Effect of Blanching and Drying on Quality of Mace (*Myristica fragrans*)

P. HEARTWIN AMALA DHAS*, T. JOHN ZACHARIAH, P. N. RAJESH AND SHINOJ SUBRAMANNIAN
Indian Institute of Spices Research, P.B. No. 1701, Calicut - 673 012, India

Blanching of mace followed by drying in an agricultural waste-fired dryer yielded good quality product. At 50°C, drying was accomplished within 4 h. The dry recovery of blanched and unblanched mace was 37.14 and 37.8%, respectively. The effect of drying and blanching on quality constituents like volatile oil, oleoresin, colour and moisture were estimated and statistically compared. Blanching in 75°C hot water for 2 min, reduced the drying time by 12.5% and enhanced the colour (lycopene) by 22.06%. Blanched mace acquired a uniform deep red colour with a glossy appearance.

Keywords: Mace, *Myristica fragrans*, Blanching, Drying, Moisture, Volatile oil, Oleoresin, Lycopene

Nutmeg (*Myristica fragrans* Houtt.), a tree-spice yielding two commercial spice products namely, nutmeg and mace, belongs to the family Myristicaceae. Nutmeg is the dried seed, while mace is the aril covering the outer surface of the seed. The yield of mace is about 15% that of nutmeg; and it is more expensive of the two spices. In India, it is grown in the States of Kerala, Karnataka, Tamil Nadu, Goa, Maharashtra and Andaman and Nicobar Islands. The fleshy fruit, resembling a large apricot, is usually pendulous and 6-9 cm long. When ripe, the succulent, aromatic, yellow pericarp splits into two halves exposing the purplish brown mace and shiny testa. Individual nutmeg seed weighs about 5 to 10 g while the aril (mace) weighs 1 to 4 g. The ratio of nut to mace in nutmeg is 20:3 (Purseglove et al. 1981). The mace, which is brilliant red in colour, is somewhat tough and leathery.

Dried nutmeg and mace are used directly as spices and also for the preparation of their derivatives, *viz.*, the distilled oils and oleoresins. Nutmeg and mace oleoresins, obtained by solvent extraction of the spices, are used as flavouring and perfumery agents. Nutmeg oil distilled from nutmegs finds the largest application in flavouring processed foods and soft drinks.

Processing of nutmeg starts with removal of surrounding mace from seed followed by drying of seed and mace separately. During drying, mace loses about 60% of its weight as moisture. If drying is delayed, mace becomes highly susceptible to mould and insect contamination. Drying to optimum moisture level without losing the inherent qualities especially colour is a prerequisite for long storage and better price. Colour plays an important role in deciding the commercial value of mace and it has been established that its scarlet-red colour is due to the pigment lycopene (Gopalakrishnan et al. 1980). This pigment is highly sensitive to heat and light. During drying, the scarlet-red colour of mace changes to light red or reddish-brown colour. Volatile oil is the main aromatic principle containing more than 50 chemical constituents. Although the essential oils are very similar in both nutmeg and mace, they have distinctive flavours.

Conventionally, mace is dried in the sun or in kitchen fireplace utilising the heat from the stove. Some farmers dry mace on clay 'kurdis' or sand medium spread over fire. In these conventional methods, it is difficult to control the temperature of drying, which has profound influence on the colour of the dried mace. The dried mace so obtained does not possess uniform red colour. Also, about 2 to 3% of the mace gets charred in the process. Though sun drying is common, it is difficult and very slow in many areas because of the active monsoon during the harvesting season. Sun drying bleaches the colour and contaminates mace with mold growth ending in poor appearance. Hence, sun drying is not an ideal practice.

Hot air drying is a viable technology for curing mace. A mild blanching and subsequent drying of mace at 50°C in a cross flow dryer helped in retention of colour and general quality of mace (Gopalakrishnan et al. 1980). The present study, therefore, was aimed at evaluating an agricultural waste-fired dryer for mace whereby the inherent qualities are retained to maximum.

