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Ceratonia siliqua L. A Promising Functional Food for Chronicle Diseases Related to Gastrointestinal System: Diabetes, and Lactose Intolerance †

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Abstract: The present study contributes to the promotion of a tree widely cultivated in the Mediterranean area, but not enough in our country Algeria; the carob tree "*Ceratonia siliqua* L."; by a mini bibliographic review which lists the agronomical, chemical, nutritional, biochemical, biological, and biotechnological properties of carob and its by-products. A mini bibliographic review which lists environmental benefits, in addition to chemical, nutritional, biochemical, biological, and biotechnological properties of carob and its by-products expressed by the evaluation of its biological activities: antioxidant, anticancer, anti-hyper-lipidemic, anti-diabetic, anti-reflux, anti- diarrheal, antibacterial, anti-inflammatory, antiulcer and enzymatic, noted in the literature for few years using a survey on several databases MDPI, Pubmed, Google scholar, Elsevier, Springer... The survey highlights environmental benefits on soil and biodiversity besides, the presence of the main primary and secondary metabolites: polyphenols, fibers and sugars; give these products very interesting properties and benefits for human health by making it dietetic product and a raw material of choice in food, pharmaceutical and biotechnology industries, in this perspective a *Ceratonia siliqua* L. fruit aqueous extract based vegetal milk was developed in our laboratory as a functional food for chronicle diseases related to digestive disorder: diabetes, lactose and gluten intolerance. This mini revue, contributes to the revive of a forgotten and neglected tree in our country by the enhancement of its crucial role in the preservation of soil, biodiversity, environment, human health and security, and consequently attract local authorities on the importance of its culture.

Keywords: Mediterranean local forester products; *Ceratonia siliqua* L.; carob; functional food; nutraceuticals

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1. Introduction

Ceratonia siliqua L. belongs to legumes' family, it is widly cultivated in Mediterranean region, where it is considered as a natural component of biodiversity and a famous local product, used by local population since ancient times for alimentation as well as traditional remedy. According to FAOSTAT 2019 statistics it is cultivated on 80 000 hectares for a world production of 160 000 t/year, with varying production yields depending on cultivars, soils, climates and agri-parctices. It is also beneficial to the local agricultural economy since it is a drought- and temperature-tolerant plant [1,2].

Last decades, scientific researches focus on tree parts application especially biological and biotechnological ones [3,11], as its bioactive components could be very interesting for functional foods industry, food supplements, nutraceuticals..., mostly because it is usually conceded as by-products.

In this context, the present mini review aims to promote renewable local bioresouces for an agriculture based on responsible and sustainable Eco-economy.

2. Experiments

Intensive and rigors researches using several national and international references (articles, books, reviews in Electronic databases: MDPI, Science Direct, Springer, ACS, RS, Pub Med, Pub Chem., Google Scholar...) were performed since 1981 until our days, to study evolution of scientific research on *Ceratonia siliqua* L. in time, and how it performs in regard of varying fields: ethnobotany, ethnopharmacology, Chemistry, Nutrition, Biological and Biotechnogical applications in order to extract maximum informations concerning investigated plant.

3. Results and Discussion

According to our review, scientific researches are generally increasing for example we identified 872 Articles for 2000 and 620 Articles for 2010, highlighting by the way growing interest, currency and relevance of studied plant. Obtained results, lead to enumerate achievements and lacks which could be interesting to investigate in the future.

3.1. Origin and Geographic Distribution

De Candolle (1883) and Vavilov (1951) reported carob tree origin to Turkey and Syria region, while Schweinfurth (1894) reported it to Yemen region. Nowadays it is extended around Mediterranean region from Spain and Morocco to Turkey [12,13], and is introduced in many other countries: USA, Australia, Argentina, India... [14].

It is grow in holm oak stand in association with *Olea europea* et *Pistacia lentiscus* [15], and is restant to salent poor soils, and sub-arid climate [16,19] which make it a natural green fence against soils degradation, erosion and desertification [18,20].

3.2. Current Uses

3.2.1. Traditional Use

Several ethnopharmalogical surveys reported carob tree among most cited plants by herbalist and local informant for nutritional value and treating gastro-intestinal system diseases [21,24].

3.2.2. Food Industry

Carob pod pulp is used as cattle feed in addition to barley floor [25,26].

