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Comparative Study between Three Sudanese Wheat Varieties Grown in Wad Madani, Sudan

Widad Hassan Abdalhaleem[1], Amani Algali Alawad[1], Ahlam.S.Mohamed[1,2] and Khadiga G. Abd Elaleem[3,4]

[1]Department of Research Services, Industrial Research and Consultancy Centre P.O. Box 268, Khartoum, Sudan
[2]Department of Biology, University College at Qaria Alolya, Hafr Elbatin University, Saudi Arabia
[3] Departments of Biology and Biotechnology, AL Neelain University / Faculty of Science and Technology, Khartoum/ Sudan
[4]Department of Biology, University College in Alkhafji, Hafr Elbatin University, Saudi Arabia

Correspondence Author: Dr. Khadiga Gaafar Abd Elaleem, Department of Biology, University College in Alkhafji, Hafr Elbatin University, Saudi Arabia.
E-mail:khadigaalaim@hotmail.com

Abstract**—** *The objective of this study is to assess and compare the chemical composition of grain and flour of three Sudanese heat tolerant wheat varieties grown in Wad Madani, Sudan, namely; Imam, Gumria and Zkia. Heat stress in sub-Saharan Africa is a major constraint on wheat production. Heat-tolerant wheat varieties, developed by scientists at the International Center for Agricultural Research in the Dry Areas (ICARDA) and Sudan's Agricultural Research Corporation (ARC), are helping farmers to adapt this situation, bringing higher and more stable yields. Farmers across the wheat-producing regions of Sudan are now achieving up to sixty \ha over successive growing seasons. Proximate analysis was performed by determining of the moisture content, crude protein, ash content, crude fat, crude fiber and carbohydrates content. Rheological analysis was performed by determining of wet, dry and index of gluten, and alpha– amylase activity. The results showed that Wheat moisture content was highest in Zkia (7.69) followed by Gumria (7.55) and Imam (7.35). Flour moisture content was highest in Gumria (8.6) followed by Zkia (8.3) and Imam (8.1). Wheat protein content was highest in Gumria (14.098) followed by Zkia (13.699) and Imam (13.566). Flour protein content was highest in Gumria (11.92) followed by Imam (11.837) and Zkia (11.837). Wheat ash content was highest in Gumria (1.66) followed by Zkia (1.48) and Imam (1.45). Flour ash content was highest in Imam (1.1) followed by Gumria (1.01) and Zkia (0.90). Wheat oil content was highest in Gumria (2.90) followed by Zkia (2.40) and Imam (2.01). Flour oil content was highest in Gumria (2.03) followed by Zkia (1.80) and Imam (1.71). Wheat crude fiber content was highest in Imam (1.90) followed by Gumria (1.70) and Zkia (1.50). Flour crude fiber content was highest in Gumria (1.18) followed by Zkia (1.08) and Imam (0.95).Wheat carbohydrates content was highest in Imam (73.724), followed by Zkia (73.231) and Gumria (72.092). Flour Carbohydrates content was highest in Zkia (78.83) followed by Imam (76.303) and Gumria (75.26). Rheological analysis such as wet gluten of wheat was higher in Imam (38.5) followed by Gumria (34.8.) and Zakia (34.1), similar to the flour, Imam (36.2) was higher followed by Gumria (34.4) and Zakia (33.71), dry gluten of wheat was higher in Imam (15.2) followed by Gumria (11.3) and Zakia (10.3), similar to the flour, Imam (14.1) was higher followed by Gumria (10.8) and Zakia (10.4), Gluten index of wheat was higher in Imam (75.8) followed by Zakia (62.0) and Gumria (60.6), similar to the flour Imam (72.2) was higher followed by Gumria (63.0) and Zakia (60.3), Falling no. of wheat was higher in Gumria (586) followed by Zakia (578) and Imam (5378), while in flour Imam (680) was higher followed by Zakia (636), and Gumria (427). In conclusion all the three varieties are largely identical to standard of Sudanese Standard and Metrological Organization (SSMO 037/2007).*

Keywords**— Chemical composition, Proximate analysis, Rheological analysis, Sudanese cultivars, Wheat.**

