CHAPTER 1

HISTORY AND ORIGIN

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Abstract: Lentil (*Lens culinaris* Medikus) is the oldest pulse crop with remains found alongside human habitation up to 13,000 years BC. Its domestication is equally old and was probably one of the earliest crops domesticated in the Old World. It is mainly grown in India, Bangladesh, Pakistan, Egypt, Greece, Italy, countries in the Mediterranean region and North America. It is also being cultivated in the Atlantic coast of Spain and Morocco. The crop has a high significance in cereal-based systems because of its nitrogen fixing ability, its high protein seeds for human diet and its straw for animal feed. It is widely used in a range of dishes and reputed to have many uses in traditional medicine. There are a range of wild lentils but *L. orientalis* is believed to be the progenitor of the cultivated lentil

1. INTRODUCTION

Lentil, the plant varies from 6 to 18 inches in height, and has many long ascending branches. The leaves are alternate, with six pairs of oblong-linear, obtuse, mucronate leaflets. The flowers, two to four in number, are of a pale blue colour, and are borne in the axils of the leaves, on a slender footstalk nearly equaling the leaves in length. The period are about 1.5 cm long, broadly oblong, slightly inflated, and contain two seeds, which are of the shape of a doubly convex lens, and about 0.5 cm in diameter.

There are several cultivated varieties of the plant, differing in size, hairiness and colour of the leaves, flowers and seeds (Figure 1). The last may be more or less compressed in shape, and in colour may vary from yellow or grey to dark brown; they are also sometimes mottled or speckled. In English commerce two kinds of lentils are principally met with, French and Egyptian. The former are usually sold entire, and are of an ash-grey colour externally and of a yellow tint within; the latter are usually sold like split peas, without the seed coat, and

S.S. Yadav et al. (eds.), Lentil: An Ancient Crop for Modern Times, 1–9.

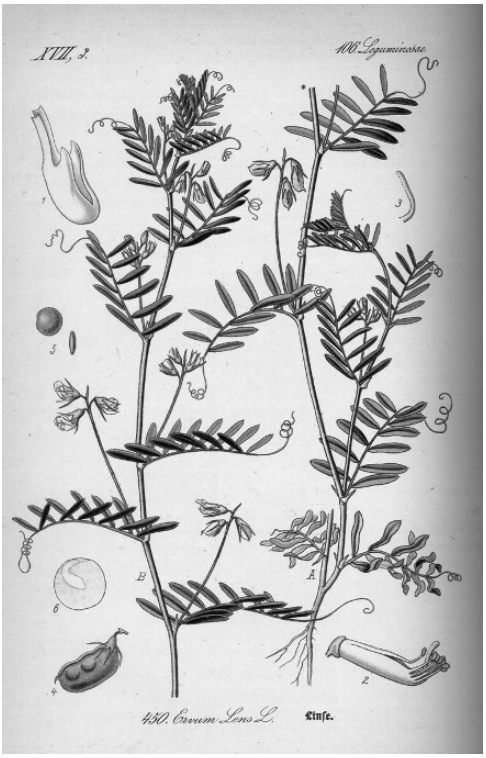

Figure 1. Illustration of the lentil plant, 1885

consist of the reddish-yellow cotyledons, which are smaller and rounder than those of the French lentil; the seed coat when present is of a dark brown colour. (www.1911encyclopedia.org,2006)

Popular in parts of Europe and a staple throughout much of the Middle East and India, this tiny, lens-shaped pulse has long been used as a meat substitute. There are three main varieties of lentils, the French or European lentil, sold with the seed coat on, has a grayish-brown exterior and a creamy yellow interior. The reddish orange Egyptian or red lentil is smaller, rounder and sans seed coat and yellow lentil. None of these varieties are used fresh but are dried as soon as they're ripe. The regular brown lentils are commonly found in supermarkets whereas the red and yellow lentils, though available in some supermarkets, must usually be purchased in Middle Eastern or East Indian markets. Lentils should be stored airtight at room temperature and will keep up to a year. They can be used as a side dish (puréed, whole and combined with vegetables), in salads, soups and stews. One of the most notable showcases for the lentil is the spicy Indian dhal. Lentils have a fair amount of calcium and vitamins A and B, and are a good source of iron and phosphorus.

