EFFECT OF DIFFERENT WHEAT GENOTYPES ON PROXIMATE COMPOSITION

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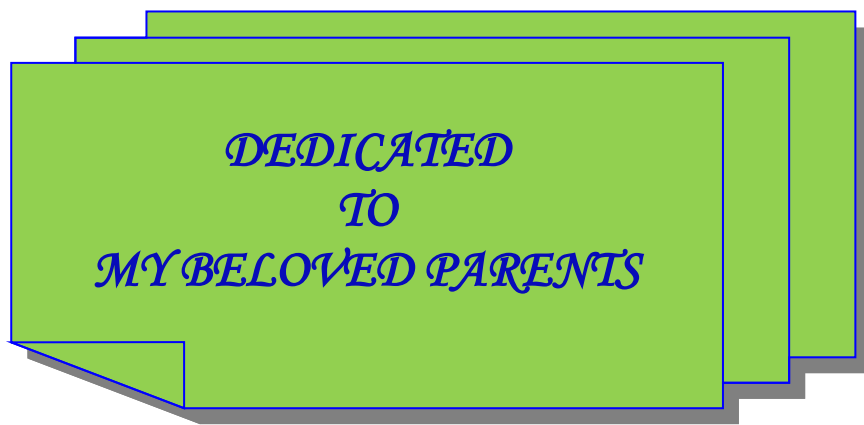Sher-e-Bangla Agricultural University

CERTIFICATE

This is to certify that the thesis entitled **'Effect of Different Wheat Genotypes on Proximate Composition'** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfilment of the requirements for the degree of **MASTER OF SCIENCE** in **BIOCHEMISTRY**, embodies the result of a piece of bonafide research work carried out by **Rejwana Benthe Hossain**, Registration number: **15-06959** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

I further certify that any help or source of information, received during the course of this investigation has duly been acknowledged.

Dated:
Dhaka, Bangladesh

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DEDICATED
TO
MY BELOVED PARENTS

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EFFECT OF DIFFERENT WHEAT GENOTYPES ON PROXIMATE COMPOSITION

ABSTRACT

The experiment was conducted during the period from August to December 2016 at the laboratory of Biochemistry Department of Sher-e-Bangla Agricultural University (SAU), Dhaka and Soil Science laboratory of Bangladesh Agriculture Research Institute, Joydevpur, Gazipur, Dhaka to find out the effect of different wheat genotypes on proximate composition. Six wheat genotypes as- BARI Gom 28, BARI Gom 29, BARI Gom 30, WYCYT-17 (Line), WYCYT-18 (Line) and KHERI (Local) were used as treatment for this experiment. The highest weight of 1000 grains (46.40 g) was recorded from BARI Gom 29, whereas the lowest weight of 1000 grains (39.20 g) was recorded from KHERI (Local). The highest dry matter content (92.49%) were observed from BARI Gom 30, while the lowest dry matter content (90.39%) was found from WYCYT-17 (Line). The highest protein content (15.54%) was found from BARI Gom 29, whereas the lowest protein content (13.18%) was recorded from WYCYT-17 (Line). The highest carbohydrate content (69.55%) was observed from WYCYT-18 (Line), whereas the lowest carbohydrate content (64.83%) was found from BARI Gom 29. The highest calcium content (0.67%) was observed from WYCYT-18 (Line), while the lowest calcium content (0.40%) was found from BARI Gom 28. The highest zinc content (33.40 ppm) was found from BARI Gom 29, whereas the lowest zinc content (30.33 ppm) was observed from KHERI (Local). The highest iron content (254.67 ppm) was found from BARI Gom 28, while the lowest iron content (221.50 ppm) from KHERI (Local).

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LIST OF ABBREVIATED TERMS

ABBREVIATION	FULL NAME
AEZ	Agro-Ecological Zone
et al.	and others
BARI	Bangladesh Agriculture Research Institute
BBS	Bangladesh Bureau of Statistics
BCR	Benefit Cost Ratio
Cm	Centimeter
^{0}C	Degree Celsius
Etc	Etcetera
FAO	Food and Agriculture Organization
MOP	Muriate of Potash
m^{2}	Square meter
UNDP	United Nations Development Program
SAU	Sher-e-Bangla Agricultural University

CHAPTER I

INTRODUCTION

CHAPTER I

INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the most important and widely grown food crops with more than 25000 different cultivars (Sapone *et al.*, 2012). It primarily grown across the exceptionally diverse range of environments is an important food crop (WRC, 2009). Importance of wheat crop may be understood from the fact that it covers about 42% of total cropped area in rice-wheat system in South Asia (Iqbal *et al.,* 2002). It contributes to the national economy by reducing the volume of import of cereals for fulfilling the food requirements of the country (Malik *et al.*, 2012). In Bangladesh, wheat is the second most important cereal crop (FAO, 2012). It occupies above 4% of the total cropped area and 11% of the area cropped in *rabi* and contributes 7% to the total output of food cereals (Anon., 2008). Generally, wheat supplies carbohydrate (69.60%), protein (12%), fat (1.72%), minerals (16.20%) and also other necessary nutrients in trace amount (BARI, 2010).

Bangladesh had become highly dependent on wheat imports while dietary preferences were changing such that wheat was becoming a highly desirable food supplement to rice. Domestic wheat production rose to more than 1 million tons per year, but was still only 7-9% of total food grain production (BARI, 2010). Wheat cultivation has been increased manifolds to meet up the food shortage in the country. But, in spite of its importance, the yield of the crop in the context of our country is low (2.2 t ha^{-1}) in comparison to other wheat growing countries of the world (FAO, 2012). The area, production and yield of wheat have been increasing dramatically based on the demand of over increasing population of Bangladesh during the last two decades, but its present yield is too low in comparison to some developed countries like Japan, France, Germany and UK producing 3.76, 7.12, 7.28, and 8.00 t ha^{-1}, respectively (FAO, 2012). At present about 706.33 thousand hectares of land in Bangladesh is covered by wheat with the annual production of 1,592 thousand tons (BBS, 2012).

Due to its wide adaptability to diverse climatic conditions and multiple end-uses along with dynamic nature of genomes and polyploidy character, it has become a crop of financial and nutritional importance especially after the emergence of hexaploid wheat

(Dubcovsky and Dvorak, 2007). Wheat is unique among cereals, because it contains gluten which has the characteristic of being elastic when mixed with water and retains the gas developed during dough fermentation. The quality of wheat flour for bread-making is generally evaluated by the amount of protein and quality of gluten (Khatkar *et al.*, 1995). The wheat flour containing large amount of protein and high quality of gluten is used for normal bread, whereas that of lower amount of protein is mostly used for confectionary or cakes (Caballero *et al.*, 2007). Wheat produced in different parts of the world differ greatly in their intrinsic protein qualities and quantities, the quantity is influenced mainly by environmental factors, but the quality of protein is mainly a heritable characteristic (Bordes *et al.*, 2008). Wheat flour is the major ingredient and consists mainly of carbohydrate (70-75%), water (14%) and proteins (10-12%). In addition, non-starch polysaccharides (2-3%), in particular arabinoxylans (AX) and lipids (2%) are important minor flour constituents relevant for bread production and quality (Goesaert *et al.*, 2005).

Wheat is one of the most important cereal grain cultivated worldwide. Starchy endosperm storage tissue from wheat grain is used to produce bread, noodles, pasta and wide range of other food products (Tosi *et al.*, 2011). For different wheat grains crude protein concentration (CP%), gluten quality, Hagberg falling number (HFN) and specific weight are among the most important quality parameters (Gooding *et al.*, 1997). The wheat quality is affected by genotype and environment (Loffler and Busch, 1982), fertilizer treatments and post harvest conditions (Stewart, 1984). Nowadays people are more concerned about quality which is forcing processors to use wheat with specific quality attributes. Grain size, protein content and its composition as well as, starch content and its ability to gelatinize are important variables that determine wheat quality.

