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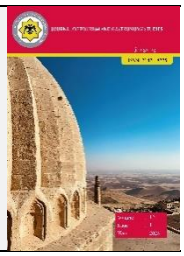

The Nutritional Content of Traditional Corn Bread and its Carotenoid Values **

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Abstract

Commonly found in nature are the pigments in many food groups. It has a significant function in the human body, such as strengthening immune system and specifically due to its provitamin A and antioxidant effects. With carotenoids' chemical functions, they help to prevent a number of health problems before they occur in the body and to improve diseases existing. The aim of the study is to determine the carotenoid and nutritional elements of corn bread that was produced with flour obtained from local corn in Turkey. Experimental research method was used in the research and these samples were subjected to chemical analysis. Within the scope of the study, lutein, beta carotene, lycopene, energy, moisture, ash, protein, carbohydrate, dietary fibre, and fat analyses were made for three samples: corn flour, bread dough mix and baked corn bread. As a result of the analysis, it was determined that the prepared corn bread is rich in lutein, protein, dietary fibre and natural oil and it is valuable in terms of the energy that it provides, but after the heat treatment, some of the nutrients are decreased.

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INTRODUCTION

Today "healthy food" consumption has a very important place in individuals' nutrition (Baysal, 1993). Natural plant food are one of the key factors for maintaining healthy and sustainable life (Arısoy, 2018). Cereals form the basis of the plant food group. Barley, wheat, rye, oat, rice, corn and such plants represent the grain group (Küçükkömürler, 2018). Corn consumption is in the first place among cereals in human nutrition along with wheat and rice (Özcan, 2009).

Corn plant is in the family of grasses, which is one of the important cereal products (Sabancı, 2016). Corn is a temperate climate plant that can be cultivated almost anywhere in the world (Algül, 2012). Corn, which can be harvested more than once in a year, has more than one variety because of its growing conditions and geographical spread (Özcan, 2009; Cobb, 2016). Corn containing many nutrients, has a significant amount of carbohydrates, sugar, dietary fibre, protein, fat, minerals such as iron, magnesium, phosphorus, potassium, vitamins B12, B6, E and carotenoids (Kumar, Sangwan, Yadaw & Langyan, 2014).

In addition to being suitable for the use as an alternative product for people who suffer from celiac disease (Sciarini, Ribotta, Leon & Perez, 2008), corn is recommended to be included in daily nutrition plans of individuals in terms of carotenoids in its composition. Carotenoids are a group of pigments grouped into hydrocarbons, xanthophylls, ketones, and acids (Tokuşoğlu, 2007; Jaswir, Noviendri, Hasrini & Octaviente, 2011). According to the studies carried out, carotenoids are known to help prevent many diseases by contributing to the immune system (Atlı & Ötleş, 1997). At the same time, their provitamin A feature increases the preferences of carotenoids in daily nutrition (Aksan, 2005).

In line with the literature review on the corn plant, it has been seen that it is frequently consumed in Turkey, especially in the Black Sea Region. Foods prepared with corn and corn products are important parts of the Black Sea cuisine culture and are also consumed at a limited level outside the Black Sea Region.

The sub-purpose of the research is to determine to what extent the determined values can meet the amount of provitamin A carotenoid that should be taken with the daily diet. Furthermore, the fact that carotenoid content of corn bread, which individuals have consumed extensively in their daily diets for many years, has been determined as a result of the research, increases the importance of the research. In addition, it is thought that it will contribute to increasing the amount of corn bread consumption in daily nutrition and in connection with this, it will support the increase market share in terms of economy in Turkish culinary culture.

Materials and Method

In this section, the applications carried out within the scope of the study, the methods and working principles are explained. Before starting the study, the study was submitted to the Ethics Commission of Ankara Hacı Bayram Veli University and was found ethically appropriate by the Commission with the letter dated 19.02.2019 and numbered E.6117 (Appendix 1).

Research Model

Experimental methods were used with the aim of obtaining data within the scope of research. The experimental model, which is one of the quantitative research models, examines the differences in variable among more than two

groups or samples. The experimental model aims to determine the cause-effect relationship between the groups with the data obtained through sample that represents the universe. It is aimed to make forward looking comments together with the results revealed in experimental research.

