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Cicer arietinum L. (Chickpea): A Mini Review

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ABSTRACT

Cicer arietinum (chickpea) is an annual herbaceous crop and the world's third most important food legume, belonging to the genus *Cicer*. Chickpea is rich in carbohydrates, proteins and bioactive compounds. A variety of climatic and environmental conditions influence chickpea growth, development and grain yield. Its significance and utilization for several health diseases have been cited in ancient manuscripts and the Ayurvedic system of medicine. Determining the origin and dispersal routes of this plant has been one of the most interesting issues among botanists. This review gives an outline of the available literature on morphological characteristics, origin, habitat features, nutritional compositionand medicinal uses of the chickpea. Chickpea is cultivated in a wide variety of agroecological conditions worldwide, especially in arid and semi-arid climates. It is susceptible to soil type, soil pH, waterlogging, temperature (drought and cold), annual rainfall, salinity, high boron, insect and pathogen attacks, herbicidesand weeds, especially broad-leafed weeds. Chickpea originated in the Mediterranean/Fertile Crescent from *Cicer reticulatum* through mutants and spread to Central Asia and likely in parallel from Central Asia to South Asia (India) and East Africa (Ethiopia). It is a chief source of sustainable, inexpensive protein, also abundant in complex carbohydrates, fatty acids, isoflavones, vitamins, minerals and dietary fiber. *Cicer arietinum* possesses several medicinally significant activities such as antimicrobial, antioxidant, anti-inflammatory, anti-hypercholesterolemia, anti-hepatotoxicity, anti-hyperglycemia, anti-cancer and nephrolithiasis.

Key words: Botany, *Cicer arietinum*, Habitat, Medicinal uses, Nutritional composition, Origin.

Cicer arietinum L. (chickpea) is an annual herbaceous crop (OGTR, 2019) and the world's third most important food legume (after the common bean and filed pea) belonging to the genus *Cicer* L. (Nathawat *et al.,* 2024). The Latin words *Cicer* and *arietinum* were taken from the Greek words *Kikus* meaning 'force of strength' and Krios referring to ram, respectively (Van Der Maesen, 1972, Sajja *et al.,* 2017). The English word, chickpea, was derived from chickpea, referring to *Cicer-pea* (Sajja *et al.,* 2017). Also, chickpea is called nakhut, naut, or nohot in Iran, Afghanistan, Turkey, Romania, Bulgaria and in parts of the Soviet Union, garbanzo in Spanish-speaking countries and the US and chana or (Bengal) gram in India (Van Der Maesen, 1987; OGTR, 2019). It is a self-pollinating diploid (2n=2x=16) pulse crop with a 738 Mbp genome size (Madurapperumage *et al.,* 2021). Insects such as bumblebees (*Bombus* spp.), honey bees (*Apis* spp.) and wild bees are reported to visit chickpea flowers, but rarely mediate cross-pollination (OGTR, 2019). Seeds in chickpea are dispersed by humans, animals (*e.g.* pig feces), insects (*e.g.* ants and dung beetles), birds (*e.g.* emus), strong winds and heavy rains (OGTR, 2019).

The chickpea is the only domesticated and cultivated species in the genus *Cicer* (Arriagada *et al.,* 2022). The chickpea is believed to have originated in the Mediterranean/Fertile Crescent, where the chickpea was domesticated and later spread to the secondary centers of diversity: Central Asia, South Asia (India) and East Africa (Ethiopia) (Varshney *et al.,* 2019). It is now widely distributed, being grown in different regions of the world, including the West, South and Center of Asia, Australia, North and East of Africa, Southern Europe, North and South and Center of America (Croser *et al.,* 2003a).

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The chickpea is cultivated in a wide variety of agroecological conditions worldwide, especially in arid and semi-arid climates (Gayacharan *et al.,* 2020). Chickpea production faces various abiotic stresses during its life cycle such as drought, cold, terminal heat, salinity, water logging, acidity and metal toxicity stresses (Jha *et al.,* 2014)and biotic stresses such as uncontrolled weeds (*e.g. Chenopodium album* L. and *Phalaris minor* Retz.) (Singh *et al.,* 2020) and insect (*e.g. Helicoverpa armigera* L.) (Jat *et al.,* 2021) and pathogen attacks (*e.g. Ascochyta rabiei* and *Fusarium oxysporum* f. sp. *ciceris*) (Reddy and Singh, 1984, Sankar *et al.,* 2022). Chickpea is now farmed on over 13.7 million hectares, with an annual production of 14.3 million tons in 2019 (Xiao *et al.,* 2022) and India is the largest producer and consumer of chickpea in the World with a cultivable area of 8.84 million ha and 8.29 million tons of production (Jayalakshmi *et al.,* 2019) and is credited for about 67% of the world's chickpea production (Bhardwaj *et al.,* 2022). There are two distinct types of chickpea genotypes, *kabuli* and *desi*, primarily based on shape, color and seed size (Kalve and Tadege, 2017).

