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DETERMINATION OF SOME CHEMICAL PROPERTIES OF KUMRU: A TRADITIONAL FERMENTED CEREAL FOOD

Özgül Özdestan*[1], Gönül Güven[2], Esra Alpözen[2], İsmail Gövercin[2], Ali Üren[3]

[1] Ege University, Faculty of Engineering, Food Engineering Department, Izmir, Turkey
[2] Ministry of Food, Agriculture and Livestock, Izmir Food Control Laboratory, Izmir, Turkey
[3] Avrasya University, Faculty of Architecture and Engineering, Food Engineering Department, Trabzon, Turkey

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Abstract

The nearly ubiquitous consumption of cereals all over the world gives cereals an important position in international nutrition. Kumru is a traditional fermented cereal food made with flour and chickpea yeast. The aim of the present study was to investigate some chemical properties of kumru. Ten samples of kumru supplied from different manufacturers in Izmir were analyzed for the first time to determine total dry matter content, total ash content, salt content and mineral content. Total ash content of samples changed from 0.69 to 1.94 g/100 g. Total dry matter content of samples changed from 63.36 to 69.71 g/100 g. Salt content of samples changed from 0.73 to 1.64 g/100 g. Cd content of samples changed from 0.01 to 0.02 mg/kg. Pb content of samples changed from non detectable levels to 0.018 mg/kg. Cu content of samples changed from 1.71 to 10.7 mg/kg. Zn content of samples changed from 5.73 to 13.18 mg/kg. Ca content of samples changed from 236 to 396 mg/kg. P content of samples changed from 1027 to 1410 mg/kg. Statistically significant differences were obtained between total dry matter contents, total ash contents and salt contents of kumru samples ($P < 0.05$).

Keywords: Kumru, chickpea yeast, mineral, salt

GELENEKSEL FERMENTE BİR HUBUBAT ÜRÜNÜ OLAN KUMRUNUN BAZI KİMYASAL ÖZELLİKLERİNİN BELİRLENMESİ

Özet

Hububat tüketiminin tüm dünyada oldukça yaygın olması, hububat ürünlerine uluslar arası beslenmede önemli bir konum sağlamaktadır. Kumru geleneksel fermente bir gıda olup, un ve nohut mayası ile yapılmaktadır. Bu çalışmada, İzmir'deki farklı üreticilerden temin edilen 10 farklı kumru örneğinin toplam kuru madde içeriği, toplam kül içeriği, tuz içeriği ve mineral içeriği belirlenmiştir. Toplam kül içeriği 0.69 ile 1.94 g/100 g arasında bulunmuştur. Toplam kuru madde içeriği 63.36 ile 69.71 g/100 g arasında bulunmuştur. Örneklerin tuz içeriği 0.73 ile 1.64 g/100 g arasında bulunmuştur. Örneklerin Cd içeriği 0.01 ile 0.02 mg/kg arasında bulunmuştur. Örneklerin Pb içeriği tespit edilemeyen düzeylerden 0.018 mg/kg'a kadar değişen konsantrasyonlarda bulunmuştur. Örneklerin Cu içeriği 1.71 ile 10.7 mg/kg arasında bulunmuştur. Örneklerin Zn içeriği 5.73 ile 13.18 mg/kg arasında bulunmuştur. Örneklerin Ca içeriği 236 ile 396 mg/kg arasında bulunmuştur. Örneklerin P içeriği 1027 ile 1410 mg/kg arasında bulunmuştur. Kumru örneklerinin toplam kuru madde içerikleri, toplam kül içerikleri ve tuz içerikleri arasında istatistiksel olarak anlamlı farklılıklar tespit edilmiştir ($P < 0.05$).