Characteristics of wheat in terms of yield and morphological and physiological characteristics and also mineral contents depend on cultivar, growing conditions and other environmental factors and the interaction between cultivar and environment (Panozzo and Eagles, 2000). In Bangladesh firstly two Mexican varieties ('Sonora 64' and 'Penjamo 62') were tested in the northern part of Bangladesh (BARI, 2010). Their spectacular performance encouraged scientists to introduce more wheat variety to this part of the country (BARI, 1993). Different varieties respond differently to morphological and physiological characteristics and also mineral contents. Recently, efforts were taken to

increase the yield of wheat in Bangladesh by releasing a number of high yielding varieties. Wheat varieties regarding 1000 grains weight and bread quality have been found to be highly significant showing different varietal behavior. Information on the morphological and physiological characteristics and also mineral contents is inadequate in Bangladesh and also not precise for different wheat varieties in Bangladesh. So, in the context of the above mentioned situation, the present piece of work was designed using three released, two lines and one local variety of wheat with the following objectives-

- To study the morphological and physiological characteristics of different wheat varieties; and

- To find out the amount of mineral content in different wheat varieties.

CHAPTER II

REVIEW OF LITERATURE

CHAPTER II

REVIEW OF LITERATURE

Wheat primarily grown across the exceptionally diverse range of environments is an important food crop. In Bangladesh research work related to morphological and physiological characteristics and also mineral contents of different wheat genotypes are scarce. To justify the present study attempts have been made to incorporate some of the important findings of renowned scientists and research work in this country and in other countries have been reviewed under the following headings:

2.1 Weight of 1000 grains

Al-Khatib and Paulesn (1990) evaluated the yield performance of 10 wheat genotypes grown under moderate (22/17^{0}C, day/night) and high (32/7^{0}C, day/night) temperature. Yield component of 10 genotypes at maturity reacted differently to high temperature. Kernel weight decreased significantly in all genotypes, whereas the reduction range was about 10% to 30%.

Islam *et al.* (1993) evaluate the performance of the existing (Sonalika) and released wheat varieties (Ananda, Kanchan, Barkat, Akbar, Aghrani) seeded from 1 November to 15 January at 15 days interval and reported that 1000-grain weight were significantly affected by variety.

WRC (2003) of Bangladesh conducted an experiment in the Wheat Research Centre Nashipur, Dinajpur to examine the performance of genotypes among various tillage operations and to understand the effects of interaction between genotypes and tillage operations. Two cultivation methods were applied in the main plot and 10 wheat genotypes (Kanchan, Gourav, Shatabdi, Sourav, BAW 1008, BAW 1006, BAW 1004, BAW 969, BAW 968 and BAW 966) were tested in the sub plots. The genotypes showed a wide range of variation for 1000 grain weight and variety Shatabdi produced maximum 1000 grain weight.

A pot experiment was carried out by Al-Musa *et al.* (2012) at Patuakhali Science and Technology University to study the performance of some BARI wheat varieties under the

coastal area of Patuakhali. Four wheat varieties viz. BARI ghom-23, BARI ghom-24, BARI ghom-25 and BARI ghom-26 were planted in the field to evaluate their comparative performance. Among the BARI varieties, BARI ghom-26 produced the higher weight of 1000-grains (49.38 g).

A study was undertaken by Mohsen *et al.* (2013) to determine the effects of sowing dates on growth and yield components of different wheat cultivar in Iran. Five sowing dates and five wheat cultivars (Pishgam, Parsi, Bahar, Sivand and Pishtaz) were in sub plots. Results showed that the effect of cultivars was significant on all parameters excluding 1000 grain weight.

Field experiments were conducted by Suleiman *et al.* (2014) at the Demonstration Farm of College of Agriculture, University of Bahri to assess the performance of different wheat cultivars under different sowing dates. The experiment comprised of four dates of sowing and five wheat cultivars namely, Al Nilein, Debiera, Imam, Sasaraib, and Wad el Neil in subplots. The cultivar Imam and Wad el Neil scored the first rank in weight 0f 1000 grains.

2.2 Physiological characteristics

2.2.1 Carbohydrate

Carbohydrate is the main component in wheat grain (54-72% of grain dry weight) and it affects the structure of baked products and it consists of 20-25% of the linear molecule, amylose and 75-80% of complex and highly branched molecule amylopectin (Stone *et al.*, 2009). The starch is deposited in starch granules in the endosperm cells. Based on the size, mainly two types of starch granules are reported; the larger A-granules and the smaller B-granules. A types are larger than 10 μm in diameter and appear 4 days after anthesis while B types are smaller than 10μm in diameter and are formed 12-14 days after anthesis (Dengate and Meredith, 1984). In addition to this, there's also C type granules with size less than 5μm and are formed very late in grain filling (Bechtel *et al.*, 1990). Although in wheat grains the number of A-granules is less (2-4%) than that of B-granules, A-granules represent the major mass (60-75%) of starch. A and B type granules consists of varying amount of amylose and amylopectin content (Ao and Jane, 2007).

Breakdown of starch by amylases produce fermentable sugars for yeast fermentation. Besides, starch plays a vital role in producing optimal viscoelastic dough by diluting gluten and acting as a reservoir for water absorption. Gelatinization takes place when starch is heated in excess of water, leading to large increase in viscosity which is the basis for dough to set in the baking process. The starch granules undergo several changes during gelatinization, where the partly break down of starch granules along with their swelling up to several times of its original size (Ahmed and Auras, 2011) are the most important. Amylopectin is considered to be responsible for water absorption, swelling and pasting of starch granules (Tester and Morrison, 1990). However, amylose tends to leak out of the starch granules during gelatinization and contribute to the formation of starch gels, affecting the structure of final product (Hermansson and Svegmark, 1996). Starch gelatinization sharply increase dough viscosity and creates cracks in cell membranes that prevents shrinkage of bread when cooled after baking (Kusunose *et al.*, 1999). The ratio of amylose to amylopectin and their molecular structure determines quality, texture and stability of end products as it affect solubility, gelatinization and retrogradation properties of starch (Blazek and Copeland, 2008). Retrogradation is the recrystallization of amorphous starch paste when cooled after gelatinization. This process leads to gritty mouth feel. Normally the ratio between amylose and amylopectin is approximately 25:75 and this seems not to vary much between varieties. But starch mutants with 100% amylopectin have been found in wheat. Today, such varieties have been commercialized, and they are used for special products, but not for leavened bread and leavened baked products as they produce bread with poor crumb characteristics.

2.2 Protein

Carbohydrates, protein, amino acids, lipids and minerals are the major components in wheat grains that affect nutritional value and end-use quality. Among them protein is an important constituent that determines bread making quality (Pomeranz, 1987; Shewry, 2009). Protein content in fully matured wheat grain varies from 10-20% (Shewry *et al.*, 1994) and normally from 10-15% in western Europe. If we assume 10 % protein content in wheat grain, it produced 66.3 × 109 kg total protein and 9.4 kg protein/capita/annum (assuming 7 billion world population) in the year 2012 (Balyan *et al.*, 2013).

Gluten forming storage proteins present in endosperm of wheat grains are responsible for rheological properties of dough that is required for the production of leavened bread and other diverse products (Gianibelli *et al*., 2001). Relation of protein content to loaf volume has been studied since long time. A pioneering work in this area by finding that loaf volume of bread is affected by protein quantity, in their study on hard red winter and spring wheat cultivars. Further study in protein revealed that both quantity and quality of protein affect bread making properties like water absorption, oxidation requirements, loaf volume and crumb characteristics. Water absorption in the flour is increased with increasing protein content resulting larger loaf volume and softer bread (Maleki, *et al*., 1980).

Grain yield and protein content are important parameters in wheat production (Groos *et al*., 2003). Protein content in wheat grain normally decreases with the increase in grain yield (Simmonds, 1995). Negative correlation between these two traits is considered to be affected genetically (Groos *et al*., 2003) that is highly heritable . So, there are some chances to improve yield without affecting quality or vice-versa through breeding (Barraclough *et al*., 2010). Mobilization of nitrogen from various plant parts to head can increase grain protein content and reduction in dry weight of plant biomass (stem weight) can increase grain yield. So, understanding the genetic base for dry weight build up and nitrogen concentration of various plant parts can be useful for successful breeding of cultivars with high grain yield and high protein content (Malik *et al*., 2012).

