

The contents are protected by copyright. The distribution by unauthorized third parties is prohibited.

Arch Lebensmittelhyg 69,
10–13 (2018)
DOI 10.2376/0003-925X-69-10

© M. & H. Schaper GmbH & Co.
ISSN 0003-925X

Korrespondenzadresse:
mozcan@selcuk.edu.tr

¹⁾ Department of Soil Science, Faculty of Agriculture, University of Selçuk, 42031 Konya-Turkey; ²⁾ Department of Food Engineering, Faculty of Agricultural, Selcuk University, 42031 Konya-Turkey; ³⁾ Çumra High Vocational School, Selçuk University, 42500, Çumra, Konya-Turkey; ⁴⁾ Faculty of Science, Department of Biology, Selçuk University, Konya-Turkey; ⁵⁾ Faculty of Veterinary, Selçuk University, Konya-Turkey

Evaluation of the mineral and trace elements of various breads

Mineralien und Spurenelemente verschiedener Brotsorten

Mustafa Harmankaya¹⁾, Ayşegül Korkmaz¹⁾, Mehmet Musa Özcan²⁾, Durmuşali Ceylan³⁾, Cengiz Akköz⁴⁾, Nesim Dursun¹⁾, Mustafa Mete Özcan⁵⁾

Summary

Bread samples were provided randomly from six bakeries (A, B, C, D, E and F) located in different district Konya in Turkey. While K contents of white bread vary between 157.0 mg/100 g (Bakery-C) and 515 mg/100 g (Bakery-F), K contents of loaf bread changed between 220 mg/100 g (Bakery-D) to 549 mg/100 g (Bakery-F) ($p < 0.05$). In addition, K contents of corn, rye and whole wheat breads changed between 215 mg/100 g (Bakery-E) and 362 mg/100 g (Bakery-A), 247 mg/100 g (Bakery-D) and 328 mg/100 g (Bakery-F) to 248 mg/100 g (Bakery-B) and 394 mg/100 g (Bakery-Bakery-F), respectively. While P contents of loaf breads change between 125 mg/100 g (Bakery-D) and 357 mg/100 g (Bakery-F), P contents of bran-bread varied between 107 (Bakery-B) and 312 mg/100 g (Bakery-E) ($p < 0.05$). Also, P contents of whole wheat breads changed between 141 mg/100 g (Bakery-B) and 240 mg/100 g (Bakery-A). The highest Ca contents of breads were found in bran-bread (758 mg/100 g) (Bakery-F), rye bread (697 mg/100 g) (Bakery-F), corn bread (377 mg/100 g) (Bakery-B) ($p < 0.05$). The highest Fe was found in whole wheat bread (4.36 mg/100 g) (Bakery-A) sample. The highest Zn contents of breads were found in loaf bread (2.46 mg/100 g) (Bakery-F) and bran-bread (2.47 mg/100 g) (Bakery-D). Mineral contents of breads showed differences depending on bread types and bakery.

Keywords: bread, wheat, corn, rye, bakery, mineral, ICP-AES

Zusammenfassung

Brotproben wurden zufällig aus sechs Bäckereien (A, B, C, D, E und F) verschiedener Bezirke Konyas in der Türkei gezogen. Während der K-Gehalt in Weißbrot zwischen 157,0 mg/100 g (Bäckerei-C) und 515 mg/100 g (Bäckerei-F) variierte, änderte sich der Inhalt des Vollkornbrots zwischen 220 mg/100 g (Bäckerei-D) auf 549 mg/100 g (Bäckerei-F) ($p < 0,05$). Darüber hinaus änderten sich der K-Gehalt beim Mais-, Roggen- und Vollkornbrot zwischen 215 mg/100 g (Bäckerei-E) und 362 mg/100 g (Bäckerei-A), 247 mg / 100 g Bäckerei-D) und 328 mg/100 g (Bäckerei -F) bis 248 mg/100 g (Bäckerei-B) und 394 mg/100 g (Bäckerei-F). Während sich der Gehalt beim Vollkornbrot zwischen 125 mg/100 g (Bäckerei-D) und 357 mg/100 g (Bäckerei-F) änderte, variierten die P-Gehalte im Kleie-Brot zwischen 107 (Bäckerei-B) und 312 mg/100 g (Bäckerei- E) ($p < 0,05$). Auch der P-Gehalt bei Vollkornbrot veränderte sich zwischen 141 mg/100 g (Bäckerei-B) und 240 mg/100 g (Bäckerei-A). Die höchsten Ca-Gehalte im Brot wurden in Kleie-Brot (758 mg/100 g) (Bäckerei-F), Roggenbrot (697 mg/100 g) (Bäckerei-F) und Maisbrot (377 mg/100 g) (Bäckerei-B) ($p < 0,05$) ermittelt. Der höchste Fe-Gehalt wurde in Vollkornbrot (4,36 mg/100g) (Bäckerei-A) gefunden. Der höchste Zn-Gehalt wurde in Vollkornbrot (2,46 mg/100 g) (Bäckerei-F) und Kleie-Brot (2,47 mg/100 g) (Bäckerei-D) gefunden. Der Mineralgehalt der Brote zeigte je nach Brot und Bäckerei Unterschiede.

