

CHESTNUT FLOUR AND APPLICATIONS OF UTILIZATION

Merve METE¹, Dilek DÜLGER ALTINER^{2*}

Abstract

In recent years, with the increasing of people's interest in nutrition and health subjects, importance of nutrition has been increased steadily and number of studies on enrichment of foods and production of functional products have been increased. Enrichment of foods is one of the developed applications for solution of health problems which are likely to be seen in society. For this purpose, various foods having various properties are being developed with the use of different fruits and vegetables' flours.

Chestnut has a rich nutrition items, it has been used since previous times in nutrition and in daily diets due to being grown at natural conditions as well. Basically, being composed of carbohydrate, water, and a very low amount of fat, chestnut shows cereal features rather than fruit. When grinded, chestnut becomes a light-colored flour. This flour is used in puddings, bakery products, and production of bread, breakfast cereals, soup and sauces.

In food industry, there are intensive studies on the production of especially cereal products with different wheat flour and different flour additives. In the light of these studies, some Europe countries, mainly in Italy, especially use of chestnut is being widespread in commercial scale in the production of biscuit, breakfast cereal, muffin and dessert. Instead of wheat flour chestnut flour is used or added in different substitution rates. Within the scope of this review, properties of chestnut fruit, nutritional facts of chestnut, chestnut flour and properties, utilization of chestnut flour in food industry were discussed.

Keywords: Chestnut flour, cereal products, nutrition, enrichment

1. Introduction

Enrichment of foods is the addition of one or more nutrition items that are insufficient or absent and is to improve the properties. Research for the investigation of functional, nutritious and sensory quality of properties is increasing day by day. Main purpose of the production of food is to provide people with healthy and happy lives delivering safe and high nutrition value foods. Recent adaptation of people for a healthy and balanced life style and increased awareness have added strength to improvements in functional food market.

Therefore, there are studies going on for development of alternative flour additives and for usage of them in foods. Beyond supplying needs

of basic nutrition items in the body, foods or food components that provide additional benefits to human physiology and metabolic functions and that are more affective in succeeding a healthier life should be produced. In the food industry, many studies have been carried out, especially on production of cereal-based functional foods. In this review, chestnut flour, limited in production and used for product development, and studies for its usage are were discussed.

Chestnut fruit and its properties

Chestnut is a closed-shell fruit of trees that form *Castanea* genus from the *Fagaceae* family and forming the edible seeds of this trees. Leaves of chestnut are a bit stiff, the edges are saw tooth shaped and these teeth have thorns. Being

¹ Istanbul Aydın University, Graduate School of Natural and Applied Sciences, Department of Food Engineering, Istanbul/ TURKEY, mervemete4@gmail.com

^{2*} Corresponding author: Istanbul Aydın University, Faculty of Engineering, Department of Food Engineering, Istanbul/ TURKEY, dilek.dulgeraltiner@gmail.com

members of the *Fagaceae* family, chestnuts (*Castanea*) can live for many years and reach up to 30-35 meters in length (Subaşı, 2004; Atasoy and Altıngöz, 2012).



Figure 1. Chestnut fruit

Cool, moist and temperate place are growing areas for chestnut fruit. Therefore, Asia (China, Korea, Japan), Turkey, South Europe and North America are substantial places for production (Bodet et al., 2001). Turkey is one of the substantial areas of chestnut, and it is spread more likely in Aegean, Mediterranean and Black sea regions (Soylu, 1984; İnkaya, 2008).

Being grown completely in natural conditions and an organic food item, chestnut has been an irreplaceable part of our nutrition list. That is why chestnut tree, in some regions, is known as “the bread tree” due to high nutrition value of its fruit (Bounous et al., 2000; İnkaya, 2008). Fresh chestnut has primarily starch and various polysaccharides, fiber materials with high quality, protein, fat in low amount, various mineral materials, B1, B2 and C vitamins. It also contains potassium, phosphorus, magnesium, chlorine, iron, sodium minerals, too (Sachetti et al., 2004; Chenlo et al., 2007).

Following is the composition of chestnut fruit grown in Turkey (Table 1).

