Plant Archives Volume 20 No. 2, 2020 pp. 9039-9044 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

THE STUDY OF TRADITIONAL AND IMPROVED SOLAR DRYING METHOD ON NUTRITIONAL PARAMETERS OF AGRICULTURE PRODUCTS

Anukriti and Singh Neetu

Department of human development and family studies School for home sciences, Babasaheb Bhimrao Ambedkar University (Central University) Vidya Vihar, Raibareli Road, Lucknow (Uttar Pradesh), India.

Abstract

Drying is an essential processing the field of food and agricultural area as well using in the other field like cement, wood and timber, textile, dairy and clay brick. Drying is one of the oldest preservation processes available to the mankind;in today's food market dried foods play an important role in the commercial and household level. As for fruits and vegetables it can be estimated that they establish about 1% of the total drying in the food industry, by large being the grains the most important. The main feature of this process comprises on lowering the moisture content to avoid or slow down food spoilage by microorganism. At this point some understanding can be derived from the vocabulary employed; common words found are "Drying" or "dehydration", or even "dewatering". There are various aspects that must be considered when drying small fruits and vegetables. A system which minimizes exposure to light, oxidation and heat, (*i.e.* high heat 70 C and shorter time duration) may help conserve critical bioactive compounds. This research focuses upon new drying technologies and advantages and disadvantages, future aspects in solar drying.

Key words: drying method; food; fruit; vegetable; dehydration; solar.

Introduction

The first drying method equipment that involved the use of solar energy was found in s. France around 8000 b.c. the use of sun drying lies in the fact that various drying methods such as heaters and fans requires energy consumption thus, restricting their usage among masses. Also, nutrient losses and food infestation was seen in the foods that were dried using inadequate methods.

Sun being the largest carbon free energy resource for humans does not lays any negative impact on the environment. The method of solar drying can be applied within the countries that lie on the sunny belt of earth thus providing ample sunlight and high radiations. Since ages, drying is used for various agricultural products and it is famously practiced in the tropical and subtropical countries. The traditional methods employed in the drying methods includeplacing the products on earth, mat, floor and even roads in the scorching sun. But, this leads to the infestation of products by dirt, dust, insects and birds droppings.

Sun drying is cheapest but it could not provide the appropriate quality needed for consumer acceptance. So solar dryer is in the demand worldwide and it provides a quality dried products. Demands of many dried vegetables such as spices, fruits, dry fruits, medicinal plants and marine products are increasing worldwide.

The method of Drying means removal of moisture to preserve. By reducing the moisture contents of food product to slow down the activities of enzymes, bacteria, yeasts and molds. Drying of agricultural products by using renewable energy such as solar energy is environmentally friendly. There are many types of solar dryer available according to the local needs and technology which developed to serve the various purposes of drying products. The best potential and popular dryers are natural convection cabinet type, forced convection indirect type and green house type. Consumption of energy is most important considerations in the drying system. It depends on the type of the product dried. Purpose of Drying to minimize the loses of agricultural products from planting

Author for correspondence : E-mail : anukritibbau03@gmail.com, neetubbau@gmail.com

to consumption.

Indian food scenario

Staggering facts India has 184 million hectares of cultivable land and the country produces 90 million tonnes of milk (highest in the world), 150 million tonnes of fruits and vegetables (second largest), 485 million livestock (largest in the world), 204 million tonnes of food grains (third largest), 6.3 tonnes of fish (third largest), 489 million poultry and 45,200 million eggs. Inspite of having a vast production base and 45,200 million eggs. Inspite of having a vast production base, the processing level of the food sector is very low, for example, 2% for fruits and vegetables, 26% for marine products, 6% for poultry and 20% for buffalo meat. [4] India is one of the world's major food producers but accounts for less than 1.5% of international food trade. There lies an immense potential for investment and development in this sector, which indicates a vast scope for investors and exporters.

Objectives

1. To identify various drying methods suitable for selected vegetable.

2. To optimize drying process to determine the nutritional property of vegetable.

Solar drying

Dehydration or drying has been a means of preserving foods from earliest times. Drying is the deliberate removal of water from food products. The water removal should be under controlled conditions causing minimum or no changes in the food properties. A major criterion of quality of dehydrated foods is that when they are reconstituted in water they be very close to, or virtually indistinguishable from the original food material used. The primary objectives in removing water from any food material are to reduce its weight and bulk, leading to economical transportation, handling and distribution; and to improve its keeping quality by reducing the water activity (aw). Fruit and vegetables have high moisture content, hence highly perishable. However, when moisture has been removed, they can be preserved over a long period with minimal microbial attack. (Kordylas, 1990) Bacteria do not grow below 18% available moisture; yeasts require 20% or more and molds require 13-16%.

