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RESEARCH ARTICLE

TAXONOMICAL ASPECT OF CORIANDER (*Coriandrum sativum* L.)

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ABSTRACT

It is believed that coriander originated from around the Mediterranean. Coriander (*Coriandrum sativum* L.) is an annual herb and, according to the climatic conditions, is cultivated as a summer or winter annual crop. At flowering, the glabrous plant can reach heights between 0.20 and 1.40 m. India has the prime position in the cultivation and production of coriander: The main coriander growing states in India are Andhra Pradesh, Rajasthan, Madhya Pradesh, Karnataka, Tamil Nadu and Uttar Pradesh. Rajasthan ranks first in coriander production which is mainly concentrated in Kota division. In addition to India, coriander is also cultivated in Morocco, Rumania, France, Spain, Italy, the Netherlands, Myanmar, Pakistan, Turkey, Mexico, Argentina and, to some extent, in the UK and the USA.

INTRODUCTION

1.1. Brief History of Plant Taxonomy

The history of plant classification is an interesting subject. We can learn how the different systems have evolved during the various stages of development, and also about people responsible for them. AP de Candole (1778-1841) coined the term 'taxonomy' for the first time. According to him, anatomy should have been on the basis of taxonomic classification rather than physiology. Plant taxonomy has a long history as it plays its central role in biology and human affairs. The first recorded document in the western world on plants and their relationships come from the Ancient Greeks. Theophrastus (c. 300 BC) wrote several manuscripts which have been published later as books dealing with plants. His most remarkable work, *Enquiry into Plants*, sets down many morphological aspects, including their growth and reproduction system. But it could not give a clear understanding of plant sexuality. Taxonomists like Andreas Caesalpino from Italy, Gaspar Bauhin from Switzerland, John Ray from England and Josef Pitton de Tournefort from France led to the positive developments for classification of medicinal plants. Their objective was to reveal classification system of god, used at the time of creation. Carl Linnaeus (1707-1778), the great Swedish botanist and 'father of plant taxonomy', extended this perspective and believed that the number of sexual structures in a plant – the stamens and carpels was the signature that God had for their proper classification. The first half of the 19th century was important in the history of taxonomy, as a number of systems of classification were put forward during this time (Leadlay and Jury, 2006).

1.2. Principles of Plant Taxonomy

Humans need hierarchical systems of information storage and retrieval to live and survive, including dealing with the living world. Due to evolutionary processes life forms show natural patterns of relationship to one another. Using selected features of plants such as, characters and states, patterns of relationship are determined that are assumed to reflect the evolutionary processes. Names are assigned to the classified groups to facilitate communication about them. All kinds of comparative data are used to assess relationships among plants for purposes of classification. Classification is the grouping and ranking of organisms based on similarities and/or differences. Therefore, taxonomy is concerned with classification, its concepts and its practical execution.

Taxonomy stands ever ready to help by providing a framework into which we can organize information. The taxonomic structure absorbs new data and adjust accordingly as the inventions go on, providing new and more robust predictions about the living world.

1.3. The importance of plant taxonomy in human affairs

For whatever fundamental reasons, biological classifications provide many positive benefits for humans in our dealing with the living world.

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- The first benefit of classification is storage and retrieval of information.
- The second benefit of a classification is that it allows us to predict attributes of organisms not yet observed or measured. If we find, for example, a secondary plant product from some plant species that shows activity in inhibiting growth of cancerous cells, we would wish to investigate related species (or genera) to discover similar compounds with perhaps even greater potency.
- The third benefit accruing from classifications is that they stimulate investigations on evolutionary and biogeographic patterns and processes. The structure of relationships within hierarchical classification reveals close relatives that have developed through time by evolutionary processes (Subrahmanyam, 1995).