Anahtar kelimeler: Kumru, nohut mayası, mineral, tuz

[1] *Corresponding author* / Yazışmalardan sorumlu yazar ;
ozgul.ozdestan@ege.edu.tr , (+90) 232 311 1315 , (+90) 232 342 7592

INTRODUCTION

Man learned the art of bread-making more than 4000 years ago. Though not always in the same form or as we know it today, bread has been a popular staple food for ages. The nearly ubiquitous consumption of bread places it in a position of global importance in international nutrition (1, 2). Carbohydrates have special significance in cereals which usually comprise about 50-80% carbohydrate on a dry weight basis (3). Cereal proteins (8-12% for wheat) comprise up to 80% gliadins and glutelins (gluten proteins) which have high contents of proline and glutamine, at the expense of essential amino acids, particularly lysine and to a lesser extent threonine (4-6). Also, although lysine is the most limiting essential amino acid in cereal proteins, its concentration is still high enough to meet the requirements of adults, but not those of children. The lysine requirement of older children can be met by rye, barley and oats (7). High contents of dietary fiber and anti-nutritional factors can, however, lower the protein digestibility (8, 9). Although lipids comprise only about 1.5-7.0% of cereal grains, they include a range of components such as essential fatty acids, fat-soluble vitamins and phytosterols (10).

Cereals contain about 1.5-2.5% minerals (11). The mineral in highest concentration (16-22% of the total ash content) in all cereals is phosphorus. Wheat, rye, barley and oats are also classified as moderate sources of calcium (100-200 mg/100 g), magnesium (100-200 mg/ 100 g), iron (1-5 mg/100 g), zinc (1-5 mg/100 g) and copper (0.1-1 mg/100 g). Besides these, a large number of other elements are present in trace quantities (12, 13).

Processing is a prerequisite for manufacturing attractive grain products and must initially render the food in a suitable form with good palatability. Processing may decrease or increase the levels of the bioactive compounds in grains and also modify bioavailability of these compounds (14).

Bread and bakery products have an important role in human nutrition. Generally, wheat bread is considered to be a good source of energy and irreplaceable nutrients for the human body. This is especially true for the products made from wholegrain or high-yield flour types (15).

Fermented food products are widely consumed all over the world. Cereal-based fermented foods play an important role in the diets of many people in Asia, Africa, the Middle East, and some parts of Europe (16). Kumru is a traditional Turkish fermented cereal product. It is a kind of sandwich bread. It is produced with chickpea (*Cicer arietinum*) yeast and called as kumru because its shape is similar to a bird, dove (kumru in Turkish) (17). Kumru has been produced and consumed in Izmir (the biggest city in the Aegean region of Turkey) for 150 years. Formerly it had been consumed cold but after 1940s it has been consumed both like a hot sandwich with salami, sausage, and cheese and as a cold sandwich with tomato and green pepper. There has been no scientific study about chemical composition of kumru. But it is a similar product to bread. Bread contains moisture 36.5 g/100 g bread, protein 5.71 g/100 g bread, fat 1.07 g/100 g bread, and carbohydrate 54.7 g/100 g bread as mean values (18).

During kumru production, dough is prepared with flour and chickpea yeast. After dough preparation and fermentation, shaping and cooking are realized. Chickpea yeast is prepared 1 day before production. Chickpea yeast is prepared by grinding chickpea, then mixing with hot water in a glass bottle. After sealing the bottle, fermentation is carried out for 9-10 hours at 25 °C. Fermentation lasts 16 hours in winter. Duration of fermentation is very important. After grinding chickpea into particles, it is filtered. This supernatant is used as yeast. Flour, chickpea yeast, warm water, and sometimes salt are mixed. It is fermented for 2-3 hours at 30 °C. Then shaping is carried out and the samples are allowed to stand for 10-15 minutes. Cooking is performed at 200-225 °C for 7-8 min. The central temperature of baked kumru is about 90 °C but it is served like bread. So kumru is consumed at about 25 °C (17, 19). The isolates obtained from chickpea starters and sweet dough sponges were identified as *Enterococcus mundtii/E. gallinarum, E. casseliflavus, Lactobacillus plantarum/L. pentosus, L. sanfrancisco, L. viridescens, L. bifermantans, Pediococcus urinea-equi, Streptococcus thermophilus, Lactococcus lactis subsp. cremoris, and Saccharomyces cerevisiae* (17, 20).

