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# Microbiological and Physico-chemical Quality Properties of Wheat Varieties in Turkey

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In this study, the microbiological and physico-chemical quality properties of 27 different wheat cultivars produced in Turkey were determined. The means total aerob mesophilic bacteria (TAMB), coliforms, *Bacillus cereus, Staphylococcus aureus*, mould and yeast counts were found 4.5 × $10^3$ cfu/g, 3.1 × $10^1$ cfu/g, 3.5 × $10^1$ cfu/g, 1.6 × $10^1$ cfu/g, 7.1 × $10^1$ cfu/g and 8.1 × $10^1$ cfu/g at wheat samples, respectively. While coliform, *B.cereus, S. aureus*, mould and yeast rates were detected 37.04, 18.52, 22.22, 40.74 and 37.04 %, respectively; in none of the samples, *Salmonella* spp., *Escherichia coli* and *Clostridium perfringes* were not determined. Dry matter, moisture, protein and ash means in wheat samples were calculated as 92.38, 7.62, 11.30 and 1.65 %. It was seen that the quality of wheat cultivars might change regarding production, storage, climate and other regional conditions. It is thought that it would be possible to get quality and healthy product with good production and protection techniques in all stages from harvest to the last product.

**Key Words: Wheat, Microbiological properties, Physico-chemical properties.**

## INTRODUCTION

Cereal grains can be contaminated by different sources such as dust, soil, fertilizer, water, insects, disease carrying plants and manure. The most common responsible contaminant bacteria families are *Pseudomonadaceae, Micrococcaceae, Lactobacillaceae, Bacillaceae* and mould species are *Alternaria, Fusarium, Helminthosporium* and *Cladosporium* in those types of contaminations. High moisture, temperature and oxygen concentration play important role in microbial composition of cereals thus storage period and product quality[1]. Fresh harvested grains can contain about $10^3$-$10^8$ microorganism in per gram depending on factors such as the kind of the cereal, harvesting method and climate conditions[2].

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Estimated grain decomposition in cereals is *ca.* 20 % due to insect infestations or moulds and this rate is higher in undeveloped countries. Mould proliferation in cereal grains cause deterioration in colour and smell, decrease the germination level of the grains besides the nutritional quality decreases due to biochemical changes in endosperm. However, mycotoxin formation and possible hazard potential for health of animals and human-beings are the more important damages of mould proliferation than decomposition and economical loss they cause[3].

Rotten grain is very important because of being first source in distribution, occurrence and generalization of disease. Most of the diseases can be transferred from field to field and from country to country by grain. About 40 different wheat disease pathogen is determined that are transferred by grain. Diseases are transferred from one place to another by grain, soil, plant residues and climate factors (such as wind, rain, *etc.*). Transferring by grain is an important factor in aspect of infecting disease free areas with pathogens. Many pathogens stay alive on grain for several years as long as grain stays alive. Pathogens can be present as sticked on grain surface, inside the grain, under the cortex, between the cortexes or seed bed in soil[4].

Wheat quality is interpreted differently in flour and semolina production sectors in means of processing. Flour and semolina producing sector primarily prefer wheat with high grindability and to consist of clean and healthy grains besides. Flour and semolina processing sector companies such as bread, macaroni, biscuits, *etc.* producers principally look for convenience for public health as well as final product quality. Besides, grain dry matter, moisture rate and ash content are also considered in wheat to measure its suitability for the industry[5].

Wheat cultivation area is 9.4 million hectares in Turkey and production is about 19 million tons according to the data obtained in 2003. In South-East Anatolia Region wheat cultivation area is 1.211.141 ha and the production is about 3.705.093 tons which corresponds to 19.5 % of total production in Turkey according to the data obtained[6] in 2003.

The aim of this study was to evaluate the microbiological and physico-chemical properties of wheat samples produced in various regions of Turkey and to determine their quality and risk potential for public health.

## EXPERIMENTAL

**Collection of wheat samples:** The most common produced 27 various wheat type samples in different regions of Turkey were taken into sterile sample bags from the silos they were kept. The samples for microbiological analyses were immediately sent to laboratory in cold chain (4 °C) and analyzed.

