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Carob Bean (Ceratonia siliqua L.) and Its Products

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ABSTRACT: *Carob bean (**Ceratonia siliqua** L.) can be seen in Mediterranean climate regions. Carob fruit has high amounts of nutrients such as sugars, minerals and phenolic compounds. Main idea of consuming carob is to take energy from a natural source. Furthermore, carob is also used for producing some commercial products. Flour (powder), syrup, locust bean gum and d-pinitol are the examples. Carob flour produced from deseeded carob by roasting and grinding. It is a substituent of cacao in food industry. In Turkey, carob bean consumed as carob syrup the most. It is a traditional product obtained by extraction and evaporation respectively. Locust bean gum is a food additive and produced from seeds. D-pinitol is a bioactive compound and there are many researches about the effect of D-pinitol on diabetes and some cancer types. In the world, there is an increase in some nutrition originated diseases. For preventing this, nutritional habits should include unrefined energy sources. Carob is an option for taking unrefined sugar, minerals and phenolic compounds at once. The aim of this review is to gather different information about carob and its products and form a source for further researches.*

Keywords: *Carob bean, **Ceratonia siliqua** L., carob powder, carob syrup, locust bean gum, dietary fiber, D-pinitol.*

Keçiboynuzu (Ceratonia siliqua L.) ve Ürünleri

ÖZ: *Keçiboynuzu (**Ceratonia siliqua** L.) Akdeniz ikliminin görüldüğü bölgelerde yetişen şeker içeriği yüksek bir meyvedir. Zengin şeker içeriğinden kaynaklanan doğal olarak enerji verici olması özelliğinin yanı sıra mineral ve fenolik maddelerce zengin olma özelliğiyle yetişkin ve çocuk beslenmesinde önemli bir yere sahiptir. Keçiboynuzu aynı zamanda çeşitli ticari ürünlerin üretiminde de hammadde olarak kullanılmaktadır. Keçiboynuzu unu, pekmez, gam ve d-pinitol bu ürünlere örnektir. Keçiboynuzu unu, çekirdekleri alınmış keçiboynuzunun fırınlanması ve öğütülmesi ile elde edilmekte olup gıda endüstrisinde kakao ikamesi olarak kullanılmaktadır. Ülkemizde keçiboynuzunun en yaygın tüketim şekli pekmezdir. Geleneksel bir ürün olan pekmez keçiboynuzunun su ile ekstraksiyonu ardından yoğunlaştırılması ile elde edilmektedir. Keçiboynuzu gamı çekirdeklerden üretilir ve gıda katkı maddesi olarak kullanılmaktadır. D-pinitol biyoaktif bir bileşendir. Günümüzde d-pinitol'ün diyabet ve çeşitli kanser tipleri üzerine olan etkilerinin araştırıldığı çalışmalar mevcuttur. Dünyada beslenme kaynaklı hastalıkların görülme sıklığı artmaktadır. Beslenme alışkanlıklarının işlenmemiş gıdaları tüketme yönünde değişmesi bu tip hastalıkların önlenmesinde önem taşımaktadır. Keçiboynuzu işlenmemiş gıdalar arasında hem enerji verici olması hem de mineral ve fenolik maddelerce zengin olması nedeniyle iyi bir seçenektir. Derlememizin amacı keçiboynuzu ile ilgili çeşitli bilgileri bir araya toplayarak gelecekteki çalışmalara kaynak oluşturmaktır.*

Anahtar Sözcükler: *Keçiboynuzu, **Ceratonia siliqua** L., keçiboynuzu unu, keçiboynuzu pekmezi, keçiboynuzu gamı, diyet lifi, D-pinitol.*

INTRODUCTION

Carob (*Ceratonia siliqua* L.) is an evergreen tree belongs to *Leguminoseae* (*Fabaceae*) family and *Caesalpinaceae* sub-family. It has wild and cultivated types. Turkey has a wide area for both types of carob bean. Carob tree is grown since antiquity in most countries of Mediterranean basin and it has an important value from economic and environmental point of view (Battle and Tous, 1997).

Carob bean is a rich source of valuable compounds such as phenolic compounds, minerals, dietary fiber and d-pinitol. Chemical composition of carob varies with genetic, environmental, climatic factors and harvesting time (Nasar-Abbas *et al*., 2016). Carob bean consist of 90% eatable part and 10% seed. The unripe pod is green and acrid, ripe one is brown and sweet.

Carob fruit has high amounts and varieties of nutrients (Karkacier and Artik, 1995; Owen *et al*., 2003; Anonim, 2017) such as sugar, dietary fiber, minerals, and phenolics. It has 62-67 % total sugar, 4-6 % protein, 23-27% dietary fiber (Table 1). 100 g deseeded carob fruit gives 293 kcal energy (Anonim, 2017).

Table 1. Composition of carob bean.
Çizelge 1. Keçiboynuzu meyvesinin kompozisyonu.

Constituent Bileşen	Amount (%) Miktar (%)
Total dry matter Toplam kuru madde	91 - 92
Total sugar Toplam şeker	62 - 67
Saccharose Sakkaroz	34 - 42
Glucose Glikoz	7 - 10
Fructose Fruktoz	10 - 12
Protein Protein	4 - 6
Dietary fiber Diyet lifi	23 - 27
Fat Yağ	0,2 - 0,4
Total mineral matter Toplam mineral madde	2,2 - 2,4
Pectic matter Pektik madde	0,03 - 0,05
D-Pinitol D-Pinitol	7 - 10
Total phenolic matter Toplam fenolik madde	3944,7 mg/kg

Carob has several kinds of minerals such as potassium (843-1215 mg/100 g), calcium (251-361mg/100 g), magnesium (63-326 mg/ 100 g), phosphorous (85-681 mg/100 g) (Table 2), and also it has 3944.7 mg/kg total phenolic matter. It has been detected that carob fruit has 24 different phenolic compounds and also gallic acid is the most commonly found (Owen *et al*., 2003).

