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RESEARCH ARTICLE

Physicochemical and microbiological properties of Kavılca Bulgur (A traditional cereal product of Turkey)

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ABSTRACT

Kavılca bulgur is a cereal product that is obtained from Kavılca wheat grown as a wheat type in Kars province and its surroundings. 40 unpackaged bulgur samples were used in this study and these samples were produced with traditional methods at family businesses under home conditions in Kars province and sold at delicatessens, grocery stores, and arcade marketplaces. In this study, which was carried out to determine the compliance of some microbial and physicochemical properties of Kavılca bulgur with the Turkish Food Codex Wheat Flour Communiqué and the Turkish Food Codex Microbiological Criteria Regulation, the samples were examined in terms of color, ash, moisture, pH, % titratable acidity (as sulfuric acid) and Total Aerobic Mesophilic Bacteria (TAMB), coliform, yeast-mold and rope-spore numbers. Ash, moisture, and % titratable acidity ratios of Kavılca bulgur samples were found within the limits specified in the Turkish Food Codex Notification on Wheat Flour. According to the results of the microbiological analysis, the yeast-mold, coliform bacteria, and rope numbers were found to be within the range of the maximum acceptable limit stipulated in the Turkish Food Codex Regulation on Microbiological Criteria. We can say that it is important to develop and support the cultivation of Kavılca wheat, which has high nutritional value and can be utilized in various ways.

Keywords: Bulgur; Kavılca; Microbial and physicochemical properties; Traditional cereal

INTRODUCTION

Wheat has played an important role in the development of civilizations throughout history. Always the most common grain relative to others, wheat has remained the primary food for humans in the history of agriculture (Anonymous 2022). Ancient wheats (einkorn, emmer, spelt, macha and vavilovii) in both wild and cultivated forms have received increasing attention in recent years. Ancient wheats are characterized by the "grain that cannot be beaten from the stem" during traditional threshing processes. Ancient wheats are found in small, high altitude areas throughout Turkey such as Kastamonu, Samsun, Kars, Sinop, Bolu, Bayburt, Gümüşhane and Kayseri. In general, these wheats are resistant to harsher environmental conditions, which may be a reason why farmers prefer these types (Anonymous 2022).

Wheat is an important cultivated plant that is one of the most planted and produced in the world and our country and it is consumed as food as well as being used as animal feed (Kün 1996). Wheat grain is the main source of calories in many countries due to its nutritional value, nutritionally balanced amino acids, ease of transportation, storage, processing, and wide adaptation limits. At the same time, it is the cereal type with the highest protein content among the grains used for nutrition (Atak 2017). Certain components in cereals, such as antioxidants (flavonoid, phenolic acid, phytic acid, tocopherols, and carotenoids) and dietary fibers, have the potential to improve the functional properties of cereal products and prevent chronic diseases (Mpofu et al., 2006; Serpen et al., 2008)

Traditional foods have been shaped by the geographical structure, climate, agricultural production opportunities, and especially the effect of traditional lifestyle in Turkey as in every culture and they have been produced for hundreds of years. Each of these foods are highly original products formed with an artistic finesse through hundreds of years of experience, without any modern technology, using only the basic factors of food preservation with the existing tools (Anonymous 2014).

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Bulgur is a nutritious and healthy product with a long shelf life, produced from hard wheat species without the need for any additives (Yılmaz 2020). The popularity of bulgur is increasing with its features such as being nutritious, healthy, not requiring additives, low cost, easy production and preservation, long shelf life, wide usage area and deliciousness. It is a semi-ready and ready-to-eat food product (Yılmaz and Koca, 2020).

Bulgur is one of the most consumed product types in emmer wheat, such as einkorn (Triticum monococcum L.). Bulgur is becoming a favorite of the markets due to the increasing interest. Bulgur is an ancient, nutritious and delicious product commonly produced from durum wheat (Triticum turgidum ssp. durum) through the stages of cleaning, cooking, drying, tempering, crushing, bran removal and sizing. (Yılmaz 2020).

