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Research Paper

Morphological characterization of *Lasia spinosa* (L.) Thw.: Screening of indigenous crop genetic resources for future food and nutritional security

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Abstract: *Lasia spinosa* (L.) Thw. is considered as a high potential indigenous vegetable in Sri Lanka due to its rich medicinal and nutritional properties though the crop has not gained wider consumer attraction. While it depicts a wide range of morphological variation, proper studies and documentations are not available. Therefore, this

study aimed at assessing the diversity of *L. spinosa* in 18 agro-ecological regions in Sri Lanka. A descriptor was developed and the morphological characters were observed, measured and documented in the field accordingly. Data were analyzed using hierarchical cluster analysis. Sixty-eight accessions collected were grouped into four main clusters mainly based on leaf characters (sagittate type, lamina-dissected type, mixed form and black *lasia*) and to several sub clusters. We were able to collect a spineless *L. spinosa* type, grouped under sagittate type, from Sri Lanka. The spineless type can be considered as superior germplasm, which could be a valuable resource in future breeding programs.

Keywords: Indigenous crop, germplasm, food security, *Lasia spinosa*

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Introduction

Indigenous crops play a vital role in food and nutritional security worldwide due to their rich nutritional and medicinal properties and their adaptability to wide range of environmental conditions (Weinberger and John 2004; Muthoni and Nyamongo, 2010; Kamga *et al.*, 2013; Adhikari *et al.*, 2017). The indigenous crops can be considered as low cost food resources and as a method of income generation for resource-limited communities in the developing world due to their

adaptability, nutritional importance and familiarity to the local community. These also play a vital role as a valuable plant genetic resource to be used in plant breeding and crop improvement programs (Chivenge *et al.*, 2015; Mehta *et al.*, 2009; Ranil *et al.*, 2016). The erosion of valuable plant genetic resources has occurred at a considerable rate and has further been accelerated by the introduction of high yielding hybrid varieties in the recent past. Apart from the

indigenous varieties, the improved selections that were grown by farmers in many countries have been replaced by the new hybrids. Unless actions are taken, the genetic base of vegetables would be further narrowed, leading to serious catastrophes in the future. Therefore, collection, evaluation, documentation and conservation of indigenous crop genetic resources are prime needs.

Lasia spinosa (L.) Thw. is an underutilized indigenous vegetable rich in nutritional and medicinal properties (Goshwami *et al.*, 2012a, 2012b, 2013a, and 2013b). It belongs to the family Araceae and native to tropical and sub-tropical Asia and New Guinea (Ara, 2001). It is commonly cultivated in South and South-East Asian countries including Sri Lanka (Sultana *et al.*, 2006). The tender leaves and rhizome of *L. spinosa* are commonly used to prepare curries and the peeled rhizomes are used for both cooking and preparing various food recipes. In addition to its food value, *L. spinosa* is playing an important role in indigenous medicine (Jayaweera, 1981; Goshwami *et al.*, 2013a; Rahmatullah *et al.*, 2010; Yusuf *et al.*, 2009; Goshwami *et al.*, 2013b; Kumar *et al.*, 2013; Yusuf *et al.*, 1994; Nguyen *et al.*, 2004). Its nutritional and chemical properties, including antioxidant capacity, antimicrobial properties and cytotoxic activities are well documented

Materials and Methods

Sample collection

Sampling of *Lasia spinosa* was done in 18 agro-ecological regions, which were selected based on information provided by farmers, agricultural officers and sellers, in the three climatic zones of Sri Lanka (Table 1). Samples were collected from selected localities in each agro-ecological region and the distance between two adjoining sampling sites was about 10 km. Samples were multiplied and planted at the germplasm unit established at the University Sub Campus at Mahailuppallama belonging to the Faculty of Agriculture, University of Peradeniya, Sri Lanka.

Morphological characterization

Morphological variation of *L. spinosa* was assessed at their sampling locations. Descriptors were developed based on the guidelines proposed by

(Goshwami *et al.*, 2012a, 2013a; Dubey *et al.*, 2014).

