

EXAMINATION OF SOME CHEMICAL AND FUNCTIONAL PROPERTIES OF CAROB AND SOY FLOURS AND USAGE OF THEM IN BAKERY PRODUCTS

Şeyma HALLAÇ¹, Dilek DÜLGER ALTINER^{2*}

Abstract

Bakery products are a nutrition group that is chosen by many people in different countries. Due to low cost, being prepared practically and nutritious, appealing to all age groups and being economical, they are preferred. Considering consumption rate of bakery products consumed by people, the enrichment by needed basic food items is inevitable.

In this study, research of some functional and chemical properties of carob and soy flour that can be used as alternatives of wheat flour, and use of them as food additives in production of bakery products such as pasta, biscuits, cracker, bread etc. is aimed.

It is investigated that carob flour (CF) and soy flour (SF) one of the materials that can be used as bakery product enrichment agent and obtain functional foods. CF has a unique smell, color and taste, has high dietary fiber content (32.87%), complex carbohydrates and a small amount of fat (0.31%). And it is also investigated that soy flour (SF) has a high protein rate ($p < 0.05$) and dietary fiber content compared to wheat flour (WF). Carob flour is found to have low energy content compared to WF and SF.

Based on the functional analyses of flour samples, it is determined that CF and SF samples have a higher water absorption capacity and solubility in water compared to WF. Due to these properties, it is predicted that these flours can be used as alternative food additives and are supposed to contribute to food industry in terms of the properties of the last product and improvement of species.

Keywords: Bakery products, carob flour, soy flour, food additives

1. Introduction

Today, main reasons of health problems are inadequate and unbalanced nutrition. In order to prevent this, food enrichment method has been applied to increase the amount of foods that are consumed or taken in the body in low amounts (Aslan and Köksel, 2003).

Cereals and cereals products are commonly consumed both all around the world and in Turkey. Besides of this, cereals are an important food source in terms of vitamin, minerals and amino acids. However, cereals products have low amounts of micro nutrient and part of these micro nutrients are lost during processing (Chenge and Harby, 2003; Poletti et al., 2004).

According to researches, majority of individuals in Turkey are suffering from diseases caused by lack of vitamins and minerals. Children at growing ages, nursing mothers, babies and women are affected from food insufficiency. In a study to overcome this problem, Vitamin C, B1, B2, B6, B12, folic acid, iron, and zinc were added to 650-750 type wheat flours by encapsulation in suggested amounts in grain products. The product was delivered to consumers after required analyses performed on it. Thus, to prevent diseases caused by nutrient insufficiency is aimed (Looker, 2004).

Requirements for the success of enhancement processes in food industry are; some nutritional

¹ Istanbul Aydın University, Department of Food Engineering, Istanbul/Turkey, seymahallac@gmail.com

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

elements that customer needs to take being insufficient, standardization of nutritional elements in diet due to observing discrepancies among them, forming a controlled diet by ensuring that newly added nutritional elements will be in harmony with main elements of food, and improving physiological benefits by adding nutritional elements with various methods (Saldamlı and Sağlam, 1998).

- ✓ It is required to not cause any change of color, odor and taste with the addition of nutritious item.
- ✓ Providing necessary technological conditions and actively quality control are essential (Richardson, 1999; Salgueiro, 2002; Anonymous, 2003).

In recent years, micro nutrients such as iron, calcium, magnesium, zinc, pyridoxine, vitamins A and B vitamins were added to flour in order to enrich the flour and bakery products. These products can be obtained with direct addition of additives as well as obtaining with the addition of some floured fruits/vegetables (Ranum, 2000). Some food additives made from vegetables or legume flour are used in production of bakery products such as pasta, biscuits, cracker and bread.

In this study, it is investigated that carob flour (CF) and soy flour (SF) can be used as bakery product enrichment agent and obtaining functional foods. Based on these properties, enrichment of the bakery products with functional additives is increased the quality and nutritional properties of it.

Whereas a definite judgement on the definition of functional foods could not be formed, according to Food and Drug Administration (FDA) a functional food should contain sufficient amount of nutritional elements, should have positive impacts on health with those nutritional elements and there should be scientific studies approved by FDA that prove the assertion of the relation between diet and illness (Anonymous, 2004).

Besides, functional foods should involve the nutrients having biologically active essences like beneficial fatty acids, particular minerals or

dietary fiber, prebiotics or antioxidants (Abdel-Salam 2010). Common features of functional foods are being natural, the fact that its nutritional ingredients are non-allergic and have positive impacts on health, being reliable, being a part of diet and that their benefits to health are scientifically proven (Anonymous, 2015).

