International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2017; 5(4): 621-623

Received: 12-05-2017
Accepted: 14-06-2017

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Effect of various drying methods on qualitative characters of nutmeg (*Myristica fragrans*) candy

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Abstract
The present investigation entitled "Effect of various drying methods on qualitative characters of nutmeg (*Myristica fragrans*) candy" was carried out at Regional Fruit Research Station, Dr. B.S.Konkan Krishi Vidyapeeth, Dapoli (MS) 415 712; to evaluate the impact of different drying methods on qualitative characters of nutmeg candy. Fruit rind of fully matured, naturally opened, fresh nutmeg fruits (var. Konkan Sugandha) was selected for candy processing. Different drying methods namely sun drying, shade drying, cabinet tray drying, thermo-centre drying and micro-wave drying were used to find out effect on qualitative characters of nutmeg candy. Nutmeg candies were further assessed for the effect of drying method used on duration required, chemical characteristics and sensory evaluation. Study revealed that among different drying methods; the longest duration (30 hours) for preparation of nutmeg candy was noticed in shade drying, while the shortest duration (5 minutes) in micro-wave. In thermo-centre drying and tray drying, drying process was completed within 36 minutes and 12 hours, respectively, While, sun drying was completed within 22 hours. Further, the total soluble solids were found the highest (68 ^{0}Brix) in thermo-centre drying and micro-wave drying samples while, the lowest (64 ^{0}Brix) in tray drying sample. The highest acidity (0.28 per cent) was retained in micro-wave drying and was significantly superior over the other methods. The recovery of nutmeg candy was found to be the highest in thermo-centre drying than shade drying. With regards to sensory evaluation; micro-wave dried samples was found to be least acceptable. Thermo-centre dried and shade dried nutmeg candy scored maximum sensory score for nutmeg candy and thus, found more acceptable. Thus, Thermo-centre and shade drying methods and can be commercially exploited.

Keywords: candy, chemical characteristics, drying, nutmeg and sensory evaluation

Introduction
Nutmeg has always been known as two in one spice. It is major spice contains 20-40 per cent of a fixed oil commonly called 'Nutmeg butter', which contains myristic acid, trimyristin and glycerihdes. Nutmeg pericarp also contains oil with components that are similar to those in Nutmeg kernel and mace oil. Nutmeg pericarps are mostly wasted under trees due to lack of awareness about its industrial applications and the medicinal and nutritional values. The whole fruit of Nutmeg consist 80-85 percent pericarp (Ameen, 2011) [1]. The fresh pericarp of the ripe fruit contains an acidic astringent juice with an aromatic flavour. Protein, fats, minerals, phosphorus, iron and carotene were found in the rind portion. The rind portion contains up to 14 per cent pectin and 27 per cent fiber (Zheng *et. al.*, 1992) [9].

The Nutmeg possesses therapeutic values and medicinal properties. A variety of value added products made from this seemingly worthless outer cover of the fruit with a little effort. Most of the research studies are based on the Nutmeg and mace portion; only little work is employed on Nutmeg pericarp. Till date a few of products are prepared with ease form of Nutmeg pericarp like jam, squash, candy, syrup, etc. Among them candy is an innovative product that is liked by customers of every age group.

Nutmeg candy is a combination of various technical methods that to be focused. Therefore, the detailed scientific study is essential to develop a complete package of appropriate technology including different unit operations for the production of Nutmeg candy of high quality and cost effective.

Drying is an important unit operation having essential relevance. It is because the drying leads to a change in the food physical, chemical and biological characteristics (Azzouz *et al.*, 2000) [3]. During the drying process physical changes are occurred such as shrinkage and crystallization. In some cases, reactions can occur, desirable or undesirable, altering the color, texture, odor and other properties of the food (Mana *et al.*, 2012) [4].

Moreover, several drying methods are commercially available and the selection of optimal method is determined by quality requirements, raw materials characteristics and economic factors. Therefore, the present study was conducted to see the effect of drying methods (sun drying, shade drying, cabinet tray drying, thermo centre drying and micro-wave drying) on physico-chemical, nutritional and organoleptic quality attributes of sugar candy.

