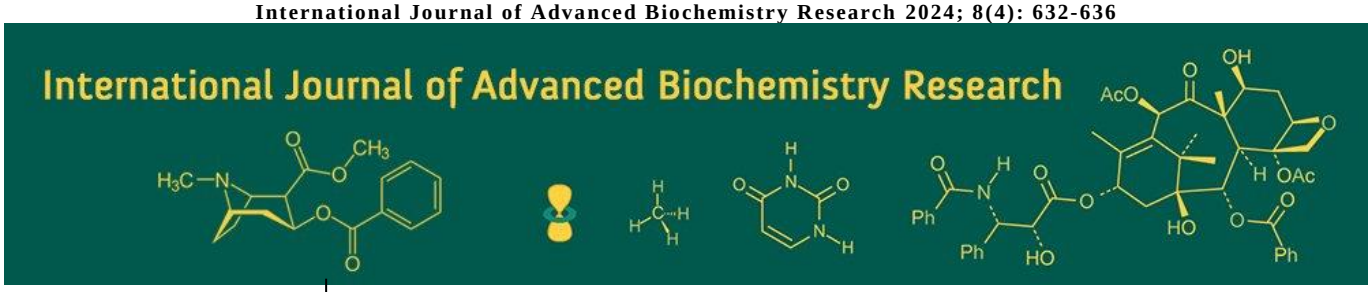

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Studies on fruit morphometric traits of *Myristica dactyloides* in relation to stages of fruit maturity

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Abstract
Myristica dactyloides belongs to the Myristicaceae family, it is one of the non-swampy tree species commonly known as "False nutmeg or Jaikai or wild nutmeg or Gidda Ramapatr". It serves the livelihood of local people living around the forest areas. Fruit and seed characteristics play an important role in seed germination and seedling growth. Variation in fruit and seed characteristics and germination behavior of a species is helpful in selecting the good quality seeds. Hence, the present study was carried out with the objective to study the fruit morphometric traits with respect to stages of fruit maturity of *Myristica dactyloides.* The fruits were collected from Heggarni village of Janmane Forest Range of Sirsi Division and its morphometric traits *viz.*, fruit length, fruit diameter, seed length, seed diameter, fresh weight (rind, seed and aril) and dry weight (rind, seed and aril) were assessed at College of Forestry, Sirsi. The results have shown that there is a decline in seed moisture content from T_1 (creamy white aril) to T_4 (red aril collection stage) due to desiccation and dry matter accumulation in fruit and seed. Higher fruit and seed parameters are noticed from initial to final stage of collection. It can be concluded from the study that the final stage (T_4- red aril) is the best stage for collection for higher biomass and superior quality of aril for commercialization.

Keywords: Germination, morphometric traits, fruit maturity

Introduction
Myristicaceae (nutmeg family), of the magnolia order (Magnoliales) is well known for its fragrant and spicy seeds particularly those of nutmeg (*Myristica fragrans*). There are 15 genera and about 380 species of evergreen trees that can be found in the humid tropical lowlands. Most species have leaves and wood that are aromatic (Anonymous, 2014) [1]. *Myristica dactyloides* is one of the non-swampy and dioecious tree species often known as "False Nutmeg or Jaikai or wild nutmeg or Gidda Ramapatre". It is indigenous to Sri Lanka and the Western Ghats of India and occupies the intermediate canopy stratum of the mid-and high-elevation of wet evergreen forests (Sharma and Shivanna, 2011) [5]. It is an evergreen tree, growing up to 20 m in height, often with stilt roots and it is also an important Non-Timber Forest Products (NTFPs) of the Western Ghats.
The aril of this fruit is used as a substitute for nutmeg (*Myristica fragrans*). It serves the livelihood of local people living around the forest areas. Fruit and seed characteristics play an important role in seed germination and seedling growth. Variation in fruit and seed characteristics and germination behavior of a species is helpful in selecting the good quality seeds (Kertadikara and Prat 1995) [2]. Hence, the present study was carried out to assess the fruit morphometric traits of *Myristica dactyloides* in relation to different fruit maturity stages.

Material and methods Study area
The present study was carried out in Department of Silviculture and Agroforestry at College of Forestry, Sirsi, Uttara Kannada which comes under the hill zone (Zone 9) of Karnataka State, in the Central Western Ghats which lies between 14° 26' N latitude, 74° 50' E longitude and at an altitude of 619 m MSL.

General features of the seed source

The seed source selected for the present investigation fall within a latitude of $14^0$24'40.98" N and longitude of $74^0$46'39.36" E. The altitude of the seed source is 586.81 ± 73 m above mean sea level (M.S.L). These sources fall under tropical climate with March-April being hottest and January-February the coldest months, with maximum rainfall during July- August.