Kavılca (Triticum dicoccum) is considered an Emmer (Gernik) type wheat. Hulled diploid and tetraploid wheats are collectively known as einkorn wheat in our country. Triticum dicoccum (emmer) is an ancient wheat type that has been cultivated in Anatolia for centuries. It is mostly grown around Kars province and is known as kavılca = kabluca = wild wheat. It is rich in fiber, has high protein content (17-19%), but it is low in gluten. Kavılca (Kavlıca) wheat is an old wheat variety adapted to the Kars climate (Atak 2017). Due to the low amount of gluten (12%), Celiac patients can easily consume bakery products obtained from Kavılca wheat (Anonymous 2015). It is also used in the production of bulgur, its flour is added to bread, noodles, and pastries. Kavılca wheat grown in the Kars region is processed as bulgur in water mills; it is used in local dishes such as bulgur pilaf traditionally made with goose meat, milk soup, or stuffed cabbage. Kavılca flour can also be used in bread making by mixing with other flours (Atak 2017; Anonymous 2020).

Kavılca, which has been grown in high and arid areas in Kars and its surroundings since the past, has survived until today due to its resistance to cold and drought. Kavılca, which is mostly cultivated around Kars province, is known as "Heirloom" wheat that has been passed down from generation to generation in Kars province and its surroundings. Kavulca is known as Emmer or Speltoides in Europe and as Gernik wheat in Anatolia (Zengin 2015; Anonymous 2020).

Cultivation areas of Kavılca wheat in Kars province and its surroundings started to decrease from the second half of 1960 and reached the point of vanishing in 2000. However, in the villages at mountains that are far from the city centers, people continued to produce it in small amounts for themselves. Kavlıca (kavılca) wheat started to disappear in the early 2000s due to the fact that it is difficult to harvest, it is not supported by the government, the grain is hard to separate from the hull, and its flour does not make a good bread by itself, but it gained importance with the efforts of some non-governmental organizations and farmers, it was supported by the United Nations Development Programme-Global Environment Facility/Small Grants Programme (UNDP GEF/SGP) in 2007 and started to be recognized nationally. (Zengin 2015). Today, the revitalized kavılca cultivation is carried out by many farmers in Kars province and its surroundings. Kavılca bulgur is made in 6 kavılca mills in the region from this type of wheat produced by traditional methods. Due to its high nutritional value, Kavılca wheat can be used in the production of bulgur, as well as mixed with other bakery products. It is important to identify the nutritional elements of Kavılca wheat so it becomes widespread in the region and for its promotion and marketing (Anonymous 2020).

In the study conducted to evaluate the technological, textural and sensory properties of einkorn wheat in comparison with durum wheat, the moisture content was determined as 10.36%, ash 1.8%, protein 16.5%, einkorn wheat 11.81%, ash 2.22%, protein 15.61%. The color values of raw bulgur obtained from durum wheat were determined as L: 40.17, a: 6.72, B: 17.47, and bulgur obtained from einkorn wheat as L: 43.98, a: 6.17 and B: 16.55, respectively (Yılmaz and Koca, 2020).

In the study conducted to determine the bulgur production potential of Emmer wheat with six production methods consisting of three cooking (traditional, autoclave, microwave) and two drying (hot air, microwave) methods, some physical, chemical and technological properties of Emmer wheat as well as yield, color, cooking properties of bulgur samples. By examining the duration, textural and sensory properties of the bulgur, it was stated that the microwave process increased the fine bulgur formation, shortened the cooking time, and this drying process increased the volume and weight increase indexes more than hot air drying thanks to the physical effects on the structure of the bulgur. According to the results of the analysis, it was stated that emmer wheat has a great potential for bulgur production and traditionally cooked and hot air-dried samples have better properties (Yılmaz 2020).

