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CHEMICAL AND NUTRITIONAL PROPERTIES OF SOME COMMERCIAL AVAILABLE CORN AND WHEAT PRODUCTS

Muhammad Usman Khan[1] , *Majid Majeed*[2] , *Muhammad Tayyab*[3], *Mohammad Ali Shariati*[4], *Shilan Rashidzadeh*[5]

Address(es):
[1]Department of Energy Systems Engineering, University of Agriculture Faisalabad,38000,Faisalabd,Pakistan,+92312667362.
[2]National institute of Food Science and Technology, University of Agriculture, Faisalabad,38000,Faisalabd,Pakistan,+92312667362.
[3]Punjab Bio Energy Institute,University of Agriculture Faisalabad, Faisalabad,38000,Faisalabd,Pakistan,+92312667362.
[4]Research Department, LLC «Science & Education», Russia and Researcher All Russian Research Institute of Phytopathology, Moscow Region, Russia.
[5]Department of Food Science and Technology, Gorgan Payamenoor Univeristy, Gorgan, Iran.

*Corresponding author: engineer_usman_Khan@yahoo.com

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ABSTRACT

Commercial corn and wheat products were obtained and investigated for, proximate composition, mineral composition and tocopherol content. Proximate composition shows moisture content in the range of 28.75-2.75%, ash (2.70-0.32%), fats (21.52 -0.75%), protein (11.54-0.940%), crude fiber (4.06-0.250%) and carbohydrates (85.80-55.96%). The data indicate that Commercial corn and wheat products vary greatly in term of protein, fats and crude fiber. White flour and whole wheat flour were determined to contain high protein content (>10% protein) while oil popped popcorn and biscuit contain high fats content of >20%. In minerals the level of iron is 9.56-51.21mg/kg, Ca (50-560 mg/kg), Zn (1.90-32.40 mg/kg), K (820-2946) and Mg (310-1512 mg/kg). Tocopherol analysis was also done by the HPLC and found that Alpha tocopherol showed higher concentration than gamma and sigma tocopherol. In tocopherols level of alpha tocopherol is 0.3385-7.135 mg/100g, Gamma tocopherol (0.000212-9.665 mg/100g)Sigmmatocopherol (0.00212-1.685 mg/100g).

Keywords: Proximate composition, minerals, tocopherol, maize, wheat

INTRODUCTION

Cereals are mostly grasses cultivated for their edible grains. These are grown at larger areas in Pakistan and cereal give more energy than any other type of crop worldwide. They are also a rich source of carbohydrate, protein, vitamins, fiber and minerals. In some developing countries, wheat or corn constitutes entire diet of poor people. In developed countries, cereal consumption is both more moderate but consumption is still substantial. In Pakistan wheat, maize and rice are grown at larger areas and these are the major energy source in the whole world than any other cereal crop. In developing countries wheat, rice and maize are the major constitutes of the entire diet of poor people. In Pakistan wheat (*Triticumaestivum*L.) is main food crop and used as staple food in country. In agricultural policies wheat it occupies a central position. In agriculture wheat contributes 12.5 percent to the value added and 2.9 % contribute to GDP. Its annual production was about 18.47 million tons and it is cultivated on an area of 8 million hectares in 2007-2008. At village stage, the storage space contains mud containers, metal containers, concrete rooms, jute hand bags and wood made bins. Open storage by putting bagged grain on plinth is also practiced by the whole sellers and for the protection it is covered with tarpaulin. Post-harvest losses are quite substantial because of poor drying and storage facilities **(Baloch and Irshad, 1986)**.
In Pakistan, maize is the third most important cereal crop after wheat and rice and is used as a staple food for humans, as feed for livestock and as raw material for industry. During 2006, it was planted on 1030 thousand hectares in Pakistan, with total production of 3560 thousand tons and having an average yield of 3.458 tons ha-1 **(Khan *et al.*, 2009)**. Maize accounts for 4.8% of the total cropped area and 3.5% of the value of agricultural output of Pakistan. It is planted on an estimated area of 0.9 million hectare with an annual production of 1.3 million tones. The bulk (97%) of the total production come from two major provinces (NWFP and Punjab), NWFP, accounting for 57% of the total area and 68% of total production **(PARC, 2007)**.
World collections of maize comprise about 12,000 accessions that are represented in 256 races, of which about 30 are in the process of extermination. Genetic erosion and habitat destruction by modern agriculture has increased the importance of germplasm characterization of plant materials **(Carvalho *et al.*, 2004)**. Maize and wheat are a multipurpose crop, providing food and fuel for human beings, feed for animals, poultry and livestock. Its grains have great nutritional value and are used as raw material for manufacturing many industrial products **(Afzal *et al.*, 2009)**. Its grains are important for the production of oil, starch and glucose **(Niaz and Dawar, 2009)**. Moreover, food composition data is important in nutritional planning and provides data for epidemiological studies **(Ali *et al.*, 2008).** However, there is limited information about the nutritional composition of the different commercial corn and wheat products which are manufactured in Pakistan. The present study aims to investigate, proximate composition, mineral and tocophero composition of the different commercial corn and wheat products which are manufactured in Punjab province of Pakistan.