Table 2. Mineral content of carob bean (Anonim, 2017).
Çizelge 2. Keçiboynuzu meyvesinin mineral madde içeriği (Anonim, 2017).

Minerals (Mineral)	mg /100 g
Potassium (Potasyum)	843 - 1215
Calcium (Kalsiyum)	251 - 361
Phosphorus (Fosfor)	85 - 681
Magnesium (Magnezyum)	63 - 326
Sodium (Sodyum)	4 - 7
Selenium (Selenyum)	0 - 5,9
Iron (Demir)	1,25 - 5,44
Zinc (Çinko)	0,61 - 4,27

CAROB BEAN PRODUCTS

Carob bean is also used for producing some commercial products. Powder (flour), syrup, locust bean gum and D-pinitol are the main examples of these products.

Carob powder (flour)

Carob powder is produced by crashing, roasting and grinding of deseeded carob respectively (Yousif and Alghzawi, 2000). It can be named as 'functional ingredient' and promotes nutritional value of foods prepared with (Seczyk *et al*., 2016). Carob flour can be used as fortification agent for products such as tarhana, pasta and some diet products (Tsatsaragkou *et al*., 2012; Tsatsaragkou *et al*., 2014; Seczyk *et al*., 2016; Çağlar *et al*., 2013).

Carob flour is used as cacao substituent. Unlike cacao, carob flour does not contain caffeine and theobromine (Ayaz *et al*., 2009). Rosa *et al*. (2015), have researched on replacing cacao powder with carob flour in different ratios for producing gluten free cakes. Final product described as rich in protein, low in calorie, pleasant sensory characteristics and suitable for people with celiac disease.

Carob syrup

Carob syrup is called as 'pekmez' in Turkey. Pekmez is a traditional product, obtained by extraction and evaporation of deseeded carob bean.

Carob syrup is rich in polyphenols, vitamins and minerals. Also it provides high energy to people.

Locust bean gum

Carob seed has three parts; Husk- Endosperm-Germ. Isolated endosperms are subjected to grinding, sifting, grading and packaging. It is a creamy white powder obtained after milling of carob seed endosperm. It is also known as locust bean gum. Locust bean gum is widely used as an additive in food industry. The main property of this gum is performing high, viscosity gel structure at wide pH range. It is used in several kinds of foods as stabilizer and thickener (Barak and Mudgil, 2014).

Dietary fiber

Carob fiber is the main by-product of carob syrup production. Mostly consists of insoluble fibers. Its glycemic index is very low. Their digestion occurs slowly. That means, blood sugar increases slowly when consumed (Anderson *et al*., 2009). Nutrition with fiber rich foods such as carob provides colon health. There are some different researches about colon health and carob (Ferguson, 2005; Klenow *et al*., 2008; Klenow *et al*., 2009; Klenow and Glei, 2009). Carob fiber has a great potential for producing supplements and functional foods (Santos *et al*., 2015).

D- Pinitol

Carob fruit is a source of a bioactive component called 'D-Pinitol'. It can obtain by several methods such as using ion exchange resins and supercritical fluids (Chul-Shin *et al*., 2003; Karhan *et al*., 2010; Alper, 2016).

D-pinitol's name comes from *Pinus lambertiana* where it has extracted first (Anderson, 1952). In addition to carob, soy bean, carnation, pine tree are other example of d-pinitol sources (Ichimura *et al*., 1998; Do, 2007).

Diabetes is a disease related with insulin and blood sugar regulation. D-Pinitol can mimic the ability of insulin, for lowering and balancing the blood sugar, in diabetes type 2 patients (Camero and Merino, 2004). Diabetes and d-pinitol relation is an important topic for global world and there are different researches about this subject (Ortmeyer *et al*. 1992; Ostlund and Sherman, 1996; Nestler *et al*. 1999; Davis *et al*., 2000; Kim *et al*., 2005).

Benefits of Carob and Its Products

The main idea of consuming this fruit is taking energy from a natural source. In our world, this kind of human diets, which includes unrefined energy sources are more beneficial for human health (Pazır and Alper, 2016).

In many developed countries, there is an increase in deaths from cardiovascular diseases. Nutritional habits should include rich dietary fiber intake for decreasing cholesterol level which is an important factor for cardiovascular diseases (Köksel and Özboy, 1993). Also dietary fiber rich nutrition provides positive effects on colon health. Hassanein *et al*. (2015) have researched the effect of carob powder on lipid profile of rats. Results show that, carob powder improved lipid profile parameters such as total cholesterol and LDL cholesterol. Carob has positive effects on cardiovascular health (Kumazawa *et al*. 2002; Ruis-Roso *et al*. 2010).

In human metabolism, d-pinitol can act like insulin and helps to decrease and balance glucose level in blood (Camero and Merino, 2004).

CONCLUSION

In the world, there is an increase in some nutrition originated diseases. For preventing this, nutritional habits should include unrefined energy sources. Carob is a suitable option for taking unrefined sugar, minerals and phenolic compounds at the same time.

In addition, carob tree can prevent soil degradation. For poor soils, carob tree is valuable from agricultural point of view.

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