Grain protein content and composition is affected by both genotype and the environment in which it is grown. Study on 212,600 lines of wheat in the World Wheat Collection showed that protein percent varied from 7 to 22% on a dry weight basis and genotype was considered to have effect on one third of variation. Protein content in wheat grain can be increased by increasing level of nitrogen fertilizer application (Uhlen *et al*., 2004). But timing of nitrogen application could have different responses depending on the environment i.e. temperature in which wheat is grown. Split application of nitrogen during stem elongation or at heading can increase protein content in wheat grain. Such, application has become a common strategy in western Europe. In a study of Dupont *et al*. (2006) application of post anthesis nitrogen under moderate temperature (24°C days and 17°C nights) increased rate of accumulation of protein as well as total protein content in

wheat. But when grown in same condition under 37°C days and 28°C nights (higher temperature) post anthesis nitrogen did not have marked effect on rate of accumulation and total content of protein. However, protein percentage in grains grown at the higher temperature was higher than those grown at the lower temperature. Usually grain protein percent increase when environment conditions like drought and high temperature hinders grain yield to reach its potential (Fowler, 2003). Bly and Woodard (2003) found post pollination application of nitrogen to be more effective for gaining wheat with higher protein content as well as higher yield when compared to application of nitrogen by boot stage.

Endosperm of wheat consists of 80% of total grain proteins and these proteins are not soluble in water at neutral pH or dilute salt solutions. Such insoluble storage proteins in endosperm are referred as gluten (Wieser, 2007). Wheat gluten proteins can be classified into monomeric gliadins, lacking either disulphide bonds or containing only intra-chain bonds and the complex polymeric glutenins, with inter-chain disulphide bonds. Further gliadins are classified as α-, γ- and ω- types based on their mobility in acid PAGE gels and glutenins as low molecular weight glutenin subunits(LMW-GS) and high molecular weight glutenin subunits (HMW-GS) which link together by intermolecular disulphide bonds and form large insoluble polymers. HMW-GS is considered to have major impact on dough elasticity and thus has been studied in

Most detail (Shewry *et al*., 2003) although quantitatively they are less (10% of total storage protein) when compared to LMW-GS (40% of total storage protein) (Payne, 1987).

The quality traits of wheat depend on its genetic constitution and these traits are the result of genes and their interaction with the environment (Gianibelli *et al*., 2001). Intra specific polymorphism present in gliadin and glutenin can be detected through gel electrophoresis. Multiple alleles present in different loci of homologous chromosomes 1 and 6 control the polymorphism of gliadin and glutenin subunits (Payne, 1987). Glu-1 loci are located on the long arm chromosomes 1A, 1B and 1D of wheat and it consists of genes that encode HMW subunits of glutenin. On each locus there are 2 tightly linked genes – x-type and y-type. X-type encodes high molecular size subunits while y-type encodes low molecular size subunits. Due to differences in gene expression bread wheat possesses 3 to 5 subunits

(Payne, 1987). All cultivars of wheat consists of the HMW-GS 1 Dx, Dy and 1Bx while only some consists of 1Ax and/or 1By (Gianibelli *et al.*, 2001). Subunits 1Ax and 1Dx5+Dy10 are considered to have major role in determining bread-making quality where subunits 1Dx5+Dy10 is most important and responsible for production of larger size glutenin polymers (Gupta and MacRitchie, 1994). So, in bread wheat, which are mainly characterized by subunits 1Dx2+1Dy12 and 1Dx5+1Dy10 in Glu-D1 locus, wheat with subunits 1Dx5+1Dy10 have superior bread quality in terms of different nutrients also (Rasheed *et al.*, 2012).

2.3 Proximate composition of different wheat genotypes

David *et al.* (2015) carried out an experiment with the objective to assess the proximate composition and selected functional properties of soft wheat flour. The commercially available soft wheat flour was purchased from local suppliers at Kajetia market in Kumasi-Ghana. The flour were cleaned of foreign materials and sieved through 75 μm. The flours were packaged in air-tight plastic containers prior to analyses. The flours were analyzed for their proximate composition. The flour functional properties were determined and compared with those of asomdwee cowpea flour. The results showed that the soft wheat flour had higher (1.33%) fat and carbohydrate content (83.60%) than the cowpea flour. The crude protein, fibre, moisture and ash content were all lower in soft wheat flour as compared to the cowpea flour. However, the bulk density, oil and water absorption capacity of the wheat flour were not significantly different from the cowpea flour. Solubility, swelling power and foam capacity of the wheat flours were lower as compared to the cowpea flour.

Wheat germ was analysed by Mahmoud *et al.* (2015) for its proximate composition, fatty acid composition, physical and chemical characteristics of wheat. The basic chemical composition analyses revealed high values of dry matter (87.37 g/100g FW), significant amounts of total protein and fat (27.69 and 8.99 g/100g FW, respectively) content and low ash content (3.08 g/100g FW). The results showed that these by-products could be used as a source of bioactive compounds beneficial for health.

Makawi *et al.* (2013) studied three wheat cultivars, Elnelain, Nepta and Argeen for their various quality and rheological characteristics compared with the Australian wheat flour (control). Physicochemical characteristics as well as farinograph, extensograph, gluten content, sedimentation value and bread quality were assessed. Significant differences were found for hectoliter weight and 1000 kernel weight between the Australian and Sudanese wheat cultivars. However, Sudanese wheat flours had a lower wet gluten (22.7-28.9 g), sedimentation values (15-20 ml), water absorption (57.9-66.4%), dough development time (2.5-6.8 min), stability (1.5-7.9 min), resistance to extension (160-304 Bu), energy (62-80 cm) and bread specific volume (3.06-3.40 cm) compared to the Australian one. Nepta cultivars gave the best characteristics of farinograph, extensograph and the highest bread specific volume among Sudanese wheat investigated.

Three wheat varieties/lines (V-94091, V-94105 and Inqulab-91) was evaluated by Sameen *et al.* (2002) at Wheat Research Institute, Faisalabad and their response to NPK fertilizers. Chemical characteristics like protein, moisture, ash, fat and fiber contents of straight grade flour of wheat varieties were determined. The results revealed that the moisture absorption by wheat flour increased by increasing the fertilizer doses. The data showed that fertilizer doses significantly affect the ash and protein contents of all varieties/lines and with increasing fertilizer rates, the crude protein and ash contents also increased. Fat and fiber contents of all wheat varieties remained unaffected by fertilizer doses.

From the above cited reviews, it may be concluded that morphological and physiological characteristics and also mineral contents are the prerequisite for quality of wheat. The literature revealed that the morphological and physiological characteristics and also mineral contents of wheat have not been studied well and have no definite conclusion in this regards.

CHAPTER III

MATERIALS AND METHODS

CHAPTER III

MATERIALS AND METHODS

The laboratory experiment was conducted to find out the effect of different wheat genotypes on proximate composition. The materials and methods those were used for conducting the experiment have been presented in this chapter. It includes a short description of the experimental site, materials used for the experiment, experimental design, data collection and data analysis procedure.

3.1 Experimental period

The experiment was conducted from August to December 2016.

3.2 Experimental site

The experiment was conducted at the laboratory of Biochemistry Department of Sher-e-Bangla Agricultural University, Dhaka and Soil Science laboratory of Bangladesh Agriculture Research Institute, Joydebpur, Gazipur, Dhaka.

3.3 Climatic condition of the experimental site

Experimental area is situated in the sub-tropical climate zone, which is characterized by heavy rainfall during the months of April to September and scanty rainfall during the rest period of the year. Details of the meteorological data during the period of the experiment was collected from the Bangladesh Meteorological Department, Agargoan, Dhaka and presented in Appendix I.

3.4 Experimental material

Different genotypes of wheat were used as experimental materials for this study. The seeds were collected from the Agronomy Division of Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur which were grown in the cropping season of 2015-16. After collection of wheat grains one thousand wheat grains were counted from each genotypes and weighed by using a digital electric balance and weight was expressed in gram (g). After that the grains were grinded for analysis proximate and mineral compositions.

3.5 Treatments of the experiment

Six wheat genotypes were used as treatment for this experiment and they were-

- BARI Gom 28

- BARI Gom 29

- BARI Gom 30

- WYCYT-17 (Line)

- WYCYT-18 (Line)

- KHERI (Local)

3.6 Brief description of wheat genotypes

BARI Gom 28: It is a short duration composite variety evolved by Bangladesh Agriculture Research Institute (BARI) in 2012 as BAW 1141. The gains size of this variety is medium.

BARI Gom 29: It is a short duration composite variety evolved by BARI in 2013. The gains size of this variety is small.

