



## PHYSICAL AND CHEMICAL PROPERTIES OF FOUR IMPORTED WHEAT TO EGYPT

Ayman H. El-Naggar<sup>1\*</sup>, M.A. Abed El-Samie<sup>2</sup> and S.I. Ghoneim<sup>2</sup>

1. Agricultural Quarantine, Ministry of Agriculture, Egypt.
2. Dept. Food and Dairy Sci. and Technol., Fac. Environ. Agric. Sci., Arish Univ., Egypt.

### ABSTRACT

Wheat is one of the most important cereal crops in Egypt. It is consumed at a high level to feed the Egyptian individual because it is relatively cheap compared to other carbohydrate sources. The domestic production of wheat is still insufficient to meet the consumer needs, which increased the food gap of wheat. The overall objective of the present study was to compare and evaluate the wheat of different origins imported to Egypt, and to check the safety of that wheat's to be consumed in Egypt. In this study wheat samples imported from four origin countries including France, Romania, Russia and Ukraine, within five importing intervals including (July-August/2014), (September-October/2014), (November-December/2014), (January-February/2015) and the (March-April/2015), used to evaluate imported wheat to Egypt by several tests like moisture content, test weight, falling number, protein content, shrunken and broken grains and insect damaged kernels.. In general the Ukrainian wheat was the best among all other wheat originated from France, Romania and Russia, Ukrainian wheat came in the first place in three tests i.e. moisture content, that ranged from 10.88% to 12.43% with an average of 11.46%, test weight, ranged from 78.77 to 80.57 kg hl<sup>-1</sup> with an average of 79.70 kg hl<sup>-1</sup> and falling number, ranged from 322.0 to 412.0 sec with an average of 360.47 sec., and came in the second order in other tests as, protein content, which ranged from 12.21 to 13.67% with an average 12.80%, shrunken and broken grains ranged from 0.746 to 1.925% with an average of 1.115%. Ukrainian wheat came in the third order in one test like, insect damaged kernels, which ranged from 0.651 to 0.883% with an average of 0.761%.

**Key words:** Wheat, chemical and physical properties, test weight, shrunken and broken grains, insect damaged kernels, moisture content, falling number, and protein content.

### INTRODUCTION

Wheat is an important cereal crop world widely as its cultivated area and the amount of produced crop are important issues. Wheat is an important crop because 2.45 billion people (35 percent of the world's population) all over the world depends on it as the main staple food and about 30 million people are engaged in wheat cultivation (Lumpkin, 2011). Wheat is considered the greatest importance among cereals because of its processing

characteristics; it is basically classified into hard, soft, and durum categories. Wheat quality cannot be simply defined since it changes depending on the workers (from the farmer to those in the processing industry) and end use (from flour to bread, pasta, or cookies) (Posner and Hibbs, 2005). Wheat grain is an excellent staple food with numerous nutritional and health-beneficial compounds (Kimball *et al.*, 2001; Zhao *et al.*, 2009). The nutritional value of wheat is extremely important as it takes an important place among the few

\* Correspondence Author: +201004214948

Email: aimannagar@yahoo.com

crop species being extensively grown as staple food sources. The importance of wheat is mainly due to the fact that its seed can be ground into flour; semolina *etc.* which forms the basic ingredients of bread and other bakery products, as well as pasta and thus it presents the main sources of nutrients to the most of the world populations (**Sramkova *et al.*, 2009**).

Physical evaluation of the wheat kernels offers a first and interesting quality control for selection as raw materials because the kernel physical features are related with design of equipment, handling, aeration and storage as well as to end use. Increasingly, analyses are implemented to assess the inherent characteristics of the grain to better know their attributes. The study of wheat kernel characteristics is necessary because new cultivars (with new and different properties) are constantly being bred and produced (**Babić *et al.*, 2011**). **El-Fawal *et al.* (2009)** cited that the physical quality of the kernel plays an important role for identifying the engineering characteristics of cereal crop grains.

Test weight has been used as a quality parameter of cereals in a large number of countries and is still employed to determine the price level (**Kleijer *et al.*, 2007**). Wheat grading systems strongly rely on HLM (Hectoliter mass) as a guide to wheat grain quality. Producers are remunerated according to the HLM value of their wheat before other factors such as protein content is taken into consideration. An increase in HLM results in a higher allocated grade and subsequently in a higher price per ton of wheat unless other grade determining factors such as protein. The HLM values of sound wheat normally vary from 70 to 85 kg hl<sup>-1</sup>, but can be higher or lower due to environmental conditions and insect damage (**Manley *et al.*, 2009**). The individual grading factors that were determined by FGIS were dockage, actual dockage, moisture, test weight per bushel, total damaged kernels, foreign material, shrunken

and broken kernels, total defects, and total fusarium (scab) damage (**Odette *et al.*, 1985**).

