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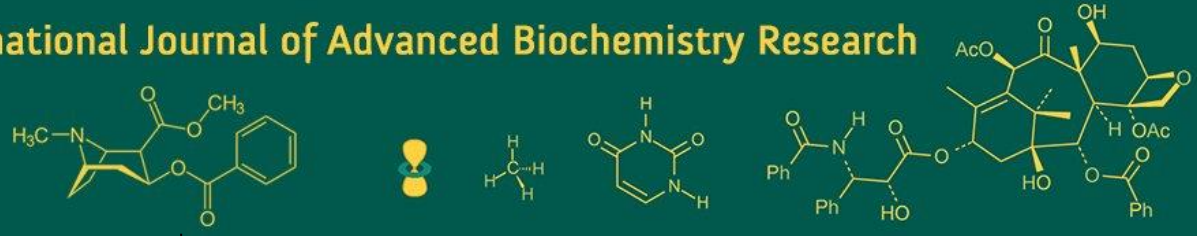

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Study of different drying methods for preparation of shatavari powder

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Abstract
The present study "Study of different drying methods for preparation of Shatavari powder" was carried out at Dr. B.S.K.K.V., Dapoli University, Post Graduate Institute of Post Harvest Technology and Management, Killa-Roha, Department of Post Harvest Management of Medicinal, Aromatic, Plantation, Spices and Forest Crops, during the year 2022-2023.
The present research was carried out to standardize different drying methods for preparation of Shatavari powder. The experiment consisted of four treatments, which includes different methods of drying such as Sun drying, Polytunnel drying, Tray drying and Shade drying. The present study revealed that the Shatavari root powder prepared from Tray dried roots show significant result up to 360 days of storage.

Keywords: Shatavari, drying methods, storage period

Introduction
India has a long history of using herbal therapy, and its Ayurvedic medical system is among the oldest once in the world. *Ayurveda* provides a full and rich perspective on living a healthy life. Having originated in India over 5000 years ago, it has since diffused its essence throughout the world and taken center stage in health care systems. *Ayurveda* is an herbal medicine that is entirely dependent on herbs.
The Indian subcontinent is home to an enormous collection of therapeutic plants that are employed in conventional medicine. For health-related issues, almost 80% of people in under developed nations turn to traditional medicines (Ekor, 2014) [15]. While only medicinal plants are utilized to prepare herbal pharmaceuticals, alternative medicines in traditional systems are derived from herbs, minerals, and organic matter. A significant part of India's healthcare system is the traditional practice of using plants as a source of medication. Approximately 70% of India's rural populace receives their medical care from the ancient Ayurvedic system (Patro, 2016) [46]. Most healers and practitioners of conventional medicine mix different concoctions and give them to patients.
Asparagus racemosus is a woody climber growing to 1-2 m in height. The leaves are like pine needles, small and uniform while the flowers are white and have small spikes. This plant belongs to the genus *Asparagus* which has recently moved from the subfamily Asparagae in the family Liliaceae to a newly created family Asparagaceae. Its habitat is common at low altitudes in shade and in tropical climates throughout India, Asia, Australia, and Africa. Out of several species of 'Asparagus' grown in India, *Asparagus racemosus* is most commonly used in indigenous medicine. Locally this plant is called *Shatawar* in Hindi; in Central Himalayan region this plant is called *Satmuli* (*shata* means hundred and *muli* means roots) (Kumar *et al*., 2008) [28].
The word Shatavari comprises of two Sanskrit words which precisely mean "she who has 100 of partners or husbands". However, in therapeutic benefits it is perceived as "She who has the potential to cure hundreds of diseases" or "she who has one hundred roots" (Sharma and Bhatnagar, 2010) [59]. *Asparagus racemosus* is an important medicinal plant of tropic and subtropical India. Its medicine usage has been reported in Indian, British pharmacopeias and in traditional system of medicines such as Ayurveda, Unani, and Siddha. *Asparagus racemosus* is commonly mentioned as a rasayan in the Ayurveda and has been used

extensively as an adaptogen to increase the non-specific resistance of organism against a variety of stresses. The *Asparagus* genus is of medical importance because of the presence of steroidal saponins and sapogenins in various parts of the plant. The powder dried roots of *Asparagus racemosus* is used in Ayurvedic medicine for Dyspepsia (Dalvi *et al*., 1990) [12]. The juice of fresh root of Shatavari has been shown to have definite curative effect curative in patients of Duodenal ulcers (Kishore *et al*., 1980) [25] and is prescribed to increase milk secretion during lactation. Generally, Shatavari crop does not get affected with pest and disease. Harvesting is done in 1.5 to 2 years after transplanting which continues for 10 to 15 years. The roots are dug out collected and cleaned. The roots are peeled off with the help of knife immediately after harvesting. It is observed that in case the roots are not peeled off within few days it is bit difficult to remove the skin in such condition the roots are kept in boiling water for about 10 minutes followed by cold water treatment to facilitate peeling after which it can be cut into small pieces and dried.

Shatavari is rich in non-nutrient bioactive principles which are essentially the secondary metabolites in addition to different types of ubiquitous primary metabolites (e.g., carbohydrates, proteins, fats and nucleic acids). The composition of Shatavari is root is shown in Table 1. It also contains saccharine, polysaccharides and mucilaginous substances in large proportion. Roots are rich in trace minerals namely zinc (53.15 mg/g), manganese (19.98 mg/g), copper (5.29 mg/g), cobalt (22.00 mg/g) along with calcium, magnesium, potassium and selenium (Mohanta *et al*., 2003; Choudhary and Kar, 1992) [33, 11]. High content of Nitrogen Free Extract indicates that Shatavari is a rich source of energy.

Nutrient composition of Shatavari root powder (Per 100 g) obtained by chemical analysis is as follows, moisture (9.5%), ash (3.55 g), protein (2.47 g), fat (0.11 g), crude Fiber (2.5 g), energy (22 Kcal), carbohydrate (3.39 g), iron (2.17 mg), calcium (26 mg), total carotene (87.5 µg) and vitamin C (3.7 mg/100 g).

Ayurveda primarily recommends *Asparagus racemosus* for the treatment and prevention of gastric ulcers, dyspepsia, and as a galactogogue. It also mentions asparagus's use in nervous system problems, inflammation, liver ailments, and several infectious diseases. The presence of 9, 10 dihydrophenanthrene in the methanol extract of its root gives it antibacterial properties against infectious disorders. For indigestion, dyspepsia, diarrhoea, and dysentery, it is a crucial traditional digestive tonic. The hepatoprotective, antibacterial, and immunomodulatory properties of alcoholic and aqueous extracts of *Asparagus racemosus* root are demonstrated against pathogenic bacteria, helminths, viruses, fungi, and protozoa (Mandal et at., 2000) [31].

When weaned rats are given alcoholic extract of *Asparagus racemosus* systemically, their mammary gland weight increases, lobulo-alveolar tissue involution is inhibited, and milk secretion is maintained because of the effect of prolactin and released corticoids (Sabins *et al*., 1968) [53].

