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# Botanical, Chemical, and Pharmacological Characteristics of Carob Tree (Ceratonia Siliqua L)

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## Abstract

In Morocco the carob tree (Ceratonia siliqua L.), is scattered in the wild or artificial state throughout the country. It belongs to the Ceasalpiniaceae subfamily of the legume family, is a sclerophyllous, xerophilic, thermophilic, calciclous and heliophilous species. The carob is a Mediterranean medicinal plant, it is characterized by ecological, socio-economic, industrial and ornamental importance. It is an agro-sylvo-pastoral species that can be used for the rehabilitation of degraded soils, thanks to its capacity to adapt to different edapho-climatic conditions. The most important producing countries are Spain, Italy, Morocco, Portugal, Greece, Turkey and Cyprus. Many factors affect the chemical composition of the fruit as well as its mineral content, for example the temperature, the origin of the cultivar and the harvest period. In therapy, this plant is known for its cholesterol-lowering, antiproliferative, antidiarrheal effect.

**Keywords:** Ceratonia siliqua L; Sclerophyll; Heliophilous; Medicinal plant; Thermophilic.

## Botanical characters

The carob tree (الخروب in Arabic, tikida in Tamazight, carob in English), derives from the Greek Keras (horn) and from the Latin siliqua designating a silique or pod and alluding to the hardness and shape of the fruit [1]. This species belongs to the genus Ceratonia, subfamily Caesalpinioidae of the family Fabaceae, which is part of the order Fabale, class Magnolipsida [2]. Ceratonia siliqua L. is an endemic Mediterranean plant of indisputable ecological, industrial and ornamental importance [3], aromatic and medicinal [4] which is currently among the most efficient fruit and fodder forest trees that exist in Morocco. It is found in its natural state mainly in Spain, Portugal, Morocco, Greece, Italy, Turkey, Algeria, Egypt and Cyprus. It has been successfully introduced in several countries with a Mediterranean climate. This is the case in Australia, South Africa, the United States, the Philippines and Iran [1]. In Morocco, the carob tree is present, in the form of natural or artificial plantations, throughout the country up to 1150 altitude in very arid areas [5]. It is found in the western and eastern Rif [6]. Carob stands fit into open or shrubby areas and are either natural or introduced as forest-generating species [6]. The main spontaneous population of the carob tree is located in the regions of Fez, Marrakech, Agadir, Essaouira, Taza, El Hoceima, Beni Mellal and Khénifra, in association with the olive tree, mastic tree, cedar or argan tree [7]. The carob tree can reproduce by two ways: Sexual propagation (Seeds) [8] and vegetative propagation (cuttings [9]; grafting [7,10], or by micro-propagation [11].

According to data from FAOSTAT [12], the world production area of the carob tree is estimated at 102939ha. The largest area, 83574ha, is that of Europe, against an estimated area of 30000ha for Morocco and 13460ha for the other North African countries. The world production of carob is estimated at 191355.64 tons [12]. It is mainly concentrated in Spain, Italy, Morocco, Portugal, Greece, Turkey, followed by Cyprus, Algeria, Lebanon and lastly Tunisia. In Morocco, production has increased insignificantly, it went from 20,000T in 2012 to 21,983T in 2017 [12].

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## Ecological characters

The carob tree, whose area of distribution extends in the sectors of the plateaus and in medium mountains up to 1700 m of altitude, is indifferent to the nature of the substrate ; it tolerates poor, heavy loamy, rocky and calcareous, schistose, sandstone soils with a pH of 6.2 to 8.6; but it fears acidic and very humid soils [13]. It adapts to several types of soil with the exception of hydromorphic and salty soils and schistose crusts. It is found on marly soils, on poor superficial and rocky calcareous soils, on rocky slopes, on inaccessible escarpments and uncultivated hills [6].

## Description of carob

**Tree:** The carob tree is a dioecious tree [14], and sometimes hermaphrodite and rarely monoecious [1], of which three forms of flowers can be distinguished (male flowers, female flowers and hermaphrodite flowers), which are carried on different feet. Initially the flowers are bisexual, but during the development of the flower (floral ontogeny), one sex is suppressed [15].

