

Post-harvest processing, value-addition and by-product utilisation of nutmeg (*Myristica fragrans*)

Nutmeg (*Myristica fragrans*), a dual spice-yielding tree producing both nutmeg and mace, holds immense commercial potential through post-harvest processing, value addition, and by-product utilization. This paper reviews traditional and improved drying methods, grading standards, and storage practices crucial for maintaining spice quality. It also explores a wide range of value-added products including essential oil, oleoresin, butter, and powders, as well as by-products like nutmeg rind that are being innovatively processed for food and health applications.

NUTMEG (*Myristica fragrans*), a native to the Moluccas Islands of East Indonesia, is now cultivated in other parts of Asia and the Caribbean, especially Grenada. The major producing countries include Indonesia, Grenada, Sri Lanka, China, and India. Two types of nutmeg are recognized in global trade: West Indian (from Grenada) and East Indian (from Indonesia).

The nutmeg tree produces two different spices. Nutmeg is the dried kernel of the seed and mace is the dried aril enveloping the seed. Both the spices have similar flavour. However, nutmeg is reported to be slightly sweeter than mace and is more preferred in food. Besides dry nutmeg and mace, a number of other valuable products like oleoresins, nutmeg butter and essential oils are also derived from *M. fragrans* and they find varied uses in the food, medicine and perfume industries.

Harvesting

Fruits are harvested when they split open on ripening. The split fruits are either plucked from the tree with a hook bill or are collected soon after they drop on to the ground. Processing of nutmeg starts with the removal of mace surrounding the nut followed by drying of nut and mace separately.

Processing

In Kerala, as the crop is harvested during monsoon

season, sun drying is not possible and most of the farmers adopt traditional methods to dry the harvested nutmeg. Firewood is generally used to dry nutmeg.

Nutmeg is spread to a thickness of about 5-8 cm on wooden trays having openings at the bottom for hot air circulation. The trays are placed approximately about 2 m above the furnace and the heat produced by burning firewood is used to dry nutmeg. Burning of firewood for drying is generally done in the evening and left as it is till the next day. Firewood is loaded into the furnace only once and no further firewood is added. This is followed for five days and by the end of 5th day the nutmeg is completely dry and the seeds inside rattle on shaking.

Hot air mechanical drying at temperatures between 40 to 45°C is commonly used for drying nutmeg. However, higher temperatures can cause the shells to crack and lead to the loss of essential oils, thereby reducing product quality. Therefore, low-temperature drying is generally preferred to preserve nutmeg quality. Additionally, farmers also employ natural convection reverse air flow dryers as an alternative drying method.

Grading of nutmeg

The dried seeds are sorted using the floatation method. Lighter kernels (which are generally unsound) float to the surface of a tank and can be removed. The sound kernels are sorted based on their quality and size. Good quality



whole kernels are separated from the lower quality and broken kernels. Nutmegs are graded according to their size. Sizing can be carried out using different mesh sized sieves. Using large metal sieves with uniform regular circular perforations the nutmeg seeds are graded. The appropriate kernels fall through the appropriate holes into collecting bags. Nutmegs, weighing about 8 g or more are considered to be superior and are traded at a higher price.

Whole nutmegs are grouped under three broad quality classifications:

Sound: Nutmegs which are mainly used for grinding and to a lesser extent for oleoresin extraction. High quality or sound whole nutmegs are traded in grades which refer to their size in numbers of nutmegs per pound: 80s, 110s and 130s (110 to 287 nuts per kg), or 'ABCD' which is an assortment of various sizes.

Substandard: Nutmegs which are used for grinding, oleoresin extraction and essential oil distillation. Substandard nutmegs are traded as 'sound, shrivelled' which in general have a higher volatile oil content than mature sound nutmegs and are used for grinding, oleoresin extraction and oil distillation; and 'BWP' (broken, wormy and punky) which are mainly used for grinding as volatile oil content generally does not exceed 8%.

Distilling: Nutmegs of poor quality are used for essential oil distillation. Distilling grades of nutmegs are: 'BIA' or 'ETEZ' with a volatile oil content of 8 to 10%; and 'BSL' or 'AZWT' which has less shell material and a volatile oil content of 12 to 13%.

Packaging and storage of nutmeg

Sorted kernels are bagged, labelled appropriately and packed into gunny bags. If other packing materials are used, care must be taken to avoid materials which might lead to 'sweating' and mould development. Nutmegs are usually sold whole, either with or without the shell. Ground nutmeg is also available, but this is generally of inferior quality and can easily be adulterated. The taste and aroma of ground nutmeg deteriorate very rapidly. Dried whole nutmegs have a long shelf life if they are stored in a dry place away from sunlight and insect infestation.

