Medicinal & Aromatic Plants
ISSN: 2167-0412

Nandini et al., Med Aromat Plants 2015, 4:4
DOI: 10.4172/2167-0412.1000209

Research Article Open Access

Morphometric Analysis of Datura Plant to Understand Variation and Similarities among Four Major Species

Nandini D[1]*, Ravikumar BS[2] and Prasanna Rashmi KK[3]

[1]Research and Develeopment Centre, Bharatiar University, Coimbatore-641 046, India
[2]AVK College for Women, Hassan-573 201, India
[3]TDU, Jaraka Bande Kaval, Yelahanka, Bengaluru-560 064, India

Abstract

Datura, well known for its poisonous and hallucinogenic properties has great importance in pharmaceuticals. Seeds and leaves are used for treating various ailments. Four commonly occurring Datura species were considered for morphometric analyis to supplement precise variability in statistical terms to taxonomy. For each quantitatiave trait an analysis of variance (ANOVA) test is conducted to test whether the means of three or more groups are the same. Turkey-Kramer test of individual charecteristics provided support to species wise grouping that indicate significant differncences among populations. Among fifteen traits measured, at least 13 traits vary between any two species. Cluster analysis reveals that *D. metel* and *D. innoxia* has related origin, *D. stramonium* and *D. ferox* forms separate group.

Keywords: Datura; Morphometric analysis; ANOVA; Cluster analysis

Introduction

Datura, has been used as a narcotic, since time immemorial. Indians have long been familiar with intoxicating properties of this plant. Its use in Ayurveda has been described by the father of Indian medicine-Shusrutha. The plant termed as *'Shiva Priya'*, *'Maatula'* in Sanskrit has been reportedly used in folk remedies [1-3]. Seeds and leaves of Datura are used for treating various ailments like asthma, rabies, insanity, Parkinsons, leprosy, boils and many other skin related problems. The plant contains hyoscyamine, atropine and northyoscyamine; its leaves also contains vitamin 'C', while seeds contain a fixed oil with a disagreeable odor and taste [4]. Certain varieties are also commercially cultivated for aesthetic and pharmaceutical purposes in South and North American countries [5].

Around 12 to 13 species of Datura are identified across the world, *viz*., *D.ceratocaula, D.candida, D.discolor, D.dolichocarpa, D.kymatocarpa, D.leichhardtii, D.metel, D.ruburra, D.wrightii, D.innoxia, D.stramonium* and *D.ferox*. Regarding nomenclature, there are more than one synonymous for single species and certain names are unresolved (The plant list) [6]. Species of Datura occurs in almost all parts of the world except in extreme cold regions [7], and so far, no studies have been undertaken to comprehend species-wise population distribution.

The word 'Datura' generally refers to *Datura metel* [1] any species belonging to the entire genus is referred to as Datura, since the word 'Datur' is derived from the Indian word for the seed capsule, 'Dhatura' [8]. Through review of literature available over the years [1,3,9-11] and their extensive field experience, the authors conclude that generally four species of Datura can be identified in India. While, *D. metel* is considered as native to India, the rest were introduced and naturalized [7]. Other species like *D. stramonium*, *D. innoxia* and *D. ferox* also go by the name of 'dathura', and are collected for medicinal purposes.

In India, this plant, which is used for medicinal purposes, are collected from road sides or open dumping yards [12]. It's seeds are commonly used as raw material in pharmaceutical industry. Different species of Datura have different types of seeds; while *D. metel* and *D. innoxia* have brown auricular seeds, *D. stromanium*, and *D. ferox* have small black seeds. However, due to similarity in appearance of plants, seeds of all species generally get mixed up, when collecting from the wild. In some cases, seeds of another plant known as *Argemone mexicana,* which also goes by a similar common name 'datturi', and having similar seed characteristics, is also sold as 'Datura' [13]. In addition, higher concentration of heavy metals were observed in the plant samples collected from roadsides in urban areas, which is not desirable for drug preparation [14]. In order to ensure suitable raw material for the chemical and pharmaceutical industries, cultivation of appropriate species on farm lands, is essential. As a first step, through morphometric analysis, this study attempts to identify the distingushing characteristics of the four major species of Datura. The results of which could further be used to identify the appropriate species for utilisation in the drug industry through further phytochemical tests.