Diyarbakir-81, Ceylan-95, Sariçanak-98, Harran-95, Aydin-93, Firat-93 (Southeastern Anatolia Region); Svevo, Zenit, Duraking, Adana-99 (Mediterranean Region); Amanos-97, Ege-88, Altintoprak (Aegean Region); Cyprus-1, Ionio (Cyprus); Pehlivan (Thrace Region, Trakya) commercial bread and durum wheat cultivars and Sorgül, Bagacak, Mersiniye, Beyaziye, Misiri, Asure, Karakilçik, Hevidi-Akbugday, Ruto, Iskenderiye, Menceki (Southeast Anatolia Region) local compactum wheat landraces were used as materials in the research.

**Microbiological analyses:** 10 g wheat sample taken in aseptic conditions was homogenized with 90 mL Peptone water (Merck, Darmstadt, Germany). The prepared decimal dilutions were cultured double parallel in appropriate medium. Total microbial counts in the following mediums performed at mentioned times after incubation at mentioned temperatures: Total aerobic mezophilic bacteria (TAMB) count after 48 h incubated in plate count agar (Oxoid CM 325) at 35 °C; coliform bacteria count after 24 h incubated in violet red bile lactose agar (Oxoid CM 107) at 35 °C; *S. aureus* count after 48 h incubated in baird parker agar base+ egg yolk tellurite emülsion (Oxoid CM 275 + SR54) at 35 °C; mould and yeast count after 5 d incubated in potato dextrose agar (Oxoid CM 139)[7] at 25 °C (AOAC, 1995); *Clostridium perfringens* after 24 h incubated in perfringes selective agar base (OPSP) + Supplements A and B (Oxoid CM543 + SR76 + SR77) at 37 °C; *Escherichia coli* count performed[8] after 4 h incubated in TBX medium (Oxoid CM945) at 30 °C and following 18 h incubated in the same medium at 44 °C.

25 g weighing sample was taken for *Salmonella* spp. count and homogenized in 225 mL buffered peptone water (Merck) then incubated at 35-37 ºC during 16-20 h for pre-enrichment. Incubation in RVS Broth (Merck) at 42 ºC for 24 h and in selenite cystine broth (Merck) at 35-37 ºC for 24 h applied for selective enrichment. Classical biochemical and serologic tests *via* Salmonella latex test were applied[9] to the developed typical colonies after 24 h incubation in selective solid mediums modified Brilliant Green agar (Oxoid CM329) and Salmonella-Shigella Agar (Merck) at 35-37 ºC (Oxoid FT 203).

*B. cereus* count was performed by total plate count after 24 h incubation by agar diffusion method in mannitol egg yolk polymyxin (MYP) agar[10] at 30 ºC. Gram staining test, lecithinase production test, acid production from mannitol, anaerobic glucose expenditure, nitrate reduction test, Voges-Proskauer test, motility test, endospore formation test and hemolysis tests were applied to the colonies purified at nutrient agar for identification of *B. cereus*[11,12].

**Physico-chemical analyses:** Crude protein quantities of the samples were evaluated by spectrophotometric method in near infrared analysis (NIR) device. Besides, ash, dry matter and mositure quantity evaluations in wheat samples were performed according to ICC standard methods[13].

## RESULTS AND DISCUSSION

Microbiological quality properties of some wheat varieties produced in Turkey was shown in Table-1, their microbial contamination rates in Table-2 and physico-chemical quality traits in Table-3. The average TAMB, coliform, *B. cereus, S. aureus*, mould and yeast counts in 27 wheat varieties inspected in this study were $4.5 \times 10^3$ cfu/g, $3.1 \times 10^1$ cfu/g, $3.5 \times 10^1$ cfu/g, $7.2 \times 10^1$ cfu/g, $1.6 \times 10^1$ cfu/g and $8.1 \times 10^1$ cfu/g, respectively. *E. coli, Salmonella* spp. and *Clostridium perfringes* were isolated from none of the samples. Coliforms, *B.cereus, S.aureus*, mould and yeast contamination rates in the samples were determined as 37.04, 18.52, 22.22, 40.74 and 37.04 %, respectively. None of those bacteria were grown in Sariçanak-98, Cyprus-2, Duraking and Ionio samples.