Processing of mace

Processing of mace must be done on the day of harvest otherwise the quality mace obtained after drying is of poor quality. Drying of mace to an optimum moisture level of 10% without losing the inherent qualities especially its colour is a pre-requisite for long storage and better price. Colour plays an important role in deciding the commercial value of mace and the scarlet red colour is due to the presence of the pigment lycopene. This pigment is highly sensitive to heat and light and during drying the colour of mace changes to light red or reddish brown colour.

Conventionally, mace is dried in the sun or in the kitchen fireplace utilising the heat from the stove. Some farmers dry mace on clay *kurdies* or sand medium spread over iron sheet which is kept over fire. In these conventional methods, it is difficult to control the temperature of drying, which has profound influence

on the colour of the mace which usually do not possess uniform red colour. Also, about 2-3% of the mace gets charred in the process. Sun drying is difficult and very slow in many areas because of the active monsoon during the harvesting season. Improved drying unit have been developed by farmers using tiled hollow bricks laid over the *chulas*. Required quantity of firewood is burnt and mace is dried without charring.

Hot air mechanical drying at a temperature of 550°C is a viable alternate technology for drying mace as it helps in the retention of colour and general quality of mace.

Storage of mace

'Agmark' Mace Grading Marking Rules, 1997, has stipulated that, whole mace shall be packed in clean, sound and dry jute cloth bags laminated with polyethylene or poly propylene or in pouches made of food grade plastic materials. Mace powder shall be packed in new, clean, sound and dry containers made of tin, glass or in punches made of laminated/extruded/ metallised/ multiplayer food grade plastic materials. Farmer's practice of storing mace in dark coloured plastic bins also helps and store safely in plastic bins.

Value-added products from nutmeg

Nutmeg and mace are two different parts of the same fruit of the nutmeg tree, *Myristica fragrans*. The fruits are harvested when they split open on ripening. Cleaning and drying are the important post-harvest operations involved.

- Cleaning: The fruits drop on to the ground while harvesting. The fruits are picked up and washed in water to remove dirt and mud adhering to the outer pericarp.
- Drying: The unshelled nutmeg is dried in the shade or under sun. The seed cover is removed mechanically or manually. It is dried to a safe moisture content of 10%.

Mace is detached from the nut carefully soon after harvest, washed, flattened by hand or between boards and then sun dried till they become brittle. Hot air oven can be used for drying and colour retention is much better than sun dried mace.

Main constituents

Nutmeg contains about 10% essential oil, which is mostly composed of terpene hydrocarbons (sabinene and pinenes; furthermore camphene, p-cymene, phellandrene, terpinene, limonene, myrcene, together 60 to 80%), terpene derivatives (linalool, geraniol, terpineol, together 5 to 15%) and phenylpropanoids (myristicin, elemicin, safrol, eugenol and eugenol derivatives, together 15 to 20%). Of the latter group, myristicin (methoxy-safrole, typically 4%) is responsible for the hallucinogenic effect of nutmeg. Nutmeg is weakly hallucinogenic. The large dosage may give rise to very unpleasant side-effects caused by other components of nutmeg, which include prolonged extreme nausea and long-term hypersensitivity to nutmeg. The hallucinogenic phenylpropanoids themselves are hepatotoxins and far from harmless for frequent users. Oil of mace (up to 12% in the spice) contains

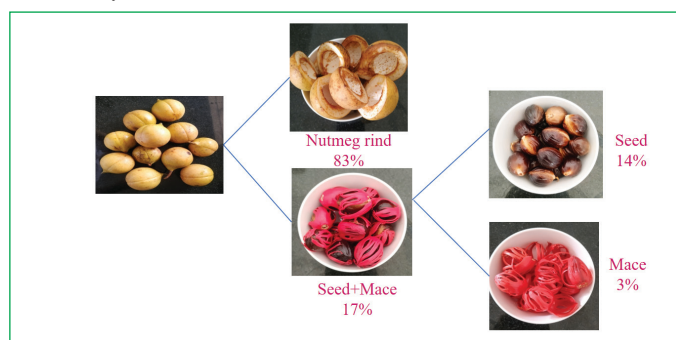
the same aroma components, but the total fraction of terpenoids is increased to almost 90% at the cost of the phenylpropanoids (10%).

Uses

Nutmeg is used to flavour many kinds of baked goods, confections, puddings, meats, sausages, sauces, vegetables, and such beverages as eggnog. The spices in their ground form are mainly used in the food processing industry, principally in the seasoning of meat products; they are also used in soups, sauces, baked goods and spice mixes. Both spices have similar taste qualities; mace is more popular because of its light orange colour in light coloured foods. Nutmeg, in general, tends to be sweeter and more delicate. These products are also used in the perfumery and pharmaceutical industries.