**Flowering:** Flowering takes place from August to November and maturation at the end of spring of the following year [1].

**Leaf:** The leaves of Ceratonia siliqua L., 11.62 cm to 18.60 cm long [7], are persistent [13], leathery, alternate and characterized by a furrowed petiole. It is composed of 7.4 to 12.4 leaflets [7], with or without terminal leaflet. The leaflets are 4.22 cm to 6.40 cm long [7], oval or elliptical in shape, opposite, shiny green on the dorsal side and pale green on the ventral side [16]. The carob tree loses its leaves every two years, in July. This tree develops a pivoting root system, which can reach 18 m in depth [6].

**Fruit:** The fruit of the carob tree, called carob, is an indehiscent pod with irregular edges, elongated, straight or curved, 10.10 cm to 20.34 cm in length, 1.46 cm to 2.38 cm in width [7,17]. The pod is composed of three parts: The epicarp, the mesocarp and the seeds, it is separated on the inside by transverse pulpy partitions and contains 8 to 16 seeds [7,17]. The development of the fruit is slow and generally requires between 9 to 10 months to reach maturity and give a dark to black fruit between July and September [1].

**Seeds:** Carob seeds are brown, flattened ovoid, biconvex and very hard. They are separated from each other by luscious partitions. The pale yellow pulp contained in the pods is floury and sweet when ripe, edible, with a chocolate taste, it is sometimes eaten in poor countries [7].

## Interests and use of the carob

The carob tree is a tree of indisputable ecological, socio-economic, industrial and ornamental importance. In terms of products, the tree and all its components (leaf, flowers, fruits, seeds, wood, bark and roots) are useful [18].

Tree, because of its hardiness and its adaptation to environmental constraints, the carob tree is often used for the reforestation of areas affected by erosion and desertification [15,19]. It is also used as an ornamental plant along roadsides and in gardens [1]. In forest areas, male plants are often pruned for fodder. Several studies have shown that the use of leaves associated with polyethylene glycol improves the digestibility and the nutritional quality of the tannins contained in the leaves [20].

Fruit of the carob tree (carob), consists of a pulp enveloping regular seeds. Indeed, the sweet pulp of carob has been used for a long time as livestock feed alongside other foods such as barley flour [7]. It is used in the human food industry, thanks to its high content of sugars and phenolic compounds. It is also used for the production of alcohol, citric acid and as a cocoa substitute for the manufacture of chocolate, as it does not contain caffeine or theobromine. Pulp flour is used in the composition of several foods such as biscuits, milk flours [21-23].

Pulp is used against diarrhea and for the treatment of certain diseases gastritis, enteritis, angina, colds and cancer [24].

The seed, all parts of the carob seed (tegument, endosperm and cotyledon), play an important industrial and medical role, but the gum (endosperm), remains the most important, since it is used as a stabilizing agent, gelling, a fixative in various fields such as the food industry (cheese, mayonnaise, salads), cosmetics (creams, toothpastes), the pharmaceutical industry (medicines, syrup), tannery and textiles [1,21].

The flower is used by beekeepers for the production of carob honey, while the leaves are useful for animal feed. The bark and roots are used in tanning thanks to their tannin content. The wood of the carob tree, hard, of red color is valued in coal and carpentry [25].

## Photochemistry

The pulp and the seeds are the two main constituents of the carob pod and represent respectively 90% and 10% of its total weight [25]. According to several authors, the chemical composition of the pulp generally depends on the cultivar, the origin and sometimes the harvest period [26]. The pulp is widely used either as a dietary supplement, a substitute for chocolate or even in animal feed. It is very rich in sugar (48-56%) [19], in particular sucrose, glucose, fructose and maltose, but low in protein (2-6%) and lipids (0.4-0.6%) including fatty acids saturated and unsaturated are in equal proportions [27]. From pod extract, five amino acids, namely alanine, glycine, leucine, proline and valine, have been isolated by [23] and two other compounds, tyrosine and phenylamine, have been reported by [31]. In addition, the pulp also has a very high fiber content (20-50%) and a significant amount of tannin (18-20%) [28]. In addition, the mineralogical analysis carried out on the pulp revealed a composition (in mg/100 g of the pulp) of: K=1110, Ca=307, Mg=42, Na=13, Cu=0.23, Fe=104, Mn=0.4 and Zn=0.59 [27].