Schlüsselwörter: Brot, Weizen, Mais, Roggen, Bäckerei, Mineralien, ICP-AES

The contents are protected by copyright. The distribution by unauthorized third parties is prohibited.

Introduction

Breads are traditional foods commonly consumed throughout the entire world, and it is not only a source of energy, but also supplier of nutrients for the human health (Isserlyska et al. 2001; Osuji, 2006; Natal et al. 2013). Bread can be eaten plain or topped with butter, margarine or jam, as a breakfast meal. Therefore, all these nutrients contribute to the total nutritive value of bread. (Gayle et al., 1986, Kent, 2002). Also, bread is a bakery product priced for its taste, aroma and texture. It is staple food prepared by baking dough of flour and water (Osuji, 2006). The popularity of bakery products has contributed to increased demand for ready to eat, convenience food products such as bread and other pastry products (David, 2006). Estimates are that there may be several types of breads in Turkey that vary in ingredients used or in baking techniques. There may be breads that have the same ingredients, but that are called different names in different locations (Isserlyska et al. 2001). Apart from that, it contains vitamins from the B group and minerals, mostly magnesium, calcium, and iron (Ranhotra, 1983). Bread is an excellent source of several vitamins and minerals whose abundance depends on the degree of grinding (Grembecka et al. 2007; Ameh et al. 2013). The importance measuring the nutrition elements in various breads made from different flour related to the nutritive values has been realized. There was an increased bread consumption such as ours in countries. With the progressive increase in the consumption of bread and other baked products in Turkey, it should be developed breads and bakery products with natural product ingredients. There are several kinds of bread commonly consumed in Turkey, and some of them is white whole flour bread, loaf bread and bran-breads. As you know, breads have desirability to all population (rich and poor, rural and urban) (Al-Mussali et al. 2009). There is limited study on the mineral composition of various breads commonly consumed in Turkey. Due to the staff of life in human nutrition, the objective of present study was to determine mineral compositions of various breads made from wheat, corn, rye flours.

Material and Method

Material

55 ml water and 1.5% salt were used for 100 g flour for making of these breads. Each dough sample was baked in the oven at 210–220 °C in 20–23 min. The parameters of the bread making procedure ranges for various bakeries are given in Table 1. Before analyses, moisture content of bread samples was get to the constant weight. Bread samples were dried at 70 °C in a drying cabinet with air-circulation until reaching constant weight. Ground bread samples were sealed in glass jar and kept in frozen storage (–18 °C) for mineral and trace elements.

Method

Determination of Minerals Contents

About 0.5 g ground sample was digested by using 5 ml of 65 % HNO₃ and 2 ml of 35 % H₂O₂ in a closed microwave system at 200 °C. The volumes of the digested samples were completed to 50 ml with ultra-deionized water and mineral (Ca, Cu, Fe, K, Mg, Mn, Na, P, S and Zn) concentrations were determined by inductively coupled plasma-optical

emission spectroscopy (ICP-AES; (Varian-Vista, Australia). Measurements of mineral concentrations were checked using the certified values of related minerals in the reference samples received from the National Institute of Standards and Technology (NIST; Gaithersburg, MD, USA). The heavy metal contents of the samples were analysed against standard solutions of known concentrations (Skujins, 1998).