Taxonomy of Coriander

2.1. Origin and distribution

It is believed that coriander originated from around the Mediterranean. Two species are found: only *Coriandrum sativum* L. is cultivated widely, mainly in the tropics. India has the prime position in the cultivation and production of coriander: it is cultivated over an approximate area of 5.25 × 105 hectares with an annual production of 3.10 × 105 tonnes. The main coriander growing states in India are Andhra Pradesh, Rajasthan, Madhya Pradesh, Karnataka, Tamil Nadu and Uttar Pradesh. In addition to India, coriander is also cultivated in Morocco, Rumania, France, Spain, Italy, the Netherlands, Myanmar, Pakistan, Turkey, Mexico, Argentina and, to some extent, in the UK and the USA.

There are two distinct morphological types: one erect and tall with a comparatively stronger main shoot and shorter branches, the other bushy with a relatively weaker main shoot and longer, spreading branches. The plants attain heights from 30 to 100 cm, depending upon the variety. The crop comes to bloom in 45–60 days after sowing and matures in 65–120 days, depending upon the variety and cropping situation. Each branch as well as the main shoot terminates in a compound umbel (determinate growth) bearing 3–10 umbels, each umbel containing 10–50 pentamerous flowers. The flowers are small, protoandrous and difficult to manipulate for controlled pollination. Like other umbelliferous plants, coriander is also a cross-pollinated crop (Purseglove *et al.,* 1981).

2.2. Botanical Description

Coriander (*Coriandrum sativum* L.) is an annual herb and, according to the climatic conditions, is cultivated as a summer or winter annual crop. At flowering, the glabrous plant can reach heights between 0.20 and 1.40 m. The germination is epigaeal and the plant has a tap root. The stem is more or less erect and sympodial, monochasial-branched, sometimes with several side branches at the basal node. Each branch finishes with an inflorescence. The colour of the more or less ribbed stem is green and sometimes turns to red or violet during the flowering period. The stem of the adult plant is hollow, and its basal parts can reach a diameter of up to 2 cm. The leaves alternate, and the first ones are often gathered in a rosette. The plant is diversifolious (Fig. 2.1). The blade shape of the basal leaves is usually either undivided with three lobes, or tripinnatifid, while the leaves of the nodes following are to a higher degree pinnatifid. The higher the leaves are inserted, the more pinnate they are. Thus, the upper leaves are deeply incised with narrow lanceolate or even filiform-shaped blades. The lower leaves are stalked, while the petiole of the upper leaves is reduced to a small, nearly amplexicaul leaf sheath. The leaves are green or light green and their underside often shiny waxy. During the flowering period the leaves sometimes turn red or violet.

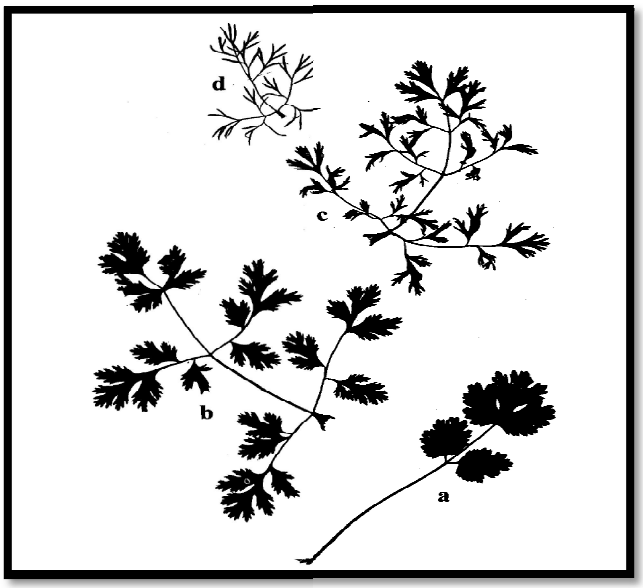

Fig. 2.1. Heterophylly of coriander (a) longest basal leaf leaves, (b,c) leaves of the middle of the stem. (d) upper leaf