Table 1. Composition of chestnut fruits grown in Sinop-Erfelek Region of Turkey (in 100 gr) (Subaşı, 2004)

Analysis	Minimum Value	Maximum Value	Average Value
Shell Thickness (mm)	0.30	0.71	0.51
Protein (N. X. 5.30) g	3.43	8.27	5.683
Fat g	0.66	3.08	1.89
Starch g	29.88	63.66	47.32
Fiber g	0.06	0.29	0.129
Ash g	1.40	4.92	2.809
Phosphorus mg	47.68	229.68	133.67
Calcium mg	69.71	201.70	87.863
Magnesium mg	59.71	202.89	105.87
Zinc mg	2.63	21.87	6.970
Iron mg	1.84	16.99	6.684
Copper mg	0.33	1.29	0.738

Chestnut fruit, in general has 40-45% water, 3-6% protein, 3-5% fat, 40-45% carbohydrate, 1.3% ash. However, these values may vary based on the ecological conditions, type, genus and process (Soylu, 2004). In the following Table 2, composition of chestnut fruit in different conditions and nutrition items are illustrated (Subaşı, 2004; Atasay and Altıngöz, 2012).

Table 2. Composition of chestnut fruit in different conditions and nutrition items (in 100 g) (Subaşı, 2004; Atasay and Altıngöz, 2012)

Analysis	Fresh	Dried	Fried	Scalded	Flour
Carbohydrates	34	57.8	39.0	24.4	63.6
Sugars	9.6	16.1	10.7	7.5	23.6
Starch	24.4	41.7	28.3	16.9	40
Fiber	7.3	13.8	8.3	5.4	14.2
Soluble	0.6	1.1	0.7	0.6	1.0
Insoluble	6.7	12.7	7.6	4.8	13.2
Protein	3.2	6.0	3.7	2.5	6.1
Fat	1.8	3.4	2.4	1.3	3.7
Moisture (%)	52.9	10.1	42.4	63.3	11.4
Calori (kcal)	160	287	200	120	343

Even though in stiff-shell fruits the fat content is high, in chestnut carbohydrate content is high. In their study, Ertan and Kılınc (2005) found carbohydrate values between 24.53 and 31.56 g/100g. Some researchers found carbohydrate contents, based on the genus of chestnut, as in the range of 71.68-88.10 g/100g (Bounous et al., 2000, Kunsch et al., 1999, McCarthy and Meredith, 1988; İnkaya, 2008).

In another study, sugar and starch rates are found as 60-70% and 20-30%, respectively (De La Montaña-Miguel et al., 2004, Moreira et al., 2012). Most of the sugar content constitutes saccharose and saccharose contents of different varieties are found generally 8-20 g/100g (Kunsch et al., 2001; Senter et al., 1994).

Neri et al., (2010), starch content in fresh chestnut is around 71% and sugar (especially sucrose, glucose, fructose) content is varying between 9.2 and 23%. While starch in the fruit releases its unique taste when cooked, sugars provide the sensory properties to be felt (Riberio et al., 2007; Miquelez et al., 2004).

Pereira Lorenzo et al. (2006) investigated that chestnut has a lower but a high-quality fat content compared to other nuts. Yang et al. (2015) revealed that the content in 10 different chestnuts grown in China is 4.3-10.2% while Neri et al. (2010) investigated that the fat content is varying between 3.27-4.15% in a chestnut genus grown in Italy. Besides of this, chestnut has significant fatty acids in addition to low fat content. In a conducted study, researchers determined 7 different organic acids in chestnut. These are citric acid, oleic, oxalic, quinic, ascorbic, cis-aconitic and fumaric acids Ribeiro et al., 2007). These organic acids are stated as beneficial for human health due to their antioxidant capacities.

Minerals are significant in healthy and balanced nutrition. Chestnut is a significant food item in terms of potassium while it contains minerals like iron, calcium, magnesium, manganese, potassium, phosphorus and zinc. In a conducted study, it

was investigated that the amount of potassium in chestnut is between 473 and 974 mg/100g. Phosphorus is the second most important mineral in chestnut and its amount is between 104 and 148 mg/100g in chestnut. Potassium is an essential mineral for protein synthesis while it provides liquid balance in the body. Phosphorus is an important mineral in terms of development of bone and tooth (İnkaya, 2008).

Kunsch et al. (1999) determined the calcium amount as 0.017-0.033% and phosphorus as 0.050-0.068% in their study. Calcium is a co-mineral for the use of iron in the body and for the diffusion of foods across cell membrane.

Magnesium content of chestnut is varying between 63 and 93 mg/100g while calcium is varying between 41 and 51 mg/100g (Bounous ve diğ., 2000, Ferreira-Cardoso ve diğ., 1993; Neri ve diğ., 2010). Magnesium is a significant mineral playing a role in the relaxation of neural system and muscles.

