**Influence of different drying methods on proximate and mineral composition of pea pods**

**Abstract**

Pea pods, by-products of the pea processing industry, are a rich source of nutrients but are frequently disposed of incorrectly.In this study, pea pod powder (PPP) was developed by using different drying methods viz., sun, solar, tray, microwave, freeze and osmotic drying and was analyzed for its proximate and mineral composition. The results revealed that in dried pea pod powder contained moisture and ash content of dried pea pods ranged from 8.95 to 5.10% and 7.74 to 5.87%, respectively. The highest crude protein, crude fat and crude fibre content of 15.02, 1.90 and 8.95 % respectively, was recorded in freeze dried pea pod powder. Further,freeze dried PPP recorded highest potassium, iron and magnesium content of 1832.37, 856.47 and 10.45 mg/100g, respectively while least potassium, iron and magnesium content of 1010.29, 718.56 and 5.84 mg/100g, respectively, were observed in sun drying pea pod powder. According to the study, freeze-dried pea pod powder retained more of its proximate components, whereas sun-drying caused a larger loss of nutrients.  
When creating functional foods that offer health benefits, the best dried pea pod powder can be utilized.

Keywords: nutrients, pea pods, freeze drying, proximate, osmotic dehydration, functional food

**INTRODUCTION**

Peas (*Pisum sativum* L.) are the second most widely planted legume in the world. Peas are consumed both in their green and dried forms all around the world. Around 5.7 million tonnes of peas were produced in India in the year 2020. Since peas are mostly processed into multiple food formats such as frozen, dried, and canned form, the outermost pod is remains unused. This outer seed coat, makes up 35–40% of the fresh weight of peas and if not properly utilized or disposed,can attract pathogens, posing a threat to human and animal life. These pea pods are rich reserves of fibre,carbohydrates, and crude proteins and may have numerous food applications. In addition, they are also rich in many macronutrients such as potassium, magnesium, iron and zinc and exhibit a low calorific value of 210 kcal/100 g, primarily because of their limited fat content (1).Pea pods have also been reported to contain phenolic acids such as cinnamic acids (5-cafeoylquinic acid, rosmarinic acid and quinic acid) and benzoic acids (e.g. gallic acid). Other polyphenols that occur in pea pods include favonoids that consist of favanones (naringenin and hesperidin), favanols (epicatechin and catechin), favonols (quercetin, quercetin 3-galattoside, and rutin), favones (luteolin, diosmin, apigenin and kaemferol 3-glucoside) and isofavones (genistein and myricetin) (2).

Drying is among the earliest and oldest techniques for maintaining crop quality (3).In the food industry, drying is a traditional and unmatched physical method of food preservation that is used for both direct product preparation and additional processing (4).The sun and solar drying have drawbacks, such as temperature swings, unregulated humidity, and unsanitary circumstances that lead to subpar food items. One of the more cost-effective and regulated methods of drying is tray drying; however, at higher temperatures, colour deterioration and heat-labile nutrients, such as vitamin C, may occur. Nowadays, microwave drying is also becoming more and more popular because of its even energy distribution and quick drying time, but it also has drawbacks such uneven heating and texture changes. By immersing food ingredients in aqueous solutions with high osmotic pressure, including sugar and salts, and then drying them conventionally, osmotic dehydration is used to partially remove water from the ingredients. Leaching of soluble components from food material into the steeping solution and prolonged drying durations are the primary drawbacks of osmotic drying. By using a low temperature and vacuum,the freeze-drying method, which is based on the sublimation principle, preserves food products' original flavour, texture, aroma, and maximal nutrients. Because it reduces lipid oxidation and the breakdown of bioactive ingredients, freeze drying is used on an industrial scale for long-term food storage (5).This study attempts to determine the best drying technique that maintains product stability and safety while minimizing nutrient losses, especially with regard to protein, fibre, fat, ash, and vital minerals. Enhancing nutrient retention, improving food processing methods, and promoting the creation of premium dried food items are all possible outcomes of the research.