The seed is composed of 30 to 33% integumentary envelope, 42 to 46% of the albumen and 23 to 25 of the embryo. The integumentary envelope is considered to be a natural source for the production of antioxidant polyphenol [29]. The albumen consists essentially of gum or galactomannan [30], which is a polysaccharide molecule composed of two sugar units, mannose and galactose, in a ratio of 4:1. This natural polysaccharide is endowed with various important properties, namely high viscosity in water even at variable temperature and pH, ability to form from very dilute solution of stable viscous solution and high potentiality to react with other polysaccharides thus inducing a synergistic effect [28].

## Pharmacology

Carob essential oil has antimicrobial, cytotoxic and pharmaceutical activities [31]. many clinical studies have highlighted the effectiveness of carob powder in the treatment of acute childhood diarrhea [32], which was confirmed by the clinical study conducted by [33] in children aged 3 to 21 months, that

the intestinal transit, the temperature and the weight of the child improved more quickly after administration of carob powder orally. According to [15] the pulp is recommended against pulmonary tuberculosis and bronchial affections. Being rich in antioxidants (phenolic compounds), sugars, proteins, fibers, potassium and calcium, this plant is known therapeutically for its hypocholesterolemic effect [34], antiproliferative, antidiarrheal and digestive disorders [35,32]. Other experimental studies have demonstrated the bactericidal capacities of carob pulp against Staphylococcus aureus, carob would also adsorb enterotoxins produced by certain strains of Escherichia coli and staphylococci as well as by the cholera vibrio, this mechanism of adsorption could be explained by the presence of tannins in the insoluble and active part of the carob [32]. In addition to its nematicidal power demonstrated by the work of [36], which due to its content of phenolic compounds, carob also has antimicrobial and antioxidant activity according to [38].

Numerous studies have demonstrated the positive influence of carob flour on the performance and health of animals subjected to a diet [37]. In addition, it plays an effective role in the suppression of intestinal parasites [39] and in the treatment of diarrhea [32]. Tannins, pectin and carotene were used in Egypt in traditional medicine [25]. According to some authors, the soluble fibers of the pulp can have a preventive or curative effect on human and animal health, thanks to the reduction of the risk of thrombosis through the reduction of blood pressure and the level of cholesterol in the serum [38]. In case of chronic renal insufficiency, the gum will retain in the digestive tract, urea, creatinine, uric acid, ammonia and phosphates causing a significant and beneficial lowering of the level of urea in the blood [35]. It is also used in the manufacture of an aromatic condiment from Senegal called nététu [40].

## Conclusion

In Morocco the carob tree is scattered in the wild or artificial state throughout the country. The carob tree is one of the landscapes of the Mediterranean with an extraordinary adaptation to extreme conditions, in particular drought, salinity and poor, calcareous soils. The carob tree can play a key role in the economic (production of fruit, wood, job creation) and social structure of rural areas in Morocco.

