A REVIEW

FOOD SCIENCE
RESEARCH JOURNAL

e ISSN-2230-9403 ■ Visit us :
www.researchjournal.co.in
Volume 8 | Issue 2 | October, 2017 | 403-408
DOI : 10.15740/HAS/FSRJ/8.2/403-408

Drying charactristics of garlic

S.V. BONDRE, A.M. SONKAMBLE AND S.R. PATIL

Garlic is most widely cultivated *Allium* next to common onion. In addition, regular consumption of garlic has been associated with several health benefits due to its high medicinal values and antioxidant properties. Processing and preservation of garlic by suitable means is a major thrust area in present scenario due to increased demand of processed products. Dehydrated garlic products have been identified as one of the major commodity preferred by the different organizations to meet the requirements of Indian and international troops. Drying is one of the oldest methods for the preservation of food products. The methods of dehydration restrict the growth and toxin produced by micro-organisms and also improves the quality of the product in the term of colour, texture and flavour. Recently, dryers like solar dryers, cabinet dryers, electric tray dryers,fluidized bed dryers and microwave dryers are gaining maximum attention due to their quality preservation of products in food processing industry. The drying characteristics studied by several researchers are reviewed here. There is utmost need to explore drying methods and their characteristics in order to evaluate the effect of different parameters on quality of garlic due to its nutraceutical importance.

Key Words : Garlic, Drying, Dryers, Preservation

How to cite this article : Bondre, S.V., Sonkamble, A.M. and Patil, S.R. (2017). Drying charactristics of garlic. *Food Sci. Res. J.*, **8**(2): 403-408, **DOI : 10.15740/HAS/FSRJ/8.2/403-408**.

INTRODUCTION

Garlic is one of the most important commercial spice crop, valued for seasoning and flavouring vegetables and meat dishes. It has a unique flavour and the particularity of improving the flavour of other foods and therefore, it is often used for culinary purposes. While intact garlic cloves have no odour, once damaged, the enzyme allinase is release from the disrupted cells and hydrolyses the S-alkyl-L-cysteine sulphoxide to produce many sulfur volatile compounds associated with the characteristic garlic flavour and pungency. The main compound formed by this reaction is thiosulphate. Allicin is formed enzymatically from the precursor allin, it is responsible for the characteristic odour and flavour of fresh garlic (Cecilia and Nunes, 2004).In addition, regular consumption of garlic has been associated with several health benefits due to its high antioxidant capacity (Benkablia, 2005). It has antibiotic, cholesterol lowering, carminative and gastric stimulant properties. Its component inhibits tumerogenesis, cardiovascular diseases and reproduction of toxic germs in stomach (Kaur and Maini, 2001). The inhalation of garlic oil or garlic juice has generally been recommended by medics against cases of pulmonary tuberculosis, rheumatism, sterility, impotency, cough, lung diseases and a specific remedy for sore eyes and earache.

In general, garlic has higher nutritive value than other bulb crops. It contains average 59 – 78 % water, 6 % protein, 0.5 % lipids, 33 % carbohydrates, 2 % fibre and 1 % sugars. Garlic is also a good source of minerals, vitamin C (31mg/100 g fresh weight) and other vitamins in lower amount. In addition, it contains 0.06 – 0.1% volatile oil. The chief constituents of garlic oil are dialleyl

MEMBERS OF RESEARCH FORUM

Author for correspondence :
S.V. BONDRE, Department of Horticulture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, AKOLA (M.S.) INDIA
Email : sandipbondre63@gmail.com

Associate Authors' :
A.M. SONKAMBLE AND S.R. PATIL, College of Horticulture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, AKOLA (M.S.) INDIA

disulfide (60%), dialleyltrisulphide (6%), a small quantity of diethyl trisulfide and probably dialleyl polysulfide (Pandey and Bhonde, 2003). Garlic is consumed throughout the year by Indian peoples in one or other preparations. Being a highly perishable crop, its storage is a serious problem. In India garlic is harvested in the month of March – April and stored throughout the year. Due to the fluctuations in daily environmental conditions in our region, it is very difficult to maintain the quality and quantity of garlic during storage period. Due to these reasons, there is inadequate availability of garlic bulbs in the market as compared to demand. Thus garlic should made available in different forms *viz.*, dehydrated cloves, garlic paste, minimally processed garlic, dehydrated powder etc.