A notable rise in milk production following lactate feeding due to the galactogogue effect's enhanced proliferation of mammary glands, alveolar tissues, and acini (Narendranath *et al*., 1986) [36]. Root is used for gastroenteritis, persistent colic, and diarrhoea. The most significant herb in ayurveda medicine for treating issues related to women's fertility is root. It is administered internally to treat bronchial infections, stomach ulcers, hyperacidity, threatening miscarriages, loss of libido, infertility, and menopausal issues. It is applied externally to treat joint stiffness (Bown, 1995) [8].

The entire plant is used to treat mental problems, diabetes, and rheumatism. Additionally, it is employed in the treatment of mild brain malfunction and behavioural disorders (Sheth *et al*., 1991) [60]. The rhizome is a calming tonic that primarily benefits the female reproductive system, the digestive system, the respiratory system, and the circulation. The root has aphrodisiac, demulcent, diuretic, galactogogue, alterative, antispasmodic, and refrigerant properties (Chopra *et al*., 1986) [10].

Materials and Methods

The Shatavari Roots was procured from nearby local farmers Mr. Vijay and Mr. Mayuresh Abhyankar, A/P.: Jambhulpada, Taluka: Sudhagad, District: Raigad (MS), Maharastra, India. After Harvesting the Shatavari roots were washed and cleaned. Clean roots were then peeled and cut into uniform pieces. Pieces were then subjected to different drying techniques such as Sun Drying, Polytunnel Drying, Tray Drying and Shade Drying. After drying powder was prepared and stored in Low Density Polyethylene bag (LDPE). The chemicals were procured from the Department of Post Harvest Management of Medicinal, Aromatic, Plantation, Spices and Forest Crops of the Post Graduate Institute of Post Harvest Technology and Management, Killa-Roha, Dist-Raigad.

Research Design

Main treatments: (Drying treatments)	T_1: Sun drying T_2: Polytunnel drying T_3: Tray drying T_4: Shade drying
Sub Treatments: (Storage period)	S1: 0 day S2: 90 days S3: 180 days S4: 270 days S5:360 days
Treatment Combinations	4×5 = 20
Replications	3
Statistical Design	FCRD

Physical parameters of Shatavari Roots during drying

Colour (L*, a*, b *Value)

The colour of the dried samples was measured with colourimeter (model CR-400/410 chromameter, Konica Minolta Holdings Inc., Tokyo, Japan) and results were expressed in accordance with the CIE Lab system (Hutchings) with reference to illuminant D65 and a viewing angle of 10° (Calvo *et al*. 2001) [9]. The L*, a*, and b*values of the fresh as well as stored powder were measured. (Neves 2020) [37].

Particle Size (micron)

Particle size of Shatavari powder determined by using sieve shaker.

Initial moisture (%)

Initial moisture content of Shatavari sample was determined by drying it by different methods still constant weight is achieved.

Final moisture (%)
The sample was dried upto constant weight is occurred. The final weight of sample was the final moisture.

$$\text{Moisture content (\%)} = \frac{Ww - Wd}{Ww} \times 100$$

Ww- Initial weight of sample in g.
Wd- Final weight of sample after drying in g.

Drying time (hour)
The time required to achieve a desired state of dryness of Shatavari roots pieces was recorded as drying time.

Chemical Parameters
Total Ash (%)
Ash is an inorganic residue remaining after the material has been completely burnt at a temperature of 550 °C in a muffle furnace. It is the aggregate of all non-volatile inorganic elements. About 5 g of finely ground dried sample was weighed and the ash content of paste sample will be determined by (Ranganna, 1986) [48]. The tare weight of three silica dishes (7 - 8 cm diameter) were noted and 5 gm of the sample will be weighed into each silica dish. The contents were ignited on a Bunsen burner and the material was ashed at not more than 525 °C for 4 to 6 hrs., in a muffle furnace. The dishes were cooled and weighed. The difference in weights represented the total ash content and was expressed as a percentage.

$$\text{Total Ash (\%)} = \frac{\text{Weight of Crucible with ash} - \text{Weight of the Crucible}}{\text{Weight of Sample (g)}} \times 100$$

Acid Insoluble Ash (%)
Acid insoluble ash was determined by the method described in the (Anonymous, 2016b) [5]. The ash was boiled in 25 ml of hydrochloric acid for 5 minutes. The mark was filtered through Whatman 541 filter paper and washed with hot distilled water. The filtrate along with the paper is added to the crucible and fired at 500 °C till constant weight is obtained.

$$\text{Acid Insoluble Ash (\%)} = \frac{\text{Weight of Crucible+Ash} - \text{Weight of Crucible}}{\text{Sample Dry weight}} \times 100$$

Alcohol Soluble Extractive (%):
Alcohol soluble extractive was determined by the method described in the (Anonymous, 2016b) [5]. Five gm of Shatavari was coarsely powdered drug is liquified in a closed flask for 24 hours by suspending in 100 ml of alcohol with continuous and frequent shaking for 6 hours and then is allowed to rest for the next 18 hours. It is rapidly filtered, precaution was taken to avert solvent loss, 25 ml of the filtrate was evaporated to dryness in a conical flask and dry at 105 °C till a constant weight is achieved.

$$\text{Alcohol Soluble Extractive (\%)} = \frac{\text{Weight of residue(g)}}{\text{Weight of Sample(g)}} \times 100$$

Water-soluble Extractive (%):
Water soluble extractive was determined by the method described in (Anonymous, 2016b) [5]. Five gm of the Shatavari Powder is macerated in 100 ml of chloroform water (2.5 ml of chloroform in 1000 ml of purified water) in a closed flask for 24 hours, shaking frequently for 6 hours and allowed to stand for the next 18 hours. It is rapidly filtered, precaution was taken to avert solvent loss, 25 ml of the filtrate was evaporated to dryness in a conical flask and dry at 105 °C till a constant weight is achieved.

$$\text{Water Soluble Extractive (\%)} = \frac{\text{Weight of residue(g)}}{\text{Weight of Sample(g)}} \times 100$$

Fiber content (%)
Extract 5 g of ground sample with ether or petroleum ether to remove fat. Then boil the dried sample and mix in 200 ml of sulphuric acid for 30 min with bumping chips. Filter through muslin cloth and wash with boiling water until washing was free of acid. Boil residue with NaOH for 30 min again filter and wash with 25 ml of boiling sulphuric acid, three times 50 ml of water and 25 ml of alcohol. Remove the residue and transfer to ash dish. Dry the residue for 2 hr at 130±2 °C, cool in desiccators and weigh it. Ignite for 30 min at 600±15 °C cool in desiccators and weight. (Thimmaiah, 2004) [62].

$$\text{Crude fibre\%} = \frac{\text{loss in weight(g)}}{\text{Weight of Sample(g)}} \times 100$$

pH
pH is defined as the logarithm of the reciprocal of hydrogen ion concentration in g/l. It is important as it measures the active acidity which influences the flavour or palatability of a product and affects the processing requirements (Ranganna, 1986) [48].

Saponin (%)
Preparation of Crude Extract
Saponins were extracted from the Shatavari root powder following the method of Obadoni and Ochuko (2002) [38].
2 gm ground powder was dispersed in 100 ml of 20% aqueous ethanol. The suspension was continuously stirred for 4 hr at about 45 °C over water bath. The mixture was filtered and the residue re-extracted with another 200 ml of 20% ethanol. The combined extracts were concentrated by using rotary evaporator in 40 °C to get 40 ml approximately. The concentrate was transferred into a 250 ml separating funnel and 20 ml of diethyl ether was added and shaken vigorously. The aqueous layer was recovered while the ether layer was discarded. The aqueous layer was re- extracted with 30 ml of n-butanol. The n-butanol extracts were washed twice with 10 ml of 5% aqueous sodium chloride. The remaining solution was evaporated. After evaporation, the samples were dried in the oven at 40 °C until constant weight.