The highest TAMB counts were in Beyaziye, Mersiniye and Diyarbakir-81 varieties 17 where the lowest counts were in Cyprus-2, Kunduru 1149, Cyprus-1, Sariçanak-98, Kiziltan-91 and Amanos-97 varieties. The highest coliforms count in wheat samples was in Altintoprak-98 ($5.4 \times 10^2$ cfu/g) samples. Mersiniye and Beyaziye varieties are local compactum wheat which are richest in protein content. *B. cereus* was isolated in Çakmak-79, Svevo, Zenit, Çukurova-1252 and Ege-88 and *S. aureus* was isolated in Diyarbakir-81, Ege-88, Çakmak-79, Selçuk-97, Altintoprak-98 and Mersiniye wheat varieties while none of those bacteria were isolated from other samples.

Dry matter (%), moisture (%), protein (%) and ash (%) content of wheat samples was 90.11-94.01, 5.99-9.89, 9.31-13.97, 1.16-2.54, respectively.

The damage related to microorganism growth in cereal grain has multiple aspects. Besides the product loss due to destruction of starch and gluten in grain, the deformation and colour change are also important because of the decrease in germination capacity. Souring, fermentation, formation of mould-like taste and odour are important factors that decrease the cereal quality. Microbial effects related decompositions, primarily the mould infections cause important economical losses. Furthermore they also cause serious health problems in case of consumption of mycotoxins[2].

Bacteria growth in cereal grains is related to temperature and moisture quantity. Moulds are primary decomposition factors while bacteria are the second ones and start to grow following mould growth. Insects also has role in microbial decomposition of cereal grains. Insects both ease the penetration of moulds to the grain and also play role in transportation of moulds and bacteria as well[3].

TABLE-1
MICROBIOLOGICAL QUALITY SPECIFICATIONS OF SOME WHEAT CULTIVARS PRODUCED IN TURKEY (MEAN VALUE cfu/g ± SD*)