Value added products

- **Nutmeg powder:** Dried nutmeg is ground to fine powder to be used in various end products.
- **Nutmeg oil:** The essential oil from nutmeg is steam distilled and the oil percentage varies from 5-15%. The essential oil is highly sensitive to light and temperature and yields a colourless, pale yellow or pale green oil with characteristic odour of nutmeg.
- **Nutmeg oleoresin:** Nutmeg oleoresin is obtained by solvent extraction of spices. Oleoresins contain saturated volatile oil, fatty oil and other extractives soluble in the particular solvent. Nutmeg extracted with benzene yields 31 to 37% of oleoresins.
- **Nutmegs butter:** The fixed oil of nutmeg is known as nutmeg butter. Nutmeg butter contains 25 to 40% fixed oil.
- **Mace oleoresin:** When extracted with petroleum ether mace yields 27 to 32% oleoresin and contains 8.5 to 22% volatile oil.
- **Mace oil:** is obtained by steam distillation of dried aril and yields 4-17% oil. It is a clear red or amber dark



Various components of fresh nutmeg fruit (w/w basis)

red liquid with characteristic odour and flavour. Mace oil is more expensive than nutmeg oil.

By-product from nutmeg processing – Nutmeg rind or Pericarp

Nutmeg rind is generally considered as a farm waste by the farmers and is generally discarded during processing. But this could be easily converted to attractive value-added products and can serve as a boon

to nutmeg farmers. The high pectin content in the rind plays an important role in maintaining the texture of the processed products and the presence of major volatile oil constituents like myristicin and elemicin in the rind is of great interest importance to food industry, as it serves as natural antioxidants.

With increasing competition in food processing sector, there is a need for mechanisation in processing, for development of value-added products. Further, the customer's requirement for tailor made products having newer taste has opened ample opportunities for the use of nutmeg rind for product diversification. Various value-added products prepared from nutmeg rind are detailed below:

Nutmeg rind squash

Harvested and separated nutmeg rind is cooked in open kettle with equal quantity of water till the rind becomes soft. The water is drained and used for the preparation of nutmeg squash with the addition of and concentrated. Preservative at the rate 0.1% and citric acid at the rate 20 g/kg of rind used is added when the produce is in luke warm condition. The squash is diluted at the rate of 1:5 at the time of consumption to obtain nutmeg juice of 16°Brix.

Nutmeg rind jam

For preparation of nutmeg rind jam, the cooked rind is transferred to a kettle and sugar is added and stirred till the mass is concentrated. The pectin in the fruit along with sugar and acid gives a gel consistency which results in the formation of jam. It is then filled in sterilized glass bottles, sealed and stored under ambient temperature.

Nutmeg rind candy

For the preparation of rind candy, the rind is sliced to a thickness of 5 mm for required length and cooked in open kettle. The water is drained and the nutmeg pieces are soaked in sugar syrup and left overnight. The following day the pieces are removed and the sugar syrup is concentrated to increase the TSS by 5° Brix. The nutmeg pieces are dried for about 3 h in a cabinet tray dryer and then added to sugar syrup once again. This process is continued by increasing the TSS every day by 5°Brix till the TSS reaches 70° Brix. The entire process is completed in about 6 days. The pieces are dried and coated with dry sugar powder and stored in clean container.

Nutmeg rind pickle

A pickle blender is used for commercial production of nutmeg pickle by blending various ingredients to uniform proportion. The ingredients that are added includes chilli powder, cumin, fenugreek, mustard, gingelly oil and curry leaf.

Dehydrated nutmeg rind

Rind powder is sliced and dried in a multipurpose tray dryer at 70°C till the material is sufficiently dry. The dried slices are pulverised using a hammer mill to obtain fine powder. A small quantity of rind powder can be added to

Value added products from nutmeg rind



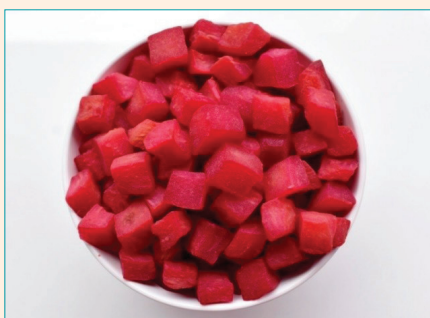
Nutmeg rind squash



Nutmeg rind jam



Nutmeg rind pickle



Vacuum impregnated nutmeg rind candy



Dehydrated nutmeg rind



Nutmeg rind candy

the dough used for preparation of confectionery products like cakes, biscuits, cookies etc. and baked in a commercial baking oven. The products have an appealing aroma and flavour of nutmeg which is very pleasant.

Vacuum Impregnated nutmeg rind candy

Vacuum Impregnated nutmeg rind candy is prepared by using a vacuum impregnation technique where the rind is processed and cut into uniform cubes, blanched, and infused with a sugar syrup solution containing

natural colours, and preservatives. The infused cubes are dried and packaged. The resulting fruit candy cubes are nutritionally enriched and shelf-stable, offering a innovative alternative to conventional products.

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