Determination of Total Saponin
Ten milli gram crude saponin extracts were dissolved in 5 ml of 50% aqueous methanol. 250 µl of aliquot was transferred to test tubes into which an equal volume of vanillin reagent (8%) was added followed by 72% (v/v) sulphuric acid. The mixture was mixed and placed in a water bath adjusted at 60 °C for 10 min. The tubes were cooled on an ice-cold water bath for 3 to 4 min and absorbance of yellow colour reaction mixture was measured at 544 nm against a blank containing 50% aqueous methanol instead of sample extract. The saponin concentrations were calculated from standard curve and expressed as mg diosgenin equivalents (DE) per g of crude extract.

Anti-oxidant

Extract Preparation

For the extraction, 20 g of each of the samples were weighed out, and 200 ml of methanol was added to each of these 20 g samples. They were left to macerate for 24 hr in a shaker at room temperature. Then, the samples were filtered with Whatman paper grade 1. The methanol was removed by evaporation at room temperature in a fume hood. The resulting extracts were stored for later analysis.

Determination of Antioxidant Activity Using the 2,2-Diphenyl-1-picrylhydrazyl (DPPH) Radical Scavenging Method

The antioxidant activity of the plant extracts against DPPH was determined using the method proposed by (Boix *et al*., 2011) [7]. A methanolic dilution of DPPH 1 × 10−4 M was prepared. Aliquots of 1 ml of each sample in the methanolic extract were collected (at 4 different concentrations: 0.1, 0.5, 1, and 2 mg/ml; two replicates per sample and concentration) and in which 2 ml of methanolic dilution of DPPH added. The mix was kept in the dark at room temperature for 16 min, and absorbance was measured at 517 nm in a UV-30 spectrophotometer. The blank was prepared with the methanolic dilution of DPPH. The results were in milligram equivalents of quercetin per milligram of dry weight. The calibration line was established using the following concentrations of quercetin: 0.001, 0.002, 0.005, 0.01, 0.02, and 0.04 mg/ml.

Total Plate Count (TPC) (cfu/g)

Using plate count agar, the total plate count was calculated in accordance with standard procedure (ISO, 2013). Using sterile saline solution, dilute the sample ten times more. Mix 1 millilitre of the sample with 9 millilitres of saline solution to create a 10-fold dilution. After thorough blending, add 1 millilitre of this dilution to 9 millilitres of saline solution. Create five dilutions, keep going through this process. Place 0.1 millilitres of every dilution onto a spread plate using a pipette. Using a sterile spreader, evenly distribute the inoculum around the plate's surface. For 24 - 48 hours, incubate the plates at 37 °C. Count the number of colonies on each plate at the end of the incubation time. Count 25 - 250 colony per plates. To find the TPC, use the formula below:

$$\text{TPC (cfu/g)} = \frac{\text{Number of Colonies} \times \text{Dilution Factor}}{\text{factor weight of sample (g)}}$$

Yeast and Mould (cfu g-1)

The sample was powdered and 1 gm of the same was added to 9 ml of distilled water to create dilution of 10^{-1} the serial dilution was continued till 10^{-5}. Potato dextrose agar was prepared with 39 gm of PDA powder in a liter of distilled water. Media was then autoclaved and poured to set in Petri dish is sterilized laminar air flow. One ml of sample is placed in the center of the plate and the sample is distributed evenly using gentle downward pressure. Place the plate in incubator in a horizontal position for 5 days at 20-25 days. (A.O.A.C, 1998) [1].

Yeast or Mold colonies = No. of colonies counted × dilution

Statistical Analysis

As a part of the experiment, the drying method and storage period was done according to Factorial completely randomized design (FCRD) to improve experimental and statistical accuracy, the observations were recorded in replicates of three and critical differences was calculated to compare the results of analysis of different treatments using mean value and ANOVA. The data were tabulated using Microsoft excel 2000 and analyzed using Statistical Package for the Social Sciences (SPSS). Analysis and interpretation of data was carried out in accordance with Panse and Sukhatme (1985) [39] and Amdekar (2014) [3] using Factorial Completely Randomized Design and valid conclusions were drawn only on significant differences between treatment mean at 5 per cent level of significance.

Results

Physical parameters

Initial moisture (%)

Initial Moisture of Shatavari Roots is 83.50% for all treatments.

Final moisture (%)

The data for final moisture percent of Shatavari roots after drying by different drying methods are presented in Table 1. The treatment T4 (12.518) recorded highest final moisture percent mean value which was followed by treatment T1 (10.529) whereas treatment T3 (9.398) recorded the significantly lowest final moisture percent mean value which was followed by treatment T2(9.532).

Drying time (hrs.)

The data for drying time of Shatavari Roots in different drying methods are presented in Table 1.

The treatment T4 (216) recorded significantly highest drying time which was followed by treatment T1 (180). The treatment T3 (47) recorded the lowest drying time which was followed by treatment T2 (56).

Colour (L*, a* and b* value)

L * value

The product's colour and look are important factors in determining its acceptability. When consumers are purchasing, their decisions may be influenced by the sensory quality of the food or its object. Shatavari root powder colour was evaluated using a colorimeter, which yields the L*, a* and b*values, which stand for lightness, red and green, yellow and blue, respectively.

The data for effect of different drying methods on L* value for colour of Shatavari powder during storage period are presented in Table 2.

In this study L* value for colour was recorded to determine lightness of Shatavari powder which decreased with corresponding increase in storage period. The decrease in L*value for colour due to increasing in browning of Shatavari powder during storage.

The treatment T_3 (57.59) recorded the significantly highest mean L* value for colour followed by T_2 (56.67) and treatment T_1 (55.65) recorded the lowest mean L* value for colour which was followed by T_4(56.05). Lightness of the colour in Shatavari powder decreased significantly with increase in storage periods from 56.89 to 56.15 during 360 days of storage. Thus, it can be concluded that lightness of the colour in Shatavari powder decreased with increase in storage period.

Interaction effect between storage period and different treatments was found to be statistically non significant.

a* value

The data for effect of different drying methods on a* value for colour of Shatavari powder during storage period are presented in Table 3.

In this study a* value for colour was recorded to determine redness of Shatavari powder which decreased with corresponding increase in storage period. The treatment T_4 (3.233) recorded the significantly highest mean a* value for colour which was followed by T_3 (2.000) while the lowest mean a* value of colour was recorded in treatment T_2 (0.633), followed by T_1 (1.160).

Redness of the colour in Shatavari powder decreased significantly with increase in storage periods from 1.975 to 1.517 during 360 days of storage. Thus, it can be concluded that Redness of the colour in Shatavari powder decreased with increase in storage period. The a* value for colour during storage of 0 days to 360 days also decreased significantly. Interaction effect between storage period and different treatments was found to be non significant.

b* value for colour

The data for effect of different drying methods on b*value for colour of Shatavari root powder during storage period are presented in Table 4.

b* value for colour was recorded to determine yellowness of Shatavari Powder which increased with corresponding increase in storage period. The treatment T_4 (16.93) recorded the significantly highest mean b* value for colour which was followed by T_3 (16.442) while the lowest mean b* value of colour was recorded in treatment T_2 (14.87), which was followed by T_1(15.37).