MATERIALS AND METHODS

Moisture content

The moisture content in the fortified whole wheat flour samples was determined in an air forced draft oven (Memmert) by following the method described in AACC [2000].

Ash content

Each flour sample was tested for ash content using muffle furnace (NEY M-525) by following the procedure outlined in AACC [2000].

Fat content

The crude fat content in whole wheat flour samples was estimated using petroleum ether as a solvent in Soxhlet apparatus (Sox. Tec System H T- 2, 1045) according to the procedure given in AACC [2000].

Protein content

The nitrogen content in flour samples was determined by Kjeldahl's method as described in AACC [2000]. The nitrogen percentage was determined as:

$$Nitrogen\ \% = \frac{\text{Vol. of 0.1 N H2SO4 used} \times 0.0014 \times 250}{\text{Weight of sample (g)} \times \text{Vol. of diluted sample used}}\ x\ 100$$

The protein percentage was calculated by multiplying % nitrogen with a factor 5.7.

Crude fiber

The crude fiber of corn products were determined as mentioned in AACC Method No. 32-10. Moisture free and fat free sample was used for this study.

Nitrogen Free Extract (NFE)

Nitrogen free extract was calculated by subtracting the percentages of moisture, protein, fat, fiber and ash from 100 as follows:

NFE = 100 - (moisture % + crude protein % + crude fat % + crude fiber % + ash %)

Mineral composition:

Mineral content was determined by inductively coupled plasma-optical emission spectrometry (ICP-OES) **(Zand *et al*., 2011)**.

Sample digestion

Each sample was mixed and homogenized using a domestic blender and three independent replicates of 0.5 g were weighed prior to adding 10 mL of concentrated H_2SO_4 (overnight) then added 1 mL H_2O_2 and digest it on the hot plate at 150 °C until white fumes comes out and transparent solution will obtained. Remove the solution and cool it. Then diluted upto 50mL vol. flask and filtered the solution with the help of whatman No.1 filter paper.

Analysis by Inductivity Coupled Plasma–Optical Emission Spectrometer (ICP–OES)

9 mL digested samples were quantitatively analyzed using an Inductivity Coupled Plasma–Optical Emission Spectrometer. Working solution of certain concentration are run to see the performance and linearity behavior of instrument. We calculate the concentration by using formulae:
Conc. in sample = Conc. × Dilution Factor / Weight of sample

Tocopherol analysis

Materials

For the analysis, oil was extracted from commercial corn and wheat products. Standard of alpha-tocopherolwas purchased from Aldrich (Steinheim, Germany), Sigmma and Gamma tocopherols were from Sigma (St. Louis, USA). All solvents were of HPLC grade.

Sample Preparation

The sample preparation and analysis of Tocopherol in corn and wheat products were performed as described in method **(Swiglo and Sikorska, 2004).** Sample of corn and wheat products were weighed (0.0400 to 0.1200 g) and dissolved in 1mL of 2-propanol. The selection of 2-Propanol was chosen because it allows solubility of oils and it is miscible with all solvents used in chromatography. Thus, no additional sample treatment is necessary. Vortexed-mixed samples were directly injected onto HPLC column. Stock and working solutions of tocopherols were also prepared in 2-propanol. Sample and standard solutions were prepared directly before analysis.Care was taken to exclude air and light exposure of sample and standard solutions throughout the analytical procedure.

HPLC analysis of tocopherols

All HPLC analyses of tocopherols were performed at room temperature on Shimadzu LC-10A high performance liquid chromatograph (Shimadzu, Kyoto, Japan) equipped with Discovery supelco C18 (250mm × 4.6 mm, 5µm, MA, USA). For determination of tocopherols in oils, a mobile phase consisting of 50% of acetonitrile (solvent A) and 50% of methanol (solvent B) was used with the flow rate 1.5 mL min-1. Injection volume was 20 µl. The eluate was detected using a fluorescence detector (RF-530) set at emission wavelength of 325 nm with an excitation at 295 nm. Tocopherols were identified by comparing their retention times with those of corresponding standards and by spiking of samples with appropriate standard.