Drying :

Drying is one of the oldest methods for the preservation of food products. Newer techniques of drying such as heated air drying due to hygienic and economic considerations have been developed (Das *et al*., 2004 and Motevali *et al*., 2010). The hot-air drying of food material has advantages such as control of product quality, achievement of hygienic conditions and on reduction of product loss (Corzo *et al*., 2008). Food scientists have found that by reducing the moisture content of food in between 10 to 20%, bacteria, yeast, mold and enzymes are all prevented from spoiling it. The flavour and most of the nutritional value is preserved and concentrated (Dennis, 1999). Moisture removal from solids is an integral part of food processing. Many food products are dried at least once at some point in their preparation. Drying fruit and vegetable products is an important means of enhancing resistance to degradation due to a decrease in water activity.

Dehydration refers to the removal of moisture by the application of artificial heat under controlled conditions. Like other biological crops, garlic is subject to waste due to respiration and microbial spoilage during storage. Dehydration is one of the commercial and suitable methods of preservation to convert the surplus production of garlic into different value added products, which will help to minimize the huge substantial storage losses and also avoid the risk of fluctuation of market price during longer storage. Dehydrated garlic powder is the unique and most demanded processed product at national and international level.

Dehydrated garlic products *viz*., garlic powder, garlic paste, dehydrated garlic, pickled garlic etc.have been identified as major commodities preferred by the different organizations to meet the requirements of Indian and international troops. Dehydration of garlic during the glut period results into less cost of production of raw material, less transportation cost, less risk of price fluctuation of garlic due to use of surplus produce for processing and reasonable prices for both the producer as well as consumer due to reduction in substantial losses and increasing the availability of garlic in processed form to market.

Effect of drying on quality of dehydrated garlic :

There are two processes during drying, the addition of heat and the removal of moisture from the food. Heating can be both beneficial and detrimental to nutrient content of foods. It generally improves the digestibility of foods, making some nutrients more available. A typical example is the protein in food crops, which is made more digestible by heating because of the inactivation of anti-nutrients such as trypsin inhibitors (Morris *et al.*, 2006). The methods of dehydration restrict the growth and toxin produced by microorganisms and also improves the quality of the product in terms of colour, texture and flavour (Tripathi and Singh, 1992).

Potter and Hotchkiss (1998) reported that, heat not only vaporizes water during drying but causes loss of volatile components from the food and as a result most dried foods have less flavour than the original material. This invariably occurs to at least a small degree.The stability of ascorbic acid during storage and processing of food is a major problem for food technologists and nutritionists. During heat treatment, ascorbic acid not only losses but also the formation of brown colour which deteriorate the quality of finished products (Chauhan *et al.*, 1998). The stability and degradation rate of vitamins such as ascorbic acid is highly affected by temperature, moisture, pH, ionic strength and metal traces because it is practically heat sensitive at high moisture contents. Heating and oxidation may destroy considerable amounts of ascorbic acid during the drying (Crapiste, 1995). The ascorbic acid is lost during drying of garlic which was mostly due to its oxidation and enzymatic browning during the storage period and also ascorbic acid is very sensitive to heat and it is also soluble to water. It might be lost due to application of heat during drying (Bondre *et al*., 2016).

It has been reported by several workers that, the titrable acidity content of dehydrated product decreases progressively irrespective of the drying methods imposed. This decrease in acidity percentage might be due to conversion of some amount of acid into sugar during respiration (Sagar, 2001 and Vaishali, 2007). Also the protein content is decreased after dehydration and during storage period. It might be due to its denaturation which is brought about by heat in presence of moisture. When so denatured the configuration of the native protein molecule is lost and specific immunological properties which distinguish most protein are diminished. This caused increase in viscosity of the protein solution. After denaturation protein undergo further alienation known as coagulation or flocculation (Descrosier and Margaret, 1977).

Achanta and Okos (1995) reported that, the loss of texture in dehydrated products is caused by the gelatinization of starch, crystallization of cellulose and localized variation in the moisture content during drying which set up internal stresses. In general rapid drying and high temperature causes greater changes to the texture of the food than do moderate rates of drying and lower temperature. The drying methods also affect the sensory characteristics of products. Drying methods and processing conditions affects the colour, texture, nutritional content, density and porosity and absorption characteristics of the material. So the raw material may end up as a completely different product depending on the type of drying method and conditions applied (Krokida and Maroulis, 2001).