The effects of functional foods on health are listed as: To regulate basic metabolic functions (prevents from obesity and diabetes), to support antioxidant defense system against oxidative stress (prevents from some diseases like cardiac diseases, cancer, cataract, Parkinson disease and Alzheimer, and has anti-aging effect), to prevent cardiac diseases by lowering cholesterol level and blood pressure, to regulate stomach-bowel activity and to improve mental and physical development (Ashwell, 2002).

1.1 Soy flour and Carob flour

Being a member of “*Leguminosae*” family, cultivated type of soybean, *Glycine max L. merrill*, is being grown annually. The seeds of soybean can be both spherical and oval. Generally being yellow, they can be purplish black, dark brown or black (Liu, 2004).

Soybeans are rich in terms of vitamins, minerals and nutrients. It contains proteins, fibers, magnesium and calcium in high proportions. Being a type of plants that provide nitrogen for the soil, soybean is categorized as oilseed crops when classification is made since soybean contains oil. Soybean contains 35-45% protein, 30% carbohydrates, 18-24% oil and 5% minerals, vitamins and some important amino acids (Anonymous, 2011).

Soy flour is a rich food source in terms of proteins. At the same time, it is an excellent source of iron, calcium and B vitamin (Öner, 2006). In the process of obtaining soy flour, protein percentage that it contains remains as 55% (in terms of dry material) since no other compounds are separated except for shell and/or oil. Soy flour is used in a large range of foods in order to decrease the cost, to provide nutrition supplement for the food and to extend the shelf life. Production scheme of soy flour is shown in Figure 1.

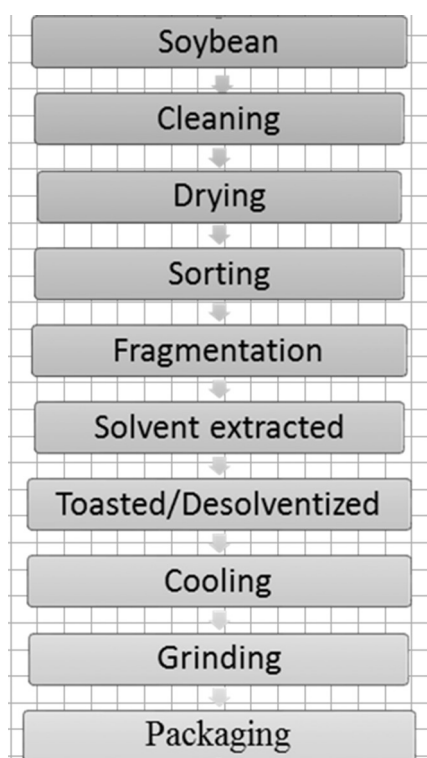


Figure 1. Soy flour production steps

Being a member of *Cesalpiniaceae* family, carob (*Ceratonia siliqua L.*) is a perennial plant (Turhan et al., 2007). Carob is a valuable nutrient used in food industry, in the production of molasses and various animal feeds as well direct consumption (Race et al., 1999; El-Shatnawi et al., 2001; Pekmezci et al., 2008). Grinded and floured form of carob, can be used as an alternative of cacao in the production of ice cream, cake and sweet foods (Pekmezci et al., 2008; Urbaş, 2008).

Being rich in terms of antioxidants, carob fruit has positive effects on human health since it contains dietary fibers and minerals in high portions (Şenay, 2009). Caron contains gallic acid in high rates (Owen et al., 2003). Due to having high amounts of dietary fibers and phenolic components, carob flour is important in terms of nutrition facts (Ortega et al., 2011). Production scheme of carob flour is shown in Figure 2.

