Five Pakistani wheat cultivars namely MH 97, Inqlab 91, Auqab 2000, Iqbal 2000 and Chenab 2000 were milled to obtain different flour mill streams viz. bran & shorts, break 1, break 2, break 3, break 4, sizing, middling, tailing and whole wheat flour. The Kernel weight of wheat cultivars varied from 33.84 to 40.40g (per thousand kernels). Test weight ranged from 69.99 (Iqbal 2000) to 73.00 kg/hL (Chenab 2000) between the wheat cultivars. Chemical components such as moisture, crude protein and total ash were affected significantly by mill streams as well as by the wheat cultivars. The mineral contents were found significantly higher in bran & shorts followed by whole wheat flour. Iron content ranged from 97.90 to 124.50 mg/kg among different flour mill streams. Zinc content varied from 30.50 to 94.93 mg/kg. Manganese content was higher in bran & shorts and the lowest was found in sizing fraction and ranged from 90.90 to 92.26 mg/kg among different flour mill streams. Copper content ranged from 6.30 to 15.90 mg/kg while Cadmium content was only found in bran & shorts and whole wheat flour i.e. 4.20 and 1.50 mg/kg respectively.  

Key Words: Wheat cultivars, flour mill streams, iron, manganese, copper, cadmium, zinc.

INTRODUCTION

Cereals, nutritionally dense, supply carbohydrate and protein as well as a variety of micronutrients; in particular certain B vitamins, vitamin E and minerals such as iron, in the case of wheat (Alldrick & Hajselova, 2002). Wheat is a staple food for the people of Pakistan and is the cheapest source of protein and calories. Cereals especially wheat has to be processed in order to maximize the bioavailability of the nutrients. Mechanical processes, such as milling, assist bioavailability in two ways; firstly, by breaking and often removing the outer seed coat; and secondly, by converting the grain to smaller particles thereby effectively increasing the surface area available to attack by digestive enzymes. (Alldrick & Hajselova, 2002)  

Modern industrial flour production involves a progressive reduction process using a system of roller mills (Kent and Evers, 1994). Wheat grains are adjusted to appropriate moisture content and pass through a system whereby they are first fragmented (Break Release) and the starchy endosperm is removed from the bran. This in itself is a progressive process, involving a number of break mills. Grain particles are separated on the basis of size by sieve process and either re-enter the break operation or pass on the second stage of the process (Reduction). Large number of wheat flour streams of varying degrees of purity and quality are available depending on many factors including wheat quality and milling conditions. Distribution of wheat flour components during milling effect the chemical and rheological properties of wheat flour (Endo et al., 1987). The inorganic material i.e. minerals are required in our bodies in a very minute quantity. Most of the minerals are essentially required in our diet and their deficiency may result in the occurrence of some type of nutritional disorders. Concentration of mineral elements varies significantly in flours of different wheat cultivars in Pakistan (Anjum et al., 2002). Ranum (2000) reported that atta from chakki mills in the Indian subcontinent has fairly high ash content (1.1%) indicating that it is high in minerals (iron content of ~30ppm), but some of the iron is in oxidized form and not fully utilized. The remainder of the iron is also not well absorbed because of its binding with phytic acid which is present at high level (~0.5%) (Rielly et al., 2002; Coultate, 1996). The objective of the present investigation was to determine the distribution of micronutrients such as iron, copper, zinc, manganese and toxic minerals i.e. lead and cadmium in different flour mill streams to find out one with better micro nutrient profile.
whole wheat flour of each cultivar was obtained by milling the grains through china chakki (Model: FFC-15, Shandong Jimo Agric. Mach. Works, China).

Fifty clean, unbroken and sound kernels were taken randomly from each wheat cultivar and their weight was recorded in grams per 1000 kernels by using an Electric Mettler Balance. The test weight (Kg/hectoliter) of each wheat cultivar was estimated by following the procedure described in AACC (2000) method No. 55-10. Different flour mill streams of each wheat cultivar were analyzed for moisture, crude protein and total ash contents by following the methods as described in AACC (2000) method No. 44-15A, 46-10 & 08-01, respectively.

The mineral contents i.e. Fe, Cu, Zn, Mn, Pb and Cd were determined by using Atomic Absorption Spectrophotometer (AAnalyst 100, Perkin Elmer, Norwalk, C.T. USA) according to method described in AOAC (1990).