Biogenic amine content of kumru was determined by Özdestan et al. (20). Ten samples of kumru supplied from different manufacturers in Turkey were analyzed for the first time to determine biogenic amine contents using HPLC with benzoyl derivatization. Of the 10 amines under study, putrescine, cadaverine, spermidine, spermine, and histamine were detected in all samples. Spermine was the prevailing biogenic amine. Spermine concentrations of kumru samples changed from 2.4 to 17.9 mg/kg of kumru. Total amine contents of kumru samples were between 23.9 and 42.2 mg/kg of kumru. Concentrations of biogenic amines were far below the allowable limits. pH values of kumru samples were in the range from 5.28 to 6.40; acidities were in the range from 0.12 to 0.28 g/100 g kumru (as lactic acid); total free amino acid contents were from 0.101 to 0.251 g/100 g kumru (as leucine). Significant correlations were detected between biogenic amine concentrations and pHs, acidities, and total free amino acid contents.

20 samples of kumru supplied from markets were analyzed to determine acrylamide levels for the first time by Güven & Üren (21). Recovery study was done on kumru samples and recovery rate was found as 99.3%. Average acrylamide level of kumru samples was found 35.11 µg/kg. pH, moisture content, L*, a*, b*, reducing sugar and protein content of kumru samples were also determined and correlation between acrylamide level and pH, moisture content, L*, a*, b*, reducing sugar content, protein content were investigated. For kumru samples a significant correlation was found between acrylamide level and moisture content and L*, a*, b*.

Some chemical properties of kumru have not been studied before. Consequently, the aim of the present study was to investigate total dry matter content (%, w/w), total ash content (%, w/w), salt content (%, w/w) and mineral content (mg/kg) of kumru samples supplied from different producers in Izmir in Turkey.

MATERIALS AND METHODS

Materials

Samples

Ten kumru samples produced in winter by different manufacturers were purchased from local markets in Izmir in Turkey. Shelf life of kumru is 3 days and all of the samples were analyzed in the first day of shelf life.

Reagents

Nitric acid, sodium borohydride, silver nitrate, potassium chromate were obtained from Merck; sodium hydroxide, hydrogen peroxide were supplied from Riedel-de Haën. High Purity Standards were used for mineral analyses. Zinc acetate dehydrate, lead (II) nitrate, cadmium acetate dehydrate, calcium carbonate, copper (II) sulfate pentahydrate, di-phosphorus pentoxide were supplied from Merck.

Methods

Determination of total dry matter content

All of the samples were milled before analyses. Total dry matter was determined by drying the samples at 110 °C to a constant weight (22).

Determination of total ash content

All of the samples were milled before analyses. Total ash content was determined by ashing the samples at 800 °C.

Determination of salt content

The salt content was determined using the Mohr method (23). About 2 g of sample was dissolved in ca. 100 ml of water. One milliliter of 5% potassium chromate solution was added and titration performed with 0.1 M silver nitrate solution (1 ml 0.1 M $AgNO_3$ = 0.005844 g NaCl).

Determination of mineral content

All of the samples were milled before analyses. EPA 3052 method (24) was used for sample preparation and microwave ashing method was used. Ashing was made by acid, pressure and heat. EPA 6010 C method (25) was used for mineral analyses. ICP OES axial instrument was used.

An Optima 2000DV Dual View (Perkin Elmer, Germany) ICP OES *spectrometer* powered by a 40 MHz radiofrequenzy generator at 1300W was used for elemental determination. This instrument operates in the sequential measurement mode (radial and axial measurements). The main argon flow was 18 min/L, and the cooling flow was 0.20 min/L. The nebulizer was a Meinhard type with Cyclonic nebulization chamber, with argon aerosol gas and a 0.55 min/L flow-rate. Sample aspiration was forced by means of a Spetec Perimax 12 peristaltic pump with a 1.5 min/ml sample delivery rate. The analytical lines (type of spectral line and the integration times) used for the different elements were: Zn, 213.857 nm (I, 0.5 s); Cu, 324.754 nm (I, 0.5 s); Pb, 220.353 nm (I, 0.5 s); Cd, 214.440 nm (I, 0.5 s); Ca, 317.933 nm (I, 0.5 s).

