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SOME PROPERTIES OF CAROB POD AND ITS USE IN DIFFERENT AREAS INCLUDING FOOD TECHNOLOGY

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Abstract

Carob (Ceratonia silliqua) is an evergreen, drought resistant tree. It has a good nutritional value, a long shelf-life (2-3 years) and it is relatively cheap. Due to its high sugar content, carob is naturally sweet. This property makes it usefulin, as an antioxidant in different foods, as a thickener, stabilizer or flavourant in food applications, in ethanol, lactic acid production, in medical applications, in cosmetic emulsionsetc. In food research, new product development of carob could contribute greatly to the promotion of carob as a food source and hence towards its commercial value. Carob's application in the food industry is mainly focused on the extraction of carob bean gum (locust bean gum). The use of the deseeded pod in food is, however, minimal and thus carob's economical market value is low. The current world production of carob extracts is estimated at 315000 tons per year, with Spain being the main producer and exporter (42%) and followed by Turkey with 5% in the Mediterranean and Aegean region. This review is focused mainly onthe properties of carob tree, chemical composition, human and animal nutrition, medical applications, health benefits, polyphenol content, and antioxidant properties of carob pod and the use of carob pod in different areas.

Key words: *carob tree, food technology, antioxidant properties, animal and human nutrition*

INTRODUCTION

Carob pods have been used in many countries as an antioxidant in different foods, as a thickener, stabiliser or flavourant in food applications, in ethanol production,in the production of cosmetics, in animal nutrition, in lactic acid production and in medical applications etc. The use of carob pods in food dates back to ancient times, where the pods are reported that in raw form have been consumed(Brandt, 2002; Haber, 2002; Owen *et al.*, 2003).

The carob pods have got especially polyphenolic compounds, carbohydrates and contain low amounts of insoluble dietary fibers, minerals, lipidsand proteins. Due to its composition carob pods are also used in animal nutrition (Avallone, et al., 1997).

Due to the presence of free sugars, organic acids and amino acids are natural constituents of many fruits and vegetables and play an important role in maintaining quality and determining nutrititive value (Ashoor and Knox, 1982). The nature and the concentration of these constituents in fruits are also of interest because of their important organoleptic properties. Free sugars are one of the most important constituents of fruits and vegetables. Other using area are in the production of traditional foods such as confectioneries, beverages, in production of bread or pasta in a few countries in the Aegeanregion. It is given below a reviewabout the use of carob pods.

1. Properties of carob tree

Carob is found not only in wild form but also in cultivated forms(Biner et al., 2007).Carobs have been cultivated for 4.000 years. The world's commercial carob is supplied from Portugal and Spain, approximately 100.000 ha of carob trees.The current world production of carob extracts is estimated at 315.000 tonnes per year, although there are no accurate statistics available about annual world production, with Spain being the main producer and exporter (42%) and followed by Turkey with 5% (Biner et al., 2007; Makris and Kefalas, 2004).

The carob tree belongs to a member of legume family, botanically known as *Ceratonia siliqua* L. which is called as Locust bean gum (LBG). The tree is known to be an important component of the vegetation and is economically important. The carob seed consists of three partsi.e., germ, endosperm and husk. In many regions, locally grown vegetables and fruit contribute substantially to local diet and due to its edible fruits, the plant has been cultivated (Avallone et al.,1997; Dakia et al., 2007; Yousif and Alghzawi, 2000). The fruit is a pod with pulp and seed, the pulp being 90% of its total dry weight (Correia and Martins-Loução, 2004).

Carob trees are resistant against drought; require little maintenance and produce a range of products from the seed and the pod (Fletcher, 1997). It grows very well at between 30° and 45°C but it is also tolerant to the hot and humid coastal areas with hot winds (Zografakis&Dasenakis, 2000, Tous et al., 1996).

The carob tree is used for various purposes suitable for preventing soil erosion and for rural area development in the Mediterranean, in the industry, forestation, prevention, as ornamentals (Turhan et al., 2006; Tous et al., 2009; Gubbuk et al., 2009). "Carob Kernel" or seeds are very important for Locust BeanGum industry (Battle and Tous, 1997b; Karkacier et al., 1995; Gubbuket al., 2010).

2. The chemical composition of Carob Pods

The nonfleshy bean-like fruit of carob tree (Chamberlain 1970; Ayaz et al. 2009), which is called carob pod, is light to dark color and straight or slightly curved in shape. Locust bean gum contains non starch polysaccharides consisting of galactose and mannose in the ratio 1:4 and hence they are known as galactomanan (Parvathy et al., 2005).The fruit and its products, are sold both in large stores and local markets,and they contribute strongly to the diet of people living in the Mediterraneanareas of Europe and also in Turkey (Ayaz et al.2007).

Except for polysaccharides carob pod contains low levels of fat and it is rich in potassium, calcium and polyphenols.