2. COMMON NAMES

Lentil is known by various names in different parts of the world. The most common names are lentil (English), adas (Arabic), mercimek (Turkey), messer (Ethopia), masser or massur (India), heramame (Japanese). Other names mentioned in literature are mangu or margu (Persian), masura, renuka, mangalaya (Sanskrit).

3. USES

Lentil seeds are consumed as whole grains and as dehulled *dhal*. There are two types of lentil, the large seeded (*macrosperma*) and the small to medium sized seeded called (*microsperma*). The colour of seeds also varies with lines being brown, red, green or white. The lentil seeds are relatively higher in protein content (25%), carbohydrates and calories than other legumes (Muehlbauer *et al.* 1985). Its seeds are also a good source of essential minerals like calcium, phosphorous, iron and vitamin B. Lentil seeds are used for various cuisines worldwide and most commonly used as main dishes, side dishes, as sprouted grain in salads with *rotis* and rice. Seeds can be fried and seasoned for other uses. It is used as a staple of the diet in many Middle Eastern countries and India. Lentil flour can be used to prepare dishes such as soups, stews and purees. The flour can be mixed with cereals to make breads and cakes and as a food for infants (Williams and Singh 1988). Besides, being highly nutritious lentil seeds also contain anti-nutritional factors such as protease inhibitors, lectins or phytohaemoglutins and oligosaccharides that cause flatulence. These anti-nutritional factors can be minimized by heating, water soaking and germination (Jumbunathan *et al.* 1994). Williams *et al.* (1994) reported that lentils have the least while fababean generally have the highest concentrations of these anti-nutritional factors. Tannins are another set of anti-nutritional compounds found in the seed coat which is removed during dehulling while processing (Williams *et al.* 1994). Plant residues like dried leaves, stalks, husk, podwall etc. left after threshing are a good source of cattle feed. These residues contain about 10.2% moisture, 1.8% fat, 4.4% protein, 50% carbohydrate, 21.4% fibre and 12.2% ash (Muehlbauer *et al.* 1985). Lentil seeds are also used by industry as a source of commercial starch for textiles and printing (Kay 1979).

4. MEDICINAL VALUES

Lentil soups have a place in traditional medicines. They are claimed to improve digestion and are prescribed by traditional physicians during convalescence and also claimed to be as a blood purifier. An old traditional medicinal practice was the application of lentil paste to the skin to erase old skin disorders. It also said to alleviate peptic or duodenal ulceration and other intestinal afflictions that are seen in rice eating people. “In India, lentils are poulticed onto ulcers that follow smallpox and slow healing sores” (Duke 1981). In the sixth century, chickpeas were believed to be an aphrodisiac while lentils were considerd to have the opposite

effect. Probably, this was the reason that lentil was a part of the diet of monasteries during seasons when there was a low availability of meat (van der Maesen 1972).

5. HISTORY

The history of lentil is as old as Agriculture (Helbaek 1963). The carbonized remains of lentil dated to 11,000 BC from Greece's Franchthi cave are the oldest known remains. Small seeded (2–3 mm) types were found at Tell Mureybit in Syria and have been dated to 8500–7500 BC (Van Zeist 1971, Zohary 1972, Hansen and Renfrew 1978). Lentil remains have been found in Neolithic, aceramic farming villages which were occupied in the 7th millennium BC in the near east arc (Helbaek 1959). The type of agriculture surround these lentils cannot be determined as during this period small seeded cultivated lentil could not be differentiated from wild lentil seeds. In an archaeological site in northern Israel the presence of a large storage of lentils clearly established that by 6800 BC lentil was a part of farming. Carbonized lentil seeds have been recovered from widely dispersed places such as Tell Ramand in Syria (6250–5950 BC), aceramic Beidha in Jordan, ceramic Hacilar in Turkey (5800–5000 BC) and Tepe Sabz in Iran (5500–5000 BC) (Van Zeist and Bottema 1971, Helbaek 1970). In Greece, lentils dating back to 6000–5000 BC have been found in Neolithic settlements such as Argissa-Magula Tessaly (Hopf 1962) and Nea Mikomedeia, Macedonia (Renfrew 1969, Van Zeist and Bottema 1971) and in the same period lentil remains were also seen in Egypt (Matmur, El Omari late 4th millennium, Helbaek 1963). The archaeobotanical remains of lentil have been found in the excavations of the Harappan civilization covering the period of 3300–1300 BC.