Drying methods:

Open sun and shade drying :

Sun drying of fruits and vegetables is still practiced largely unchanged from ancient times. Traditional sun drying takes place by storing the product under direct sunlight. Sun drying is only possible in areas where, in an average year, the weather allows foods to be dried immediately after harvest. The main advantages of sun drying are low capital and operating costs and the fact that little expertise is required.Jain and Tiwari (2003) reported that open sun drying was the most common method of crop drying in developing countries. Despite several disadvantages, it is widely practices because it is a simple way of drying. Crop temperature, temperature around the crop, solar temperature and rate of moisture evaporation are the important parameters in open sun drying of garlic. Anju Sangwan *et al.* (2010) carried out nutritional evaluation of garlic powder dried by shade, solar, oven and microwave drying methods. Proximate composition varied from 0.78 to 8.87 % and mineral content ranged from 0.29 to 86.50 mg/100 g. Polyphenol content was almost similar in all the dried garlic powders whereas beta – carotene and ascorbic acid contents were maximum in shade dried garlic powders.

Solar drying :

Solar dryers generate higher temperature and lower relative humidity which results in shorter drying time, lower product moisture content and reduced spoilage. Solar dryers have some advantages over sun drying when correctly designed. They give faster drying rates by heating the air to 10-30°C above ambient, which causes the air to move faster through the dryer, reduces its humidity and deters insects. The faster drying reduces the risk of spoilage, improves quality of the product and gives a higher throughput, so reducing the drying area that is needed. Maini *et al.* (1984) conducted research on solar dehydration of onion. Drying in solar dryer by using different types of drying surfaces showed that, drying rate in the drier was comparatively lower in the beginning but it picked upto the level of drying after 8 hours. Maini *et al.* (1984) evaluated the storage behaviour and drying characteristics of four commercial varieties of onion *i.e.* Mahuva, Rupali, Nasik and Rangda. 5 mm thick slices were spread on the aluminium tray and forced indirect solar drier was used for dehydration. Onion powder of these varieties was stored in 200 gauge HDPE which showed good results as it taken minimum time (6 to 10 hours) to reduce moisture level upto 5 %.Rawat (2011) found that, the organoleptic parameters of dried garlic slices *viz*., colour, aroma, taste and texture were best in solar drying as compared to mechanical and microwave drying.

Cabinet drying :

Munde and Agrawal (1988) studied the process development multistage dehydration of onion flakes. The onion flakes were dried at 50, 60, 70, 80, 90 and 100^0 C upto 30, 40, 50 and 60 per cent cut off moisture levels. The remaining moisture was removed at control temperature at 50^0 C. It was found that drying temperature and drying time did not affect the reconstitution of onion

flakes. Sagar and Maini (1997) studied the packaging and storage of dehydrated onion slices. The result reported that the product can be prepared within 10 hours, when it dehydrated at a tray load of 2 kg/m^2 in a cabinet drier at 60^0 C. The product was stable at low temperature as compared with high temperature in respect of colour, flavour and texture. Dawn *et al*. (1998) studied dehydration of garlic cloves where cloves were dehydrated by four methods *viz*., sun drying, cabinet drying, mechanical drying and fluidized bed drying. From the results, it was noticed that cabinet drying registered the superior method than sun drying and mechanical drying. Dhingra (2003) had undertaken a study to optimise the drying process of garlic. The slices were dipped in 0.1, 0.2 and 0.3 % sodium metabisulphite solution, for 5 minutes at 25^0 C temperature and dried at air temperature of 55^0 C, 60^0 C and 65^0 C. The optimum levels of independent process variables were found to be 60^0 C temperature, 3 mm thickness, 9 m/s velocity and 0.1 % concentration of sodium metabisulphite as pre-treatment. These conditions yielded garlic slices of lighter colour (having L* values greater than 80), high dehydration ratio (greater than 2.25), moisture content below 5.5%, high organoleptic score and drying time was observed to be approximately 180 minutes. Bondre *et al.* (2016) reported that cabinet dried garlic powder showed the best results in physico-chemical properties with high recovery per cent (39.00%) and registered high sensory score (7.3) than solar drying.However it took more time (14.7 hours) fordrying upto 5 % moisture level.

