

THE MORPHOLOGY OF THE INFLORESCENCE AND FRUIT IN JACK (*ARTOCARPUS HETEROPHYLLUS* LAM.)

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Abstract : The inflorescence in jack is a catkin. The individual flowers are radially arranged on a fleshy peduncle. The perianth tubes of male flowers are free from each other, while those of female flowers are fused in the middle region. Androecium consisted of a single stamen with a basifixed four celled anther. Gynoecium consisted of a white waxy clavate stigma, a slender style and a unicelled ovary with a solitary ovule inside, attached by marginal placentation. The female catkin after pollination developed into a large composite fruit (sorosis) which is a 'false fruit', with the persistent perianth forming the hulk of the fruit. The 'true fruit' resembled an achene. Except for the texture of the flakes after ripening, the two types studied had the same morphological features; the 'koozha' with soft mushy flakes and 'varikka' with crisp hard flakes.

Key words : Jack fruit, jack inflorescence, fruit morphology

INTRODUCTION

The jack fruit stands unique in its size and morphological peculiarities. Brief descriptions of flower and fruit of jack have been given by Hooker (1885), Ochse (1931), Corner (1939) and Sundararaj and Ramanujam (1953). A complete detailed description of the inflorescence and flowers of jack and their development into fruits is found wanting. This study initiated in the Kerala Agricultural University pertains to the above aspects of jack in 'varikka' and 'koozha', the crisp and soft flaked forms of jack respectively.

MATERIALS AND METHODS

The experimental material was collected from eight 'varikka' and six 'koozha' trees available at the Agricultural Research Station, Mannuthy, Trichur. The description of catkin were taken from 25 male and 25 or available number of female catkins in each tree. The number of flowers per unit area of the catkins was counted from the middle portions of each catkin. To study the fruit dimensions, 15 fruits were dissected and observations taken.

RESULTS AND DISCUSSION

Jack tree is monoecious, the inflorescence is borne on special flowering shoots produced on main trunk and older woody branches, during

the flowering season from October to March. The male catkins are also produced in large number on the new lateral shoots.

The catkins are axillary in position enclosed by two concave, spathaceous, amplexicaul stipules, the male and female catkins were found to possess shades of green colour, varying from light green to dark green in the different trees. An involucre was present at the base of the peduncle which was more prominent in the female catkins. The occurrence of involucre in condensed inflorescence has been pointed out by Swami and Rao (1976). The presence of a fleshy ring has been mentioned by Ochse (1931) and annulus by Corner (1939).

Male catkin : The data on length, girth and number of flowers per cur in a male catkin are presented in Table 1. The male catkin was usually oblong or oblong clavate in shape, 3.5 to 6.5 cm in length and 4 to 9.5 cm in girth. A cross section of the catkin showed radial arrangement of the male flowers around a fleshy creamy white peduncle. The individual flowers were completely free from each other. Each male flower of a catkin was not more than 1mm in length. It consisted of two greenish tubular perianth parts bifid at the tip and fused below and had a single stamen. Each stamen had a basifixed four-celled creamy white anther and a colourless broad filament. The stamen emerged on the surface of the catkin at the time of anthesis. 'Varikka' and

Table 1. Length and girth of catkin and number of flowers per unit area of catkin in 'varikka' and 'koozha' types of jack

Type and sex	Mean length of catkin, cm	Mean girth at the middle of catkin, cm	Mean no. of flowers per cm ² of the catkin
Varikka male catkin	5.13	6.30	857.4
Koozha catkin	5.72	7.92	858.25
't' value	1.45 ^{NS}	1.74 ^{NS}	0.42 ^{NS}
Varikka female catkin	6.52	12.34	61.88
Koozha catkin	6.97	12.64	62.39
't' value	0.79 ^{NS}	0.49 ^{NS}	1.69 ^{NS}

Table 2. Measurement of fruit axis, perianth parts, true fruit and number of flakes per 1000 spines in jack (*Artocarpus heterophyllus* Lam.)

Max. diameter of fruit axis, cm	Meat length of persistent perianth				Mean no. of spines/ cm ²	Length of seed, cm	Girth of seed, cm	No of flakes/ 1000 spines	
	Total length	Length of flake	Length of rind	Length of spine					
Range	7-11	71-9.8	5.5-7.2	1.1-1.5	0.6-0.9	3-6	2.8-4	3.1-4.7	5-19
Mean	10.3	8.4	6.51	1.23	0.73	5.21	3.1	3.82	11.57

'koozha' types did not differ significantly in any of the characters studied.