The production is high in desi type, about 80 per cent and 20 per cent in *kabuli* (Karthikeyan *et al.,* 2021). Desi chickpea is mainly produced in countries like India, Australia, Pakistan, Bangladesh and Myanmar, while kabuli chickpea is mainly produced in Iran, Canada, Turkey, Ethiopia and Mexico (Karthikeyan *et al.,* 2021).

Cicer arietinum is highly valued in the cropping system for its effects on soil health, especially in rotation with cereals (Kagan and Kayan, 2014, Asati *et al.,* 2024) and as a legume, it improves soil fertility by fixing atmospheric nitrogen (N2), meeting up to 85% of its N requirement from symbiotic N2 fixation (Zorawar and Guriqbal, 2018, Kaur *et al.,* 2022). It leaves notable amounts of producing N for subsequent crops and adds organic matter to preserve and augment soil health and fertility (Gaur *et al.,* 2010).

Chickpea is one of the earliest grain crops cultivated by man (Croser *et al.,* 2003b). It is traditionally commercialized as seed, flour, or canned foods (Boukid, 2021). Chickpea is a source of dietary protein and is utilized as a protein supplement in many countries, for example, India, Pakistan and European countries (Gao *et al.,* 2015). Its seed contains 59% carbohydrate, 29% protein (rich in lysine and arginine), 5% oil, 4% ash and 3% fiber (Yadav *et al.,* 2022). Chickpea chemical composition can fluctuate due to either intrinsic factors (mainly genetics) or extrinsic factors, such as types of soil, climatic factors, agronomic methods, technological treatmentsand storage (Yegrem, 2021). It can also be used as fodder for livestock (Kagan and Kayan, 2014).

An electronic search of published articles was conducted from 1883 to 2024 through PubMed, Google Scholar, Scopus, Web of Science and local databases. Additional sources were identified by cross-references. Search terms included combinations of *Cicer arietinum*, chickpea, morphology, origin, habitat, ecology, chemical compound, nutritional composition, traditional medicine, therapeutic, pharmacological and biological activity.

Morphological characteristics

Cicer arietinum is a short annual herb (usually less than a meter) and the plant assumes a 'prostrate, spreading, semi-spreading, semi-erect and erect' growth habit. All external surfaces of the plant, except for the corolla, are covered with glandular and non-glandular hairs. Stems are erect, branched, or dispersed, at times shrubby and much branched, pubescent, bluish green, or dark green in color, up to 150 cm. Three kinds of branches are produced in chickpea: primary, secondary and tertiary. Depending on the genotype and growing conditions, tertiary branches may or may not be present. Leaves are compound, uni imparipinnate and petiolate. The rachis is 25-60 (75) mm long and each rachis supports 11-13 (15-17) leaflets, each with a small pedicel. The leaflets are obovate to elliptical, opposite or alternate, pubescent, serrated, 8-17 mm long and 5-14 mm wide. Stipules ovate to oblique-triangular in shape and serrated, 2-4(6) teeth, 3-5 (11) mm long, (1) 2-4 (6) mm wide, in some cases up to 14 mm long. The inflorescence is an axillary raceme with naturally a single papilionaceous flower. Occasionally, there are 2 or 3 flowers on the same node. Such flowers have both a peduncle and a pedicel. The peduncle is about 6-30 mm long, while the pedicel is about 6-13 mm long. Flowers are complete, zygomorphic (the flower is bilaterally symmetrical), bisexualand have a papilionaceous corolla. Bract is small triangular or tripartite perules, up to 2 mm. The calyx consists of five sepals with deep lanceolate teeth. The calyx tube is oblique, 3-4 mm long and the teeth are 5-6 mm long. The corolla consists of five petals (pink, white, purple, or blue in color) in a typical papilionaceous arrangement with a big standard (vexillum), two wingsand two keels. The vexillum is obovate, nearly 8-11 mm long, 7-10 mm wide and either glabrous or pubescent with no glandular hair on its outer surface. The wings are also obovate with short pedicels (nails), about 6-9 mm long and 4 mm wide, with an auriculate base. The keel is 6-8 mm long, rhomboid, with a pedicel 2-3 mm long. The androecium is 10 stamens in diadelphous (9+1) condition. The ovary is ovate, pubescent (glandular hairs predominate), superior, monocarpellary, unilocular and with marginal placentation. The ovary is around 2-3 mm long and 1-15 mm wide. There are 1-3 ovules, rarely 4 per flower. Style is roughly 3-4 mm long, linear, upturned and glabrous, except at the base. The stigma is globose and capitate. The pod shape changes from rhomboid and oblong to ovateand its size ranges 15 to 30 mm in length, 2-15 mm in width and 7-14 mm in thickness. The number of seeds pod ranges from one to two, with the maximum being three. Seeds are distinctly beaked and often ram's head shaped and strongly wrinkled or ribbed. Occasionally quasi-spherical and intermediate shapes are also observed. The length and width of the seed can vary between 4-12 and 4-8 mm, respectively (Van Der Maesen, 1972; Singh, 1997; Singh and Diwakar; 1995; Gaur *et al.,* 2012; Al-Snafi, 2016; OGTR, 2019).

