Nutritive Appraisal of Various Wheat Varieties/Lines for Developing Biofortified Wheat (*Triticum Aestivum L.*)


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**Abstract**

Essential micronutrients such as iron and zinc deficiencies affect more than two billion people globally especially the pregnant women and children below the age of five. Wheat, like many other staple cereals, contains low levels of the essential micronutrients iron and zinc. It contributes 13.1 percent to the value added in agriculture and 2.8 percent to GDP of Pakistan. National Wheat Breeding program at Faisalabad, Pakistan analyzed 240 samples of wheat varieties/lines both from irrigated and rainfed conditions. The analysis revealed that 1000 grain weight ranged from 23.9-50.2 in irrigated and 31-42.0 g in rainfed conditions while test weight range was found to be 59.9-75.8 (irrigated) and 64.5-79.8 Kg hl⁻¹ (rain-fed). Protein and gluten content ranged between 12.0-16.1, 13-16.2 and 21-34 & 21-38% in irrigated and rainfed trial, respectively. Starch content was found to be 51.8-57.1 and 51.9-56.1% in irrigated and rainfed set, respectively. Falling No. (FN) values were recorded in the range of 352-814 in irrigated and 352-814 sec in the rain-fed set. Most of the varieties/lines had narrow range of Zn (31-32.6 & 31.2-33.9) and Fe (35-40 & 35-43 ppm) in irrigated and rainfed trial, respectively. In irrigated, conditions, cluster 3(5 genotypes) represented relatively high value of Fe and Zn contents while in rainfed condition, cluster 2 (31 genotypes) and cluster 3(15 genotypes) represented relatively high value Fe and Zn. Statistical analysis of both sets showed gluten & protein being directly correlated to each other, showing a positive correlation with Fe & Zn but a negative one with starch. In both sets, a direct correlation of FN with starch was observed only in rainfed set.

**Keywords:** Nutritive appraisal; Biofortified; Developin; Wheat

**Introduction**

Wheat production was estimated at 25.750 million tons during 2016-17 [1] which was surplus than country requirement and serves as an important indicator of food security. Annual consumption of wheat on per capita basis is 125 Kg [2] and mostly it is consumed as chapatti (unleavened flat bread).

Wheat, like many other staple cereals, contains low levels of the essential micronutrients iron and zinc. Globally up to two billion people are victim of iron and zinc deficiencies, particularly in regions with predominantly cereal-based diets [3]. Nutritional considerations, therefore, are vital. It contributes 13.1 percent to the value added in agriculture and 2.8 percent to GDP of Pakistan.

Wheat crops play an important role in satisfying daily calorie intake in Pakistan, but they are inherently very low in Fe, Zn and protein concentrations in grain, particularly when grown on Fe and Zn-deficient soils. Wheat serves as an important dietary item of the people of Pakistan and accounts for nearly 843 Kcal/capita/day of energy (37 percent of daily calories) and 22 g/capita/day of protein (37 percent of daily protein consumption). Therefore, it calls for quality depictin to determine nutritive value in respect of its intake.

Wheat was physico-chemically evaluated to find out its qualitative status in order to develop bio-fortified wheat which may be useful in overcoming Fe and Zn deficiency among vulnerable population. National Wheat Breeding program based 240 samples of various wheat varieties/lines included in Irrigated and Rainfed National Uniform Wheat Yield Trials NUWYT) during 2016-17 were physico chemically analyzed for quality characteristics like 1000 grain weight, test weight, protein, starch, gluten, falling number, Fe and Zn.

**Material and Method**

Protein was determined by Kjeldahl method (Instruction manual VELP Scientifica). Two grams sample was taken and added a tablet of digestion mixture and 10 ml sulphuric acid. Digested sample was diluted. After distillation sample was titrated against sodium hydroxide. Protein was determined after multiplying correction factor with nitrogen percentage. Starch by NIR instrument (instruction Manual Omeg Analyzer G) wheat sample was taken in hopper and used eighteen mm sample spacer for getting reading of starch content value [4]. Gluten content by glutomatic apparatus used in ISO-17025 certified CT Lab [5]. A 10 gram sample of flour weighed and placed into the glutomatic washing chamber on top of the polyester screen. The sample was mixed and washed with a 2 percent salt solution for 5 minutes. The wet gluten was removed from the washing chamber, placed in the centrifuge holder and centrifuged. The residue retained and passed through the screen was weighed. α-amylase activity by falling number apparatus being used in ISO-17025 certified CT Lab [6]. About seven gram sample of ground wheat was weighed and combined with 25 ml of distilled water in a glass falling number tube with a stirrer and shaken to form slurry. As the slurry was heated in a boiling water bath at 100 Degree Celsius and stirred constantly, the starch gelatinized and formed a thick paste. The time took the stirrer to drop through the paste was recorded as the falling number value. 1000 grain weight was determined by counting the grains from seed counter, Numigral II (Chopin, France). After counting 1000 grains, their weight was done with the help of balance (GR 200, Japan) used in the ISO-17025 Certified cereal technology laboratory. Test weight of the wheat samples was assessed with test weight apparatus. A bowl of one liter capacity was filled with wheat.
grains and by weighing with the help of this apparatus test weight was measured. Test weight of the wheat samples was assessed with test weight apparatus. A bowl of 1 liter capacity was filled with wheat grains and by weighing with the help of this apparatus, test weight was measured. Iron and Zinc were analysed by Atomic Absorption Spectrophotometer (Model: 969, Unicam Limited, Cambridge, UK). Protein was determined by AOAC Method No. 985.35 [7].