Solar drying Solar drying is often differentiated from ‘‘sun drying’’ by the use of equipment to collect the sun's radiation in order to harness the radiative energy for drying applications. Sun drying is a common farming and agricultural process in many countries, particularly where the outdoor temperature reaches 30C or higher. In many parts of South East Asia, spice crops and herbs are routinely dried. However, weather conditions often preclude the use of sun drying because of spoilage due to rehydration during unexpected rainy days. Furthermore, any direct exposure to the sun during high temperature days might cause case hardening, where a hard shell develops on the outside of the agricultural products, trapping moisture inside. Therefore, the employment of solar dryer taps on the freely available sun energy while ensuring good product quality via judicious control of the radiative heat. Solar energy has been used throughout the world to dry food products. Such is the diversity of solar dryers that commonly solar-dried products include grains, fruits, meat, vegetables and fish.

Methods of drying

1. Sun Drying- The content of acid and sugar is high in fruits make them safe to dry in the sun. Plate Vegetables and meats are not recommended for sun drying. Vegetables are low in sugar and acid which increases the risk for food spoilage. In some protein rich foods like Meats making them ideal for microbial growth when heat and humidity cannot be controlled. To dry in the sun, hot, dry, breezy days are best. A minimum temperature of 86^{0} F is needed with higher temperatures being better. It takes several days to dry foods out-of-doors. Because the weather is uncontrollable, sun drying can be risky. Also, the high humidity in the South is a problem. Humidity below 60 percent is best for sun drying.

2. Solar Drying -Recent efforts to improve on sun drying have led to solar drying Solar drying also uses the sun as the heat source. A foil surface inside the dehydrator helps to increase the temperature. Ventilation speeds up the drying time. Shorter drying times reduce the risks of food spoilage or mold growth.

3. In freeze drying - the moisture of a material is removed by sublimation. Conventionally, the material in a closed vessel is rapidly frozen at “10°C or lower. Then the pressure is reduced below the vapor pressure of ice at the operating temperature and heat is slowly supplied

	Merits	Demerits
Solar dryer vs. Sun dryer	Superior quality dried products Minimization of losses and contamination Less drying area Better preservation of nutrition and colorLess labor intensive Save time duration and less chance of spoilage and drying Bring down to safe moisture level, which allows longer storage Controlled drying	Comparatively more expensive In some cases, food quality is not significantly improved In some cases, market value of food will not be increased

by conduction: ice sublimes and leaves the material. When ice has been entirely removed, this is the end of the primary drying: the heat of sublimation is no longer needed and the product temperature increases. The secondary drying, the removal of the unfrozen water (10% to 35% of the initial water content), is carried out under vacuum at 50°C or 10 to 35°C for heat sensitive products (Nail and others 2002; Liapis and Brutini 2014). The overall drying times range from 4 to 24 h (Saravacos and Kostaropoulos 2002).

4. Dielectric drying- is an electronic drying method based on radio frequencies (RF) and microwaves (MW). Dielectric drying takes advantage of the polarization at the atomic and molecular scales (Piyasena and others 2003). In an oscillating electric field, the permanently polarized dipolar molecules, like water, constantly align themselves with the polarity of the electric field. With high frequencies oscillations, typically 915 and 2450 MHz for MW and 13.56, 27.12 and 40.68 MHz for RF (Piyasena and others 2003), the polarized molecules reorient millions of times per second, generating heat inside the material.

5. Infrared drying- Along with microwaves and radiofrequencies, infrared radiation (IR) transfers thermal energy in the form of electromagnetic waves (Sakai and Hanzawa 1994).

6. Vacuum drying- During vacuum drying, vacuum replaces the air to remove moisture from the product. The applied vacuum reduces the vapor pressure saturation at a given temperature and water vapor is constantly eliminated from the drying vessel.

Radiation drying- Heat is supplied by conduction or by radiation (Saravacos and Kostaropoulos 2002; Zhang and others 2006). Temperature is usually between 35 and 60°C (Sokhansanj and Jayas 2014) and the process may require up to 24 h (Saravacos and Kostaropoulos 2002; Lewicki 2006).