BARI Gom 30: It is a short duration composite variety evolved by BARI in 2013. The gains size of this variety is medium.

WYCYT-17 (Line): It is an advanced line of wheat variety and developed by BARI.

WYCYT-18 (Line): It is another advanced line of wheat variety and developed by BARI.

KHERI (Local): It is a local variety and cultivated in the different wheat growing of Bangladesh.

3.7 Experimental design

The experiment was laid out in the ambient condition of the laboratory considering in a Completely Randomized Design (CRD) and the treatments was replicated four times for each.
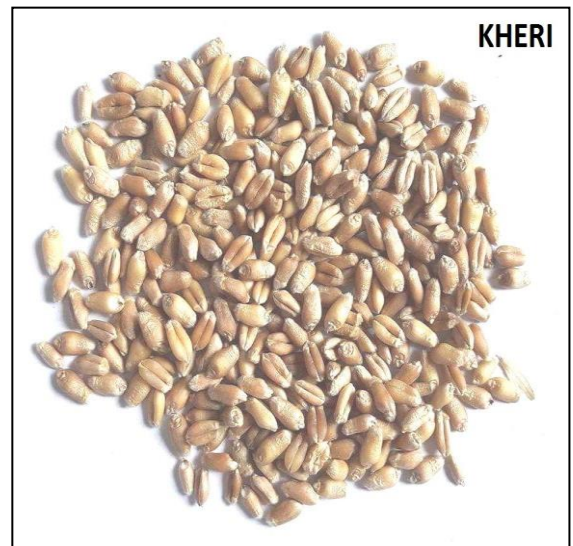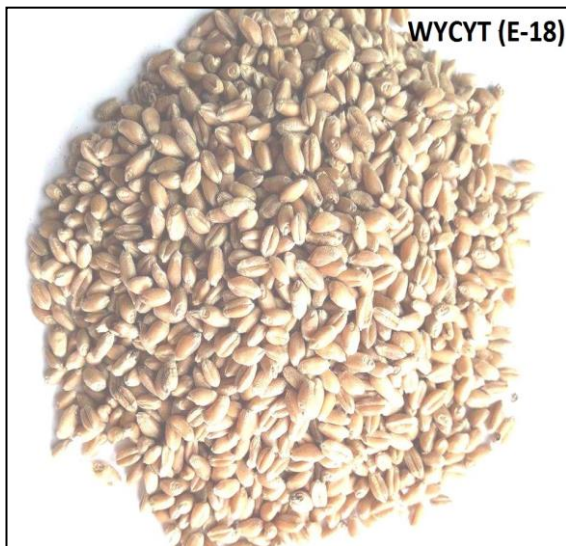
Plate 1. Photograph showing wheat genotypes were used as treatment

3.8 Grinding of grains

The dried wheat grains were grinded in a grinder filtered with a suitable screen. If the grinding takes a long time, the sample will absorb moisture and it is necessary to dry the sample again in the oven at 105^0C overnight and the wheat grains sample were ready for the estimation of proximate composition and minerals content.

3.9 Data collection

Three sampling of wheat grains was taken for measuring proximate composition and mineral content of wheat seeds. The following data were recorded:

1. Proximate composition of wheat variety

    - Moisture percentage

    - Determination of dry matter

    - Determination of total ash

    - Determination of crude fiber

    - Total carbohydrate estimation

    - Determination of protein

    - Total fat estimation

2. Estimation of minerals
    - Determination of Ca, Mg, K, P, Zn, B, Cu, Mn and Fe.

3.10 Proximate composition of wheat genotypes

3.10.1 Moisture percentage

Seed moisture content was determined following low constant temperature oven method and done as soon as the seeds were collected. An aluminium container was taken with cover and weighed (M_1) collected wheat varities. Some (about 5 g) wheat seed sample was taken in the container and weighed the seed with cover (M_2). The container was placed on its cover and dried in an oven maintained at a temperature of 103 ± 2ºC for 17 ± 1 hours. The drying period begins at the time the oven returns to the required temperature. After 17 hours the door of the oven was opened and the transferring tray with seeds was taken out. The container was closed immediately with its cover and was stored in the

desiccators. After cooling (about 30 minutes) the container was weighed with their covers and the weight was recorded as M_3 to three decimals. The moisture content of wheat seeds was determined using the following formula indicated by ISTA (1987). In this process moisture percentage was taken and estimated as follows:

$$\text{Moisture percentage (\%)} = \frac{M_2\text{-}M_3}{M_2\text{-}M_1} \times 100$$

Where,

M_1 = Weight of container + cover

M_2 = Weight of container + cover + seed before drying

M_3 = Weight of container + cover + seed after drying

3.10.2 Determination of dry matter

A clean container (dish or beaker) was place in an oven at 105^0C overnight. The container was allowed to cool in desiccators and was weighed. The sample was kept into the container and weighed with the sample. The container was placed in the oven at 105^0C for 24 hours. The container was allowed to cool in desiccators and was weighted. Again, the container was placed in the oven at 105^0C for 2 hours. It was cooled in desiccators and weighed again. Repeat drying, cooling and weighing were continued until the weight became constant. The dried sample was stored in an airtight container. The moisture content of the sample was calculated and dry matter was determined by redacting the moisture content from fresh sample.

3.10.3 Determination of total ash

One gram of the sample was weighed accurately into a crucible. The crucible was placed on a clay pipe triangle and heated first over a low flame till all the material was completely charred, followed by heating in a muffle furnace for about 5-6 hours at 600^0C. It was then cooled in a desiccators and weighed. To ensure completion of ashing, the crucible was then heated in the muffle furnace for 1h, cooled and weighed. This was repeated till two consecutive weights were the same and the ash was almost white or grayish white in color. Then total ash was calculated as following equation (Raghuramulu et al., 2003):

$$\text{Ash content (g/l00 g sample)} = \frac{\text{Weight of ash}}{\text{Weight of sample taken (g)}} \times 100$$

3.10.4 Determination of crude fiber

Ten gram of moisture and fat-free sample was taken in a beaker and 200 ml of boiling 0.255 N H_2SO_4 was added. The mixture was boiled for 30 minutes keeping the volume constant by the addition of water at frequent intervals. The mixture was then filtered through a Maslin cloth and the residue washed with hot water till free from acid. The material was then transferred to the same beaker and 200 ml of boiling 0.313 N NaOH was added. After boiling for 30 minutes (keeping the volume constant as before) the mixture was filtered through a Maslin cloth and the residue was washed with hot water till free from alkali, followed by washing with some alcohol and ether. It was then transferred to a crucible, dried overnight at 80-100^{0}C and weighed (We) in an electric balance *(KEY: JY-2003; China)*. The crucible was heated in a muffle furnace *(Nebertherm: Mod-L9/11/c6; Germany)* at 600^{0}C for 5-6 hours, cooled and weighed again (Wa). The difference in the weights (We-Wa) represents the weight of crude fiber (Raghuramulu *et al.*, 2003).

Therefore,

Crude fiber (g/l00 g sample) = [100-(moisture + fat)] $\times$ (We- Wa)/

Wt. of sample.

3.10.5 Total carbohydrate estimation

The content of the available carbohydrate was determined by the following equation (Raghuramulu *et al.,* 2003):

Carbohydrate (g/l00 g sample) = 100 - [(Moisture + Fat + Protein + Ash + Crude Fiber)

g/100 g].

3.10.6 Determination of protein

The protein contents of the wheat seeds were determined by the standard Micro-kjeldhal procedure. According to this method total nitrogen contents of the samples were estimated and protein contents were finding out by multiplying by 6.25 to the total nitrogen values. The total nitrogen was determined by the Kjeldahl methods, which

depends upon the conversion of protein nitrogen into ammonium sulfate, by digestion ammonia liberated from the ammonium sulfate by making the solution alkaline were distilled into known volume of a standard acid, which was then back titrated.