Female catkin : The data on length, girth and number of flowers per cm² in a female catkin are presented in Table 1. The female catkins were generally clavate or cylindrical with a rounded apex. The length ranged from 5-9 cm and girth 10-16 cm. The individual flowers were distinct on the surface of the catkin as tiny rounded protuberance. A cross section of female catkin revealed radial arrangement of individual flowers on the peduncle as in male catkin. Individual female flowers had two greenish tubular perianth parts fused to form a perianth tube. The perianth tubes of individual flowers in a female catkin were not entirely free from each other. Three distinct regions could be identified on the perianth tube i.e., (1) basal free region, (2) middle fused region and (3) upper free region. The basal free region is the site where the ovary is enclosed. This region was 1-2 mm in length, fleshy and creamy white in colour. The middle fused

region was also creamy white in colour and 4-5 mm in length. In the cross section, the middle fused region of the flowers formed a continuous circle clearly demarcating the free regions above and below. The flowers lost their individual appearance at this region. The free apical region could be seen as tiny protuberance on the surface of the catkin, through which the stigma came out. This region was 3 to 4 mm in length, green in colour and horny in texture. The apices were rounded in early stages but later became spinous.

At the time of anthesis, a single white waxy, clavate stigma emerged out of the perianth tube from the centre or a little, to the side of the protuberance. The stigma showed an upward curve. The style was long (7-8 mm) and slender and was embedded in the middle fused region of perianth and could not be teased out easily. Ovary was oblong and unicelled. The ovule was solitary and suspended obliquely by marginal placentation, little below the top of

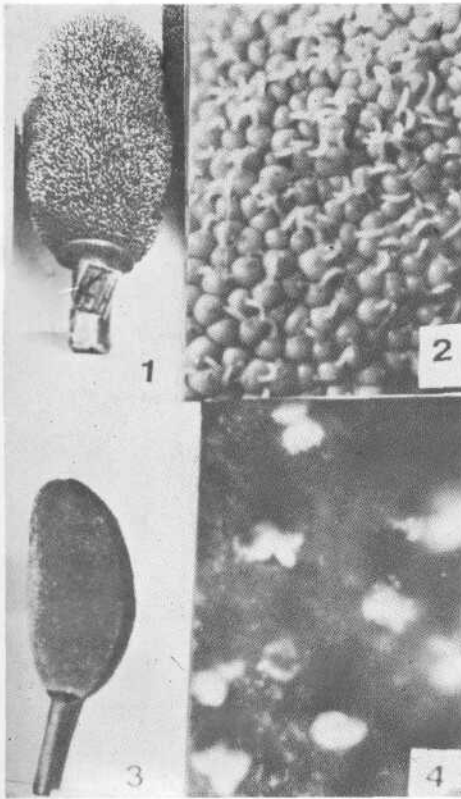


Fig 1. Female and male catkin in jack

1. A female catkin in jack at anthesis (x 0.50 approx.), 2. A portion of female catkin enlarged showing female flowers (x 100), 3. A male catkin in jack at anthesis (x1 approx.), 4. A portion of male catkin enlarged showing dehiscent anthers (x 1000)

the ovary. The two types 'varikka' and 'koozha', did not differ significantly in any of the characters studied. The observations on individual male and female flowers are in conformity with the reports of Corner (1939). Hooker (1885), Ochse (1931) and Purseglove (1974) however, failed to distinguish the distinct regions in the perianth and the arrangement of flowers in relation to one another.

Fruit : After anthesis the female catkin developed into a large composite fruit which was a sorosis. In fact, increase in size was noticed even during anthesis period, which extended for three weeks. The increase in size of fruit

was mainly due to growth of the perianth of flowers. Other than perianth, peduncle and the ovary also showed development resulting in increased size, each developing into the edible flakes, the fruit axis and the 'true' fruit respectively. The data on the descriptions of fruit and seed are presented in Table 2.

1. *The fruit axis :* This is the modified inflorescence axis or peduncle on which the individual flowers are arranged. In a mature fruit it is club shaped, the blunt tip tapering towards the stalk and has a mean diameter of 10.03 cm in the widest region. It is fleshy and spongy in texture with the presence of latex exudates. In a ripe 'koozha' fruit, the fruit axis could be easily pulled out, the flakes being very soft and mushy.