Electric tray drying :

Tray dryers constitute an important family of convective dryers, where the drying medium is hot air or combustion gases coming from a furnace. They are adaptable to the drying of almost any material that can be put in a tray. Bisnoi *et al*. (2008)described the dehydration characteristics of garlic treated by using different methods. The results of the study showed that, the product quality of blanched sample for 55ºC and sodium metabisulphite treated sample for 65^0 C in electric tray dryer was best as compared to rest of the samples.

Fluidized bed drying :

Fluidized bed drying is a boon for the drying of food especially fruits and vegetables. They provide an effective method of drying relatively free flowing particles with a reasonable narrow particles size distribution. The feed may take the form of powders, granules, crystals, seed, pre-forms and non-friable agglomerates. Fluidized bed dryers can process a wide variation of feed rates from pounds to several hundred tons per hour. Fluidization is the state at which all the particles come in the suspended form. Ambrose and Sreenarayanan (1998) reported that dryingof garlic at 60°C for 4 hrs in a fluidized bed dryer gave good quality powder with moisture content below 3%. Vaishali (2007) conducted research at Department of Agricultural Process Engineering, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola and reported that fluidized bed drying could be preferred for drying as it takes considerably less drying time than cabinet drying but the quality was not acceptable.

Microwave drying :

Microwave energy-alone or in combination with conventional energy sources makes it possible to control the drying process more precisely to obtain greater yields and better quality products in the shortest possible time. The mechanism for drying with microwave energy is quite different from that of conventional drying. Microwaves are not forms of heat but rather forms of energy that are manifested as heat through their interaction with materials. Microwaves initially excite the outer layers of molecules. The inner part of the material is warmed as heat travels from the outer layers inward. Most of the moisture is vaporized before leaving the material. If the material is very wet and the pressure inside rises rapidly the liquid will be removed from the material due to the difference in pressure. This creates a sort of pumping action forcing liquid to the surface, often as vapor. This results in very rapid drying without the need to overheat the atmosphere and perhaps cause case hardening or other surface overheating phenomena.Sharma and Prasad (2001) reported that combined microwave–hot air drying resulted in a reduction in the drying time to an extent of 80–90% in comparison to conventional hot air drying and a superior quality final product when carried out with 100 g sample sizes at temperatures of 40°C, 50°C, 60°C and 70°C at airvelocities of 1.0 and 2.0 m/s, using continuous microwave power of 40 W.

Conclusion:

From the reviews of different drying methods, it is revealed that various investigative methods are available

and studied to analyze drying characteristics and quality aspects of garlic. There is need to reconnoiter and standardize the processing conditions with special allusion to drying methods to be adopted for garlic dehydration due to its nutritional, high medicinal values and antioxidant properties which should be retained maximum after drying. Also research should be focused on use of time and cost saving energy efficient methods for which possibilities to choose multimodal drying practices have wider scope. Moreover the newer drying technologies *viz*., microwave drying, fluidized bed drying etc. should be explored. Such research outcomes will be helpful to recommend appropriate drying methods and to elevate required conditions for drying of garlic.

LITERATURE CITED

Achanta, S. and Okos, M.R. (1995). Impact of drying on biological product quality in Food preservation and moisture control, fundamentals and applications, *Eds., Barbosa-Carovas, G.V. and Welti-Chanestechnomic publishing, lancaste*.pp. 637.

Ambrose, D. and Sreenarayanan, V.V. (1998). Studies on the dehydration of garlic.*Food Sci. & Technol.,* **35** (3): 242-244.

Anju Sangwan, Kawatra, A. and Sehgal, S. (2010). Chemical composition of garlic powder using different drying methods. *Asian J. Home Sci.*, **5** (1): 90 – 93.

Benkablia, N. (2005). Free radical scavenging capacity of antioxidant properties of some selected onions (*A. cepa* L.) and garlic (*A. sativum* L.) extracts. *Brazilian Arch. Biol. & Technol.*, **48**: 753 – 759.

Bisnoi, N.,Punam Kumari and Yadav, Y.K.(2008). Study of dehydration characteristics of garlic. *J. Dairying Foods & Home Sci.*, **27** (3 & 4): 238 – 240.