Working conditions of ICP-AES

Instrument:	ICP-AES (Varian-Vista)
RF Power:	0.7–1.5 kw (1.2–1.3 kw for Axial)
Plasma gas flow rate (Ar):	10.5–15 L/min. (radial) 15 “ (Axial)
Auxiliary gas flow rate (Ar):	1.5 “
Viewing height:	5–12 mm
Copy and reading time:	1–5 s (max. 60 s)
Copy time:	3 s (max. 100 s)

Statistical Analyses

A complete randomized split plot block design was used, and analysis of variance (ANOVA) was performed by using JMP version 9.0 (SAS Inst. Inc., Cary, N.C.U.S.A.). All analyses were carried out three times and the results are mean ± standard deviation (MSTAT C) of independent bread samples (Püskülcü and İkiz, 1989).

Results and Discussion

Mineral contents of breads produced in six different commercial bakeries are given in Table 1. The following minerals were detected and quantified in all bread samples investigated. The levels of these minerals were high in all the breads. However, the levels of Cu, Fe, Mn and Zn were significantly very low in all bread samples. These breads are good sources of Ca, P, K, Mg and Na as compared with the recommended dietary allowances. Some of these present results in the mineral composition of Turkey breads corroborate previous reports in literature. While K contents of normal bread change between 157.0 mg/100 g and 515 mg/100 g, K contents of loaf bread varied between 220 mg/100 g to 549 mg/100 g (p<0.05). In addition, K contents of corn bread changed between 215 and 311 mg/100 g. K contents of rye bread changed between 247 mg/100 g and 328 mg/100 g. In addition, K contents of whole wheat bread varied between 248 and 394 mg/100 g. P contents of breads were found partly low compared to their K contents of bread samples. While P contents of loaf bread change between 125 and 357 mg/100 g, P contents of bran-bread varied between 107 and 312 mg/100 g (p<0.05). The highest Ca contents of bread samples were found in bran-bread-F (758 mg/100 g), rye bread-F (697 mg/100 g) and-A (644 mg/100 g), corn bread-B (377 mg/100 g) (p<0.05). Generally, Fe contents of whole wheat breads were found higher than those of Fe results of other bread types. The highest Fe in bread

TABLE 1: Parameters of bread making procedure in different bakeries.

Steps	Time (min.)	Temperature (°C)
Mixing	5.0– 7.0	25.0– 29.0
Maturing	85.0–90.0	28.0– 32.0
Proofing	25.0–28.0	30.0– 33.0
Baking	20.0–23.0	210.0–220.0

The contents are protected by copyright. The distribution by unauthorized third parties is prohibited.

samples was found in whole wheat bread-A (4.36 mg/100 g) sample. Also, the highest Mg in bread samples was determined in white bread-C (237 mg/100 g). It was observed statistically significant differences commercial bakeries and bread types ($p < 0.05$). In previous study, various breads in Saudi Arabia contained 2.2–12.5 mg/100 g Ca, 41.9–320.8 mg/100 g P, 83.2–794.6 Na, 0.7–224.2 mg/100 g K and 1.6–7.8 mg/100 g Fe (Al-Kanhal et al. 1999). Balady bread contained 35–4.1 Mn, 126–1421 Mg, 1.58–2.101 Zn, 0.42–0.421 Cu, 21–221 Ca and 190–2201 mg/100 g P (Al-Mussali et al. 2009). Hussein et al. (2001) stated that pan bread from white flour contained 217.4 mg/100 g Na, 134.51 K, 128.21 Mg, 1.901 Mn, 0.351 Cu, 0.61 Zn, 27.91 Ca, 1.121 mg/100 g Fe. In other study, Eduehi et al. (2007) determined 548–2006 Na, 55–305 Mg, 0.9–6.5 Mn, 41–224 K, 94–190 Ca,

0.04–1.0 Cu, 0.3–65.0 Zn and 0.2–5.3 mg/100 g Fe. Demirözü et al. (2003) determined 19.2 Fe, 22.1 Cu and 10.0 mg/Kg Zn in 120 bread samples. Al-Kanhal et al. (1999) reported that Mafroud, Samouli and white sliced loaf breads in Saudi Arabia contained 2.2, 2.4 and 12.5 mg/100 g Ca, 41.9, 320.8 and 75.8 mg/100 g P, 207.7, 304.3 and 274.5 mg/100 g Na, 67.2, 101.4 and 89.4 mg/100 g K and 1.9, 1.7 and 2.6 mg/100 g Fe, respectively. Breadstuff contained 512 mg P, 0.7 mg Cu, 20 mg Ca, 93 mg Mg, 602 mg Na, 183 mgK, 4.5 mg Fe and 3 mg Zn (Winiarska-Mieczan, 2011). Isserliyska et al. (2011) reported that Bulgarian wheat bread contained 0.023 g/100 g Ca, 0.027 g/100 g Mg, 0.001 g/100 g Fe and 0.001 g/100 g Zn. Iskendar and Davis (1992) reported that breads contained 5.06 B, 326 Ca, 2062 Cl, 0.95 Cr, 0.044 Co, 54.0 Fe, 2086 K, 692 Mg, 11.6 Mn, 1709 Na,