RESULTS AND DISSUSIONS

Proximate compostion corn and wheat products

The mean values for moisture content of different corn and wheat samples have been shown in the Table 1. The moisture content of different products of wheat ranged from the 3.40-28.75%. Among the products higher moisture content (28.75%) was noted in the bread followed by the (12.08%) in the white flour, (11.20%) in wheat flour and (3.40%) in the biscuit. Similar results for the moisture content in the wheat samples were obtained by **(Parveen, 2007; Rehman, 2011)**. While the result pertaining to the moisture content of commercial corn samples have been given in Table 1. Among these samples higher moisture content was determined in corn flour (9.50%) followed by the air popped popcorn(9.0%), oil popped popcorn (2.82%) and corn flakes(2.75%). The result of this study are in close agreement with the finding of **(Padovani *et al*., 2007; Akram *et al*., 2011)**. The ash content in the wheat samples varied from 0.32-0.90%. The result showed that maximum ash content was found in the bread (0.90 %). Lowest was observed inwhite flour (0.32 %). Mean values of all samples of corn are presented in the Table 1. The highest value of ash (2.70 %) was determined in oil popped popcorn followed by the corn flakes (1.90%), Air popped popcorn (1.72%) and corn flour (0.40%). The crude fat content in the wheat samples varied from 1.32-21.52%. Among the samples higher fat content (21.52 %) was noted in the biscuit followed by the (6.09 %) bread, (1.67 %) in wheat flour and (1.32 %) in the white flour. Among corn samples higher crude fat content was determined in oil popped popcorn (26%) followed by the air popped popcorn (3.9 %), corn flour (1.06%) and corn flakes(0.75 %). Highest amount of crude fat is determined in the oil popped popcorn because these popcorn are fried in the oil. . The crude fiber content in the wheat products varied from 0.25-1.14%. The result showed that maximum crude fiber content was found in the wheat flour (1.14 %). Lowest was observed in biscuit (0.25 %). Crude fiber content for the different corn products were significantly different from each other The highest value of crude fiber (4.06 %) was determined in the air popped popcorn followed by the oil popped popcorn (3.40%), corn flakes. (3.00 %) and corn flour (2.30%).The crude protein content in the wheat samples varied from 7.75-11.54%. Among the products higher protein content (11.54 %) was noted in the white flour followed by the (10.71 %) wheat flour, (9.21 %) in biscuitsand (7.75 %) in bread. Among corn products higher crude protein content was determined in oil popped popcorn (8.74%) followed by the air popped popcorn (8.67 %), corn flakes (6.26%) and corn flour(0.940 %). The mean values for NFE content of different wheat products have been shown in the Table 1 The NFE content in the wheat samples varied from 55.96-74.54%. The minimum mean value of NFE was found in bread (55.96%) followed by the biscuit (65.02%), white flour (74.20 %) and wheat flour (74.54 %).

Mineral composition

Iron content for the different wheat products which include T_1, T_2, T_3, and T_4 was ranged from 9.59 to 51.21 mg/kg. The highest value of iron (51.21 mg/kg) was determined in the T_1 followed by the T_3 (36.42 mg/kg), T_4 (28.75 mg/kg) and T_2 (9.59 mg/kg). The results were comparable with the finding of **Padovani*et al.* (2007).** They compared proximate, mineral and vitamin composition of common foods. Kadam*et al*. (2012) also found the similar results. They determined the iron content in whole wheat flour. Three elements group after milling showed major decrease in the concentration, i.e., Fe, Mg and Zn. Aleurone layer particularly abundant with these metals. Iron content was determined in the different corn samples which include S_1, S_2, S_3 and S_4. The highest value of iron (41.06 mg/kg) was determined in S_2 followed by the S_3 (27.90mg/kg), S_4 (26.70 mg/ kg) and S_1 (11.1 mg/kg). Calcium content for the different wheat samples was ranged from 38.49 to 355.20 mg/kg. The highest value of calcium (355.2 mg/kg) was determined in T_1 followed T_4 (230 mg/kg), T_2 (180.50 mg/kg), T_3 (38.49 mg/kg). Calcium content for the different corn products were ranged from 50 to 560 mg/kg. The highest value of calcium (560 mg/kg) was determined in S_2 followed by S_3 (100.21 mg/kg), S_4 (98 mg/kg) and S_1 (50 mg/kg). Zinc content for the different wheat samples was ranged from 7.89 to26.35 mg/kg. The highest value of calcium (26.35 mg/kg) was determined in T_3 followed by T_1 (17.32 mg/kg), T_2 (8.40 mg/kg), T_4 (7.89 mg/kg) . Zinc content for the different corn samples were ranged from 1.90 to 32.40 mg/kg. The highest value of calcium (32.40 mg/kg) was determined in S_4 followed by S_3 (25.40 mg/kg), S_1 (7.22 mg/kg) and S_2 (1.90 mg/kg). Potassium content for the different wheat samples was ranged from 990 to2468 mg/kg. The highest value of potassium (2468 mg/kg) was determined in T_4 followed by T_1 (1810.6 mg/kg), T_2 (1511 mg/kg), and T_3 (990 mg/kg). Potassium content for the different corn samples which include S_1, S_2, S_3 and S_4. The highest value of potassium (2946 mg/kg) was determined in S_4 followed by S_3 (2210 mg/kg), S_1 (1620.5 mg/kg) and S_2 (820 mg/kg). Magnesium content for the different wheat products was ranged from 106.5-1512 mg/kg. The highest value of Magnesium (1512 mg/kg) was determined in T_3 followed by T_1 (943.80mg/kg), T_2 (310 mg/kg), and T_4 (106.4 mg/kg). **Kadam *et al*., 2012).** Magnesium content for the different corn samples which include S_1, S_2, S_3 and S_4. Range of magnesium content was from 79 to 1310 mg/kg. The highest value of Magnesium (1310 mg/kg) was determined in S_4 followed by S_3 (1060 mg/kg), S_2 (505 mg/kg) and S_1 (400 mg/kg).