**Materials and methods**

The pea pods were purchased from local vegetable vendor’s shelling shelled peas in Jammu and sent to the food processing and training centre of the Division of Post Harvest Management, SKUAST-Jammu.The hot water blanching procedure was used to sift, clean, and blanch the pods. To blanch, pea pods were submerged in 80°C hot water for two minutes, and then they were immediately submerged in cold running water for three minutes. The blanched pods' parchment coating was carefully removed. The pods were then divided into six lots and subjected to different drying methods at different temperature such as T1-Sun drying (ambient), T2-Solar drying (ambient), T3-Tray drying (60oC), T4-Microwave drying(900W), T5- Freeze drying (-60oC),T6-Osmotic dehydration (brining) 10% salt solution (60oC).

**Analysis of proximate and mineral composition**

The moisture,crude fat, crude fibre and ash content of dried pea pod was determined according to AOAC(6). The crude protein was determined by micro kjeldahl method by (7).Following the ash determination, the mineral contents (potassium, magnesium, and iron) were ascertained in accordance with the AOAC (8) protocol. Every formulation's ash residue was broken down using a solution of perchloric acid and nitric acid (1:4). After allowing the samples to cool, their contents were filtered using Whatman filter paper 42. Distilled water was added to each sample solution until the final amount reached 25 ml.Using an Atomic Absorption Spectrophotometer (Spectra AA 220, USA Varian), the aliquot was utilized independently to measure the mineral contents of potassium, magnesium, and iron.

**Statistical analysis**

The data were statistically examined using analysis of variance (ANOVA) and completely randomized design (CRD). A 5% probability level was used to calculate the importance of the treatments.

**Results and discussion**

**Proximate components**

The water activity of freeze dried pea pod powder was showed low water activity (0.42) due to high removal of moisture content as a result of sublimation.The moisture content of the pea pod drastically decreased as a result of all the drying techniques. The highest moisture of 8.95 % was found in sun drying sample followed by solar drying represent 8.12% (Table 1). This could be as a result of sun drying's variable temperature and relative humidity as opposed to tray drying, which uses a constant temperature to effectively remove moisture (9). The lower moisture content was found in freeze drying because, in contrast to conventional drying techniques, the sublimation of frozen moisture to direct vapours causes a larger loss of water which is in agreement with findings of (10).The crude protein concentration of pea pod powder was significantly impacted by the various drying methods. The freeze dried (FD) pea pod powder had higher crude protein content (15.02%) followed by tray drying(14.79%) while the lesser crude protein content is presented in sun and solar drying 12.44 and 13.04%, respectively (Table 1). Similar to our findings, (11) discovered that sea cucumbers dried by freeze dried had the highest protein content. This is because the low temperatures that freeze dried uses for drying which helps maintain the protein content.

Pea pods have a naturally low lipid content, which contributes to the low-fat level of pea pod powder. Pea pods have a comparatively modest amount of lipid, with linoleic acid being the main fatty acid. Nonetheless, in comparison to other components, the total fat content is still quite low. The low-fat level of pea pod powder due to its composition makes it appropriate for uses -where a lower fat intake is preferred (12). The data showed in Table 1 reported the effect of different drying methods on crude fat content of pea pods.In comparison to other drying techniques, the freeze drying process preserved a larger level of crude fat content (1.90%) due to shorter drying times and reduced exposure to damaging conditions, better preserving the lipids and yielding a higher fat content in the final powder., which is consistent with findings by (13) that showed freeze-dried edible botanicals retain more crude fat than those that are sun- or oven-dried.

The crude fibre content in dried pea pods powder wasin the range of 8.95 to 7.52% (Table 1). The crude fibre is higher in freeze dried pea pod powder because of the concentration affect and structural integrity of fibre components during drying (14). The crude fibre content followed the order of freeze dried pea pod powder>microwavedried pea pod powder >traydried pea pod powder >Osmotic dehydrationdried pea pod powder >solardried pea pod powder >sun dried pea pod powder. These results are in line with the findings of (15) reporting higher crude fibre in peels of oven dried avocado and melons than the samples subjected to freeze drying.When comparing the impact of various drying techniques on the amount of ash,the highest ash content was revealedin freeze dried pea pod powder as compared to other methods. The reason for this could be that the low temperatures and vacuum used during the freeze-drying process improved mineral retention, leading to greater ash values (116).According to (10)reported higher ash content in freeze dried yam flourin comparison to oven dried samples compatible with our findings. While comparing the sun and solar drying methods of pea pods powder, the sun and solar drying methods showed lower ash content (Table 1). This is because longer air exposure combined with temperature and humidity variations causes more mineral loss (5).

