International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249-8958 (Online), Volume-4 Issue-2, December 2014

Effect of Solar Drying on the Nutritive Value of Fenugreek Leaves

S. R. Navale, Upasni Supriya, V. M. Harpale, K. C. Mohite

Abstract - A cabinet solar dryer with varying width of chimney has been designed and fabricated. In this work an attempt has been made to evaluate the performance of cabinet solar dryer (CSD) and open sun drying (OSD) to dry the fenugreek leaves. Result obtained showed that drying time for cabinet solar drying was found 43% less than that of open sun drying. After drying, samples were powdered and nutritive tests were carried out at national agricultural and Food research institute (NAFARI) .The results showed significant increase in the nutrients studied of the dried samples except for vitamin C. The quantitative retention of nutrients like, energy, carbohydrates, calcium and sodium was found 4%, 2.5%, 66.47%, and181.66% more in sample dried in cabinet solar dryer as compared to open sun.

Keywords: Cabinet solar dryer, open sun drying, fenugreek, Nutrients

I. INTRODUCTION

Drying is the process of removal of moisture due to simultaneous heat and mass transfer. It is the classical method of food preservation, which serves lighter weight for transportation and small space for storage [1]. It enhances the transportability and retention of nutritional value [2]. The relevance of solar energy in drying practice of agriculture product has tremendous potential as it can easily provide the low temperature heating essential for drying. The drying practice using solar energy ranges from traditional open sun dryings to solar dryers. Open sun drying widely used in many countries. However open sun drying has many problems such as contamination by dust, insect, infestation, microbial attack and required drying time for given sample is somewhat large. Drying rate is slow and quality of dried products is poor [3]. In comparison to open sun drying, solar dryers generate higher temperature, lower relative humidity, lower product moisture content and reduced spoilage during the drying process [1,2 3]. In addition, it takes less time and is relatively inexpensive [4, 5]. According to a survey conducted in several countries in Asia Pacific region the best potential and popular solar dryers are i) Natural convection cabinet dryer ii) Forced convection indirect type and iii) Green house type [4]. The forced convection dryer and green house dryer having higher cost compared to natural convection cabinet dryer.

Manuscript published on 30 December 2014.
***** Correspondence Author (s)
S. R. Navale, Department of Physics, S.N. Arts, D.J.M. Commerce and B.N.S. Science College Sangamner, M.S., India.
Upasni Supriya, Department of Physics, AISSMS, College of Engineering, Pune, M.S., India.
V. M. Harpale, Department of Physics, Ahmednagar College, Ahmednagar, India.
K. C. Mohite, Department of Physics, H.V. Desai College of Arts, Science and Commerce, Pune, M.S., India.

In the present study a simple low cost cabinet solar dryer has been fabricated. The advantages of this dryer are- it is easy to operate, it requires no training and it is low cost since it is made by locally available materials. It is easy to build and requires semiskilled persons and limited facilities to fabricate. Furthermore, the sample dried in the cabinet solar dryer shows excellent nutritive quality.

II. MATERIAL AND METHOD

2.1. Cabinet solar dryer

The cabinet solar dryer consists mainly of two parts such as cabinet and chimney. The cabinet was made by waterproof plywood. An opening was provided at the bottom of the cabinet to suck the air inside the dryer. Inner side of cabinet was polished by black paint. Inside the cabinet at mid position perforated tray was placed. Further the flatten chimney was attached to the cabinet. The chimney was also made of waterproof plywood and its inner surface was painted black. The front sides of cabinet and chimney were covered with transparent glass. The temperature of chimney was more than the temperature of cabinet and the temperature of the cabinet was more than the surrounding and hence the natural convection is set up in the dryer. The schematic diagram is shown in following figure1. The temperature inside the cabinet can be set according to drying temperature of vegetables by adjusting the width of chimney mechanically. For fenugreek leaves required temperature for drying was 45^0C to 60^0C. [6] This temperature was maintained in the cabinet by adjusting the width of chimney