Reagents

a) Concentrated sulfuric acid

b) Digestion Mixture: Potassium sulfate : Copper sulfate (98 : 2 w/w)

c) 40% Sodium hydroxide in distilled water

d) N/10 Sulfuric acid and N/10 Sodium hydroxide

e) 0.1% methyl red indicator: 0.1 g of the indicator was dissolved in 60 ml of alcohol and the volume was made 100ml with the distilled water

Procedure

Weighed dried sample 2.0 g, 5.0 g of the digestion mixture, 25 pieces of the glass beads, and 25ml of concentrated sulfuric acid were taken in a Kjeldahl flask. The content of the flask was digested in a flame chamber until the total content became clear. The digested materials were quantitatively transferred into a one liter flat-bottomed flask and the volume was made up to about 400ml with distilled water. Then about 40% NaOH and some pumice stone were added to prevent bumping, and distilled immediately in the distillation chamber of the Kjeldahl apparatus. The distillation was continued till its volume diminished to one-half of the initial. The distillate was collected in a receiver containing 100ml of N/10 sulfuric acid containing 2/3 drops of methyl red indicator. The liberated ammonia absorbed in the sulfuric acid solution was titrated against standard (N/10) NaOH solution.

Calculation

$$\text{Percentage of nitrogen} = \frac{(A-B)\times14\times100}{W\times1000}$$

Where,

A = ml of NaOH required in the titration of blank

B = ml of NaOH required in the titration of sample

N = Normality of the NaOH

W = Weight of the sample

The protein content in gram per 100 g of the dried sample

$$= \frac{\text{Percentage of nitrogen} \times 6.25 \times D}{100}$$

Where, D = Percentage of dried sample from the fresh sample

3.10.7 Total fat estimation

Fat was estimated as crude ether extraction of the dry materials. The dried sample (about 5.0 g) was weighed into a conical flask and plugged with fat free cotton. The flask was then placed in an electric shaker and extracted with anhydrous ether for about 16 hours. The ether extract was filtered into another weighed conical flask. The flask containing the original ether extract was washed 4 to 5 times with small quantities of ether and the washings were also transferred to the filter paper. The ether in the conical flask was then removed by evaporation, and the flask with the residual was dried in an oven at 80^0C to 100^0C, cooled in desiccators and weighed. The result was expressed as follows:

Fat contents (g) per 100 g of dried sample =

$$\frac{\text{Weight of ether extract} \times \text{Percentage of dried sample}}{\text{Weight of the dried sample taken}}$$

3.11 Estimation of minerals

3.11.1 Equipments

For elementary composition analysis the equipment were used as electric balance, desiccators, atomic absorption spectrophotometer (AAS), spectrophotometer, porcelain crucible, beaker and flame photometer etc.

3.11.2 Determination of Ca, Mg, K, Fe, S, Zn and P

The sample was digested with nitric acid to release of Ca, Mg, K, Fe, S, Zn and P. Minerals Ca, Mg, Fe, S and Zn were determined by atomic absorption spectrophotometer, K was determined by flame photometry and P by spectrophotometer.

3.11.2.1 Digestion

1. 0.500 g of dried sample was taken into each of 18 nitrogen digestion tubes. The two remaining tubes were kept blanks. 5 ml nitric acid were added to each of all 20

tubes. The tubes were left overnight mixing the contents in the tubes. Covering with the exhaust manifold, the tubes were placed in the digester and the temperature was set to 125°C, turning on the digester, the digestion was continued for 4 hours after boiling started.

2 After cooling, the digestion mixture was transferred with distilled water to a 100 ml volumetric flask water added to make the volume up to the mark.

3 Filtration was performed on a dry filter into a dry bottle, which could be closed with a screw cap. Keeping the filtrate in the closed bottle Ca, Mg, K, Fe, Mn, Zn, S, Cu and P were determined in the filtrate.

3.11.2.2 Estimation of Ca

20 ml diluted filtrate was transferred into a 50 ml volumetric flask using a pipette. 5 ml $LaCl_3$-solution was added and the volume was made with water and mixed. Then the content of Ca was measured by atomic absorption spectrophotometer (AAS).

3.11.2.3 Estimation of Mg

20 ml diluted filtrate was transferred into a 50 ml volumetric flask using a pipette. 5 ml $LaCl_3$-solution was added and the volume was made with water and mixed. Then the content of Mg was measured by AAS.

3.11.2.4 Estimation of K

10 ml diluted filtrate was transferred into a 50 ml volumetric flask using a pipette to volume with water and mixed. The content of K was measure by flame photometer.

3.11.2.5 Estimation of P

5 ml diluted filtrate was transferred into a 50 ml volumetric flask using a pipette. 30 ml water was added, mixed and then 10 ml ammonium molybdate-ascorbic acid solution was added to volume with water and mixed. After 15 minutes, the absorbance was measured on a spectrophotometer at 890 nm.

3.11.2.6 Estimation of Fe and Zn

The content of Fe and Zn elements were measured by atomic absorption spectrophotometer (AAS) directly in the undiluted filtrate.

3.11.2.7 Calculations: For   Ca, Mg, K and P

$$\text{mg per kg sample} = \frac{a \times 25000}{b \times c}$$

Where,   a= mg/L Ca, Mg, K or P measured on atomic absorption spectrophotometer, flame photometer or spectrophotometer

b= ml diluted filtrate transferred into the 50 ml volumetric flask for determination of Ca, Mg, K or P

c = g sample weighed into the digestion tube

If an additional dilution is made before the transfer to the 50 ml volumetric flask, the result is multiplied with the dilution factor. But the above elements were in trace. So addition of dilution was not to be performed.

For Zn and Fe

$$\text{mg per kg sample} = \frac{d \times 100}{c}$$

Zn and Fe measured on atomic absorption spectrophotometer

c = g sample weighed into the digestion tube

3.11.2.8 Determination of total sulphur

Organic matter is destructed and sulphur is oxidized to sulphate by digestion with a mixture of nitric and perchloric acid. The sulphate is determined by precipitation as barium sulphate using the following formula.

$$\% \text{ S} = \frac{A \times 1374}{M \times W} \qquad\qquad \% \text{ SO}_3 = \% \text{ S} \times 2.50$$

Where,

A = weight of $BaSO_4$ g

M = amount of soln. transferred to beaker for precipitation of $BaSO_4$ (ml)

W = weight of sample in g

3.12 Statistical analysis

The data obtained for different parameters were statistically analyzed to find out the significant difference of different wheat genotypes in respect of proximate composition and mineral content. The mean values of all the characters were calculated and analysis of

variance was performed by the 'F' (variance ratio) test. The significance of the difference among the treatment means was estimated by the Duncan's Multiple Range Test (DMRT) at 5% level of probability (Gomez and Gomez, 1984).

CHAPTER IV

RESULTS AND DISCUSSION

CHAPTER IV

RESULTS AND DISCUSSION

The experiment was conducted to find out the effect of different wheat genotypes on proximate composition. Data was recorded on some morphological and physiological characteristics and also mineral contents of different wheat genotypes. The analysis of variance (ANOVA) of the recorded parameters has been presented in Appendix II-III. The results have been discussed and presented under the following headings:

4.1 Morphological Characteristics

4.1.1 Weight of 1000 grains

Weight of 1000 grains showed statistically significant differences due to different wheat genotypes (Appendix II). Data revealed that the highest weight of 1000 grains (46.40 g) were recorded from BARI Gom 29 which was statistically similar (45.73 g and 44.33 g) to BARI Gom 28 and WYCYT 17 (Line), respectively and closely followed (42.93 g) by BARI Gom 30, whereas the lowest weight of 1000 grains (39.20 g) was recorded from KHERI (Local) which was statistically similar (41.40 g) to WYCYT-18 (Line) genotypes (Table 1). Generally weight of grains is a genetical character and it is controlled by the genetic makeup of the genotypes and different genotypes produced different size and weight of grains. It was also revealed that management practices influences weight of 1000 grains. WRC (2003) of Bangladesh reported that genotypes showed a wide range of variation for 1000 grain weight and variety Shatabdi produced maximum 1000 grain weight. Islam *et al.* (1993) reported that 1000-grain weight was significantly affected by variety. Al-Musa *et al.* (2012) reported that among the BARI varieties, BARI ghom-26 produced the higher weight of 1000-grains (49.38 g). Mohsen *et al.* (2013) observed that that the effect of cultivars was significant for all wheat parameters excluding 1000 grain weight.

