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Effect of Drying Methods on Physical, Proximate and Mineral Content of Ghol (*Portulaca oleracea*)

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ABSTRACT: To assess the effects of various drying techniques, including solar, cabinet, sun, and shade drying, on physical, proximate, and mineral content, ghol (*Portulaca oleracea*) leaves were used. Hunger is one of today's most pressing problems, and using wild edible plants can be one of the solutions. To obtain the best processed form of leaves with the most nutrients, the effect of processing on nutrient retention was evaluated. Effect of drying techniques on the physical characteristics of dehydrated Ghol powder revealed that cabinet drying produced the best results for true density, bulk density, angle of repose, Carr index, and Hausner ratio. In comparison to fresh leaves, the dehydrated Ghol powder had a significantly higher ash, fat, protein, fibre, and carbohydrate content, and a lower moisture content with better retention in cabinet drying method. Results of mineral composition showed that there was significant increase in mineral content of dehydrated Ghol powder as compare to fresh leaves with better retention in cabinet drying.

Keywords: Ghol *(Portulaca oleracea)*, drying methods, physical, nutrients.

INTRODUCTION

Hunger is one of today's most pressing problems, and using wild edible plants can be one of the solutions. The term "wild edible plants" (WEPs) describes plant species that are not domesticated or grown but can be found in a variety of natural habitats and are used for food. WEPs are crucial to the fight against poverty, ensuring food security, diversifying agriculture, generating income sources, and reducing malnutrition (Bhatia *et al.*, 2018).

The wild edible vegetables are essentially important in the biochemical and nutritional aspects as they are the best sources of proteins, amino acids, carbohydrates, fibre, vitamins, minerals and bioactive compounds which are very important for health and play an active roles in prevention of many diseases like cancer, diabetes, coronary heart diseases, etc. (Saikia and Deka 2013). Hence, these wild edible plants can be integrated into the normal diet to achieve daily requirements of important nutrients from food. There are many therapeutic uses of wild vegetables in case of eye, stomach, kidney diseases, dysentry, toothache, piles, haemorrhoid, dizziness, anemia, joint pain, ear and skin diseases (Naik *et al*., 2017).

A diet rich in antioxidants, phytochemicals such polyphenolics, carotenoids, flavonoids, and terpenoids, which have the ability to scavenge free oxygen radicals, protects against cellular damage (Dhakarey, 2005).

Ghol (*Portulaca oleracea*), an old and widely distributed species, is one of 580 species in the family Portulacaceae and one of 21 genera in the genus Portulaca. It is primarily an annual but could be perennial in tropical climates. Its stem can grow up to 30 cm long and 2-3 mm in diameter. It is smooth, reddish, and generally prostrate. Flat, fleshy, obovate, 1–5 cm long, green or green with a red edge, alternate or opposite, and clustered at stem joints and ends are the characteristics of the leaves. In addition to being an edible vegetable, It is also used as a drug in traditional medicine to treat bloody dysentery, snake and insect bites, asthma, ulcers, diarrhea and hemorrhoids due to its antiseptic, antispasmodic and diuretic properties. Fresh Ghol contains high amounts of vitamins E, C and A, minerals, carotenoid derivatives, omega 3 fatty acids, glutathione, glutamic acid, aspartate, flavonoids and phenolic compound (Keser *et al*., 2021).

Vegetables are perishable goods with extremely high moisture contents, so dehydrating them significantly reduces their weight and bulk, which saves money on storage (Kamela *et al*., 2016).

Commercially, a variety of dryers and drying techniques are used to remove moisture from various vegetables. The choice of a certain dryer or drying technique depends on the kind of raw material, its attributes, and the required properties of the dried output. Dried veggies are delicious, healthy, light, and simple to make, store, and consume. They are also more concentrated than any other preserved form of food (Mehmet *et al*., 2011). The technique of heating vegetables is crucial in the food processing sector. The goal is to create dried foods with minimum nutrient and sensory deterioration that are shelf-stable, microbiologically safe, and safe to consume.

The primary goals of drying are to increase food shelf life by reducing water activity and content, avoid the need for expensive refrigeration systems for storage and transportation, reduce the amount of space needed for storage and transportation, and diversify the supply of foods with a variety of flavours and textures to give consumers a great selection when they shop for food (Raquel, 2018).

