Chemical composition of nutmeg and mace

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ABSTRACT

The proximate analysis of nutmeg and mace, unlike in most earlier reports, has been carried out using the raw spices. The major hallucinogenic principle in Indian nutmeg/mace oils appears to be myristicin which is present in good amount. GC profiles of the oils compared very well with reports in literature. The rind of the nutmeg fruit contain good quality pectin upto 14%.

Key words: *Myristica fragrans* Houtt., Myristicaceae, kernel, aril, rind, proximate analysis, essential oils

Introduction

Variations in chemical composition and quality of nutmeg and mace grown in major producing areas of the world have been reported in literature (Guenther 1950). The changes may be attributed mainly to the varietal differences, but geographic, climatic and maturity conditions could also greatly influence the spice quality. In India, nutmeg cultivation has picked up in Southern regions especially in Kerala in recent years. A chemical evaluation of the spices grown in this region has been made recently (Gopalakrishnan 1986). The proximate analysis of nutmeg and mace, unlike in earlier reports (Thorpe and Whitely 1939, Wealth of India 1950), has been carried out using the raw spices. The report also touches on certain aspects hitherto not reported on these spices. The rind part of the fruit was also analysed with a view to its better utilization. A preliminary report on the pectin in nutmeg rind has been already communicated (Pruthi *et al* 1980). In the case of mace, information on the chemical nature of its attractive scarlet pigment has also been provided (Gopalakrishnan *et al* 1979). The flavonoids of the nutmeg constituting 1.5% of the spice also has been studied. (Hermann 1979; Schulz and Hermann 1980; Gopalakrishnan and Mathew 1980).

There are also numerous reports on the nutmeg and mace oils (Purseglove *et al* 1981) of which a few are comprehensive in nature (Dann *et al* 1977; Schenk and Lamparsky 1981). An understanding of the chemical nature of these spices will help in formulating viable post-harvest technologies for the spices. The studies conducted were oriented to these specific needs. Reports on the improved processing methods for nutmeg and mace have been published (Gopalakrishnan *et al* 1980).

Materials and methods

Mature nutmeg fruits (*Myristica fragrans* Houtt) harvested during peak season (July) from local gardens of Trivandrum were used for this study. The morphological characters were noted down and the various parts of the fruit were analysed as per AOAC methods (AOAC 1975). Sugar was determined by the rapid colourimetric method (Ting 1956). Pectin in the rind was extracted, determined and graded according to standard procedure (Kertesz 1951, Owens *et al* 1952).

The nutmeg, mace and rind parts were used separately for extraction of polyphenols by standard procedure (Harborne 1964, Lakshminarayana and Mathew 1967).

The nutmeg and mace oil were analysed for their physico-chemical properties by ISI (BIS) methods (IS, 1969). GC analysis of the oils was done using a Hewlett-Packard 584 0A gas chromatograph equipped with an integrator using a 6' x 1/8" (i.d.) SE-30 column, with temperature programmed from 75 to 200° C @ 5°C/min with nitrogen as carrier gas (20 ml/min), injector temperature at 250°C and FID temperature at 275°C. The peaks were identified by comparison of their retention times with those of authentic samples and their quantities were calculated from triplicate analysis values of integrated area percentages.

Results and discussion

The average recovery of the nut, mace and rind was found to be as given in Table1. The fleshy rind constituted the bulk of the fruit (81.5%). The mace, because of its low yield (2.2%) and finer aroma was expected to fetch a premium price.

Table 1. Recovery of nut, mace and rind

Total	Nut with shell		Mace		Rind		Mechanical loss	
Wt. (gm)	Wt. (gm)	%	Wt. (gm)	%	Wt. (gm)	%	Wt. (gm)	%
540	86.5	160.0	12	2.2	440.5	81.5	1.5	0.3

The proximate analysis of the nutmeg, mace and rind is given in Table 2. Nutmeg and mace at the time of harvesting had moisture content of about 40% whereas the fleshy rind had 88% moisture. The latter was also highly acidic and astringent. The volatile oil content in nutmeg (11.0%) and mace (15.3%) was comparable with values reported elsewhere. The rind part carried only traces

of oil. Nonvolatile ether extract was more in the kernel region (33.6%), less in the aril and comparatively very less in the rind.

Table 2. Proximate analysis of nutmeg, mace and rind

Proximate	Nutmeg		Mace		Rind	
composition %	FWB	DWB	FWB	DWB	FWB	DWB
Moisture	40.00	-	40.00	-	88.00	-
Acidity	-	-	-	-	2.50	20.83
Volatile oil (V/W)	6.60	11.00	9.20	15.30	0.10	0.83
Nonvolatile ether extract	20.20	33.60	13.19	21.98	0.45	3.75
Starch	18.10	30.20	26.43	44.05	0.05	0.42
Sugars						
a) glucose	0.06	0.10	0.10	0.17	0.90	7.50
b) fructose	0.04	0.07	0.06	0.10	0.68	5.66
Total reducing sugars	0.10	0.17	0.16	0.27	1.58	13.16
Sucrose	0.43	0.72	0.23	0.39	0.09	0.75
Total sugars	0.53	0.89	0.39	0.65	1.67	13.92
Protein	4.30	7.16	5.95	9.91	0.64	5.3
Crude fibre	7.00	11.70	2.36	3.93	3.31	27.58
Total ash	1.54	2.57	0.94	1.56	0.89	7.42
Ash insoluble in HCL	0.12	0.20	0.09	0.15	0.07	0.58
Polyphenols*						
Total tannins	1.50	2.50	-	-	0.29	2.42
True tannins	0.60	1.00	-	-	0.11	0.92
Pectin	-	-	-	-	1.69	14.10

FWB - Fresh weight basis, DWB - Dry weight basis
* Lowenthal-Procter method as quercitannic acid.