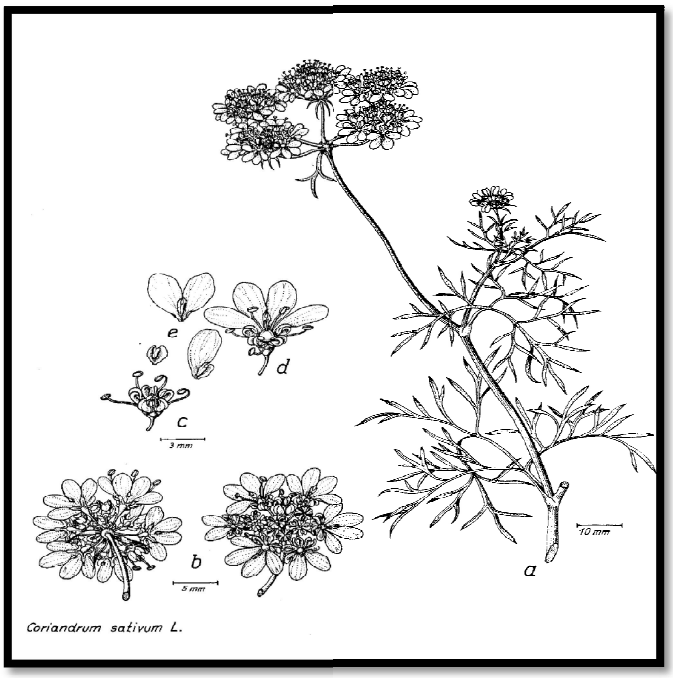

Fig. 2.2. (a) flowering branch of coriander, (b) umbellet from top and bottom, (c) central flower of an umbellet, (d) marginal flower of an umbellet with lengthened petals at the outside, (e) different shapes of petals

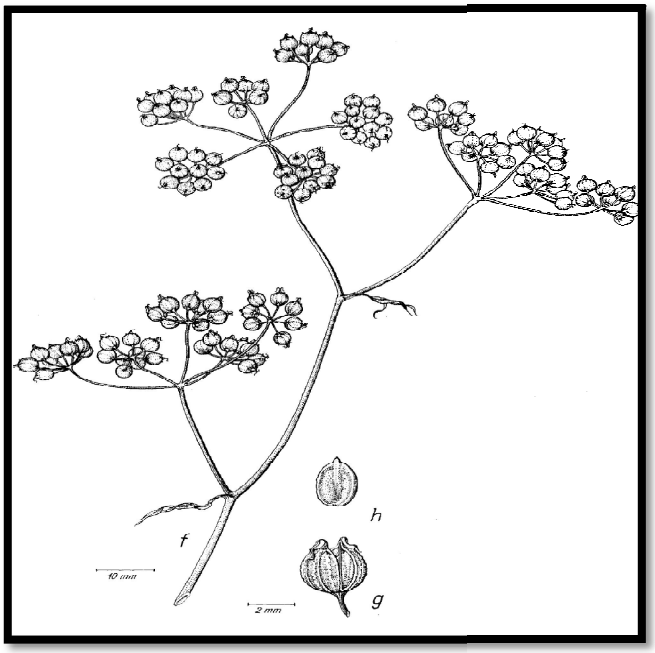

Fig. 2.3. (f) Branch of ripe coriander fruit, (g) ripe fruit, split, (h) seed after removal of the pericarp