MATERIAL AND METHODS

Material

Raw material and authentication. The green coloured matured underutilized wild vegetable i.e. Ghol (*Portulaca oleracea*) was collected from local market of Parbhani, Maharashtra.

Chemicals. All the chemicals, organic solvents and acids used were of analytical grade. Chemicals required for processing of raw materials and analysis of fresh and dehydrated vegetables were obtained from Department of Food Business Management, College of Food Technology, V.N.M.K.V., Parbhani, Maharashtra, India.

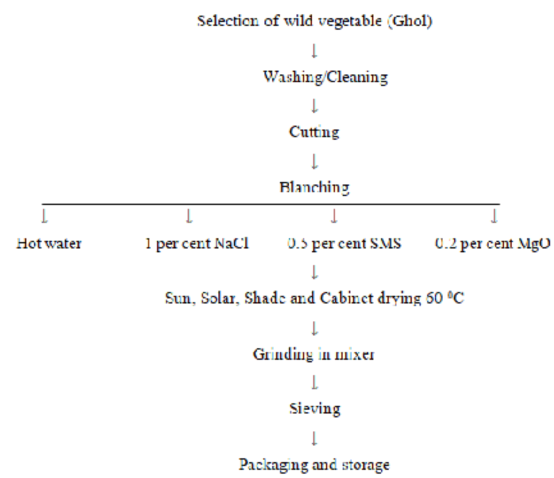
Methods

Preparation of dehydrated Ghol powder. Four blanching treatments were selected namely hot water blanching, hot water blanching with 1 % NaCl solution, hot water blanching with 0.5 % SMS solution, hot water blanching with 0.2 % MgO solution. The wild vegetables leaves were sorted, washed with distilled water and spread on musclin cloth then placed in above blanching solutions for 3 minutes followed by dipping in cold water to stop further processing. The best blanching treatment 0.5 % sodium metabisulphite was followed for blanching of leaves prior to drying. Then these blanched leaves were dried by different drying techniques. Later the dried materials were milled in a powder with mixer cum grinder, sieved through a 0.4 mm wire mesh and stored in air tight container at room temperature (Stevel and Babatunde 2013).

Physical properties of wild vegetables powder.

(i) Bulk density, true density and angle of repose. Bulk density was determined by Okaka and Potter (1979) method. True density was determined by liquid displacement method. Angle of repose was determined by Martin *et al*. (1991) research heap process.

(ii) Carr index and Hausner ratio. Carr index was determined from Carr (1965) as the difference between the true and the bulk densities divided by the true density. Hausner ratio was calculated as true density divided by bulk density, as per Hausner (1967).



Flowsheet 1. Preparation of Ghol powder.

Analysis of proximate composition. Proximate composition such as moisture, crude fat, crude Protein, total ash, crude fibre was estimated by A.O.A.C. (2000) method. Carbohydrate content was estimated by using Phenol- H_2SO_4 process given by Ranganna (2011).

Analysis of minerals. Mineral content of vegetables was estimated by method given by Ranganna (2011). Spectrophotometric method was used to determine phosphorus content. Calcium was measured with titrimetric method. Iron content of vegetables was determined by using a-a, dipyridyl method AOAC (1990). Colorimetric method was used to estimate magnesium. Estimation of copper, manganese and zinc was done by using Atomic Absorption Spectrophotometer (AAS).

RESULTS AND DISCUSSION

Effect of drying methods on physical properties of dehydrated Ghol vegetables powder. The effect of drying methods on physical properties of dehydrated Ghol vegetables powder was discussed in Table 1.

Effect of drying methods on physical properties of dehydrated Ghol vegetables powder was discussed in Table 1. It was observed that true density was highest in cabinet dried sample (0.52 g/ml) and lowest in sun dried sample (0.45 g/ml).The bulk density was highest in cabinet dried sample (0.44 g/ml) and lowest in sun dried sample (0.36 g/ml).The variation in bulk density and true density might be due their particle size and drying conditions.

Table 1: Effect of drying methods on physical properties of dehydrated Ghol vegetables powder.