TABLE 2: Mineral contents of various breads made from wheat, corn, rye flours (mg/100 g).

	Fe	Zn	Cu	Mn	Ca	Mg	K	P	Na	S
White wheat bread -A	2.46±0.27c	1.13±0.09b	0.16±0.01c	0.63±0.02d	57±2b	83±5e	288±18c	160±9d	524±22b	156±8c
White wheat bread -B	1.71±0.16e**	0.60±0.02d	0.17±0.00c	0.42±0.02d	88±2a	56±1f	209±6d	123±3e	402±13d	133±6e
White wheat bread -C	2.66±0.58b	0.90±0.12c	0.24±0.01b	4.88±0.08a	42±9c	237±5a	157±4e	68±3f	30±1f	178±13b
White wheat bread -D	2.50±0.39c	0.93±0.07c	0.25±0.05b	1.63±0.03c	43±3c	105±8d	292±32c	190±4c	142±13e	144±8d
White wheat bread -E	2.12±0.31d	1.20±0.11a	0.25±0.04b	2.66±0.05b	35±5d	135±6c	457±21b	263±15b	512±12c	139±19e
White wheat bread -F	3.44±0.76a	1.21±0.13a	0.46±0.02a	2.74±0.15b	21±10d	157±7b	515±31a	360±8a	548±31a	206±6a
Loaf bread -A	2.97±0.12a	1.58±0.02b	0.30±0.03a	1.42±0.03b	35±1b	96±1b	285±7b	193±3b	169±6f	161±5b
Loaf bread -B	2.09±0.31d	0.71±0.05d	0.18±0.01d	0.57±0.03d	91±3a	65±2c	224±9d	137±4c	365±13d	145±14c
Loaf bread -C	2.35±0.39b	0.95±0.05c	0.23±0.02c	0.78±0.05c	39±3b	62±2d	251±4c	133±4c	423±5ce	157±3b
Loaf bread -D	2.00±0.09d	0.98±0.05c	0.20±0.01c	0.69±0.04c	33±1b	53±3e	220±11d	125±6d	332±13	150±3b
Loaf bread -E	2.17±0.07c	0.88±0.02a	0.22±0.02c	0.81±0.06c	46±4b	60±4d	236±2d	130±2c	450±18b	141±3c
Loaf bread -F	2.33±0.13b	2.46±0.11a	0.27±0.04b	3.24±0.09a	39±2b	163±8a	549±18a	357±21a	591±6a	192±12a
Corn bread -A	2.10±0.19c	1.42±0.12a	0.45±0.02	1.24±0.08a	53±1a	94±5	362±6.9a	184±7a	554±6a	217±13a
Corn bread -B	2.03±0.21c	1.06±0.04c	0.16±0.01	0.29±0.01e	38±6b	79±1	311±5b	165±4b	501±3b	149±4d
Corn bread -C	2.34±0.27a	1.23±0.09b	0.20±0.02	0.60±0.06d	30±3b	53±7	261±35d	122±10e	478±20d	133±10e
Corn bread -D	2.06±0.30c	1.14±0.12c	0.23±0.03	0.85±0.06b	30±0b	68±6	290±6c	136±9d	497±12c	145±5d
Corn bread -E	2.36±0.39a	0.97±0.04d	0.21±0.02	0.72±0.01c	52±3a	52±4	215±11e	121±7e	325±13e	177±19c
