A Note on Debatable Taxonomic Identity of *Luffa tuberosa* Roxb. (Cucurbitaceae): A Potential Wild Edible Vegetable in India

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Luffa tuberosa Roxb. (Cucurbitaceae) is of great interest to taxonomists due to its debatable taxonomic status under the genus *Luffa* and *Momordica.* The systematic study was attempted to provide evidence supporting inclusion of *L. tuberosa* Roxb. under *Momordica* as *M. tuberosa* (Roxb.) Cogn. (syn *M. cymbalaria* Hk.f.). In the present investigation comparison was made among some neglected morphological characters using 16 accessions of *Luffa* and six of *Momordica.* These characters were fruit peduncle shape, nature of pericarp, ornamentation of fruit wall, seed structure and seed dispersal mechanism.

Key Words: India, *Luffa tuberosa,* Macro- and micro-morphological characters, *Momordica,* Neglected characters, Potential vegetable, Systematic study, Wild edible vegetable

Introduction

Luffa tuberosa Roxb. is a member of family Cucurbitaceae with chromosome number 2n= 22 (Ayyangar, 1976). This perennial vine occurs wild in Indian states of Andhra Pradesh, Karnataka, Madhya Pradesh, Maharashtra and Tamil Nadu and also in tropical Africa mostly in dry habitat condition. This wild vegetable species is commonly known by diverse names 'Athalakkai' (Tamil), 'Karchikai' (Kannada) and 'Kadavanchi', 'Kuduhunchi' (Marathi) in India. Unripe fruits from wild are harvested and sold in the local markets of areas of occurrence. Plant propagates naturally through perennial root tubers and seeds, though the former method is more common in nature. Root tubers can be collected in the months of December-January. Plant produces flowers and fruits during October-December and seeds can be gathered in the month of December onwards.

This species has long been known for medicinal use in Indian System of Medicine especially for anti-diabetic properties similar to that of the bitter gourd. Recently it has gained attention for its potential value as neutraceutical, myocardial and cardio protective drug (Raju *et al.*, 2008). The fruits are rich in calcium, potassium, sodium and vitamin C (a known antioxidant) as compared to that of the bitter gourd (Parvathi and Kumar, 2002) and high crude fibres (6.42 g/100g) content and maleic acid (Gopalan *et al.,* 1993).

Systematic study of the species under investigation was undertaken to address debatable taxonomic position under the genus *Luffa* and *Momordica*. Comparative study using species of *Luffa* and *Momordica* based on some neglected characters like fruit peduncle shape, nature of pericarp, ornamentation of fruit wall, seed structure and seed dispersal mechanism favoured inclusion of *L. tuberosa* Roxb. into the genus *Momordica* as *M. tuberosa* (Roxb.) Cogn. (syn *M. cymbalaria* Hk.f.).

Materials and Methods

The present study was undertaken as a part of research work under the institutional project on "Systematic Study of Indian Taxa" during 2011 and 2012. The tuberous roots of *L. tuberosa* were collected from fields of Virudhunagar district, Tamil Nadu, India in the month of January 2010 and raised in earthen pots maintained in polyhouse at the National Bureau of Plant Genetic Resources (NBPGR), New Delhi during monsoon (July 2011 and 2012). One-month-old seedlings were transplanted in the net house for detailed investigation. Accessions of taxa of *Luffa* (*L. aegyptiaca* - 6 accessions, *L. acutangula* - 3 accessions, *L. acutangula* var. *amara* - 2 accessions, *L. hermaphrodita* - 3 accessions, *L. echinata* - 1 accession, *L. tuberosa* - 1 accession) and *Momordica* (*M. charantia* var. *charantia* - 4 accessions, *M. charantia* var. *muricata* - 1 accession, *M. dioica* - 1 accession) were procured from different source localities and were simultaneously grown in the net house. Since the seeds of *M. charantia* var. *muricata* did not grow beyond seedling stage, the observations were recorded using material available in natural habitat (Sohna, Haryana) and also with herbarium specimen available in the National Herbarium of Cultivated Plants (NHCP), New Delhi. Comparison

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of characters of *L. tuberosa* was made with these taxa. Macro-morphological observations were recorded using hand lens (x10 magnification). Data on vegetative and reproductive parts were recorded from 10 plants each of the representative species. Quantitative data was recorded as an average value of each character. Measurement was done on detached plant parts. The voucher specimens and seed samples were deposited in National Herbarium of Cultivated Plants (NHCP), NBPGR, New Delhi (HS number 20630, 20631-20651).