**Mineral components**

The data in table 2 shows the effectof drying on mineral composition of pea pod. It was observed that higher mineral content (potassium, magnesium and iron) of 1832.65,987.54 and 10.45 mg/100g,respectively were observed in freeze dried pea pods. The lower temperature and vacuum used in freeze-dried pea pods may have contributed to the higher mineral retention by reducing the microbial and metabolic processes that drive mineral losses. Similar results were found by(17) in freeze dried amla fruit.Due to the greater temperature, lower humidity, and quicker drying time during solar drying as opposed to sun drying pea pods, the solar dried sample was found to have a higher mineral content than the sundried sample (Table 2).According to (18) observed a similar pattern in the mineral content of amaranth leaves that were subjected to solar drying and the sun.

**Conclusion**

Drying is a traditional food preservation technique.  Nutrient losses vary in magnitude depending on the operating circumstances of various drying techniques. Freeze drying is highly recommended for pea pods due to its ability to retain essential nutrients, including proteins, fibre, and mineral. Unlike other drying methods, freeze drying minimizes thermal degradation, thereby preserving the structural and functional integrity of nutrients.Freeze drying uses low temperatures and vacuum, which reduces nutrient loss, whereas sun drying causes more loss due to changing ambient conditions. The dried pea pods can be used as a functional ingredient in a number of products with additional value.

**REFERENCES**

1. Nasir G, Zaidi S and Tabassum N. (2022). A review on nutritional composition, health benefits and potential applications of by-products from pea processing. Biomass ConversionBiorefinery.2022[https://doi.org/10. 1007/s13399-022-03324-0](https://doi.org/10.%201007/s13399-022-03324-0)

2. Castaldo L, Izzo L, GaspariA, Lombardi S, Rodríguez-CarrascoY, Narváez A, GrossoM, Ritieni A. Chemical composition of green pea (*Pisum sativum* L.) pods extracts and their potential exploitation as ingredients in nutraceutical formulations. Antioxidants.2021;11(1):105.

3. XuY, Xiao Y, Lagnika C, Li D, Liu C, Jiang N, Song J, Zhang M. A comparative evaluation of nutritional properties, antioxidant capacity and physical characteristics of cabbage (Brassica oleracea var. capitate Var L.) subjected to different drying methods. Food Chemistry. 2020; 309, 124935. [https://doi.org/10.1016/j.foodc hem.2019.06.002](https://doi.org/10.1016/j.foodc%20hem.2019.06.002)

4. Calín-Sánchez Á, Lipan L,Cano-Lamadrid M,Kharaghani A,Masztalerz K, Carbonell-Barrachina ÁA, Figiel A. Comparison of Traditional and Novel Drying Techniques and Its Effect on Quality of Fruits, Vegetables and Aromatic Herbs. Foods, 2020;*9*:1261. <https://doi.org/10.3390/foods9091261>

5. Bashir N, Sood M, andBandral JD. Impact of different drying methods on proximate and mineral composition of oyster mushroom (*Pleurotus florida*). Indian Journal of TraditionalKnowledge;(2020).

6. AOAC.2012. Official Methods of Analysis.19th edition. Association of Official Analytical Chemists, Washington, D.C.

7. SadasivamS, Manickam A. Anti-nutritional factor: In Biochemical Methods for Agricultural Science. New International Publication Limited, 2008 New Delhi,India.215-216.

8. AOAC.2005. *Official Methods of Analysis*.17th edition. Association of Official Analytical Chemists, Washington, D.C.

9. Muyanja C, Kyambadde D,NamugumyaB. Effect of pretreatments and drying methods on chemical compositionand sensory evaluation of oyster mushroom (*Pleurotus oestreatus*) powder and soup. Journal Food Processing and Preservation, 2012;38(1): 457-465.

10. Hsu C, Chenb W, Wenga Y,Tsenga C. Chemical composition, physical properties and antioxidant activities of yam flours as affected by different drying methods. Food Chemistry, (2003);83(1): 85-92.