In this study, it was aimed to determine the compatibility of some microbial and physicochemical properties of Kavılca Bulgur obtained with the traditional method from Kavılca, grown in and around Kars province, with the Turkish Food Codex Wheat Flour Communique (2018) and Turkish Food Codex Microbiological Criteria Regulation and it is aimed to support the studies to be carried out for the development and dissemination of Kavılca wheat

production, which has a high value. This article is the first report on the microbiological content and some physicochemical properties of Kars Kavılca Bulgur.

The making of kavılca bulgur with the traditional method

Kavılca bulgur is a grain product obtained by peeling the husk of wheat without boiling (without heat treatment) and breaking it in stone mills (Anonymous 2020).

Kavılca bulgur is irregularly broken, large and small, of heterogeneous sizes. The outer color and inner color are cocoa brown, while the inner face of the broken grains appears to be bright dark brown like glass.

In a research conducted to identify the microbial and physicochemical properties of Corn and wheat flour in a milling company in Lesotho, moisture was found to be 13.31% and ash 0.71% in whole wheat flour. The total number of bacteria was found to be 4.78 $\log_{10}$ CFU g^{-1} coliform bacteria 3.73 $\log_{10}$ CFU g^{-1}, and yeast-mold number 2.78 $\log_{10}$ CFU g^{-1} (Victor et al., 2013).

Ekinci and Ünal (2002), found the moisture content of the flour samples obtained from 30 factories producing flour in 19 different provinces belonging to 7 different regions of Turkey as 9.59-14.17% and the amount of ash as 0.52-0.82%.

For the first time in Turkey, the average coliform bacteria in the raw material, flour samples were found to be $4.4x10^1$ CFU g^{-1}, and the average number of mold $6.8x10^3$ CFU g^{-1} in the dough production facilities (Arda and Aydın 2011).

Vita et al. (2006) They found that the ash content of 20 Triticum dicoccum (emmer) samples collected from Foggia in the southern region of Italy between 2002 and 2004 varied between 1.92% and 2.39%.

Giacintucci et al. (2014) reported that the amount of raw ash in Triticum dicoccum (emmer) wheat grain collected in the spring was 1.61%, the moisture content was 10.3%, and the amount of crude ash in Triticum dicoccum (emmer) collected in autumn was 1.10% and the moisture content was 12.5%.

Belcar et al. (2020) They found the moisture content of the ancient Emmer wheat grain to be 11.52%.

Zengin (2015), Triticum dicoccum (emmer) wheat flour obtained from 9 producers from Ihsangazi District of Kastamonu Province and Susuz District of Kars Province has an average L value of 87.90 (86.35-89.09), an average value of 1.54 (1.22-1.75) and an average b value of 12.19 (11.17-13.72-1), and the ash content was found to be 1.66 (1.48-1.86%) on average.

The moisture content of the coarse wheat produced from the wheat obtained from the factory producing bulgur in Mardin province was found to be 12.5% and the amount of ash 1.33% (Can et al. 2014).

Hayıt (2018) found the moisture content as 13.5% and the ash content as 0.71% in wheat flour for bread.

Savaş and Basman (2016), found the ash ratio of the bread wheat used in the production of bulgur as 1.38-1.43% and the color values as L; 54.78-64.01, a; 7.50-7.98 and b; 14.88-22.44.

In another study examining the properties of industrial and homemade bulgur in Turkey, the moisture content of homemade bulgur was found to be 9.7% and ash content 1.49% Ertaş (2017).

MATERIALS AND METHODS

Material

As material, 40 unpackaged Kavılca bulgur samples produced in family businesses under home conditions in Kars province and sold in delicatessens, grocery stores, and arcade marketplaces were used. Samples were taken as offered to the consumers by the sellers and brought to the laboratory immediately for microbiological cultivation and some chemical analysis. The traditional method of making kavılca bulgur (Fig. 1), coarse-grained and fine-grained kavulca bulgur images are given in Figs. 2 and 3.

Method

Physicochemical analysis of Kavılca bulgur samples

Color readings of kavılca bulgur samples in L*, a* and b* were carried out using the Chroma Meter (Konica Minolta Japan) L* value [(0) black- (100) white], a* value [(+) red- (-) green], and the b* value [(+) yellow - (-) blue] (Francis 1998).