Starch was predominant in mace (44%), in relatively good concentration in the kernel (30%) but practically absent in the rind. The kernel and mace contained traces of sugars while the rind part carried appreciable amount of sugars (~ 14%). The sugars of the kernel were mainly of the non-reducing type, those of mace both reducing and non-reducing type in equal amounts and those of the rind mainly of reducing type.

Protein content was more in mace and relatively less in the kernel and rind in that order. Fibre content was high in the rind part (~ 27%) while it was normal in the kernel (~ 11.7%) and mace (~ 4.0%). Ash content was more in the rind (7.42%) as compared to the kernel (~ 2%) and mace (~ 2%). Polyphenols were uniformly present in all the fruit parts at immature stages while it was practically absent in the aril at the fully mature stage. Both

kernel and rind contained about 2.5% of total polyphenols of which 40% comprised of true tannins.

The rind of the nutmeg was found to carry good quality pectin (upto 14%) which can be commercially exploited for the preparation of pectin. The best recovery of pectin from nutmeg waste was obtained by using 0.25% hydrochloric acid or 0.75% citric acid when the yield of pectin on a dry weight basis were 21.73-14.33% and 12.54%, respectively. A recovery of 93% pectin could be obtained by single extraction with dilute hydrochloric acid, but with citric acid, two extraction steps were necessary. The optimum time of extraction was 60 minutes at a temperature of 85-90°C. The pectin obtained was of very high quality with a jelly grade of 225-250.

The physico-chemical characteristics of nutmeg and mace oils are given in Table-3 which more or less agreed with reported values.

Table 3. Physico-chemical characteristics of nutmeg and mace oils

	Nutmeg oil	Mace oil
Sp. gravity (26°C)	0.8766	0.8848
Ref. index (26°C)	1.4702	1.4702
Sp. rotation (26°C)	+ 34°54'	+ 10° 22'

The gas chromatographic analysis of nutmeg and mace oils (Table 4) showed qualitative resemblance to values available in literature, but quantitative variations in many aspects. The low boiling constituents particularly the monoterpene hydrocarbons, were present in high concentrations in both the oils, probably because the oils were extracted from fresh materials. α - pinene, β- pinene and sabinene together constituted 77.38% in nutmeg and 60.76% in mace oil. The constituents imparting the typical spice flavour namely the monoterpene alcohols, their esters and aromatic compounds were also found to be at appropriate levels in both oils. In nutmeg oil myristicin (3.28%) and elemicin (1.38%) together accounted for 4.66% of the whole oil while in mace oil their concentrations were still higher (5.92% and 3.14% respectively). Considering the relatively high concentration of highly volatile monoterpenes in both oils the concentration of hallucinogenic principles (myristicin and elemicin) appears to be very high in Indian oils. The major hallucinogenic principle in Indian nutmeg and mace oils thus appears to the myristicin. The general sensory characteristics of the oil compare very well with the best products in world market.

Table 4. Gas chromatographic analysis of nutmeg and mace oils

Compound	Composition		
	Rt	Nutmeg oil	Mace oil
α - Pinene	2.76	14.72	15.24
β – Pinene + Sabinene	3.41	62.66	45.52
α – Phellandrene	3.56	3.06	3.17

Δ^3-Carene	3.78	0.60	0.67
α-Terpinene + P-Cymene	3.95	1.08	3.53
1:8-Cineol + Limonene	4.23	6.18	6.97
U.I.	4.52	-	-
β - Phellandrene	4.71	1.08	2.80
U.I.	4.90	0.28	
γ - Terpinene	5.29	0.54	1.83
Linalool + Terpinolene	5.54	0.48	0.42
β - Terpineol	6.02	0.25	0.32
Borneol (tentative)	6.47	0.05	0.16
Terpinen - 4-0l	7.18	1.85	4.59
α - Terpineol + Piperitol	7.45	0.36	0.94
U.I.	7.94	0.02	0.27
Geraniol	9.20	0.02	0.22
Safrole + p-Cymene-8-ol	9.53	0.53	0.67
Bornyl acetate	10.18	0.07	0.09
U.I.	10.62	0.01	0.08
U.I.	10.95	-	0.01
Methyl eugenol	11.28	0.14	0.22
Eugenol + terpenyl acetate	11.53	0.22	0.15
Geranyl acetate + α - Copaene	12.15	0.29	0.16
Isoeugenol (cis)	12.35	0.31	0.45
U.I.	13.13	0.03	0.05
β - Caryophyllene + isoeugenol (trans)	13.49	0.07	0.07
α - Humulene	14.06	0.02	0.03
U.I.	14.41	0.04	0.08
δ - Cadinene	14.53	0.08	0.15
Myristicin	15.08	3.28	5.92
Elemicin	15.76	1.38	3.14
U.I.	17.22	0.05	0.11
U.I.	17.44	0.02	0.18
U.I.	17.90	-	0.27
U.I.	19.2	-	0.07
U.I.	19.47	-	0.03
U.I.	21.57	-	0.04
Myristic acid	23.12	0.01	0.01
U.I.	23.80	-	0.03
U.I.	24.42	-	0.04
U.I.	25.22	-	0.10
U.I.	25.62	-	0.08
Trimyristin	26.12	0.06	0.05
U.I.	27.44	-	0.22
U.I.	29.74	-	0.02

Rt - Retention time; U.I. -Unidentified

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