| S. no. | Wheat variety | TAMB | Coliforms | *B. cereus* | *S. aureus* | Mould | Yeast |
|---|---|---|---|---|---|---|---|
| 1 | Diyarbakir-81 | $1.2\times10^{4} \pm 1.0\times10^{3}$ | ND** | ND | $1.1\times10^{1} \pm 1.5\times10^{1}$ | $9.0\times10^{1} \pm 1.0\times10^{1}$ | ND |
| 2 | Amanos-97 | $9.9\times10^{2} \pm 1.2\times10^{2}$ | ND | ND | ND | ND | $2.7\times10^{2} \pm 1.2\times10^{2}$ |
| 3 | Ionio | $7.0\times10^{3} \pm 5.7\times10^{1}$ | ND | ND | ND | ND | ND |
| 4 | Svevo | $1.1\times10^{3} \pm 6.4\times10^{1}$ | ND | $2.3\times10^{2} \pm 1.2\times10^{2}$ | ND | $2.2\times10^{2} \pm 7.2\times10^{1}$ | $3.3\times10^{2} \pm 1.5\times10^{2}$ |
| 5 | Zenit | $1.1\times10^{3} \pm 1.0\times10^{2}$ | $4.7\times10^{1} \pm 5.7\times10^{0}$ | $1.7\times10^{2} \pm 5.8\times10^{1}$ | ND | ND | ND |
| 6 | Kiziltan-91 | $9.9\times10^{2} \pm 1.7\times10^{1}$ | ND | ND | ND | $2.7\times10^{2} \pm 1.5\times10^{2}$ | ND |
| 7 | Ege-88 | $7.6\times10^{3} \pm 1.3\times10^{2}$ | ND | $1.3\times10^{2} \pm 5.8\times10^{1}$ | $1.1\times10^{2} \pm 1.2\times10^{1}$ | $1.3\times10^{2} \pm 5.8\times10^{1}$ | $8.0\times10^{1} \pm 3.5\times10^{1}$ |
| 8 | Ceylan-95 | $2.1\times10^{3} \pm 2.0\times10^{2}$ | ND | ND | ND | $3.0\times10^{2} \pm 1.7\times10^{2}$ | ND |
| 9 | Sariçanak-98 | $9.1\times10^{2} \pm 1.1\times10^{1}$ | ND | ND | ND | ND | ND |
| 10 | Harran-95 | $1.2\times10^{3} \pm 2.1\times10^{1}$ | ND | ND | ND | $7.7\times10^{1} \pm 2.5\times10^{1}$ | ND |
| 11 | Aydin-93 | $1.0\times10^{3} \pm 4.0\times10^{1}$ | ND | ND | ND | $9.4\times10^{1} \pm 1.2\times10^{1}$ | ND |
| 12 | Firat-93 | $4.2\times10^{3} \pm 1.7\times10^{2}$ | $1.4\times10^{1} \pm 5.8\times10^{0}$ | ND | ND | ND | ND |
| 13 | Duraking | $2.9\times10^{3} \pm 1.1\times10^{2}$ | ND | ND | ND | ND | ND |
| 14 | Cyprus-1 | $9.6\times10^{2} \pm 3.6\times10^{1}$ | $1.4\times10^{1} \pm 1.2\times10^{1}$ | ND | ND | ND | ND |
| 15 | Cyprus-4 | $9.0\times10^{3} \pm 4.0\times10^{2}$ | ND | ND | ND | ND | $2.3\times10^{2} \pm 1.2\times10^{2}$ |
| 16 | Gediz-75 | $3.1\times10^{3} \pm 2.1\times10^{2}$ | ND | ND | ND | ND | $2.6\times10^{2} \pm 2.2\times10^{2}$ |
| 17 | Adana-99 | $4.0\times10^{3} \pm 1.8\times10^{2}$ | $1.0\times10^{1} \pm 0.0\times10^{1}$ | ND | ND | ND | ND |
| 18 | Çakmak-79 | $6.0\times10^{3} \pm 4.2\times10^{1}$ | ND | $3.0\times10^{2} \pm 2.0\times10^{2}$ | $6.7\times10^{0} \pm 5.8\times10^{0}$ | ND | ND |
| 19 | Selçuk-97 | $1.0\times10^{3} \pm 1.6\times10^{1}$ | $2.3\times10^{1} \pm 1.2\times10^{1}$ | ND | $9.3\times10^{1} \pm 1.2\times10^{1}$ | ND | ND |
| 20 | Altintoprak-98 | $6.9\times10^{3} \pm 4.2\times10^{1}$ | $1.4\times10^{2} \pm 3.5\times10^{1}$ | ND | $1.3\times10^{2} \pm 2.5\times10^{1}$ | $1.0\times10^{2} \pm 0.0\times10^{1}$ | ND |
| 21 | Kunduru-1149 | $8.5\times10^{2} \pm 5.0\times10^{1}$ | $6.6\times10^{0} \pm 5.7\times10^{0}$ | ND | ND | $3.3\times10^{2} \pm 2.1\times10^{2}$ | $1.5\times10^{2} \pm 1.3\times10^{2}$ |
| 22 | Çukurova-1252 | $1.0\times10^{3} \pm 1.0\times10^{2}$ | ND | $1.0\times10^{2} \pm 0.0\times10^{1}$ | ND | ND | $1.3\times10^{2} \pm 5.8\times10^{1}$ |
| 23 | Menceki | $2.0\times10^{3} \pm 6.4\times10^{1}$ | $1.4\times10^{1} \pm 5.7\times10^{0}$ | ND | ND | ND | ND |
| 24 | Mersiniye | $1.7\times10^{4} \pm 6.4\times10^{1}$ | $3.7\times10^{2} \pm 3.8\times10^{1}$ | ND | $9.4\times10^{1} \pm 2.1\times10^{1}$ | $2.0\times10^{2} \pm 1.0\times10^{2}$ | $2.3\times10^{2} \pm 1.5\times10^{2}$ |
| 25 | Beyaziye | $2.3\times10^{4} \pm 6.4\times10^{1}$ | $2.0\times10^{2} \pm 3.8\times10^{1}$ | ND | ND | $1.2\times10^{2} \pm 7.2\times10^{1}$ | $3.3\times10^{2} \pm 1.2\times10^{2}$ |
| 26 | Cyprus-2 | $8.0\times10^{2} \pm 1.8\times10^{1}$ | ND | ND | ND | ND | ND |
| 27 | Bagacak | $3.0\times10^{3} \pm 6.3\times10^{1}$ | ND | ND | ND | ND | $1.7\times10^{2} \pm 1.2\times10^{2}$ |
| | **Mean value** | $\mathbf{4.5\times10^{3}}$ | $\mathbf{3.1\times10^{1}}$ | $\mathbf{3.5\times10^{1}}$ | $\mathbf{1.6\times10^{1}}$ | $\mathbf{7.1\times10^{1}}$ | $\mathbf{8.1\times10^{1}}$ |

*SD = Standard deviation; **ND = Not detection.