The pod consists mainly of pulp (90%), which is rich in sugars (48–72%), but also may contain a large amount of condensed tannin, which are bitter-tasting chemical compounds that bind proteins. In table 1 is shown the chemical composition of carob pods. It can be seen that the concentration of each component is variable and the composition depends on the variety, climate and growingtechniques (Tous, 1990; Petit et al., 1995; El-Shatnawi, 2000; Morton, 1987) in a wide range.

Table 1: Proximate composition of carob pods (Calixto and Cańellas, 1982; Marakis, 1996; Avalloneet al., 1997; Battle andTous, 1997b; Yousifand Alghzawi, 2000; USDA, 2006)

Chemical constituent	Concentration (g.100 g^{-1})
Moisture	3.6-18
Ash	1-6
Fat	0.2-2.3
Protein	1-7.6
Carbohydrates	48-88.9
Total sugars	32-60
Dietary Fibre	2.6-39.8
Polyphenols	0.5-20

3. Effect of polyphenol content on the antioxidant and medicinal properties of Carob

Phenolics are compounds with an aromatic ring bearing one or more hydroxyl groups. Polyphenols occur in foods of plant origin and because of their antioxidative properties ability to modulate several proteins, polyphenols generally have beneficial effects on human health once consumed (Vinson, 2001; Sakakibaraet al., 2003). However, data on carob's antioxidant properties and the core functionality, with relation to its polyphenolic components, is still limited. Moreover, the profile as well as the nature of polyphenolic components of carob pods are still not fully understood.

Synthetic and natural antioxidants are used successfully to block or delay the oxidation process in meats (Cross et al., 1987).

Due to their safety and toxicity problems of synthetic antioxidants,there is increasing interest in use of natural antioxidants (Li et al. 2011; Ahn, et al., 2002). Moreover, as well as increasing lipid stability,an antioxidant added to a food product may act as an antioxidant in the body, thus reducing the risk of various diseases related to the production of free radicals (Bravo, 1994; Boskou, 1999). Therefore, there is an increasing interest in the natural antioxidants,e.g. polyphenols, present in medicinal and dietary plants,which might help in preventing oxidative damage.

The recent investigations showed that antioxidant properties, responsible for the majority of observed biological effects of carob flour, can to be significantly influenced during roasting (Sahin, et al., 2009). It was found that certain phenolic compounds can degrade during roasting. Polyphenols exhibit a wide range of biological properties, and the antioxidant activity is the best known. Phenolic antioxidants prevent against oxidative damage of some important biomolecules like DNA, protein, and lipids and leads to degenerative diseases such as cancer, inflammatory, cardiovascular. (Scalbert et al., 2005).

4. Use of Carob Pob in animal nutrition

Main carob bean producer and exporter countries are Spain, Italy, Portugal, Morocco,Greece, Cyprus and Turkey (Roukas, 1994b; Catarino, 1993; Battle and Tous, 1997b; Race et al., 1999; Tunalıoğlu and Ozkaya, 2003). Carob pods and seed seem to be promising as anon-conventional feed resource that can be used for small ruminants feeding. Guessous et al. (1989) reported that increasing lambs fed diets with 200 g/kg carob meal obtained more than 200 g/d and decreased the time needed to reach significant weight. For centuries, due to the high sugar content, carob pods have been used as animal feed (Battle &Tous, 1997a; Würschet al., 1984). When fed to animals in feeding trials, carob pods have been shown to give results similar to those reported for barley. Cattle, horses, goats and sheep have also been reported to feed on the lower leaves and branches of the carob tree (Marakis, 1996).The carob tree is highly recommended for use as feed supplement for animal farming in drought stricken regions (Battle andTous, 1997a).

Carob pulp as a favourable fatty acid composition due to the presence of essential fatty acids, such as linoleic and alpha-linolenic acids (Ayaz et al., 2009)and might represent a natural source of desirable fatty acids in the diets of concentrate-fed animals. In the studies is conducted to evaluate the possibility of feeding carob pulp to livestock have mainly focused on ruminants (Silanikove et al., 2006; Priolo et al., 2000). For humans, carob pods have been used primarily in traditional foods.

5. Use of Carob pod in Food Technology

From the seed of carob, the endosperm is extracted to produce a galacto mannan, which forms locust bean gum, a valuable natural food additive for its strong gel characteristics, which are useful in products such as canned pet food, since they are maintained after heating. The carob pod is used actually as grinded to obtain carob powder, which can be used for human consumption although high tannin content limits this application.

There are controversy statements regard to tannin content of carob pods. According to Battle and Tous(1997a); Würsch et al., (1984); Bravo et al., (1994) carob pod contains a large amount of condensed tannins (16-20%), according to Youssif and Alghzawi, (2000) carob pods contain lower tannin values. Carob leaves have been reported to contain considerably lower values of 0.7% dry matter basis (Silanikove, 2001).

