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Comparative Study for Quality Characteristics of Different Drying Methods of Ashwagandha Roots

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A B S T R A C T

Application of convective- microwave and convective drying of ashwagandha roots was investigated. Ashwagandha roots of uniform size were used in the drying experiment which were conducted air temperatures of 40°, 50° and 60°C, air velocities of 1.0 and 1.5 m/s and microwave power level of 2,4 and 6W/g. A laboratory convective dryer which was already developed had the provision of regulating of air temperature and air velocity and were conducted air temperatures 40°C, 50°C and 60°C, air velocities of 1.0 m/s and 1.5 m/s. Convective -microwave drying and Convective drying was carried out till the moisture content of the ashwagandha roots reduced from initial moisture content of 5.06 kg water/kg of dry matter to an ideal level of 0.06 kg water/kg of dry matter. The effect of air velocity increment in convective drying reduced the drying time thereby increasing the drying rate. The quality attributes of fresh and dehydrated ashwagandha roots were evaluated for colour parameter (L, a, b values), total alkaloids content. The rehydration ratio was also determined for dehydrated roots. The quality attributes of the samples were compared convective -microwave drying, convective drying technique with sun drying. The result revealed that the power level of 6W/g, velocity of 1.5 m/s and air temperature of 50°C gave a good quality dehydrated ashwagandha roots in convective-microwave drying process and convective drying with air velocity of 1.5 m/s and air temperature of 60°C gave a good quality dehydrated ashwagandha roots in convective drying process as compared to sun drying.

Keywords

Ashwagandha roots, convective microwave drying, convective drying, Sun drying Rehydration ratio.

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Introduction

Ashwagandha [*Withania somnifera* (Solanaceae)] is an important medicinal plant, widely used as home remedy for several diseases in India as well as other parts of the world. It is described as an herbal tonic and health food in Vedas and considered as Indian

Ginseng in traditional Indian system of medicine (Mohammad *et al.*, 2009). It contains nicotine and group of alkaloids and also contain the ingredients i.e. foreign matter (Not more than 2%), total ash (7%), acid soluble ash (1%), alkaloids (2.5%) and water (80%) (Baraiya, 2004). In ashwagandha, the root parts contain more active ingredients, volatile oil, flavour and alkaloids as compared to the other parts of the plants (Prasad *et al.*, 1986). Ashwagandha is used for tumors, inflammation (including arthritis), anemia, breathing difficulties, cancer, cough, insomnia, paralysis, ulcers, memory loss, women's health, skin disease, eyesight, pains and a wide range of infectious diseases and used in food, cosmetic and pharmaceutical industries. Drying is one of the oldest and most widely used methods of food preservations because of longer shelf life, product diversity and substantial volume dried products. Drying is also indispensable unit operations at the final stage in processing of many food materials and hence determines, to a large extent, the quality of the product being manufactured. The improvements of drying could be increased the current degree of acceptance of dehydrated roots in the market. Ashwagandha root has a short shelf life. In order to extend its shelf life, preservation is needed in some form.

Drying is the most important process which should be taken into consideration because of its vital influence on the quality of the drugs. In India, ashwagandha roots are dried by small scale industries using by sun drying on the field without any aseptic conditions and more time consuming and does not maintain the quality of the final products. Dehydration is often a final step in the industrial process and determines to a large extent, the final quality of the products being manufactured. A growing resistance of consumers to the use of chemicals for food preservation and the increasing popularity of high quality fast dried foods with good rehydration properties are now leading to a renewed interest in drying operations. In recent years, convective drying has been popularly used as drying method for a number of food products such as fruits, vegetables and medicinal roots Feng and Fengchang, 2004. The research work on convective drying of agricultural commodities has been reported for high moisture food products in which ashwagandha root is having high moisture commodity and due to having medicinal value, it requires mild heat for drying. So, the convective drying that reduce the drying time and produce good quality of ashwagandha roots could make significant contribution to the pharmaceutical industries and promote the export of dehydrated ashwagandha roots as well as powder.