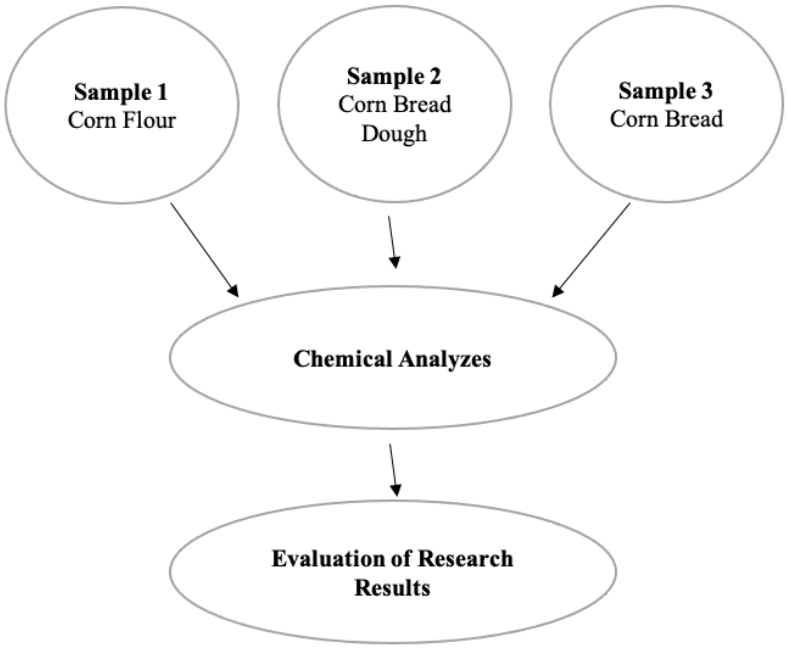


Figure 1.1. Research Model

In the study, chemical analyses were carried out using appropriate methods on corn flour, bread dough mixture and baked corn bread samples.

Preperation of Samples

Corn flour, 2000 g, used within the scope of thesis was obtained from the company "2n14.com – Korunmuş Lezzetler". 500 g of the supplied corn flour was used as raw for the analysis and 1500 g was used in the production of corn bread. While 750 g of the mixture prepared from 1500 g of corn flour was separated as raw, the remaining 750 g was cooked.

1/3 mixture of the corn prepared with corn flour, water and salt was separated as raw, and the test was baked for 3:30 minutes at 135 °C on 11 December 2019 in Arzum brand bread baking machine to ensure standardization. The prepared samples were rapidly cooled to +4 'C. Samples prepared from corn bread, bread dough and corn flour obtained as a result of the applied heat treatment were placed in vacuum bags to prevent contamination during the transport to the laboratory and were sent to the laboratory to be analysed.

Analysis of Samples

As a result of literature review, it has been found out that high performance liquid chromatography (HPLC) is the most accurate method for determining the amount of carotenoids in foodstuffs. The samples were sent to TUBITAK Marmara Research Centre for analysis on 11 December 2019. In addition to carotenoid tests, moisture, ash, protein, carbohydrate, diet fibre and fat values of the samples were analysed at TUBITAK Marmara Research centre, energy. Within the scope of the study, the following analyses were carried out.

Paremeter	Method
ß Carotene	Hplc Uv Method
Lutein	Hplc Uv Method
Lycopene	Hplc Uv Method
Energy	Atwater Method (Merril and Watt 1973)
Mouisture	AOAC Official Method 925.10
Ash	AOAC Official Method 925.03
Protein	AOAC Official Method 925.52
Carbohydrate	Atwater Method (Merril and Watt 1973)
Fiber	AOAC 991.43
Fat	Internal Method D.05.G8

Table 1.1. Analysis of Samples

Devices Used in Analysis

The devices in which the chemical analysis were carried out and the analyses carried out within the scope of the study are given in the table below.

Paremeter	Method
Binder Fan Oven	Determination of Moisture
Protherm Muffle Furnace	Determination of Ash
Foss Tecator 2300 Nitrogen Anlyzer	Determination of Protein
VEP SER 148	Determination of Fat
Shimadzu 20A HPLC Device	Determination of ß Carotene
Shimadzu 20A HPLC Device	Determination of Lutein
Shimadzu 20A HPLC Device	Determination of Lycopene

Table 1.2. Devices Used in Analysis

Results and Discussion

With the determined purpose, the ingredients and process steps used in the production of corn bread prepared according to the traditional recipes of the Black Sea Region are presented below.