I. INTRODUCTION

Wheat is an important and most widely cultivated food crop in the world. This crop played a central role in combating hunger and improving the global food security. Wheat is ranked second in total cereal production behind corn, with rice being the third, FAO [1]. The grains of this plant provide about 20% of all calories and proteins consumed by people on the globe (Shiferaw *et al*. [2]). In

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Sudan, wheat is the second most essential cereal food and the main staple food for many peoples in both rural and urban areas. This crop is traditionally cultivated in the northern region of Sudan where the winter conditions are favorable for plant growth and grain yield. However, in the last decade's wheat cultivation in Sudan expanded southward to latitudes lower than 15°N, entering a new and warmer environment and inhabiting most of the irrigated sectors in central and northern states (Elsheikh *et al* [3]). The rate of wheat grain production in the Sudan is far below the consumption needs. High temperature and drought stresses, low nitrogen content, and lack of quality seeds of improved varieties are the main constraints limiting wheat production in Sudan (Ali *et al*. [4] and El Siddig *et al*. [5]). To overcome these limitations wheat breeders have developed several varieties and inbred lines with enhanced tolerance to most of these stresses (Elahmadi [6] and Ali *et al* [4]), and with better grain yield and quality. Although the grain yield of these advanced wheat lines have been extensively studied by many researchers, reports on the end-use quality of these lines are rare (Ali *et al*. [4]). In recent years, demand for wheat has significantly increased as a result of the global population growth, and thus wheat production has a strategic role in food security and the world economy. As a result, horizontal expansion of wheat production has arisen in recent years by moving wheat into nontraditional areas formerly considered unacceptable for production. However, the global warming introduced various abiotic stresses such as drought, temperature extremes, and salinity that adversely affect the yield and grains quality of wheat (Huseynova and Rustamova [7]). To meet the demands of future population's explosions and ensure grain production in these environments, cultivars must be developed and evaluated for their high yield and high quality. Thus, the objective of wheat breeders is to produce well-adapted and high-yielding varieties with finest end use quality (Lopes *et al* [8] and Li *et al* [9]).
Therefore, the primary objective of this study was to assess and compare the chemical composition of wheat grain and flour of three Sudanese heat tolerant varieties grown in Wad Madani, Sudan, namely; Imam, Gumria and Zkia.

II. MATERIALS AND METHODS

2.1. SOURCE OF PLANT MATERIALS:

Three local wheat varieties namely; Imam, Gumria and Zkia were obtained from Wad Madani Agricultural Research Station, Agricultural Research Corporation, Sudan.

2.2. METHODS

2.2.1. SAMPLE PREPARATION

22.1.1. CLEANING:

Wheat samples were cleaned by aspiration sieving, manual separation of impurities by hand. The seeds were sieved by 2.8 mm to have uniform seeds and removing small grains.

2.2.1.2. MILLING:

Whole meal wheat flour was obtained by milling 500 g of wheat in tecator-mill through 0.4 mm sieve. Wheat grains (1 kg sample) were conditioned to 13% moisture for 24 hours, water to be added was calculated according to the general equation below: Water to be added (ml) to raise moisture to 13% = $\left[\frac{100-grain\ moisture}{100-moisture\ required\ (13\%)}\right]$-1 x 1000

The conditioned and tempered grains were milled in qyadramat junior mill using nylon sieve 160 mesh.

2.2.2. PROXIMATE ANALYSIS:

The proximate analysis Moisture content, crude protein Ash content, crude fat, crude fiber, and carbohydrate content) were determined using the procedure described by Association of Official Analytical Chemists (AOAC, [10]).

2.2.3. RHEOLOGICAL ANALYSIS

2.2.3.1. DETERMINATION OF GLUTEN

Gluten was determined according to International Association for Cereal Chemistry ICC Standard method, 1986. Ten grams of flour were mixed with 5.2 ml distilled water for 20 seconds in a test chamber with bottom sieve. The dough was first washed with 2% Na Cl for 15 minutes and then with distilled water in a test chamber which is automatically controlled. The gluten ball obtained was centrifuged for a minute and then weighed to give the wet gluten. It was then dried in a glutrok heater to give the dry gluten (the weight of gluten obtained was multiplied by 10 to give the percentage of gluten).

2.2.3.2. WET GLUTEN

Gluten quantity and quality were carried on wheat flour according to standard ICC method (1986), ICC [11] by using Glutomatic instrument (Type 2000),

2.2.3.3. DRY GLUTEN

Gluten quantity and quality were carried on wheat flour according to standard ICC method (1986) ICC [11] by using Glutomatic instrument (Type 2000).