Drying method	True density (g/ml)	Bulk density (g/ml)	Angle of repose (θ)	Carr index (%)	Hausner ratio
Sun drying	0.45	0.36	36	20.00	1.25
Solar drying	0.47	0.38	34	19.14	1.23
Shade drying	0.51	0.42	32	17.64	1.21
Cabinet drying	0.52	0.44	31	15.38	1.18
SE±	0.012	0.021	0.186	0.073	0.016
CD at 5%	0.036	0.066	0.560	0.222	0.050

Sneha and Deb (2020) reported the lower bulk density in sun drying than oven drying since rate of volumetric shrinkage increases with a reduction of moisture content, the inter granular porosity shows reduction with increase in drying temperature & inter granular porosity decreased with increase in drying temperature. Shams *et al*. (2022) observed that cabinet dried sample having higher bulk density & true density than freeze dried sample. He also found that higher the Carr index and Hausner ratio, more cohesive the powder and less able to flow freely.

The angle of repose is very important in characterization of the flow properties of powders. It is a characteristic related to inter particulate friction or resistance to movement between particles. It was found that angle of repose of all dried samples were in the range of (31-36°). According to the scale of angle of repose the best result of angle of repose was found in cabinet dried sample (31°) which is good as per the scale.

In recent years the compressibility index and the closely related Hausner ratio have become the simple, fast, and popular methods of predicting powder flow characteristics. They are useful methods in new product development. It was found that Carr index of all dried samples were in the range of (15.38-20.00 %). According to the scale of Carr index the best result of Carr index was observed in cabinet dried sample (15.38 %) which is good as per the scale. The Hausner ratio was found in the range of (1.18-1.25). The best results of Hausner ratio was observed in cabinet dried sample (1.18) which is good according to the scale of Hausner ratio. Mirhosseni and Amid (2013) reported the lowest Carr index in dried seed gum thus indicating good flow characteristics also reported that if the angle of repose decreases, the binding level of granules increases.

Lower Carr Index or lower Hausner ratios of a material represents better flowing properties than other samples. The CI of less than 10 per cent or HR of less than 1.11 is considered as 'excellent' flow whereas CI more than 38 per cent or HR more than 1.60 is considered as 'very very poor' flow (Carr, 1965; Hausner, 1967).

Effect of drying methods on proximate composition of dehydrated Ghol vegetables powder. The effect of drying methods on proximate composition of dehydrated Ghol vegetables powder was mentioned in Table 2.

Table 2: Effect of drying methods on proximate composition of dehydrated Ghol vegetables powder (Per cent).

Drying methods	Moisture	Ash	Fat	Protein	Fiber	Carbohydrate
Fresh leaves	89.00	1.62	0.24	2.94	1.04	5.00
Sun dried	8.24	17.32	3.30	16.62	4.38	47.34
Solar dried	7.20	17.24	2.98	16.50	4.12	47.22
Shade dried	9.00	16.74	2.78	16.10	3.16	46.86
Cabinet dried	7.10	18.20	3.40	16.78	4.60	48.88
SE±	0.066	0.079	0.075	0.084	0.138	0.205
CD at 5%	0.199	0.238	0.226	0.253	0.415	0.616

Effect of drying methods on proximate composition of dehydrated Ghol vegetables powder was mentioned in Table 2. Maximum moisture content was in shade dried sample (9.00 %) and minimum moisture content was observed in cabinet dried sample (7.10 %).This might be due to the extremely high temperature applied at moderately short time in cabinet drying. This was because according to Yousif *et al*. (1999), during the long hours of drying, the heat was conducted from the surface to the interior of the leaves and the rate of evaporation of water from the surface of the leaves was faster than rate of diffusion to the surface. This result was according to the findings of Waldron *et al*. (2003).

On dehydration, there was significant increase in ash content, however maximum increment was found in cabinet dried leaves *i.e*. 18.20 per cent as compared to fresh leaves *i.e.* 1.62 per cent. This result was similar to that of Kowsalya and Vidhya (2004) who reported increase in ash content after dehydration of Arai kerrai leaves and found that maximum ash content was in cabinet drying as compare to sun and shade. The fat content was highest in the cabinet dried sample (3.40 %) and lowest in the shade dried sample (2.78 %). The dehydrated leaves were having higher amount of fat than fresh one was reported by Vimala (2000). The fresh leaves contain (2.94 %) protein. The protein content was highest in the cabinet dried sample (16.78%) and lowest in the shade dried sample (16.10 %). The Difference in Protein Content of dehydrated leaves compare to the fresh leaves was significant. The drying process increased the protein content due to the loss of moisture Osum *et al*. (2013). The fresh leaves contain (1.04 %) fiber. Highest fiber content was in cabinet dried sample (4.60 %) and lowest in shade dried sample (3.16 %). The leaf sample was a rich source of fiber.