Collection of fruits/seed material

Seeds were collected from the trees which were having healthy vigor and free from pest and diseases to ensure the good quality and viable seeds. Utmost care was taken to collect the seeds from middle-aged, well branched trees with good canopy cover.

The fruits were collected at four stages (Stage I, Stage II, Stage III and Stage IV) depending on the colour of the fruits and aril *i.e.*, Stage I-creamy white aril, Stage II- yellowish orange aril, Stage III-orange aril, Stage IV-red aril. Stages of fruit maturity were considered as treatments.

Fruit processing

After the collection, the fruits were packed in gunny bags and transported to the laboratory on the same day in order to avoid moisture loss. The fruit lots were manually pre-cleaned by removing the waste materials such as leaves, twigs and foreign matter from the fruit lot in order to increase the purity of the lot. The seeds were extracted by cutting the fruits into two halves with the help of knife and further aril covering the seed was removed.

Observations Recorded

Colour index of aril was the main criteria for assessing the maturity as, even after maturity the fruit still remains brown in colour and attached to the branches. The fruit and seed parameters recorded were fruit length (mm), fruit diameter (mm), seed length (mm), seed diameter (mm), fresh fruit weight (g), dry fruit weight (g), fresh seed weight (g), dry seed weight (g), fresh rind weight (g), dry rind weight (g), fresh aril weight (g) and dry aril weight (g). Length and diameter of fruit and seed was measured using digital Vernier caliper.

Results and Discussion

The present study indicated statistically significant difference among fruit maturity stages for all the fruit parameters (fruit length, fruit diameter, fruit weight, fresh rind weight and dry rind weight), aril parameters (fresh aril weight, dry aril weight and aril moisture content) and seed parameters (seed length, seed diameter, fresh seed weight, dry seed weight and seed moisture content).

Treatment T_4 (Stage – IV) was found to be significantly superior (64.72 mm, 48.00 mm, 39.37 g, 58.20 g and 10.00 g) from T_1 (Stage – I) (57.07 mm, 43.65 mm, 32.00 g, 44.61 gm and 7.58 g) for fruit length, fruit diameter, fruit weight, fresh rind weight and dry rind weight respectively. On the other hand, rind moisture content followed a decreasing trend from T_1 (Stage – I) (83.01%) to T_4 (Stage – IV) (82.82%) and results were found to be non-significant (Table 2).

Also, the results have shown significant effect on aril parameters for all the fruit maturity stages. The treatment T_4 (Stage – IV) found to be significantly superior (3.51 g and 2.62 g) over other maturity stages and least was in T_1 (Stage – I) (2.61 g and 1.13 g) for fresh aril weight and dry aril weight respectively. Highest dry aril weight and low moisture content was observed in T_4 (Stage – IV) (Fig. 1).

Additionally, the study found that, various fruit maturity stages did demonstrate a considerable impact on all seed parameters. As like earlier, the stages of fruit maturity showed increasing trend from T_1 (Stage – I) to T_4 (Stage – IV) and latter (T_4) was significantly superior (39.37 mm and 7.86 g) over other stages with a minimum value in T_1 (32.00 mm and

2.34 g) for seed length and dry seed weight respectively. Also, the seed moisture showed significant difference among various fruit maturity stages with minimum moisture content in T_4 (29.58%) (Fig. 2).

From the results it was observed that Stage – IV (red aril) was the best stage for collection of fruits from trees as it showed a positive impact (increased weight) on aril and seed which acts as an income generation for farmers. Similar results were reported by Sangakkara (1993) [4] in *Myristica fragrans* Houtt. where seed moisture content reduced drastically with increasing seed maturity. The results of study are in accordance with the results of Prabhugoud (2015) [3], where collection time played a significant role for all the parameters in *Myristica malabarica*. Highest moisture content was recorded in M1 (1st fortnight of December) *i.e.*, 65.61 per cent and lowest (40.91%) in M6 (2nd fortnight of February) collection time.