There are two types of cultivated chickpea based on seed morphology (seed size, shape and color)-desi and kabuli (GRDC, 2016, 2017; Madurapperumage *et al.,*2021).

Desi type (Microsperma): Chickpea with colored and thick seed coat are named desi type. The seeds are generally small (around 0.2 g per seed) and angular, with a rough surface. The seeds have a combination of brown, light brown, yellow, green and black colors. There are 2-3 ovules in each pod, but 1-2 seeds are produced per pod. The plants are short with small leaflets. The flowers are naturally pink or purple and the plants show various degrees of anthocyanin pigmentation. The desi type was reported for 80-85% of the chickpea area. The split seeds (dal) and floor (besan) are consistently made from desi-type chickpea (Singh, 1997; GRDC, 2016; Sajja *et al.,* 2017; OGTR, 2019).

Kabuli type: (Macrosperma): The kabuli-type chickpea is distinguished by a white, cream, or beige-colored seed with a ram's head shape, smooth seed surface and thin seed coat. The seeds are naturally large (about 0.3-0.5 g per seed) to extra-large (more than 0.5 g per seed). The plant is medium to tall, with white flowers, large leaflets and contains no anthocyanin. As compared to the desi type, the kabuli type has higher levels of sucrose and lower levels of fiber (GRDC, 2017; Sajja *et al.,* 2017; OGTR, 2019).