Microwave drying has been popularly used as drying method for a number of food products such as fruits, vegetables, snack foods, dairy products and medicinal roots like ashwagandha. Microwaves drying is relatively a new addition in the existing drying technique viz. hot air, cabinet, spray, vacuum and freeze drying (Prabhanjan *et al.*, 1995; Ren and Chen, 1998). Microwaves are rarely used alone but rather in combination with hot air, steam, vacuum conditions or the conventional methods have more synergistic effect.

Two narrow band of microwave allotted for use in industrial food processing application are 915 and 2450 MHz which can be absorbed by water containing materials and converted to heat (Khraisheh *et al.*, 1999). Because the waves can penetrate directly into the material, heating is volumetric (from the inside to outside) and provides fast and uniform heating throughout the product. The comparative studies for quality characteristics of various drying of ashwagandha roots were studied.

Materials and Methods

Fresh ashwagandha root having initial moisture content 80-85% (wb) with minimum maturity four months were collected from medicinal farm of Kharagpur in the state of West Bengal (India) used in the present investigation. The initial moisture content of ashwagandha root had 4.5 to 5.0 g water /g dry matter and were stored in a cold storage chamber maintained approximately at 15^0 C temperature and 85 % relative humidity.

Moisture content

The vacuum oven method was used to determine the moisture content of ashwagandha root. The roots samples of approximately 30 g were placed in a predried aluminum dishes in vacuum oven. The operating temperature was taken as that of 70^0C at negative pressure of 13.3 kPa and the sample was taken out of oven after 24 h (Young & Mason, 2002). The samples were cooled in desiccator and weighed using an ANAMED top pan electric balance with a sensitivity of 0.01 g. The fresh and bone dried roots weights were taken to calculate the moisture content expressed as g water /g dry matter.

Experimental procedure

Ashwagandha root were taken out from cold storage and allowed to maintain equilibrium with ambient conditions. Roots were washed thoroughly and samples of 10-14 mm diameter were cut in 5cm length under the hygienic conditions and 100g of each sample was used for drying experiment. Prior to drying, samples were pretreated with hot water at 100^0C for 2 mins to improve the quality of the dehydrated product (Xiao *et al.*, 2012; Sharma & Prasad, 2001). The sun drying was carried out open filed conditipon. The convective drying experiments were conducted at air velocities at 1.0 m/s and 1.5 m/s at temperatures 40, 50 and 60^0C. The sample sizes were studied. The dryer was run without the sample for about 30 min to set the desired drying conditions before each drying experiments. Moisture loss was recorded periodically during drying for the determination of drying curves by digital balance. Samples were dried until it reached to a moisture content of about 5 % (db). The drying data were then analyzed to study the drying behavior of Ashwagandha root. A cooling effect from the drafted air may influence the drying process. Therefore the effect of air velocity was also included in the study. Two levels of air flow, 1.0 m/s and 1.5 m/s were chosen. The air velocity was measured by an anemometer (Make: Kanomax, Japan) with a least count 0.1m/s. A 900W, 2450 MHz microwave oven (IFB make, model Electron) having inside chamber dimension of 300(width) × 240(depth) ×210(height) mm^3 was used for convective microwave drying experiment (Sharma & Prasad, 2001; Tulsidas *et al.,* 1995). The oven had the facility to adjust power supply and the time of processing. A variac of 15 A/230 V rating was also placed on the primary side of the high voltage transformer to regulate the anode current, thus varying the output power of the magnetron between 0 and 600 W with 5 duty cycles or settings. Calibration of Microwave Power level was done using potable water in the dryer to set the desire drying conditions before start the experiment. The temperatures were measured by thermometer. The air velocity was measured by an anemometer (Make: Kanomax, Japan) with a least count 0.1m/s. The convective - microwave drying experiments were carried out at different microwave power levels of 2, 4 and 6W/g, at air velocities of 1.0 m/s and 1.5 m/s, air temperatures of 40, 50 and 60^0C. The samples were placed inside the microwave cavity. The drying was performed according to the preset power and time schedule. The weight loss of the roots was determined after every 1-5 min until it reached to a moisture content of about 5-6% (db).The weight loss of the roots was determined until it reached to a moisture content of about 5-6% (db).