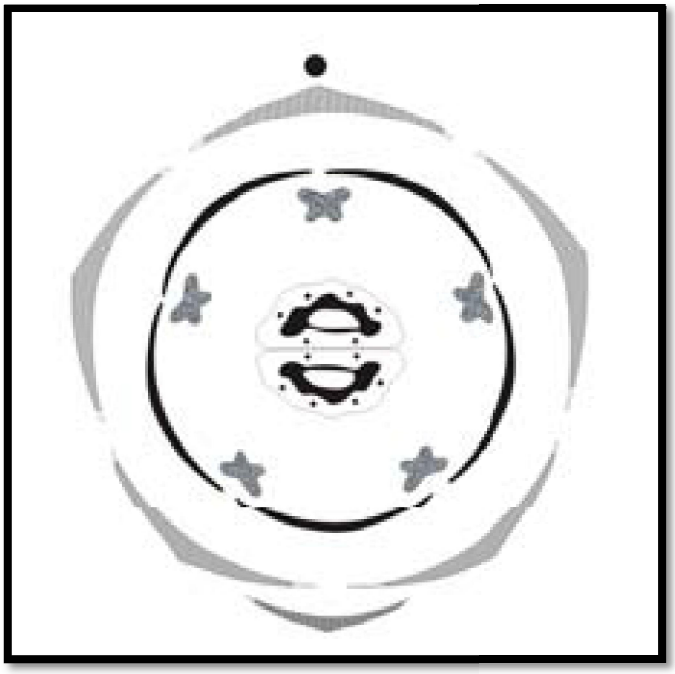

Fig. 2.4. Floral diagram of Coriander

They wither before the first fruits are ripe starting from the basal leaves. The inflorescence is a compound umbel (Fig. 2.2). Sometimes there are one or two linear bracts. The umbel has two to eight primary rays, which are of different length, in such a way that the umbellets are located at the same level. Two, three or more bracteols carry the umbellets with five to twenty secondary rays. Flowering starts with the primary umbel. In every umbel the peripheral umbellets, and in every umbellet the peripheral flowers are the first ones to flower. These flowers are protandrous. The central flowers of the umbellets are staminiferous or sometimes sterile. Coriander has an inferior ovary and the five calyx teeth surrounding the stylopodium are still visible in the ripe fruit (Fig. 2.3). The five calyx teeth are of different length, as are the petals in peripherally situated flowers. The flowers have five petals. The peripheral flowers of every umbellet are asymmetric, as the petals toward the outside of the umbellets are lengthened. The central flowers are circular, with small inflexed petals (Fig. 2.2). The colour of the petals is pale pink or sometimes white.

In general the flowering and pollination biology of coriander is typical of that for umbelliferous plants. The inner flowers of the umbellets are staminate. The umbels of higher order usually contain more staminate flowers than the first ones, and their flowering period is shorter. In a single flower, the five filaments of the staminas are located between the five petals. After the flower opens, the white filaments are visible between the petals, because they are bent and the pollen sacs at their top are hidden in the centre of the flower. This stage is the best for artificial emasculation of the flowers, because the filaments are easy to distinguish, and they have not yet spread any pollen grains. Since the peripheral flowers of every umbellet reach this stage earlier than the central flowers, the latter should be removed so that their pollen will not lead to fertilization. Depending on the weather conditions, 2-3 days after opening of the first flowers, the pollen sacs change their colour and become pink or violet, then the filaments stretch and the pollen sacs open and spread the pollen. The empty pollen sacs fall off and the filaments are left. When this process has finished, the two pistils become longer and separate from each other at the top. The former green colour sometimes changes to pink or violet too. This is the right moment for successful pollination. The stigma is receptive for pollination for a maximum period of 5 days. The plant can be artificially pollinated by placing pollen grains of the father plant on the stigma using a paintbrush or by carefully brushing the stigmas with flowering umbels of the father plant. The complete process of flowering for one single umbel takes about 5-7 days, but as mentioned above, its length is very much dependent on the weather conditions, as is the length of the plant's flowering period. This is considerably lengthened by cold and rainy weather. As a result, flowers which encountered unfavourable weather will have a reduced number of fruits, or several fruits will have only one mericarp containing a seed. Furthermore, the important pollinating insects do not visit the flowers during periods of cold or wet weather. Under optimum conditions, many different insect species are pollinators or visitors of coriander umbels (Pruthi, 1980).

2.3. Systemic position of coriander (Sambamurty, 2005)

Bentham and Hooker	*Engler and Prantl*	*Hutchinson*
Angiospermae	Angiospermae	Angiospermae
Dicotyledones	Dicotyledoneae	Dicotyledones
Polypetalae	Archichlamydeae	Herbaceae
Calyciflorae	Umbelliflorae	Umbellales
Umbellales	Umbelliferae	Umbelliferae (*Apiaceae*)
Umbelliferae		

2.4. Plant profile

2.4.1. Scientific classification (Pimenov and Leonov, 1993)

Kingdom	Plantae
Subkingdom	Viridaeplantae
Infrakingdom	Streptophyta
Division	Tracheophyta
Subdivision	Spermatophytina
Infradivision	Angiospermae
Class	Magnoliopsida
Superorder	Asteranae
Order	Apiales
Family	Apiaceae
Genus	Coriandrum L. – coriander
Species	*Coriandrum sativum* L.