Origin

Cicer arietinum is an ancient cool season food legume crop cultivated by man in more than 50 countries such as Argentina, Australia, Burma, Canada, Ethiopia, India, Iran, Mexico, Myanmar, Pakistan, Russia, Spain, Syria, Tanzania, Turkey, Yemen and United States and has been found in Middle Eastern archaeological sites dated 7500-6800 BC (Croser *et al.,* 2003b; Merga and Alemu, 2019; Rani *et al.,* 2020). Prior to the phylogenetic study of chickpea by Varshney *et al.* (2019), earlier botanists had hypothesized several different origins for this food species. De Candolle (1883) outlined the origin of chickpea in a region south of the Caucasus and Northern Persia. Vavilov (1926) designated two primary centers of origin, the Mediterranean and southwest Asia and Ethiopia as one secondary center. Then, Vavilov (1951) recognized five centers of origin for cultivated chickpea, including the Near East Center, the Mediterranean, Central Asia, the Indian Center and a secondary center in Ethiopia, but Van Der Maesen (1984) noted that the core of the centers, southeast Turkey, is likely the original and earliest one and it is in the Near East center. However, Zeven and de Wet (1982) proposed that chickpea has different secondary centers of diversity found in at least four regions, including the Mediterranean region (including Palestine and Lebanon), the Near East region (comprising the Fertile Crescent), the Hindustani region (basically the current India and East Pakistan) and Central Asian region (with Afghanistan, Western Pakistan, Iran and the South of the former USSR). Van der Maesen (1987) has described the origin and history of chickpea, which most probably originated in an area of present-day southeastern Turkey and Northern Syria, around the upper reaches of the Tigris and Euphrates rivers. Harlan (1992) stated that chickpea has one definable center of origin, wide dispersaland one or more secondary centers of diversityand the crop most probably originates from the area of present-day southeastern Turkey and adjoining Syria (Harlan, 1992). Also, Harlan (1992) proposed India and Ethiopia as secondary centers of diversity of cultivated chickpea. Lately, a comprehensive investigation based on whole-genome resequencing of 429 lines sampled from 45 countries proposes the Eastern Mediterranean as the primary center of origin and migration route of chickpea from the Mediterranean/Fertile Crescent to Central Asia and likely in parallel from Central Asia to South Asia (India) and East Africa (Ethiopia). In addition, the migration to the New World (Americas) occurred straight from Central Asia or East Africa rather than exclusively from Iberia or the Mediterranean and Ethiopia (East Africa) was approved as the secondary center of diversity (Varshney *et al.,* 2019). Three wild annual species of *Cicer* including *C. reticulatum* Lad., *C. echinospermum* P.H. Davisand *C. bijugum* K.H. Rech. in south-eastern Turkey have high affinity to the chickpea, but it is now generally believed that *C. reticulatum* is its wild progenitor, based on karyotype (Ahmad *et al.,*1987), seed storage protein profiles (Kabir and Singh, 1988), interspecific hybridization (Ahmad, 1988), isozyme markers (Labdi *et al.*, 1996), molecular markers including amplified fragment length polymorphisms (AFLP) (Sudupak *et al.,* 2004) and random amplified polymorphic DNA (RAPD) studies (Iruela *et al.,* 2002). Two types of chickpea cultivars are admitted globally-kabuli and desi (GRDC, 2016). It is commonly accepted that the large-seeded domestic 'kabuli' chickpea originated from the small-seeded 'desi' chickpea, but Toker (2009) noted that the domestic 'kabuli' chickpea could have directly originated from *C. reticulatum* in ancient Eastern Turkey through mutants. The kabuli type is generally grown in the Mediterranean and temperate regions, including Western Asia, Southern Europe and Northern Africa, while the desi type is grown mainly in the semiarid tropics, such as the Indian subcontinent and Ethiopia (Singh *et al.,* 2022). There are linguistic indications that the kabuli type reached India only two centuries ago, apparently through Afghanistan, as its Hindi name is Kabuli chana (chana= chickpea), an allusion to the Afghanistan capital Kabul (Singh, 1997; Varshney *et al.,* 2019).

Habitat features

Cicer arietinum is grown across a wide range of environments, from the subtropics of India and north-eastern Australia to Mediterranean-climatic areas around the Mediterranean basin and in Southern Australia (Hosseini *et al.,* 2009). Smithson *et al.* (1985) categorized chickpea-growing regions into four major geographical regions, including 1) the Indian subcontinent, 2) West Asia, North Africa and Southern Europe, 3) Ethiopia and East Africa and 4) The Americas and Australia.

Chickpea needs adequate nutrition such as nitrogen (N), phosphorus (P), potassium (K), sulfur (S), calcium (Ca), magnesium (Mg) and micronutrients such as boron (B), cobalt (Co), iron (I), copper (Cu), manganese (Mn), molybdenum (Mo) and zinc (Zn) to achieve optimum yields (OGTR, 2019). Although micronutrients such as boron, cobalt, molybdenum and zinc contribute substantially to reaching higher production through their effects on the symbiotic nitrogen-fixing process, excess levels of these cause toxicity limiting crop production (Singh *et al.,* 2010; GRDC, 2017). For example, boron is an essential micronutrient for chickpea growth, but high boron in the soil causes marginal necrosis of old leaflets, later the necrotic leaflets become dry and shed (Singh *et al.,* 2010). Chickpea can be cultivated in a wide range of soils, but the best yield is reached on fertile sandy, loam soils with good drainage (Parwada *et al.,* 2022). Acid soils are unsuitable for chickpea production because acidic conditions increase aluminum toxicity, which reduces nodulation and nitrogen fixation in chickpea (GRDC, 2017). The maximum nutrient availability from the soil is at a pH range of 5.7 to 7.2 (Singh and Diwakar, 1995).