Yellowness in Shatavari powder increases significantly with increase in storage period from 15.405 to 16.395 during 360 days of storage. Thus, it can be concluded that yellowness of the colour in Shatavari powder increased with increase in storage period. The b* value for colour during storage of 0 days to 360 days also increased significantly. Interaction effect between storage periods and different treatments was found to be non significant.

Particle size (micron)

The data for effect of different drying methods on particle size of Shatavari powder during storage period are presented in Table 5.

The treatment T_4 (50.313) recorded the highest mean particle size which was at par treatment T_1 (50.273) and treatment T_3 (50.16) recorded the lowest mean particle size which was followed by treatment T_2 (50.24).

Particle size of Shatavari powder increased significantly with increase in storage periods from 50.033 to 50.425 during 360 days of storage. Particle size in Shatavari powder slightly increased with increase in storage period from 0 days to 360 days storage.

Interaction effect between storage period and different treatments were found to be statistically non significant.

Chemical parameters

Total ash (%)

The data on effect of different drying methods on total ash for Shatavari powder during storage are presented in Table 6.

Ash refers to the inorganic residue remaining after either ignition or complete oxidation of organic matter in a food sample. It helps to determine the amount and type of minerals in food and is considered important because the number of minerals can determine the physicochemical properties of foods and microorganisms' activity.

The significantly maximum mean total ash was found in treatment T_3 (5.475%) followed by T_2 (5.292%) while the minimum mean total ash was recorded in T_4 (4.331%) followed by T_1 (4.835%).

Total ash percentage of Shatavari powder decreases significantly with increase in storage periods from 5.583 to 4.350 during 360 days of storage. Total ash in Shatavari powder slightly decreased with increase in storage period from 0 days to upto 360 days of storage.

Interaction between the different drying methods and storage period of Shatavari powder on total ash content (%) was found to be statistically significant. The maximum total ash content was recorded in T_3 (5.767) initially while lowest in T_4 (3.70) at 360 days of storage.

Acid Insoluble ash (%)

The data on effect of different dying methods on acid insoluble ash (%) value for Shatavari powder during storage are presented in Table 7.

The maximum mean acid insoluble ash was found in treatment T_3 (0.447%) followed by T_2 (0.393%) while the minimum acid insoluble ash mean was recorded in T_4 (0.287%) followed by T_1 (0.360%).

Acid insoluble ash percentage of Shatavari powder decreased significantly with increase in storage periods from 0.450 to 0.300 during 360 days of storage. Acid insoluble ash in Shatavari powder slightly decreased with increase in storage period from 0 days to upto 360 days of storage.

Interaction between the different drying methods and storage period of Shatavari powder on acid insoluble ash content (%) was found to be statistically non-significant.

Alcohol Soluble extractives (%)

The data on effect of different drying methods alcohol soluble extractive (%) value for Shatavari Powder during storage are presented in Table 8.

The maximum mean alcohol soluble extractive was found in treatment T_3 (16.861%) followed by T_2 (15.927%) while the minimum mean alcohol soluble extractive was recorded in T_1 (15.693%) followed by T_4 (15.873%).

Alcohol soluble extractive of Shatavari powder decreased significantly with increase in storage periods from 17.685 to 14.824 during 360 days of storage. Alcohol soluble extractives in Shatavari powder slightly decreased with increase in storage period from 0 days to 360 days storage.

Interaction between the different drying methods and storage period of Shatavari root powder on alcohol soluble extractives (%) was found to be statistically significant. The significantly maximum alcohol soluble extractive was recorded in T_3 (18.517) initially while minimum alcohol soluble extractive was observed in T_1 (14.31) at 360 days of storage.

Water Soluble extractives (%)

The data on effect of different drying methods on water soluble extractive (%) value for Shatavari powder during storage are presented in Table 9.

The maximum mean water soluble extractive was found in treatment T_3 (76.306%) followed by T_2 (74.157%) while the minimum mean water soluble extractive was recorded in T_4 (70.833%) followed by T_1 (73.898%).
Water soluble extractive of Shatavari powder decreased significantly with increase in storage periods from 76.385 to 71.275 during 360 days of storage. Water soluble extractives in Shatavari powder slightly decreased with increase in storage period from 0 days to 360 days storage.
Interaction between the different drying methods and storage period of Shatavari powder on water soluble extractives (%) was found to be statistically significant. The significantly maximum mean water soluble extractives of Shatavari powder was found in T_3 (79.247%) initially while lowest water soluble extractives was recorded in T_4 (68.953%) at 360 days of storage.

Crude fibre content (%)
The data for effect of different drying methods of crude fiber content percent of Shatavari powder during storage periods are presented in Table 10.
The presence of crude fibre in diet increases the bulk of faeces, which has a laxative effect in the gut. Fiber percent of Shatavari powder was slightly decreased with corresponding increase in storage period.
In this study the treatment T_3 (12.800) recorded the highest mean crude fiber percent which was followed by treatment T_2 (12.627) and treatment T_4 (12.333) recorded the significant lowest mean fiber percent which was followed by treatment T_1(12.473). The crude fiber percent during storage of 0 to 360 days also decreased significantly. Crude fiber percent in Shatavari powder decreased with increase in storage period from 13.088 to 12.092 upto 360 days of storage.
Interaction effect between storage period and different treatments was found to be statistically significant. The maximum crude fiber content was observed in T_3 (13.167%) initially where it was recorded minimum crude fiber content in T_4 (12.033%) at 360 days of storage.

pH
The data on effect of different drying methods for pH content of Shatavari powder during storage periods are presented in Table 11.
The pH scale is logarithmic and inversely proportional to concentration of hydrogen ions in the solution. As acidity decreases pH of powder increases. pH of Shatavari powder which decreased with corresponding increase in storage period.
The treatment T_3 (5.549) recorded the significantly highest mean value of pH which was followed by treatment T_2 (5.528) and treatment T_4(5.470) recorded the significantly lowest mean value of pH which was followed by treatment T_1 (5.505). The pH during storage of 0 to 360 days also decreased significantly from 5.649 to 5.422. Interaction effect between storage period and different treatments was found to be statistically significant.
The interaction effect between storage period and different treatment was found to be statistically significant. The maximum pH value was recorded initially in T_2, T_3, T_4 (5.65) which was at par with T_1(5.64) while lowest pH value was observed in T_4 (5.35) at 360 days of storage.

Saponin content (mg/g)
The data for effect of different drying methods on saponin content of Shatavari powder are presented in Table 12.
The highest mean saponin content of Shatavari powder was found in Treatment T_2 (22.838%) which was at par with T_3 (22.825%). The lowest mean saponin content was found in treatment T_4 (22.051%) followed by T_1 (22.733%).
The saponin content (%) during storage of 0 to 360 days decreased significantly. Saponin Content in Shatavari powder decreased with increase in storage period from 23.246 to 21.433 upto 360 days of storage. Interaction effect between storage period and different treatments was found to be statistically significant.
The significantly maximum saponin content in shatavari powder initially in T_3 (23.353%) while the minimum saponin content in shatavari powder was recorded in T_4 (20.687%) at 360th day of storage.

