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Effect of Drying Techniques on Physicochemical Properties of Wood Apple (*Limonia acidissima*)

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Abstract—*Wood apple (Limonia acidissima) is one of the underutilized fruit that belongs to the family Rutaceae and only kind of species of its genus. The present study was aimed to produce whole fruit powder (WFP) and seed powder (SP) with different drying method and their physicochemical properties. Drying method used was oven drying and freeze drying that affect the color formation of powders measured using chromometer. Moisture content of oven dried powder was lower than freeze dried powder in addition ash content of oven dried powder was higher in freeze dried powder. The fruit was rich in fat content, freeze drying seed powder showed 30 % fat content while oven dried seed powder had 19.33% fat. The study revealed that it was good source of fibre, oven dried seed powder contains fibre 11.20% while whole fruit powder had 6.12% fibre; on other hand freeze dried WFP and SP has 7.85% and 17.6% fibre respectively. Freeze-dried powder contains pectin more than oven dried powder, that is beneficial in consistency development of the product. In present study freeze drying method for powder making of wood apple was appropriate according to the compositional and physicochemical properties.*

Introduction

Limonia acidissima is belongs to the family *Rutaceae*and it is the only species of its genus. It also called as wood apple, elephant apple and other dialectal names in India. Other Indian names includes kath bel, kotha etc.(Amin Henna, 2017). The wood apple is predominantly found in forest and dry plain area of Indian subcontinents. Wood apple fruit has brown aromatic sweet and sour pulp with embedded of seeds with hard shellexhibits excellent nutritional and medicinal properties. It is an ideal tree to be exploited for growing in wasteland (Veeraraghava that ham *et al*, 2008). Its fruit is good source ofbeta-carotene, thiamine, riboflavin and also contain significant quantity vitamin C. Traditionally the fruit has been used for relief against the diarrhea, dysentery, tumors, asthma, wounds, cardiac debility and hepatitis (Sharma*et al,* 2014). Its fruit are rich in medicinal properties and processed into dried powder to embolden their use in various food formulations (Anandhi *et al,* 2011). This fruit has antioxidant properties used to treat diarrhea, dysentery, throat infection and help in many diseases due to its various medicinal properties such as anti-tumor, anti-inflammatory, antipyreticand antimicrobial activities. Its seeds rich in dietary fibre, good source of nutritional and functional properties that possess goodantioxidant properties which can be preserved using dryingtechnology (Arya1 *et al,* 2016). While considering all these, the present work was carried out to prepare whole wood apple powder and seed powder by different methods of drying andto determine the physicochemical properties of powders.

Material and methods

The mature wood apple was procured from the local market Kolkata, separate the shell and pulp with help of knife. Split fruit in two part that is whole fruit and seed, then dried in hot air oven at 50±3 ^{0}C for 6-7 hrs and in lypholizer. After drying grounded by using analytical grinder into a fine powder and stored in refrigerator at 4 ^{0}C temp. in zip lock pouch for further uses.

Physical characteristics

Ten fruit randomly selected for analysis of physical characteristics. Fruits were weigh on electronic weighing balance. Volume was measured by water displacement method. Weight density was obtained by ratio of weight and volume. Dimensions were measured by using Vernier caliper and then calculate the density of selected fruit.

Color

Color of dried whole fruit powder (WFP) and seed powder (SP) was measured using digital chromometer (Konica Minolta R-400/410 digital chromometer) (Kit L. Yam a, 2004). Color of powder was measure in terms of L*, a*, b* values, in which 'L*' value represents lightness, 'a*' value indicates redness – greenness and 'b*' value show blueness – yellowness. Instrument was calibrated with a standard white base or pure black base. The chroma, C* and hue angle, h*, of sample was also calculated, where $C^* = \sqrt{a^2 + b^2}$ and H^o = arctan(b*/a*). Hue show color attribute by which red, yellow, green and blue color spectrum are identified, while chroma or color intensity differentiate between dull and vivid colors (Rai et al. 2015).

Estimation of moisture

Two gram of powder samples was taken in petri plate and was placed in hot air oven for drying at 105 ^{0}C for 4-5 hr or till constant weight was achieved. Cool and weight the samples.