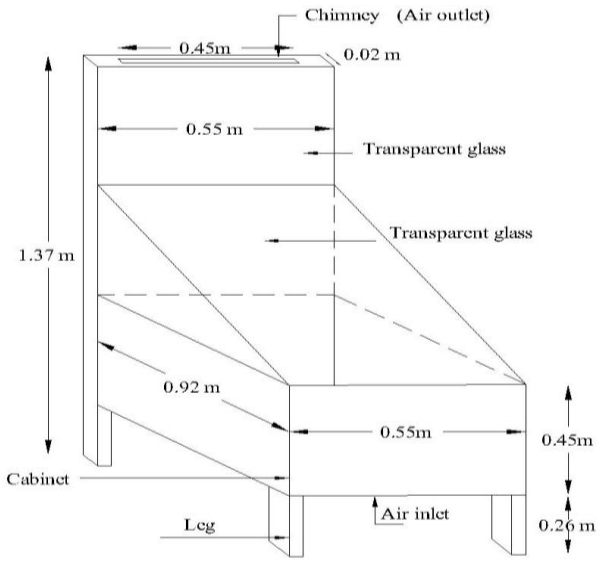

Figure 1. Cabinet Solar Dryer

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)

2.2. Sample collection

One kg fenugreek leaves sample was collected from the one farm only to ensure the uniformity and to avoid the effect of soil variation on the nutrient content of the sample.
The fresh and green fenugreek leaves were selected and discoloured, as well as wilted leaves removed to avoid bad odour and loss of nutrients after dehydration.

2.3. Sample preparation

The fenugreek leaves were cut from the stem in order to make them free of soil and dirt. The leaves were washed with ample of fresh and clean water number of times. After washing the leaves which was then leaves were air dried at room temperature to eliminate the residual moisture in the sample. Any non leafy part present in the sample was then removed to get a homogenous collection of fenugreek separated in two equi-weighted quanta for open sun drying (OSD) and cabinet solar drying (CSD). The sample weight was recorded before the actual experimental drying was started. The OSD & CSD were carried out in an open space on the terrace of building with GPS location 19^0 35'at North latitude and 74^0 11' at East longitude. Both the drying systems i.e. CSD & OSD have the same surface area of the mesh used to spread the sample. The temperature and insolation, of OSD and CSD were recorded at an interval of one hour.

2.4. Open sun drying and cabinet solar drying

For OSD the leaves were uniformly spread on a mesh kept at a 0.3m height from the ground. The intention of such system was to avoid the contamination of dust. In OSD the temperature and the heat content depends solely upon the amount of incident radiation from the sun. The leaves were kept in open sun from 10:00 a.m. till the leaves were sufficiently dried up to the 13 % moisture content. For CSD the air dried leaves were uniformly placed over the mesh; which has same dimension as used for OSD.

III. NUTRITIVE TESTS

The fenugreek leaves dried by OSD & CSD, were powdered using a grinder and were sifted by a fine mesh. Powdered samples were then analysed by nutritive tests. The tests were carried out at National Food and Agricultural Research Institute, Tilak Road, Pune. (Certified by the Government of India)

3.1 Carbohydrates

The total carbohydrates are calculated by following formula, after determining the percentage of moisture, ash, fat and protein

Total carbohydrates = 100 – (A+B+C+D)

Where, A = Moisture percent in the given sample, B = Ash content in the given sample,

C = Fat content in the given sample, and D = Protein content in the given sample.

3.2 Energy value

By knowing the value of Protein, Carbohydrates and Fats, the energy value is given by

Energy = (P × 4) + (C× 4) + (F × 9)

Where P = Protein content, C = Carbohydrates and F = Fat content

3.3 Dietary fiber

The sample weight was taken and adjusts it to the pH 1.5. Now pepsin 0.05gm, Chloroform 0.2 ml was added in the solution and incubates at 37 ^{0}C for 18 hours. Again the pH of the solution was adjust at 6.0 and 25 ml of Phosphate buffer, 0.1 gm of Pancreatin, 1 ml of Amyl glycosidase, few crystal of Thymol was added. Further the solution was incubates at 37°C for 18 hours. Warm 95 % Ethanol was added for 3 times and precipitates kept for 1 hour. The filter paper was dried and weight was taken. Now solution was filtered through oven dried filter. After complete filtration the solution was washed by 5 ml Acetone, 5 ml Ethanol and 5 ml diethyl ether. Again filter paper was dried in oven for 70 ^{0}C, cooled and weight was taken. By measuring the following parameter the dietary fiber was calculated.