2.2.3.4. GLUTEN INDEX

Gluten quantity and quality were carried on wheat flour according to standard ICC method (1986) ICC [11] by using Glutomatic instrument (Type 2000).

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2.2.4. FALLING NO.

Alpha – amylase activity was carried according to International Association for Cereal Chemistry ICC Standard method, 1986 ICC [10].

2.2.5 STATISTICAL ANALYSIS

Triplicates of each sample were analyzed using statistical analysis system. The analysis of variance was performed to examine the significant effect in all parameters measured least significant difference (LSD) test was used to separate the means, all statistical tests were carried out using the SPSS Statistical program.

III. RESULTS AND DISCUSSIONS

3.1. PROXIMATE ANALYSIS:

3.1.1. MOISTURE CONTENT:

The proximate composition of wheat grain and floor is shown in Fig (1). In comparison between grain and flour for the three studied varieties, we note that the highest moisture content recorded by the accurate category Gumria flour (8.6) followed by Imam (8.1), while the lowest moisture content recorded obtained Zekia flour (6.3). On the other hand moisture content obtained in wheat grain was ranged from (7.69) in Zkia followed by Gumria (7.55) and Imam (7.35) with significant difference. These results are lower than those reported by Mutwali [12], who reported a range of moisture were ranged from (10.21 to 13.13) for several Sudanese wheat cultivars grown in three different locations. These above results agree with Sudanese Standard and Metrological Organization (SSMO 037/2007) that recommended moisture content does not exceed 13.5%.

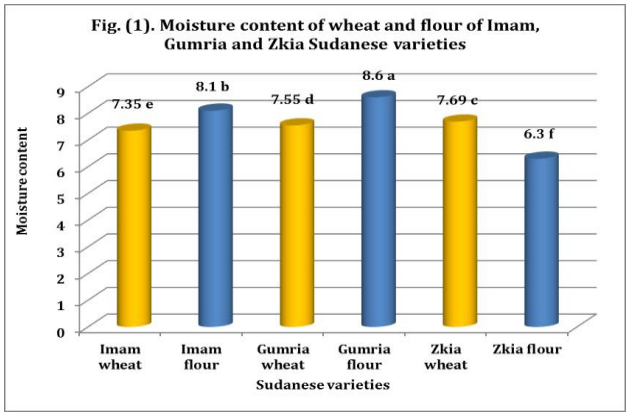

Fig 1: Moisture content of wheat and flour of Imam, Gumria and Zkia Sudanese varieties.

3.1.2. PROTEIN CONTENT:

Fig (2) Shown the Protein content, grain protein is of primary importance in determining the bread making quality of wheat. Wheat grain protein content was highest in Gumria (14.098), followed by Zkia (13.699) and then Imam (13.566). Flour protein content were (11.92, 11.837and 11.837) for Gumria, Imam and Zkia respectively, with a significant difference. The results of Imam protein content of wheat flours was near to what was found by Ali [13], as (13.70%, 13.81%) respectively. These results are higher than that reported by Ahmed [14] and Mohammed [15] who found that the fiber contents for whole wheat were in the range of 1.75 to 2.34 and 1.85 and 2.25% respectively. These above results agree with Sudanese Standard and Metrological Organization (SSMO 037/2007) that recommended lowest recommended protein content 11%.

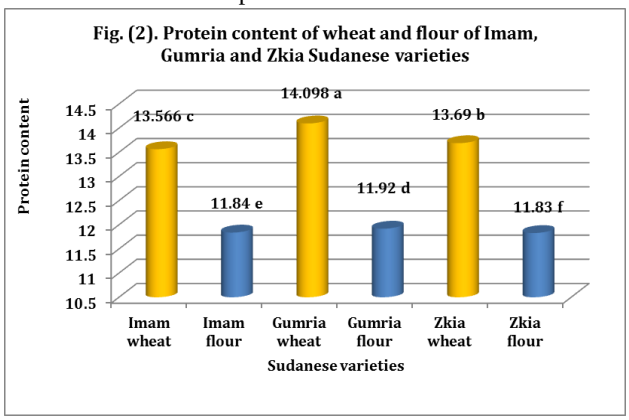

Fig 2: Protein content of wheat and flour of Imam, Gumria and Zkia Sudanese varieties.