Mace collected from Indian Institute of Spices Research Experimental Farm, Peruvannamuzhi was used for the study. Drying was carried out in the Central Plantation Crops Research Institute model agricultural waste-fired dryer (Plate 1). The dryer has a burning-cum-heat exchanger, plenum chamber and drying zone. The cylindrical burning cum-heat-exchanger is located at the centre of the plenum chamber and made of 18 gauge thick galvanized iron (GI) sheet. The other end of the heat exchanger is connected to the chimney. The heat from the burning chamber is transferred by radiation and convection to the surrounding air moving up from the bottom. Firewood is burnt in the heat exchanger as and when required to keep the fire burning (Nair 1994).

Mace, weighing 5 kg, after separation from the kernel was spread in a single layer over the wire-mesh-bottom drying cham-

Plate 1. Agricultural waste-fired dryer

*Corresponding Author. Present address: National Dairy Research Institute, Adugodi, Bangalore - 560 030.
E-mail:heartwin@rediffmail.com

ber. To improve the colour, mace was also subjected to blanching in hot water (75°C) for 2 min. The blanched and unblanched samples were dried simultaneously at 50°C. The weight reduction was recorded at every half an hour interval. Drying was continued till the weight reduction became insignificant. The dry recovery at the end of drying was recorded. The drying equation for mace was fitted and the predicted moisture content values were determined. The predicted and observed drying curves were then compared. The results are average values of three replications.

Quality analyses: Biochemical analyses were carried out on both fresh and dried mace. The parameters estimated were moisture content, volatile oil, oleoresin and lycopene. Moisture content was estimated by Dean and Stark method. Volatile oil and oleoresin were estimated using American Spice Trade Association (ASTA 1985) procedures. Colour of the mace was estimated as lycopene, by reading the absorbance of acetone extract at 503 nm in a Shimadzu UV visible spectrophotometer (Sadasivam and Manickam 1996). Biochemical data on quality of dried mace were statistically compared (independent 't' test) using SPSS (ver. 7.5 for Windows) package to find out the significant differences in quality. The data in percentage were transformed using arcsine transformation and compared.

Initial trials to ascertain the feasibility of blanching were done in 60, 75 and 95°C hot water taken in a stainless steel vessel. It was found that blanching at 75°C gave the best mace in terms of colour. Therefore, in this work, blanching was standardized at 75°C for 2 min. Table 1 gives the quality of fresh, dried and blanched cum dried mace. Fresh mace had 1.75 g/g (dm) of moisture, 15.11% (db) oil, 31.37% (db) oleoresin and 334.945 mg/100 g (db) lycopene. Due to blanching, the leathery texture of mace did turn soft and mace became very vulnerable to moisture loss.

Drying: Drying of mace to the optimum moisture level is an essential step for good keeping quality. Volatile oil, oleoresin and lycopene are some of the factors to be taken care of during drying. Hot air drying of unblanched mace required 4 h to complete drying. The weight reduction was higher during the initial phases of drying, which then decreased subsequently. Fig. 1 shows the weight reduction of blanched and unblanched mace during drying. The drying rate and corresponding moisture content show that drying occurred in the falling rate period. Blanched and unblanched mace tend to exhibit the same trend in drying. However, blanched mace dried comparatively faster as drying was achieved in 3.5 h. After 1 h of drying, it was observed that blanched and unblanched mace lost, respectively 77 and 65% of available moisture. The dry recovery of blanched and unblanched mace was recorded as 37.80 and 37.14% of the fresh weight while the drying ratio was observed as 2.62:1 and 2.61:1, respectively. Dried mace was free from smoke and other contaminants. However, data on lycopene of dried mace indicate that considerable amount of the pigment was lost by drying. This proved that lycopene is very sensitive to heat.

The drying equation for unblanched and blanched mace is given by:

$$y = a * e^{bt}$$

where, y = moisture content (db) at any point of time; a, b = constants; and t = drying time, min.