The moisture content of the kavılca bulgur samples was tested according to (AACC Method 44-01.01 (AACC 1999), ash content according to AACC Method 08-01. 01 (AACC 1999) % titratable acidity (in terms of sulfuric acid) according to Uylaşer and Başoğlu (2014), and pH level according to the method specified by Kotancılar et al (1997).

Microbiological analysis

10 g of kavılca bulgur samples were homogenized with 90 ml (1:10 dilution ratio) sterile peptone saline for 2 minutes and serial dilutions were prepared up to 10^6 step with sterile 0.1% peptone saline, and inoculation was made on the media from the relevant dilutions. Plate Count Agar

(PCA, Oxoid) for total mesophilic aerobic bacteria and psychrotroph, PDA (Potato Dextrose Agar) for yeast and mould, VRB Agar (Violet Red Bile Agar) (VRB, Oxoid) for total coliform bacteria and Dextrose Tryptone Broth (Oxoid) was used and the 3-tube EMS method was used in the determination of rope spore. The rope number in grams of samples was calculated according to the EMS (Most Likely Number) table (Ünlütürk and Turantaş, 2002). Incubation conditions were applied as follow: PCA for 24-48 hours at 30 °C, PDA at 25 °C for 5 days, VRB at 37 °C for 18-24 hours (Anonymous 2005).

Statistical analyses

In the evaluation of the obtained results, the mean value and standard deviation of the samples were determined by using the SPSS package program and the differences between the samples were examined by the Duncan test (SPSS 2018).

RESULTS

Analysis results of Kars Kavılca bulgur samples are given in Table 1, Table 2, and Table 3.

Moisture, physicochemical properties of flours are the main determinants of consumer acceptability and safety. Moisture is a very important parameter, considering the quality of flour and the acceptability of flour products. It affects the shelf life and microbial development during storage (Çetinkaya 2019).

Table 1: Physical and chemical analysis results of Kars Kavulca bulgur samples (n=40)

Parameters	Range	Mean±SE	Minumum	Maximum
Dry Matter (%)	91.06-95.04	93.43±0.13	91.06	95.04
pH	6.08-6.80	6.36±0.03	6.08	6.80
Acidity (%TAE)	0.02-0.08	0.06±0.01	0.02	0.08
Moisture (%)	8.97-8.93	6.57±0.13	4.97	9
Ash	1.11-2.40	1.65±0.05	1.11	2.40

TAE: Titratable acidity

Table 2: Total microorganism numbers of Kars Kavılca bulgur (n=40)

Microorganizms (log CFU g^{-1})	Range	Mean±SE	Minumum	Maximum
Total aerobic mesophilic (TAMB)	4.19-5.49	4.68±0.14	4.19	4.49
Yeast and Mold	0.00-3.30	1.35±0.35	0.00	3.30
Coliform	0.00-4.00	1.73±0.31	0	4.00
Rope	< 1	< 1	< 1	< 1

Table 3: Color values of Kars Kavılca bulgur (n=40)

Parameters	Range	Mean±SE	Minumum	Maximum
L	46.98-63.23	35.76±0.61	46.98	63.25
a*	5.95-9.68	7.87±0.14	5.95	9.68
b*	20.07-28.80	24.47±0.35	20.07	28.80

DISCUSSION

Dry matter values of Kavılca bulgur samples were found to be 93.43 % on average.