2. *The persistent perianth :* The major part of the large composite fruit is comprised of persistent perianth. In a jack fruit, of the numerous flowers in a catkin, only a few flowers showed normal development, the rest got aborted. The lower free region of the flower which was only 2 mm in the catkin initially, showed rapid growth. In normally developed flowers, this part of the perianth became large juicy and bulbous measuring on an average 6.57 cm in length. This forms the edible flakes which were sweet and turned yellow, when ripe.

The middle fused region of the perianth tube developed into the tough rind of the fruit. Compared to the lower free portion, its growth was very little. Initially the middle fused portion had a mean length of 5 mm which increased to 1.23 cm in mature fruit.

The upper free portion of the perianth got modified into the horny pyramidal protuberances on the rind of the fruit. Soon after anthesis, this region appeared conical in individual flowers, measuring on an average 4mm in length. It showed very little development, measuring on an average 7.3 mm only in the mature fruit. As the fruit developed, the base of the conical protuberance flattened, the tips retaining its size, forming the spines on the rind. The mean number of spines per cm soon after emergence of catkins was found to be 62.14 and after maturity of fruit it was reduced to 5.21.

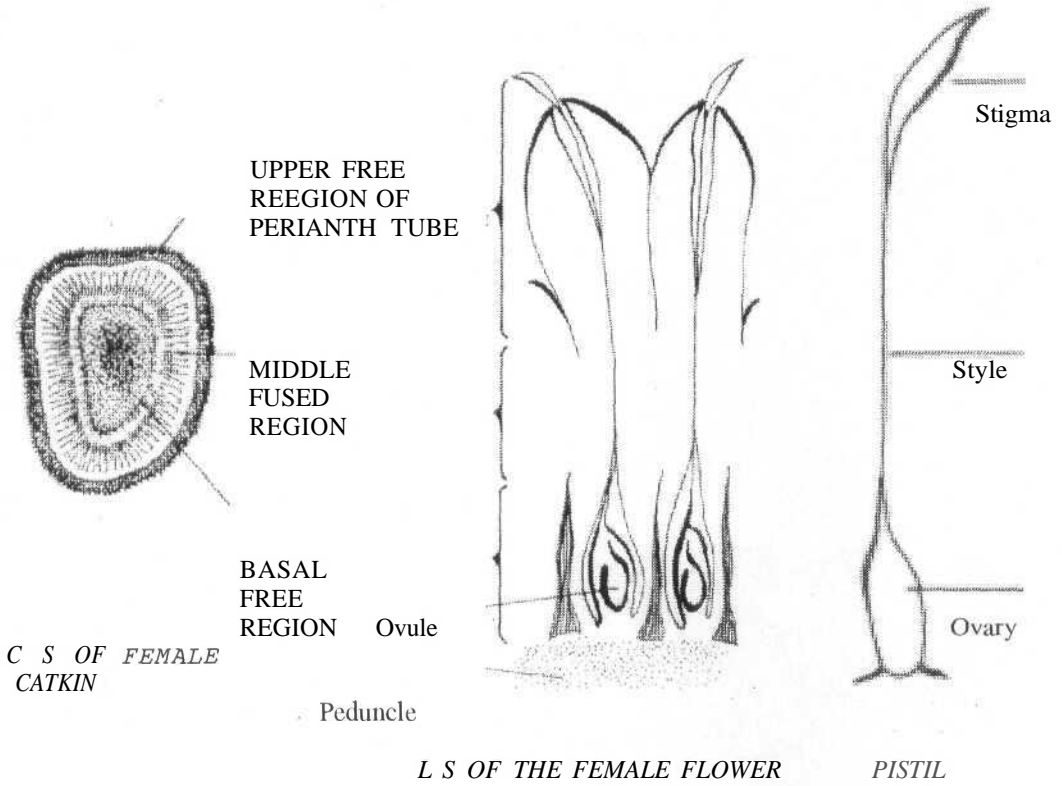


Fig 2 . Female flower structure of jack

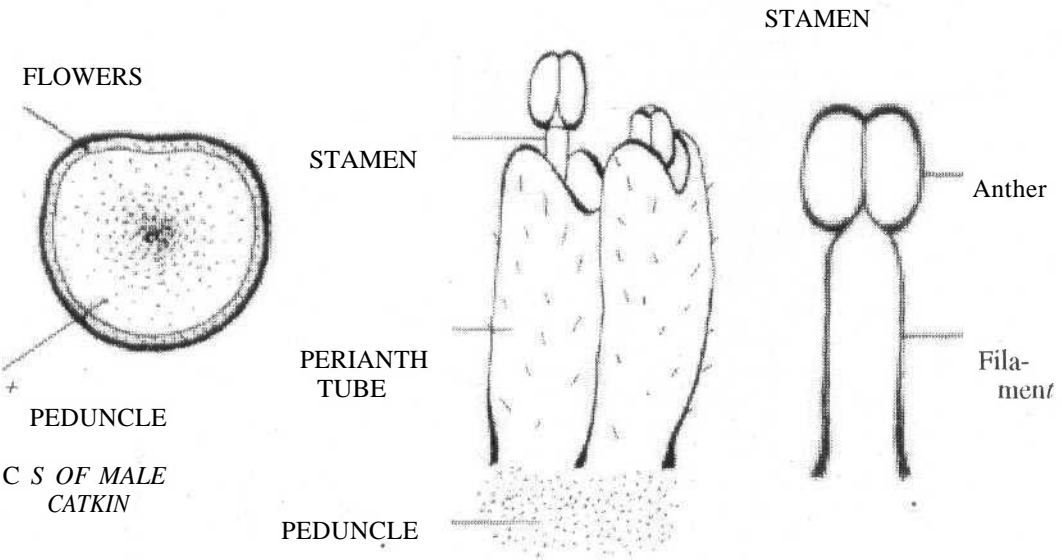


Fig 3. Male flower

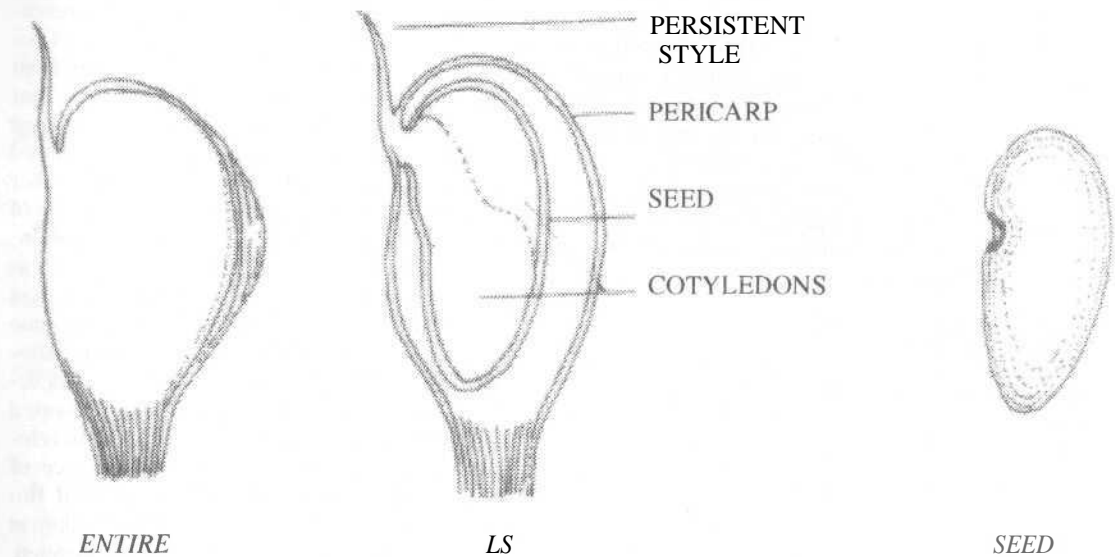


Fig 4. The true fruit in jack

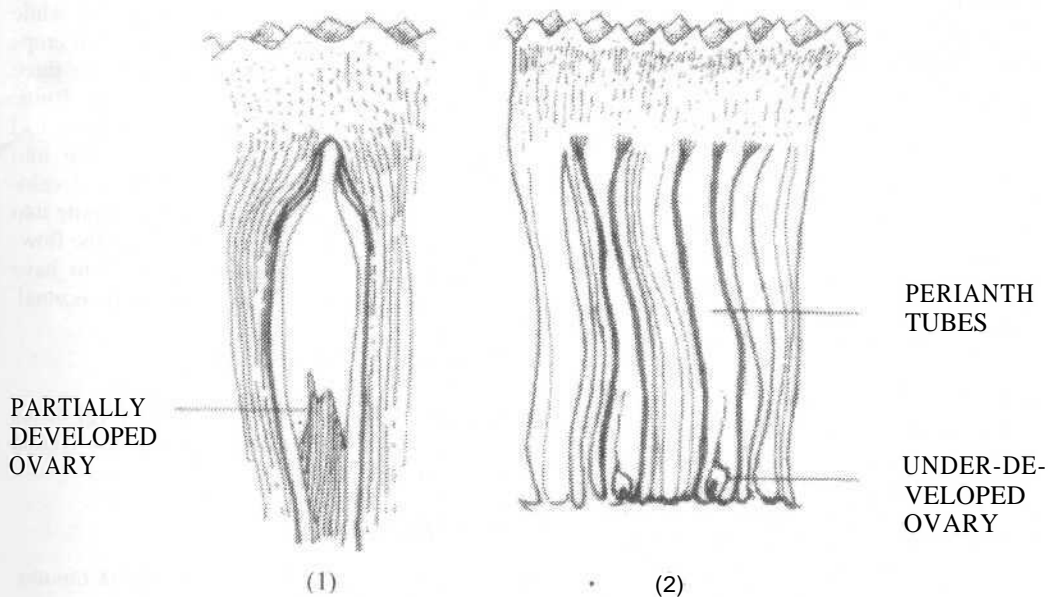


Fig 5. Aborted flowers in jack