The data were analyzed by using the software program MSTAT-C (Freed et al., 1991) according to standard statistical procedures (Steel et al., 1996).

RESULTS AND DISCUSSION

Thousand kernel weight differed significantly among the wheat cultivars. The results (Table 1) indicated that the kernel weight was found to be the highest in Chenab 2000 followed by Inqlab 91 while it was the lowest in MH 97. The test weight was non significant in wheat cultivars and ranged from 69.99 to 73.00 Kg/hi and the highest was found in Chenab 2000 and lowest in Iqbal 2000 (Table 1). These results are in close agreement with the results reported by Ahmad (1993) and Butt et al. (1997a) who reported that the test weight varied in different wheat cultivars.

Table 1. Thousand Kernel Weight and Test Weight of Various Wheat Cultivars

<table>
<thead>
<tr>
<th>Wheat Cultivars</th>
<th>Thousand Kernel Weight (g)</th>
<th>Test Weight (kg/hectoliter)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inqlab 91</td>
<td>39.99 ab</td>
<td>72.82 NS</td>
</tr>
<tr>
<td>Auqab 2000</td>
<td>38.39 bc</td>
<td>71.65</td>
</tr>
<tr>
<td>Chenab 2000</td>
<td>40.40 a</td>
<td>73.00</td>
</tr>
<tr>
<td>Iqbal 2000</td>
<td>36.91 c</td>
<td>69.99</td>
</tr>
<tr>
<td>MH 97</td>
<td>33.84 d</td>
<td>70.75</td>
</tr>
<tr>
<td>Mean</td>
<td>37.90</td>
<td>71.64</td>
</tr>
</tbody>
</table>

(p<0.01)

The chemical components such as moisture, crude protein and total ash differed significantly in mill streams (Table 2) as well as in wheat cultivars (Table 3). The moisture content differed significantly among the different flour mill streams, wheat cultivars and interaction between flour mill streams and wheat cultivars. Highest moisture content was found in Iqbal 2000 followed by Chenab 2000 and lowest was found in MH 97 and was ranged from 9.99 to 10.66 %.

Among different mill streams, the highest moisture content was found in break-1 ranged from 9.75 to 12.03 %. The reason of higher moisture content in break-1 and break-2 was that tempered wheat grains were first passed through these two break roll systems and in subsequent milling operation the moisture content may be reduced due to exposure of material with air current during carriage from one step to another. The results are in line with the earlier results reported by Tariq (1990) and Ahmad (1993) who reported that moisture content in different flour mill streams of various wheat cultivars ranged from 10 to 12 %.

Table 2. Means of Moisture, ash & protein content of different flour mill streams of various wheat cultivars

<table>
<thead>
<tr>
<th>Milling Fractions</th>
<th>Moisture (%)</th>
<th>Ash (%)</th>
<th>Protein (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B + S</td>
<td>9.71 h</td>
<td>2.92 a</td>
<td>15.60 a</td>
</tr>
<tr>
<td>WWF</td>
<td>8.74 l</td>
<td>1.69 b</td>
<td>13.19 b</td>
</tr>
<tr>
<td>BK-1</td>
<td>11.67 a</td>
<td>0.74 f</td>
<td>10.73 f</td>
</tr>
<tr>
<td>BK-2</td>
<td>11.52 b</td>
<td>0.81 e</td>
<td>11.17 e</td>
</tr>
<tr>
<td>BK-3</td>
<td>10.60 c</td>
<td>0.92 d</td>
<td>11.71 d</td>
</tr>
<tr>
<td>BK-4</td>
<td>10.37 d</td>
<td>1.12 c</td>
<td>12.25 c</td>
</tr>
<tr>
<td>Sizing</td>
<td>10.21 e</td>
<td>0.59 l</td>
<td>9.77 l</td>
</tr>
<tr>
<td>Middlings</td>
<td>10.14 f</td>
<td>0.63 h</td>
<td>9.98 h</td>
</tr>
<tr>
<td>Tailings</td>
<td>10.05 g</td>
<td>0.69 g</td>
<td>10.26 g</td>
</tr>
</tbody>
</table>

B + S = Bran + Short WWF = Whole Wheat Flour
BK = Break

The data were analyzed by using the software program MSTAT-C (Freed et al., 1991) according to standard statistical procedures (Steel et al., 1996).
Micronutrients in various mill streams of wheat cultivars