Lasia spinosa shows a wide range of morphological variations, both in natural habitats and commercial cultivations (Alam *et al.*, 2012; Ara, 2001; Hore and Tanti 2014; Hossain and Sharif, 1984; Nicolson, 1987; Sultana *et al.*, 2006). Though Sri Lankan *L. spinosa* population shows a high morphological diversity (Bauren, 1917; Ibrahim *et al.*, 1983; Trimen, 1900), it has not been properly studied and documented. Due to this high level of polymorphism in their natural habitats as well as in cultivated lands, taxonomic status of *L. spinosa* has become more complex. Hence, identification of variation of existing population of *L. spinosa* in Sri Lanka is fundamental to select superior germplasm for cultivation purposes, for future variety improvement and to develop cultivation guidelines. The morphological characterization can be considered as the essential first step in this exercise before conducting in-depth biochemical or molecular studies. Therefore, this study was executed with the objective of assessing the morphological diversity of *L. spinosa* in different agro-ecological regions covering major cultivation regions in Sri Lanka.

the International Board for Plant Genetic Resources (IPGR; <https://www.biodiversityinternational.org>). A total of 68 accessions were assessed.

Rhizome characters

Rhizome length, inter nodal length, number of internodes, colour, shape of the cross section, width or diameter, presence or absence of spines and their density per cm² area were assessed.

Leaf characters Leaf form, immature and mature leaf colour, length and width of leaf blade, number of lobes and leaves, shape of the leaf base and leaf apex, pattern of venation, petiole length, absence or presence of spines and hairs on leaf and petiole, number of spines on leaf, spine density of petiole, and spine colour and shape were the leaf characteristics measured.

Flower and fruit characters

Spathe colour, length and width, and fruit colour and length were measured.

Data analysis

Data were analyzed using Statistical Analysis System (SAS, version 9.1). Non-parametric data were analyzed using the cluster analysis.

Table 1. Sampling locations of three climatic zones of Sri Lanka

Climatic zone	Agro-ecological regions*	No. of samples
Wet zone	WM2b	05
	WM3b	02
	WL1a	04
	WL1b	05
	WL2a	06
	WL2b	04
	WL3	03
Intermediate zone	IU3c	03
	IU3a	03
	IM3a	03
	IL1a	03
	IL1b	03
	IL3	05
Dry zone	DL1b	04
	DL1c	04
	DL2a	03
	DL2b	04
	DL5	04

*based on Punyawardena (2007).

Results and Discussion

Based on the characters and parameters considered, the 68 accessions were grouped into four main clusters (Figure 1). The leaf characters significantly contributed to the clustering of collected accessions. Accordingly, the main clusters were (i) lamina-dissected type, (ii) sagittate type, (iii) mixed type and (iv) black *Lasia* (locally known as *Kalu-kohila* or *Rath-kohila*) (Figures 2 and 4). The first two types are relatively common in cultivation and the mixed form is relatively rare in Sri Lanka. The mixed form can be postulated as a hybrid between lamina-dissected type and sagittate type. Black *Lasia* (*Cyrtosperma johnstonii* N.E.Br.) is an introduced species to Sri Lanka but originated in Solomon Islands. This species is mostly misidentified as a local *Lasia* variety by the indigenous community. Historical records revealed that it has been used in the indigenous

medicine system over a long period. Moreover, the black *Lasia* has dark green coloured mature leaves with pink-coloured immature leaves. Furthermore, pink coloured prominent veins were observed in black *Lasia*. Usually *L. spinosa* is characterized by its numerous and pointed spines in its rhizome and other vegetative parts. Interestingly, this study was able to identify two populations of spineless type of *L. spinosa* from two homegardens in the western and southern provinces of Sri Lanka. In the cluster analysis, spineless type was grouped under sagittate type. Even though spines were absent on its rhizome, they were marginally present on the leaf petiole and lower surface of leaves. Furthermore, there were three types when the presence or absence of spines on rhizome is considered namely, rhizome with highly-densed spines, rhizome with moderately-densed spines and rhizome without

spines (Figure 3). Though people were well aware of its nutritional benefits, the presence of spines is a major barrier in popularizing *L. spinosa* among consumers as well as farmers. Therefore, the spineless type described in this study can be

considered as superior genetic material for cultivation purposes and future varietal development programs.