Corn bread -F	2.24±0.16b	1.20±0.20b	0.28±0.03	0.78±0.05c	38±1b	72±3	280±5d	156±8c	470±15d	189±7b
Rye bread -A	3.10±0.27a	1.11±0.04b	0.19±0.01c	1.06±0.04a	644±13b	82±1b	305±21c	161±4b	517±6a	163±9c
Rye bread -B	2.28±0.22c	0.87±0.05d	0.23±0.01b	1.11±0.04a	162±4c	94±2a	278±5d	166±4b	445±8f	143±6d
Rye bread -C	2.38±0.12b	1.04±0.15c	0.24±0.03b	0.91±0.06b	38±3d	93±5a	308±29c	186±7a	471±12d	151±15c
Rye bread -D	2.43±0.15b	1.33±0.02a	0.24±0.04b	0.89±0.02b	55±6d	63±1d	247±6e	130±5d	462±5e	140±9d
Rye bread -E	2.39±0.45b	1.22±0.09a	0.28±0.02a	0.79±0.02c	48±5d	74±3c	314±20b	163±10b	504±10b	193±6b
Rye bread -F	3.18±0.36a	1.08±0.01b	0.24±0.01b	0.79±0.02c	697±33a	73±1c	328±47a	159±4c	495±19c	209±10a
Whole wheat bread-A	4.36±0.57a	1.82±0.01a	0.32±0.01b	1.93±0.02b	40±1b	122±2a	306±7c	240±5a	328±18d	167±1b
Whole wheat bread-B	2.47±0.06d	0.80±0.04d	0.19±0.01e	0.84±0.05d	70±2b	68±3e	248±8e	141±6e	522±7b	135±22d
Whole wheat bread-C	2.62±0.40c	0.96±0.10d	0.26±0.03d	0.82±0.05d	37±1b	72±4d	283±17d	148±8e	301±19e	149±7c
Whole wheat bread-D	2.46±0.20d	1.65±0.09b	0.27±0.05d	1.14±0.03c	55±2b	88±6b	323±22b	162±19d	290±17f	140±17c
Whole wheat bread-E	4.04±0.35a	1.49±0.22c	0.38±0.06a	2.70±0.02a	64±3b	85±11c	391±10a	204±5b	496±1c	213±12a
Whole wheat bread-F	3.67±0.14b	1.36±0.04c	0.30±0.05c	0.79±0.03d	265±11a	88±11b	394±20a	197±9c	570±8a	205±12a
Bran-bread -A	3.53±0.26b	2.03±0.09b	0.40±0.03b	2.77±0.05a	57±4c	158±4a	419±9b	309±16b	300±11d	149±19c
Bran-bread -B	1.61±0.04d	0.62±0.06d	0.12±0.01e	0.52±0.03d	20±2d	52±3e	160±15f	107±6e	173±17e	103±4d
Bran-bread -C	3.00±0.19c	1.53±0.12c	0.31±0.04c	1.96±0.04b	41±4c	89±6d	330±24e	172±2d	481±28c	157±9c
Bran-bread -D	2.90±0.38c	2.47±0.02a	0.33±0.03c	1.74±0.05b	54±5c	101±5b	384±17c	206±10c	529±10b	151±6c
Bran-bread -E	3.58±0.34a	1.40±0.17c	0.44±0.02a	1.18±0.04c	157±10b	88±10d	529±24a	312±7a	526±19b	218±23a
Bran-bread -F	3.82±0.22a	1.41±0.08c	0.26±0.01d	1.26±0.15c	758±22a	94±6c	372±37d	201±21c	572±14a	199±8b