TABLE-2
CONTAMINATION RATES OF WHEAT SAMPLES WITH SELECTED BACTERIA

| | TAMB | Coliform | *S. aureus* | *B. cereus* | Mould | Yeast |
|---|---|---|---|---|---|---|
| Positive | 27 | 10 | 6 | 5 | 11 | 10 |
| (%) | (100.0) | (37.04) | (22.22) | (18.52) | (40.74) | (37.04) |
| Negative | - | 17 | 21 | 22 | 16 | 17 |
| (%) | (0.0) | (62.96) | (77.78) | (81.48) | (59.26) | (62.96) |

TABLE-3
CHEMICAL QUALITY SPECIFICATIONS OF SOME WHEAT CULTIVARS PRODUCED IN TURKEY (MEAN VALUE ± SD*)

| S. no. | Wheat variety | Dry matter (%) | Moisture (%) | Protein (%) | Ash (%) |
|---|---|---|---|---|---|
| 1 | Diyarbakir-81 | 92.45 ± 0.02 | 7.56 ± 0.02 | 9.31 ± 0.63 | 1.16 ± 0.05 |
| 2 | Amanos-97 | 92.97 ± 0.02 | 7.03 ± 0.02 | 10.18 ± 0.38 | 2.03 ± 0.05 |
| 3 | Ionio | 91.63 ± 0.03 | 8.37 ± 0.03 | 10.41 ± 0.27 | 1.74 ± 0.05 |
| 4 | Svevo | 92.98 ± 0.01 | 7.02 ± 0.01 | 11.08 ± 0.48 | 1.33 ± 0.05 |
| 5 | Zenit | 92.64 ± 0.03 | 7.36 ± 0.03 | 10.29 ± 0.67 | 1.56 ± 0.02 |
| 6 | Kiziltan-91 | 92.59 ± 0.01 | 7.41 ± 0.01 | 10.25 ± 0.55 | 1.30 ± 0.06 |
| 7 | Ege-88 | 92.20 ± 0.02 | 7.80 ± 0.02 | 10.99 ± 0.80 | 1.76 ± 0.04 |
| 8 | Ceylan-95 | 91.80 ± 0.22 | 8.20 ± 0.22 | 10.06 ± 0.60 | 1.20 ± 0.01 |
| 9 | Sariçanak-98 | 92.23 ± 0.01 | 7.77 ± 0.01 | 11.77 ± 0.47 | 1.53 ± 0.01 |
| 10 | Harran-95 | 92.75 ± 0.06 | 7.25 ± 0.06 | 11.88 ± 0.56 | 1.90 ± 0.02 |
| 11 | Aydin-93 | 92.81 ± 0.02 | 7.19 ± 0.02 | 12.28 ± 0.36 | 1.58 ± 0.01 |
| 12 | Firat-93 | 90.11 ± 0.02 | 9.89 ± 0.02 | 11.07 ± 0.20 | 1.79 ± 0.01 |
| 13 | Duraking | 92.82 ± 0.02 | 7.18 ± 0.02 | 12.48 ± 0.33 | 1.38 ± 0.01 |
| 14 | Cyprus-1 | 92.03 ± 0.02 | 7.97 ± 0.02 | 10.84 ± 0.10 | 1.56 ± 0.02 |
| 15 | Cyprus-4 | 91.43 ± 0.02 | 8.57 ± 0.02 | 10.90 ± 0.46 | 1.48 ± 0.04 |
| 16 | Gediz-75 | 92.63 ± 0.02 | 7.37 ± 0.02 | 9.95 ± 0.49 | 1.65 ± 0.03 |
| 17 | Adana-99 | 90.43 ± 0.02 | 9.57 ± 0.02 | 9.40 ± 0.20 | 2.54 ± 0.09 |
| 18 | Çakmak-79 | 91.81 ± 0.02 | 8.19 ± 0.02 | 11.22 ± 0.62 | 1.70 ± 0.01 |
| 19 | Selçuk-97 | 92.41 ± 0.02 | 7.59 ± 0.02 | 11.31 ± 0.24 | 1.17 ± 0.05 |
| 20 | Altintoprak-98 | 92.78 ± 0.07 | 7.22 ± 0.07 | 12.05 ± 0.42 | 1.47 ± 0.01 |
| 21 | Kunduru-1149 | 93.83 ± 0.02 | 6.17 ± 0.02 | 11.43 ± 0.40 | 1.76 ± 0.00 |
| 22 | Çukurova-1252 | 93.80 ± 0.08 | 6.20 ± 0.08 | 9.63 ± 0.49 | 1.88 ± 0.02 |
| 23 | Menceki | 92.83 ± 0.02 | 7.17 ± 0.02 | 13.58 ± 0.56 | 1.96 ± 0.04 |
| 24 | Mersiniye | 92.66 ± 0.07 | 7.34 ± 0.07 | 13.62 ± 0.72 | 1.78 ± 0.01 |
| 25 | Beyaziye | 94.01 ± 0.01 | 5.99 ± 0.01 | 13.97 ± 0.56 | 1.58 ± 0.02 |
| 26 | Cyprus-2 | 93.06 ± 0.07 | 6.94 ± 0.07 | 11.30 ± 0.45 | 1.98 ± 0.01 |
| 27 | Bagacak | 90.69 ± 0.13 | 9.31 ± 0.13 | 13.79 ± 0.52 | 1.78 ± 0.01 |
| | **Mean value** | **92.38** | **7.62** | **11.30** | **1.65** |