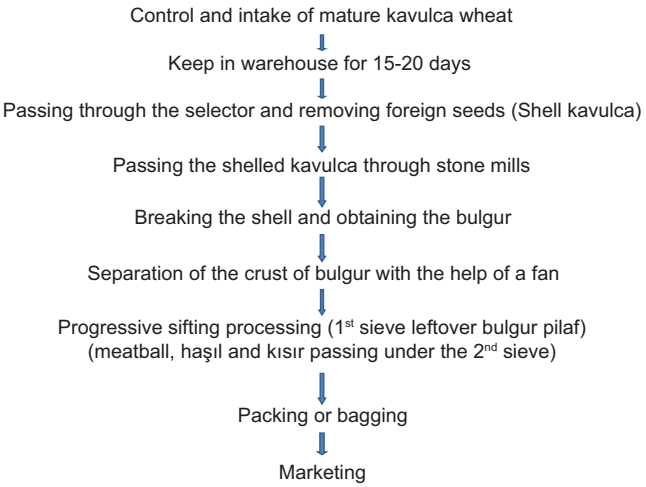

Fig 1. The making of Kavılca bulgur with the traditional method.

Fig 2. Fine-grained kavılca bulgur.

Fig 3. Coarse grain kavılca bulgur.

The moisture content of Kars Kavılca bulgur samples was found to be 10.63% (8.93-11.62) on average. The moisture content of Kavılca bulgur produced by the traditional method in Kars province has been stated as 10.7-11.8% (Anonymous 2020). The values we have found in the examples are in this range and are similar to the value found.

The value found is similar to the value found by Giacintucci et al. (2014) for spring Emmer wheat grains, lower than the value found in fall period grains and coarse bulgur found by Can et al (2014), higher than the value found by Ertaş (2017) in homemade bulgur wheat, the moisture content found by Victor et al (2013) in wheat flour samples is higher than the lower limit and close to the upper limit of the moisture values found in the Kavılca bulgur samples, lower than the upper limit of the values found in the wheat flour samples by Ekinci and Ünal (2002) obtained from 30 factories producing flour in 19 different provinces.

Ash content of Kavılca bulgur samples was found to be in the range of 1.12-2.40 % and on average (1.65%). It has been stated that ash content values in Kavılca bulgur produced in Kars province are in the range of 1.52-3.52% (Anonymous 2020).

The ash values found are similar to the values found by Giacintucci et al. (2014) in spring Emmer wheat grains, higher than the values in autumn season grains, in coarse wheat found by Can et al. (2014) and in bread wheat grains found by Savaş and Basman (2016) and in homemade bulgur found by Ertaş (2017).

The amount of ash in wheat is closely related to the flour yield, and the ash amount may differ very little in flours with the same efficiency obtained from different wheat. A high ash rate is not a desired property (Ünal 2002). While the amount of ash in the flour of wheat varieties decreases in rainy crop years, dry years cause an increase in ash amount values depending on the decrease in flour yield. Ash content is used as a factor of flour classification. The crude ash ratio may vary according to the wheat type, climate, and soil conditions, and the amount of product decreases in dry years and due to the decrease in the amount of available phosphorus (Elgün et al.,1999).

The pH values of the Kars Kavılca bulgur samples ranged from 6.17-6.78 and on average 6.36. It was found to be higher than the value found by Kotancılar et al. (1997) in the flour they stored for three months.

The average titratable acidity value (sulfuric acid) of the Kavılca bulgur samples was found to be 0.05%, which is between 0.02% and 0.08%. In the Wheat Flour Communiqué, it is stated that it should be between 0.07-0.09% in wheat flour, and the values we found in Kavılca bulgur samples are in accordance with these values.

Total Aerobic Mesophilic Bacteria is widely used to get a general idea of the hygienic quality and microbiological load of foodstuffs (Çetinkaya 2019).

Microbiological analysis findings of Kavılca bulgur samples are given in Table 2. The TAMB number of the samples ranges from 4.19-5.49 log CFU g^{-1}, with an average of 4.68 log CFU g^{-1}. It was found that 35 of the samples were lower than the TAMB number (1.10^5 CFU g^{-1}) specified in the Turkish Food Codex Microbiological Criteria Communiqué in all grain-based products and above the acceptable limits foreseen by the Turkish Food Codex in 5 samples (Turkish Food Codex 2011). The values we found are higher than the value found by Victor et al. (2013) in the wheat flour milling company in Lesato and in Arda and Aydın (2011). We can state that the high total aerobic bacteria in some samples may be due to the storage conditions of wheat, the processing method of the bulgur, the storage conditions, and the situation of packaged or unpackaged sales.