Chickpea is prone to waterlogging, especially during flowering and seed filling (Worku, 2016). Waterlogging declined extremely nitrogen fixation by Rhizobia (Worku, 2016). Also, waterlogging can lead to nutrient deficiency (especially iron and potassium), dying roots, decreasing photosynthesis, chlorosis and shedding of leaves by interfering with absorption and translocation (GRDC, 2017; OGTR, 2019).

The chickpea is highly susceptible to salinity and sodicity in the soil (Singh and Diwakar, 1995). It is more sensitive to salinity than some crops, such as wheat, barleyand canola (Flowers *et al.,* 2010). The chickpea is intrinsically sensitive to salinity during the reproductive stages (Kaashyap *et al.,* 2022). An increase in salinity (sulfate or chloride) leads to decreased germination, plant growth, photosynthesis, nodulation, nodule size, N2-fixation capacity, flowering, number and weight of pods, the number of seeds per pod, 100 seed weightand seed filling (Ram *et al.,* 1989; Flowers *et al.,* 2010, Jha *et al.,* 2014, Dudhe *et al.,* 2018). Chickpea tolerance to sodicity in the root zone (to 90 cm) is less than 1% exchangeable sodium percentage (ESP) on the surface and less than 5% ESP in the subsoil (GRDC, 2017). The yield loss in the chickpea due to salinity has been assessed to be about 8-10% of total global production (Mann *et al.,* 2019).

The chickpea is well suited as a winter crop for medium rainfall (300-500 mm) areas (GRDC, 2017). The desi type requires above 350 mm of annual rainfall and the kabuli type needs more than 450 mm (Pulse Australia, 2016). In general, the desi type is more tolerant than the kabuli type because the desi genotype has shown lesser yield reduction than the kabuli chickpea genotype when grown in the field under limited water stress (Nisa *et al.,* 2020). Water stress increases chickpea susceptibility to insect and pathogen attacks and herbicide residues (GRDC, 2017).

Low light intensities, as experienced during cloudy weather, have been shown to affect chickpea yield by reducing the number of pods per plant, the number of seeds per podand the average seed weight (Van Der Maesen, 1972). The greatest impact of shading on yield happens at the beginning of flowering, peaking about 20 days after flowering (OGTR, 2019). The effect of low light on chickpea yield is aggravated under well-watered conditions, which increase aborted flowers and reduce seed yields (Verghis *et al.,* 1999).

Chickpea is a poor competitor to weeds because of their slow growth rate at the early stages of crop growth and establishment (Gaur *et al.,* 2013, Merga and Alemu, 2019). Uncontrolled weeds reduce grain yield (over 85%) in chickpea because they reduce plant dry weight, number of branches, pods per plant and 100-seed weight (Mohammadi *et al.,* 2005; Frenda *et al.,* 2013; GRDC, 2017). The critical period of crop weed competition (CPWC) is vital to prevent unacceptable yield loss of crop species (Frenda *et al.,* 2013) and depends on the density of weed infestation, crop species characteristics and climatic and environmental conditions (Singh *et al.,* 2020). The critical period for controlling weeds in chickpea is during the seedling stage to early flowering or about 17-60 days after emergence, depending on the environmental condition (Mohammadi *et al.,* 2005; Frenda *et al.,* 2013). For example, Mohammadi *et al.* (2005) estimated a CPWC of 17 to 49 days after emergence (DAE) or between four-leaf and beginning of flowering stages, but in a second location, the CPWC was between 24 and 48 DAE or between five-leaf and the full flowering stages. The slow-growing nature of the chickpea in winter makes it vulnerable to weeds, specifically when invaded by broadleaf weeds (Mahajan *et al.,* 2022). The important weeds that infest the chickpea crop under rained conditions are *Anagallis arvensis* L., *Lathyrus aphaca* L., *Convolvulus arvensis* L., *Cyperus rotundus* L., *Fumaria indica* (Hausskn.) Pugsley, *Cynodon dactylon* (L.) Pers, *Medicago ploymorpha* L.and *Carthamus oxycantha* L. (Ahmad Khan *et al.,* 2018). Furthermore, it is reported that the *Lantana camera* L., an invasive shrub species, inhibits the growth and germination of the chickpea by allelopathic effects (Lallianpuii and Rai, 2023). Herbicides, hand weedingand mechanical wood control are the three methods of weed control for chickpea (Gaur *et al.,* 2013). Sheep and cattle grazing may also be used to control some weeds (Osten *et al.,* 2007).