Table 1. Weight of 1000 grains, moisture and dry matter content of different released variety, advanced lines and local variety of wheat

Name of wheat genotypes	Weight of 1000 seeds (g)	Moisture (%)	Dry matter (%)
BARI Gom 28	45.73 a	9.00 a	91.00 b
BARI Gom 29	46.40 a	7.87 b	92.13 a
BARI Gom 30	42.93 bc	7.51 b	92.49 a
WYCYT-17 (Line)	44.33 ab	9.61 a	90.39 b
WYCYT-18 (Line)	41.40 cd	9.14 a	90.86 b
KHERI (Local)	39.20 d	9.32 a	90.68 b
LSD$_{(0.05)}$	2.607	0.827	1.065
CV(%)	3.49	5.87	4.27

All determinations were done three times for each genotype

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

4.2 Physiological Characteristics

4.2.1 Moisture

Statistically significant variation was recorded in terms of moisture content due to different wheat genotypes (Appendix II). The highest moisture content (9.61%) were found from WYCYT-17 (Line) which was statistically similar (9.32%, 9.14% and 9.00%) to KHERI (Local), WYCYT-18 (Line) and BARI Gom 28. On the other hand, the lowest moisture content (7.51%) from BARI Gom 30 which was statistically similar (7.87%) to BARI Gom 29 (Table 1).

4.2.2 Dry matter

Different wheat genotypes showed statistically significant variation for dry matter content (Appendix II). The highest dry matter content (92.49%) were observed from BARI Gom 30 which was statistically similar (92.13%) to BARI Gom 29, while the lowest dry matter content (90.39%) was found from WYCYT-17 (Line) which was statistically similar

(90.68%, 90.86% and 91.00%) to KHERI (Local), WYCYT-18 (Line) and BARI Gom 28, respectively (Table 1). Mahmoud *et al.* (2015) reported high values of dry matter (87.37 g/100g FW) in different genotypes of wheat.

4.2.3 Protein

Statistically significant variation was recorded due to different wheat genotypes in terms of protein content (Appendix III). The highest protein content (15.54%) were found from BARI Gom 29 which was statistically similar (14.49%) to BARI Gom 30 and followed (13.94%) by BARI Gom 28, whereas the lowest protein content (13.18%) was recorded from WYCYT-17 (Line) which was statistically similar (13.45% and 13.67%) to WYCYT-18 (Line) and KHERI (Local), respectively (Table 2). Protein is an important constituent that determines bread making quality (Pomeranz, 1987; Shewry, 2009). Protein content in fully matured wheat grain varies from 10-20% (Shewry *et al.*, 1994) and normally from 10-15% in Western Europe and assumed that 10% protein content in wheat grains.

Table 2. Protein, lipid, ash, carbohydrate and crude fiber content of different released variety, advanced lines and local variety of wheat

Name of wheat genotypes	Protein (%)	Lipid (%)	Ash (%)	Carbohydrate (%)	Crude fiber (%)
BARI Gom 28	13.94 bc	1.84 cd	2.04 a	67.39 bc	14.79 abc
BARI Gom 29	15.54 a	2.23 a	2.36 a	64.83 d	15.04 a
BARI Gom 30	14.49 ab	2.05 ab	2.34 a	66.26 c	14.86 ab
WYCYT-17 (Line)	13.18 c	1.83 cd	1.84 b	68.98 ab	14.17 bc
WYCYT-18 (Line)	13.45 c	1.77 d	1.95 b	69.55 a	13.28 c
KHERI (Local)	13.67 c	1.91 bcd	2.15 a	68.52 ab	13.75 c
LSD$_{(0.05)}$	1.429	0.226	0.323	1.455	1.331
CV(%)	5.78	3.28	3.11	4.08	3.98

All determinations were done three times for each genotype

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability
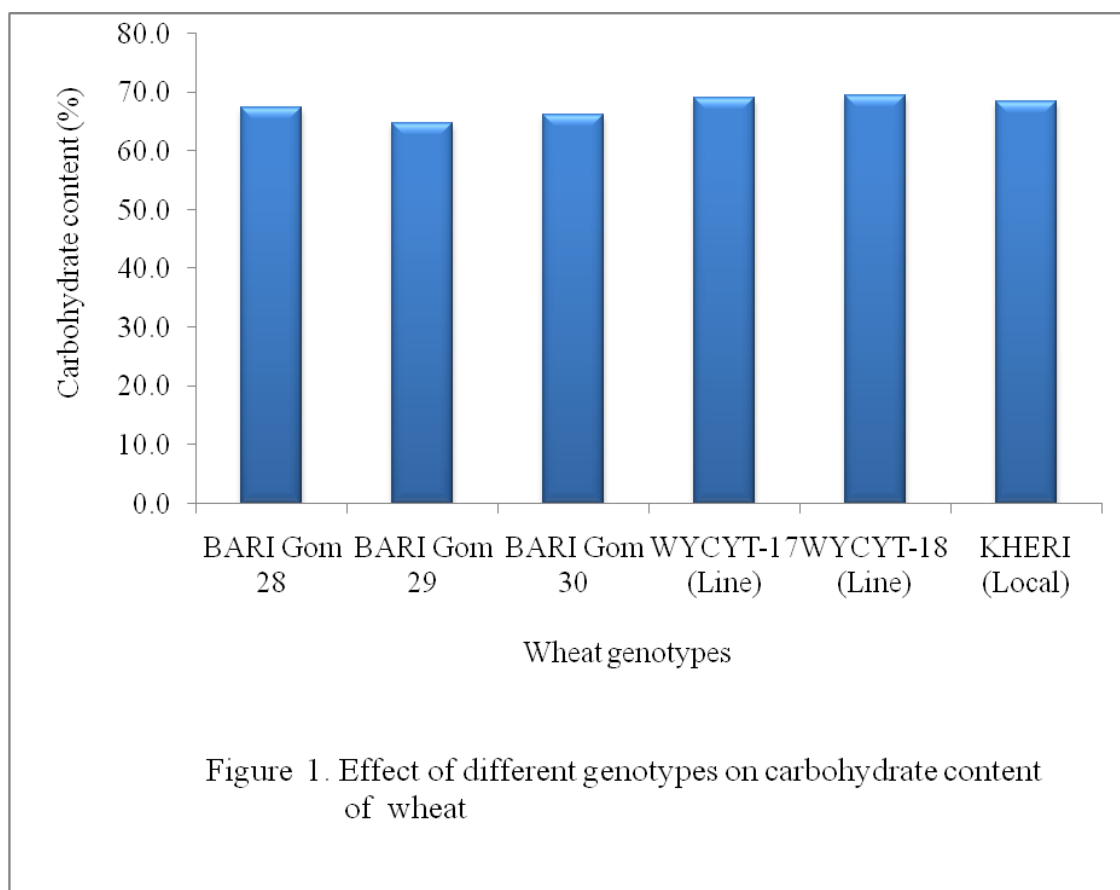
4.2.4 Lipid

Lipid content showed statistically significant variation due to different wheat genotypes (Appendix III). The highest lipid content (2.23%) were recorded from BARI Gom 29 which was statistically similar (2.05%) to BARI Gom 30 and closely followed (1.91%) by KHERI (Local). On the other hand, the lowest lipid content (1.77%) was observed from WYCYT-18 (Line) which was statistically similar (1.83% and 1.84%) to WYCYT-17 (Line) and BARI Gom 28, respectively (Table 2). Wieser (2007) reported high values of lipid (2.18%) in different genotypes of wheat.

4.2.5 Ash

Different wheat genotypes varied significantly in terms of ash content (Appendix III). The highest ash content (2.36%) were recorded from BARI Gom 29 which was statistically similar (2.34%, 2.15% and 2.04%) to BARI Gom 30, KHERI (Local) and BARI Gom 28, while the lowest lipid content (1.84%) was recorded from WYCYT-17 (Line) which was statistically similar (1.95%) by WYCYT-18 (Line) (Table 2). Mahmoud *et al*. (2015) reported high values of ash content (3.08 g/100g FW) in different genotypes of wheat.

4.2.6 Carbohydrate

Statistically significant variation was recorded in terms of carbohydrate content due to different wheat genotypes (Appendix III). The highest carbohydrate content (69.55%) were observed from WYCYT-18 (Line) which was statistically similar (68.98% and 68.52%) to WYCYT-17 (Line) and KHERI (Local), respectively and followed (67.39%) by BARI Gom 28, whereas the lowest carbohydrate content (64.83%) was found from BARI Gom 29 which was followed (66.26%) by BARI Gom 30 (Figure 1). Carbohydrate is the main component in wheat grain (54-72% of grain dry weight) and it affects the structure of baked products and it consists of 20-25% of the linear molecule, amylose and 75-80% of complex and highly branched molecule amylopectin (Stone *et al*., 2009).