*: mean ± standard deviation; **: Values within each row followed by different letters are significantly different ($p < 0.05$); A, B, C, D, E, F: Bakery companies

The contents are protected by copyright. The distribution by unauthorized third parties is prohibited.

0.28 Se and 11.5 µg/g Zn. Al-Kanhal et al. (1999) reported that corn bread contained 3.6 Ca, 142.7 P, 250.5 Na, 219.3 K, and 5.4 mg/100 g Fe. In addition, Khalil and Sawaya (1984) reported that Pearl Millet bread contained 102 Fe, 0.96 Zn, 0.55 Cu and 1.89 mg/100 g Mn. Na contents in all breads were found high due to ingredients such as salt and bread making system in addition cultural growing factors such as fertilizer and other climatic factor. Also, the variation of sodium content in the breads under study may be due to the addition of salt of different quantity in the local bakeries. Our results exhibited partly nutrition information on various breads commonly consumed in Turkey. Mineral contents of breads changed depending on bread types and bakery. Results showed partly differences compared with literature values. These differences can be probably due to different types of flour, bakery types, yeast, and fermentation method, fermentation time, water and bran. In conclusion, Turkey breads are rich in some micronutrients, which are essential for normal growth and health of humans.

Acknowledgement

The authors would like to thank Selçuk University-BAP.

Conflict of interest

No conflict of interest exist.

References

- Al-Kanhal MA, Al-Mohizea IS, Al-Othaimen AI, Akmal Khan M (1999):** Nutritive value of various breads in Saudi Arabia. *Int J Food Sci Nutr* 50: 345–349.
- Al-Mussali MS, Al-Gahri MA (2009):** Nutritive value of commonly consumed bread in Yemen. *E-Journal Chem* 6 (2): 437–444.
- Ameh MO, Gernah DI, Igbabul BD (2013):** Physico-Chemical and Sensory Evaluation of Wheat Bread Supplemented with Stabilized Undefined Rice Bran. *Food Nutr Sci* 4: 43–48.
- David MO (2006):** Nigeria, No 1 market for U.S. Wheat; Potential for other grains and feeds, USAID Foreign Agric. Serv. Bull., pp. 1–2.
- Demiroz B, Saldamli I, Gursel B, Ucak A, Cetinyokus F, Yuzbas N (2003):** Determination of Some Metals Which are Important for Food Quality Control in Bread. *J Cereal Sci* 37: 171–177.
- Ebuehi OATO, Owolabi CC, Ikanone Amabib IT, Ajeke AP (2007):** Organoleptic, minerals and vitamins' evaluation of some Nigerian breads. *Nigerian Food J* 25: 2, 95–100.
- Gayle PE, Knight EM, Adkins JS, Harland BF (1986):** Nutritional and organoleptic evaluation of wheat bread supplemented with pigeon pea. *Cereal Chem* 63: 136–138.
- Grembecka M, Kusiuk A, Szefer P (2007):** Zawartość magnezu, fosforu, cynku i żelaza w różnych gatunkach pieczywa [Content of magnesium, phosphorus, zinc and iron in different kinds of bread]. *Bromatol Chem Toksykol* 4: 319–323.
- Hussein NM (2001):** Studies on improving the nutritional value of some types of bread, Ph D Thesis, Faculty of Agri., Cairo-University, Egypt.
- Isserliyska D, Karadjov G, Angelov A (2001):** Mineral composition of Bulgarian wheat bread. *Eur Food Res Technol* 213: 244–245.
- Iskander FY, Davis KR (1992):** Mineral and traces element contents in bread. *Food Chem* 45: 269–277.
- Kent J (2002):** Technology of wheat, 5th ed., Pergamon press, Oxford, p109–136.
- Khalil JK, Sawaya WN (1984):** Mineral and vitamin contents of Saudi Arabian pearl millet flour and bread. *Cereal Chem* 61: 301–304.
- Natal DIG, Dantas MIS, Vidigal MCTR, Ribeiro SMR, Silva RR, Martino HSD (2013):** Physical and sensorial properties of potato breads fortified with whole soybean flour. *Rev Chilena de Nutr* 40: 62–70.
- Osuji CM (2006):** Importance and use of additives in breadmaking. A paper presented at a training workshop on the use of cassava/wheat composite flour and non-bromate additives for making bread and other confectionaries. Held at Michael Okpara University of Agriculture, Umudike.
- Püskülcü H, İkiz F (1989):** Introduction Statistic (İstatistiğe Giriş). Bilgehan Press, Bornova-İzmir, Turkey. (in Turkish).
- Ranhotra G (1983):** Bioavailability of magnesium in cereal-based foods. *Cereal Foods World* 28: 349–351.
- Skujins S (1998):** Handbook for ICP-AES (Varian-Vista). A hort Guide To Vista Series ICP-AES Operation. Varian Int. AGŞ-Zug. Version 1.0. pp 29. Switzerland.
- Winiarska-Mieczan A, Kwiecień M (2011):** Evaluation of the mineral composition of breadstuff and frequency its consumption. *Acta Sci Polon Technol Aliment* 10(4): 487–495.

Address of corresponding author:

Prof. Dr. Mehmet Musa Özcan
Department of Food Engineering
Faculty of Agriculture
University of Selçuk
42031 Konya
Turkey
mozcan@selcuk.edu.tr