Antioxidant (%)
The data pertaining to the effect of different drying methods on anti-oxidant content are presented in Table 13.
Significantly highest mean anti-oxidant content of Shatavari powder was found in Treatment T_4 (75.198) followed by treatment T_2 (72.963). Lowest mean Anti-oxidant content was found in Treatment T_3 (70.800) and followed by T_1 (72.272).
The Antioxidant content (%) during storage period of 0 day to 360 days decreased significantly. Antioxidant Content in Shatavari powder decreased with increase in storage period from 79.105 to 66.110 upto 360 days of storage.
Interaction effect between storage period and different treatments were found to be statistically significant. The significantly maximum antioxidant content was recorded initially in T_1 (80.14%) while the minimum antioxidant content was observed in T_3 (62.77%) at 360th day of storage.

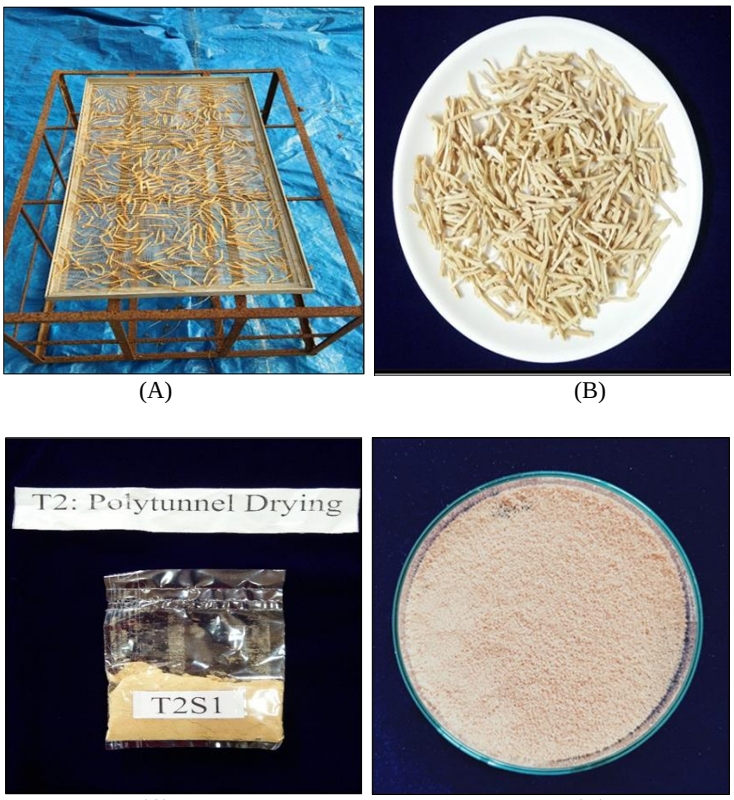
Microbial Analysis
Total Plate count (cfu/g)
The data on effect of different drying methods on total plate count for Shatavari powder during storage in is presented in Table 14.
Significantly highest mean of Total Plate count (cfu/g) Shatavari root powder was found in Treatment T_4(0.399×10^5) followed by treatment T_1 (0.243×10^5). Lowest mean of Total Plate Count was found in Treatment T_3 (0.199×10^5) and followed by T_2 (0.219×10^5).
The total plate count during storage of 0 to 360 days increased significantly. Total Plate count (cfu/g) in Shatavari powder increased with increase in storage period from 0 to 1.323 upto 360 days of storage. Interaction effect between storage period and different treatments was found to be statistically significant.
The total plate count was not detected during the initial 270 days where maximum total plate count was observed in T_4 (1.993 cfu/g) and minimum total plate count was noticed in T_3 (0.993 cfu/g) at 360 days of storage.

Yeast and mould (cfu g-1)
The data on effect of different drying method mould and yeast for Shatavari powder during storage is presented in Table 15. Yeast and mould were not detected in Shatavari powder in storage period of 0 days to 360 days of storage. (ND: Not Detected)

(A) (B)

(C) (D)

Fig 1: (A) Fresh peeled Shatavari Roots (B) Sundried Shatavari Root (C) Packed Sundried Shatavari Powder in LDPE (D) Sundried Shatavari Root Powder



(A) (B)

(C) (D)

Fig 2: (A) Fresh Peeled Shatavari Roots (B) Poly tunnel dried Shatavari Roots (C) Polytunnel dried Shatavari Root Powder Packed (D) Polytunnel dried Shatavari Powder in LDPE

(A) (B)

(C) (D)

Fig 3: (A) Fresh Peeled Shatavari Roots (B) Tray dried Shatavari Roots (C) Packed Tray dried Shatavari Powder in LDPE (D) Tray dried Shatavari Root Powder

(A)

(B) (C) (D)

Fig 4: (A) Fresh Peeled Shatavari Roots (B) Shade dried Shatavari Roots (C) Shade dried Shatavari Powder packed in LDPE (D)Shade dried Shatavari Root Powder

Washed Shatavari Roots

Peeled Shatavari Roots

Cutting Shatavari Root in uniform size

Shatavari Root Pieces

Dried Shatavari Roots

Shatavari Powder

Shatavari Powder Packed in LDPE

Fig 5: Flow chart for preparation of Shatavari powder.

Table 1: Changes in the physical quality parameters of the Shatavari Roots during drying

Treatments	Final Moisture	Drying Time
T1	10.529	180
T2	9.532	56
T3	9.398	47
T4	12.518	216
Mean	10.494	124.75
SE(m) ±	0.041	0.029
C.D. at 5 %	0.124	0.087

Table 2: Effect of drying methods on L* value for colour of Shatavari root powder during storage

Treatments	L* value for colour					Mean
	Storage Period (Months)					
	0	90	180	270	360	
T_1	56.14	55.77	55.63	55.45	55.27	55.65
T_2	57.03	56.79	56.65	56.51	56.37	56.67
T_3	57.95	57.71	57.57	57.43	57.29	57.59
T_4	56.45	56.21	56.07	55.83	55.69	56.05
Mean	56.89	56.62	56.48	56.30	56.15	
	S. Em±			CD at 5%		
Treatment (T)	0.021			0.061		
Storage (S)	0.024			0.068		
Interaction (T×S)	0.047			NS		

Table 3: Effect of drying methods on a*value for colour of Shatavari root powder during storage

Treatments (Dying methods)	a*value for colour					Mean
	Storage Period (Months)					
	0	90	180	270	360	
T_1	1.400	1.300	1.167	1.067	0.867	1.160
T_2	0.833	0.733	0.633	0.533	0.433	0.633
T_3	2.233	2.167	2.033	1.833	1.733	2.000
T_4	3.433	3.333	3.233	3.133	3.033	3.233
Mean	1.975	1.883	1.767	1.642	1.517	
	S. Em±		CD at 5%			
Treatment (T)	0.020		0.057			
Storage (S)	0.022		0.064			
Interaction (T×S)	0.045		NS			

Table 4: Effect of different drying methods on b*value for colour of Shatavari powder during storage