Yeast-mold was not detected in 35 of Kavılca bulgur samples (<1), the number of yeast-mold detected in 5 samples was between 2.78-3.30 log CFU g^{-1} and it was found that the yeast-mold number of the samples are in the range of (1.10^3 CFU g^{-1}), which is within the acceptable yeast-mold number specified by the Turkish Food Codex Communiqué on Microbiological Criteria (Turkish Food Codex 2011). The yeast-mold number found in the samples is higher than the value found by Victor et al. (2013) for wheat flour and lower than the value found by Arda and Aydın (2011) in flour.

Coliform bacteria and E. coli counts are important as they are indicative of the general hygienic properties of foodstuffs. There are many different factors as the cause of mold contamination, and these factors include contamination of the cereal grain during the transformation of the grain into flour and low sanitation controls (Arda and Aydın, 2011).

While no coliform bacteria were detected in 31 of Kars Kavılca bulgur samples, the number of coliform bacteria in 9 of them was found to be between 2.72-4.00 log CFU g^{-1}. It has been found that the values are in accordance with the number of coliform bacteria (1.10^4 CFU g^{-1}) specified in all grain-based products in the Turkish Food Codex Microbiological Criteria Communiqué. The number of coliform bacteria found in Kavılca bulgur samples was lower than the values found by Arda and Aydın (2011), and higher than the values found by Victor et al. (2013) in wheat flour.

Rope spores are generally heat-resistant *Bacillus subtilis* spores in foods (Adams and Moss 1995). *Bacillus subtilis* is a soil-borne bacterium, and its spores are frequently isolated from flours and can cause significant problems in the bakery industry, especially in bread. No rope spore was detected in eighteen of the Kavılca bulgur samples (<30 EMS/g) examined in our study, but 93 EMS/g was found in two samples. The amount found in the samples is below the amount specified in the Turkish Food Codex Microbiological Criteria Communiqué (Turkish Food Codex 2011).

The average color values found in the samples are given in Table 3. The color values of the samples were found to be L; 55.75 (46.98-63.23), a; 7.87 (5.95-9.68), and the b; 24.47 (20.07-28.80). It was found to be lower than the L value found by Zengin (2015) in Emmer wheat and higher than a and b value, it was found smaller than the lower limit of the L values, similar to the upper limit, close to the a value, and higher than the b values found by Savaş and Basman (2016) in bread wheat used in bulgur production. In Kars Kavılca bulgur produced by the traditional method, the average L value was found to be 46.90, a value 9.35, and b value 16.56 (Anonymous 2020). The color values we found in Kars Kavılca bulgur samples were high L and b values and low a value among these values.

When the literature results and the results obtained in our study are compared, it can be said that the difference between the samples may be due to the differences in processing stages, wheat type, processing time, and processing stages and storage properties.

CONCLUSIONS

The physicochemical and microbiological analysis results of the examined Kars bulgur samples differ from the results found by other researchers. It can be stated that these differences may be due to the influence of many factors such as the type of wheat, the climate conditions in which it is grown, the structure of the soil, harvesting conditions, processing methods, whether heat treatment is applied or not, the amount of moisture, storage conditions, packaged or open sale.

In the analyses, the numbers of yeast-mold and coliform bacteria were found to be within the limits specified in the Turkish Food Codex Wheat Flour Communiqué, and the number of Rope was below the limit value. Identifying the yield, quality, and functional properties of the Kavılca bulgur and the Kavılca wheat used in production and conducting studies to popularize its consumption will make significant contributions to the spread of the cultivation of this product. This study will serve as an example for future studies on identifying various properties of Kavılca bulgur.

Conflicts of interest

The authors declare that they have no conflict of interest.

Author contribution

Asya Çetinkaya: Methodology, investigation, resources, writing-orginal draft. Güven Gülbaz: writing-review and editing. All authors read and approved the final manuscript.