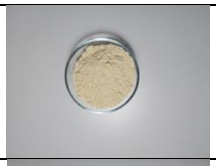
Ingredients	
1500 g corn flour 1200 ml fresh water 22,5 g salt	
Process Steps	
1. Cornflour is taken into a deep bowl.	
2. First salt and then water are added into the flour and mixed.	
3. Dough is obtained from the prepared mixture.	

Table 2.1. Cornbread Processing Steps (cont.)

4. The dough obtained is taken to the bread baking machine, mixed until it becomes homogeneous again and cooked in dry heat.	
5. After the baked bread cools down, it is taken out of the machine.	

Table 2.1. Cornbread Processing Steps (cont.)

The findings obtained from the experimental analyses carried out within the scope of the research, carotenoid content of the samples and the nutritional elements are detailed in the table below.

Paremeter	Cornmeal Analysis Result	Corn Bread Dough Analysis Result	Corn Bread Analysis Result
Energy (100 g)	344 kcal	184 kcal	251 kcal
Mouisture (100 g)	11.99 g	39.39 g	10.28 g
Ash (100 g)	1.21 g	0.89 g	1.09 g
Protein (100 g)	7.63 g (Nx6.25)	3.69 g (Nx6.26)	4.50 g (Nx6.25)
Carbohydrate (100 g)	65.64 g	35.28 g	40.75 g
Fiber (100 g)	10.19 g	4.69 g	8.16 g
Fat (100 g)	3.34 g	2.00 g	6.01 g
Lutein (100 g)	138 µg/g	178 µg/g	82 µg/g
ß Carotene (100 g)	Not Detected	Not Detected	Not Detected
Lykopen (100 g)	Not Detected	Not Detected	Not Detected

Table 2.2. Analysis Results

As a result of the analysis made on corn flour, in 100 g; protein 7.63 g, carbohydrates 65.64 g, dietary fibre 10.19 g, and fat 3.34 g were detected. In the analysis results of corn flour, ß carotene and lycopene were not detected while lutein was determined as 138 µg/g. At the same time, the determined energy value is 344 kcal. Baysal (2015) stated that daily amount of energy needed for an adult male (average 70 kg, 168-195 cm height) as 2520 kcal/100 g, and for an adult woman (average 60 kg, 155-180 cm height) the energy needed as 1980 kcal/100 g. The determined energy value is at a level that can meet approximately 16-17% of the energy that is needed.

As a result of the analyses applied to the bread dough, in 100 g, protein 3.69 g, carbohydrates 35.28 g, dietary fibre 4.69 g, and fat 2.00 g were detected. Protein, carbohydrate, dietary fibre and fat amounts increased when it is compared to the amounts in the bread dough mixture. However, it was found out that there was a decrease in the values when compared to the untreated corn flour. While ß carotene and lycopene were not detected as a result of the carotenoid analysis of corn bread, the amount of lutein was detected as 82 µg/g. The amount of the lutein determined as a result of cooking is at a remarkable rate. It was also determined that while there was an increase in the amount of the energy when compared to the bread dough mixture, there was a decrease compared to the corn flour (251 kcal). With these results, it was determined that if 100 g or corn bread is taken with the daily diet, 10-12 % of the required energy can be met.

As a result of the analyses to the determine carotenoid (lutein, ß carotene, lycopene) values of corn flour, bread dough mixture and baked corn bread, only lutein was detected. It was determined that bread dough mixture had the highest value in lutein (178 µg/100 g) and baked corn bread had the lowest lutein value (82 µg/100 g). Based on the research findings of Bachetti, Masciangelo, Micgeletti & Ferretti (2013) and Scott & Eldridge (2004), 82 µg/100 g

of lutein was detected in the corn bread sample and the value is acceptable. The lutein contained in corn bread is important in terms of protecting health and strengthening immune system as well as showing antioxidant properties. Lutein values of these three samples are presented in Figure 2.1.