Treatments (Drying method)	b*value for colour					Mean
	Storage Period (Months)					
	0	90	180	270	360	
T_1	14.85	15.11	15.37	15.63	15.89	15.37
T_2	14.39	14.63	14.87	15.11	15.35	14.87
T_3	15.93	16.21	16.45	16.69	16.93	16.442
T_4	16.45	16.69	16.93	17.17	17.41	16.93
Mean	15.405	15.66	15.905	16.15	16.395	
	S. Em±			CD at 5%		
Treatment (T)	0.021			0.059		
Storage (S)	0.023			0.066		
Interaction (T×S)	0.046			NS		

Table 5: Effect of different drying methods on Particle size (mm) of Shatavari powder during storage

Treatments	Particle Size (mm)					Mean
	Storage Period (Days)					
	0	90	180	270	360	
T_1	0.5003	0.5020	0.5030	0.5036	0.5046	0.5027
T_2	0.5003	0.5016	0.5023	0.5033	0.5043	0.5024
T_3	0.5003	0.5013	0.5016	0.5020	0.5026	0.5016
T_4	0.5003	0.5023	0.5033	0.5043	0.5053	0.5031
Mean	0.5003	0.5018	0.5025	0.5033	0.5042	
	S. Em±			CD at 5%		
Treatment (T)	0.00015			0.00042		
Storage (S)	0.00016			0.00047		
Interaction (T×S)	0.00033			NS		

Table 6: Effect of different drying methods on total ash (%) of Shatavari powder during storage

Treatments (Drying Methods)	Ash (%) Storage Period (Months)					Mean
	0	90	180	270	360	
T_1	5.547	5.437	5.017	4.267	3.907	4.835
T_2	5.617	5.537	5.423	5.31	4.573	5.292
T_3	5.767	5.623	5.437	5.33	5.22	5.475
T_4	5.4	4.557	4.117	3.883	3.7	4.331
Mean	5.583	5.288	4.998	4.698	4.35	
	S. Em±			CD at 5%		
Treatment (T)	0.052			0.149		
Storage (S)	0.058			0.167		
Interaction (T×S)	0.116			0.334		

Table 7: Effect of different drying methods on acid insoluble ash of Shatavari powder during storage

Treatments (Drying Methods)	Acid Insoluble Ash (%) Storage Period (Months)					Mean
	0	90	180	270	360	
T_1	0.433	0.400	0.367	0.300	0.300	0.360
T_2	0.467	0.433	0.367	0.367	0.333	0.393
T_3	0.500	0.467	0.467	0.433	0.367	0.447
T_4	0.400	0.333	0.267	0.233	0.200	0.287
Mean	0.450	0.408	0.367	0.333	0.300	
	S. Em±			CD at 5%		
Treatment (T)	0.012			0.036		
Storage (S)	0.014			0.040		
Interaction (T×S)	0.028			NS		

Table 8: Effect of different drying methods on alcohol soluble extractive (%) of shatavari powder during storage

Treatments (Drying methods)	Alcohol soluble extractive (%) Storage period (Months)					Mean
	0	90	180	270	360	
T_1	17.247	16.563	15.847	14.5	14.31	15.693
T_2	17.437	16.803	15.94	14.907	14.55	15.927
T_3	18.517	17.443	16.73	15.897	15.72	16.861
T_4	17.54	16.243	15.747	15.12	14.717	15.873
Mean	17.685	16.763	16.066	15.106	14.824	
	S. Em±			CD at 5%		
Treatment (T)	0.023			0.066		
Storage (S)	0.026			0.074		
Interaction (T×S)	0.051			0.147		

Table 9: Effect of different drying methods on of wate soluble extractive (%) shatavari powder during storage

Treatments (Drying methods)	Water soluble extractive (%) Storage period (Months)					Mean
	0	90	180	270	360	
T_1	76.507	75.143	74.413	72.407	71.02	73.898
T_2	77.067	75.457	73.057	73.287	71.92	74.157
T_3	79.297	77.887	76.383	74.757	73.207	76.306
T_4	72.67	71.56	71.08	69.9	68.953	70.833
Mean	76.385	75.012	73.733	72.588	71.275	
	S. Em±			CD at 5%		
Treatment (T)	0.127			0.364		
Storage (S)	0.142			0.407		
Interaction (T×S)	0.284			0.814		

Table 10: Effect of different drying methods on fiber content (%) of shatavari powder during storage

Treatment (Drying methods)	Crude fiber (%) Storage Period (Days)					Mean
	0	90	180	270	360	
T_1	13.033	12.833	12.367	12.067	12.067	12.473
T_2	13.133	12.867	12.567	12.367	12.200	12.627
T_3	13.167	12.967	12.833	12.633	12.400	12.800
T_4	12.700	12.467	12.367	12.133	12.000	12.333
Mean	13.008	12.783	12.533	12.300	12.092	
Factors	SE(m)			C.D. at 5%		
Treatment(T)	0.018			0.051		
Storage (S)	0.02			0.057		
Interaction (T X S)	0.039			0.113		

Table 11: Effect of different drying methods on pH of shatavari powder during storage

Treatment (Drying methods)	pH					Mean
	Storage Period (Days)					
	0	90	180	270	360	
T_1	5.647	5.540	5.45	5.45	5.44	5.505
T_2	5.650	5.543	5.55	5.45	5.447	5.528
T_3	5.650	5.547	5.55	5.55	5.450	5.549
T_4	5.650	5.450	5.45	5.45	5.350	5.470
Mean	5.649	5.520	5.50	5.475	5.422	
Factors	SE(m)			C.D. at 5%		
Treatment(T)	0.001			0.003		
Storage(S)	0.001			0.003		
Interaction (T*S)	0.002			0.006		

Table 12: Effect of drying methods on Saponin (%) of shatavari powder during storage

Treatments (Drying methods)	Saponin (%)					Mean
	Storage Period (Months)					
	0	90	180	270	360	
T_1	23.283	23.243	22.980	22.650	21.510	22.733
T_2	23.303	23.283	23.097	22.743	21.763	22.838
T_3	23.353	23.29	22.967	22.743	21.770	22.825
T_4	23.043	22.843	22.627	21.057	20.687	22.051
Mean	23.246	23.165	22.918	22.298	21.433	
	S. Em±			CD at 5%		
Treatment (T)	0.006			0.016		
Storage (S)	0.006			0.018		
Interaction (T×S)	0.013			0.036		

Table 13: Effect of different drying methods on antioxidant (%) of shatavari powder during storage

Treatments (Drying methods)	Antioxidant (%)					Mean
	Storage Period (Months)					
	0	90	180	270	360	
T_1	80.14	76.82	72.30	68.050	64.05	72.272
T_2	78.79	76.44	73.05	69.817	66.72	72.963
T_3	78.39	75.29	70.86	66.690	62.77	70.800
T_4	79.10	77.61	75.31	73.070	70.90	75.198
Mean	79.105	76.54	72.88	69.407	66.11	
	S. Em±			CD at 5%		
Treatment (T)	0.006			0.018		
Storage (S)	0.007			0.02		
Interaction (T×S)	0.014			0.04		

Table 14: Effect of drying methods on Total Plate Count (cfu/g) of shatavari powder during storage

Treatments	Total Plate count (cfu/g)					Mean
	Storage Period (Months)					
	0	90	180	270	360	
T_1	ND	ND	ND	ND	1.213	0.243
T_2	ND	ND	ND	ND	1.093	0.219
T_3	ND	ND	ND	ND	0.993	0.199
T_4	ND	ND	ND	ND	1.993	0.399
Mean	0	0	0	0	1.323	0.243
	S. Em±			CD at 5%		
Treatment (T)	0.001			0.002		
Storage (S)	0.001			0.002		
Interaction (T×S)	0.001			0.004		

