Comparison of different drying modes for preparation of Indian horse chestnut flour

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ABSTRACT

Indian horse chestnut is a wild nut which is a good source of starch and has many other medicinal properties. It contains toxic compound known as saponins which makes it bitter and unsuitable for edible purposes. This saponin content of Indian horse chestnut mass was removed by pre-treatment. The pre-treated mass was dried under different drying modes like open sun, solar tunnel drier and mechanical cabinet drier before converting into flour. On the basis of physico-chemical and sensory characteristics of flour, mechanical cabinet drier was found to be the best drying mode in which pre-treated mass was dried to 6.30 per cent moisture level within 18 hours of drying. Other quality characteristics like total solids (93.70%), starch (64.20%), total sugars (3.87%), fibre (2.58%) and protein (105 mg/100) were found higher in this drying mode than others.

Keywords: Indian horse chestnut; saponins; drying modes; flour; temperature

INTRODUCTION

Indian horse chestnut (*Aesculus indica* Colebr) is a wild fruit which is found in temperate regions of Asia, Europe and north America with altitude varying from 900-3600 m (Santapau and Henry 1973). It is found in moist and shady ravines of Kashmir, Himachal Pradesh and Uttrakhand in India. Besides a good source of starch it also contains anti-nutritional factors like saponins (aesculin) which make it inedible and poisonous to many animals including human being as it destroys the red blood cells. Nuts have also been used as food during the times of famine by various tribes of north and northeastern India with certain pre-treatments. The nuts can be ground into powder and used as gruel (Hedrick 1972, Singh and Kachroo 1976). As reported by Rajasekaran and Singh (2009) nuts are first dried and ground into flour which is soaked in water for about 12 hours to remove bitter component. After soaking the water is decanted and flour in the form of paste is dried and Halwa is made out of this debittered flour. This Halwa is locally known as Tattwkhar which is used as Phalahar (non-cereal food) during fasts in certain parts of Himachal Pradesh. Various other uses of this nut have also been reported. No efforts have been made in the world to commercialize drying technology for the horse chestnut flour. Therefore the present investigations were aimed at to standardize the drying technology for the pre-treated mass of it so as to utilize it as food item with the broad objective of comparison of different drying modes for preparation of its flour.

MATERIAL and METHODS

Horse chestnuts harvested at optimum maturity were procured from Chota Bhangal area of district Kangra, Himachal Pradesh and analysed for various physico-chemical characteristics under laboratory conditions. These nuts were dehulled manually, grated with the help of mechanical grater and the grated mass was further treated by the following treatments as suggested by earlier workers. The standardization of time-temperature combination for drying of pre-treated mass in mechanical cabinet drier under temperature conditions like 55 (T_1), 60 (T_2)

and 65°C (T_3) on the basis of physico-chemical and sensory characteristics was done. The best selected time-temperature combination of mechanical cabinet drier was further compared with other drying modes like open sun drying and solar tunnel drying for selection of best drying mode on the basis of physico-chemical and sensory characteristics score.

Mechanical cabinet drying: Pre-treated, wet and grated mass (12 kg) was spread on the perforated aluminium trays of dimension 76 x 56 cm and dried at varying temperature inside a mechanical cabinet drier having internal dimensions 78 x 58 x 128 cm up to a constant weight. The trays were shifted inside the drier by rotation to ensure uniform heat transmission to all the trays.

Solar tunnel drying: Pre-treated, wet and grated mass (12 kg) was spread on the aluminium trays and put on the stand for drying inside a solar tunnel drier of dimensions 297 x 204 x 207 cm. The structure of drier was covered with polyethylene sheet of thickness 0.31 mm. The temperature recorded in the solar tunnel drier during these studies was in the range of 40-45°C. The pre-treated wet and grated mass was dried in this tunnel drier till it attained a constant weight.

Sun drying: Pre-treated, wet and grated mass (12 kg) was spread on the aluminium trays and kept in the open sun in an inclined position for drying. The material was kept till the sunset before shifting it back to the laboratory for night. Mass was dried in the sun till it attained a constant weight.