6. ORIGIN

Lens culinaris is indigenous to the near East and Central Asia. The putative progenitor of cultivated species *Lens culinaris* subsp. *orientalis* (Bioss.) Ponert is found in Turkey, Syria, Lebanon, Israel, Jordan, Iraq, Iran, Afghanistan, Greece, Uzbekistan (Ladizinsky 1979a, Cubero 1981, Zohary 1973). Most of the West Asian lentils have a flattened lens-like appearance while South Asian lentils have a convex shape on both sides. The electrophoretic studies of seed protein profiles in 22 lines comprising of 11 of *L. culinaris,* six of *L. orientalis,* four of *L. ervoides* and one line of *L. nigricans* belonging to different regions of distributions showed that *L. culinaris, L. orientalis* and *L. nigricans* were related to each other while *L. ervoides* was different (Ladizinsky 1979b). Further, Renfrew (1973) suggested that *L. nigricans* is the progenitor of the cultivated species *L. culinaris* based on his belief of the domestication of lentil in southern Europe. Other groups of workers more recently (Ladizinsky 1979a, Barulina 1930, Zohary 1972 and Williams *et al.* 1974) have claimed that *L. orientalis* is the progenitor of the cultivated species based on the fact that the wild species were found in the fields of the farmers where lentil crops were cultivated in the Middle East. Secondly, plant

characteristics and pollen grain morphology were found to be quite close. Further, Ladizinsky (1979c) attempted the cross between *L. culinaris* and *L. orientalis* and studied the behaviour of F_1 and F_2 populations. He also concluded that pod indehiscence is governed by single recessive gene. Together these data gave a reason to believe that domestication of lentil might have started with selection of the variants from wild populations which were non-pod dehiscence (Ladizinsky 1979b). Non-pod dehiscence variants made the harvesting easy due to retention of pods till harvest. *L. orientalis* might have originated first from perennial species and at the secondary level become the progenitor of cultivated species (Singh 2001). According to Ladizinsky (1979a), *L. orientalis* is the progenitor of cultivated species based on the cytoplasmic studies. In the cytogenetic analysis of interspecific hybrids, three chromosome interchanges were found between the cultivated *L. culinaris* and *L. nigricans* while only one was found between the cultivated species and *L. orientalis*, which accentuates the concept that *L. orientalis* is the most probable progenitor of the domestic lentil. *Lens orientalis* is the presumed progenitor of *Lens culinaris* and the two species are crossable and produce fully fertile progeny (Muehlbauer *et al* 2006).