Let a_1 = Weight of dried filter paper, a_2 = Weight of the filter paper after cooling

e = Total dietary fiber on dry basis, b_1 = Weight of crucible previously oven dried

b_2 = Weight of crucible after ashing, b_3 = Ash and a_3 = Residue

$a_3 = (a_2 - a_1)$

$b_3 = (b_2 - b_1)$

c = Ash (%) $= b_3 / a_3 \times 100$

d = Ash = $c / 100 \times a_3$

e = $(a_3 - d)$ / weight of sample ×100

Total dietary fiber (%) = Total solid × e / 100

3.4 Mineral content

About 5-10 gm sample was ash in muffle furnace at 5500C. After ashing the crucible was cooled and 6N HCL was added. This solution was boiled and cooled and was filter through the filter paper (whatman No.1) repeatedly. Then 100 ml solution was made with distilled water. The blank solution was prepared in similar manner without taking any sample. The absorbance of the test solution and blank solution was measured on Atomic absorption spectrophotometer (AAS). The Absorbance versus concentration curve was plotted.

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

$$\text{Concentration of Nutrients (\%)} = \frac{\text{Concentration of sample} \times \text{Total volume}}{\text{Sample weight}} \times 100$$

IV. RESULT AND DISCUSSION

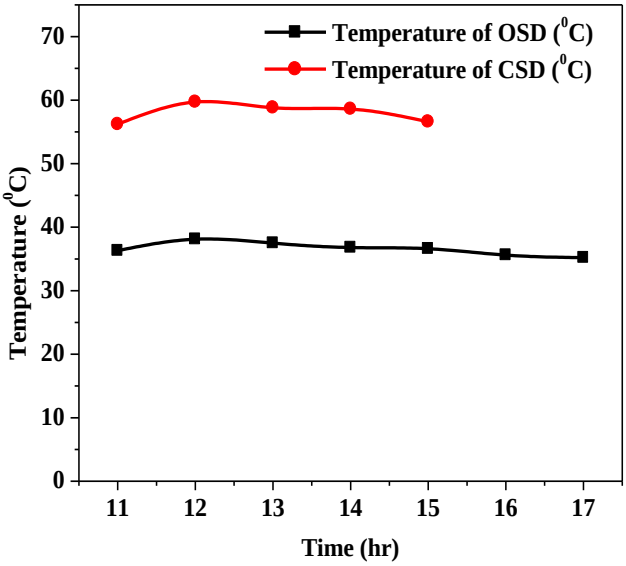

Figure 2. Temperature variations of CSD and OSD

From figure 2 it is observed that the cabinet solar dryer attained a maximum temperature of 59.7^{0}C at 12:00 noon with a minimum of 56.2^{0}C at 11:00 a.m. with the ambient temperature of 38.8 ^{0}C and 36.2 ^{0}C respectively. This higher temperature of cabinet solar dryer leads the faster drying than open sun drying and hence time required for CSD is lower. (240 minutes for cabinet solar dryer and for open sun drying it is 420 minutes) [7, 8, 9]

4.1 Result of nutritive tests

The various nutritive tests were carried out on the leaves dried in open sun and dried in cabinet solar dryer; various contents were determined which include the moisture, energy, carbohydrate, fibre, mineral (calcium, phosphorus, sodium, potassium). These contents are shown in table1, table 2, table 3.

Table 1. Nutrient composition of fresh & dehydrated fenugreek leaves

Nutrient	Fresh leaves	Open sun drying	Cabinet Solar dryer	Unit
Moisture	86.3	15.04	12.7	gm/100gm
Energy	49	321	333	Kcal/100gm
Carbohydrates	6.0	71.0	72.8	gm/100gm
Fibre	4.7	33.69	30.04	gm/100gm

Table 2. Mineral composition of dehydrated fenugreek leaves

Nutrient	Fresh leaves	Open sun drying	Cabinet Solar dryer	Unit
Calcium	395	1063	1753	mg/100
Phosphorus	51	407.24	348.52	mg/100
Sodium	76.1	762.1	2146.41	mg/100
Potassium	31.0	2988.8	2863.77	mg/100

From table1, table2, and table3 it is observed that dried fenugreek leaves shows higher nutrient content than fresh leaves [10, 11, and 12]. The result of various nutritive tests showed that the fenugreek leaves after dehydration become a concentrated source of the nutrients [12, 13, 14, 15, 16]. However the retention of nutrients like energy, carbohydrates calcium and sodium is larger in CSD compared to OSD. This result signifies that the sample dried in CSD shows good nutritive quality than OSD.