Physico-chemical, rheological and sensory analysis: Among the different chemical characteristics of Indian horse chestnut flour moisture content was estimated by drying the weighed samples to a constant weight in a hot air oven at 70 ± 1°C. Loss in weight of flour after drying represented the moisture content and was expressed as per cent (W/W) whereas total solids were estimated by subtracting moisture content from the fresh weight of the nut. Starch was determined by the method given by Ranganna (2009) and sugars as per the standard procedure given by Lane and Eynon (1934). Total soluble solids (TSS) were estimated using hand refractometer after correcting the readings for temperature variation. The results were expressed as degree Brix (°B). The pH was determined using a digital pH meter (CRISON Instrument Ltd, Spain), protein as per Lowry's method as described by Sadasivam and Manickam (1996), total fiber content by the method given by Gould (1978), the total phenolics content by the Folin-Ciocalteu procedure given by Singleton and Rossi (1965), ash content using muffle furnace at temperature of 550°C as given by Ranganna (2009) and the oil content using soxhlet apparatus using petroleum ether as solvent. The quantitative estimation of saponin content was carried out as per the standard procedure given by Obadoni and Ochuko (2001), bulk density by the procedure of Okaka and Potter (1979) and water absorption capacity and oil absorption capacity as given by Beuchart (1977). Sensory analysis of flour was carried out by using 9 point hedonic scale as described by the Amerine et al (1965).

Statistical analysis: The data pertaining to the physico-chemical and sensory evaluation of Indian horse chestnut flour were analyzed by randomized block design (RBD) as described by Mahony (1985) whereas the data pertaining to the saponin content was analysed using completely randomized design (CRD) (Cochran and Cox 1967).

RESULTS and DISCUSSION

Data pertaining to temperature standardization in mechanical cabinet drier for drying of grated mass of horse chestnut reveal that temperature combination T2 was found to be the best on the basis of various sensory characteristics. Fig 1 reveals that T2 had maximum scores for colour (7.80), texture (6.70), taste (7.50), aroma (7.70) and overall acceptability (7.30). The Indian horse chestnut grated mass dried at 60°C had other characteristics like yield (11.50%), time to dry (18 h), moisture (6.30%) and water activity (0.147) and had gray brown colour (Table 1).

Comparison of drying modes

While comparing the different drying modes like mechanical cabinet drier (D_1), solar tunnel drier (D_2) and open sun (D_3) for drying of pre-treated Indian horse chestnut flour it was found that mechanical cabinet drier was the best on the basis of various physico-chemical and sensory characteristics. Table 2 reveals that Indian horse chestnut grated material dried in mechanical cabinet drier (D_1) took least time to dry (18 h) and had lowest moisture (6.30%), water activity (0.147) and pH (5.75). Treated material dried in mechanical cabinet drier also recorded highest total solids (93.70%) and starch (64.20%). The minimum time for drying, low moisture, minimum water activity and high total solids recorded in the mechanical cabinet dried and grated mass might be due to the fast and