Materials and Methods

The fully matured, naturally opened, fresh Nutmeg fruits (var. Konkan Sugandha) were collected from Cashew farm, Regional Fruit Research Station, Vengurle, Dist. Sindhudurg. Healthy, disease and pest free Nutmeg pericarps were selected for the processing of Nutmeg candy. Fruit pericarps were washed properly under running tap water. Peeling was done manually with the help of peeler and cut in to small pieces. Fruit pieces were boiled in 2 per cent brine solution up to easily mashed by fingers. Removed boiled fruit pieces and drained out excess water. Sugar was added in 1:1 proportion in four steps. Half of sugar was added immediately after excess water was drained out. Remaining sugar divided in three equal proportions and added same in next three days simultaneously. At the end of third day TSS raised up to 75 ^{0}Brix. After 8 days, fruit pieces were removed from sugar syrup and washed with clean water.

These fruit pieces were spread in the aluminum trays uniformly and were kept for drying as per treatments under study i.e. sun drying, shade drying, cabinet tray drying, thermo centre drying and micro-wave drying. In cross flow cabinet tray dryer and in thermo centre, drying was carried out at 60±2 ^{0}C and 120±2 ^{0}C temperature, respectively. While in case of micro-wave oven, drying was 550W. When the sufficiently dry and leathery texture was achieved, product was removed from dryer and cooled to ambient temperature. It was immediately packed in 300 gauge polyethylene bags, sealed, labeled and stored properly.

Moisture content

The Nutmeg candy was weighed at an interval of 2 and 3 hours during sun and shade drying, 2 hours in case of tray drying and 4 minute and 1 minute for thermo centre and micro-wave drying till the completion of drying process, respectively. Moisture content at each measurement time was calculated based on initial moisture content and weight loss (Tandon *et al.*, 2006) [8]. Moisture loss curve can be obtained experimentally by plotting the loss of moisture content versus drying time.

Drying yield: The following equation was used to calculate the drying yields

$$\text{Yield (\%)} = \frac{\text{mass after drying}}{\text{Initial mass of sample (before drying)}} \times 100$$

Chemical Analysis

Moisture determination was made by the difference of the original mass of the sample and the final mass after heating to constant mass. To determine total soluble solids, the fruit product was uniformly mashed with a mortar and pestle. A drop of mashed pulp was placed on the prism of hand refractometer (ERMA make) and total soluble solids was recorded as ^{0}Brix. The pH was determined by using a digital pH meter after standardizing it with buffers of pH 4.0 and 9.0. Measurement of titratable acidity was carried out by using the titration method given by (Ranganna, 1986) [7].

Organoleptic evaluation of Nutmeg candy

Freshly prepared samples of Nutmeg candy were evaluated for sensory characteristics like appearance, colour, taste, flavour, texture and overall acceptability by 10 semitrained panel members comprised of academic staff members of the Regional Fruit Research Station, Vengurle; on 9- point Hedonic scale. Judgments were made through rating products on a 9 point Hedonic Scale with corresponding descriptive terms ranging from 9 'like extremely' to 1 'dislike extremely' (Amerine *et al.*, 1965) [2].

Statistical analysis

All processing equipments and analysis of samples were run in triplicate. Analysis of variance was calculated using standard ANOVA procedure. The data obtained for various treatments was recorded and statistically analyzed by complete randomized design to find out the level of significance as per the method proposed by (Panse and Sukhatme, 1967) [5]. The analysis of variance revealed at significance at P< 0.05 level. The standard error (SE) and critical difference (CD) at 5 % level were mentioned where required.

Results and Discussion:

Effect of drying methods on moisture content and yield of Nutmeg candy

The different drying methods used have different influence on final moisture content and yield obtained, which is tabulated in Table 1. The data presented and depicted in Table 1 revealed that, the shade drying lasted for 30 hours, which is found to be longest duration, and the fastest drying occurred in micro-wave, took 5 minutes for drying. The next fast methods are thermo centre drying and tray drying which completed the process in 36 minutes and 12 hours, respectively. While, sun drying being a slower method depends upon sunlight as energy source took 22 hours.

In case of Nutmeg candy, the moisture content at the end of sun drying period was reduced up to 23.06 per cent, while this reduction in shade drying, tray drying, thermo centre drying and micro-wave drying was 21.69, 30.03, 21.23 and 37.65 per cent, respectively.