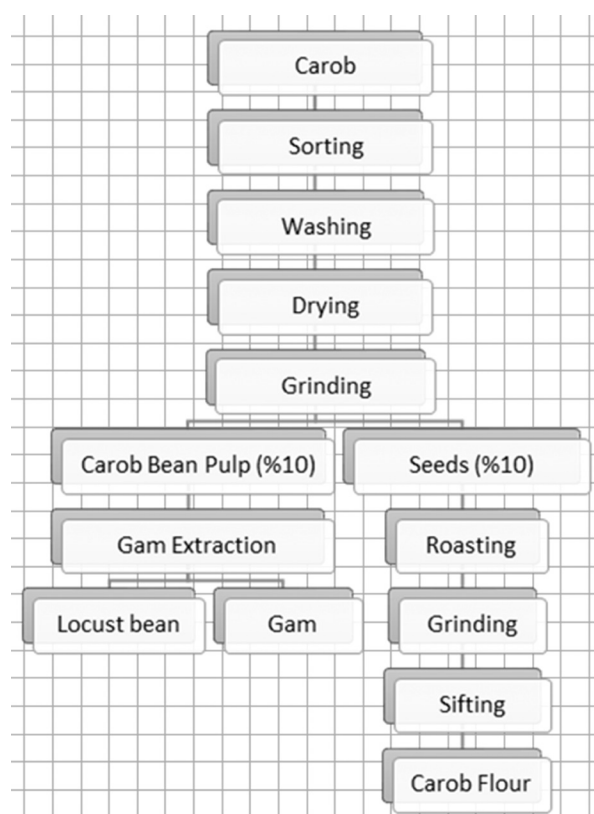


Figure 2. Carob flour production steps

2. Materials and methods

2.1. Materials

Among the raw materials used in this study, soy flour was supplied from Doğalsan Ltd., Ankara, carob flour was supplied from Global Gıda-Haşhaşcızade, Afyonkarahisar, durum wheat flour was supplied from Bandırma Toru Un Ltd. Şti.

2.2. Methods

2.2.1. Chemical analyses

For the determination of chemical components AACCI methods were used. AACCI method no: 44.01 for moisture, AACCI method no: 08.01 for ash content, AACCI method no: 46.12 for the protein content, AACCI method no: 30-25.01, for the oil content and AACC method no: 02-31 titratable acidity (in terms of acetic acid) (AACC, 2000) were performed.

Functional analyses

Oil absorption capacity

3 gr of each flour were introduced to the sample tubes. Then, 30 mL of corn oil (Bizim corn oil) was added and samples were vortexed for 30 seconds. Samples were kept at room temperature for an hour. After keeping 1 hour at room temperature, the samples were centrifugated at 2800 rpm for 10 minutes (Hettich-Rotofix 32 A).

After centrifugation, separated supernatant part was removed and the precipitate was weighed. Oil absorption capacity of the samples were calculated using the following formula (2.2).

$$\text{Oil absorption capacity} \left(\frac{\text{g}}{\text{g}} \right) = \frac{\text{weight of precipitate (g)} - \text{weight of dry sample (g)}}{\text{weight of dry sample (g)}} \quad (2.2)$$

Solubility and water absorption capacity

0.5 g (M1) was introduced in to the test tubes and 5 mL of pure water was added. After each 5 minutes the tubes were vortexed for 15 seconds. After vortex process, samples were centrifugated at 2100 rpm for 10 minutes. Supernatant and precipitate were separated. Wet precipitate in the tubes were weighed (M3). The samples were dried in stove overnight at 100 °C and supernatant (M2) and the precipitate (M4) were weighed. The water absorption capacities and solubility of the samples were calculated using the following formula (2.3).

$$\text{Solubility (\%)} = \frac{M_2}{M_1} * 100 \quad \text{Water absorption (\%)} = \frac{M_3 - M_4}{M_1} * 100 \quad (2.3)$$

Total dietary fiber analysis

Total dietary fiber amount was determined enzymatically (AOAC 985.29) (using alpha amylase, amyloglycosidase and protease enzymes).

Calculation of carbohydrate and energy

Carbohydrate and energy values determined in pasta samples are calculated with the following formula.

$$\begin{aligned} \% \text{ Carbohydrate} &= 100 - (\% \text{ Moisture} + \% \text{ Ash} + \% \text{ Protein} + \% \text{ Oil}) \\ \text{Energy} &= (9 * \% \text{ Oil}) + (4 * \% \text{ Protein}) + 4 * (\% \text{ Carbohydrate} - \% \text{ TDF}) \end{aligned}$$

Statistical Analysis

Data obtained from the analyses were calculated using Enterprise 5.1 software and differences arising from the addition of carob and soy flours to pasta were evaluated. Least Significant Difference (LSD) was used to determine the statistical difference ($p < 0.05$) when the Analysis of Variance shows a significant difference among averages. In the determination of statistically different groups among the obtained averages, LSD test was applied at the level of probability of $p < 0.05$. The LSD method applies standard t tests to all possible group mean pairs.