One of the most relevant wheat kernel quality parameters is insect damage. This particular assessment is considered one of the most critical degrading factors (**El-Naggar and Mikhael, 2011**), because it relates to flour yield and color and increases the amounts of insect fragments present in flours and processed products which are considered as one of the most important quality factors related to food sanitation. Presence of insects induces losses in quantity and quality by insect consumption, grain weight loss, contamination (toxicity) with excrement, bodily fragments and chemical secretions that disfavor flour flavor and odor. In addition, insects increase heat and kernel moisture due to their metabolic activity. The potent enzymes produced by insects and by the grain respiration system are known to negatively affect milling and baking qualities (**Singh *et al.*, 2010; Brabec *et al.*, 2015**).

Determining moisture content is an essential first step in analyzing wheat or flour quality since this data is used for other tests. Flour millers adjust the moisture in wheat to a standard level before milling (**Husejin *et al.*, 2008**). Wheat or flour with low moisture content is more stable during storage. Moisture content can be an indicator of profitability in milling (**Trajković *et al.*, 1983**).

**Hagberg (1960,1961) and Perten (1964)** developed the falling number method as a simple and rapid technique for determining  $\alpha$ -amylase activity using wheat meal as the native substrate. Subsequently, this method has become the international standard (**ICC, 1968; AACC, 1972**) that is used widely in grain classification, quality control and marketing. Grain with a low falling number due to high  $\alpha$ -amylase activity causes substantial economic losses to growers, significant processing and storage problems and is generally reflected

in poorer quality end-products (Derera, 1989; Edwards *et al.*, 1989). Protein content is one of the most important standards for measuring wheat quality (Natalja *et al.*, 2016). Protein content is traditionally recognized as the most influential factor affecting wheat bread making quality (Shewry *et al.*, 1986). The importance of protein content lies in the ability of gluten to produce dough with the desired rheological properties (Ktenioudaki *et al.*, 2010). A wide gap in self-sufficiency between the production and consumption of food occurred in the light of the increasing population, rising standards of living, declining of trade in food grains and high prices in the market (Gerber, 2014).

## MATERIALS AND METHODS

Four types of imported wheat were used in their assessment, namely French wheat, Romanian wheat, Russian wheat and Ukrainian wheat. Samples were drawn from imported wheat shipments when they reached the ports of (Alexandria, El Dekhela and Damietta), the biggest ports in Egypt receiving imported wheat. The samples drawn in five importing intervals including 1<sup>st</sup> interval (July-August/2014), 2<sup>nd</sup> interval (September-October/2014), 3<sup>rd</sup> interval (November-December/2014), 4<sup>th</sup> interval (January-February/2015) and the 5<sup>th</sup> interval (March-April / 2015).

### Test Weight

Test weight was measured in special Seedburo Filling Hopper (model 151) according to (AACC, 2000), method No. 55-10. After cleaning and passing through specific sieves, the hopper was filled with the sample. Excess grains were scraped off with a strike. Reading was noted and result calculated as kg hl<sup>-1</sup>.

### Shrunken and Broken Grains

A shrunken and broken kernel is a grading factor for wheat. To determine shrunken and broken kernels in wheat, the

inspector places 250 grams on a 0.064 × 3/8 inch (1.626 mm × 9.545 mm) oblong-hole sieve and mechanically shakes the sieve 30 times from side to side. The machine used to sieve the sample, a Strand Sizer, with a stroke counter and always starts and stops in the same position. One complete stroke takes approximately 1 second (Grain Inspection Handbook, 2014).

Shrunken and broken kernels (%) =  $\frac{\text{Weight of Shrunken and broken kernels sample in 250 g} \times 4 \times 100}{1000}$

### Insect Damaged Kernels

Determine insect-damaged kernels on a representative portion of dockage free and shrunken and broken-free wheat. Insect damaged kernels are kernels bored or tunneled by insects (Grain Inspection Handbook, 2014).

Insect damaged kernels (%) =  $\frac{\text{Weight of Insect damaged kernels sample in 250 g} \times 4 \times 100}{1000}$

### Wheat Milling

Wheat samples milling through a Buhler, MLU-202, pneumatic mill according to AACC (2000) method No. 26-31.

### Moisture Content

Moisture was determined according to AACC (2000) method No. 44-19. Two grams flour was placed in preheated and weighed metallic dish and dried in a hot air oven at 130°C for 2 hours or till constant weight. The loss in weight was calculated as percentage of moisture content.

### Falling Number

Falling number was determined by using instrument "Falling No.1600" according to AACC (2000) method No. 02-06. A 7 gram sample of ground wheat or flour is 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 is heated in a boiling water bath at 100°C and stirred constantly, the starch gelatinizes and

forms a thick paste. The time it takes the stirrer to drop through the paste is recorded as the falling number value.