0.5000 g homogenized sample was placed into Teflon tubes. 9 ml of nitric acid and 1 ml of H_2O_2 (30%, v/v) was added for digestion. The optimized microwave digestion programme applied included two steps: 25-180 °C for 15 min. and 180 °C for 15 min., both at 1200 W, followed immediately by ventilation at room temperature. Tubes are washed with deionized water and diluted up to 25 ml.

Apparatus

Mineral analyses (Cd, Pb, Cu, Zn, Ca, P) were performed by using Optima 2000 DV series ICP-OES (Perkin Elmer, Massachusetts, USA). Sample preparation for the determination of mineral content was realized by microwave wet ashing system (MARS 5, CEM Corp., Matthews, NC, USA).

The determinations of total dry matter contents were realized by using an oven (Dedeoğlu, Turkey).

Statistical analysis

Throughout the present study all the experiments were performed in triplicate. Statistical analyses were realized with the SPSS 16.0 statistics package program. The statistical analyses of the data were achieved by using one-way analysis of variance (ANOVA) and Duncan post-test. In all data analyses a value of $P < 0.05$ was considered as statistically significant.

RESULTS AND DISCUSSION

Table 1 shows total ash content, total dry matter content and salt contents of 10 kumru samples supplied from markets in Izmir. Total ash content of samples changed from 0.69 to 1.94 g/100 g. Average total ash content of samples was 1.25 g/100 g. Significant differences were detected amongst ash contents of kumru samples ($P < 0.05$). Total dry matter content of samples changed from 63.36 to 69.71 g/100 g. Average total dry matter content of samples was 66.24 g/100 g. Significant differences were detected amongst total dry matter contents of kumru samples ($P < 0.05$). Salt content of samples changed from 0.73 to 1.64 g/100 g. Average salt content of samples was 1.11 g/100 g. Significant differences were detected amongst salt contents of kumru samples ($P < 0.05$).

Table 2 shows trace elements (Cd, Pb) and mineral (Cu, Ca, Zn, P) contents of kumru samples. Cd content of samples changed from 0.01 to 0.02 mg/kg. Average Cd content of samples was 0.016 mg/kg. Pb content of samples changed from non detectable levels to 0.018 mg/kg. Average Pb content of samples was 0.018 mg/kg. Cu content of samples changed from 1.71 to 10.7 mg/kg. Average Cu content of samples was 2.91. Zn content of samples changed from 5.73 to 13.18 mg/kg. Average Zn content of samples was 7.24 mg/kg. Ca content of samples changed from 236 to 396 mg/kg. Average Ca content of samples was 296.9 mg/kg. P content of samples changed from 1027 to 1410 mg/kg. Average P content of samples was 1119.8 mg/kg. Detection limits of minerals and trace elements for the applied method were 0.01 mg/kg for Cd, 0.01 mg/kg for Pb, 0.01 mg/kg for Cu, 0.05 mg/kg for Zn, 0.5 mg/kg for Ca, 0.5 mg/kg for P.

Table 1. Mean total dry matter, total ash, salt contents and standard deviation values of kumru samples[a]

Sample code	Total dry matter content (g/100 g)	Total ash content (g/100 g)	Salt content (g/100 g)
K1	67.47^{c}±0.07	0.92^{i}±0	0.73^{g}±0
K2	64.93^{e}±0.13	1.19d^{c}±0.04	0.96^{e}±0.01
K3	64.16^{f}±0.41	1.94^{a}±0.05	1.57^{b}±0.03
K4	68.11^{b}±0.06	1.89^{a}±0.05	1.64^{a}±0
K5	67.36^{c}±0.23	1.22^{c}±0.05	0.96^{e}±0.03
K6	65.25^{e}±0.17	1.09^{de}±0.11	1.08^{d}±0.02
K7	66.98^{d}±0.06	0.95^{f}±0.01	0.86^{f}±0.02
K8	65.07^{e}±0.21	1.01^{fe}±0.04	0.84^{f}±0.01
K9	63.36^{g}±0.04	1.57^{b}±0.04	1.50^{c}±0
K10	69.71^{a}±0.16	0.69^{g}±0.03	0.97^{e}±0.01