Datura is a genus in the family Solanaceae. Shrubs or annual or perennial herbs; stem pubescent or course. Large leaves, entire or deeply toothed. Calyx long tubular, persistant. Large bugle shaped floweres, white, cream or purple, solitory and errect with 5 to 10 lobes. Stamens 5 attached near base, filaments filiform; anthers linear longitudinally dehising. Fruit ellipsoid spinescent 4 celled capsule, dehiscing regularly (*D. Stramonium* and *D. ferox*) dehising irregularly (*D.metel* and *D. innoxia*). Seeds many; compressed black or brown [9,10] Variations within *D. metel*, like flower colour and multiple whorls, were not treated separately for this study.

Materials and Methods

Natural populations of *D.metel, D.innoxia* and *D. ferox* from in and

***Corresponding author:** Nandini D, Research and Develeopment Centre, Bharatiar University, Coimbatore-641 046, India, Tel: +919739067051; E-mail: nandinidholepat@gmail.com

Received August 18, 2015; **Accepted** September 09, 2015; **Published** September 14, 2015

Citation: Nandini D, Ravikumar BS, Prasanna Rashmi KK (2015) Morphometric Analysis of Datura Plant to Understand Variation and Similarities among Four Major Species. Med Aromat Plants 4: 209. doi:10.4172/2167-0412.1000209

around Bengaluru (12°.98' N 77°. 58'E) were considered to measure morphological characters. Only *D. stramonium* was collected from Male Mahadeshwara hills (12°1N 77°35'E), Chamarajnagar district, south of Bengaluru, as *stramonium* is found only on these hills. Since plants were available only in the wild and were not cultivated, places across the locations where they were found in the wild were identified. Random sampling method was used to collect the plants for observations. A total of one hundred well-grown and healthy plants for each of the species were collected. Fifteen morphological characterisics were measured. Longest stems of the plants were considered to measure its height. Leaves from these stems were selected for measuring length and breadth. Leaf length was measured considering the lowest base of the leaf to the tip, and breadth was measured at the widest portion of the leaf. The same leaf was considered for measuring the petiole length which was measured as the length from branch to the lowest base of the leaf. Fully bloomed flowers were selected for measuring the floral charecteristics. The pedicel length was measured from branch to the base of the flower; length of the flower is from base of the flower to the tip of the corolla; corolla margin was measured using a string due to its sinuate feature. Length of the stamen was measured from the base to the anther and gynecium from the base of the ovary to stigma. Matured fruits were considered for meauring fruit length, breadth, spine length and weight. The number of spines were counted through visual observation. The seeds were separated from fruits and weighed [15]. The units of measuremens are given in Table 1.

Statistical analyses was done using MS Excel. Descriptive statistics were generated, listing the mean and standard deviation for each characteristic. For each quantitative characteristic, the analysis of variance (ANOVA) test was conducted to test the equality of means, followed by post-hoc analysis to identify the characterisitics that were different or similar among the species. Further, to identify which species were more similar to the others, a dendrogram was created using the means of the characteristics, using an online software [16]. Dendrograms help in grouping/identification of "clusters" of objects that are similar to each other. It provides a visual representation of the overall strength of a classification as well as the compactness and isolation of individual classes. A similarity matrix is also provided from the analysis. A similarity matrix is constructed based on the ratio of the number of attributes two objects share in common compared to the total list of attributes between them. Objects which have everything in common are identical, and have a similarity of 1.0. Objects which have nothing in common have a similarity value of 0.0 [17].

Results and Discussion

Table 1 provides the characteristics of fifteen morphological traits of the four major species of Datura that have been considered for the present study. The results of the test of differences in means using ANOVA tests indicates that the species differ significantly with respect to most morphological characteristics, except for a few such as leaf length, petiole length and seed weight.