Table 3.1. Chemical analysis results of carob, wheat and soy flours

Sample	Moisture (%)	Ash (%)*	Oil (%)*	Protein (%)*	Titratable acidity (%)
Wheat Flour (WF)	14.8±0.01 a	1.15±0.01 c	2.04±0.01 a	13.9±0.01 b	0.03±0.1 b
Carob Flour (CF)	7,57±0.04 b	3.09±0.14 b	0.31±0.03 b	6.03±0.1 c	0,27±0.8 a
Soy Flour (SF)	7,04±0.04 c	7,61±0.25 a	2.04±0,3 a	59.16±0.08 a	0,36±0.00 a
Min-Max	7.04-14.8	1.15-7.61	0.31-2.04	6.03-59.16	0.03 -0.36
Av±SD	9.8±4.3	3.95±3.31	1.45±0.9	26.4±28.7	0.23±0.18

* Calculated for the dry substance

* Among the averages shown with different letters in the same column in LSD test, there is a significant difference statistically ($p < 0.05$)

3. Results and discussion

Chemical analysis results of carob and soy flours used for the enrichment process are given in Table 3.1.

According to the obtained results, the highest moisture is found in wheat flour, the highest protein and ash content were found in soy flour. Protein content that soy flour contains is higher than other raw materials.

Based on the titratable acidity (TA) values, they are found as 0.03 % in wheat flour, 0.28% in soy flour and 0.38% in carob flour. According to Turkish Food Codex Legislations, flour can have a maximum acidity value of 0.07%. The obtained results are in compliance with the legislations. Since soy and carob flours are categorized as fruit/vegetable flours, acidity contents are found to be higher.

In the study revealed by Polat (2007), in bread flour, the moisture content is found to be 14.75%, the ash content to be 0.62% and the protein content is 9.76%. Yousif and Alghzawi (2000) found moisture content in carob flour as 9%, ash content as 2.48%, protein content as 5.82% and oil content as 0.74% in their study. In the study of Ortega et al. (2011), the moisture content in carob flour is 2.3%, ash content is 3.3%, protein content is 3.8% and oil content is 0.3%. In our study, the contents for ash, oil and protein of the flours are in the ranges of abovementioned values.

Bashir et al. (2012) examined the contents of moisture, ash, protein, oil and total carbohydrate in the flours of defatted soy and wheat. They found moisture rate in soy flour as 7.14±0.11%, ash rate as 5.93±0.09%, oil rate as 0.77±0.05%, protein rate as 49.90±0.37% and total carbohydrate rate as 35.84±0.18%. They found moisture rate in wheat flour as 11.66±0.31%, ash rate as 0.80±0.01%, oil rate as 1.02±0.05%, protein rate as 12.99±0.25% and total carbohydrate rate as 73.92±0.19%. They found moisture rate in chickpea flour as 10.99±0.39%, ash rate as 2.59±0.25%, oil rate as 4.57±0.26%, protein rate as 21.61±0.37%

and total carbohydrate rate as 59.0±0.08%. The additive flours used in this study have lower moisture values than that of others in the literature. And this is advantageous in terms of shelf life. It is investigated that flours used in this study, have higher ash values and low oil value compared to chickpea flour. Considering the protein rates, protein rate of soy flour was found to be higher compared to other studies. This result is affected by the fact that soybean is a protein-rich food. Besides, the conditions of growing of soybean, the type of used soil and climate conditions and other applied processes are among the other reasons.

Table 3.2. Total carbohydrate and dietary fiber values of raw materials

Sample	Total Carbohydrate (%)	Total Dietary Fiber (%)	Energy (kcal)
Wheat Flour (WF)	68.14±0.01 b	2,93±0,01 c	334,42±0,54 a
Carob Flour (CF)	83.03±0.11 a	32,87±0,57 a	227,41±3,17 c
Soy Flour (SF)	24.14±0.06 c	18,38±0,08 b	278,04±2,33 b
Min-Max	24.14- 83.03	2,92-33,27	225,17-334,8
Av±SD	58.44±30.62	18,06±13,40	279,96±47,91

* Calculated for the dry substance

*Among the averages shown with different letters in the same column in LSD test, there is a significant difference statistically ($p<0.05$)

Total dietary fiber of carob flour used in this study is 32.87% while in soy flour it was found to be 18.38% (Table 3.2). Total carbohydrate values are 83.03% in carob flour, 24.14% in soy flour.

As the results, total carbohydrate and dietary fiber rate of carob flour was found to have significantly higher than dietary fiber rate of soy flour. Considering energy values, the highest energy values were found in wheat flour, carob flour and

soy flour, respectively. Low carbohydrate rate of soy flour is important in terms of decreasing the glycemic index in the products containing soy flour. The reason why the amount of carbohydrate is high in locust-bean flour is being carbohydrate-rich nutrient.