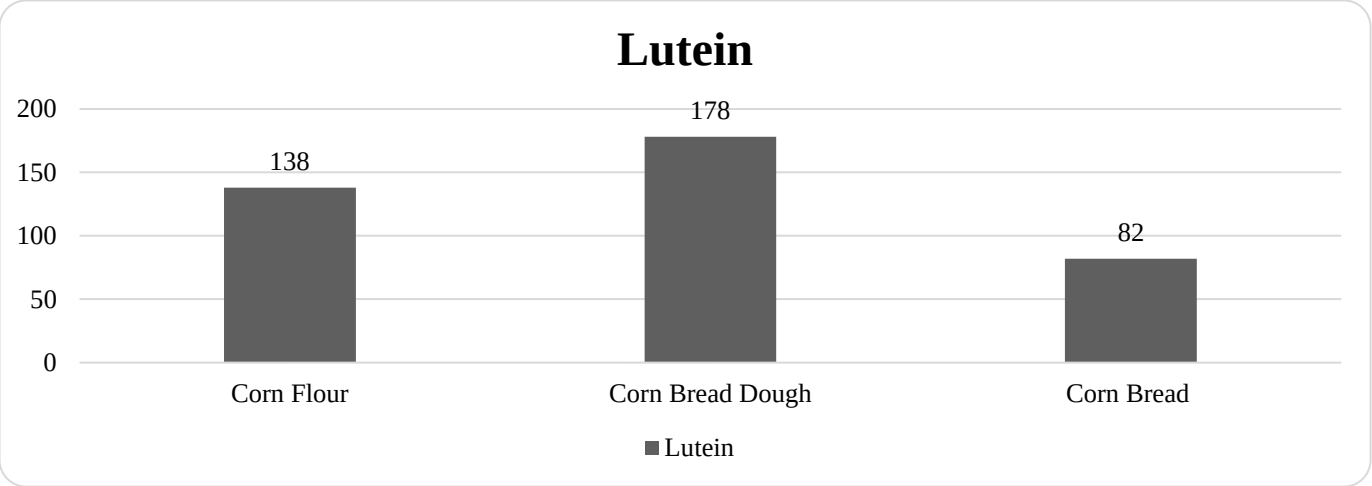


Figure 2.1. Lutein Values of Corn Flour, Bread Dough Mix and Corn Bread (µg/100g)

In the analyzed corn flour sample, 344 kcal/100g, in the bread dough mix sample 184 kcal/100g and in the corn bread 251 kcal/100g energy were determined. When the values between corn flour and corn bread were compared, it was observed that there was a change in the values as a result of the applied process. 251 kcal/100g energy determined in the baked bread is very important as it corresponds to 10-12% of the recommended daily energy intake (Women: 1980 kcal, Men: 2530 kcal).

The amount of protein in the three samples compared showed a decreasing tendency after each treatment. Protein at the rate of 4.5 g/100g was determined in the final product. This ratio will help to meet the protein needs of individuals at a limited level.

After the applied heat treatment, it was determined that the dietary fibre detected in corn bread was as 8.16 g/100g. This determined amount meets approximately 4/1 of 25-40g dietary fibre amount recommended by the World Health Organization (Ekici & Ercoşkun, 2007). It is recommended that children should consume 5 g fibre + daily dietary fibre according to the child's age, starting from age of 2 (Erdoğan, 2005). Dietary fibre is a nutrient fermented in the large intestine. In addition to helping to prevent the formation of diseases such as constipation, haemorrhoids, bowel cancer, obesity, it is also important in terms of providing satiety (Dülger & Şahan, 2011).

As a result of the analyses, the amount of natural vegetable oil contained in the samples increased in the applied heat treatment and was determined as 6.01 g/100g in corn bread. Fats have important duties for human health and should be added in the daily nutrition plan (Baysal, 2015). It is very important to provide the energy needed for the body provided by natural resources. For this reason, this determined amount will also help to meet the amount of calories required to provide the energy that is needed during the day.