Table 15: Effect of drying methods on Yeast and Mould (cfu g-1) of shatavari root powder during storage

Treatment	Yeast and Mould (cfu g-1)				
	Storage Period				
	0	90	180	270	360
T_1	ND	ND	ND	ND	ND
T_2	ND	ND	ND	ND	ND
T_3	ND	ND	ND	ND	ND
T_4	ND	ND	ND	ND	ND

Discussion

The current experimental study, titled " Study of different drying methods for preparation of Shatavari powder. " was conducted at the Department of Post Harvest Management of Medicinal, Aromatic, Plantation Spices and Forest Crops, Post Graduate Institute of Post-Harvest Technology and Management, Killa– Roha, Raigad, Maharashtra, India. The experiment was laid out in factorial completely randomized design with three replications and four main treatments with five sub treatment in each replication. This part of chapter

deals with the possible reasons for the results observed in the physico-chemical parameters during storage of Shatavari powder which were supported by available references from the literature to study of different drying methods of Shatavari roots. Results of the experiment presented in the preceding part of the chapter have been discussed and clarified in this chapter. The entire discussion part has been divided into following parameters:

Physical parameters

Initial Moisture (%)

The initial moisture content of Shatavari roots was same for all the drying methods Fresh A. racemosus roots had an average moisture content of 83.508 percent on a fresh weight basis. The results observed were in accordance with work done by Saini *et al*. (2019) [54].

Final Moisture (%)

The data pertaining to effect of different drying methods on final moisture of Shatavari roots during drying was given in Table 1.

The highest final moisture percent mean value of Shatavari root was observed in drying method of shade drying and lowest final moisture percent mean value was observed in tray drying.

The results were found similar to Jadhav *et al*. (2015) [21], Shatavari roots were dried using a sun drying method. The final moisture content of the dried roots was 10.2%. Deshmukh *et al*. (2018) [13] concluded a similar trend in shatavari roots which were dried using a tray dryer set at 50 °C. The final moisture content of the dried roots was 8%. Kumari and Gupta (2016) [29] found moisture in Shatavari roots was 9.5%.

Drying Time (hrs.)

The data pertaining to effect of different drying methods on drying time of Shatavari roots during drying was given in Table 1.

The highest time of drying Shatavari root was observed in shade drying and lowest time of drying was observed in tray drying.

Jadhav *et al*. (2015) [21] showed a similar trend in which Shatavari roots were dried by using a sun drying method the drying time for the roots required was 48 hours. Deshmukh *et al*. (2018) [13] and Patel *et al*. (2020) [40] showed Shatavari roots were dried at 50°C using a tray dryer. The roots required 120 hours to dry. Kumar *et al*. (2017) [27] showed how to dry plant items using a poly tunnel drier (PTD)

Colour (L*, a* and b* value)

L* value for colour

The data regarding effect of different drying methods on L* value for colour of Shatavari powder during storage period was given in Table 2.

The method of tray drying was recorded the highest mean L* value for colour and shade drying was recorded lowest mean L* value for colour.

L* value for colour of Shatavari powder decreased with increase in storage period of 360 days. The L* colour value indicates the Shatavari root powder colour during storage is significantly influenced by the drying process and length of storage. The lightness of the Shatavari powder in this investigation was measured using the L* colour value, which dropped as the storage period increased. The reduction in colour L* value of Shatavari powder's increased browning during storage.

The similar line of work was mentioned in Raza *et al*. (2019) [51] in evaluation impact of drying methods on composition and functional properties of date powder procured from different cultivars. Thiangma *et al*. (2022) [61] also noted the colour shift. Minimal variations in colour value throughout storage tests suggested that there have been no notable alterations during the storage period. It was shown that the length of storage and drying method had a considerable impact on the colour change.

a*value for colour

The data regarding effect of different drying methods on a* value for colour of Shatavari powder during storage period was given in Table 3.

The shade drying method was recorded the highest mean a* value for colour and lowest mean a* value for colour was recorded by Polytunnel drying. a* value was recorded to determine redness of Shatavari powder which decreased with corresponding increase in storage period.

The similar line of work was mentioned in Raza *et al*. (2019) [51] in evaluation impact of drying methods on composition and functional properties of date powder procured from different cultivars. Thiangma *et al*. (2022) [61] noted low a* colour value which should remain relatively stable, suggesting that the colour of shatavari root powder is quite stable.

b* value for colour

The data regarding effect of different drying methods on b* value for colour of Shatavari powder during storage period was given in Table 4.

The Shade drying method recorded the significantly highest mean b* value for colour while the lowest mean b* value of colour was recorded in polytunnel drying. Yellowness of the colour in Shatavari powder increased with increase in storage period.

The similar line of work was mentioned in studies of Karadiguddi *et al*. (2022) [23] and Thiangma *et al*. (2022) [61] in which b* value for colour was minimum in Shatavari. The actual b* values could vary depending on various factors, such as the specific drying conditions, the quality of the shatavari roots, and the storage conditions.

Particle size (micron)

The data pertaining to effect of different drying methods on particle size of Shatavari powder during storage period was given in Table 5.

The higher particle size of Shatavari powder was observed in shade drying and lowest particle size was observed in tray drying. Particle size in Shatavari powder slightly increased with increase in storage period upto 360 days of storage. Particles may cluster or agglomerate together because of changes in particle size brought on by moisture absorption, which will increase the size of the particle.

Similar line of work was found by Pawar *et al*. (2023) [47] in Alovera. The particle size of Shatavari root powder is influenced by various factors, with drying methods and storage time playing crucial role. By understanding these influences and utilizing appropriate processing and storage techniques, the desired particle size characteristics achieved, contributing to a high-quality and effective Shatavari powder product.

Chemical parameters

Total ash (%)

The data pertaining to effect of different drying methods on total ash of Shatavari powder during storage period was given in Table 6.

The maximum total ash of Shatavari powder was observed in tray drying and minimum was observed in shade drying. Total ash in Shatavari powder decreased with increase in storage period upto 360 days of storage.

Ash is defined as the inorganic residue that is left in a food sample after the organic material has burned up or totally oxidised. Similar results were observed by Kadam *et al*. (2011) [34] on determination of ash values of some medicinal plants of genus sesbania. Gokarn *et al*. (2016) [18] and Unadkat *et al*. (2022) [64] said that the quality and purity of the plants are influenced by the ash value. Pathak *et al*. (2022) [44] studied a similar trend in Shatavari.

Acid Insoluble ash (%)

The data pertaining to effect of different drying methods on to acid insoluble ash of Shatavari powder during storage period was given in Table 7.

The maximum acid insoluble ash of Shatavari powder was observed in tray drying and minimum was observed in shade drying. Total acid insoluble ash in Shatavari powder decreased with increase in storage period upto 360 days of storage. Acid insoluble ash is the percentage of total ash that is still insoluble in acid (10%). Acid insoluble ash in Shatavari powder slightly decreased with increase in storage period. A similar trend was observed by Gokarn *et al*. (2015) [18], Pathak *et al*. (2022) [44] and Rao and Gupta (2021) [50]. They showed a decreasing trend in acid insoluble ash over a period of a year, initial 0.79%, two months 0.51%, six months 0.15, one year 0<0.5% in Shatavari and their products.