The constants 'a' and 'b' for blanched and unblanched mace are presented in Table 2. From the drying equation, the predicted moisture content values at different time intervals were determined. The observed and predicted drying curves for blanched and unblanched mace were plotted and are shown in Fig. 2 and 3. Both the drying curves show high degree of comparability with R^2 values of 0.946 and 0.999 for blanched and unblanched mace, respectively.

Effect of blanching: The moisture content in unblanched and blanched mace lowered from 1.75 to 0.05 g/g (dm) after 4 h and 3.5 h of drying, respectively. Thus, due to blanching, the drying time was reduced by 12.5% compared to simple hot air drying. The volatile oil and oleoresin yields in unblanched mace were 12.16 and 23.88% (db) while the lycopene content was 156.99

TABLE 1. QUALITY ANALYSIS OF MACE

Mace sample	Moisture g/g (dm)	Volatile oil, % (db)	Oleoresin, % (db)	Lycopene, mg/100 g (db)
Fresh	1.75	15.11	31.37	334.95
Air dried	0.05	12.16	23.88	156.99
Blanched & dried	0.05	13.04	23.40	191.62

TABLE 2. DRYING CONSTANTS OF MACE

Mace sample	a	b	R^2
Unblanched	1.7418	-0.0167	0.999
Blanched	1.4075	-0.0190	0.946

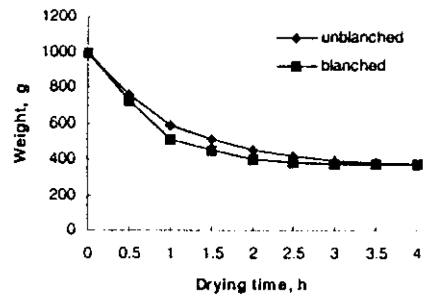

Fig. 1. Drying curve of mace

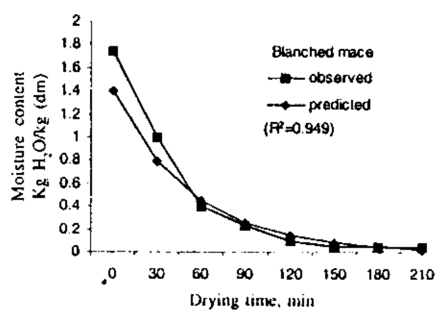

Fig. 2. Observed and predicted drying curves for unblanched mace

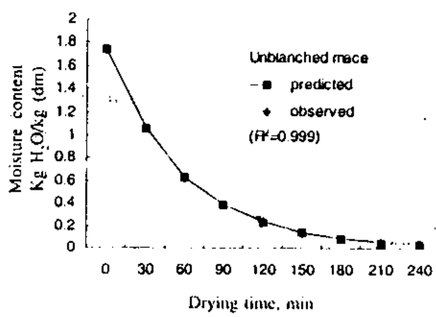

Fig. 3. Observed and predicted drying curves for blanched mace.

mg/100 g. Corresponding oil and oleoresin contents for blanched mace were 13.04 and 23.40% while the lycopene content was 191.62 mg/100 g.

The effect of blanching on quality of mace was prominent. After drying, blanched mace acquired a deep red colour and a glossy appearance while unblanched mace was reddish-brown in colour. Blanching softened the mace tissue and ruptured the cell walls making it more susceptible to moisture loss. Lycopene in blanched mace was significantly higher by 22.06% ($p < 0.05$) compared to unblanched mace. The higher lycopene content in blanched mace might be due to the cessation of oxidative reactions and other physiological changes during blanching. That is, the action of polyphenolase that oxidizes lycopene is inhibited. Also, as the blanched mace dried faster, it as exposed to less heat treatment. Lycopene, being very sensitive to heat, was thus retained more in blanched mace. Thus, blanching enhances the lycopene content in dried mace. However, the volatile oil and oleoresin yield of blanched mace were statistically on par with unblanched mace, which indicated that blanching had no detrimental effect on vital constituents like oil and oleoresin. A marginal reduction in dry recovery was noted in blanched mace, which however, was not significant.