The number of detailed research about microbial quality of wheat and other cereals is too limited. Defined wheat quality by Turkish Standards Institution is only involved some physical and chemical quality specifications and allows maximum 14 % moisture content[14]. There are some legal arrangements about cereal flours mentioned in Microbiological Criteria Regulation of Turkish Food Codex[15]. According to that counts of maximum acceptable Aerobic mesophilic bacteria, *E. coli, Bacillus cereus, Clostridium perfringens* and mould are $1.0 \times 10^5$ cfu/g, 9 MPN/g, $1.0 \times 10^4$ cfu/g, $1.0 \times 10^4$ cfu/g and $1.0 \times 10^4$ cfu/g, respectively while no *Salmonella* spp is allowed in sample of 25 g. Hence, all the microorganism counts in inspected sample are within legal limits.

It is suggested that protein, dry matter and moisture rates of the grain are also important in total microorganism count in grain together with the cultivation and storage conditions[16]. It is known that local and improved durum wheat in Southeastern Anatolian Region (SAR) are the varieties which are particularly rich in protein, with round shaped grain and large surface area[17]. The presence of highest TAMB and coliform bacteria in local SAR varieties such as Beyaziye and Mersiniye also support that idea.

Moisture rate is very important for wheat trade and storage. Excess low moisture rates are undesirable due to grinding technique while high rates encourage microbial growth in product[18]. The wheat samples in this study was determined to have 7.62 % average moisture rate. Tekeli[19] has determined average moisture of wheat grown in Turkey as 9.0 % while Atli and Kösker[2] were determined average moisture content in wheat samples collected from 72 different provinces as 10.71 %. The moisture content in grain changes depending on wheat variety, cultivation conditions, harvesting period and many other factors[16]. That situation explains the different results between the researches.

Protein quantity and quality are principal factors in final wheat-made product quality. Durum wheat varieties have higher protein content than bread wheat varieties. The height of protein quantity determines the solidity, elasticity and sticky traits of boiled macaroni texture. Although the protein quantity is affected by environmental conditions, it is a hereditary factor[5]. In a study conducted by Atli *et al.*[16] in order to inspect the effects of different climatic regions in Turkey over wheat quality, they suggested that Southeastern Anatolia, Central Anatolia, Blacksea Region, inner passage and slope of east mountains climate conditions are highly probable to obtain high protein quantity. According to the results of present study the protein content of local compactum wheat samples in Southeastern Anatolian Region are over 13 %. The quality traits of local varieties are superior to improved varieties. The average protein content of all the samples involved in the study was 11.30 %.

The average ash quantity of the wheat samples in this study was 1.65 % of weight. Çakmak and Türker[20] determined the total ash rate as 0.36 % while Uluöz and Saygin[18] have reported the total ash rate in flour of grinded durum and compactum wheat as 0.49 and 0.45 %, respectively. Ash content is an important quality factor which changes the colour of macaroni if high. Optimum ash content in durum wheat is 1.5-1.8 % in dry matter[21].

In conclusion, the microbiologic and physico-chemical quality of analyzed 27 different wheat varieties in this study was observed to be variable depending on some factors such as wheat type, cultivation region, climate and storage conditions. It was concluded that the samples were within legal limits, however, good and hygienic production techniques have to be applied at all stages such as harvesting, storage and processing because of the probable microbial proliferation or contamination during flour production from wheat or its usage in different products.

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