## References


1. Battle IJ, Tous Carob tree. Ceratonia siliqua L. Promoting the conservation and use of under-utilised and neglected crops 17. Institute of Plant Genetics and Crop Plant Research, Gatersleben/ International Plant Genetic Resources Institute. Rome, Italy. 1997; 93.
2. Quezel P, S Santa. Nouvelle flore de l"Algérie et des régions désertiques méditerranéennes. Tome 1. Edit CNRS. Paris. 1962; 63.
3. Walali Loudiyi DM, Brhadda N, et al. Abousalim Ressources génétiques. Actes du séminaire international sur les innovations scientifiques et leur application en oleiculture et oleotechnie. Florence, Italie: Conseil oléicole international. 1999; 10: 12
4. Say H. Le caroubier au Maroc- Un arbre d'avenir. Centre de Recherche Forestière. Collection Maroc Nature. Haut-Commissariat des Eaux et Forêts et à la Lutte Contre la Désertification. 2008.
5. Guinochet MR. Vilmorin Flore de France. Edit. CNRS, Paris. 1984.
6. Aafi A. Note technique sur le caroubier (Ceratonia siliqua L.), Centre Nationale de la Recherche Forestière, Rabat (Maroc). 1996; 10.
7. Ait Chitt M, Belmir M, A Lazrak, et al. Production des plantes sélectionnées et greffées du caroubier. Transfert de technologie en Agriculture, IAV Rabat. 2007; 153: 1-4.
8. Gharnit N « Caractérisation et essai de régénération in vivo du caroubier (Ceratoniasiliqua L.) originaire de la province de Chefchaouen (Nord-Ouest du Maroc) ». Th. Doc en science. Université Abdelmalek Essaadi. Tanger. 2003.
9. Baillière JB. Atlas d'arboriculture fruitière: Definitions, historique, la multiplication, la préparation du terrain, la fertilisation, les tracés de plantations, généralités sur les tailles et interventions diverses, la création des formes fruitières, la protection sanitaire, la protection. Collection des Techniques Horticoles Spécialisées, Paris, France. 1975; 1.
10. Boublenza I. Contribution à l"étude de multiplication du caroubier: Ceratonia siliqua L, Université Abou-bekr Belkaïd- Tlemcen, Faculté des Sciences de la Nature et de la Vie et des Sciences de la Terre et de l"Univers, Mémoire de Magister. 2012.
11. Neghmouchi S, Khouja ML, Khaldi A, Rejeb MN, Zgoulli S, et al. In: Povilitis, Tony (Ed.), Biochemical Diversity of Wild Carob Tree Populations and Its Economic Value. Topics in Conservation Biology. 2012
12. FAO. www.faostat.fao.org.
13. Zouhair O Le caroubier: Situation actuelle et perspectives d'avenir, Document interne, Eaux et forêts, Maroc. 1996; 22.
14. Kaderi M, Ben Hamouda G, Zaheir H, Hanana M, L Hamrouni. Notes ethnobotanique et phytopharmacologique sur Ceratonia siliqua L. Lavoisier SAS. 2014; 13: 144-147.
15. Rejeb MN. Le caroubier en Tunisie: Situations et perspectives d'amélioration, in Quelavenir pour l'amélioration des plantes? Edit. AUPELF-UREF. John Libbey Eurotext, Paris.1995; 79-85
16. Rejeb MN, Laffray D, P Louguet. Physiologie du caroubier (Ceratonia silique L.) en Tunisie. In Physiologie des arbres et arbustes en zones arides et semi-arides, Group d'Etude de l'Arbre, Paris, France. 1991; 417-426.
17. Boublenza I, El haitoum A, Ghezlaoui S, Mahdad M, Vasai F, et al. (Ceratonia siliqua L.) populations. Morphological and chemical variability of their fruits and seeds. 2019; 256(15): 108537.
18. Hariri A, N Ouis, Sahnouni F. D Bouhadi Mise en oeuvre de la fermentation decertains ferments lactiques dans des milieux a base des extraits de caroube, rev. microbiol. ind. san et environn. 2009; 37-55.
19. Biner B, Gubbuk H, Karhan M, Aksu M, M Pekmezci. Sugar profiles of the pods of cultivated and wild types of carob bean (Ceratonia siliqua L.) in Turkey. Food Chemistry. 2007; 100: 1455.
20. Priolo A, Waghorn G C, Lanza M, Biondi LP Pennisi. Polyethylene glycol as a means for reducing the impact of condensed tannins in carob pulp: Effects on lamb growth performance and meat quality. J. Anim. Sci. 2000; 78: 810- 816.
21. Dakia PA, C Blecker, C Robert, B Wathelet, M Paquot. Composition and physicochemical properties of locust bean gum extracted from whole seeds by acid or water dehulling pre-treatment Food Hydrocolloids. 2008; 22: 807-818.
22. Makris DP, Kefalas P. Carob pods (Ceratonia siliqua L.) as a source of polyphenolic antioxidant. Food Technol. Biotechnol. 2004; 42: 105-108.
23. Corsi L, Avallone R, Cosenza F, Farina F, Baraldi C, et al. Antiproliferative effects of Ceratonia siliqua L. on mouse hepatocellular carcinoma cell line. Fitoterapia. 2002; 73: 674-684.