Carob flour obtained by grinding terrified dried pods after shelled, is widely used in dietary food industry due to its high content in sugars, free gluten and phenols which is recommended for oeucolic persons [17,27–28], it is also used in preparation of milk flour [29–31], drinks, citric acid, jams, sirup, honey [13,15,32] as substitute of cacao in chocolate and biscuits [29].

Seeds tires is used as substitute of pectin, gelatin, stabilizer, fixer in several products such as cheese, sauces, mayonnaise; it is also used as thickening E410 in candy production [33].

3.2.3. Cosmetology

Due to its capacity to form viscous solutions at low concentrations, its thinking, emulsifier and stabilizing proprieties [14,34,35]; it is used as natural adjuvant in soaps, creams, toothpaste... [36].

3.3. Chemical Composition

3.3.1. Primary Metabolits

- Carob tires

Major constituent of carob tires is a galactomannane (80–85%), a polysaccharide present in carob seeds [37], in addition to 13% of lipids; 4% of proteines, 1–4% of celluloses and lignin and 1% of ashes and water content [38].

- Pod pulp

Pod pulp is rich in simple hydrocarbs (saccharose, fructose, glucose) and fibers [39,40] and its content depends on culyivars, soils, seasons and climates. [14,41–44]. Algerian cultivars reports 37,5 to 45,3% total sugars content, and according to Avallone (1997) [45], the average composition is 27–40% of Saccharose, 3–5% of Glucose, 3–8% of Fructose, 2–6% of Protéines, 0,4–0,6% of Lipids, 2–3% of ashes and 27–50% of Fibers.

3.3.2. Secondry Metabolits

- *Phenols*

Carob is an interesting phenols source (16–20%) [45,46], with a high molecular weight even in comparison with other plants [47], responsible of its antioxidant activity [48,49].

According to Owen (2003), flavones content in carob is about 0.132 g/kg) [42], Würsch (1984) and Saura-Calixto (1988) reported a tannin content of 16–20% on dry weight in pods [47,50].

Kamal K. et al. (2013), reported that coumarins content in carob flour is about 4,49 ppm while lignins are about 33.06 ppm [51].

3.4. Nutritional Value

Carob fruit is relatively caloric sice 100 g of caroub flour give about 222 kcal/933 kJ [51].

3.5. Biological Activities

3.5.1. Antioxydant Activity

Several phytochemical studies were realized using DPPH and ABTS tests showing an important antioxidant activity [17,49,52–53].

3.5.2. Aticancer Activity

Polyphenols and fibers are offently reported as cancer inhibitors especially colorectal one which is negatively correlated to a rich fiber diet [54]. Consequently, carob fibers are potent agents in cancers prevention [55].

3.5.3. Antihyper Lipidic Activity

According to Valero-Munoz (2014- 2017) studies, carob fibers are active in the treatment of blood lipid troubles due to the high quantity of insoluble fibers: cellulose and hemicelluloses and/or polyphenols in carob fibers [57].

Carob gum as soluble fiber has the potent to lower plasmatic blood cholesterol value [57]. Moreover, Carob fibers hypocholesterol agent derivative was patented [58].

3.5.4. Antidiabetic Activity

In vitro studies reported Carob gum as a blood glicemian reductor [59].

3.5.5. Antireflux Activity

Prior studies, reported Carob gob as infants reflux reductor and its symptoms[60–62].

3.5.6. Antidiarrehal and Antibacterial Activity

Kivçak, et al. (2002) found positive results for *Ceratonia siliqua* L. leaves inhibitory effect on different *Escherichia coli strains, Staphylococcus aureus and Staphylococcus epidermidis,* thus, glyconutriments in Carob act as prébiotiques, which make it a diarrhea natural treatment [49,63].

4. Conclusions

The present bibliographic mini review on carob tree and its organic derivatives (pods, pulp, seeds, flowers, leaves), exhibits its richness in several primary (fibers, hydrocarbs) and secondary metabolites (phenols, Gallic acids, catechins, quercetin, tannins...) which content and profile depend on plant studied part, soil, climate, cultivar, extraction and characterization methods. Besides, an important antioxidant activity, a high nutritional value and dietary profile make its plant parts derivatives very interesting functional foods, dietary supplements, adjuvant in pharmaceutics, nutraceutical, to treat several chronically diseases related to nutrition such as cancer, diabetes, ulcer, gluten intolerance.

In this regard, a range of dietary products was developed in our laboratory: free gluten floor, molasses, vegetable milk, tires, to promote local organic products for a sustainable eco-responsible economy.

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