Drought and cold are the common abiotic stress that reduces the yield of chickpea (Croser *et al.,* 2003a; OGTR, 2019). Heat stress (over 35°C) significantly reduces germination rate, soil osmotic potential, stomatal conductance, leaf water content, chlorophyll, membrane integrity, photosynthesis, photochemical efficiency and nodulation (Kaushal *et al.,* 2013; Jha *et al.,* 2014; Maqbool *et al.,* 2017). Furthermore, it impairs sucrose metabolism and transports it to developing pollen grains, resulting in reduced pollen function, impaired fertilization and poor pod set (Wang *et al.,* 2006; Kaushal *et al.,* 2013). The chickpea yield losses have increased to 100% in many chickpea genotypes with increasing temperatures (Rani *et al.,* 2020). On the other hand, a major constraint to chickpea production is cool temperatures at flowering because low temperature (less than 15°C) affects both the development and function of reproductive structures in the chickpea flower (Clarke and Siddique, 2004; Jha *et al.,* 2014, Rani *et al.,* 2020). Pollen development is inhibited when plants are exposed to low-temperature stress (3°C) during two temperature-sensitive stages of pollen development at 9 and 4-6 days before anthesis (Clarke and Siddique, 2004). In genotypes that do not have chilling tolerance (between 1.5°C and 15°C), low temperatures can also reduce fertilization by inhibiting the growth of pollen tubes in the style (Croser *et al.,* 2003a). About half of the productivity losses in chickpea are because of exposure to low temperatures (Rani *et al.,* 2020).

Chemical compounds

Chickpea seed is an excellent repository of protein, carbohydrate, lipid, fiber, isoflavone, vitamin and mineral contents (Elango *et al*., 2022, Xiao *et al*., 2022).

Carbohydrates in chickpea seed are classified into available (mono- and disaccharides) and unavailable (oligosaccharides, resistant starch, non-cellulosic polysaccharides, pectins, hemicellulose and cellulose) carbohydrates (Jukanti *et al*., 2012; Kishor *et al*., 2017). Chickpea seed contains monosaccharides (ribose, glucose, galactose and fructose), disaccharides (sucrose and maltose) and oligosaccharides (stachyose, ciceritol, raffinose, melibiose and verbascose (Kishor *et al.,* 2017; Elma Mathew and Shakappa, 2022).

Chickpea seed proteins are composed of globulin (salt soluble; 56%), glutelin (acid/alkali-soluble; 18.1%), albumin (water-soluble; 12%), a prolamin (alcohol soluble; 2.8%) and residual proteins (Soto-Madrid *et al.,* 2023). The amino acid composition of chickpea seed includes essential amino acids (valine, isoleucine, leucine, methionine, phenylalanine, threonine, histidine, lysineand tryptophan) and non-essential amino acids (alanine, tyrosine, serine, cysteine, glycine, proline, arginine, aspartic acid and glutamic acid) (Elma Mathew and Shakappa, 2022; Xiao *et al.,* 2022).

The lipid components of chickpea seeds contain polyunsaturated (62-67%), monounsaturated (19-26%) and saturated (12-14%) fatty acids (Elma Mathew and Shakappa, 2022). Saturated fatty acids are palmitic, tricosanoic, stearic, arachidic, henicosanoi, heptadecanoic, myristic, behenic, pentadecanoic, lignoceric and unsaturated fatty acids are palmitoleic, oleic, cis-11-eicosenoic, linoleic, linolenic, gadoleic and erucic (Zia-Ul-Haq *et al.,* 2007; Jukanti *et al.,* 2012; Elma Mathew and Shakappa, 2022; Xiao *et al.,* 2022). The oil from chickpea seed has sterols such as campesterol, D7-avenasterol, stigmasterol, β-sitosterol, clerosterol, D5-avenasterol, tocopherols α, β, γ, δ and Tocotrienols γ (Zia-ul-HAQ *et al.,* 2009; Jukanti *et al.,* 2012).

The mineral composition of chickpea seed includes macroelements such as sodium, potassium, calcium, magnesium, phosphorusand microelements such as manganese, zinc, copper, iron, molybdenum, nickel and boron (Kose and Mut, 2020; Elma Mathew and Shakappa, 2022). Also, trace elements (aluminum, chromium, cobalt, lead, lithium, mercuryand selenium) are present in chickpea seeds (Elma Mathew and Shakappa, 2022).