The main use is the production of carob bean gum from the seed endosperm which is used as the food additive (stabilizer and thickener) in food- and pharmaceutical industry. In addition, carob fruits are used in food industry as a source of many products such as gum, sugar and alcohol (Carlson, 1986).

Carob is used in many Arab countries to make a popular drink which is consumed mainly in the month of Ramadan. Carob is also used in preparation of special traditional types of Arabic confectionery. In western countries, carob powder is produced by deseeding of carob pods, yielding of kibbled carob, followed by roasting and milling of the kibbled carob. Carob juice concentrate (CJC) is produced by boiling carob juices without any added ingredients and technological or scientific techniques. Due to its high sugar content, carob was consumed as a food especially in ancient times, as a sweet for children or in emergency situations such as war (Owen et al. 2003).

Throughout the Mediterranean region including Turkey, gently milled carob pods are processed to a cocoa-like flour which issold as a "*carob cocoa*" in big stores and local markets. The milled flour is often added to hot or cold milk for drinking (Morton, 1987).

6. Health benefits

The reason of using carob as a chocolate substitute resides in that carob is an ingredient free from caffeine and the obromine. High glycemic index (GI) and glycemic load (GL) have been proposed to be associated with increased risk of chronic diseases. High GI food intake may elevate postprandial blood glucose levels, leading to high insulin demand. Some studies have shown that the consumption of low glycemic index food improves blood glucose control, lipid profile and lipo protein concentrations. Some other benefits are known as the prevention of coronary heart diseases, cancer prevention, promotion of anti-allergy effects and vaso-relaxation (Sakakibara et al., 2003).

7. Ethanol/Lactic acid Production

Raw materials containing fermentable sugars (e.g., sugar cane, sugar beet,sweet sorgum and carob), hydrolyzable polysaccharides (wheat, maize,and other starch-containing grains) are used also for bioethanol production. Due to high carbohydrate content, it is possible to use of carob interesting source for bioethanol production.Carob pod has usually been neglected for a long time alternative utilization especially about biotechnological processes and fermentation. In recent years, carob has attracted considerable attention because of high carbohydrate and mineral content (Li et al., 2011). Many high value-added products are produced such as lactic acid,(Turhanet al., 2010) mannitol (Carvalheiro et al., 2011) citric acid (Pramod and Lingappa, 2012) and pullulan (Roukas and Biliaderis, 1995) were produced by using carob via fermentation process.Turhan et al., (2010) performed that ethanol production from carob pod extract by using *Saccharomyces cerevisiae*. The final ethanol concentration, and maximum production rate were found to be 42.6 g/L and 3.37 g/L/h, respectively. Vaheed et al.,(2011) investigated also that ethanol production from carob pod extract. The carob pod is used actually as animal feed or is grinded to obtain carob powder, which can be used for human consumption. The production of ethanol from non sterilized carob pod extracts using *Saccharomyces cerevisiae* could be investigated (Roukas, 1994a, b, c).

CONCLUSIONS

Carob seeds are the largest output of the locust bean gum in food industry. Thus, the industrial target is to get high seeds yield with high nutritional properties. Indeed, carob rich in sugars, polyphenols, fibre and minerals are interesting for health consumer particularly in food industry, medicinal and pharmacological industries. Due to its sweetness and flavor similar to chocolate, the pods milled into flour are used in the Mediterranean region as cocoa substitute for sweets, biscuits, and processed drinks production. And another property it can be concluded that carob pod contains antioxidant substances such as polyphenols, which exhibit a wide range of biological properties, and among these, the antioxidant activity is the best known. Phenolicantioxidants prevent against oxidative damage of some important biomolecules like DNA, protein, and lipids.

Another area for using carob pods is known in production of ethanol and different kind of acids, which is explained below:

1. raw materials containing fermentable sugars (sugar cane, beet and sweet shorgum),
2. polysaccharides that can be hydrolyzed for obtaining fermentable sugars (starch contained in several grains, like maize and wheat) and
3. lignocellulosic biomass

The production of lactic acid using fermentation has several advantages compared to chemical synthesis because of low-cost substrates and low energy consumption. It may be expensive when purified sugars such as glucose and sucrose are used as a feedstock. Therefore, agricultural by products or residues are the cheaper alternatives to refined sugars for lactic acid production (Hofvendahl and Hagerdal, 2000).

The RCSF (a raw carob seed flour) and GERM (grinding of germs) flours are therefore interesting sources of insoluble fibre and compounds with antioxidant activity, lignan in particular. Carob seed flours could be used as an alternative raw material and incorporated as an ingredient in new food formulations. In particular, the antioxidant properties of the carob seed flours make them a potentially interesting ingredient for functional foods.

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