[a]Different matching letters in a column mean significant differences according to Duncan test *(P < 0.05)*

Table 2. Mean mineral (Cd, Pb, Cu, Zn, Ca, P) contents (mg/kg) of kumru samples

Sample code	Cd	Pb	Cu	Zn	Ca	P
K1	0.01	0.01	1.92	6.15	236	1082
K2	0.02	0.01	1.72	5.73	262	1027
K3	0.02	0.01	1.87	13.18	396	1410
K4	0.01	0.04	1.71	7.26	327	1145
K5	0.02	0.01	1.98	6.01	282	1089
K6	0.01	0.01	1.86	6.09	257	1053
K7	0.02	0.01	1.71	7.16	315	1105
K8	0.02	ND	10.7	6.08	279	1167
K9	0.01	0.03	2.42	7.82	299	1034
K10	0.02	0.05	3.18	6.88	316	1086

ND=not detected.

Nineteen different bread varieties baked at 13 different locations in Egypt, from Aswan at the far South to Edfina on the Mediterranean Sea, were collected by Iskander & Davis (26). These breads were formulated with wheat and/or corn flour with or without other ingredients such as fenugreek or okra. Sixteen elements were measured by instrumental neutron activation analysis (INAA). The overall average concentrations of these elements in the investigated breads were as follows (in µg/g): Br, 5.06; Ca, 326; Cl, 2062; Cr, 0.95; Co, 0.044; Fe, 54.0; K, 2086; Mg, 692; Mn, 11.6; Na, 1709; Rb, 1.6; Sb, 0.040; Sc, 0.01; Se, 0.28 and Zn, 11.5. No As was detected in any of the bread types investigated. Assuming an average daily intake of 500 g, bread delivers 15-35% of RDA for Ca; 29-69% for K; 62-100% for Mg; 1-100% for Na; 33-77% for Zn; 43-100% for Se; 73-100% for Cr and 100% for Fe and Mn (26).

The work presented by Demirözü et al. (27) allowed determination the level of iron, copper, zinc, lead and cadmium in bread samples obtained from 20 bakeries in Ankara and Samsun, Turkey. The atomic absorption spectrophotometry method was used to determine these metals. The mean values of iron, copper, zinc, lead, and cadmium levels were found as 19.2±8.1 mg/kg-dry weight (dw), 2.1±1.0 µg/kg-dw, 10.0±3.0 µg/kg-dw, 86.8±176.0 µg/kg-dw, and 12.2±6.1 µg/kg-dw, respectively. No significant differences were found in copper and lead levels of samples obtained from bakeries in general, and in copper and cadmium levels of the samples from different provinces (*P > 0.05*), while they were considered significant in iron, zinc, and cadmium levels of samples in general, and in iron, zinc and lead levels of samples from different provinces (*P < 0.05*) (27).

Wheat bread contains 9.1 g/100 g protein, 31.8 g/100 g moisture, 0.8 g/100 g fat, 56.4 g/100 g carbohydrate, 1.9 g/100 g ash, 19 mg Ca, 0.7 mg Fe, 77 mg P, 74 mg K, 585 mg Na (28). Kumru has a similar chemical composition with bread. According to our results, kumru is a better source of some minerals such as P and Ca.