Figure 1. Effect of different genotypes on carbohydrate content of wheat

4.2.7 Crude fiber

Crude fiber showed statistically significant differences in terms of content due to different wheat genotypes (Appendix III). The highest crude fiber content (15.04%) were recorded from BARI Gom 29 which was statistically similar (14.86% and 14.79%) to BARI Gom 30 and BARI Gom 28, respectively and followed (14.17%) by WYCYT-17 (Line). On the other hand, the lowest crude fiber content (13.28%) was recorded from WYCYT-18 (Line) which was statistically similar (13.75%) by KHERI (Local) genotypes (Table 2). Wieser (2007) reported high values of crude fiber (15.22%) in different genotypes of wheat.

4.3 Mineral content

4.3.1 Calcium content

Statistically significant variation was recorded in terms of calcium content due to different wheat genotypes (Appendix IV). The highest calcium content (0.67%) were observed from WYCYT-18 (Line) which was statistically similar (0.60% and 0.53%) to BARI Gom 29, WYCYT-17 (Line) and KHERI (Local) and followed (0.47%) by BARI Gom 30, while the lowest calcium content (0.40%) was found from BARI Gom 28 (Table 3). Different genotypes have different amount of mineral content. BARI (1997) reported that wheat supplies minerals (16.20%) and also other necessary nutrients in trace amount.

4.3.2 Magnesium content

Different wheat genotypes showed statistically significant variation for magnesium content (Appendix IV). The highest magnesium content (0.33%) were recorded from WYCYT-17 (Line) which was closely followed (0.29%, 0.28% and 0.27%) by BARI Gom 30, BARI Gom 28, KHERI (Local) and WYCYT-18 (Line) and they were statistically similar, whereas the lowest magnesium content (0.26%) was observed from BARI Gom 29 (Table 3). BARI (1997) reported that wheat supplies necessary nutrients in trace amount.

4.3.3 Potassium content

Potassium content varied significantly in terms of due to different wheat genotypes (Appendix IV). The highest potassium content (0.197%) were found from BARI Gom 28 which was statistically similar (0.184%, 0.179% and 0.176%) by BARI Gom 29, BARI Gom 30 and WYCYT-17 (Line). On the other hand, the lowest potassium content (0.167%) was observed from KHERI (Local) which was statistically similar (0.170%) to WYCYT-18 (Line) genotypes (Table 3).

Table 3. Major minerals calcium, magnesium, potassium and phosphorus content of different released variety, advanced lines and local variety of wheat

Name of wheat genotypes	Calcium (%)	Magnesium (%)	Potassium (%)	Phosphorus (%)
BARI Gom 28	0.40 c	0.28 bc	0.197 a	0.298 cd
BARI Gom 29	0.60 ab	0.26 c	0.184 ab	0.262 d
BARI Gom 30	0.47 bc	0.29 b	0.179 abc	0.395 ab
WYCYT-17 (Line)	0.53 abc	0.33 a	0.176 abc	0.458 a
WYCYT-18 (Line)	0.67 a	0.27 bc	0.170 bc	0.389 ab
KHERI (Local)	0.53 abc	0.28 bc	0.167 c	0.352 bc
LSD$_{(0.05)}$	0.166	0.029	0.139	0.0761
CV(%)	17.92	6.37	4.45	11.89

All determinations were done three times for each genotype

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability.

4.3.4 Phosphorus content

Statistically significant variation was recorded in terms of phosphorus content due to different wheat genotypes (Appendix IV). The highest phosphorus content (0.458%) were recorded from WYCYT-17 (Line) which was statistically similar (0.395% and 0.389%) by BARI Gom 30 and WYCYT-18 (Line) and closely followed (0.352%) by KHERI (Local), while the lowest phosphorus content (0.262%) was recorded from BARI Gom 29 which was statistically similar (0.298%) to BARI Gom 28 (Table 3). Wieser (2007) reported high values of phosphorus content (0.449%) in different genotypes of wheat.

4.3.5 Zinc content

Different wheat genotypes showed statistically significant differences in terms of zinc content (Appendix V). The highest zinc content (33.40 ppm) were found from BARI Gom 29 which was statistically similar (32.87 ppm and 32.33 ppm) by BARI Gom 28 and BARI Gom 30, whereas the lowest zinc content (30.33 ppm) was observed from KHERI

(Local) which was statistically similar (30.80 ppm and 31.40 ppm) to WYCYT-17 (Line) and WYCYT-18 (Line) genotypes (Figure 2).

Figure 2. Effect of different genotypes on zinc content of wheat

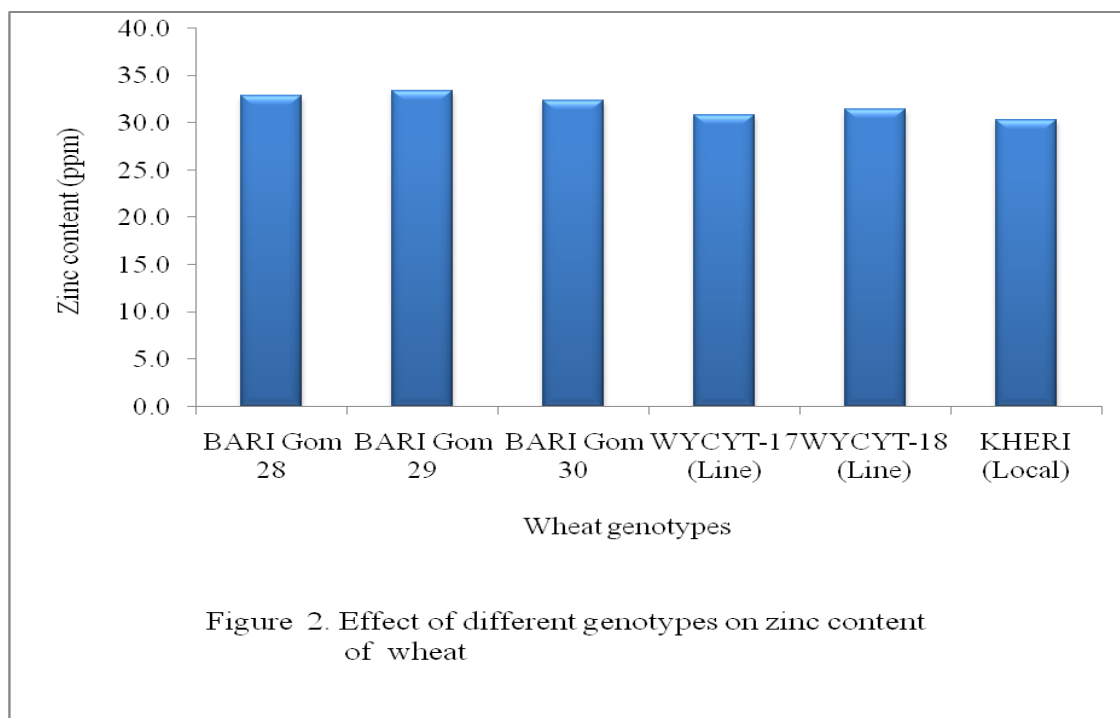### 4.3.6 Boron content

Statistically significant variation was recorded in terms of boron content due to different wheat genotypes (Appendix V). The highest boron content (17.50 ppm) were observed from BARI Gom 29 which was statistically similar (16.18 ppm) by BARI Gom 28 and closely followed (15.11 ppm and 14.28 ppm) by BARI Gom 30 and WYCYT-17 (Line), while the lowest boron content (13.13 ppm) was recorded from WYCYT-18 (Line) which was statistically similar (13.87 ppm) to KHERI (Local) genotypes (Table 4). BARI (1997) reported that wheat supplies necessary nutrients in trace amount.

4.3.7 Cupper content

Cupper content showed statistically significant variation for different wheat genotypes (Appendix V). The highest cupper content (13.26 ppm) were found from WYCYT-17 (Line) which was closely followed (11.97 ppm) by BARI Gom 30. On the other hand, the lowest cupper content (10.47 ppm) was observed from WYCYT-18 (Line) which was statistically similar (10.52 ppm, 10.68 ppm and 10.86 ppm) to BARI Gom 28, BARI Gom

29 and KHERI (Local) genotypes (Table 4). Wieser (2007) reported high values of cuper content (12.95%) in different genotypes of wheat.

