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Fluidized Bed Drying of Nutmeg Mace for Better Colour Retention

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ABSTRACT

Fluidized bed drying is the more efficient method for drying of foods, fruits and vegetables. Higher drying rates with less drying time and retention of better quality of the product can be achieved by fluidized bed drying. In this study, fluidized bed drying and sun drying of nutmeg mace were carried out. The drying time of mace under fluidized bed drying was less compared to mace dried under sun drying. The colour values of the dried mace under sun drying and fluidized bed drying methods were compared to see the effect of fluidisation and retention of the colour. Colour of the dried mace was more darker and redder than the sundried mace.

Key words: *Drying rate, sun drying, fluidization, heat and mass transfer.*

INTRODUCTION

Nutmeg (*Myristica fragrans* Houtt.) which belongs to the family Myristicaceae a unique tree spice plant gives two commercial spice products namely, nutmeg and mace. In India, nutmeg and mace are used more as drugs than as condiments because of their valuable medicinal properties[6]. Drying to optimum moisture level without losing the inherent qualities especially the colour yields better price and is a prerequisite for long storage. sun drying of mace takes about 12 to 16 hours under open sun[2] . Also mace is dried by smoke or in kitchen fire place utilizing the heat from the stove. The dried mace obtained by these methods does not possess good appearance and there is loss of volatile oil[6]. Dried nutmeg and mace possess great importance in international trade and are used in the preparation of extractives and volatile oils[2]. Among various hot air drying methods, the more efficient method is fluidized bed drying for drying of foods, fruits and vegetables. It offers significant advantages like high heat and mass transfer, mixing solid materials efficiently with the drying air, high drying rate and uniform moisture reduction with less drying time. It provides uniform bed temperature throughout the drying period and lengthened constant drying rate period[3]. In this study, fluidized bed drying is applied for drying of mace, which results in better color retention of nutmeg mace.

MATERIAL AND METHODS

Nutmeg mace procured from Areacode, is used for this study. The major engineering properties like bulk density, terminal velocity and colour of nutmeg mace relevant to the development of fluidized bed drying system were studied.

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The bulk density of nutmeg mace in kg/m^3 is determined by finding the ratio of weight of mace to the volume of mace in 1000 ml cylindrical container[1]. The terminal velocity is the air velocity determined by regulating the velocity of blower so that the nutmeg mace comes under fluidization condition in a conventional fluidized bed drier. The colour values are determined by using Hunter lab colour flex meter (Hunter Association laboratory, Inc., Reston, Virgina, USA; mode). HunterLab's ColourFlex spectro colourimeter consists of 1.Sample cup port plate, 2. Glass Sample Cup and 3. Sample Cup Opaque Cover. The glass cup is filled with the sample and placed on the port provided and the opaque cover will act as the light source to exclude the interference of the external light. Calibration of the instrument was made prior to the actual measurement and then place it sample over the port and L*, a* and b* values were recorded. The fluidized bed dryer consists of 1hp blower with power source, air controlling valve, heating chamber, plenum chamber and drying chamber. In the heating chamber, a finned heating coil of 500 W capacity was arranged in a stainless steel pipe having a diameter of 77 m. sun drying is carried out for nutmeg mace as a traditional drying method and hence this method was considered as control for comparing the developed technique. Weighed mace sample was uniformly distributed as thin layer in a stainless steel tray and dried in sun from 9.30 AM to 4.30 PM in the month of March. The temperature range between 27 to 32°C and humidity between 75 to 79% was recorded. The average temperature and solar intensity were measured by using a thermometer and a lux meter and it is measured as 610 W/m^2 and 32 to 35°C. At each 1 hour, the weight of sample was taken till the constant weight was achieved instead of two heating coils of 2000 watts capacity in a heating coil box of 250×110×100 mm. Weighed mace sample of 100 g was dried in fluidized bed drier

RESULTS AND DISCUSSION

Engineering properties of nutmeg mace relevant to developed system

The bulk density of nutmeg mace was found as 1191 in kg/m^3. The terminal velocity of nutmeg mace was found as 5.1 m/s. The colour values of fresh mace were found as L*- 21.28 ± 0.05, a*- 22.23 ± 0.02, b*- 9.09 ± 0.05.