Carbohydrate content of dried leaves powder was in the range of 46.86-48.88 per cent. The maximum carbohydrate content was observed in cabinet dried sample (48.88 %) and minimum carbohydrate content was observed in shade dried sample (46.86 %). There was significant increase in the carbohydrate content of dried leaves as compare to fresh leaves. The carbohydrate content of fresh leaves was same as per Pandey and Pathak (2009) who reported 4.9 g carbohydrate content in fresh leaves whereas Singh *et al.* (2007) reported the carbohydrate content of fresh leaves to be 5.36 g /100g and for dehydrated leaves it was 34.36 g/100g. The proximate composition of dehydrated Ghol vegetables powder was same as that of Mastud *et al*. (2018).

Effect of drying methods on mineral composition of dehydrated Ghol vegetables powder (mg/100g). The effect of drying methods on mineral composition of dehydrated Ghol vegetables powder was mentioned in Table 3.

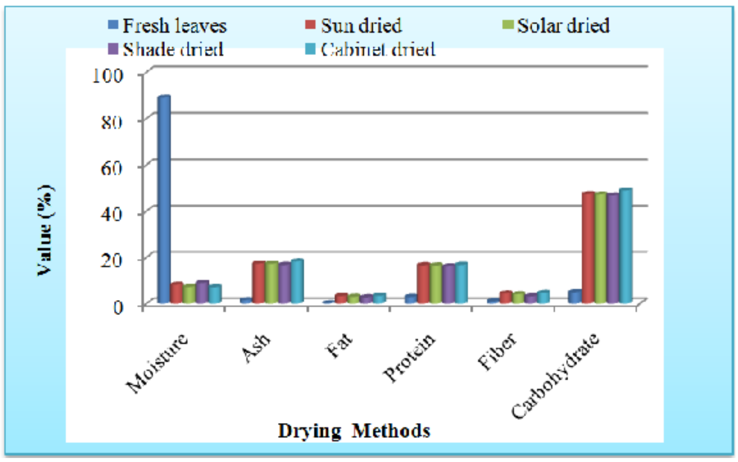


Fig. 1. Effect of drying methods on proximate composition of dehydrated Ghol vegetables powder (Per cent).

Table 3: Effect of drying methods on mineral composition of dehydrated Ghol vegetables powder (mg/100g).

Drying method	Calcium	Phosphorus	Magnesium	Iron	Zinc	Copper	Manganese
Fresh leaves	200.00	44.32	68.00	2.00	0.70	0.11	0.14
Sun drying	940.32	146.27	190.62	24.64	1.60	0.54	4.05
Solar drying	910.42	134.36	160.74	23.42	1.40	0.51	3.90
Shade drying	988.46	176.28	246.96	26.34	2.06	0.58	4.10
Cabinet drying	1050.00	200.44	274.52	28.10	2.20	0.60	4.26
SE±	5.936	2.939	2.376	0.191	0.033	0.025	0.049
CDat 5%	17.870	8.849	7.153	0.576	0.098	0.077	0.148

The effect of drying methods on mineral composition of dehydrated Ghol vegetables powder was described in Table 3. Fresh leaves showed (200.00 mg/100g) calcium. Drying enhanced calcium content of leaves significantly. Dehydration of leaves led to concentration of calcium by 4 to 5 folds. Maximum increment of calcium was observed in cabinet (1050.00 mg/100g) and minimum calcium content was observed in solar dried powder (910.42 mg/100g). According to Perez-Lopez *et al*. (2002), the calcium content was affected by drying temperature, levels of calcium chloride concentration and processing time.

Fresh leaves showed (44.32 mg/100g) phosphorus. Phosphorus content was highest in cabinet dried powder (200.44 mg/100g) and lowest in solar dried powder (134.36 mg/100g). Drying enhanced phosphorus content of leaves significantly. According to Murray *et al*. (2003) the higher phosphorus helps in bone formation and development, energy metabolism and nucleic acid metabolism.