From the results, it is concluded that blanching imparted a uniform deep red colour and glossy appearance to mace with little change in volatile oil and oleoresin content. It was also free from extraneous matter and contaminants adhering to the mace and ensured a clean dried product. The drying time was also reduced by 12.5%. Therefore, a simple blanching in hot water at 75°C for 2 min. may be recommended as a safe method for preserving the quality of mace during drying.

The authors are thankful to Shri. P.A. Mathew, Principal Scientist and Scientist in-charge, IISR Experimental Farm and Shri. B. Krishnamoorthy, Head, Division of Crop Improvement and Biotechnology, IISR for their valuable suggestions and physical help rendered during the study.

References

ASTA (1985) Official Analytical Methods. American Spice Trade Association. New Jersey.

Gopalakrishnan M, Thomas PP, Bhat AV, Varkey AG, Menon N, Mathew AG (1980) Post harvest technology of nutmeg. In: Processing Technology and Marketing: George KV (ed). Proceedings of the Third Annual Symposium on Plantation Crops, Indian Society for Plantation Crops, Kasaragod, India. pp 1-7.

Nair MK (1994) Copra dryers. Technical Bulletin No. 29, Central Plantation Crops Research Institute (ICAR), Kasaragod, India.

Purseglove JW, Brown EG, Green CL, Robbins SRJ (1981) Spices. Longman, New York.

Sadasivam S, Manickam A (1996) Biochemical Methods, 2nd edn. New Age International Pvt. Ltd., New Delhi.

Varghese J (2001) Nutmeg and Mace - II. Spice India 14(4): 11-16.

Received 13 August 2002; revised 14 August 2003; accepted 21 August 2003

RESEARCH NOTE *J. Food Sci. Technol., 2004, Vol. 41, No.3, 308-312*

Resistance of Black Gram to Airflow

P. M. NIMKAR* AND V. N. MATE

Department of Agricultural Process Engineering, Dr. Punjabrao Deshmukh Krishi Vidyapeeth, Akola - 444 104, India

Pressure drops were measured in clean black gram (*Vigna mungo* Proxb.) beds at moisture content of 5.02 to 20.21 % (d.b.) for superficial air velocities ranging between 0.0108 and 0.8651 $m^3/s\ m^2$ at bed depths of 0.2 to 0.6 m with bulk density ranging from 690 to 825 kg/m^3. The airflow resistance of black gram was found to increase with increased airflow rate, bulk density, bed depth and decreased moisture content. Results indicated that 15.19% increase in moisture content decreased the pressure drop by 36% whereas, 6.4% increase in bulk density increased the pressure drop by 43%. Modified Shedd's equation and Hukill and Ives equation were examined for pressure drop prediction. Airflow resistance was accurately described by modified Shedd's equation.

Keywords : Airflow rate, Black gram, *Vigna mungo*, Hukill and Ives model, Pressure drop, Shedd's model

Black gram (*Vigna mungo* Proxb.) is extensively used as vegetable, processed food and splits. The grain forms an important source of protein with protein content of 24%. In India, black gram is cultivated on 2.89 million hectares with an annual production of 1.27 million tonnes (Anon 1999). In order to design efficient drying/aeration system, airflow resistance data are needed. The pressure drop for airflow through any particulate system depends on the rate and direction of airflow, surface and shape characteristics of the grain, the number, size and configuration of the voids, the particle size range, bulk density, depth of product bed, method of filling bin, fines concentration and moisture content (Brooker et al. 1992). A number of research workers have studied pressure drop characteristics of various cereals, oilseeds, vegetable seeds, root and bulb vegetables, leafy vegetables and grass seeds. Forages, biomass, seed cotton and legumes were also studied but to a very

* *Corresponding Author.*