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Characterization and evaluation of nutmeg (*Myristica fragrans* Houtt.) genotypes of Coastal Karnataka for yield attributes

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Abstract
The present study evaluated thirty nutmeg (*Myristica fragrans* Houtt.) accessions collected from Dakshina Kannada and Udupi districts of coastal Karnataka during 2024-25 to assess variability in yield-contributing traits. Significant differences were observed among the accessions for fruit, mace, nut and kernel characteristics, reflecting a wide range of genetic diversity. Accession 24 exhibited superior performance with the highest fruit size, mace and nut weights and kernel yield per tree, followed closely by Accession 30, while Accession 21 consistently recorded the lowest values. High dry recovery percentages in mace and nut of superior accessions indicated better post-harvest efficiency. Correlation analysis revealed strong positive associations between fruit and nut traits with overall yield and high heritability estimates suggested that these traits are reliable targets for selection. The study highlights the existence of considerable genetic variability in coastal nutmeg germplasm and identifies Accession 24 and Accession 30 as promising genotypes for large-scale cultivation and future improvement programmes aimed at enhancing productivity and quality under coastal Karnataka conditions.

Keywords: Nutmeg, *Myristica fragrans*, yield traits, genotypes, variability, productivity

Introduction

Nutmeg (*Myristica fragrans* Houtt.) is a perennial evergreen tree of the family Myristicaceae, widely valued for its aromatic seed (nutmeg) and lacy aril (mace). Native to the Moluccas Islands of Indonesia, also known as the “Spice Islands,” it was introduced to India in the 18th century and is now successfully cultivated in Kerala, Tamil Nadu and coastal Karnataka. The crop thrives under tropical conditions with well-drained soils, making it suitable for smallholder and commercial cultivation in these regions. Nutmeg is a dioecious and cross-pollinated species, exhibiting considerable variability in tree growth, fruiting pattern and yield traits. The inability to determine plant sex at the seedling stage and the long juvenile period are major constraints to uniform orchard management and reliable yield prediction. Previous studies have reported significant differences among genotypes in tree vigour, canopy spread, stem girth, fruit size and yields of nut, mace and kernel, indicating the presence of high genetic variability. Such diversity provides opportunities for selecting superior accessions with enhanced productivity.

Systematic evaluation of nutmeg genotypes for yield traits is essential for identifying elite lines, improving productivity and supporting sustainable cultivation. Coastal Karnataka harbors diverse nutmeg germplasm, but detailed information on growth and yield performance is limited. Assessing variability in yield-related traits can facilitate selection of high-performing genotypes for large-scale cultivation, help standardize orchard management practices and guide future crop improvement programs. Considering its economic and nutritional significance, this review focuses on characterizing and evaluating nutmeg genotypes in coastal Karnataka with respect to growth and yield traits. The study aims to identify promising accessions that can serve as potential candidates for commercial cultivation, contributing to enhanced productivity, conservation of genetic resources and sustainable development of nutmeg as a high-value spice crop.

Materials and Methods

The present investigation, "Characterization and evaluation of nutmeg (*Myristica fragrans* Houtt.) genotypes of Coastal Karnataka for yield attributes," was conducted during 2024-25 in Udupi and Dakshina Kannada districts of coastal Karnataka. Thirty nutmeg accessions, aged 12-15 years, were selected from plantations in four villages (Mandarthi, Mudrady, Ajekar and Bandaje) based on thorough visual evaluation of vigour, fruiting history and overall health (Rao *et al*., 2010) [10].

For each accession, ten fruits were randomly harvested from all four sides of the tree to ensure representative sampling. Fruit length (mm), diameter (mm) and weight (g) were measured using vernier calipers and laboratory electronic weighing balances (DUS guidelines). After processing, nut length (mm), nut diameter (mm), fresh and dry weight of nut (g) were recorded. Mace was separated and fresh and dry weights (g) were measured. Similarly, kernel length (mm), kernel diameter (mm) and kernel dry weight (g) were recorded. From these data, dry recovery (%), mace-to-nut ratio, number of fruits per tree, mace yield per tree (g) and kernel yield per tree (g) were calculated. Dry weights were obtained by oven-drying nuts at 40-50 °C and mace at 55-60 °C until a constant weight was achieved (Clevenger, 1982; ASTA, 1968) [3, 2].

Data were analyzed statistically using descriptive statistics, analysis of variance and variance components (Singh and Choudhary, 1977) [12] and heritability, genetic advance, correlation, path coefficient and clustering were estimated following standard protocols (Weber and Moorthy, 1952; Dewey and Lu, 1959; Panse and Sukhatme, 1967; Al-Jibouri *et al*., 1958) [13, 4, 8, 1]. This methodology enabled a comprehensive evaluation of variability and yield-related traits among the 30 nutmeg accessions.