V. CONCLUSION

The cabinet solar drying is faster than open sun drying. The nutrient content in dehydrated leaves was larger than fresh leaves. Dehydration technique resulted in concentration of nutrients. The nutrients like, energy, calcium, sodium and carbohydrates have larger retention in cabinet solar dried sample than that in open sun dried sample. Hence cabinet solar dried coriander leaves showed superior quality.

REFERENCES

[1] Bukola, O. Bolaji, Tajudeen, M.A. Olayanju and Taiwo, O. Falade. (2011) Performance evolution of a solar wind ventilated cabinet dryer. West Indian journal of engineering, Vol. 33, pp.12-18.

[2] Hussain, M.Y.and Islam ud-din, A.M. (2008) Dehydration of agriculture products by mixed mode solar dehydrator. International journal of agriculture and biology Vol.10, pp. 333-336

[3] Bolaji, B.O. (2005). Performance evaluation of box type absorber solar air collector for crop drying. Journal of food technology. Vol. 3, pp. 595-600.

[4] James stiling and Pieter stroeve. (2012) Performance evaluation of an enhanced fruit solar dryer using concentrating panels. Energy for sustainable development. Vol.16, pp. 224-230.

[5] Bolaji, B.O. (2008). Analysis of moisture transport in the solar drying of food items. Pacific journal of science and technology, Vol. 9, pp. 640-646

[6] Babagana gutti, Silas kiman and Ahmed, M. (2012) Solar dryer an effective tool for agricultural products preservation. Journal of applied technology in environmental sanitation. Vol. 2, pp. 31-38.

[7] Erteken, C., Yaldiz, O. (2004) Drying of eggplant and selection of suitable thin layer drying model. Journal of food engineering. Vol.63, pp. 349-359.

[8] Umesh Toshniwal and karale, S. R. (2013) A review paper on solar dryer. International journal of engineering research and application. Vol. 3, pp. 896-902

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

[9] Navale, S.R.; Thorat, S.K.; Harpale, V. M.; and Mohite, K.C. (2013) Dehydration of leafy vegetables using cabinet solar dryer. Indian stream research journal. Vol.3, pp. 1-6.
[10] Kiremire, B.T. Musinguzi E, Kikafunda, J.K, and F. B. Lukwago (2010) Effect of vegetable drying techniques on nutrient content: A case study of south western Uganda. Vol. 10, pp. 2587- 2597.
[11] Ojike, O., Nwoke O.O and Okonkwo W. I. (2011) The influence of different solar drying systems on the vitamin content of Pawpaw. Australian journal of agricultural engineering, Vol.2, pp. 8-11
[12] Satwase, A.N. Pandhre, G. R., Sirsat, P.G. and Wade, Y.R. (2013) Studies on drying characteristic and nutritional composition of drumstick leaves by using sun, shadow cabinet and oven drying method. Open access scientific reports. Vol. 2, pp. 2-4
[13] Nambiar, V.S. and Seshadri, S. (1998) Beta carotene content of green leafy vegetables of western India by HPLC. Journal of food science and technology. Vol. 35, pp. 365-367
[14] Lakshmi, B. and Vimala, V. (2000) Nutritive value of dehydrated green leafy vegetable powders. Journal of food science and technology. Vol.37, pp. 465-471.
[15] Esper, A., Muhlbauer, W. (1998) Solar drying an effective means of food preservation. Journal of renewable energy. Vol.15, pp. 95-100.
[16] Pallavi joshi and Dipika mehta (2010) Effect of dehydration on the nutritive value of drumstick leaves. Journal of Metabolomics and system biology. Vol. 1, pp. 5-9

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)