Estimation of ash content

Two gram of each powder samples was taken in pre-weighted dried silica crucible and before placing in muffle furnace, charreduntil samples turned black or till the smoke disappeared then charred sample placed in pre heated muffle furnace at 550 ^{0}C temp. for 4-5 hrs. or till white colored ash was obtained, cooled in desiccator and weighed.

Estimation of fat content

Two gram of each sample was transferred in pre-weighted dried extraction thimble and that placed in Soxhlet extraction apparatus. Extraction was done using petroleum ether solvent for 4-5 hrs. then solvent was removes by evaporation and weight was measured. Loss of weight in sample was considered as loss of fat from the sample(Somananda et al, 2017).

Estimation of crude fibre

Two gram of fat and moisture free samples was digested with 200 ml 1.25 % H_2SO_4 solution, after digestion, filtration and washing with distilled water using Buchner funnel and samples were again digested with 200 ml 1.25 % NaOH solution. Then filtrate was washed with hot distilled water, twice washing with alcohol twice and acetone three time was carried out. The residues were transferred to crucibles then dried at 130 ^{0}C for 2-3 hrs. and weight was taken. After that crucibles were placed in muffle furnace at 550 ^{0}C for 1 hr. and final weight was taken after cooling in desiccator (Gogakar et al, 2017).

Estimation of pectin content

Two g of each samples was boiled with 400 ml 0.05 N HCl for 30 min., filter, wash and pooled the filtrates then make to volume 500 ml. Take 100 ml aliquots into 250 ml water and neutralize the acid with 1 N NaOH after that allow it to stand overnight. Add 50 ml 1 N acetic acid, after 5 min. 25 ml 1 N calcium chloride solution and leave for 1 hr. after boiling filter through whattman no. 1 filter paper. Wash with boil water and test the filtrate with silver nitrate for chloride, dry it overnight at 100 ^{0}C, cool and weigh (Ranganna,1979).

Result and Discussion

Physical properties of wood apple shown in Table 1. Fresh fruits parameter shows that average weight of fruit 146.37 g, fruits breadth and length measured as 98.89 mm and 103.69 mm respectively. Fruit has 34 percent of pulp with embedded of seeds andpulp to seed ratio lies between 0.7 to 0.8 varies with stage of maturity. Results also shown by Sharma et al. 2014 that range of weight lie between 290 g to 192 g depends upon maturity stage and size of fruits and according to that density of fruit varies from 0.98 to 0.89 g/l.

Table 1: Physical characteristics of fresh fruit

Average wt. of fruit (g)	146.37±7.33
Breadth (mm)	98.89±6.81
Length(mm)	103.69±2.90
Density (g/l)	0.941±0.04
Volume	154.6±13.32
Shape	1.05±0.04

Wood apple powder color was significantly affected by method of drying, it shown in Table 2 that freeze-dried powder has higher L* value than oven dried powder which indicates the lightness in freeze dried powder. Oven dried powder has higher a* value (redness) than freeze dried powder, whole fruit powder obtained by oven drying show a* (8.61) that showmore redness than freeze dried whole fruit powder (3.45). whereas, b* value was maximum in freeze dried powder and minimum in oven dried powder. A study by Verma et al, (2015) in guavapowder show that L* value lower in sun dried sample (38.04) and higher L* value in freeze dried sample (59.87) with brighter appearance. He also observed that a* value has higher in sun dried sample as compared in freeze dried sample that indicate more redness in sun dried samples.It was observed in wood apple powders that hue angle was higher in freeze dry powder as compared to oven dry powder. Whereas, minimum chroma value of oven dried powder indicates dullness in color of powder apart from this freeze-dried powder has maximum chroma value (Tolvaj et al, 2008).