Conclusion

As a result of the chemical analyses carried out to determine the carotenoid values of corn flour, bread dough mixture and baked corn bread, lutein, a xanthophyll carotenoid was determined in all three samples. Lutein was determined as 138 µg/100 g in corn flour, 178 µg/100 g in bread dough mixture, and 82 µg/100 g in baked corn bread

while ß carotene and lycopene could not be determined in all three samples. Carotenoids prevent oxidation by using the oils in the eye lenses and thus play a significant role in preventing the development of cataracts (Akdoğan, et al., 2008). Lutein and zeaxanthin, which are especially active in the eye, play a role for the prevention of diseases such as cataracts and macular degeneration (AMD) that occur with aging (Hankinson, et. al., 1992). As a result of the observations of individuals with cataract problems in the studies of Hankinson et al. (1992), it was determined that the rate of catching cataract disease is higher in case of low consumption of vegetables and fruits with high lutein and zeaxanthin content (Hankinson, et al., 1992; Bakan, Akbulut & İnanç, 2014). At the same time, in a study conducted on a group of men who were given synthetic lutein and zeaxanthin, the participants were epidemiologically examined for 8 years and it was seen that their risk of cataract was reduced by approximately 19%. In the studies conducted with carotenoids taken naturally, it was determined that the incidences of eye diseases decreased considerably (Gökbulut & Şerer, 2008).

In the study conducted by Scrob et al., (2014), it was aimed to determine the carotenoid amount of the difference in maize genotypes. For this purpose, analyses were made on 19 different maize hybrids in 2011 and 2012 at the Romanian Agricultural Research and Development Station. As a result of the research, the total carotenoid content was determined at the highest rate in light yellow, dark yellow and orange samples among 19 samples. In that case, it was thought that the climate and soil conditions were effective. From this point of view, the fact that lutein was detected among the carotenoids in this study is thought to be related to the type of corn used in the study, production techniques and the geography in which the production is carried out (Scrob et al., 2014).

When the literature was examined, studies were carried out to measure the carotenoid values between corn varieties and products with different cooking techniques. In the study conducted by Muzhingi et al., (2008), it was aimed to determine the differences in carotenoid amounts in yellow corn varieties as a result of different processes such as boiling, baking and saponification. Along with this purpose, uncooked corn, sadza, pridge, corn porridge dishes named as mangai and muffins were prepared. Some of the prepared foods were boiled and some of them were cooked by applying dry heat. It was determined that the level of carotenoids increased in the samples prepared by boiling and the level of carotenoids in the baked samples decreased by almost 70% compared to raw corn. It has also been stated that yellow corn is a good source of provitamin A carotenoids (Muzhingi, Langyintuo, Malaba & Banziger, 2008).

In our study for the chemical analyses carried out, the energy value of maize flour was determined as 344 kcal/100g, 184 kcal/100g for bread dough mixture and 251 kcal/100g for baked corn bread. It has been found out that 251 kcal/100g energy detected in the baked corn bread is at a level that will help to meet 10-12% of the daily recommended calorie intake.

As a result of the analyzed applied to the three samples, the amoung of fat was determined as 3.34 g/100g in corn flour, 2.0 g/100g in bread dough mixture and 6.01g/100g in baked corn bread. After the heat treatment, the amount of oil in the bread dough mixture tripled.

In one of the studies carried out by Kotancılar et. al. (2018), 8 pieces of corn bread were traditionally produced. The ratio of corn flour in the content of the corn breads differentiated from 0% to 100%, however, different amounts of egg, butter, and yoghurt combinations were also added. Corn flour and other subsidiary products in the content of these breads caused differences in the properties such as moisture and the volume of the bread along with the sensory

properties, especially the colours of the breads. The results of this study showed that the interactions with the addition of corn flour in the preparation of corn bread are important factor in the sensory and chemical properties of the bread (Kotancılar, Gütük & Seyyedcgeraghi, 2018).

As a results of the analyses, the amount of dietary fibre was determined as 10.19 g/100g in corn flour, 4.96 g/100g in bread dough mixture, and 8.16 g/100g in baked corn bread. The amount of dietary fibre specified in baked corn bread meets approximately 20% of the daily and recommended dietary fibre.

According to the chemical analyses applied to the samples of carotenoids (lutein, ß-carotene, lycopene) of corn flour, bread dough mixture and baked corn bread to detect energy and nutritional elements (moisture, ash, protein, carbohydrate, dietary fibre, fat), as a result of mechanical (mixing and kneading) and heat treatment, differences were found out in each element of the samples.

In the study carried out by Hassan et. al. (2020), they evaluated the Fino Bread prepared with pearl millet, rice and corn flour. As a result of the study, it was determined that the samples with higher millet density compared to corn and rice flour were found to have higher contents of antioxidant, protein, fibre, phenol, compound, flavonoid and mineral, but they were found to have low carbohydrate levels (Hassan, Fahmy, Magdy & Hassan, 2020).