Chestnut is one of the most fiber-containing nuts. Fresh chestnut contains 8-10 g/100g fiber material (Anonymous, 2016a). Dietary fibers, as well as their functional and technological properties, are the components that have protecting effects on diseases such as diverticulum, constipation, colon cancer, obesity, diabetes and cardiovascular (Dülger and Şahan, 2011).

Chestnut flour is being used widely in cake, cookie, pasta, milky pudding products, bread, breakfast cereals, soups, sauce and gravies. As a result, interest in chestnut is increasing day by day due to the potential effects of it on nutrition quality and health.

2. Chestnut flour production

Chestnut flour is gluten-free flour that does not contain additive addition, is prepared naturally, by freeze drying or scalding drying methods (Seferoğlu, 2012).



Figure 2. Chestnut Flour

In the first step of chestnut flour production, chestnuts are cleaned and separated with respect to their sizes (Figure 2). They are immersed in water for 1 day. Therefore, they easily peeled from their shells. The grinding process is performed after softened chestnuts are separated from the shells by the steam pressure system. Drying process is performed in low-temperature drying ovens so that nutrition values in chestnuts are not affected. Following the drying process, cooling process is performed at room temperature and flour is sifted through appropriate-sized sieves and the packaging process is started. Storage is done at normal conditions (+4°C) (İnkaya, 2008).

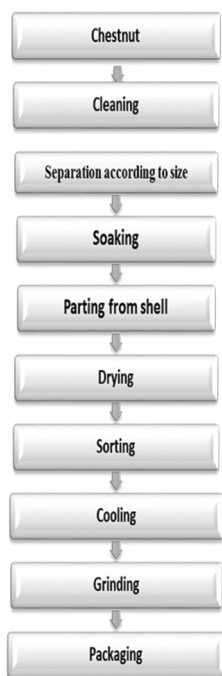


Figure 3. Chestnut flour production steps

3. Chestnut flour and studies for utilization

Chestnut flour can be used for celiac patients due to being gluten-free as well as its nutritious properties. Some researchers investigated that chestnut flour can be used as an alternative to cow milk in the preparation of dessert and soups that are suitable for kids since lactose in cow milk has allergic effects for kids. Chestnut flour also can be used in the preparation of milky puddings, bread, baby formulas, pasta, flakes (corn flakes) (Anonymous, 2016b).

Chestnut flour contains high protein content, high amount sugar (20-32%), starch (50-60%), dietary fiber (4-10%), essential amino acid (4-7%), and low amount fat (2-4%). Also it is rich in vitamins B, C and E and potassium, magnesium and phosphorus (Sacchetti et al., 2004; Chenlo et al., 2007). The use of chestnut flour is thought to be beneficial at this stage since most of the gluten-free products are insufficient in terms of vitamin B, iron and fibers (Seferoğlu, 2012).

There are not many literature sources about chestnut flour. Mert (2012) in the study aimed to produce higher quality gluten-free wafer by mixing rice-corn flour, rice-buckwheat, and rice-chestnut flour in different rates (80:20, 60:40, and 40:60).

Chestnut flour is also used in gluten-free bread preparation due to its nutritional value enhancing effect. In a study for preparation of gluten-free bread, Demirkesen et al. (2010) investigated that chestnut flour contains 10.79% moisture, 47.80% starch, 21.51% sugar, 9.50% dietary fiber, 3.80% fat, 4.61% protein and 1.99% ash. In the study, using some gums and emulsifiers as well as chestnut and rice flour in different portions (0/100, 10/90, 20/80, 30/70, 40/60, 50/50 and 100/0), gluten-free bread was prepared. Rheological, cooking and sensory properties of the bread samples were examined. As a result, it was investigated that the sample 30%/70% chestnut/rice flour mixture has the best cooking property.

In another study, aiming gluten-free bread production, chestnut flour was used and

some physical and chemical properties were investigated during storage. Using chestnut flour in bread samples prepared using gluten-free flours, decreased the volume, and caused hardness inside of the bread but hardly enough in the bread's crust. In addition, in the both bread samples doped by 10% and 20% chestnut flour additives, the antioxidant capacity increased and especially in 20% doped sample an increased was observed in the amount of insoluble dietary fiber. Moreover, chestnut flour provides more stability during the storage protecting the color property of the bread (Pacuilli et al., 2016).

Sacchetti et al. (2004) increased the use of chestnut flour in snacks and similar products and stated that chestnut flour is appropriate for extrusion products. In addition to this, in the study it is mentioned that chestnut flour can be used as functional component in those products and addition of chestnut flour to cereal-based foods is thought to increase some nutritional contents (high dietary fiber, lysine, γ -amino butyric acid, E and B group vitamins), physical properties (textural, density, color) and sensory properties.