REFERENCES

AACC. 1999. International Approved Methods of Analysis. Method 44-01.01. Calculation of Percent Moisture. Approved November 3. 11th ed. AACC International, St. Paul., MN, U.S.A.

AACC. 1999. International. Approved Methods of Analysis. Method 08-01.01. Total Ash-Basic Method. Approved November 3. 11th ed. AACC International, St. Paul, MN, U.S.A

Adams, M. R and M. O. Moss. 1995. Food Microbiology. Royal Society of Chemistry, Cambridge.

Anonymous. 2005. Merck Practise of Food Microbiology. Basak Matbaacılık Ltd Sti. Ankara, Turkey, p.1-358.

Anonymous. 2014. IV. Geleneksel Gıdalar Sempozyumu. Sonuç Bildirgesi 17-19 Nisan 2014. Adana/Turkey.

Anonymous. 2015. Kars ili Tarımsal Yatırım Rehberi. T.C. Gıda Tarım ve Hayvancılık Bakanlığı Strateji Geliştirme Başkanlığı Tarımsal Yatırımcı Danışma Ofisi. Bitkisel üretim, Kars/Turkey.

Anonymous. 2020. Kavulca Bulguru Özellikleri. Available from: https://www.kavilca.com.tr/blog/kavilca-bulguru-uretimi-ve-ayirt-edici-ozellikleri.html [Last accessed on 2021 Mar 10].

Anonymous. 2022. Ancient wheats. In: Zencirci, N., H. Ulukan, F. S.Baloch, S. Mansoor and A. Rasheed. (Eds). Springer Nature, Switzerland AG, p.255.

Arda, Ş and A. Aydın. 2011. A study on the relationship of thin sheet of dough microbiological quality between quality of raw material and some hygiene parameters. İstanbul Üniv. Vet. Fak. Derg. 37: 135-147.

Atak, M. 2017. Wheat and wheat landraces of Turkey. MKU Tar. Bil. Derg. 22: 71-88.

Belcar J, A. Sobczy, M. Sobolewska, S. Stankowski and J. Gorzelany. 2020. Characteristics of technological properties of grain and flour from ancient varieties of wheat (einkorn, emmer and spelt. Acta Univ. Cibin. Ser. E Food Technol. 24:269-278.

Can, Z., M. Çimen, Ş. Aslan and B. Öztürk. 2014. Determination of compliance of chemical properties of bulgur for rice and meatballs produced in Mardin province with Turkish Standards. İstanbul Aydın Üniv. Derg. 23: 7-11.

Çetinkaya, A. 2019. Chemical and microbiological properties of kavut flour producedin some regions of Turkey. Int. J. Food Nutr. Res. 2: 1-8.

Ekinci, R. and S. Unal. 2002. Some properties of flour types produced in different region of Turkey I. Some physical and technological proporties. Gıda. 27: 201-207.

Elgün, A., Z. Ertugay, M. Certel and H. G. Kotancılar. 1999. Tahıl ve Ürünlerinde Analitik Kalite Kontrolü ve Laboratuvar Uygulama Kılavuzu. 2nd ed. Atatürk Üniversitesi Yayın No: 867, Ziraat Fakültesi. Yayın No: 335, Ders Kitapları Serisi No: 82, 245 s, Erzurum.

Ertaş, N. 2017. A comparison of industrial and homemade bulgur in Turkey in terms of physical, chemical and nutritional properties. Chem Ind. Chem. Eng. Q. 23: 341-348.

Francis, F. J. 1998. Colour analysis. In: Nielsen, S. S. (Eds.), Food Analysis. An Aspen Publishers, Maryland, Gaithersnurg, U S A. p.599-612.

Giacintucci, V., L. Guardeño, A. Puig, I. Hernando, G. Sacchetti and P. Pittia. 2014. Composition, protein contents, and microstructural characterisation of grains and flours of emmer wheats (*Triticum turgidum* ssp. dicoccum) of the central Italy type. Czech J. Food Sci. 32: 115-121.