Quality Evaluation of dried ashwagandha root

The quality of ashwagandha roots samples dried by convective- microwave drying, convective drying and sun drying conditions, were evaluated by measuring rehydration ratio, total alkaloids content and colour adopting the standard procedure described below.

Colour

The colour parameters of ashwagandha roots were measured before and after drying by using chromameter. The colour values were expressed as L*(Whiteness/darkness), a* (redness/greenness) and b*(yellowness/blueness) and the total colour difference from the fresh ashwagandha root Δ*E*, as defined the following, was used to describe the colour change during drying: (Bai *et al.,* 2013).

$$\Delta E = \sqrt{\left\{\left(L_o^* - L^*\right)^2 + \left(a_0^* - a^*\right)^2 + \left(b_0^* - b^*\right)^2\right\}} \quad ...(3.0)$$

Subscript "o" refers to the colour reading of fresh Ashwagandha roots, *L**, *a**and *b** indicate brightness, redness and yellowness of dried samples respectively. Fresh Ashwagandha root was used as the reference and larger ΔE denotes: greater colour change from the reference.

Total alkaloid content

The standard technique was adopted to determine the total alkaloid extraction (Govt. of India, 1986) and (Owais *et al.,* 2005; Datta, *et al.,* 2011). Dragandorf's Reagent was prepared using Solution 1 and Solution 2. Solution 1 was prepared by dissolving Bismuth oxy Nitrate in 40 ml of water and 10 ml of acetic acid and Solution 2 was prepared by dissolving 2.8 g of Potassium Iodide in 20 ml of water. Equal volumes of Solution 1 and Solution 2 were mixed and 10 ml of the resultant mixture was added to 100 ml of water and 20 ml of acetic acid.

Dried root was powered using laboratory grinder and weighed accurately 5 g. 5g powder was completely immersed in 90 % alcohol for overnight. Extract was then prepared using soxtherm. Solvent was evaporated at 60^0C and concentration solution was serially washed with 25, 20, 15 and 10 ml portion of 5% Sulphuric Acid and treated with excess Dragandorf's reagent followed by Acetone (1 ml). The Acetone solution was treated with freshly prepared suspension of 2 g Silver Carbonate. The solution filtered and the precipitate was washed with Acetone, Alcohol and water in order. To the filtrate, sufficient Hydrogen Sulphide was passed and the solution was boiled for 10 minutes; filtered and evaporated under water bath at 60 ^{0}C till constant weight reached. The alkaloid content is expressed in percent.

Rehydration ratio

Rehydration ratio for the dehydrated ashwagandha roots was carried out by immersing of convective as well as sun dried samples in water. The roots obtained after 5 h of rehydration were evaluated for rehydration ratio. Approximetely 5 g of sample was put in hot water bath to maintained water temperature of 35 o c for 5 h. The water of the beaker was drained and the sample was removed. Surface moisture was wiping it off with a tissue paper and the weight was taken (Sharma & Prasad, 2001) and (Feng & Tang, 1998). Rehydrated ashwagandha roots were evaluated using the following formula:

$$\text{Rehydration ratio (RR)} = \frac{W_r}{W_d} \text{ ..... (4.0)}$$

Where, W_r = weight of Rehydrated ashwagandha roots, g

W_d = Weight of the dried roots, g

Results and Discussion

Quality attributes of Ashwagandha roots dried by convective- microwave drying (Table 2),convective drying((Tables 1)and sun drying method(Table 3) were evaluated in respect of rehydration ratio and total alkaloid content and colour parameters Table 4 (Convective drying)Table 5(sun drying) &Table 6 (Convective –microwave drying). For determination of quality parameters, the standard methods have already discussed in previous paragraphs. The sample of sundried ashwagandha roots was used as a control for quality evaluation of Convictive and convective- microwave drying process. It can be inferred that the most favorable parameters for rehydration ratio and alkaloid content was 6W/g of microwave power level, an air velocity of 1.5m/s and air temperature of 50^0C for convective-microwave drying (Table 2) and total alkaloid content was good in Convictive drying compared to convective-microwave and sun drying. The microwave power increment from level 2W/g to 6W/g helped to raise the rehydration ratio for all the experiments due to the increased power level reduced the drying time appreciably to contribute faster drying and hence good rehydration of the final product. The higher rehydration ratio was found in case of convective-microwave dried sample because of less case hardening in microwave heating as compared to convective as well as sun drying. When the dried sample was put into water, the volume of absorbed water increases with increasing rehydration time, irrespective of the power level, temperatures, air velocities and sizes (Sharma and Prasad, 2001). The power level, temperature and air velocity are significant model terms when rehydration model is taken into consideration where as the model term power level (W/g) was not found to be significant when total alkaloid content was taken into consideration. The colour of convective-microwave drying sample of ashwagandha root was much lighter (higher L* value) than the convective and sun dried product. The total colour change (ΔE) values of ashwagandha root were compared with convective-microwave drying, convective drying and sun drying (Maskan, 2000 and Maskan, 2001). Convective-microwave caused little and sun drying caused more colour change among the drying methods (Xiao *et al.*, 2014). It can be inferred that the most favorable parameters for rehydration ratio and alkaloid content was 60^0C air temperature and an air velocity of 1.5 m/s for convective drying. But total alkaloid content was good in convective drying as compared to sun drying. The higher rehydration ratio was found in case of convective dried sample because of less case hardening in drying process as compared to sun drying.

Based on the results of the study, we can be concluded that the convective-microwave drying of ashwagandha roots found to be more faster than sun drying. The effect of process parameters on rehydration ratio and total alkaloid content was found significant at 1% level of significance in convective-microwave drying and convective drying method. In convective-microwave drying, the optimum conditions for good colour and rehydration ratio were power level of 6W/g, velocity of 1.5m/s and air temperature of 50°C. The most suitable conditions for convective drying of Ashwagandha roots with respect to alkaloid content, colour and rehydration characteristics were air temperature of 60°C and air velocity of 1.5 m/s.

Table.1 Rehydration ratio and Total alkaloid content of Ashwagandha roots dried by convective drying method

Sr. No.	Drying process parameters		Quality attributes	
	Air temperature (^oC)	Air velocity (m/s)	Rehydration ratio	Total alkaloid content (%)
1	40	1.0	3.801	2.427
2	40	1.5	3.911	2.453
3	50	1.0	3.912	2.462
4	50	1.5	3.953	2.487
5	60	1.0	3.95	2.493
6	60	1.5	3.973	2.516

Table.2 Rehydration ratios and total alkaloids content of ashwagandha roots dried by convective - microwave drying method

Sr.No.	Drying process parameters			Quality attribute	
	Power level (W/g)	Temp. (°C)	Air velocity (m/s)	Rehydration ratio	Total alkaloids content (%)
1	2	40	1	4.03	1.812
2	2	40	1.5	4.05	1.832
3	2	50	1	4.01	1.821
4	2	50	1.5	4.08	1.796
5	2	60	1	4.10	1.801
6	2	60	1.5	4.09	1.901
7	4	40	1	4.10	1.842
8	4	40	1.5	4.11	1.812
9	4	50	1	4.12	1.861
10	4	50	1.5	4.12	1.927
11	4	60	1	4.12	1.921
12	4	60	1.5	4.13	1.882
13	6	40	1	4.11	1.921
14	6	50	1.5	4.16	1.941
15	6	60	1	4.12	1.901
16	6	40	1.5	4.13	1.882
17	6	50	1	4.14	1.915
18	6	60	1.5	4.13	1.892