**Results and Discussion**

National uniform wheat yield trials (Irrigated and Rain-fed) samples were physico-chemically analysed for various quality characteristics. Analysis of the various quality parameters revealed; 1000 grain weight were physico-chemically analysed for various quality characteristics. Results and Discussion

Significant at 5% level and **highly significant at 1% level.

<table>
<thead>
<tr>
<th>GW</th>
<th>Tw</th>
<th>Protein</th>
<th>Starch</th>
<th>Gluten</th>
<th>FN</th>
<th>Fe</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.022</td>
<td>0.868</td>
<td>0.110</td>
<td>0.0234</td>
<td>0.094</td>
<td>0.057</td>
<td>0.121</td>
</tr>
<tr>
<td>0.017</td>
<td>0.088</td>
<td>0.042</td>
<td>0.121</td>
<td>0.037</td>
<td>0.052</td>
<td>0.054</td>
</tr>
<tr>
<td>0.003</td>
<td>0.410</td>
<td>0.041</td>
<td>0.515</td>
<td>0.027</td>
<td>0.011</td>
<td>0.026</td>
</tr>
<tr>
<td>0.002</td>
<td>0.232</td>
<td>0.041</td>
<td>0.054</td>
<td>0.015</td>
<td>0.001</td>
<td>0.011</td>
</tr>
</tbody>
</table>

Table 1: Correlation coefficients for qualitative traits in bread wheat under irrigated condition.

*Table 2: Correlation coefficients for qualitative traits in bread wheat under rainfed condition.*
Cluster Centroids

<table>
<thead>
<tr>
<th>Variables</th>
<th>Cluster-1</th>
<th>Cluster-2</th>
<th>Cluster-3</th>
<th>G. Centroid</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Irrigated</td>
<td>Rainfed</td>
<td>Irrigated</td>
<td>Rainfed</td>
</tr>
<tr>
<td>Grain Wt (grams)</td>
<td>35.855</td>
<td>37.400</td>
<td>37.998</td>
<td>36.971</td>
</tr>
<tr>
<td>Test Wt (kg/hl)</td>
<td>69.455</td>
<td>75.611</td>
<td>69.786</td>
<td>75.479</td>
</tr>
<tr>
<td>Starch (%)</td>
<td>54.523</td>
<td>54.425</td>
<td>54.784</td>
<td>54.190</td>
</tr>
<tr>
<td>Falling No.(Sec)</td>
<td>597.788</td>
<td>660.964</td>
<td>478.114</td>
<td>565.210</td>
</tr>
<tr>
<td>Fe (ppm)</td>
<td>37.742</td>
<td>38.768</td>
<td>37.205</td>
<td>39.645</td>
</tr>
<tr>
<td>Zn (ppm)</td>
<td>31.842</td>
<td>32.400</td>
<td>31.825</td>
<td>32.447</td>
</tr>
</tbody>
</table>

Table 3: Cluster analysis of wheat varieties/lines under irrigated and rainfed conditions.

Figure 1: Biplot of wheat varieties/lines under irrigated condition.

Figure 2: Biplot of wheat varieties/lines under rainfed condition.

Figure 3: Dendrogram of wheat varieties/lines under irrigated condition.

Figure 4: Dendrogram of wheat varieties/lines under rainfed condition.

represent 23%, 52% and 25% of total genotypes, respectively. Cluster 1 exhibited relatively high value of test weight. Cluster 2 had high value of Fe. Cluster 3 represented relatively high value of grain weight, protein, gluten and Zn while lowest value of falling number (Table 3). To cover iron and zinc deficiency among vulnerable population, it is the need of the time to fortify wheat flour with iron and zinc. Moreover, Blackstrap molasses may be added in the bakery products to replace their sugar contents and also to improve their iron content. Among other techniques best preferred approach is to develop wheat varieties containing high iron and zinc content [13]. For this purpose, various wheat varieties/lines are being screened for iron and zinc contents to develop bio-fortified wheat.

Conclusion

The analysis revealed that 1000 grain weight was higher (23.9-50.2 g) in irrigated than the rainfed condition (31-42.0 g) while test weight was found to be lower in irrigated condition (59.9-75.8) higher in rainfed condition (64.5-79.9 Kg hl^{-1}). Protein, gluten, and starch content ranged between 12.0-16.1, 13-16.2, 21-34 & 21-38 and 51.8-57.1 and 51.9-56.1% in irrigated and rainfed trials, respectively. Falling No. values were remained the same in both condition(352-814 sec) Most of the varieties/lines had narrow range of Zn (31-32.6 & 31.2-33.9) and Fe (35-40 & 35-43 ppm) in irrigated and rainfed trial, respectively. Statistical analysis of both sets showed gluten & protein being directly correlated to each other, showing a positive correlation with Fe & Zn but a negative one with starch. In both sets, a direct correlation of falling No. with starch was observed only in rainfed set. In irrigated, conditions, cluster 3(5 genotypes) represented relatively high value of...
Fe and Zn contents while in rainfed condition, cluster 2 (31 genotypes) and cluster 3 (15 genotypes) represented relatively high value Zn. To overcome iron and zinc deficiency among defenseless population, there could be several approaches such as fortifying wheat flour with iron and zinc, adding blackstrap molasses in the bakery products, however, the most preferred and sustainable option is the development of bio fortified wheat varieties and makes those available to the vulnerable masses.

Acknowledgment
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References