The vitamin composition of chickpea seed includes water-soluble, including vitamin C, vitamin B1 (thiamine), vitamin B2 (riboflavin), vitamin B3 (niacin), vitamin B5 (pantothenic acid), vitamin B6 (pyridoxine), vitamin B7 (biotin), vitamin B9 (folic acid), Vitamin B12 (cobalamin)and Fat soluble, including vitamin A (carotene), vitamin E and vitamin K (phylloquinone) (Jukanti *et al.,* 2012, Elma Mathew and Shakappa, 2022).

Forty-six flavonoids in chickpea seeds were detected by ultra-high-performance liquid chromatography coupled with triple quadrupole mass spectrometry (UPLC-QqQ-MS) analysis (Xiao *et al.,* 2022). Chickpea seed is rich in isoflavones such asdaidzin, biochanin A, genistin, troxerutin, isorhamnetin, astilbin, L-epicatechin, astragalin, acacetin, hyperoside and myricitrin (Xiao *et al.,* 2022).

Finally, the dietary fiber composition of chickpea seed includes polysaccharides like lignin, cellulose, hemicellulose and pectin (Vasishtha and Srivastava, 2011).

Biological activity

Besides being a good source of nutrition, chickpea seeds have been used in traditional medicine as tonics, stimulants and aphrodisiacs (Zia-Ul-Haq *et al.,* 2007; Jukanti *et al.,* 2012). In the Ayurvedic system of medicine, chickpea preparations are used to treat a variety of ailments such as throat problems, bronchitis, blood disorders, skin diseases and liver- or gall bladder-related problems (biliousness) (Jukanti *et al.,* 2012). Chickpea have also been extensively utilized in traditional Uighur medicine to treat and control hypertension, hyperlipidemia, diabetes, itchy skin, flatulence, low libido, tumor formation and osteoporosis (Al-Snafi *et al.,* 2016). In addition to these applications, chickpea seeds are also used for the treatment of the burning sensation in the stomach, acne, insufficient milk, abdominal pain, nausea, constipation, diarrhea, diabetes, menstrual pain, headache, stomatitis, inflammations, hepatomegaly, blood enrichment, skin ailments, ear infections, liver and spleen disorders, kidney stones and urinary problems (Zia-Ul-Haq *et al.,* 2007; Jukanti *et al.,* 2012, Kaur *et al.,* 2019, Koul *et al.,* 2022). Finally, the studies showed that malic and oxalic acids are discovered in the glandular secretions of chickpea leaves, stemsand pods and have some traditional medicinal features (Kaur *et al.,* 2019, Koul *et al.,* 2022). These sour-tasting acid exudates can be used as vinegar or as medicine (Koul *et al.,* 2022, Elma Mathew and Shakappa, 2022). These exudates can treat several diseases such as hypercholesterolemia, bronchitis, sunstroke, dyspepsia, cholera, catarrh, constipation, diarrhea, snakebite, flatulence and wart (Koul *et al.,* 2022).

Pharmacological studies showed that chickpea possessed various biological effects ranging from antioxidant (Mahbub *et al.,* 2021), anti-hypercholesterolemia (Pittaway *et al.,* 2006), anti-hyperglycemia (Chen and Huang, 2020), anti-inflammatory (Mahbub *et al.,* 2021), anticonvulsant (Sardari *et al.,* 2015), antimicrobial (Kan *et al.,* 2010, Kumar *et al.,* 2014, Heymich *et al.,* 2021), anti-hepatotoxicity (Mekky *et al.,* 2016), anti-cancer (Kumar *et al.,* 2014, Chino *et al.,* 2017; Gupta *et al.,* 2018) and nephrolithiasis (Biglarkhani *et al.,* 2019). Some reported pharmacological activities of chickpea are summarized here:

Kan (2010) showed that chickpea seed extract has antibacterial activity against gram-negative strains (*Klebsiella pneumoniae*, *Escherichia coli*, *Pseudomonas aeruginosa*) in the MIC range 16-64 μg/mL as well as antifungal action towards Cand*ida albicans* at a concentration of 8 μg/mL. Using the antimicrobial peptides Leg1 and Leg2 in chickpea, Heymich *et al.* (2021) showed that Leg1/Leg2 with sodium benzoate have antibacterial activity against *Escherichia coli* and *Bacillus subtilis* at concentrations of 0.625 and 0.75, respectively. They ascertained that Leg1/Leg2 have antifungal activity, with minimum inhibitory concentrations of 250/125 μM against *Zygosaccharomyces bailii* and 500/250 μM against *Saccharomyces cerevisiae*. Additionally, Heymich *et al*. (2021) cited that Leg1 and Leg2 have no cytotoxic effects against human Caco-2 cells at concentrations below 2000 μM and 1000 μM, respectively. Kumar *et al.* (2014) isolated C-25 (an antifungal protein) from *Cicer arietinum* and tested it against oral cancer cells in the MIC range of 9-60 5 μg/mL. and human pathogenic fungi such as *Candida krusei*, *Candida tropicalis* and *Candida parapsilosis* in the MIC range 1.56-12.5 5 μg/mL. They observed that the C-25 protein reduced the cell proliferation of human oral carcinoma cells at the concentration of 37.5 5 μg/mL and exhibited strong antifungal activities against human pathogens: *Candida krusei*, *Candida tropicalis* and *Candida parapsilosis* of MIC values 1.56-12.5 5 μg/L. Therefore, Kumar *et al.* (2014) documented that C-25 can be regarded as an effective anti-mycotic as well as an anti-proliferative agent against human oral cancer cells. Mahbub *et al.* (2012) showed that desi chickpea hull phenolic extract reduced the production of inflammatory markers (such as nitric oxide (NO) and interleukin-6 (IL-6) and increased the activity of catalase and glutathione peroxidase (GPx). They suggest that chickpea hull phenolic extract may alleviate oxidative stress and inflammation by regulating pro-inflammatory markers and antioxidant enzymes associated with chronic inflammation. Chen and Huang (2020) found that chickpea (CP) improved hyperlipidemia, hepatic lipid accumulation and kidney function in obese mice by modulating the composition of the gut microbiota. Using 330 mg of chickpea seed extract (desi type) three times a day for 30 days, Biglarkhani *et al.* (2019) concluded that *Cicer arietinum* extract could be an adequate and safe therapeutic alternative for patients with 6-10 mm renal stones. Chino *et al.* (2017) showed that consumption of 2% or 10% cooked chickpea in mice decreases the expression of inflammatory enzymes (COX-2 and iNOS), b-catenin (one of the most important oncogenic proteins in colon cancer) and lipid, proteinand DNA oxidation. Therefore, they concluded that the addition of cooked chickpea seeds (2% and 10%) to the daily diet is proposed as a chemopreventive agent against colon cancer. Also, Gupta *et al.* (2018) demonstrated that chickpea lectin has anticancer activity and could be used as a vital source of medicine leading to the therapy of breast cancer.

CONCLUSION

Cicer arietinum is the only domesticated and cultivated species in the genus *Cicer* and is grown in different regions of the world, especially in arid and semi-arid climates. Chickpea originated in the Middle East (area between south-eastern Turkey and adjoining Syria) from *Cicer reticulatum* through mutants and spread to the Old World (Asia and Africa) and New World (Americas). Chickpea studies confirmed that environmental factors influence growth, development and grain yield. Conservation of the *Cicer arietinum* should be done since planting in the field by considering adequate nutrition, suitable soil and pH, inhibiting of salinity, high microelements especially high boron, water stress, waterlogging, low light, drought, cold, weeds, herbicides and pest attacks. After the common bean and field pea, chickpea is the most consumed pulse in the world. It is a rich source of protein, carbohydrates, fatty acids, isoflavones, vitamins, minerals and dietary fiber and conveys a massive role in human nutrition. Scientists documented that it possessed various biological effects ranging from antioxidant, anti-hypercholesterolemia, anti-hyperglycemia, anti-inflammatory, anticonvulsant, antimicrobial, anti-hepatotoxicity, anti-cancer and nephrolithiasis. Chickpea studies suggest that chickpea seed extract is a safe chemo-preventive/therapeutic agent with the potential to cure several cancers such as colon cancer and breast cancer through decreases in the expression of inflammatory enzymes (COX-2 and iNOS), b-cateninand lipid, protein and DNA oxidation. However, further experimental and clinical studies are required to better understand the role of chickpea in the chemo-prevention and treatment of various types of cancer.

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Conflict of interest

The author declares no conflict of interest.

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