3. *The 'true' fruit* : In a normally developed flower, the ovary which was enclosed in the basal free region of the perianth developed to form the 'true' fruit. The ovary wall developed into a thin membranous pericarp, which could not be distinguished into epicarp and mesocarp. The fruit resembled an achene. The pericarp was thick and fleshy during early stages but later thinned out and became membranous. The style was persistent laterally inserted to the pericarp.

Inside the pericarp the ovule developed into a single large seed (mean length 3.1 cm and girth 3.8 cm) which remained attached to the pericarp at the base of the style. The seed consisted of two integuments, the outer one was tree, white and scaly, while the inner layer was brown, thin and closely covering the two unequal cotyledons.

From the present studies on the morphology of the inflorescence and the developed fruit, it was evident that the composite fruit of jack is a 'false' fruit with the persistent perianth forming the bulk of the fruit and the 'true' fruit being insignificant. In this respect, jack closely resembles mulberry where the perianth becomes fleshy and edible (Bechtel, 1921) and pineapple, where bract and sepals enlarge considerably into fleshy fruit (Okimoto, 1948). The development of the perianth into the edible portion and rind has been reported by Corner (1939) and Sundararaj and Ramanujam (1953). Ochse (1931) wrongly called the fleshy perianth as the pericarp of the fruit. The achenal type of fruit observed in jack was also reported in other members of Moraceae like mulberry and ficus (Cronquist, 1961).

4. *Aborted flowers*: Apart from the flakes which represented the normal well developed fertilized flowers, numerous aborted flowers were also found in association with the flakes. These consisted of two types; those which were whitish strap-like and inedible with undeveloped ovary at the base of the perianth and those which showed partial development of the ovary and perianth, and hence edible. In the former, abortion might have taken place before fertilization and in the latter after fertilization.