Table.3 Rehydration ratio and Total alkaloid content of Ashwagandha roots dried by sun drying method

Quality attributes		
Sr.No.	**Rehydration ratio**	**Total alkaloid content (%)**
1	2.77	1.60
2	2.78	1.54
3	2.81	15.6
4	2.67	1.62
5	2.70	1.58
6	2.71	1.48
7	2.83	1.54
8	2.86	1.58
9	2.88	1.50
10	2.70	1.44
Mean	2.76	1.54

Table.4 Colour of Ashwagandha roots dried by convective drying

Parameters	Fresh root	Drying Method (Convective)					
		40°C 1.0m/s	40°C 1.5m/s	50°C 1.0m/s	50°C 1.5m/s	60°C 1.0m/s	60°C 1.5m/s
L*	43.42	36.45	36.34	36.42	36.38	37.10	37.22
a*	6.12	4.82	4.78	4.86	4.39	4.13	5.09
b*	15.51	10.73	10.81	10.84	10.75	10.86	11.82
ΔE	0	8.55	8.60	8.50	8.13	8.08	7.38

Table.5 Colour of Ashwagandha roots dried by sun drying

Parameters	Fresh root	Drying Method (Sun Drying) Samples									
		1	2	3	4	5	6	7	8	9	10
L*	43.42	37.19	37.24	37.15	37.34	37.42	37.30	37.50	37.22	36.58	37.14
a*	6.12	5.09	5.23	5.14	5.01	5.09	5.10	5.05	5.20	5.18	5.00
b*	15.51	11.30	11.21	11.61	11.52	11.65	11.20	11.32	11.15	10.12	12.11
ΔE	0	7.589	7.581	7.44	7.28	7.22	7.56	7.13	7.64	8.75	7.23

Table.6 Colour changes of fresh and dried ashwagandha roots by convective -microwave drying

Parameters	Fresh root	Drying method Convective cum microwave																	
		2W/g 40°C 1.0m/s	2W/g 40°C 1.5m/s	2W/g 50°C 1.0m/s	2W/g 50°C 1.5m/s	2W/g 60°C 1.0m/s	2W/g 60°C 1.5m/s	4W/g 40°C 1.0m/s	4W/g 40°C 1.5m /s	4W/g 50°C 1.0m/s	4W/g 50°C 1.5m/s	4W/g 60°C 1.0m/s	4W/g 60°C 1.5m/s	6W/g 40°C 1.0m/s	6W/g 40°C 1.5m/s	6W/g 50°C 1.0m/s	6W/g 50°C 1.5m/s	6W/g 60°C 1.0m/s	6W/g 60°C 1.5m/s
l*	43.42	37.82	37.92	36.95	37.5	37.11	37.82	37.51	37.62	37.82	37.52	37.86	37.73	37.72	37.56	37.86	38.08	38.01	37.91
a*	6.12	6.08	6.10	6.07	6.01	6.05	6.09	6.01	6.22	6.15	6.11	6.09	6.12	6.10	6.06	6.12	6.18	6.19	6.01
b*	15.51	12.84	12.92	12.72	12.82	12.79	12.93	12.22	12.35	12.92	12.72	12.83	13.01	12.56	12.83	13.11	13.65	12.91	12.63
ΔE	0	6.204	6.07	6.99	6.50	6.51	6.16	6.761	6.614	6.17	6.52	6.18	6.22	6.418	6.44	6.05	5.654	6.53	6.13

Extraction of total alkaloids from Ashwagandha roots was maximum in case of convective drying (2.5%), convective-microwave drying (1.92%) followed by and sun-drying (1.58%).

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