3.1.3. ASH CONTENT:

Fig (3) showed Ash content: Ash content has been considered an important indicator of flour quality. It gives some indication of the miller's skill and the degree of refinement in processing and it is directly related to the amount of bran in the wheat, and hence has a rough inverse relationship to flour yield (Zeleny [16]). Wheat ash content was highest in Gumria (1.66) , followed by Zkia (1.48) and then Imam (1.45) , on the other hand Ash content of wheat four was low (1.1.1.01 and 0.9) for Imam, Gumria and Zkia respectively.

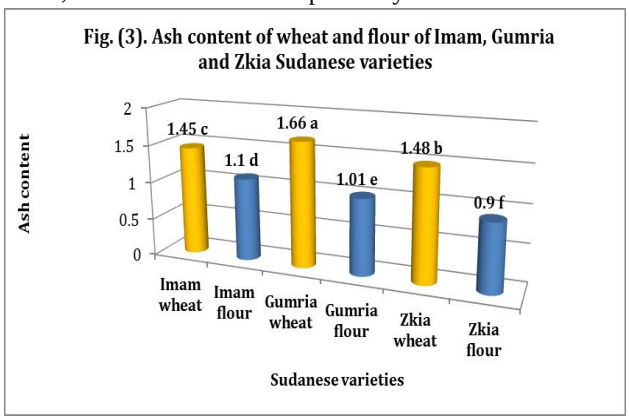

Fig 3: Ash content of wheat and flour of Imam, Gumria and Zkia Sudanese varieties.

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These results were higher than those reported by Mutwali [12] who found that the ash content of 20 Sudanese wheat cultivars was ranged between 0.47 to 0.85%. However, Sudanese Standard and Metrological Organization (SSMO 037/2007) recommended that ash content of whole flour does not exceed 1.7%.

3.1.4. OIL CONTENT:

The findings of the current study as shown in Fig (4) indicated that the oil content of wheat grain and flour are ranged from 2.9-2.01 and 2.03- 1.71, respectively. Wheat oil content was highest in wheat grain of Gumria (2.90) followed by Zkia (2.40) and Imam (2.01) (fig.4). Flour oil content was high in Gumria (2.03) followed by Zkia (1.80) and Imam (1.71) with a significant difference.

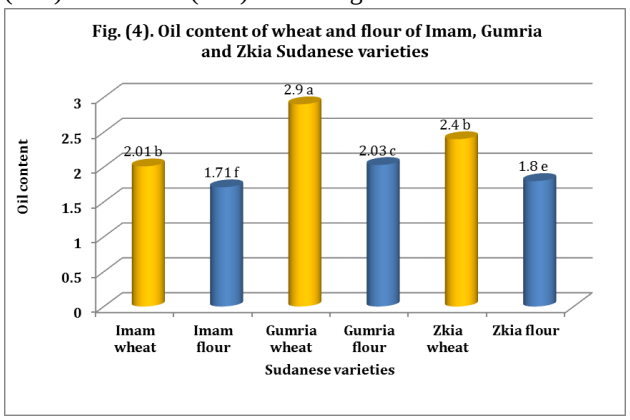

Fig 4: Oil content of wheat and flour of Imam, Gumria and Zkia Sudanese varieties.

3.1.5. CRUDE FIBER CONTENT:

Wheat crude fiber content as shown in Fig (5) was highest in Imam (1.90) followed by Gumria (1.70) and Zkia (1.50). Flour crude fiber content was highest in Gumria (1.18) followed by Zkia (1.08) and Imam (0.95) with a significant difference. These results were near to that reported by Ahmed [14] and Mohammed [15] who found that the fiber contents for whole wheat were in the range of 1.75% to 2.34%.