7. DOMESTICATION

Domestication is likely to have started with selection of plants from wild species that retain their seeds in pods before harvesting and continuous selection for large seed size. Lentil is a self-pollinated crop species and this would have helped greatly in maintaining line identity in the process of domestication. Archaeological studies, presented above, have confirmed the presence of lentil in the Turkey-Syria-Iraq region as far back as 8500–600 BC. This region probably played an important role in lentil domestication and starting the further spread to the Nile, Greece, Central Europe and eastwards to South Asia (Nene 2006). At the same time, lentil also spread to Ethopia, Afghanistan, India, Pakistan, China and later to the New World including the Latin America (Cubero 1981, Duke 1981, Ladizinsky 1979a). Bahl et al. (1993) suggested that probably lentil's domestication was the oldest among grain legumes. Lentil was thus an important part right from the start of the agricultural revolution in the Old World alongside the domestication of wheat, barley, pea, flax, einkorn and emmer wheats (Zohary 1976). The crop was part of the assemblage of Near Eastern grain crops introduced to Ethopia by the invaders of the Hamites. From the Bronze age onward, lentils were grown wherever wheat and barley were cultivated throughout the expanding realm of Mediterranean-type agriculture (Erskine 1989). This indicates a specific demand for lentil in the social system as the yield of lentil was quite low in comparison to wheat and barley. Thus along with other grain crops, lentil cultivation as part of a farming system was probably initiated in late 5th or early 4th millennia BC. The Harappan civilization (3300–1300 BC) remains are indicative of domestication of lentil starting prior to 2500 BC in India. De Candolle (1882) dated the start of lentil cultivation on linguistic grounds. "It may be supposed that the lentil was not in this country (India)

before the invasion of the Sanskrit speaking race." This probably occurred before 2000 BC and is consistent with the other evidence presented above.

8. BOTANICAL DESCRIPTION

Lentil is annual bushy herb with erect, semi-erect or spreading and compact growth habit. It has many branches with soft hairs. Its stems are slender, angular, light green in colour about 15–75 cm in height (Duke 1981, Muehlbauer *et al.* 1985). The rachis is 4–5 cm in length bearing 10–15 leaflets in 5–8 pairs. Generally, the upper leaves are converted into tendrils or bristle, whereas the lower leaves are mucronate (Muehlbauer *et al.* 1985). The leaves are alternate, compound, pinnate and yellowish green, light yellow green, dull green, dark green or dark bluish green in colour. The stipules are small or absent. The axillary racemes generally bear 1–4 flowers on short peduncles having 2.5–5.0 cm length. The flowers are small, white, pink, purple, pale purple, pale blue in colour (Muehlbauer *et al.* 1985). The flowering proceeds acropetally. The lowermost buds open first and flowering proceeds upward and it takes about two weeks to complete opening of all the flowers on the single branch (Nezamudhin 1970). The opening of flower occurs between 8.00 to 10.00 hrs and continues till noon and each flower remains open for about 16–24 hrs. At the end of the second day and on the third day all the opened flowers close completely and the colour of the corolla begins to fade. The setting of pods occurs after 3–4 days. The flowers have small ovaries with one or two ovules. The style is covered with a hairy inner surface. The pods are oblong, flattened or compressed, smooth with 1–2 cm in length. Pods have a curved beak, persistent calyx and contain 1–3 seeds. The seeds are biconvex, round, small, lens-shaped and weigh between 2–8 g per 100 seeds. The colour of the testa varies from tan to brown black, purple and black. The mottling and speckling of seed is a common feature in some germplasm lines. The cotyledons are red, orange, yellow or green, bleaching to yellow (Kay 1979, Duke 1981, Muehlbauer *et al.* 1985). The germination of seed is hypogeal.

9. TAXONOMY

The genus *Lens* comprises six species (Ferguson 1998; Ferguson *et al.*, 2000) as *Lens orientalis* is generally now classified as *Lens culinaris* subsp *orientalis.* Only one species, *L. culinaris* Medikus is cultivated. Among the wild species namely *L. montbretii* (Fisch and Mey.) Davis and Plit., *L. ervoides* (Brign.) Grande; *L. nigricans* (Bieb.) Godr., and *L. orientalis* (Boiss.) M. Popov., the latter two species possess morphological similarities to the cultivated lentil (Ladizinsky 1979b). However, Ladizinsky and Sakar (1982) suggested that *L. montbretii* should be placed in the genus *Vicia* and named as *Vicia montbretii* (Fisch & Mey.) based on morphological and cytological data and breeding experiments. The cultivated lentil originated from *L. orientalis* (Barulina 1930) and chromosome number of cultivated lentil, its progenitor species, *L. orientalis* and