Ash content was significantly higher in bran & shorts (ranged between 2.74 – 3.11%) obtained from Iqbal 2000 followed by Inqlab 91 and lowest was found in bran & shorts of Auqab 2000. Ash content in whole wheat flour (1.62 – 1.75 %) of Iqbal 2000 was found to be higher followed by whole wheat flour of Inqlab 91. The ash content in various flour mill streams except bran & shorts ranged from 0.52 to 1.20 % among different wheat cultivars having the highest in break-4. The findings are in close agreement with the findings of Tariq (1990), Ahmad (1993) and Butt et al. (1997b) who reported the ash content in different milling fractions ranged from 0.2 – 1.8 % among different flour samples.

The protein content was maximum in bran & shorts of Iqbal 2000 while minimum in sizing fraction of MH 97. The highest protein is attributed to adhering of some portion of bran with endosperm in break-3 and break-4 mill streams. Protein and mineral contents are higher in bran. The results are in conformity to earlier reports (Jones and Zielger, 1969) that protein content generally rises progressively from 1st to last break flour. Different flourmill streams derived from different portions of endosperm with varying degree in refinement differ in protein content (Pyler, 1988).

The results regarding mineral content of various wheat cultivars and different milling fractions are depicted in Fig. 1 & Fig. 2 respectively.

The iron content was higher in bran & shorts of Auqab 2000 followed by Iqbal 2000 while minimum was in bran & shorts of Chenab 2000. The iron content in bran & shorts of wheat cultivars ranged from 137.92 to 150.25 mg/kg while in whole wheat flour (125.65 to 137.25 mg/kg) was higher in Auqab 2000 followed by Iqbal 2000. The iron content in different flour millstreams except bran & shorts was significantly higher in break-4 and minimum in sizing fraction. The higher amount of iron content in break roll system may be due to small portion of bran remain adhered with endosperm in break-3 and bread-4 mill stream and the bran is relatively rich in minerals (Kulp et al., 1980). These results are in conformity with those reported by Pyler (1988) & Davis et al., (1984).

Zinc content (except bran & shorts and whole wheat flour) of various wheat cultivars (30.50- 55.52 mg/kg) was significantly higher in break-4 (Auqab 2000) and minimum was in sizing of Chenab 2000. Among different mill streams, the zinc content (67.17 – 94.93 mg/kg) was higher in bran & shorts (maximum in Chenab 2000 & minimum in MH 97) followed by whole wheat flour (Maximum in MH 97 & lowest in Iqbal 2000). The results are in line with the findings reported for ash, protein, iron in which the similar pattern was observed as bran is rich in protein and minerals and higher amount of bran is found in breaks than other milling streams (Pyler, 1988).

Manganese content was significantly higher in bran & shorts (Maximum in Inqlab 91 & lowest in Iqbal 2000) followed by whole wheat flour (maximum in Inqlab 91 & lowest in Iqbal 2000) and among different flour mill streams except bran & shorts the manganese content was higher in break-4 of Inqlab 91 and lowest in sizing fraction of Iqbal 2000. The results are in line with the findings of Anjum et al., (2002).

Copper content was significantly higher in bran & shorts (Higher in Iqbal 2000 & lowest in Chenab 2000) followed by whole wheat flour (Maximum in Iqbal 2000 & minimum in Chenab 2000). The copper content was higher in break-4 of Iqbal 2000 whereas lowest in sizing fraction of Chenab 2000 (6.30-8.85 mg/kg). The results are in accordance with the earlier findings of Kulp et al., (1980) & Peterson et al., (1983).

Cadmium was found in bran & shorts (4.20 mg/kg) and whole wheat flour (1.50 mg/kg) of Inqlab 91. Lead content was not detectable by the procedure adopted in this study.

CONCLUSION

The present investigation revealed that concentration of minerals and protein is higher in bran & shorts followed by whole wheat flour and break-4 flour. This suggests that refinement of flour reduces the amount of protein and minerals.

REFERENCES


Fig. 1. Mineral content in different wheat cultivars
Fig. 2. Effect of Different Milling Fractions on the Mineral Content of Various Wheat Cultivars

Micronutrients in various mill streams of wheat cultivars.
Anjum, Ahmad, Pasha & Butt