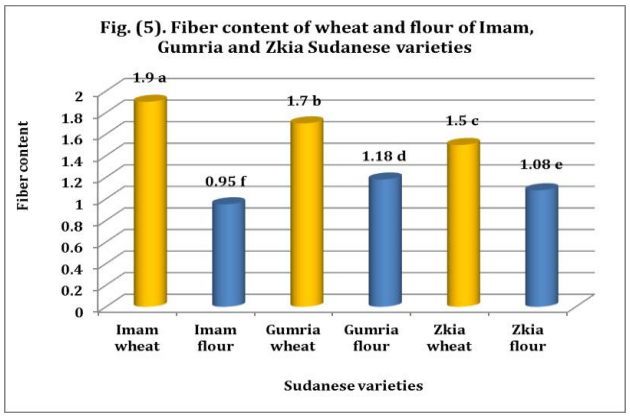

Fig 5: Fiber content of wheat and flour of Imam, Gumria and Zkia Sudanese varieties.

3.1.6. CARBOHYDRATES CONTENT

As general floor carbohydrate content is higher than wheat grain carbohydrate content. Flour Carbohydrates content was highest in Zkia (78.83) followed by Imam (76.303) and Gumria (75.26). Wheat grain Carbohydrates content was high in Imam (73.724), followed by Zkia (73.231) and Gumria (72.092) as shown in Fig (6) with a significant difference.

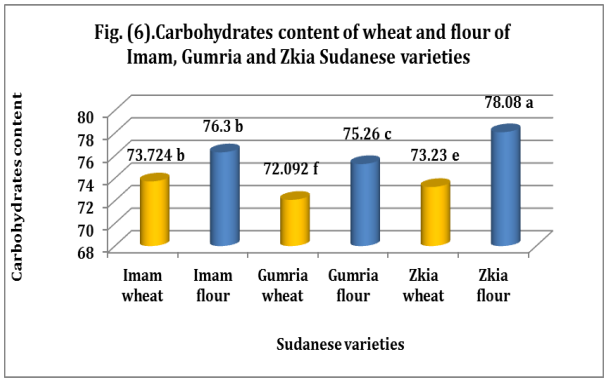

Fig 6: Carbohydrates content of wheat and flour of Imam, Gumria and Zkia Sudanese varieties.

3.2. RHEOLOGICAL ACTIVITIES

3.2.1. WET GLUTEN

Rheological analysis such as wet gluten of wheat grain and flour was studied, wet gluten of wheat grain was highest in Imam (38.5) followed by Gumria (34.8.) and Zakia (34.1), while in flour Imam wet gluten is (36.2) followed by Gumria (34.4) and Zakia (33.71) with a significant difference as shown in Fig (7). The wet gluten content agreed with Pakistan spring cultivars which ranged between 28.47% and 38.83% (Khan *et al* [17]). Moreover, Mutwali [12] reported that the wet gluten value of 20 Sudanese cultivars is ranged between 28.63% and 46.94%. However, Sudanese Standard Specifications (SDS) (SDS 036/2007) (SSMO 037/2007) that recommended the lowest Gluten content 27% for bread making.

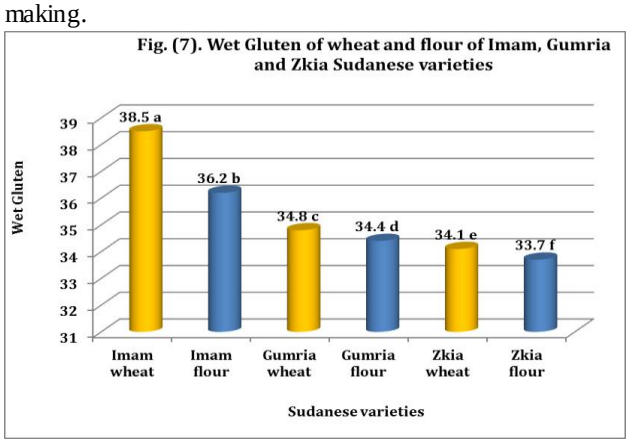

Fig 7: Wet Gluten of wheat and flour of Imam, Gumria and Zkia Sudanese varieties.

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3.2.2. DRY GLUTEN

Dry gluten of wheat grain was highest in Imam (15.2) while in Gumria was (11.3) and Zakia (10.3), while in flour Imam dry gluten was (14.1) followed by Gumria (10.8) and Zakia (10.4) with a significant difference as shown in Fig (8). These result is disagree with, Mutwali [12] reported that the wet gluten value of 20 Sudanese cultivars is ranged between 28.63% and 46.94%, this may due to varied in cultivars.