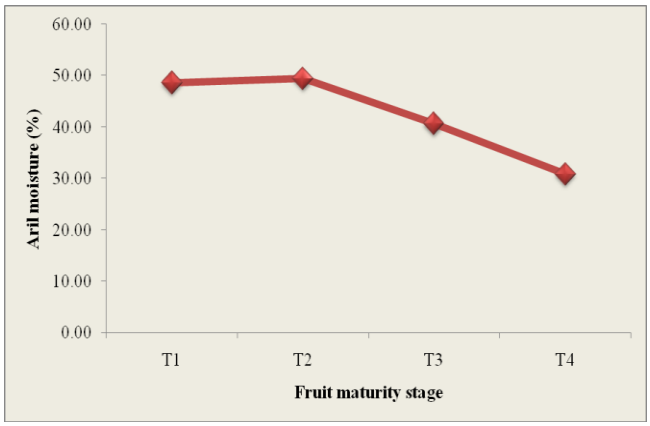

Fig 1: Effect of fruit maturity on aril moisture content of *Myristica dactyloides*

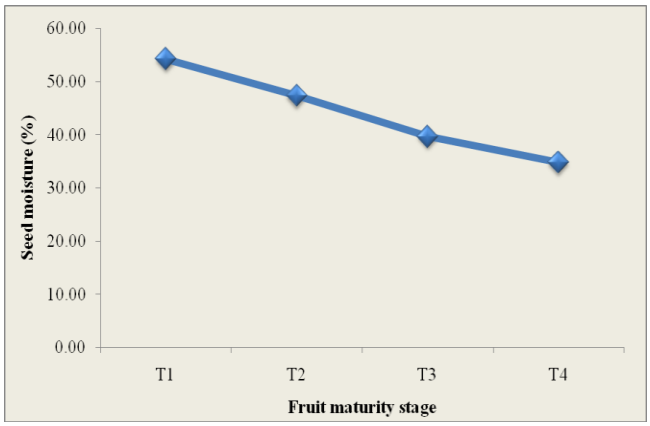

Fig 2: Effect of fruit maturity on seed moisture content of *Myristica dactyloides*

Table 1: Treatment details for collection time of *Myristica dactyloides*

Treatments	Stage of collection	Aril colour	Collection time
T_1	Stage I	Creamy white	1st week of January
T_2	Stage II	Yellowish orange	1st week of February
T_3	Stage III	Orange	4th week of February
T_4	Stage IV	Red	1st week of April

Table 2: Effect of fruit maturity on fruit parameters of *Myristica dactyloides*

Treatment	Description	Fruit length (mm)	Fruit diameter (mm)	Fruit weight (gm)	Fresh rind weight (gm)	Dry rind weight (gm)	Rind moisture content (%)
T_1 (Stage – I)	Creamy white aril	57.07	43.65	32.00	44.61	7.58	65.62
T_2 (Stage – II)	Yellowish orange aril	58.90	43.94	34.68	42.59	7.23	65.62
T_3 (Stage – III)	Orange aril	58.63	43.14	33.28	41.75	7.12	65.53
T_4 (Stage – IV)	Red aril	64.72	48.00	39.37	58.20	10.00	65.42
SEm ±		1.01	0.53	2.05	1.75	0.22	0.33
CD @ 5%		2.95	1.54	5.99	5.11	0.65	NS

Table 3: Effect of fruit maturity on aril parameters of *Myristica dactyloides*

Treatment	Description	Fresh aril weight (gm)	Dry aril weight (gm)	Aril moisture content (%)
T_1 (Stage – I)	Creamy white aril	2.61	1.13	48.60
T_2 (Stage – II)	Yellowish orange aril	3.03	1.28	49.43
T_3 (Stage – III)	Orange aril	3.47	1.99	40.67
T_4 (Stage – IV)	Red aril	3.51	2.62	30.86
SEm ±		0.18	0.21	2.58
CD @ 5%		0.52	0.62	7.51

Table 4: Effect of fruit maturity on seed parameters of *Myristica dactyloides*

Treatment	Description	Seed Length (mm)	Seed Diameter (mm)	Fresh seed weight (gm)	Dry seed weight (gm)	Seed moisture content (%)
T_1 (Stage – I)	Creamy white aril	32.00	17.37	6.88	2.34	54.24
T_2 (Stage – II)	Yellowish orange aril	34.68	23.36	11.77	5.39	47.29
T_3 (Stage – III)	Orange aril	33.28	22.30	10.54	6.78	39.64
T_4 (Stage – IV)	Red aril	39.37	21.85	11.04	7.86	34.73
SEm ±		0.58	0.45	0.39	0.41	1.86
CD @ 5%		1.69	1.32	1.14	1.18	5.42

Plate 1: *Myristica dactyloides* (a) Red sap from bark, (b) Tree, (c) Harvested fruits and (d) Branch with fruits

Plate 2: Stages of fruit maturity (a) Stage I – creamy white aril, (b) Stage II – yellowish orange aril, (c) Stage III – orange aril and (d) Stage IV – red aril