L. nigricans are same, i.e. 2n = 14. The cultivated species, *L. culinaris* has been divided into two sub-species (Barulina 1930) namely *macrosperma* (seed diameter, 6–9 mm) and *microsperma* (seed diameter, 2–6 mm). The *macrosperma* type have yellow cotyledons and very light or no pigmentation in their flowers and other plant parts, whereas the *microsperma* types have red, orange or yellow cotyledons and pigmented flowers and other plant parts. Williams *et al.* (1974) classified *L. culinaris* in the order Rosales, sub-order Rosineae, family Leguminosae and sub-family Papilionaceae. The genus *Lens* occupies an intermediate position between *Vicia* and *Lathyrus*, the two other members of papilionaceae. However, it is more closely related to the genus *Vicia.* Of the annual *Lens* species, *L. nigricans* can be separated from *L. culinaris* and *L. orientalis* from the stipule shape (Barulina 1930, Ball 1968, Davis and Plitmann 1970, Williams *et al.* 1974). The stipules of *L. culinaris* and *L. orientalis* (*Lens culinaris* subsp *orientalis*) are oblong or elliptic, lanceolate, entire, whereas stipules of *L. nigricans* are semi-hastate, entire or dentate. The classical taxonomy is based on morphological characteristics, it does not necessarily represent biological entities. Hybridization within the genus indicates the classification of species based on morphology is not valid and accessions based on morphology classified in the same species sometimes turn out to be cross – incompatible. Due to this reason, *L. odemensis*, formerly a member of *L. nigricans*, has been described as a new species (Ladizinsky 1986). The stipules of *L. nigricans* are semi-hastate with up right position, whereas in *L. odemensis* the stipules are less dentate, semi-hastate with horizontal position. Both these species are cross incompatible (Ladizinsky 1993). The detailed characteristic features of various *Lens* species are as follows: The wild species *L. nigricans* is a slender, densely pilose having semi-hastate stipules, conspicuously aristate peduncles and mauve flowers. The pods are glabrous and small usually with two tiny lenticular seeds. It is morphologically more closely related to cultivated species *L. culinaris.* However, it can be differentiated from cultivated lentil by many characters like toothed semi-hastate stipules and the strong aristate peduncles. The wild species *L. ervoides* is very slender (10–30 cm tall), with semi-hastate stipules and long filiform penduncles. It has very small puberulent pods with lenticular seeds. Like *L. nigricans,* it is also morphologically closely related to cultivated lentil. However, it can be separated from cultivated lentil by traits like structure of stipules and peduncle, size of pod and seed and flower shape.

The wild species *L. orientalis* (*Lens culinaris* subsp *orientalis*) is slender, pilose (10–30 cm tall) and has a very strong resemblance to *L. culinaris* with respect to vegetative growth and structure of the flower and pod. The stipules are entire, obliquely lanceolate and unappendaged. The calyx is 4–6 mm long with teeth much longer than tube. The pods are glabrous with small lenticular seeds. Overall, *L. orientalis* (*Lens culinaris* subsp *orientalis*) looks like a miniature version of *L. culinaris* and morphological boundaries between both the species are occasionally intermixed. Some intergradation between the two species has been reported by Davis and Plitmann (1970) and some intermediates were also found in several localities in the Judean hills and in Galilee, Israel (Zohary 1972). The wild species

L. odemensis is decumbent-ascending with single or branched column. It has small rachis (8–20 mm) with 6–8 leaflets per leaf and ending in a tendril. The stipules are semi-hastate, slightly dentate at the base and horizontal to the stem. The calyx is 4–6 mm with long teeth. Pods are glabrous, rhomboid with 1–2 motted gray-brown small seeds.

Lentil is one of the oldest grain legumes. It is a short statured, annual, self-pollinated, high valued crop species. It is native to the Near East and Central Asia and rapidly spread to other parts of world. *L. orientalis* is the most probably a secondary level progenitor of the cultivated species *L. culinaris* Medikus. *L. orientalis* might had originated from the wild perennials through natural selection. The wild lentil species are potential resources yet to be tapped.

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