Dokic et al. (2014), in their study on the sensory effects of use of chestnut flour additive to cookies, investigated chemical, textural and color properties. They identified that texturally addition of chestnut flour to cookies increased the hardness, and about the color property they reported that luminescence (L) values decreased while red (a) and yellow (b) values increased. Moreover, it was reported that the quality properties of addition of 20% chestnut flour are similar in quality with that of control sample.

İnkaya (2008) in his study produced chestnut flour by freeze drying and scalding the chestnut samples obtained from 3 different provinces (Aydın, Bursa, Kütahya) and used it in three different portions (10, 20, 30%) in biscuit production. It was reported that spreading rate and hardness values of biscuits doped with freeze-dried chestnut flour are higher than that of scalding-dried chestnut flour doped biscuits. Moreover, in the study it was

reported that chestnut flour prevents the spreading rate in especially reduced-fat biscuits and addition of chestnut flour is appropriate flour for the production of standard and reduced-fat biscuits in terms of quality and sensory properties.

Seferoğlu (2012) examined sensory properties of gluten-free cake, bread and biscuit obtained for celiac patients by using chestnut flour in different proportions (20%, 40%, 80% and 100%). As a result of the study, it was reported that chestnut flour is a significant product for utilization in the production of cake, bread and biscuit and the acceptability of it is fairly high in terms of sensory properties. Healthy individuals and celiac patient participated in the study. In both groups, it is mentioned that the sensory scores of products obtained from chestnut flour are higher. In addition, at the end of the study, it is determined that chestnut flour is a delicious product that can be used in the production of cake, bread and biscuit and by mixing with other gluten-free flours to use it is even more appropriate for the general acclaim and cost. Celiac disease (CD, gluten enteropathy) is identified as proximal small intestine disease which is a permanent intolerance mainly against gluten in wheat and other cereals proteins similar to gluten in such cereals like barley, rye, oat in genetically sensitive individuals (In order to contribute to the treatment of this disease by diet, instead of the flours of these cereals different fruit and vegetable flours should be produced).

Dietary fibers, due to many positive effects of them on health, after determination of technological and physical properties, are lately being used to develop some desired properties in foods. Besides, dietary fibers are the main components of today's diet products due to low energy values and causing the feel of fullness. In addition to this, ability of dietary fiber to regulate blood sugar, to decrease the level of cholesterol, to be protective against constipation, obesity, bowel cancer and coronary heart diseases is thought one the positive effects on health (Budurlu and Karadeniz, 2003). Mete and Dülger Altiner (2016) used chestnut flour in order to enrich noodle samples that were

produced in conventional types in dietary fiber and some nutrition items. In the study conducted for chestnut flour-doped noodle, they examined some chemical, physical, cook and sensory properties. They added chestnut flour to the noodle in the following portions; 0%, 5%, 10%, 20%, 30% and 40%. As a result of the study, they found the dietary fiber content in chestnut flour 23.57% and parallel to this they found the content in noodle as varying between 2.54% and 11.08%. Moreover, in terms of the general acclaim, they mentioned that the highest score between chestnut flour-doped noodles is achieved by the noodles doped with 10% and 20% chestnut flour portions.

4. Result

In this study, it is predicted that the use of chestnut flour in different foods especially bakery products will make contributions to the development of different product markets in terms of improvement of nutrition value and functional properties. Besides, chestnut flour is thought to be used as an alternative flour additive.

The use of chestnut flour, due to its nutritious property and appropriate sensory properties, is spreading in food industry. It is considered that chestnut flour will positively affect human health when used in food enrichment since it contains E and C vitamins, unsaturated oils like omega-3, dietary fiber components, phenolic and antioxidant components as well as the highly nutritious property content.

The use of chestnut flour in gluten-free food market and high dietary-fiber containing foods instead of wheat flour by being doped with different additives is increasing the significance of itself. Chestnut flour, which is of great significance for celiac patients, should be produced more and be added to different products. Chestnut flour can also be used in the preparation of milky pudding products, bread, flakes (corn flakes), can be used to sauce soups and gravies and for flavoring. Chestnut flour is a sought-after product in cosmetics sector as well.

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CURRICULUM VITAE

Merve METE was born in Midyat. She graduated from İstanbul Aydın University in 2014. She obtained a master degree from Department of Food Engineering of İstanbul Aydın University in 2016. Her master thesis advisor is Assist. Prof. Dr. Dilek DÜLGER ALTINER from İstanbul Aydın University, Faculty of Engineering, Department of Food Engineering.