Recommended nutrient intakes for males and females between the ages of 25 and 50 years were given as follows by Welch and Graham (29). 800 mg for Ca, 800 mg for P, 15 mg for males and 12 mg for females for Zn. Estimated safe and adequate daily dietary intake for Cu was 1.5-3.0 mg. Kumru delivers 38.8%-19.4% of estimated safe and adequate daily dietary intake for Cu. Assuming an average daily intake of 200 g, kumru delivers 7.4% of RDA for Ca; 9.7% of RDA for males for Zn, 12.1% of RDA for females for Zn; 28% of RDA for P.

CONCLUSION

The nearly ubiquitous consumption of cereals all over the world gives cereals an important position in international nutrition. Cereals need to be processed for the production of bakery products and more specifically bread and it is known that processing may decrease or increase the levels of the bioactive compounds and also modify their bioavailability. Milling, for example, is necessary for bread production and the extraction rate determines to a great extent the nutritional composition of the flour. Furthermore, mixing, fermentation and baking all influence the nutritional quality of bread.

According to the results of this study; average total ash content of samples was 1.25 g/100 g. Average total dry matter content of samples was 66.24 g/100 g. Average salt content of samples was 1.11 g/100 g. Average Cd content of samples was 0.016 mg/kg. Average Pb content of samples was 0.018 mg/kg. Average Cu content of samples was 2.91 mg/kg. Average Zn content of samples was 7.24 mg/kg. Average Ca content of samples was 296.9 mg/kg. Average P content of samples was 1119.8 mg/kg. Kumru is a good source of minerals and it is safe for Cd and Pb contents.

REFERENCES

1. Barrett F. 1975. Role of bread in international nutrition. *Cereal Food World* 20: 323.

2. Cauvain SP. 2004. How much more bread research do we need. *Getreidetechnologie* 58: 364-366.

3. Shelton DR, Lee WJ. 2000. Cereal carbohydrates. In: Kulp, K., Ponte Jr., J.G. (Eds.), Handbook of Cereal Science and Technology, second ed. Marcel Dekker Inc., New York, pp. 385-416.

4. Mariotti F, Pueyo ME, Tome D, Berot S, Benamouzig R, Mahe S. 2001. The influence of the albumin fraction on the bioavailability and postprandial utilization of pea protein given selectively to humans. *J Nutr* 131: 1706-1713.

5. Mariotti F, Pueyo ME, Tome D, Mahe S. 2002. The bioavailability and postprandial utilisation of sweet lupin (Lupinus albus)-flour protein is similar to that of purified soyabean protein in human subjects: a study using intrinsically N-15-labelled proteins. *Brit J Nutr* 87: 315-323.

6. Morens C, Bos C, Pueyo ME, Benamouzig R, Gausseres N, Luengo C, Tome D, Gaudichon C. 2003. Increasing habitual protein intake accentuates differences in postprandial dietary nitrogen utilization between protein sources in humans. *J Nutr* 133: 2733-2740.

7. Klopfenstein CF. 2000. Nutritional quality of cereal-based foods. In: Kulp, K., Ponte Jr., J.G. (Eds.), Handbook of Cereal Science and Technology, second ed. Marcel Dekker Inc., New York, pp. 705-724.

8. Hopkins DT. 1981. Effects of variations in protein digestibility. In: Bodwell, C.E., Atkins, J.S., Hopkins, D.T. (Eds.), Protein Quality in Humans: Assessment and In vitro Estimation. AVI Publishing Co, Westport, pp. 169-193.

9. FAO/WHO 1991. Protein quality evaluation report of a joint FAO/WHO expert consultation. Food and Agriculture Organization, Rome.

10. Ruibal-Mendieta NL, Rozenberg R, Delacroix DL, Petitjean G, Dekeyser A, Baccelli C, Marques C, Delzenne NM, Meurens M, Habib-Jiwan JL, Quetin-Leclercq J. 2004. Spelt (*Triticum spelta L.*) and winter wheat (*Triticum aestivum L.*) wholemeals have similar sterol profiles, as determined by quantitative liquid chromatography and mass spectrometry analysis. *J Agr Food* 52: 4802-4807.

11. Bock MA. 2000. Minor constituents of cereals. In: Kulp, K., Ponte Jr., J.G. (Eds.), Handbook of Cereal Science and Technology, second ed. Marcel Dekker Inc., New York, 479-504.