Result and Discussion

Luffa tuberosa is of great interest to taxonomists due to its debatable taxonomic status under the genus *Luffa* and *Momordica* known with different synonyms *viz. Luffa tuberosa* Roxb., *Momordica cymbalaria* Fenzl and *M. tuberosa* (Roxb.) Cogn. On the basis of characters of endosperm haustorium and morphology of fruit that resembles *L. acutangula* (L.) Roxb. var. *amara* (Roxb.) C.B. Clarke, absence of cystoliths in leaf and absence of foliaceous bracts, it was placed under genus *Luffa* (Singh, 1964; Chakravarty, 1982). Evidences from seed coat anatomy (Singh and Dathan, 1990), seed fat characteristics (conjugated triene acid) (Azeemoddin and Rao, 1966), morpho-anatomy (Kumar *et al*., 2011), phytochemistry (Rao *et al*., 1999; 2001; Shantha *et al*., 2009) and ecogeography (Joseph, 2005) have supported its placement under the genus *Momordica*. Recent study using molecular phylogenetic data (nrDNA ITS sequences data analysis) has supported transfer of *Luffa tuberosa* to *M. tuberosa* (Roxb.) Cogn. under the genus *Momordica* (Ali *et al*., 2010).

Systematic study using morphological characters like number of tendrils, trichome structure, attachment of fruit stalk with fruit and anther lobes if free/coherent have been considered significant to delineate different taxa under Cucurbitaceae (Agdagwa and Nadukwa, 2004). Earlier investigations in support of taxonomic position of *L. tuberosa* based on evidences from morpho-anatomical characters such as cystolith in leaf, exocarp, dehiscence of fruit, seed structure and seed coat anatomy were dealt by various workers in part. While characters delineating this species on the basis of characters of peduncle, fruit wall colour at maturity, wall degeneration, nature of endocarp/aril, seed coat morphology and seed dispersal were neglected.

In the present investigation comparison was drawn among 16 accessions of *Luffa* and six of *Momordica*. Similarities in plant habit, species distribution pattern and gross morphological characters of leaf, flower, petiole and stem were noted across these two taxa. *Luffa* species are annuals with non-woody and non tuberous taproot system in comparison to that of *L. tuberosa* that is perennial, and has woody and tuberous roots similar to that of the *M. dioica* (Fig 1). All species under investigation were seed propagated unlike *L. tuberosa* and *M. charantia* var. *muricata* and *M. dioica* that were mainly propagated by tuberous roots. Tendril was trifid in *L. acutangula* and *L. aegyptiaca*, bifid *L. echinata* and tri-five fid (one developed more than rest) in *L. hermaphrodita.* Tendril was simple in *L. tuberosa* like *Momordica charantia* var. *charantia* and *M. charantia* var. *muricata*.

Fruit was green-pale green with prominent markings on pericarp of *L. aegyptiaca* and *L. hermaphrodita*, ribbed in *L. acutagula* and densely bristled in *L. echinata*. Fruit wall was dry, fibrous at maturity in all species of *Luffa*. In comparision to the above species fruit wall was ribbed-tubercled and fleshy in *M. charantia* var. *charantia*, *M. charantia* var. *muricata* and echinate in *M. dioica.*

Fig. 1 *Luffa tuberosa* **(left to right anti-clock wise): Plant growing in experimental plot; close up of male flower; branch with female flowers and tender fruits; and tuberous, woody underground root for propagation**

Fruit is a specific character in *Luffa* and in *L. tuberosa*, structure of fruit wall is neither muricate nor echinate but ribbed or angular comparable to that of *L. acutangula* var. *amara* (Chakravarty, 1882). On morphological investigation, the authors recorded pericarp of *L. tuberosa* that was similar in pattern to muricated wall of *M. charantia*. The ribs of the former species turned fibrous at maturity but in the latter species they remained soft even at maturity and degenerated on fruit dehiscence. Stopple (operculum) was present at the apical end of

fruit in all species of *Luffa* without exception but absent in all species in *Momordica*. In this respect *L. tuberosa* was morphological same as that of the *Momordica* without stopple.