Materials and Methods

Study area and sampling

In this experimental study solar dryer SD 500 with height 4 feet by 2 feet .it was used for small scale drying of selected green leafy vegetables .the dryer was located in the experimental area of department of geology. The direction of sun was kept in mind and hence it was oriented, dryer was oriented in an east west direction to increase the efficacy of dryer. The dryer was fully covered by glass fibre sheet, a galvanized sheet used for absorbing the solar radiation. The fan which was placed at the back of the solar dryer that functions automatically as per the suns radiations. To maximize the use of solar energy, the orientation was kept to the south with a collector angle of 30^0c.

Fig. 1: Solar Dryer SD 500.

Methodology

Agricultural products being hygroscopic in nature have a very short shelf life and thus, drying method can be inculcated to achieve the desire result. As drying of food stuff is one of the most critical process pertaining to the fact that it contains more than 35% percent of moisture depending upon the various environmental conditions. Hence, it is proposed to integrate small solar dryer SD 500 for drying agricultural products.

Equipment design

The equipment used in this experiment is a solar dryer SD 500 which is 4 feet by 2 feet, shaped, consisting of one solar fan located at back of the dryer. The solar dryer consist of 1 ms net tray with a clear nalli sheet that goes up to a maximum temperature of 50 to 55^0c.

Sample collection

The Green leafy vegetables that were selected and preprocessed, namely Green fenugreek leaves, Spinach leaves, *Chenopodiumalbum*for studying there dehydration composition. Fresh GLV were procured Originally from local markets and there vegetation was isolated from the roots. Further, they were washed under running water to minimize the Particles that were stuck along with the mud and then they were thoroughly drained in the strainer. One package of greens had been used as such Analytics. After completing the above process, the vegetables were kept in the solar dryer on steel trays at 55°C for 10 to 12 Hrs. The GLV was pulverized in a mixer after drying, stored In an airtight packaging and held in a freezer.

Compositional analysis

The following components were analysed to study the dehydration effect on GLV Moisture and estimated minerals were inspected using standard methods (AOAC) (2000). Total iron was analysed using colorimetrics α – α bipyridyl (AOAC 1965) and calcium AOAC méthode (2000). The visual titration of the ascorbic acid was calculated Method 2 , 6 - dicholorophenol-indophenol reduction Dye. It extracted complete carotene in acetone; β-carotene Column chromatography was isolated and estimated in colorimetry (Ranganna 1986).

Processing

The processing was done under the following head

a) Selection Of Green Leafy Vegetables- GLVs being a highly perishable food product can be easily spoiled. Though it is loaded with nutrients yet, it's availability during summers is a tedious task. Hence, the drying is done to make these GLV's available to the masses during off season.

b) Cleaning- After the selection of green leafy vegetables first step is to remove out the waste particles of the GLV's.

c) Washing- when cleaning is done then washing of the GLV'S to remove out the dust particles.

d) Draining- after washing complete rest out food stuff for draining when all the water drain out Put GLV's in drying process.

e) Drying- The raw fenugreek and spinach and chino podium leaves were each subdivided into category depending upon the size which they were cut. The leaves were spread on 2 m^2 plastic wire-mesh drier racks and dried either in the open sunshine or solar drier to moisture content 6.0-8.7% when both the leaves and stalks were completely dried and easy to crush into tiny pieces. The drying time was 9-12 hours on hot sunny days and 21-24 hours during the winter season.

f). Packaging- Dried GLVs were packaged in high density polythene of gauge 200, immediately upon removal from the sunshine and sealed to prevent moisture re-absorption. The packaged vegetables were kept at room temperature in dark-coloured blue buckets to protect from light.

Results and Discussion

Green fenugreek fresh leaves are among the oldest herbs posessing β-carotene 388IU vitamin C 53 mg/ 100mg (Srinivasan (2006), Iron 25.8 ,mg/100mg (Al Jasass and Al Jasser, 201).

On dehydration these constituents were reduced and data inferred that after dehydration vitamin C, was 50.85 mg/100g, iron and carotene were 2.31 mg/100g , 285 IU respectively.

Fig. 2: Dried Fenugreek.

Table 1: Comparative analysis of constituents between fresh and dehydrated leaves of fenugreek leaves.