24. Hamed TE, Ezzat A, Al-Okbi SY. Therapeutic diets for diarrhea: Biological evaluation in rats. Pak. J. Biological Sci. 2003; 6: 1501-1508.

25. El Bouzdoudi B, Saïdi R, Embarch K, El Mzibri M, Nejjar El Ansari Z, et al. Mineral composition of mature carob (Ceratonia siliqua L.) pod: Study. Int. Food Sci. Nutr. Eng. 2017; 7(4): 91-103. https://doi. org/10.5923/j.food.20170704.04

26. Albanell E, Caja G J. Plaixat Charactreristics of Spanisch carob pods and nutritive value of carob Kibbles. Cahiers. Opt. Mediterranean's. 1991; 16: 135-136.

27. Youssef MKE, El-Manfaloty MM, HM Ali. Assessment of proximate chemical compossition, nutritional status, fatty acid composition and phenolic compounds of carob (Ceratonia siliqua L.). Food Public Health. 2013; 304-308.

28. Puhan Z and MW Wielinga Products derived from carob pods with particular emphasis on Carob Bean Gum (CBG). Report Technical Committee of INEC (12). 1996; 123-127.

29. Makris DP, Kefalas P. Carob pods (Ceratonia siliqua L.) as a source of polyphenolic antioxidant. Food Technol. Biotechnol. 2004; 42: 105-108.

30. Kök MS, Hill SE, JRA Mitchell. Comparison of the rheological behavior of crude and refined locust bean gum preparations during thermal processing. Carbohydr. Polym.1999; 38: 261-265.

31. Ben Hsouna A, Trigui M, R Ben Mansour. Chemical composition, cytotoxicity effect and antimicrobial activity of Ceratonia siliqua essential oil with preservative effects against Listeria inoculated in minced beef meat. Int J Food Microbio, 2011; 148: 66-72.

32. Serairi-Beji R, Mekki-Zouiten L, Tekaya-Manoubi L, Loueslati M H, Guemira F, et al. Peut-on associer la pulpe de caroube et la solution de réhydratation orale dans le traitement de la diarrhée aigue Med. Trop. 2000; 60: 125-128.

33. Loeb H, Vandenplas Y, Wursch P and P Guesry Tannin-rich carob pod for the treatment of acute-onset diarrhea. J. Pediatr. Gastroenterol. Nutr.1989; 8: 480-485.

34. Goulas V, Stylos E, Chatziathanasiadou MV, Mavromoustakous T, AG Tzakos. Review functional component of carob fruit: Linking the chemical and biological space. Int. J. Mol. Sci. 2016; 17: 1875.

35. Berrougui H, Le caroubier (Ceratonia siliqua L.), une richesse nationale aux vertus médicinales, Maghreb Canada Express. 2007; 5 (9): 20.

36. El Allagui Nisrine, Saïda Tahrouch, Mohamed Bourijate, Abdel hakim Hatimi. Action de different extraits végétaux sur la mortalité des nématodes à galles du genre Meloidogyne ssp, Acta Botanica Gallica. 2007; 4: 503-509.

37. Lizardo R, Cañellas J, Mas F, Torrallardona D, J Brufau. L'utilisation de la farine de caroube dans les aliments de sevrage et son influence sur les performances et la santé des porcelets, Journées de la Recherche Porcine. 2002; 34: 97-101.

38. Min B R, Hart S P. Tannins for suppression of intestinal parasites. J. Anim. Sci. 2003; 81: 102-109.

39. Williams C L, Bollella M, Spack A, D Puder. Soluble fibre enhances the hypocholesterolemic effect and the step I diet in chilhood. J. Am. College Nutr. 1995; 14: 251- 257.

40. Ndir B, Lognay G, Wathelet B, Cornelius C, Marlier M, et al. Composition chimique du nététu, condiment alimentaire produit par fermentation des graines du caroubier africain Parkia biglobosa (Jacq.) Benth, (4, 5) Biotechnol. Agron. Soc. Environ. 2000; 4(N°2): 101-105.