Bondre, S.V., Sonkamble, A.M. and Patil, S.R. (2016). Effect of drying methods on quality of garlic powder. *Adv. Life Sci.*, **5** (19): 8850-8853

Cecilia, M. and Nunes, N. (2004). Galic in colour atlas of post harvest quality of fruits and vegetables.*Blackwell publishing*, state avenue, ames, lowa, USA. pp 443 – 454.

Chauhan, A.S., Ramteke, R.S. and Eipeson, W.E. (1998). Properties of ascorbic acid and its applications in food processing: A critical appraisal. *J. Food Sci. Technol.*, **35**(5): 381-392.

Corzo, O., Bracho, N., Pereira, A. and Vasquez, A. (2008). Weibull distribution for modeling air drying of coroba slices. *Food Sci. Technol.,* **41**(6): 1108-1115.

Crapiste, G.H.(1995). Simulation of drying rates and quality changes. In: *Trends in food engineering*, Lozano, E.J., Annon, C., Parade-Arias, E., Barbosa-Canovas, G. (Eds) C.R.C Press.

Das, I., Das, S.K. and Bal, S.(2004). Specific energy and quality aspects of infrared (IR) dried parboiled rice. *J. Food Engg*., **62** : 9-14.

Dawn, C.P., Ambrose, D. and Sreenarayanan, V.V. (1998). Studies on the dehydration of garlic cloves. *J. Food Sci. Technol.*, **35** (3): 242 – 244.

Dennis, S. (1999). Improving solar food dryers; extracted from *Home Power Magazine*, **69**: 24-34.

Descrosier, C.B. and Margaret, N.(1977). Studies in protein content in dehydration technique. *Internat. J. Preservation*, **19**(3) : 53-57.

Dhingra, D.(2003). Optimization of the drying process of garlic (*Allium sativum*). M.Sc.Thesis, Punjab Agricultural University, Ludhiana, Punjab (India).

Jain, D. and Tiwari, G. N. (2003). Thermal aspects of open sun drying of various crops. *Energy Oxford*, **28** (2): 37-54.

Kaur, C. and Maini, S.B. (2001). Health food for new millennium. *Indian Hort.*, pp – 30.

Krokida, M. K. and Maroulis, Z. (2001). Quality changes during drying of food materials. *J. Food Sci. & Technol.*, **49**(2): 33-39.

Maini, S.B., Diwan, B. and Anand, J. C. (1984). Storage behavior and drying characteristic of commercial cultivar of onion. *J. Food Sci. Technol.*, **21**: 417 – 419.

Morris, A., Audia, B. and Olive-Jean, B.(2006). Effect of processing on nutrient. *Foods Nutri.*, **37**(3): 160-165.

Motevali, A., Minaeiy, S.,Khoshtaghazaz, M.H.,Kazemi, M. and Nikbakhtyy, A.M.(2010). Drying of pomegranate arils: Comparison of predictions from mathematical models and neural networks. *Internat. J. Food Engg.*, **6**(3): 15 -16.

Munde, A.V. and Agrawal, Y.C.(1988). Process development for multistage dehydration of onion flakes. *J. Agril. Engg.*, **25** (1): 19 – 24.

Pandey, V.B. and Bhonde, S.R. (2003). Garlic cultivation in India.Technical Bulletin No. 7, NHRDF, Nashik.

Potter, N.N. and Hotchkiss, J.H. (1998). *Food Sci*. 5th Ed.Aspen Publishers pp. 211-212.

Rawat, M. (2011). Studies on drying of garlic (*A. sativum* L.) M.Sc. Thesis, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior, M.P. (India).

Sagar, V.R. and Maini, B. (1997). Studies on packaging and storage of dehydrated onion slices. *J. Food Sci. Technol.*, **19** (6): 14 – 25.

Sagar, V.R. (2001). Preparation of onion powder by means of osmotic dehydration and its packaging and storage.*J. Food Sci. Technol.*, **38** (5): 525 – 528.

Sharma, G.P. and Prasad, S. (2001). Drying of garlic (*A. sativum*) cloves by microwave–hot air combination. *J. Food Engg.*, **50** (2) : 99-105.

Tripathi, V. K. and Singh, M. B.(1992). Osmotic dehydration of onion flakes. *Indian Food Packer*, **42** (6): 60 – 66.

Vaishali, V. L. (2007). Dehydration of onion. M. Tech (Agril. Engg.) Thesis, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, M.S. (India).

Received : *01.06.2017;* **Accepted :** *25.09.2017*