In the study revealed by Ahmad et al. (2012), in production of bread, grain flours that are rich in beta-glucan. Based on the results, it was investigated that beta-glucan is increasing viscosity in bread dough and is causing an increase in dietary fiber in bread. Besides of these, an increase in hardness of bread was observed.

In a study, revealed by Polat (2007), pumpkin flour doped bread was produced. Total dietary fiber amount of pumpkin flour used for production was determined as 10.13%. With the addition of apple fibers, carob and fatty soy flours to biscuits prepared with wheat flour (65%) and type 500 wheat flour, variations in total dietary fiber rates were examined. As a result of the addition of carob flour to biscuits, an increase of 42% was observed (Sebecic et al., 2007). In a study carried out by Ory and Conkerton (1983), 12.5% peanut flour was added to wheat flour and alterations on bread were examined. Based on the results, an increase of 0.1-0.3% was found in total dietary fiber rate found in bread. Total dietary fiber rates of additive flours used in this study were found higher.

Dülger and Şahan (2011), used dietary fiber for enrichment purposes which grow in importance in recent years, as components that are indigestible in small intestine and fermented in large intestine. Higher rates of total dietary fibers (TDF) of products used in this study and were determined as significant in terms of providing fiber products of grain samples used as additives and possessing beneficial properties of dietary fibers. According to Levi et al., 2001; Kahlon et al., 2001, it was reported that dietary fibers are protective against colon cancer and shortening the transport time of foods in intestines which results in preventing constipation by fecal volume.

Table 3.3. Functional properties of raw materials

Sample	Water Absorption Capacity (%)	Water Solubility (%)	Oil Absorption Capacity (%)
Wheat Flour (WF)	104,66±0,64 c	6.8±0.6 c	0.97±0.03 c
Carob Flour (CF)	185.5±2.12 b	44±4.24 a	0.74±0.22 b
Soy Flour (SF)	293±26.9 a	29±2.8 b	1.06±0.01 a

**Among the averages shown with different letters in the same column in LSD test, there is a significant difference statistically (p<0.05)*

Based on obtained results, water absorption capacity was determined higher in soy flour, significantly lower in wheat flour (p<0.05). Oil absorption capacity of soy flour was found to be significantly higher (p<0.05) compared to other flours (Table 3).

Functional properties are physical chemistry properties affecting behaviors of protein during preparing, process and consumption. Usage of various flour in food processing as additive is depending on the functional properties of them. Information of functional properties of proteins provides information about performances of these additives. Solubility is a result of surface active properties of proteins. Food materials having high water absorption capacity behave like functional components. With the addition of components having high water absorption capacity, viscosity and texture of the last product (soup, dough and bakery products) can be modified.

Components having high oil absorption capacity have a significant functional role in stabilization of food systems and improve viscosity and texture acting as emulsifiers. Results obtained in this study are at moderate level.

Aydın (2004), studied on pumpkin flour samples and applied different processes. It has been reported that water solubility values change in the range of 3.96-21.22% and water absorption values change in the range of 66.89-91.66%. Water solubility and water absorption capacity values of flours used in this study are higher than that of pumpkin flour.

Sahan et al. (2012) studied on oleaster flour and oleaster+peel flour produced by different processes. As a result, water solubility values were found to be in the range of 90.33-96.01% and water absorption capacity values in the range of 372.74-430.33%. Water solubility and water absorption capacity values of flours used in this study are lower than that of oleaster flour.

4. Conclusion

It has been revealed that, it is possible to enlarge the using area of carob and soy flour in food industry such as using in the production of high protein and high dietary fiber and low oil and calorie containing foods. Besides, it is predicted that these flours can be used as alternative additive in different food groups as well as grain products. According to the results of the research, it can be said that CF can be used in food sector as an alternative additional matter in order to improve the nutritional and functional properties of foods.

Studies show that enrichment of different products in terms of nutrition facts and functional properties are important. Accordingly, nutritious and functional properties of foods are increased with the addition of flours obtained from fruits/vegetables and lack of nutritious items in foods is eliminated. As a result, diseases arising from malnutrition can be prevented. In order to achieve this, offering varieties to enrichment agents is necessary. Thus, production of both economical and rich foods in terms of nutrition facts will be provided. Based on this study, enrichment of different samples can be succeeded.

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CURRICULUM VITAE

Şeyma HALLAÇ was born in Van. She graduated from Milli Piyango Anatolian High School and studied at Istanbul Aydın University. She obtained a master degree from Department of Food Engineering of Istanbul Aydın University in 2016. Her master thesis advisor is Assist. Prof. Dr. Dilek DÜLGER ALTINER.