Table 2 which provides the similarity matrix of the species, indicates that *D. metel* and *D. innoxia* are more similar to each other, while *D. ferox* was different from all the other species. This is also confirmed by the dendrogram produced in Figure 1. This is in confirmation with the identification of different forms of Datura as species. Further studies can be taken up to identify similarities and differences through chemical and genetic analysis [18].

Conclusion

The morphometric approach undertaken ascertains the differences in the morphological characteristics among the four species of Datura. This study assessed the morphological variation among commonly occurring. Datura plants to identify patterns of variation at the species levels. Unique phonetypes were observed, with differences in most

Morphological characteristics	*D. metel*	*D. ferox*	*D. stramonium*	*D. innoxa*	F Value	CD
1. Height (cm)	81.31 ± 18.51	32.20 ± 8.27	58.63 ± 9.48	69.35 ± 10.18	290.03	3.41
2. Petiole length (cm)	2.92 ± 1.03^{A}	2.44 ± 0.25	7.15 ± 1.80^{A}	2.43 ± 0.17	477.95	0.29
3. Leaf length (cm)	10.39 ± 1.27	9.36 ± 1.40^{A}	16.16 ± 3.82	9.26 ± 1.41^{A}	213.95	0.62
4. Leaf width (cm)	6.13 ± 0.85	7.61 ± 0.32^{A}	11.07 ± 3.05	7.61 ± 0.23^{A}	172.79	0.44
5. Pedicel length (cm)	0.72 ± 0.21	0.33 ± 0.09	0.87 ± 0.27	0.51 ± 0.11	165.94	0.05
6. Flower length (cm)	15.48 ± 1.06	6.98 ± 0.74	5.16 ± 0.22	14.87 ± 1.25	3460.55	0.25
7. Corolla margin (cm)	24.76 ± 1.63	11.72 ± 1.52	22.09 ± 2.96	35.23 ± 2.51	1863.22	0.62
8. Stamen length (cm)	7.00 ± 0.25	4.19 ± 0.60	2.99 ± 0.14	7.26 ± 0.38	3017.11	0.11
9. Pistil length(cm)	14.29 ± 1.16	6.09 ± 0.59	2.98 ± 0.13	14.64 ± 1.04	4902.89	0.23
10. Fruit length (cm)	11.36 ± 1.86	5.49 ± 0.52	2.82 ± 0.40	14.20 ± 1.58	1711.50	0.35
11. Fruit breadth (cm)	4.26 ± 0.75^{AB}	4.10 ± 0.74^{AC}	8.77 ± 4.30	4.28 ± 0.36^{BC}	105.13	0.62
12. Spine length(cm)	0.47 ± 0.17^{AB}	0.46 ± 0.10^{AC}	0.45 ± 0.14^{BC}	0.66 ± 0.28	28.71	0.05
13. No.of spines	242.93 ± 26.44	22.70 ± 3.11	134.36 ± 11.93	192.48 ± 18.03	3047.21	4.75
14. Fruit weight (gm)	26.05 ± 3.66	20.03 ± 2.66	59.62 ± 8.67	30.75 ± 4.73	1025.02	1.52
15. Seed weight (gm)	0.04 ± 0.01^{A}	0.02 ± 0.00^{B}	0.02 ± 0.02^{B}	0.05 ± 0.05^{A}	27.09	0.01

CD=Critical difference for post hoc ANOVA test.
Values with similar letter superscripts indicates that there is no significant differences in the characteristics for those species.

Table 1: Average values of morphological characteristics and results of ANOVA test for four selected species of *Datura*.

D. metel	*D. metel*	D. ferox	*D. stramonium*	*D. innoxa*
	1	0.669	0.942	0.996
D. ferox		1	0.8	0.704
D. stramonium			1	0.953
D. innoxa				1

Table 2: Similarity matrix for the four species of *Datura*.