12. Kent NL. 1975. Chemical composition of cereals. Technology of Cereals with Special Reference to Wheat, second ed. Pergamon Press Ltd., Oxford, New York, pp. 43-73.

13. Dewettinck K, Van Bockstaele F, Kuhne B, Van de Walle D, Courtens TM, Gellynck X. 2008. Nutritional value of bread: Influence of processing, food interaction and consumer perception. *J Cereal Sci* 48: 243-257.

14. Slavin JL, Jacobs D, Marquart L. 2001. Grain processing and nutrition. *Crit Rev Biotech* 21: 49-66.

15. Skrbic B, Filipcev B. 2008. Nutritional and sensory evaluation of wheat breads supplemented with oleic-rich sunflower seed. *Food Chem* 108: 119-129.

16. Tamer CE, Kumral A, Asan M, Sahin I. 2007. Chemical compositions of traditional tarhana having different formulations. *J Food Process Pres* 31 (1): 116-126.

17. Alpözen E, Güven G, Üren A. 2009. Three Traditional Bakery Foods Specific to Izmir; Izmir Gevreği, Kumru and Boyoz. 2nd Traditional Foods Conference Book (27-29 May 2009, Van), pp 920-923. [Izmir'in 3 geleneksel fırın ürünü; Izmir gevreği, kumru ve boyoz, 2. Geleneksel Gıdalar Sempozyumu Kitabı (27-29 Mayıs 2009, Van) in Turkish].

18. El SN. 1999. Determination of glycemic index for some bread. *Food Chem* 67: 67-69.

19. Sıkılı OH. 2003. Investigation of microbiological and flavour characteristics of chickpea sweet dough. Ph. D. thesis, Ege University, Food Engineering Department, pp 39-41, Izmir, Turkey.

20. Özdestan Ö, Alpözen E, Güven G, Üren A. 2012. Monitoring of biogenic amines in kumru: A traditional fermented cereal food. Int J Food Prop DOI:10.1080/10942912.2010.511754, Available online: 07 Apr 2011 [In press].

21. Güven G, Üren A. 2010. Determination of acrylamide level of kumru and boyoz. Master thesis, Ege University, Food Engineering Department, Izmir, Turkey, 66 p.

22. Ibanoğlu S, Ibanoğlu E, Ainsworth P. 1999. Effect of different ingredients on the fermentation activity in tarhana. *Food Chem* 64: 103-106.

23. Mohr Method. 1981. Pearsons chemical analysis of foods (8th ed.) (p. 13). England: Longman Scientific & Technical.

24. EPA (United States, Environmental Protection Agency) Method 3052 Microwave assisted acid digestion of siliceous and organically based matrices, http://www.caslab.com/EPA-Methods/PDF/EPA-Method-3052.pdf, 20 pages (Revised 1996).

25. EPA Method 6010-C: Trace elements in solution by ICP AES. Official Name: Inductively Coupled Plasma - Atomic Emission Spectroscopy (ICP-AES), November 2000 (3rd revision), 34 pages, http://www.caslab.com/EPA-Methods/PDF/EPA-Method-6010-C.pdf

26. Iskander FY, Davis KR. 1992. Mineral and trace element contents in bread. *Food Chem* 45 (4): 269-277.

27. Demirözü B, Saldamlı I, Gürsel B, Uçak A, Cetinyökü F, Yüzbaşı N. 2003. Determination of some metals which are important for food quality in bread. *J Cereal Sci* 37 (2): 171-177.

28. Baysal A, Keçecioğlu S, Arslan P, Yücecan S, Pekcan G, Güneyli U, Birer S, Sağlam F, Yurttagül M, Çehreli R. 1991. Composition of nutrients, 3. Press, Ankara. 53 p.

29. Welch RM, Graham RD. 2004. Breeding for micronutrients in staple food crops from a human nutrition perspective. *J Exp Bot* 55: 353-364.