulp were shown in table 1. Due to high moisture content, the fresh calabash pulp was highly susceptible to microbial and physiological reactions. The dried calabash pulp had shown a good rehydration ratio (4.02±0.01) by drying at 56^{o}C for 7 hours. Under this drying condition, the total soluble solid, moisture, titratable acidity, ascorbic acid were 42.85^{o}Brix, 16.34%, 1.63%, 24.53 mg/100g, respectively. Ascorbic acid had different biological activities due to its antioxidant properties (Davey et al. 2000; Lee and Kader, 2000). The dried product is generally safe and shelfstable (Solomon et al. 2006) but thermal treatment also caused degradation of ascorbic acid content in fruit to a significantly low level (Vinson, 1999; Takeoka et al. 2001; Dewanto et al. 2002; Slavin, 2006; Slatnar et al. 2011). Both the wet and dry pulp of of calabash fruit have reasonable values of phytochemicals and are free from HCN toxicity (Marc, 2008).

Antioxidant attributes of fresh and dried calabash pulp

Dehydration is a complicated process involving simultaneous, coupled heat and mass transfer phenomena occurring inside the material (Yilbas et al. 2003). The heat transfer occurs when the hot air (low relative humidity) met with the wet surface that transfer heat by conduction and then liquid migrates on the material surface by the convection method followed by the transport of the moisture within solid food occur by surface diffusion, vapor diffusion, hydrostatic pressure difference (Kurozawa et al., 2012). Table 2showed the antioxidant activities of fresh and dried calabash pulp.

Table 1: Physico-chemical attributes of fresh and dried calabash pulp

Drying (hours/^{o}C)	Fresh	8.0/52	7.5/54	7.0/56	6.5/58	6.0/60
Total soluble solid (^{o}Brix)	14.37±0.13^{d}	39.42±0.07^{c}	40.96±0.02^{b}	42.85±0.04^{a}	41.53±0.12^{ab}	40.11±0.17^{bc}
Moisture (%)	77.65±0.08^{a}	18.83±0.11^{b}	17.21±0.05^{c}	16.34±0.02^{d}	16.90±0.06^{cd}	17.82±0.11^{bc}
Titratable acidity (%)	0.56±0.02^{d}	1.39±0.06^{c}	1.48±0.01^{b}	1.63±0.03^{a}	1.54±0.03^{ab}	1.15±0.00^{bc}
Ascorbic acid (mg/100g)	11.43±0.09^{d}	20.84±0.15^{c}	21.97±0.06^{bc}	24.53±0.04^{a}	23.07±0.05^{ab}	22.70±0.07^{b}
Rehydration ratio	-	3.06±0.03^{c}	3.67±0.04^{b}	4.02±0.01^{a}	3.85±0.02^{ab}	3.37±0.00^{bc}

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%).

Table 2: Antioxidant attributes of fresh and dried calabash pulp

Drying (hours/^{o}C)	Fresh	8.0/52	7.5/54	7.0/56	6.5/58	6.0/60
TPC (mg GAE/100g)	109.53±0.02^{a}	26.41±0.00^{d}	27.83±0.01^{cd}	31.14±0.04^{b}	30.65±0.02^{bc}	29.06±0.01^{c}
TFC (mgCE/100g)	79.65±0.01^{a}	11.90±0.03^{d}	12.71±0.02^{cd}	15.04±0.00^{b}	14.20±0.01^{bc}	13.88±0.05^{c}
DPPH (%)	89.30±0.00^{a}	37.63±0.01^{d}	38.56±0.03^{cd}	40.66±0.02^{b}	39.04±0.00^{bc}	39.75±0.03^{c}
FRAP (µg/g)	51.07±0.03^{a}	7.42±0.05^{d}	8.59±0.04^{cd}	10.73±0.03^{b}	9.11±0.03^{bc}	9.96±0.02^{c}

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%).

Table 3:Sensory score of fresh and dried calabash pulp

Drying (hours/^{o}C)	Fresh	8.0/52	7.5/54	7.0/56	6.5/58	6.0/60
Color	4.50±0.04^{d}	6.85±0.03^{c}	7.13±0.01^{bc}	8.40±0.02^{a}	7.69±0.00^{ab}	8.01±0.02^{b}
Texture	4.12±0.03^{d}	5.43±0.01^{c}	5.79±0.00^{bc}	6.95±0.03^{a}	5.97±0.02^{ab}	6.38±0.01^{b}
Flavor	4.77±0.01^{d}	6.95±0.02^{c}	7.28±0.03^{bc}	8.27±0.01^{a}	7.72±0.03^{ab}	7.96±0.00^{b}
Taste	4.33±0.02^{d}	5.61±0.00^{c}	5.84±0.01^{bc}	6.89±0.00^{a}	6.12±0.01^{ab}	6.53±0.03^{b}
Overall acceptance	4.43±0.03^{d}	6.21±0.02^{c}	6.51±0.01^{bc}	7.63±0.02^{a}	6.88±0.02^{b}	7.22±0.02^{ab}

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%).

Fresh pulp showed high antioxidant activity than dried one. Under drying at 56^{o}C for 7 hours, the most total phenolic, flavonoid, free radical scavenging activity, ferric reducing antioxidant power were highly preserved. Our results were similar to finding by Ghan et al. (2019). Antioxidant capacity decreased during thermal dehydration was correlated to ascorbic acid degradation (Kapasakalidis et al. 2006).

Sensory score of fresh and dried calabash pulp

Sensory evaluation carried out by the a group of panelists for the fresh and dried calabash pulp was described in table 3. The highest sensory score was noticed at drying at 56^{o}C for 7 hours. The dried calabash pulp had longer stability and nutrient value as compared to fresh one (Ghan et al., 2019).

CONCLUSION

The pulp of calabash (*Crescentiacujete*) fruit has a good source of essential minerals and phyto-nutrients which possess strong pharmacological and medicinal properties making useful contributions to human and animal health. Due to its perishable nature it is very difficult to keep them for longer sability while maintaining its nutritive value. Drying is one of the most ancient techniques in the preservation of fruit. In this research, we have successfully examined different variables of convective drying to physico-chemical, antioxidant and organoleptic attributes of the dried calabash pulp.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

ACKNOWLEGEMENT

We acknowledge the financial support for the publication provided by Thu Dau Mot University, Vietnam.

AUTHOR CONTRIBUTIONS

Nguyen Phuoc Minh arranged the experiments and also wrote the manuscript.

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