11. Öztürk F, Gündüz H. The effect of different drying methods on chemical composition, fatty acid, and amino acid profiles of sea cucumber (*Holothuria tubulosaGmelin*, 1791). Journal of food processing and preservation,2018;1-10.

12. Mateos-AparicioI, CuencaAR, Suarez MVJ. Pea pod, broad bean pod and okara, potential sources of functional compounds. LWT 2010;43(9):1467-1470.

13. Oni MO, Ogungbite OC, Akindele AK.The effect of different drying methods on some common Nigerian edible botanicals.International Journal of Advanced Research in Botany,2015;1(1): 15-22.

14.Siriwattananon, L. and Maneerate, J. Effects of drying methods on dietary fiber content in druit fruit and vegetable from non-toxic agricultural field. International journal of Geomate,2016;11(6):2896-2900.

15. Morais, DR, Rotta, EM, Sargi, SC, Bonafe, EG, Suzuki, RM, Souza, NE, Matsushita, M. andVisentainer, JV. Proximate composition, mineral contents and fatty acid composition of the different parts and dried peels of tropical fruits cultivated in Brazil.Journal of the Brazilian Chemical Society, 2017;28(2):308-318

17. Tyagi A and Pal A. Physico-chemical properties of chakiya variety of amla (Emblica officinalis) and effect of different dehydration methods on quality of powder. WorldJournal ofPharmaceutical Research,2015;4(6): 1042-1048.

18.Ukegbu PO, and Okereke CJ.Effect of solar and sun drying methods on the nutrient composition and microbial load in selected vegetables, African spinach (*Amaranthushybridus*), fluted pumpkin (*Telferia occidentalis*) and okra (*Hibiscus esculentus*).Journal of Food Science andTechnology,2013;2(5): 35-40.

**Table 1- Effect of drying methods on proximate composition of pea pods**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Drying methods** | **Water activity**  **(aw)** | **Moisture**  **(%)** | **Crude protein**  **(%)** | **Crude fat**  **(%)** | **Crude fibre (%)** | **Ash (%)** | **Carbohydrate (%)** | **Energy (Kcal/100g)** |
| **T₁** | 0.67 | 8.95 | 12.44 | 1.10 | 7.52 | 5.87 | 62.12 | 308.14 |
| **T₂** | 0.64 | 8.12 | 13.04  . | 1.23 | 7.84 | 6.04 | 63.73 | 318.15 |
| **T₃** | 0.57 | 7.98 | 14.79 | 1.79 | 8.01 | 6.81 | 60.31 | 316.51 |
| **T₄** | 0.53 | 7.56 | 14.20 | 1.45 | 8. 32 | 6.45 | 61.39 | 315.41 |
| **T₅** | 0.42 | 5.10 | 15.02 | 1.90 | 8. 95 | 7.74 | 62.23 | 326.10 |
| **T₆** | 0.48 | 7.15 | 13.97 | 1.67 | 7.11 | 7.55 | 62.07 | 321.71 |
| **Mean** | **0.55** | **7.47** | **13.91** | **1.52** | **7.62** | **6.74** | **61.97** | **317.67** |
| **CD**(p≤0.05) | **0.05** | **0.06** | **0.20** | **0.31** | **0.24** | **0.08** | **0.38** | **2.51** |

**Table 2- Effects of drying methods on mineral composition of pea pod**

|  |  |  |  |
| --- | --- | --- | --- |
| **Drying methods** | **Potassium**  **(mg/100g)** | **Magnesium**  **(mg/100g)** | **Iron**  **(mg/100g)** |
| **T₁** | 1010.29 | 718.56 | 5.84 |
| **T₂** | 1163.55 | 795.02 | 5.95 |
| **T₃** | 1324.32 | 921.22 | 8.82 |
| **T₄** | 1297.74 | 874.68 | 8.27 |
| **T₅** | 1832.65 | 987.54 | 10.45 |
| **T₆** | 1182.37 | 856.47 | 6.69 |
| **Mean** | **1301.82** | **858.91** | **7.67** |
| **CD** (p≤0.05) | **4.36** | **3.69** | **0.04** |