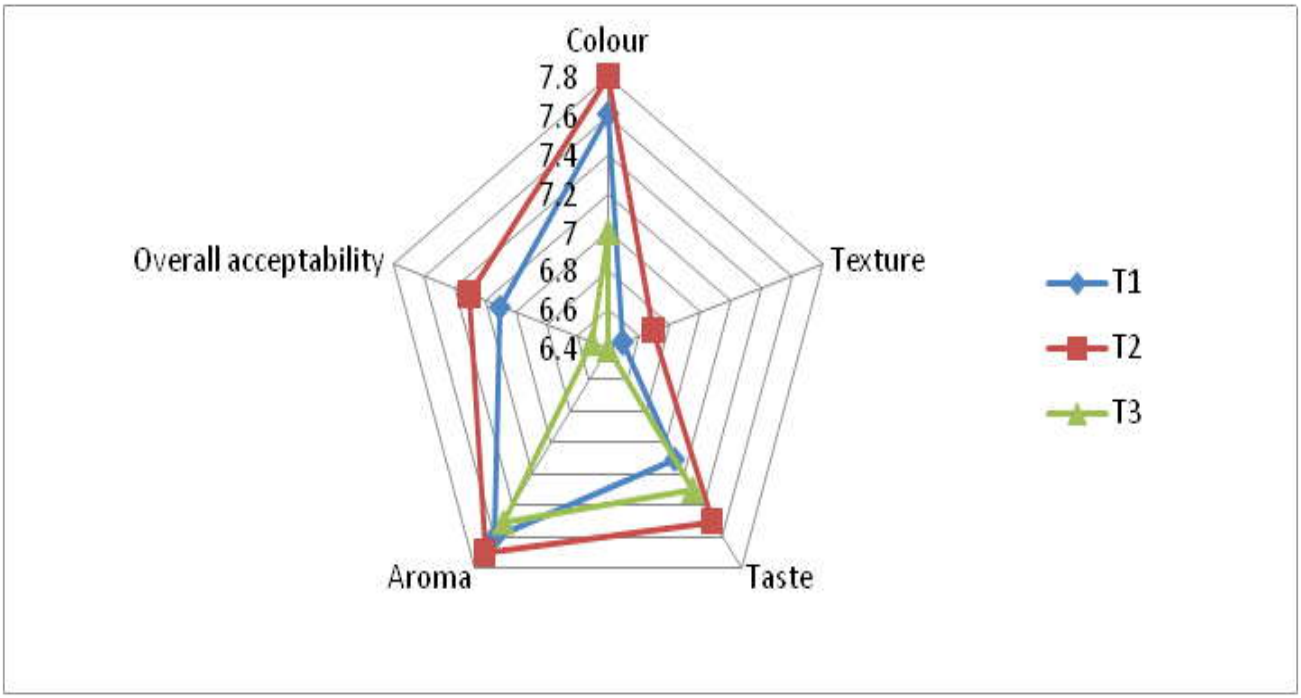

Fig 1. Sensory characteristics of Indian horse chestnut flour under different drying temperatures in mechanical cabinet drier

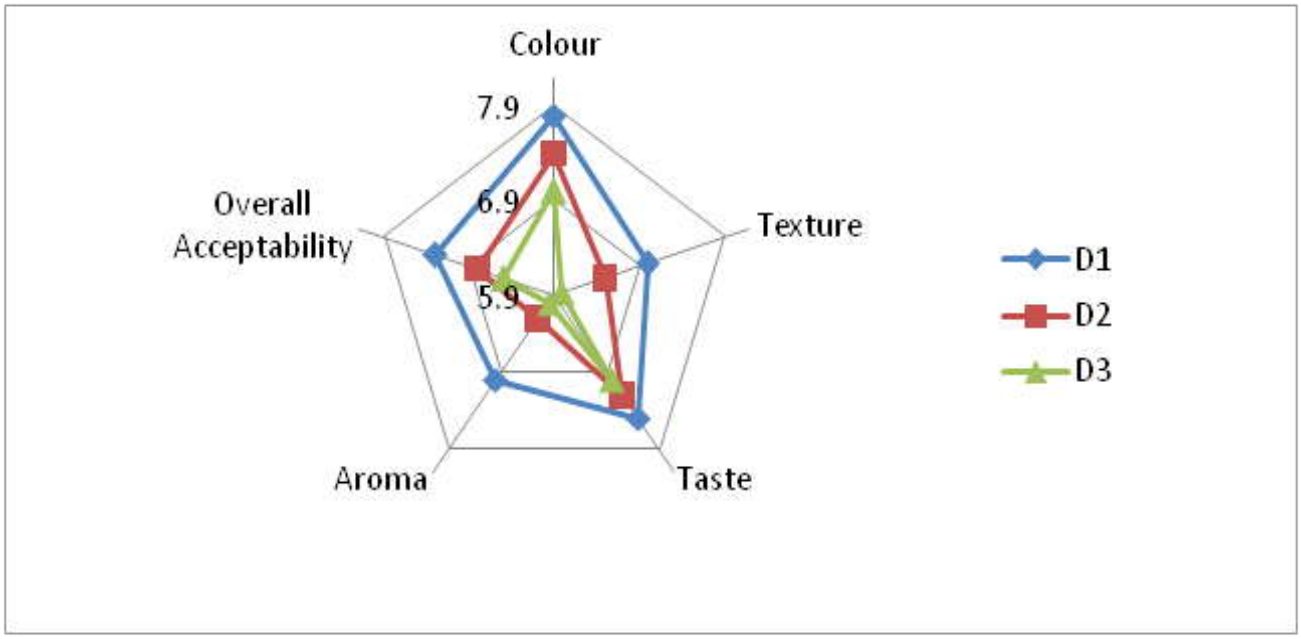

Fig 2. Sensory characteristics of Indian horse chestnut flour under different drying modes

efficient moisture removal because of the continuous air movement and controlled temperature conditions in the mechanical cabinet drier as compared to the solar tunnel drier (D_2) and open sun (D_3). The trend of results obtained for drying time, moisture and total solids in grated horse chestnut mass is similar to the results reported for dried wild pomegranate arils by various workers (Pruthi and Saxena 1984, Chandel et al 1989, Singh and Kingsley 2008, Thakur et al 2010). The above results are also in conformity with the findings of Bhardwaj and Lal (1990) in apple rings. The highest retention of starch (64.20%) found in the chestnut flour dried in mechanical cabinet drier might be because of fast drying rate which restricted the