When considered the gluten-free food market that has increased due to increasing health problems and/or changes in consumer preferences in recent years, the studies by Yılmaz & Koca (2020), various breads with high quality nutritional content with cheap and additions. It was seen that the protein, fat, lysine, tryptophan, Omega-3 and various mineral contents of the bread which contains fish flour in the samples were higher than the control sample. With this study, it is thought that various bakery products with different food additives by enriching their content may have a great potential (Yılmaz & Koca, 2020).

According to these results, the recommendations can be listed as follows:

Sectroral Perspective,

- The food which includes carotenoid content is preferred by consumers specifically for healthy nutrition. Therefore, including corn bread and/or other foods prepared with corn in the diet may help individuals support a healthy life.

- In the study, dietary fibre, fat, protein and energy amounts of corn bread baked with local corn flour were determined at very important levels in nutrition. In that case, it is thought that corn bread in the daily diet can help strengthen the immune system and therefore it can reduce the risk of disease. The high amount of dietary fibre not only helps the digestive system, but it can also help prevent nutritional disorders such as obesity.

- The increase in the tendency to plant-based nutrition throughout the world has led to the emergence of several culinary trends. Foods prepared with corn bread and corn products can also be an alternative for individuals who have vegan and vegetarian nutritional sensitivities and those with gluten sensitivity, with their rich nutritional content.

- Promotional activities can be held to present the corn bread prepared in accordance with the traditional Black Sea cuisine recipes for consumption by people who live in other regions.

Academic Perspective,

- Along with the data in the study, it was seen that especially the dietary fibre content, fat, energy and lutein values of corn and corn bread were significant. This information shows that many foods produced from corn can have an important place in human nutrition when they are prepared with appropriate preparation and cooking conditions. From this point of view, the foods prepared with corn products and their composition values can be analysed and standardized recipes can be introduced. Thus, it can be helpful both for the literature and the sustainability of traditional food. In addition, commercial enterprises can be contributed to gastronomy as a marketing tool.

- In the recent years, apart from the sea, sun and sand tourism preferences, interests in many different alternative tourism types have been increasing. Especially, the increase in local and traditional interests brings gastronomic tourism to the agenda with food-beverage element. When literature is examined, it is seen that the process from harvesting to processing and cooking of corn in the Black Sea Culinary Culture have been carried out as a ritual. These can be gained as a touristic element to increase the attractiveness of the region as a part of tourism today. If these activities are practiced, economic profit can be provided in the region.

Decleration

All authors of the article contributed equally to the article process. The authors have no conflicts of interest to declare. The study was submitted to the Ethics Commission of Ankara Hacı Bayram Veli University and was found ethically appropriate by the Commission with the letter dated 19.02.2019 and numbered E.6117 (Appendix 1).