Tocopherol analysis

Comparison of mean of wheat samples which include T_1, T_2, T_3 and T_4 showed that higher amount of Alpha-tocopherol exists in T_4 (7.135 mg/100g) followed by

T_1 (4.21 mg/100g), T_2 (3.67 mg/100g) and T_3 (1.52 mg/100g) as shown in the Table 4.30. The finding of present study are in line with the finding of **(Piironen *et al.*, 1986).** Even if cereal tocols vary in dependence on genotype and location. They reported that the richest source is wheat germ. The germ contains lipids, vitamins, and minerals. The lipids mostly consist of linolenic acid (2.3 Wt. %), linoleic (55 Wt. %) and oleic (1 8 Wt. %) (Kulp and Ponte, 2000).Tocopherol is the major fat soluble vitamin which is present in the germ. Corn products which include S_1, S_2, S_3 and S_4. Among these samples Alpha-tocopherol content was ranged from 0.3385 to5.885 mg/100g. The highest value of alpha-tocopherol (5.885 mg/100g) was determined S_3 followed by S_2 (3.59 mg/100g), S_4 (1.70 mg/100g) and S_1 (0.3385 mg/100g) . Gamma-tocopherol content for the different wheat products was ranged from 0.0002 to 2.81 mg/100g. The highest value of Gamma-tocopherol (2.62 mg/100g) was determined in T_3 followed by T_4 (1.197 mg/100g), T_2 (0.430 mg/100g) and T_1 (0.000212 mg/100g). The analysis of varience of gamma- tocopherol content in different samples of wheat are shown in the Table 4.33. Our results are also in good agreement with the finding of **(Piironen *et al.*, 1986)**. Even if cereal tocols vary in dependence on genotype and location. They determined the tocopherol and tocotrienols in cereals from Finland. Our results are also supported by **Panfili*et al.* (2003)**. **Nielsen and Hansen (2008)** reported that gamma tocopherol is in traces in wheat flour. Corn samples which include S_1, S_2, S_3 and S_4. Among these samples Gamma-tocopherol content was ranged from 10.33 to 0.565 mg/100g. The highest value of Gamma-tocopherol (9.665 mg/100g) was determined in S_4 followed by S_2 (8.255 mg/100g), S_3 (2.77 mg/100g) and S_1 (0.5285 mg/100g). **Swiglo and Sikorska (2004)** also found the similar results. They determined that Gamma-tocopherol in corn oil is more than the alpha and sigma tocopherol. **Akram (2011)** determined the tocopherol contents of commercially available corn products. Our result are in line with the finding of **Akram (2011). Piironen*et al.* (1986)** determined the tocopherol and tocotrienols in cereals from Finland. Our results are also in good agreement with the finding of **Piironen *et al.* (1986).** Comparison of mean of wheat samples which include T_1, T_2, T_3 and T_4 showed that higher amount of Sigma-tocopherol exists in T_4 (0.6455 mg/100g) followed by T_3 (0.3965 mg/100g), T_2 (0.0888 mg/100g) and T_1 (0.00194 mg/100g). Our results are also in good agreement with the finding of **(Piironen *et al.*, 1986).** They determined the sigma tocopherol from different cereal products which are in close agreement with our finding. **Nielsen and Hansen (2008)** reported that gamma tocopherol is in traces in wheat flour. Our results are aslo supported by **Panfili *et al.* (2003).** Sigma-tocopherol content for the different corn samples was ranged from 0.0144-1.685 mg/100g. The highest value of sigma-tocopherol (1.685 mg/100g) was determined in S_4 followed by S_2 (1.225 mg/100g), S_3 (0.3135 mg/100g) and S_1 (0.0144 mg/100g). Our results are also in good agreement with the finding of **(Piironen *et al.*, 1986).** They determined the tocopherol and tocotrienols in cereals from Finland. Our results are also comparable with finding of **Akram (2011)**. They determined the nutritive quality and aflatoxins contents of commercially available corn products.