Drying characteristics of nutmeg mace under sun drying method

In sun drying, the moisture content of nutmeg mace decreased from 66.67 %d.b. to 6.28 % d.b. in 16 hrs. Fig. 1 showed the variation in moisture content (%d.b.) of nutmeg mace against drying time (min) by sun drying method. The moisture content was decreased non-linearly. The initial moisture content was found as 66.67% (d.b). In sun drying, it is decreased to 7.1% (d.b) in 16 h. similar results were reported by Naveen kumar, *et al.*[4], and Gopalakrishnan, *et al.*[2] for nutmeg mace. Drying rate is slower under sun drying.

Drying characteristics of nutmeg mace under fluidized bed drying method

Fig. 3 showed the variation in moisture content (%d.b.) of nutmeg mace against drying time (min). The moisture content decreased from 66.67 %d.b. to 6.8% d.b. in 255 min at 40°C temperature but at 45°C it was decreased to 6.0 %d.b. in 240 min and at 50°C it decreased to 5.8 %d.b. in 225 min. At the initial stage of drying, the moisture content decreased very rapidly. The initial moisture content was found as 66.67% (d.b). As the drying progressed, the available moisture content on the surface of the product decreased. Similar findings were reported by Parlak[5] for ginger. Higher temperatures provide a larger water vapor pressure deficit, which is one of the driving forces for the outward moisture diffusion[7].

From fig., 1 and 2 it is clear that, the drying time of mace under fluidized bed drying was less compared to mace dried under sun drying. In fluidized bed drying, more surface of the product is exposed to heat energy due to its fluidization condition. So, the product dried in a very less time in fluidized bed dryer.

Comparison of the quality characteristics of dried mace

The colour values of the dried mace under sun drying and fluidized bed drying methods were compared to see the effect of fluidization and retention of the colour. From table 1, it is clear that the colour of the dried mace was darker

and redder than the sundried mace. At the temperature of 45°C, nutmeg mace dried under fluidized bed dryer showed highest colour values of L*-17.56 ± 0.05, a*- 14.34 ± 0.02and b*- 8.26 ± 0.05 than the other two temperatures.