Seeds were surrounded by dry papery membrane in *Luffa* but embedded in fleshy, coloured endocarp/aril in *Momordica*. The seed dispersal mechanism which is through the opening of the stopple in all species of *Luffa*. In *Momordica* degeneration of fruit wall and colour change from green to pale yellow was followed by bursting of the fruit wall. In the species under investigation the fruit wall on maturing got softened, turned yellowish-green and burst opened exposing the seeds. The fibrous nature of the mature pericarp was another important character that was exhibited by all species of *Luffa* but none of the species of *Momordica* at any stage of fruit development.

Comparison of characters in *L. tuberosa* with other taxa of *Luffa* and *Momordica* under investigation is briefed in table 1.

Conclusion

Based on comparative morphology of *Luffa tuberosa* with other taxa of *Luffa* and *Momordica* in the present investigation, the authors concluded that neglected characters such as tendril type (simple), shape of stalk at point of attachment, nature of fruit wall (non-fibrous, absence of stopple, wall degeneration at maturity), seed structure, fleshy endocarp/aril and seed dispersal mechanism were of more relevance in taxonomic study. Characters of trichome, tendril, shape of fruit stalk, fibrous/ non-fibrous nature of fruit wall at maturity and fruit wall degeneration were discussed for the first time in relevance to systematic study in this species. Thus the study supported transfer of *L. tuberosa* Roxb. into the genus *Momordica* as *M. tuberosa* (Roxb.) Cogn. (syn *M. cymbalaria* Hk. f). However, the bottleneck for detailed systematic study of this species is availability of diverse germplasm, restricted distribution, and knowledge on reproductive biology.

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Table 1. Comparison of characters of *L. tuberosa* with other species of *Luffa* and *Momordica*

Character	*L. tuberosa*	*Luffa* *	*Momordica***
Habit	Perennial; monoecious	Annual; monoecious/ dioecious	Annual, perennial; monoecious
Root	Tuberous, woody	Non-tuberous, non-woody	Tuberous, root stock, non-tuberous
Mode of propagation	Tuberous roots, seed	Root stock, seed	Tuberous roots, root stock, seed
Tendril	Simple	Two-five fid	Simple
Fruit stalk	Peduncle attenuate at apex and base	Peduncle angular to round, cuneate-obtuse	Peduncle attenuate-cuneate
Fruit characters	Dark green when young but pale yellow at maturity; prominently eight ridged	Green and pale green, wall smooth, eight ridged, echinate but never muricate	Green when young, yellow-orange, red at maturity, wall with spinose hairs, muricate but never ridged
Fruit at maturity	Fleshy, indehiscent, no stopple/ operculum, fruit bursts by wall degeneration; sponge not formed	Dry, endocarp (wall woody at maturity), fibrous, dehiscent usually by stopple; sponge formed	Wall not woody, indehiscent, endocarp not fibrous, fruit bursts by wall degeneration; sponge not formed
Seed	Few seeded; subglobose, rugose-appendaged at one end, testa without any sculpture; surrounded by fleshy endocarp	Many seeded; oblong, dry, compressed, sometimes marginate, testa smooth, endocarp not mucilaginous but membranous	Many to few seeded, smooth or corrugated/ sculpture, enclosed under the mucilaginous tissue; endocarp bright colour on maturity
Seed dispersal	Dispersal due to degeneration of fruit wall	Dispersal through stopple (operculum)	Dispersal due to degeneration of fruit wall

*Luffa** (*L. aegyptiaca*, *L. acutangula*, *L. acutangula* var. *amara*, *L. echinata*, *L. hermaphrodita*); and *Momordica*** (*M. charantia*, *M. charantia* var. *muricata*, *M. dioica*)

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