The highest yield was observed in thermo centre drying (78.77 per cent) with the desirable moisture content. However, the least yield is reported in micro-wave dried samples (62.35 per cent).

Effect of drying methods on chemical composition of Nutmeg candy

The chemical parameters *viz.*, TSS, acidity and pH were analyzed to observe the effect of drying methods on Nutmeg candy depicted in Table 2. It can be visualized from Table 2 that, prepared Nutmeg candy varies with the type of drying method used, shown wide difference with regard to chemical constituents of final product. Of the five samples under studies,

The total soluble solids were found maximum (68 ^{0}Brix) in thermo centre drying and micro-wave drying samples while, it was found lowest in tray drying sample.

Acidity was found richest (0.28 per cent) and significantly superior in micro-wave drying over the other samples. Micro-

wave drying sample is followed by thermo centre drying sample (0.25 per cent) which is in accordance of results of (Pareek and Kaushik, 2012) [6] who observed in Aonla powder dried by different methods *viz.*, sun drying, oven drying, micro-wave drying and fluidized drying.

Effect of drying methods on organoleptic evaluation of Nutmeg candy

Although the micro-wave drying is proved to be the best on the basis of lowest drying time and highest nutritional profile but still it is important to assess the acceptability of product by customer on the basis of organoleptic evaluation. Hence, the samples were evaluated organoleptically by a group of 10 panel member on 9 point hedonic scale. The data pertaining to effect of drying methods on sensory qualities of product is tabulated in the Table 3. It is evident from Table 3 that, the different drying methods affected appearance and colour of candy distinctly, as sugars undergo browning as a result of thermal effect. Therefore the least thermal effect was found in thermo centre dried and shade dried samples whereas the most in micro-wave dried samples.

The mean score for appearance was found maximum in thermo centre dried with 8.63 followed by shade dried sample (8.13), Sun dried sample (7.50), tray dried sample (7.50) and micro-wave dried sample (7.25). The same decreasing trend was also obtained for colour in micro-wave dried samples. Micro-wave dried candies recorded lower score (6.63) as it produces blackened spots over the surface of candy. Next to appearance and colour, the flavour and taste was found to be significantly highly scored for thermo centre dried samples and least for micro-wave dried samples. It is because stickiness on the surface of micro-wave dried samples may be as a result of movement of syrup from centre to the surface along with moisture for evaporation. Essentially, the most important parameter for assessment of candy quality is texture, which might be greatly affected by the different drying methods. The average scores for texture in sun dried, shade dried, tray dried, thermo centre dried and micro-wave dried 8.13, 8.32, 8.24 8.63 and 6.38, respectively. Thermo centre dried sample was rated highest and indicated that it was having good texture acceptability. The overall acceptability scores for thermo centre dried sample which is comparable to shade dried sample were 8.42 and 7.99 in candy.

Drying curve

The moisture content of the samples as a function of drying time expressed as a drying curve which is shown in figure 1, 2, 3, 4 and 5. The regression was fitted to the drying period required by various methods under study; as moisture content (y) and drying period (x). It is clear from regression equation that, the rate of moisture loss in dried Nutmeg candy at uniform interval was highest (-6.899) in the micro-wave drying whereas, it was lowest (-2.123) in thermo centre drying followed by shade drying (-2.301). The observations regarding thermo centre drying and micro-wave drying recorded at an interval of few minutes, while in other methods of drying, observations recorded at an interval of hours. The coefficient of determination reveals the maximum (99.6%) variation in tray drying, while it was lowest (82.7%) in thermo centre drying.

Conclusion

Candy preparation is an umbrella of technologies comprising blanching, pre-treatment, syruping (osmosis) and drying. Drying is also an important step that may affect the quality of candy. Therefore, the prepared candies were further assessed for the effect of drying method used on the basis of chemical characteristics and sensory evaluation. Drying curves were showed that, the moisture content decreases continuously with drying time. And diffusion is the dominant physical mechanism governing moisture movement in the candy. The yield of Nutmeg candy was found to be maximum in thermo centre drying than shade drying. Organoleptic evaluation is of great significance to assess the product acceptability. The study revealed that, micro-wave dried samples although retained higher titratable acidity but found to be organoleptically least acceptable. However, thermo centre dried and shade dried Nutmeg candy were organoleptically acceptable and can be further commercially exploited.

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