The exact cause for the abortion of ovary and non-development of the flowers was not revealed from the present studies. The fruit set per 1000 spines in a fruit was found to range from 5 to 19, the mean being 11.57 (Table 2). That is, in a fruit the percentage of fully developed flakes was only 1.16, the rest were aborted flowers. This phenomenon is observed in other fruit crops like mango, where the number of flowers ultimately carried to harvest in an inflorescence is very low, just one per cent as pointed out by Mukherjee (1953). The rest got aborted and dropped off. In jack the same situation was met with, but as the whole inflorescence with the entire set of flowers developed into a composite fruit, the aborted flowers were retained in the catkin and developed along with the fruit. The occurrence of undeveloped ovary in strap-like aborted flowers would have been due to pistil abortion, at blooming or due to failure of fertilization. The occurrence of intermediate types showing partial development of the ovary might perhaps be as a result of arrest of the development of embryo some time after fertilization due to competition for nutrients. One of the reasons for failure of fertilisation might be inadequate pollination. Chandler (1925) while studying the fruit drop in deciduous fruit crops has given a similar explanation for the three waves of drop occurring in such fruits, Sambamurthy and Ramalingam (1954) had classified the flowers in a fresh spike into fertile and sterile one, the fertile ones developing into flakes and sterile one developing into strap-like structures. In this study, all the flowers at the time of anthesis seemed to have same morphology and appeared to be normal.

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