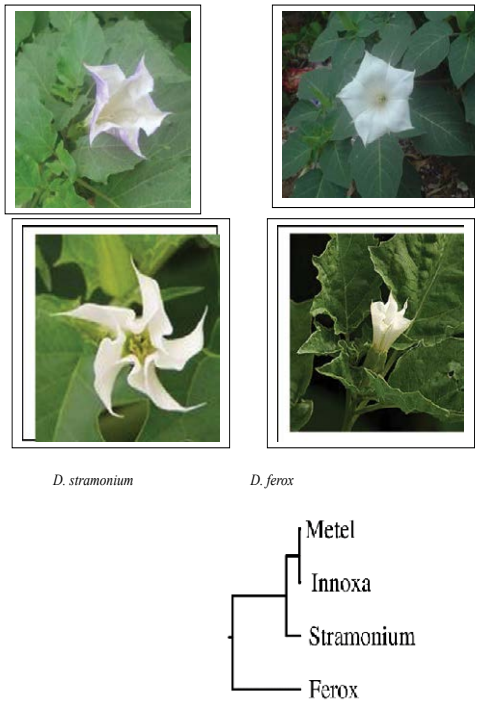

Figure 1: Dendrogram of similarity between four species of Datura.

charecteristics such as plant height, flower size and spines on fruits, suggesting a distinct morphological identities. The morphological characteristics became significantly different between any of the two species. The cluster tree generated gives a clear picture of the relationship among the four species. It may be concluded that the species have emerged from a common ancestor. Among the four species, morphologically, *D. metel* and *D. innoxa* were more similar and formed a cluster, while, and *D. stramonium* was different from this cluster, and *D. ferox* was distinct from the other three species. The results of this study provides sufficient evidence regarding the distinct morphological characterises of the species, which could be used in providing information to the collectors to identify authentic species for commercial purposes.

Acknowledgement

Our gratitude to Dr. Geeta R, Prof. Department of Botany, University of Delhi, who guided us to research on plant distribution and evolutionary biology.

References

1. Bapalal GV (2009) Nighantu Aadarsh. Chankhamba Bharati Academy 1st edn 1: 914.
2. Muddebihala C R (1999) Dravya guna vijnana 1: 274-284.
3. Rajbhandari RK (2001) Ethnobotany of Nepal. Ethnobotanical Society of Nepal pp. 142.
4. The Wealth of India (1976) A Dictionary of Indian Raw Materials & Industrial Products; Raw Materials, Publication and Information Directorate, CSIR: New Delhi, India, 3: 14.
5. International Brugmansia and Datura Society (2014) Datura.
6. The Plant List (2013) Version 1.1 Published on the Internet
7. Geeta R, Waleed G (2007) Historical evidence for a pre-Columbian presence of Datura in the Old World and implications for a first millennium transfer from the New World. Biosci. 32: 1227–1244.
8. Safford WE (1920) Daturas of the old world and new. Smithsonian Publ. 2644:537-567 .
9. Gamble JS (1921)(rep. edi. 1986) Flora of the Presidency of Madras 2: 940-941.
10. Rao RR and Razi B A (1981) A synoptic Flora of Mysore District. International Bioscience Series-7. TTNP, New Delhi.
11. Warrier PK (1994) Indian Medicinal Plants, Orient Longman.
12. Ved DK, Goraya GS (2008) Demand and supply of medicinal plants in India. Foundation for Revitalisation of Local Health Traditions, Bangalore. pp 136
13. Nandini D and Girija BV (2008) Studies on evolution, distribution and uses of Datura plant. Proceedings of 4th Kannada Science Congress.
14. Nandini , Amaraneni SR (2014) Estimation of mineral nutrient concentration among Datura innoxia and Datura metel. Antharmuka. 1: 20-23.
15. Kaplani, Karol M (2012) Multivariate morphometric analysis of the Potamogeton, compressus group (Potamogetonaceae). Botanical Journal of the Linnean Society, 170: 112–130.
16. DendroUPGMA (2002) A dendrogram construction utility. Universitat Rovira i Virgili (URV). Tarragona. Spain.
17. Cluster analysis (2013) Hal`s agglomerative clustering presentation.
18. Gardner, Zoe E, Lueck L, Erhardt EB, Lyle EC (2012) A morphometric analysis of Actaea racemosa L. (Ranunculaceae). Journal of Medicinally Active Plants 1: 47-59.