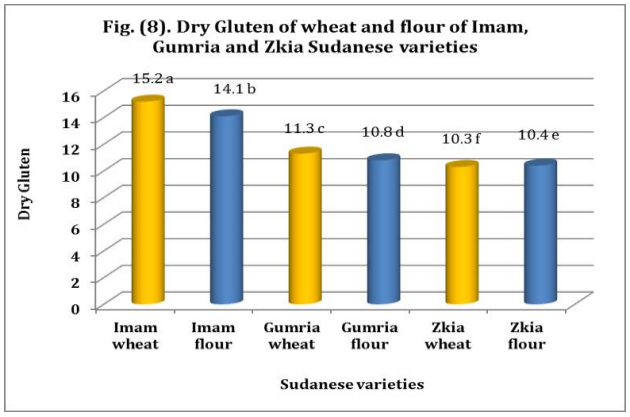

Fig 8: Dry Gluten of wheat and flour of Imam, Gumria and Zkia Sudanese varieties.

3.2.3. GLUTEN INDEX

Gluten index of wheat grain was higher in Imam (75.8) followed by Zakia (62.0) and Gumria (60.6), while in flour Imam gluten index was (72.2) followed by Gumria (63.0) and Zakia (60.3) as shown in Fig (9), with a significant difference. These results of Imam gluten index in agreed with (Ali, [13]) who postulated that Imam Wheat flour gluten index (75.87%).

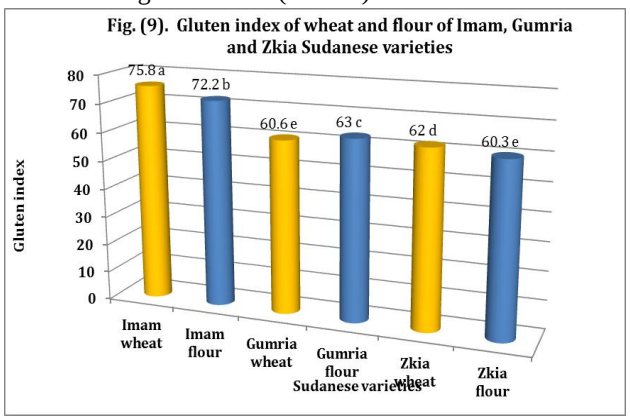

Fig 9: Gluten index of wheat and flour of Imam, Gumria and Zkia Sudanese varieties.

3.3. FALLING NUMBER

Falling No. of wheat grain was higher in Gumria (586) followed by Zakia (578) and Imam (537), while in flour falling number of Imam was (680) followed by Zakia (636), followed by Gumria (427) as shown in Fig (10) with a significant difference. The falling numbers to great extend agreed with the range of 508 to 974 sec that reported by Mutwali [12] for 20 Sudanese wheat cultivars. And agree with Mohammed [15] found that the falling number of four Sudanese wheat cultivars (Debaira, Alneelain, Condor and Sasaraib) ranged between 425 and 675sec. The falling number above 400 sec indicated that there is deficient alpha amylase and that the flour should be supplemented with alpha amylase to the desirable level of enzyme activity (Cauvain and Young [18]). These results agree with Sudanese Standard and Metrological Organization (SSMO 037/2007) that recommended falling number must be not less than 250sec.

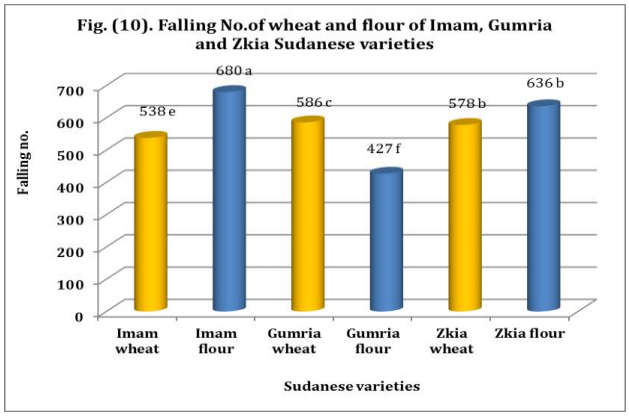

Fig 10: Falling number of wheat and flour of Imam, Gumria and Zkia Sudanese varieties.

IV. CONCLUSION

In conclusion all the three varieties are largely identical to standard of Sudanese Standard and Metrological Organization (SSMO 037/2007).

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