Table 1. Physico-chemical characteristics of Indian horse chestnut flour under different drying temperatures in mechanical cabinet drier

Treatment	Temperature (°C)	Yield (%)	Visual colour*	Moisture (%)	Water activity	Time taken to dry given tray load (h)
T_1	55	12.75	Gray brown group 199 (D)	7.60	0.178	18.50
T_2	60	11.50	Gray brown group 199 (D)	6.30	0.147	18.00
T_3	65	11.00	Gray brown group 199 (D)	6.10	0.140	17.50
$CD_{0.05}$	-	0.14	-	0.08	0.01	0.77

*Colour card number of Royal Horticulture Society, London

Table 2. Physico-chemical characteristics of Indian horse chestnut flour under different drying modes

Characteristics	Drying mode			$CD_{0.05}$
	Mechanical cabinet drier (D_1)	Solar tunnel drier (D_2)	Open sun (D_3)	
Drying time	18	96	120	-
Flour yield (%)	11.5	12	13	0.90
Moisture (%)	6.30	7.00	8.00	0.63
Total solids (%)	93.70	93.00	92.00	0.63
Colour*	Grey brown group 199 (D)	Grey brown group 199 (D)	Grey brown group 199 (D)	-
Starch (%)	64.20	63.75	63.00	0.83
Fibre (%)	2.58	2.50	2.44	NS
Reducing sugars (%)	1.7	1.5	1.0	NS
Total sugars (%)	3.87	3.50	3.03	NS
pH	5.75	5.79	5.90	NS
Protein (mg/100 g)	105	92.0	80.0	8.31
Oil (%)	2.10	1.97	1.85	0.06
Water activity	0.147	0.152	0.192	0.007
Saponin content (%)	2.10	2.00	1.95	NS
Bulk density (g/ml)	0.675	0.724	0.781	0.05
Water absorption capacity (ml/g)	4.70	4.50	3.95	0.06
Oil absorption capacity (ml/g)	1.66	0.88	0.86	0.06

*Colour card number of Royal Horticulture Society, London

breakdown of starch to sugars. Sufficient amount of reducing sugars (1.7%), total sugars (3.87%) and minimum pH (5.75) found in the flour dried in mechanical cabinet drier (D_1) might be due to the faster drying and lower moisture retention in the flour. Maximum total proteins (105 mg/100 g) found in cabinet dried flour (D_1) might be due to better drying conditions in mechanical cabinet drier (D_1) that lead to the minimum breakdown of total proteins during drying as compared to the flour dried in other drying modes and the highest bulk density (0.675), water absorption capacity (4.70 ml/g) and oil absorption capacity (1.66 ml/g) due to minimum moisture content in it as compared to the other modes. The above results are in conformity with the findings of Bhardwaj and Lal (1990) in apple rings and Bhat (2007) and Sharma (2012) in wild pomegranate arils.

Higher sensory characteristics scores were recorded in the mechanical cabinet-dried flour as compared to other modes of drying (Fig 2). The reason of best score for colour might be due to the retention of natural colour of the flour while the good texture due to low moisture content in it. The quick drying might have provided a good taste and aroma to the flour thereby improving the overall acceptability. Consequently the combined effect of the pre-treatments and drying under controlled conditions in

mechanical drier reduced the drying time and therefore low moisture content of cabinet-dried flour prevented deteriorative chemical reactions like Maillard reaction and other associative reactions thus leading to the development of good dried flour with the maximum overall acceptability scores. Similar results have been observed by Bhat (2007) and Sharma (2012) in wild pomegranate arils.

CONCLUSION

On the basis of various quality parameters it can be concluded that Indian horse chestnut flour prepared from pre-treated mass by using mechanical cabinet dryer (D_1) at temperature 60 ± 2°C was found to be the best as compared to solar tunnel drier and open sun drying modes. The flour so prepared can be further packed in different packaging materials and used for development of different products.

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