Results and Discussion

Fruit Characters

Significant variability was recorded in fruit characteristics among the thirty nutmeg accessions from coastal Karnataka, reflecting broad genetic diversity influencing yield (Table 1). Fruit weight ranged from 52.96 g to 92.59 g, with Acc. 24 producing the heaviest fruits, followed by Acc. 30, while Acc. 21 had the lowest. Larger fruit size in these elite accessions is a desirable selection trait as it directly enhances mace and nut yields. Fruit length and diameter varied from 45.94-73.53 mm and 41.24-55.41 mm, respectively, with Acc. 24 consistently superior, indicating its strong genetic potential and regional adaptability. Similar variability in nutmeg fruit biometrics was reported by Senthilkumar *et al*. (2010) [11] and Kumar *et al*. (2002) [6] in nutmeg, who highlighted the role of genetic and environmental interactions in fruit morphology.

The number of fruits per tree varied between 207.67 and 660, with Acc. 24 recording the maximum, followed by Acc. 30, indicating superior reproductive efficiency and canopy productivity. These differences are attributed to larger canopy spread, higher flower retention and efficient pollination, consistent with observations by Haldankar *et al*. (2003) [5] and Rahul *et al*. (2014) [9] in nutmeg linking yield performance with vegetative vigor and fruit-bearing habit.

Mace Characters

Substantial variation was observed in mace traits (Table 2). Fresh mace weight ranged from 1.71 g (Acc. 21) to 2.28 g (Acc. 24), followed by 2.20 g (Acc. 30), indicating superior aril development. After drying, mace weight declined proportionally, with the highest dry weight in Acc. 24 (1.05 g) and lowest in Acc. 21 (0.49 g). Dry recovery percentage varied between 28.72 and 46.05 percent, with Acc. 24 again superior, suggesting dense aril tissue and better drying efficiency. Although Acc. 22 recorded the highest mace-to-nut ratio (0.24), Acc. 30 showed the lowest (0.11), indicating the influence of nut size on ratio expression. Mace yield per tree was highest in Acc. 24 (694.90 g), followed by Acc. 30 (539.70 g).

Such variation stems from both genetic and environmental factors. Larger fruits and thicker arils contribute to higher mace weight and recovery. Comparable findings were noted by Rao *et al*. (2010) [10], Senthilkumar *et al*. (2010) [11], Rahul *et al*. (2014) [9] and Miniraj (2015) [7] in nutmeg, confirming that genetic diversity governs mace productivity and post-harvest quality.

Nut Characters

Nut biometrics showed marked differences among accessions (Table 3). Nut length ranged from 26.86 mm (Acc. 21) to 43.83 mm (Acc. 24) and diameter from 15.74-24.23 mm. Acc. 24 and Acc. 30 exhibited superior nut size and weight (8.68-19.21 g fresh, 2.78-8.67 g dry). Dry recovery ranged from 27.26 to 45.13 percent, with Acc. 24 and Acc. 30 again superior, reflecting higher dry matter content. These variations can be attributed to genotype-environment interactions, particularly soil fertility and rainfall distribution. Similar results were reported by Haldankar *et al*. (2003) [5] in nutmeg, who emphasized the influence of genetic constitution and agroclimatic adaptation on nut traits.

Kernel Characters

Kernel traits followed the same trend as nut parameters (Table 4). Kernel length ranged from 17.02 mm (Acc. 21) to 30.26 mm (Acc. 24) and diameter from 10.25-18.47 mm. The highest kernel dry weight (6.48 g) and kernel yield per tree (4278.67 g) were recorded in Acc. 24, followed by Acc. 30, while Acc. 21 showed the lowest values. The superior kernel yield of Acc. 24 can be linked to its high fruit set, large nut size and greater canopy spread enhancing photosynthetic efficiency. These results align with Haldankar *et al*. (2003) [5], who also reported wide variability in kernel traits among nutmeg genotypes, underscoring the influence of genetic makeup on seed productivity.