S.N.	Constituent	Fresh	Dehydrated
1	Vitamin c, mg/100g	53	50.85
2	Iron, mg/100g	25.8	2.31
3	Carotene,IU	388	285

Fig. 4: Dried Spinach leaves.

Table 2: Distinctive study between concentration of constituents in fresh and dehydrated spinach leaves.

S.N.	Constituent	Fresh	Dehydrated
1	Iron, mg/100g	19.8	10.27
2	Carotene,IU	20,976	56,26
3	Potassium,mg/100mg	167	55.58

Spinach fresh leaves are among the oldest herbs possessing iron 2.3mg/100g (zang, D &Hendrick 1989), carotene 20976 IU (USDA U. 2015), potassium 167 mg/ 100mg (Megan Ware, 2018). On dehydration these vale were altered and data illustrated that after dehydration concentration of Iron, carotene, potassium were 0.27 mg/ 100g, 56,26 IU and 5.58 mg/100 respectively.

*Chenopodiumalbum*leaves are among the ancient herb.

Fig. 3: Dried Chinopodium.

Table 3: Distinctive analysis of concentration of constituents present in fresh and dehydrated leaves.

S.N.	Constituent	Fresh	Dehydrated
1	Vitamin c, mg/100g	78.1	50.8
2	Calcium, mg/100g	33.5	13.85
3	Phosphorus, mg/100g	1.55	1.55
4	Iron, mg/100g	2.49	0.93
5	Carotene,IU	45,54	449

That possess vitamin C 78.1mg/100g, calcium 33.5 mg/100g, iron 2.49 mg/100g, carotene IU 4554 (Sheetal Gupta *et al.,* 2011) and Phosphorus 1.55 mg/100mg (Bahadur *et al.,* 2011).

After dehydration the constituents were changed and this value shifted toward 0.8 mg/100g, 3.85 mg/100g, 1.55 mg/100g, 0.93mg/100g and 449IU for vitamin C, calcium, phosphorus, iron and carotene respectively.

In one of pioneering approaches Chawla *et al.,* (1988) identified *in vitro* iron availability and in six associated GLV constituent (amaranth, Drumstick, colocasia, fenugreek, shepu and spinach) andit was discovered to be about 2.8%-4.6%. Lucarini *et al.,* (2000) Studied artichoke, asparagus, broccoli, cauliflower, kale, cabbage, tomato and dialyzable iron content Mine. The dialyzable iron *in vitro* varied between 10.7 - except for artichoke and asparagus, 23.1 percent. Similar results were also published by Gillooly *et al.,* (1983), the bioavailability of *in vitro* iron in uncommon GLV India's Uttaranchal region ranged between 4.62 6.20% (Raghuvanshi *et al.,* 2001). The reduction in dialyzability on dehydration could be due to the fact that iron dehydration could have been linked to other vegetable constituents, thus reducing solubility. The dialyzability of mineral influences in turn. Ascorbic acid which promotes bioavailability of iron is also wrecked during dehydration.

Conclusion

Dehydration is among the easiest ways to preserve green leafy vegetables. Being rich in vital micro-nutrients the green leafy vegetables can be used for enrichment of nutritionally deficient products purposes. To resolve the health-related issues, dehydrated green leafy vegetable powder can be used in many conventional as well as commercial items for added value. The shifts in composition which resulted upon dehydration element varied. The closest values were the least complete iron content and calcium content decreased moderately, yet mineral dialysability decreased markedly. Dehydrated GLV can be used in commercial manufacture of refined foodstuffs. The added value of foodstuffs with GLV dehydrated may be championed as a realistic solution to combating hunger Malnutrition with the micronutrients.

References

Kordylas, J.M. (1990). Processing and Preservation of Tropical and Subtropical Foods. Macmillan Publishers Ltd. London.

Lewicki, P.P. ((2006). Design of hot air drying for better foods. *Trends in Food Science and Technology,* **17:** 153-163.

Aravindh, M.A. and A. Sreekumar (2015). Solar Drying- A Sustainable Way of Food Processing, Energy Sustainability through Green Energy, p 521.

Subhash B. Kakade and V.S. Neeha (2014). Dehydration of Green Leafy Vegetable: Review, *International journal of innovative research in technology,* **1(8):** p58-64.

Seidu J.M., E.Y.H. Bobobee, W.K.J. Kwenin, R. Frimpong, S.D. Kubge, W.J. Tevor and A.A. Mahama (2012). Preservation of indigenous vegetables by solar drying, *Arpn Journal of Agricultural and Biological Science,* p 407-415.