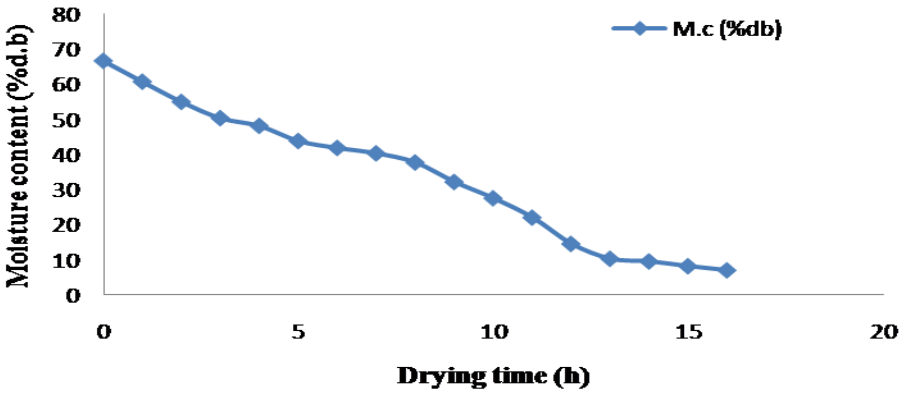

Fig. 1: Variation in moisture content (%d.b.) with drying time (min): sun drying

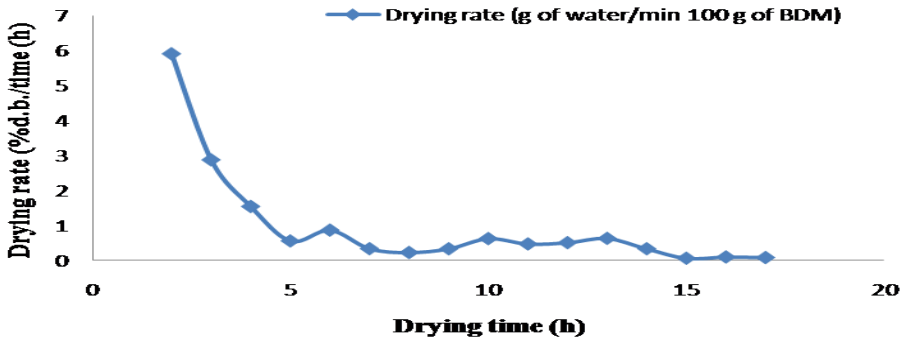

Fig. 2: Variation in drying rate with drying time (min): sun drying

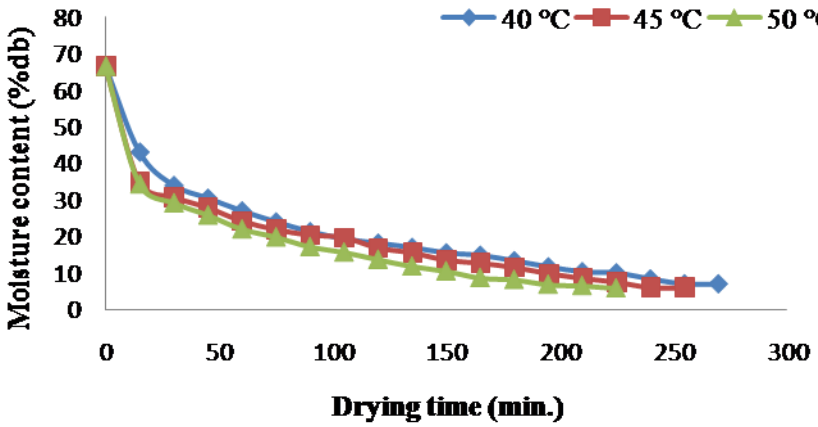

Fig. 3: Variation in moisture content (%d.b.) with drying time (min): fluidized bed drying

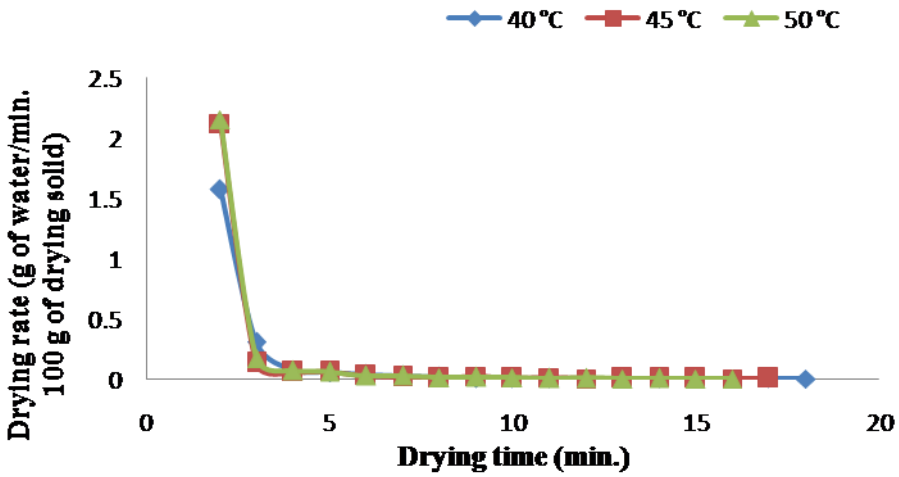

Fig. 4: Variation in drying rate with drying time (min): Fluidized bed drying

Table 1: Comparison of fluidised bed drying at different temperatures with sun drying

Parameter	40°C	45°C	50°C	Sun drying
L*	16.23 ± 0.05	17.56 ± 0.05	18.36 ± 0.05	15.28 ± 0.05
a*	12.26 ± 0.02	14.34 ± 0.02	12.65 ± 0.02	10.56 ± 0.02
b*	7.07 ± 0.05	8.26 ± 0.05	8.76 ± 0.05	6.56 ± 0.05

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