Magnesium content of fresh leaves was (68.00 mg/100g). Magnesium content of fresh leaves was coincide with the value (54.7 - 146 mg/100 g) reported by Schonfeld and Pretorius (2011). The highest magnesium content was observed in cabinet dried powder (274.52 mg/100g). The lowest magnesium content was observed in solar dried powder (160.74 mg/100g). Drying enhanced magnesium content of leaves significantly.

Iron content of fresh leaves was (2.00 mg/100g). The highest iron content was observed in cabinet dried powder (28.10 mg/100g) followed by shade (26.34

mg/100g), sun (24.64 mg/100g) and solar dried powder (23.42 mg/100g). The significant increase in iron content was observed in all dried samples as compare to fresh leaves. Laxmi and Kohila (2007) reported the similar results of iron content. The iron content of fresh Agathi was 3.9 mg/100g. On dehydration, the iron content raised to 22.7-25.3 mg/100g and they found that maximum iron content was in shade drying and minimum was in sun drying method.

Zinc content of fresh leaves was (0.70 mg/100g). The zinc content in powder was in the range (1.40-2.20 mg/100g) and it was maximum in cabinet dried powder and minimum in solar dried powder. Fresh leaves showed the copper content (0.11 mg/100g). The copper content of powder was found in the range of (0.51-0.60 mg/100g).Cabinet drying method showed the highest copper content and solar drying method showed the lowest copper content**.** Manganese content of fresh leaves was (0.14 mg/100g). The range of manganese content in the powder was (3.90-4.26 mg/100g). It was observed highest in cabinet drying (4.26 mg/100g) and lowest in solar drying (3.90 mg/100g). The results of mineral content of ghol powder were similar to Gindy (2017); Hanan (2014). However, the value of mineral content increased in relation to the drying methods as compare to fresh leaves. It may be due to the removal of water molecule by drying and the powder was in concentrated form.

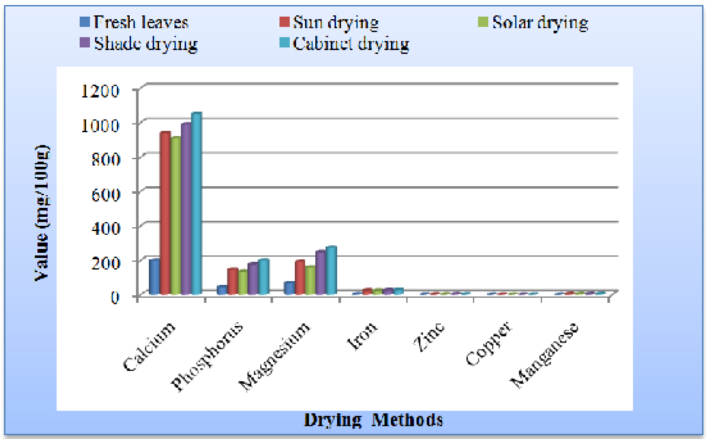


Fig. 2. Effect of drying methods on mineral composition of dehydrated Ghol vegetables powder (mg/100g).

CONCLUSIONS

Effect of drying methods on physical properties of dehydrated Ghol powder showed that the best results of true density, bulk density, angle of repose, carr index and hausner ratio were observed in cabinet drying. Effect of drying methods on proximate composition of dehydrated Ghol powder revealed that there was significant increase in ash, fat, protein, fiber and carbohydrate and decrease in moisture content in dehydrated Ghol powder as compare to fresh leaves. The better retention of proximate composition of powder was observed in cabinet drying method. Effect of drying methods on mineral composition of dehydrated Ghol powder revealed that there was significant increase in mineral content of dehydrated Ghol powder as compare to fresh leaves. The better retention of mineral composition of powder was observed in cabinet drying method. The cabinet drying method was best among all drying methods with better retention of physical and nutritional quality parameters with less time require for drying.

FUTURE SCOPE

Dehydrated vegetables are more practical than their fresh counterparts for food manufacturing. Further research should be undertaken to utilize dehydrated wild vegetables which are rich in the nutrients for preparation of different commercially available food products.

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Conflict of Interest. None.

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