Hayıt, F. 2018. Production of Frozen Gluten-Free Bread for Celiac Patients Effects of the use of Quinoa and Method Part Baked Frozen on the Quality of Gluten Free Bread. Süleyman Demirel University Graduate School of Natural and Applied Sciences Department of Food Engineering, Ph.D. Thesis, 2018. Isparta, Türkiye.

Kotancılar, H. G., İ. Çelik, Z. Ertugay and A. Elgün. 1997. An investigation on chemical alterations of the flours stored with different packaging materials with and without ingredients. Gıda. 22: 59-65.

Kün, E. 1996. Tahıllar-I (Serin İklim Tahılları). Ankara Üniversitesi Ziraat Fakültesi Yayınları, Yayın No: 1452, Ankara.

Mpofu, A., H. D. Sapirstein and T. Beta. 2006. Genotype and enviromental variation in phenolic content, phenolic acid composition, and antioxidant activity of hard spring wheat. J. Agric. Food Chem. 54: 1265-1270.

Savas, K and A. Basman. 2016. Infrared drying: A promising technique for bulgur production. J. Cereal Sci. 68: 31-37.

Serpen, A., V. Gökmen, A. Karagöz and H. Köksel. 2008. Phytochemical quantification and total antioxidant capacities of emmer (*Triticum dicoccon* Schrank) and einkorn (*Triticum monococcum* L.) wheat landraces. J. Agric. Food Chem. 56: 7285-7292.

SPSS. 2018. Statistics Student Verssion 20.0. SPSS Inc., Chicago, IL.

Turkish Food Codex. 2011. Mikrobiyolojik Kriterler Tebliği, Resmi gazete. Başbakanlık Yayınları, Ankara.

Turkish Food Codex. 2017. Bulgur Tebliği, Resmi Gazete. Tebliğ No: 2016/49, Sayı: 29960. Resmi Gazete, Turkey.

Turkish Food Codex. 2018. Türk Gıda Kodeksi Buğday Unu Tebliği, Resmi Gazete, Tebliğ No: 2018/39, Sayı: 30560. Resmi Gazete, Turkey.

Ünal, S. 2002. Importance of Wheat Quality and Methads in Wheat Quality Determination. Hububat Ürünleri Teknolojisi Kongre ve Sergisi 3-4 Ekim 2002, Gaziantep, Türkiye, p.25-37.

Ünlütürk, A and F. Turantaş. 2002. Gıdaların Mikrobiyolojik Analizi Düzeltilmiş İkinci Baskı. Meta Basım, İzmir.

Uylaşer, V and F. Başoğlu. 2014. Temel Gıda Analizleri. Dora Yayıncılık, Bursa, 125 s.

Victor, N., M. S. Bekele, M. Ntseliseng and M. Makotoko. 2013. Microbial and physicochemical characterization of maize and wheat flour from a milling Company Lesotho. Int. J. Food Saf. 15: 11-19.

Vita, P. De., C. Riefolo, P. Codianni, L. Cattivelli and C. Fares. 2006. Agronomic and qualitative traits of *T. turgidum* ssp. dicoccum genotypes cultivated in Italy. Euphytica. 150: 195-205.

Yılmaz, V. A. 2020. Effects of several production methods on technological, textural and sensorial properties of emmer (*Triticum turgidum* ssp. dicoccum) bulgur. J. Food Sci. Technol. 57(10): 3874-3883.

Yılmaz., V. A and A. F. Koca. 2020. Quality, sensorial and textural properties of einkorn and durum bulgur produced with several methods. Int. J. Gastron. Food Sci. 22: 100263.

Zengin, G. 2015. Bazı Ilkel Buğdaylarda Kalite Parametrelerinin Belirlenmesi Üzerine bir Araştırma. Selçuk Üniversitesi Fen Bilimleri Enstitüsü, Gıda Mühendisliği Anabilim Dalı, Yüksek Lisans Tezi.Konya, Türkiye.