Table 1 Proximate composition of commercial corn and wheat products

Treatment	Moisture	Ash	Fat	Fiber	Protein	NFE
Wheat flour	11.20^{b}	0.74^{ab}	1.67^{c}	1.14^{a}	10.71^{b}	74.54^{a}
White flour	12.08^{b}	0.32^{c}	1.32^{c}	0.46^{b}	11.54^{a}	74.20^{a}
Bread	28.75^{a}	0.90^{a}	6.09^{b}	0.55^{b}	7.75^{d}	55.96^{c}
Biscuits	3.40^{c}	0.60^{b}	21.52^{a}	0.250^{a}	9.21^{c}	65.02^{b}
Corn flour	9.50^{a}	0.40^{c}	1.06^{c}	2.30^{d}	0.940^{c}	85.80^{a}
Corn flakes	2.75^{c}	1.90^{b}	0.75^{c}	3.0^{c}	6.26^{b}	85.34^{a}
Oil popped popcorn	2.82^{c}	2.70^{a}	26.0^{a}	3.40^{b}	8.74^{a}	56.34^{c}
Air popped pop corn	9.00^{a}	1.72^{b}	3.9^{b}	4.06^{a}	8.67^{a}	72.64^{b}

Note: Values in each row having the same letters are not significantly different (p>0.05). Values in each column having the superscript values are not significantly different (p>0.05).

Table 2 Mineral composition of commercial corn and wheat products (mg/kg)

Treatment	Iron	Calcium	Zinc	Potassium	Magnesium
Wheat flour	51.21^{a}	355.20^{a}	17.32^{b}	1810.6^{b}	943.80^{b}
White flour	9.56^{d}	180.50^{c}	8.40^{c}	1511^{c}	310^{c}
Bread	36.42^{b}	38.49^{d}	26.35^{a}	990^{d}	1512^{a}
Biscuits	28.75^{c}	230^{b}	7.89^{c}	2468^{a}	106.40^{d}
Corn flour	11.11^{c}	50.0^{b}	7.22^{c}	1620.5^{c}	400^{d}
Corn flakes	41.06^{a}	560^{a}	1.90^{d}	820^{d}	505^{c}
Oil popped popcorn	27.90^{b}	100.21^{b}	25.40^{b}	2210^{b}	1060^{b}
Air popped pop corn	26.70^{b}	98^{b}	32.40^{a}	2946^{a}	1310^{a}

Note: Values in each row having the same letters are not significantly different (p>0.05).Values in each column having the superscript values are not significantly different (p>0.05).

Table 3 Tocopherol composition of commercial corn and wheat products (mg/ 100g)

Treatment	Alpha-Tocopherol	Gamma-Tocopherol	SigmmaTocopherol
Wheat flour	4.21^{b}	0.000212^{d}	0.00212^{c}
White flour	3.67^{b}	0.430^{c}	0.0888^{c}
Bread	1.52^{c}	2.625^{a}	0.3965^{b}
Biscuits	7.135^{a}	1.197^{b}	0.6455^{a}
Corn flour	0.3385^{d}	0.5285^{c}	0.0144^{c}
Corn flakes	3.59^{b}	8.255^{a}	1.225^{b}
Oil popped popcorn	5.885^{a}	2.77^{b}	0.3135^{c}
Air popped pop corn	1.70^{c}	9.665^{a}	1.685^{a}

Note: Values in each row having the same letters are not significantly different (p>0.05). Values in each column having the superscript values are not significantly different (p>0.05).

CONCLUSION

The data indicate that commercial corn and wheat products vary greatly in term of protein, fats and crude fiber contents. The variability observed in carbohydrates, protein, fats, ash content, crude fiber and moisture content is both genetic and environmental which may influence the individual chemical composition. These results will be useful to know about the nutritional properties of commercial corn and wheat products and Food composition data is important in designing strategies for nutritional planning and provides data for epidemiological studies.

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