Table 1: Performance of nutmeg (*Myristica fragrans* Houtt.) accessions for fruit characters

Accessions	Fruit length (mm)	Fruit diameter (mm)	Fruit weight (g)	Number of fruits per tree
Acc. 01	65.23	46.52	68.27	319.33
Acc. 02	47.65	42.03	75.27	253.67
Acc. 03	64.32	52.85	78.29	356.67
Acc. 04	46.35	42.56	67.43	226.76
Acc. 05	66.37	52.83	65.78	470.67
Acc. 06	48.71	43.61	73.56	267.00
Acc. 07	63.80	50.67	69.18	365.00
Acc. 08	49.58	46.88	74.60	285.00
Acc. 09	62.92	49.82	69.97	437.00
Acc. 10	68.25	54.30	58.25	518.33
Acc. 11	61.22	48.73	72.77	458.33
Acc. 12	60.56	47.95	76.19	477.33
Acc. 13	67.58	53.81	72.31	502.67
Acc. 14	59.53	55.12	63.37	412.67
Acc. 15	58.51	49.92	58.58	317.00
Acc. 16	53.68	51.11	80.19	256.33
Acc. 17	54.28	51.65	81.82	292.00
Acc. 18	57.51	48.25	76.63	359.00
Acc. 19	56.22	44.33	72.50	320.00
Acc. 20	56.12	48.86	83.28	281.33
Acc. 21	45.94	41.24	52.96	207.67
Acc. 22	50.57	48.48	68.93	237.67
Acc. 23	55.74	52.64	75.19	253.33
Acc. 24	73.53	55.41	92.59	660.00
Acc. 25	71.52	54.52	72.17	545.00
Acc. 26	69.96	53.28	76.22	553.67
Acc. 27	65.17	52.17	82.49	467.33
Acc. 28	52.23	49.85	80.79	266.33
Acc. 29	64.21	52.07	82.04	386.00
Acc. 30	72.91	54.95	88.20	560.00
S.Em±	2.67	2.06	2.42	21.53
CD @ 5%	7.56	5.42	6.84	60.96

Table 2: Performance of nutmeg (*Myristica fragrans* Houtt.) accessions for mace characters

Accessions	Fresh weight of mace (g)	Dry weight of mace (g)	Dry recovery (%)	Mace to nut ratio	Mace yield per tree (g)
Acc. 01	1.79	0.52	29.27	0.14	167.27
Acc. 02	2.03	0.83	40.89	0.19	210.40
Acc. 03	2.12	0.86	40.57	0.21	305.78
Acc. 04	1.73	0.53	30.63	0.18	115.69
Acc. 05	1.98	0.65	32.82	0.19	305.60
Acc. 06	1.95	0.75	38.46	0.21	200.20
Acc. 07	1.82	0.67	36.81	0.19	244.74
Acc. 08	1.89	0.62	32.92	0.21	177.98
Acc. 09	1.91	0.60	31.28	0.22	262.53
Acc. 10	2.06	0.75	36.41	0.20	388.13
Acc. 11	2.01	0.69	34.46	0.18	316.08
Acc. 12	1.85	0.68	36.76	0.20	324.95
Acc. 13	1.76	0.65	36.93	0.16	326.63
Acc. 14	1.93	0.61	31.55	0.15	251.33
Acc. 15	2.13	0.78	36.62	0.16	247.84
Acc. 16	2.18	0.80	36.70	0.19	205.31
Acc. 17	1.97	0.82	41.62	0.21	238.07
Acc. 18	1.87	0.57	30.33	0.20	203.08
Acc. 19	1.97	0.78	39.59	0.22	248.84
Acc. 20	2.03	0.72	35.47	0.18	202.59
Acc. 21	1.71	0.49	28.72	0.18	103.33
Acc. 22	2.18	0.73	33.49	0.24	172.42
Acc. 23	1.83	0.58	31.67	0.17	146.78
Acc. 24	2.28	1.05	46.05	0.12	694.90
Acc. 25	2.11	0.92	43.68	0.13	502.43
Acc. 26	1.98	0.69	34.85	0.10	380.63
Acc. 27	2.14	0.71	33.18	0.12	333.11
Acc. 28	2.02	0.75	37.13	0.12	200.40
Acc. 29	1.88	0.65	34.41	0.13	249.38
Acc. 30	2.20	0.96	43.64	0.11	539.70
S.Em±	0.05	0.03	1.59	0.01	25.21
CD @ 5%	0.13	0.09	4.34	0.04	71.38

Table 3: Performance of nutmeg (*Myristica fragrans* Houtt.) accessions for nut characters