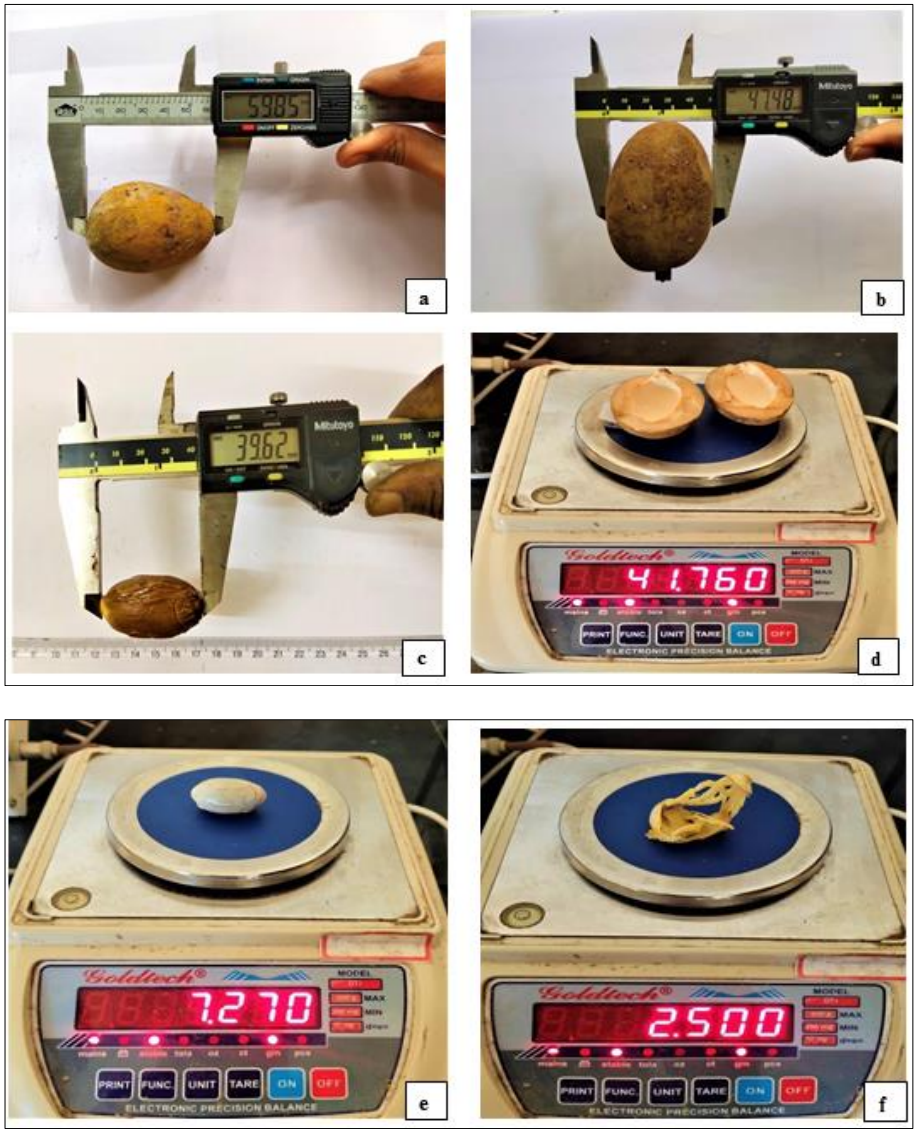

Plate 3: Measurement of fruit seed and aril parameters (a) Fruit length, (b) Fruit diameter, (c) Seed length, (d) Fresh rind weight, (e) Fresh seed weight and (f) Fresh aril weight

Conclusion

The study shows the fruit morphometric traits of *Myristica dactyloides* across different stages of fruit maturity, which revealed the significant differences among the stages, particularly in fruit, aril, and seed parameters. The results showed that, as the fruit matured from Stage I (creamy white aril) to Stage IV (red aril), there was a notable increase in fruit length, diameter, weight, aril weight, and seed length and weight. This increase was accompanied by a decline in moisture content, indicating desiccation and dry matter accumulation in the fruit and seed.

However, the final stage of fruit maturity (Stage IV - red aril) stood out as the optimal stage for collection. At this stage, *Myristica dactyloides* exhibited superior characteristics, including higher biomass and superior aril quality, which are crucial for commercialization and income generation. These findings align with previous studies on similar species, indicating the importance of timing in fruit collection for maximizing seed quality.

The knowledge gained from this research provides valuable insights for seed collectors and farmers, emphasizing the significance of selecting the appropriate maturity stage for *Myristica dactyloides* fruits to ensure better seed quality and yield. Further research could explore additional aspects of seed germination and seedling growth related to different fruit maturity stages, contributing to the sustainable management and utilization of this important Non-Timber Forest Product (NTFP) of the Western Ghats.

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