2.4.2.Common names of the species (Goetsch *et al.*, 1984)

Table 2.1.

Language	Name
Arab kuzbara,	Kuzbura
Armenian	Chamem
Chinese	yuan sui, hu sui
Czech	Koriandr
Danish	Coriander
Dutch	Coriander
English	coriander, collender, chinese parsley
Ethiopian (Amharic)	Dembilal
French	coriandre, persilarabe
Georgian (Caucasus)	kinza, kindza, kindz
German	Koriander, Wanzendill, Schwindelkorn
Greek	koriannon, korion
Hindi	dhania, dhanya
Hungarian	Coriander
Italian	Coriandolo
Japanese	Koendoro
Malay	Ketumbar
Persian	Geshnes
Polish	Kolendra
Rumanian	Coriándru
Portugese	Coentro
Russian	koriandr, koljandra, kinec, kinza, vonjueezel'e, klopovnik
Sanskrit	dhanayaka, kusthumbari
Spanish	coriandro, cilantro, cilandrio, culantro
Turkish	Kisnis
Swiss	Chrapfechörnli, Böbberli, Rügelikümmi

2.4.3. Common Indian names (Bhatnagar, 1950)

Table 2.2.

Language	Name
Bengali	dhane, dhania
Gujarati	kothmiri, konphir, libdhane
Kannada	kothambri, kothmiribija
Kashmiri	daaniwal, kothambalari
Malayalam	kothumpkalaribija, kothumpalari
Marathi	dhana, kothimber
Oriya	Dhania
Punjabi	Dhania
Tamil	Kothamali
Telugu	Dhaniyalu

2.4.4. Plant Parts (Kumar, 2002)

Habit: An annual cultivated herb.

Stem: Erect, herbaceous, green cylindrical, hollow, solid in the lower region, dichotomously branched, smooth, swollen at nodes.

Leaf: Simple, highly dissected, alternate, amplexicaul, exstipulate, sessile (Fig. 2.5).

Fig. 2.5. Coriander Leaf

Inflorescence: A compound umbel. The primary branches of a compound umbel are called rays, the members of the involucres are bracts, and the members of the involucel subtending the umbelet sarebractlets (Fig. 2.6).

Fig. 2.6 Umbellet Inflorescence

Flower: Six different kinds of flower are present:

- Outermost Sterile Flower: Pedicellate, bracteates, incomplete, zygomorphic.
- Outer Female Flower: Pedicellate, bracteate, unisexual, zygomorphic, epigynous.
- Outer Male Flower: Pedicellate, bracteate, unisexual, zygomorphic.

- Outer Bisexual Flower: Pedicellate, bracteate, bisexual, zygomorphic, epigynous.
- Inner Male Flower: Unisexual, actinomorphic.
- Inner Bisexual Flower: Bisexual, complete, actinomorphic, epigynous.

Fig. 2.7. Coriander flower

Fig. 2.8. Coriander seed

Calyx: 5 sepals, gamosepalous, in zygomorphic flowers 2anterior sepals are larger, valvate, green, persistent, epigynous, all sepals equal-sized in actinomorphic flowers.

Corolla: 5 petals, polypetalous, pinkish white, valvate lobed, the zygomorphic flowers have an anterior large-lobed petal, the two on its sides are with one large and one small lobe and the rest two have 2 small lobes each; all petals are of equal size in actinomorphic (central) flowers.

Androecium: 5 stamens, incurved in bud condition, free, epigynous; filaments long, anther dorsifixed and extrose.

Gynoecium: Bicarpellary, syncarpous, ovary inferior, bilocular, axile placentation, one ovule in each loculus, two flat stigmas, two long styles which flatten at the base into a bilobedepigynous disc called *Stylopodium.*

Fruit: A cremocarp which splits up into two mericarps which remain suspended on the carpophores for some time.

Floral Formula of bisexual Flower: **Θ, ♂♀, $K_{(5)}$, C5, A_5, G (2)**

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