Table 2: Color value of wood apple dried powder

		Visual Color of Fruit			Color Intensity	Hue Angle
		L*	**a***	**b***	**$C^*=(a^{*2}+b^{*2})^{1/2}$**	**$H^o=\arctan(b^*/a^*)$**
Oven drying	**WFP**	60.86	8.61	20.86	22.57	67.56
	SP	59.55	7.35	19.21	20.57	69.03
Freeze drying	**WFP**	69.89	3.45	24.65	24.89	82.02
	SP	69.20	2.86	24.37	24.54	83.30

As we can observe in Table 3, on average moisture content of fresh whole fruit was 66.67 % and seed contain 79.67%, moisture content in oven dried whole fruit powder was observed as 7.54±1.05 % and in seed powder 5.10±0.28 % of moisture while freeze dried whole fruit powder has 13.83±0.10 % and seed powder contain 5.58±0.42 % of moisture on the wet bases. As reported by Sharma *et al*,(2014) that moisture content present in wood apple fruit was 75.16% and it increases with ripening of fruit. Vijayakumar et al, (2013) was report that when wood apple dried by hot air oven thenmoisture content of powder was notices as06.75 %. Ash content of whole fruit powder by oven drying and freeze drying was comparatively same, in case of seed powder, ash content observed in oven drying as 5.35±0.21 % and in freeze

drying 4.39±0.56 %. Wood apple seed contain good amount of fat 19.33±0.61% when dried by hot air oven, while freeze dried powder has contain higher amount of fat as compared to oven dried method that is 29.90±0.84% which is excellent source of fat. According to Arya1 *et at,* (2016) wood apple seed flour has 24.9% fat content, that flour possess high level of of essential fatty acids and minerals, hence this seed powder could be used in formulation of food products to meet the requirementsof population growth. Similary fat content in whole fruit powder was 12±1.65% in freeze drying method and during oven drying method fatcontent decreases remain 9.07±0.46% in whole fruit powder. Sharma*et al,*(2014) observed that on average fat content of whole fruit 3.55 % was obtained and a report according to *Pal et al,* (2018), fruit pulp contain fat nearly 0.6% but pectin content varies between 3 to 5 precent.

As we can observe from Table 3, pectin content of oven dried whole powder was 8.50±1.06 % and seed powder contain 3.00±1.41% but during freeze drying method pectin content was less effected so amountof pectin in whole fruit powder was 9.88±2.30% and in seed powder 13.75±3.54%. The finding acording to Deen *et al,* (2018), in whole fresh fruit pectin content lies between 1.22-1.30 percent and in pulp or whole fruit 3 to 8% of pectin present. This fruit was good in fibre that shows beneficial effects related to indigestibility in the small intestine and that also help in maintaining healthy weight. Oven dried whole fruit powder contain 6.12±0.16% of fibre while seed powder has 11.10±0.36 % fibre content but when powder obtained from freeze drying fibre content effected less, freeze dried seed powder possess higher fibre content 17.60±0.86% in addition to whole fruit powder contain 7.85±1.29% offibre.

Table 3: Physicochemical properties of wood apple fruit

		WFP	SP
Moisture content (%)	Fresh fruit	66.67±1.15	11.41±0.48
	Oven drying	7.54±1.05	5.10±0.28
	Freeze drying	13.83±0.10	5.58±0.42
Ash content (%)	Fresh fruit	0.89±0.29	3.36±0.40
	Oven drying	4.38±0.29	5.35±0.21
	Freeze drying	4.24±0.63	4.39±0.56
Fat content (%)	Oven drying	9.07±0.46	19.33±0.61
	Freeze drying	12±1.65	29.90±0.84
Pectin content (%)	Oven drying	8.50±1.06	3.00±1.41
	Freeze drying	9.88±2.30	13.75±3.54
Crude fibre (%)	Oven drying	6.12±0.16	11.10±0.36
	Freeze drying	7.85±1.29	17.60±0.86

Conclusion

In terms of drying characteristics of wood apple powder, physicochemical properties of freeze-dried powders exhibited higher index than oven dried powders. From above study it was concluded that freeze dried powders can utilized for further development of value-added food products with higher nutrition value. Freeze-dried powder contains pectin more than oven dried powder, that is beneficial in consistency development of the product and this fruit also contain good amount of fat and fibre content that enhance the food value. In present study freeze drying method for powder making of wood apple was appropriate according to the compositional and physicochemical properties. This fruit was underutilized fruit therefore can be utilized for preparation of various product with good quality even during off-season.

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