Natabirwa, H., J. Mukiibi, E. Zziwa and J. Kabirizi (2016). Nutritional and physicochemical properties of stored solar-dried cowpea leafy vegetables, *Uganda Journal of Agricultural Sciences,* **17(1):** 1-10.

Nail, S.L., S. Jiang, S. Chongprasert and S.A. Knopp (2002). Fundamentals of freeze-drying. *Pharm Biotechnol.,* **14:** 281–360. doi:10.1016/0140-7007(79)90079-3.

Sokhansanj, S. and D.S. Jayas (2014). Drying of foodstuffs. In: Mujumdar AS, editor. Handbook of industrial drying. 4th ed, ebook edition. Boca Raton, Florida: CRC Press. p 521–44. ISBN-13: 978-1-4665-9666-5.

Sakai, N. and T. Hanzawa (1994). Applications and advances in far-infrared heating in Japan. *Trends Food Sci. Technol.,* **5(11):** 357–62. doi:10.1016/0924-2244(94)90213-5.

Saravacos, G.D. and A.E. Kostaropoulos (2002). Food dehydration equipment. In: G.D. Saravacos, A.E. Kostaropoulos, editors. Handbook of food processing equipment. 1st ed. USA: Springer. p 331–82. doi:10.1007/978-1-4615-0725-3.

Piyasena, P., C. Dussault, T. Koutchma, H.S. Ramaswamy and G.B. Awuah (2003). Radio frequency heating of foods: principles, applications and related properties- a review. *Crit. Rev. Food Sci. Nutr.,* **43(6):** 587–606. doi:10.1080/10408690390251129.

Schippers, R.R. (2000). African Indigenous vegetables. An overview of the cultivated species, chathan, UK: Natural Resources Institute (ACP-EU) Technical centre for agricultural and rural cooperation. pp. 22; 172b; 121c; 3d.

Zhang, D., D.G. Hendricks and A.W. Mahoney (1989). Bioavailability of total iron from meat, spinach (*Spinacea oleracea* L.) and meat–spinach mixtures by anaemic and non-anaemic rats. *British journal of nutrition*, **61(2):** 331-343.

USDA, U. (2015). National nutrient database for standard reference, release 28. Health benefits and nutritional value of spinach https://www.medicalnewstoday.com/articles/270609.

Gupta, S., B.S. Gowri, A.J. Lakshmi and J. Prakash (2013). Retention of nutrients in green leafy vegetables on dehydration. *Journal of food science and technology*, **50(5):** 918-925.

Bahadur, A., Z. Chaudhry, G. Jan, M. Danish, A. ur Rehman, R. Ahmad and F.G. Jan (2011). Nutritional and elemental analyses of some selected fodder species used in traditional medicine. *African Journal of Pharmacy and pharmacology*, **5(8):** 1157-1161.

Chawla, S., A. Saxena and S. Seshadri (1988). *In vitro* availability of iron in various green leafy vegetables. *J. Sci. Food Agric.,* **46:** 125–127.

Lucarini, M., G. Di Lullo, M. Cappelloni and G. Lombardi-Boccia (2000). *In vitro* estimation of iron and zinc dialyzability from vegetables and composite dishes commonly consumed in Italy: Effect of red wine. *Food Chem.,* **70:** 39–44.

Gillooly, M., T.H. Bothwell, J.D. Torrance, A.P. Macphail, D.P. Derman, W.R. Bezwoda, W. Mills and R.W. Charlton (1983). The effect of organic acids, phytates and polyphenols on the absorption of iron from vegetables. *Br. J. Nutr.,* **49:** 331–342.

Raghuvanshi, R.S., R. Singh and R. Singh (2001). Nutritional composition of uncommon foods and their role in meeting micronutrient needs. *Int. J. Food Sci. Nutr.,* **53:** 331–335.

AOAC (2000). Official Methods of Analysis, 17th edn, Methods 934.01, 920.39 and 942.05. Association of Official Analytical Chemists, Arlington.

AOAC (1965). Official methods of analysis, 10th edn. Association of Official Analytical Chemists, Washington DC.

Ranganna, S. (1986). Handbook of analysis and quality control for fruit and vegetable products, 2nd edn. Tata McGraw-Hill, New Delhi.