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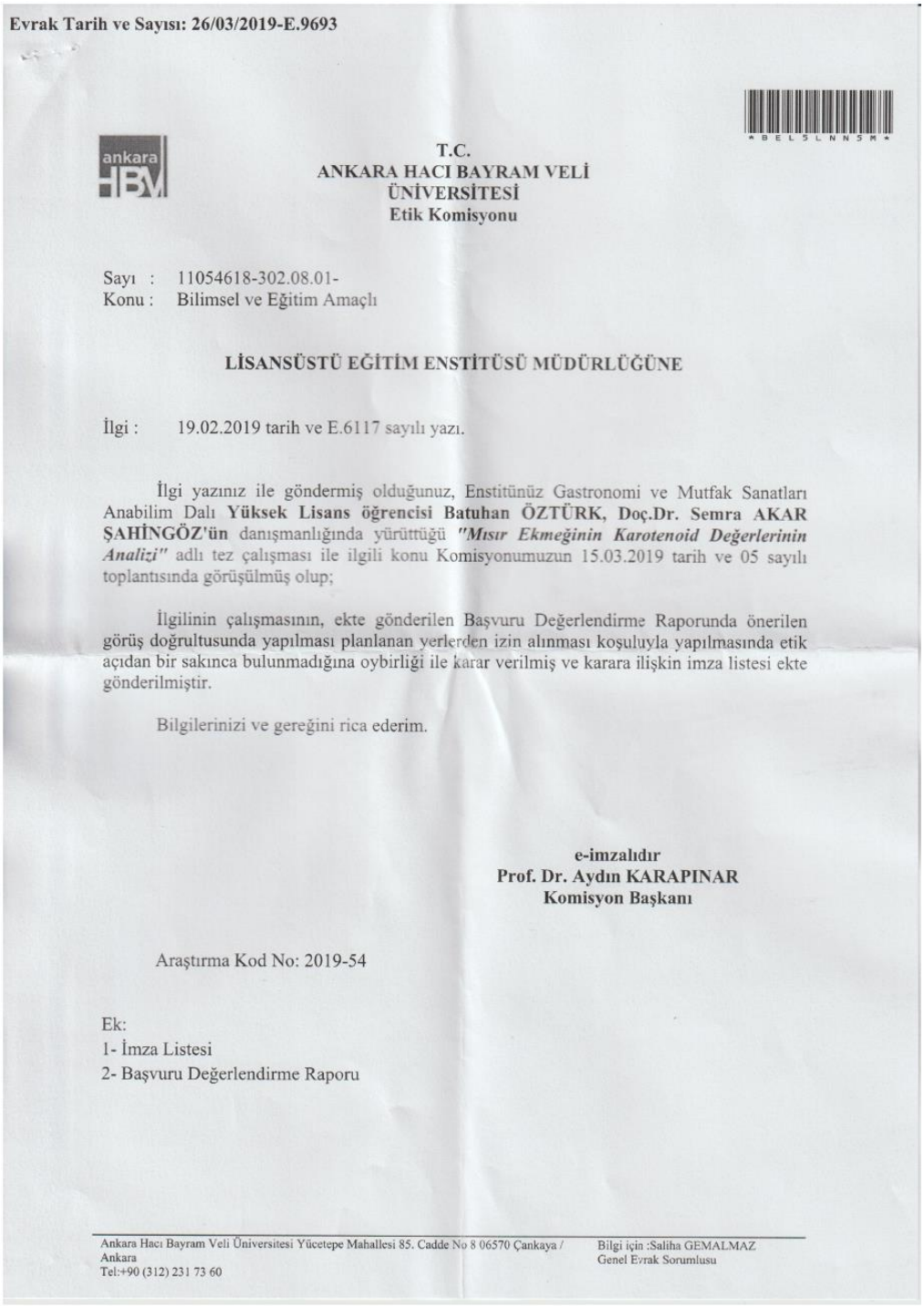
Appendix 1. Ethics Committee Permission



Evrak Tarih ve Sayısı: 26/03/2019-E.9693

T.C.
ANKARA HACI BAYRAM VELİ ÜNİVERSİTESİ
Etik Komisyonu

Sayı : 11054618-302.08.01-
Konu : Bilimsel ve Eğitim Amaçlı

LİSANSÜSTÜ EĞİTİM ENSTİTÜSÜ MÜDÜRLÜĞÜNE

İlgi : 19.02.2019 tarih ve E.6117 sayılı yazı.

İlgi yazınız ile göndermiş olduğunuz, Enstitünüz Gastronomi ve Mutfak Sanatları Anabilim Dalı **Yüksek Lisans öğrencisi Batuhan ÖZTÜRK, Doç.Dr. Semra AKAR ŞAHİNGÖZ'ün** danışmanlığında yürüttüğü ***"Mısır Ekmeğinin Karotenoid Değerlerinin Analizi"*** adlı tez çalışması ile ilgili konu Komisyonumuzun 15.03.2019 tarih ve 05 sayılı toplantısında görüşülmüş olup;

İlgilinin çalışmasının, ekte gönderilen Başvuru Değerlendirme Raporunda önerilen görüş doğrultusunda yapılması planlanan yerlerden izin alınması koşuluyla yapılmasında etik açıdan bir sakınca bulunmadığına oybirliği ile karar verilmiş ve karara ilişkin imza listesi ekte gönderilmiştir.

Bilgilerinizi ve gereğini rica ederim.

e-imzalıdır
Prof. Dr. Aydın KARAPINAR
Komisyon Başkanı

Araştırma Kod No: 2019-54

Ek:
1- İmza Listesi
2- Başvuru Değerlendirme Raporu

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Bilgi için :Saliha GEMALMAZ
Genel Evrak Sorumlusu