Accessions	Nut length (mm)	Nut diameter (mm)	Fresh weight of nut (g)	Dry weight of nut (g)	Dry recovery (%)
Acc. 01	31.21	18.86	11.50	3.73	32.43
Acc. 02	31.95	19.17	15.00	4.32	28.80
Acc. 03	31.97	18.98	11.84	4.15	35.05
Acc. 04	30.01	18.60	10.34	2.95	28.53
Acc. 05	30.78	18.28	9.00	3.42	38.00
Acc. 06	30.99	18.92	12.00	3.52	29.33
Acc. 07	31.43	19.02	11.02	3.45	31.31
Acc. 08	29.86	18.21	9.87	2.97	30.09
Acc. 09	29.38	17.24	10.31	2.81	27.26
Acc. 10	31.34	18.99	9.00	3.71	41.22
Acc. 11	32.06	20.05	10.12	3.95	39.03
Acc. 12	30.86	18.76	11.01	3.40	30.88
Acc. 13	31.86	19.12	10.56	4.16	39.39
Acc. 14	32.43	19.54	12.00	4.23	35.25
Acc. 15	32.56	19.62	15.00	4.96	33.07
Acc. 16	31.77	18.95	12.00	4.33	36.08
Acc. 17	31.94	19.22	10.89	3.97	36.46
Acc. 18	29.33	17.98	9.12	2.87	31.47
Acc. 19	31.29	19.63	10.00	3.63	36.30
Acc. 20	33.12	20.93	11.00	3.92	35.64
Acc. 21	26.86	15.74	10.00	2.78	27.80
Acc. 22	27.76	16.23	9.80	2.99	30.51
Acc. 23	31.43	18.83	10.00	3.48	34.80
Acc. 24	43.83	24.23	19.21	8.67	45.13
Acc. 25	33.53	20.87	16.00	7.03	43.94
Acc. 26	33.98	21.64	16.00	6.94	43.38
Acc. 27	35.56	22.32	19.00	6.00	31.58
Acc. 28	33.11	21.97	18.20	6.34	34.84
Acc. 29	32.99	21.89	18.50	5.04	27.24
Acc. 30	39.21	22.67	19.00	8.45	44.47
S.Em±	0.89	0.51	0.38	0.21	1.56
CD @ 5%	2.51	1.42	1.05	0.60	4.43

Table 4: Performance of nutmeg (*Myristica fragrans* Houtt.) accessions for kernel characters

Accessions	Kernel length (mm)	Kernel diameter (mm)	Kernel dry weight (g)	Kernel yield per tree (g)
Acc. 01	20.15	12.54	2.08	664.28
Acc. 02	19.49	11.37	2.27	576.01
Acc. 03	20.28	11.49	1.98	705.16
Acc. 04	18.52	10.75	1.67	379.79
Acc. 05	18.97	10.96	2.43	1143.94
Acc. 06	19.94	11.56	1.96	523.99
Acc. 07	19.73	12.04	2.03	741.20
Acc. 08	18.84	11.56	1.78	507.43
Acc. 09	18.36	10.65	1.45	633.62
Acc. 10	19.16	11.06	1.69	876.05
Acc. 11	19.38	11.37	2.21	1013.48
Acc. 12	19.65	10.89	1.75	835.37
Acc. 13	20.86	10.95	1.86	936.56
Acc. 14	19.82	11.39	2.59	1067.28
Acc. 15	20.17	11.03	2.83	897.26
Acc. 16	22.38	10.98	2.76	707.31
Acc. 17	21.26	11.86	1.96	572.29
Acc. 18	19.32	11.45	1.34	481.38
Acc. 19	20.55	11.27	1.86	595.46
Acc. 20	20.64	12.38	2.19	616.19
Acc. 21	17.02	10.25	1.16	240.72
Acc. 22	17.98	11.05	1.45	344.95
Acc. 23	20.58	11.75	2.85	723.10
Acc. 24	30.26	18.47	6.48	4278.67
Acc. 25	24.69	12.97	4.87	2655.16
Acc. 26	26.31	12.86	4.35	2407.00
Acc. 27	24.65	15.73	4.07	1903.32
Acc. 28	23.55	13.04	3.63	966.95
Acc. 29	21.76	12.51	3.85	1486.13
Acc. 30	27.79	16.45	6.22	3483.10
S.Em±	0.94	0.19	0.04	44.86
CD @ 5%	2.67	0.53	0.12	127.00

Conclusion

The present evaluation of thirty nutmeg accessions from coastal Karnataka revealed considerable genetic variability in fruit, mace, nut and kernel traits, indicating rich potential for selection and crop improvement. Among the accessions, Acc. 24 consistently exhibited superior performance across all yield components-fruit size, mace weight and recovery, nut and kernel dimensions and overall productivity-followed closely by Acc. 30. These accessions demonstrated high dry matter recovery and mace yield per tree, making them promising candidates for elite cultivar development and large-scale propagation under coastal conditions. The observed variability also highlights opportunities for future breeding programs aimed at improving both yield and quality traits.

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