4.3.8 Manganese content

Different wheat genotypes varied significantly in terms of manganese content (Appendix V). The highest manganese content (18.93 ppm) were recorded from BARI Gom 28 which was statistically similar (18.73 ppm, 18.40 ppm and 17.53 ppm) to BARI Gom 29, BARI Gom 30 and WYCYT-17 (Line), whereas the lowest manganese content (16.67 ppm) was recorded from KHERI (Local) which was statistically similar (17.00 ppm) to WYCYT-18 (Line) genotypes (Table 4). BARI (1997) reported that wheat supplies necessary nutrients in trace amount.

Table 4. Minor minerals content boron, cupper, manganese and iron content of different released variety, advanced lines and local variety of wheat

Name of wheat genotypes	Boron (ppm)	Cupper (ppm)	Manganese (ppm)	Iron (ppm)
BARI Gom 28	16.18 ab	10.52 c	18.93 a	254.67 a
BARI Gom 29	17.50 a	10.68 c	18.73 a	244.80 abc
BARI Gom 30	15.11 bc	11.97 b	18.40 ab	238.19 abcd
WYCYT-17 (Line)	14.28 bc	13.26 a	17.53 abc	232.84 bcd
WYCYT-18 (Line)	13.13 c	10.47 c	17.00 bc	231.88 cd
KHERI (Local)	13.87 c	10.86 c	16.67 c	221.50 d
LSD$_{(0.05)}$	1.956	0.808	1.390	18.63
CV(%)	7.69	4.34	4.45	7.72

All determinations were done three times for each genotype

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

4.3.9 Iron content

Statistically significant variation was recorded in terms of iron content due to different wheat genotypes (Appendix V). The highest iron content (254.67 ppm) were found from BARI Gom 28 which was statistically similar (244.80 ppm and 238.19 ppm) to BARI Gom 29 and BARI Gom 30, while the lowest iron content (221.50 ppm) was recorded from KHERI (Local) which was statistically similar (231.88 ppm and 232.84 ppm) to WYCYT-18 (Line) and WYCYT-17 (Line) genotypes (Table 4). Uhlen *et al*. (2004) reported high values of iron content (261.33 ppm) in different genotypes of wheat.

CHAPTER V

SUMMARY AND CONCLUSION

CHAPTER V

SUMMARY AND CONCLUSION

The experiment was conducted during the period from August to December 2016 at the laboratory of Biochemistry Department of Sher-e-Bangla Agricultural University (SAU), Dhaka and Soil Science laboratory of Bangladesh Agriculture Research Institute, Joydebpur, Gazipur, Dhaka to find out the effect of different wheat genotypes on proximate composition. Six wheat genotypes as- BARI Gom 28, BARI Gom 29, BARI Gom 30, WYCYT-17 (Line), WYCYT-18 (Line) and KHERI (Local) were used as treatment for this experiment.

The highest weight of 1000 grains (46.40 g) was recorded from BARI Gom 29, whereas the lowest weight of 1000 grains (39.20 g) was recorded from KHERI (Local). The highest moisture content (9.61%) were found from WYCYT-17 (Line) and the lowest moisture content (7.51%) was observed from BARI Gom 30. The highest dry matter content (92.49%) were observed from BARI Gom 30, while the lowest dry matter content (90.39%) was found from WYCYT-17 (Line). The highest protein content (15.54%) were found from BARI Gom 29, whereas the lowest protein content (13.18%) was recorded from WYCYT-17 (Line). The highest lipid content (2.23%) were recorded from BARI Gom 29 and the lowest lipid content (1.77%) was observed from WYCYT-18 (Line. The highest ash content (2.36%) were recorded from BARI Gom 29, while the lowest lipid content (1.84%) was recorded from WYCYT-17 (Line). The highest carbohydrate content (69.55%) were observed from WYCYT-18 (Line), whereas the lowest carbohydrate content (64.83%) was found from BARI Gom 29. The highest crude fiber content (15.04%) were recorded from BARI Gom 29 and the lowest crude fiber content (13.28%) was recorded from WYCYT-18 (Line).

The highest calcium content (0.67%) were observed from WYCYT-18 (Line), while the lowest calcium content (0.40%) was found from BARI Gom 28. The highest magnesium content (0.33%) were recorded from WYCYT-17 (Line), whereas the lowest magnesium content (0.26%) was observed from BARI Gom 29. The highest potassium content (0.197%) were found from BARI Gom 28 and the lowest potassium content (0.167%)

was observed from KHERI (Local). The highest phosphorus content (0.458%) were recorded from WYCYT-17 (Line), while the lowest phosphorus content (0.262%) was recorded from BARI Gom 29. The highest zinc content (33.40 ppm) were found from BARI Gom 29, whereas the lowest zinc content (30.33 ppm) was observed from KHERI (Local). The highest boron content (17.50 ppm) were observed from BARI Gom 29, while the lowest boron content (13.13 ppm) was recorded from WYCYT-18 (Line). The highest cupper content (13.26 ppm)   Z was found from WYCYT-17 (Line) and the lowest cupper content (10.47 ppm) was observed from WYCYT-18 (Line). The highest manganese content (18.93 ppm) was recorded from BARI Gom 28, whereas the lowest manganese content (16.67 ppm) was recorded from KHERI (Local). The highest iron content (254.67 ppm) was found from BARI Gom 28, while the lowest iron content (221.50 ppm) was recorded from KHERI (Local).

Recommendations:

1. Further analysis of different wheat genotypes should be done to know their comparative status of nutritional value.

2. Nutritional analysis is also replicated more than three times using different instrument.

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APPENDICES

Appendix I.   Monthly record of air temperature, relative humidity, rainfall, and sunshine (average) of the experimental site during the period from August to December 2016

Month (2016)	Air temperature (^{0}c)		Relative humidity (%)	Rainfall (mm)	Sunshine (hr)
	Maximum	Minimum			
August	36.0	23.6	81	319	4.0
September	34.8	24.4	81	279	4.4
October	26.5	19.4	81	22	6.9
November	25.8	16.0	78	00	6.8
December	22.4	13.5	74	00	6.3

Source: Bangladesh Meteorological Department (Climate & weather division) Agargoan, Dhaka–1207

Appendix II.   Analysis of variance of the data on weight of 1000 grains, moisture and dry matter content as influenced by genotypes

Source of variation	Degrees of freedom	Mean square		
		Weight of 1000 seeds (g)	Moisture (%)	Dry matter (%)
Between	5	22.061**	4.910**	310.603**
Within	12	2.217	0.092	44.651

** Significant at 0.01 level of probability;

Appendix III.   Analysis of variance of the data on protein, lipid, ash and crude fiber content as influenced by genotypes

Source of variation	Degrees of freedom	Mean square				
		Protein (%)	Lipid (%)	Ash (%)	Carbohy-drate	Crude fiber (%)
Between	5	3.956*	0.076*	0.178**	18.456**	3.123*
Within	12	1.309	0.023	0.069	1.452	1.003

** Significant at 0.01 level of probability;   * Significant at 0.05 level of probability

Appendix IV. Analysis of variance of the data on major minerals calcium, magnesium, potassium and phosphorus content as influenced by genotypes

Source of variation	Degrees of freedom	Mean square			
		Calcium (%)	Magnesium (%)	Potassium (%)	Phosphorus (%)
Between	5	0.026*	0.617**	1.950*	1.136**
Within	12	0.009	0.028	0.630	0.189

** Significant at 0.01 level of probability;   * Significant at 0.05 level of probability

Appendix V. Analysis of variance of the data on minor minerals zinc boron, cupper, manganese and iron content as influenced by genotypes

Source of variation	Degrees of freedom	Mean square				
		Zinc (ppm)	Boron (ppm)	Cupper (ppm)	Manganese (ppm)	Iron (ppm)
Between	5	3.767**	7.876**	7.340**	1.950*	437.728**
Within	12	0.427	1.248	0.213	0.630	113.195

** Significant at 0.01 level of probability;   * Significant at 0.05 level of probability