Maximum distance

Figure 1. Dendrogram resulted in from the analysis of 68 accessions collected from 18 agro-ecological regions of Sri Lanka.

Morphological polymorphism of *L. spinosa* in Sri Lanka has been reported in previous studies. Trimen (1900) has reported variable leaf forms however, has not clearly explained the characteristics of each form. Bauren (1917) has found two distinct varieties of *L. spinosa* in Sri Lanka based on the leaf form namely, sagittate leaves and dissected lamina. Ibrahim *et al.* (1983) also noted two *Lasia* varieties in Sri Lanka based on leaf form, where one had only hastate leaves and the other with heterophyllus leaves (hastate and dissected leaves) arising from the same rhizome. However, the present study provides strong evidence for occurrence of five variable forms of *L. spinosa* in Sri Lanka.

The results further revealed that the lamina-dissected type, sagittate type and mixed type are co-occurring. Further studies are needed to confirm such variable forms using phytochemical and molecular fingerprinting techniques. Understanding the significance of different forms

with respect to nutritional and pharmaceutical properties will also be useful.

Apart from Sri Lanka, a wide range of genetic and morphological variations of *L. spinosa* are reported in other Asian countries (Alam *et al.*, 2012; Ara 2001; Hore and Tanti 2014; Hossain and Sharif 1984; Nicolson 1987; Sultana *et al.*, 2006). Hossain and Sharif (1984) have distinguished the different form of *L. spinosa* in Bangladesh. Later, four different morphological forms were reported by Ara (2001) from Bangladesh based on leaf morphology, namely, sagittate form, lamina-dissected form, entire lamina margin form and a mixed form of sagittate and lamina dissected. Furthermore, the mixed form may be a natural hybrid between the sagittate and the lamina-dissected form (Sultana *et al.*, 2006). Recently, two leaf morphological forms, *i.e.* lamina-dissected and a mixed form of both sagittate and lamina-dissected were reported from Assam in India (Hore and Tanti, 2014).

Figure 2. Three morphological forms of *Lasia spinosa* reported in Sri Lanka. A: Sagittate form. B: Lamina-dissected form. C: Mixed form

Figure 3. Different morphological types of *L. spinosa* based on rhizome spines. A: Rhizome with highly dense spines. B: Rhizome with moderately dense spines. C: Rhizome without spines

Apart from the forms based on leaf morphology, two forms have been reported by Alam *et al.* (2012) based on the spathe colour as common red flower form and rare green colour form. The limited taxonomic work carried out in the past depicts that a substantial level of morphological and genetic variability exist in the Asian population of *L. spinosa* and the paramount

importance of using them for development of new cultivars and cultivation packages. A comprehensive taxonomic study with morphological, cytological, phytochemical and molecular evidence will resolve taxonomic complications, before embarking on developing new cultivars for farmers.

Figure 4. Different morphological types of *L. spinosa*. A: Lamina-dissected type population. B: Sagittate type population. C: Mixed form. D: Black *Lasia* (*Cyrtosperma johnstonii*). E: Population of spineless type. F: Rhizome of spineless type.

Conclusion

The study was able to identify four different forms of *L. spinosa* and a closely related species with similar characteristics. The spineless type has a potent value of genetic constitution, which can be utilized to develop new cultivars. Furthermore, such superior germplasm need to be conserved in both *ex-situ* and *in-situ* conditions while focusing on further studies on their nutritional and pharmacological properties. It is known that both anthropogenic and natural factors would largely contribute to the erosion of plant genetic resources from both farmlands and natural

habitats. Therefore, collection, evaluation, conservation and utilization of indigenous crop genetic resources are important, because they play a vital role in future food and nutritional security, especially in the context of the developing world. Moreover, further studies would lead to identification of specific bioactive compounds and their therapeutic values. A continuous dialog among researches, industry and consumers aiming to popularize such high potential indigenous crops among farmers and consumers is of national and global significance.

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