Alcohol Soluble extractives (%)

The data pertaining to effect of different drying methods on alcohol soluble extractive of Shatavari powder during storage period was given in Table 8.

The maximum alcohol soluble extractive of Shatavari powder was observed in tray drying and minimum was observed in sun drying. The alcohol soluble extractive in Shatavari powder decreased with increase in storage period upto 360 days of storage.

Rao and Gupta (2021) [50] showed a similar trend, alcohol soluble extractive initially 15.1%, two months 16.8%, six months 14.99% and 14.56% at the end of year and Gokarn *et al*. (2015) [18] followed this trend in Shatavari granules.

Water Soluble extractives (%)

The data pertaining to effect of different drying methods on water soluble extractive of Shatavari powder during storage period was given in Table 9.

The maximum water soluble extractive of Shatavari powder was observed in tray drying and minimum was observed in shade drying. The water soluble extractive in Shatavari powder slightly decreased with increase in storage period upto 360 days of storage.

A similar trend was found by Rao and Gupta (2021) [50], water soluble extractive initially 55.29%, after two months 57.4%, after six months 58.09% and 52.13% at the end of year. Gokarn *et al*. (2015) [18] observed average values of water soluble extractives as 54%.

Crude fibre content (%)

The data pertaining to effect of different drying methods on crude fiber content of Shatavari powder during storage period was given in Table 10.

The maximum crude fiber content of Shatavari powder was observed in drying method of tray drying and minimum was observed in shade drying. The crude fiber content in Shatavari powder decreased with increase in storage period upto 360 days of storage.

Dietary fibre increases the volume of faeces produced, which in the gut has a laxative effect. Similar results were found by Kumari and Gupta (2016) [29] as well as Rani *et al*. (2019) [49]. Shatavari root powder was said to contain 16.06 percent of all dietary fibre. Sannake *et al*. (2021) [55] explored studies on preparation of medicinal Shatavari cookies including crude fiber (%) 2.72 equals to 27.2g in Shatavari root powder.

pH

The data regarding to effect of different drying methods on pH of Shatavari powder during storage period was given in Table 11.

The maximum pH of Shatavari powder was observed in tray drying and minimum was observed in shade drying. The pH of Shatavari powder decreased with increase in storage period upto 360 days of storage.

The pH scale is logarithmic and inversely proportional to concentration of hydrogen ions in the solution. As acidity decreased pH of powder increased. pH of Shatavari powder which increased with corresponding increase in storage period. Similar results were observed by Rao and Gupta (2021) [50] in Shatavari (*Asparagus racemosus* willd) *Churna,* who found pH value initially of 5.44, after two months 5.55, after six months 5.53 and 5.47 at the end of year. Along with Gokarn *et al*. (2015) [18].

Saponin content (%)

The data related to effect of different drying methods on saponin content of Shatavari powder during storage period was given in Table 12.

The highest saponin content of Shatavari powder was observed in tray drying and polytunnel drying whereas minimum was observed in shade drying. The saponin content of Shatavari powder decreased with increase in storage period upto 360 days of storage.

Interaction effect between storage period and different treatments was found to be statistically significant. Similar findings were observed by Rao and Gupta (2021) [50].

Antioxidant (%)

The data related to effect of different drying methods on antioxidant of Shatavari powder during storage period was given in Table 13.

The highest antioxidant content of Shatavari powder was observed in shade drying where minimum was observed in tray drying. The antioxidant content of Shatavari powder decreased with increase in storage period upto 360 days of storage.

Similar trend was observed by Kumari and Gupta (2016) [29] who reported 77.3% of free radical scavenging activity (DPPH). Veena *et al*. (2014) [65] reported *A. racemosus* increases glutathione levels and reduces lipid peroxidation to function as a possible antioxidant. Saini *et al*. (2016) [54] *A. racemosus* roots had more DPPH activity (73.5 percent).

Patel *et al*. (2018) [42] evaluated antioxidant activity of shatavari (*Asparagus racemosus*) root powder prepared by different drying methods.

Microbial load analysis

Total Plate Count (TPC) (cfu/g)

The data regarding effect of different drying methods on total plate count of Shatavari powder during storage period was given in Table 14.

The highest mean value for total plate count of Shatavari powder was observed in shade drying minimum was observed in tray drying. The total plate count of Shatavari powder increased with increased in storage period upto 360 days of storage.

Interaction effect between storage period and different treatments was found to be statistically significant. Similar trend was found in studies conducted by Liaotrakoon *et al*. (2022) [30] were low moisture and bacteria count were probably caused by spray drying, it is a possibility the colour was kept via freeze drying.

Yeast and Mould Count (cfu/g)

The data regarding effect of different drying methods on yeast and mould count of Shatavari powder during storage period was given in Table 15.

The yeast and mould count were not detected in this study. Deshmukh *et al*. (2020) [14] concluded similar findings were Yeast and mould development were not detected by the TYMC during the examination.

Conclusion

The present study entitled, "Study of different drying methods for preparation of Shatavari powder" was undertaken in the Department of Post-Harvest Management of Medicinal, Aromatic, Plantation, Spices and Forest crops, Post Graduate Institute of Post-Harvest Technology and Management, Killa-Roha, Dist.- Raigad, Maharashtra, India. The Shatavari roots were dried using different drying methods Shatavari powder was prepared and storage study was observed. The experimental data was analysed statistically using Factorial Completely Randomized Design (FCRD). The observations on the changes in physical and chemical parameters of Shatavari powder during storage were recorded at 0 days, 90 days, 180 days, 270 days, and 360 days of storage.

The study is summarized as under

Physical parameters

The maximum b* value for colour was observed in shade drying while L* value in tray drying was observed maximum, a* value of Shade drying was observed to be the highest. The particle size increased significantly as the minimum change were found in treatment Tray drying.

According to the study it was observed that significant loss in initial moisture was observed in tray drying with minimum drying time.

Chemical Parameters

According to the study, it was observed that the maximum mean Total Ash, Acid Insoluble Ash, Alcohol Soluble extractive, Water soluble extractive, pH Content (5.475%, 0.447%, 16.8%, 76.30%, 5.55) respectively was observed in tray drying. The maximum mean value antioxidant (75.198%) was found in shade drying. Saponin Content was maximum in polytunnel drying (22.833%) which was at par with tray drying (22.825%)

Microbial Analysis

Significantly highest mean of Total Plate count (cfu/g) Shatavari root powder was found in shade drying (0.399×10^5) and the yeast and mould count were not detected in the powder.

Conclusion

Based on the findings of the current studies, it can be concluded that Shatavari powder prepared by tray dried roots exhibits the best outcomes when compared to other results. Total ash, acid insoluble ash, alcohol soluble extractive, water soluble extractive was retained in tray dried shatavari powder, through 360 days of storage.

Saponin which is the main constituent of Shatavari, was retained in polytunnel drying. Crude fiber and antioxidant were closely followed in shade drying T_4 and Polytunnel drying T_2.

Due to fast drying time and retention of essential chemical parameters the tray dried Shatavari root powder was observed best among the other drying methods along with 360 days storage.

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