### Protein Content

Protein content of whole wheat was determined using the Kjeldahl Tecator System (AACC, 2000). The protein content can be calculated as follows:

Protein content (%) = N (nitrogen) (%) × 5.7 (stationary factor for whole wheat).

### Statistical Analysis

Data analyzed by using completely randomized design (analysis of variance) and producer using MSTAT-C package differences pattern (Michigan university, 1983). Means were compared by using each of least significant differences (LSD) (Steel and Torrie, 1980) and Duncan's multiple range test (Duncan, 1955) at the 5% level.

## RESULTS AND DISCUSSION

### Test Weight

Imported wheat samples from four origin countries including France, Romania, Russia and Ukraine, within five importing intervals including 1<sup>st</sup> interval (July-August/2014), 2<sup>nd</sup> interval (September-October/2014), 3<sup>rd</sup> interval (November-December/2014), 4<sup>th</sup> interval (January-February/2015) and the 5<sup>th</sup> interval (March-April/2015) were evaluated for their Test weight and were all recorded as kg hl<sup>-1</sup> in Table 1. From results in Table 1, It is clear that, test weight of Ukrainian wheat was the highest, comparing to all other wheat originated from France, Romania and Russia, as the Ukrainian wheat samples' Test weight ranged from (78.17 - 80.57 kg hl<sup>-1</sup>) with an average of 79.70 kg hl<sup>-1</sup> comparing to 79.47, 78.45 and 79.35 kg hl<sup>-1</sup> for Russian, Romanian and French wheat samples respectively. Within the Ukrainian wheat samples, 5<sup>th</sup> interval got the biggest

Test weight (80.57 kg hl<sup>-1</sup>) while 4<sup>th</sup> interval scored the minimum Test weight (78.17 kg hl<sup>-1</sup>). Minimum Test weight was obtained with the Russian wheat in the 3<sup>rd</sup> interval (78.11 kg hl<sup>-1</sup>) with range of (78.11- 80.49 kg hl<sup>-1</sup>) and average of 79.47 kg hl<sup>-1</sup>. Maximum Test weight of Russian wheat was 80.15 and 80.49 kg hl<sup>-1</sup> for the 2<sup>nd</sup> and 4<sup>th</sup> intervals respectively.

Test weight of the imported Romanian wheat was in the range 78.27-78.71 kg hl<sup>-1</sup> with an average of 78.45 kg hl<sup>-1</sup> which was the least Test weight comparing to all other importing country. Within this wheat samples imported from Romania, fifth interval scored the maximum Test weight (78.71 kg hl<sup>-1</sup>), followed by fourth interval with score (78.43 kg hl<sup>-1</sup>). Second and third intervals were significantly same in score (78.41 kg hl<sup>-1</sup>). Minimum Test weight in the Romanian wheat was scored by sample of first interval 78.27 kg hl<sup>-1</sup> and that was the least Test weight among all imported wheat samples.

Test weight of the imported French wheat was in the range 78.59-80.25 kg hl<sup>-1</sup> with an average of 79.35 kg hl<sup>-1</sup>. Within this wheat origin country (France) fourth interval scored the maximum Test weight (80.25 kg hl<sup>-1</sup>) followed by third interval with score (79.74 kg hl<sup>-1</sup>) second and fifth intervals came bellow with significant difference in between with (79.09 and 79.07 kg hl<sup>-1</sup>) respectively. Minimum Test weight was scored for first interval sample (78.59 kg hl<sup>-1</sup>). Looking for these data and for the information that test weight is the quantity (measured in mass or weight) of wheat that can be contained in a standard volume, so it could be concluded that Romanian is better than other wheat especially in interval one imported from July to August. and looking for importing periods, no significant differences were noticed.

**Table (1): Test weight of four imported wheat in five intervals from Jul. 2014 to Apr. 2015 (kg hl<sup>-1</sup>).**

Origin	Interval					Interval mean ± SD
	Jul. Aug.	Sep. Oct.	Nov. Dec.	Jan. Feb.	Mar. Apr.	
French Wheat	78.59 <sup>g</sup> ±0.87 <sup>l</sup>	79.09 <sup>cf</sup> ±1.10	79.74 <sup>b-d</sup> ±0.41	80.25 <sup>ab</sup> ±1.00	79.07 <sup>cf</sup> ±0.93	79.35 <sup>a</sup> ±0.97
Romanian wheat	78.27 <sup>g</sup> ±0.15	78.41 <sup>g</sup> ±0.65	78.41 <sup>g</sup> ±0.04	78.43 <sup>g</sup> ±0.57	78.71 <sup>fg</sup> ±0.52	78.45 <sup>b</sup> ±0.41
Russian wheat	79.52 <sup>de</sup> ±0.76	80.15 <sup>a-c</sup> ±1.18	78.11 <sup>g</sup> ±0.12	80.49 <sup>a</sup> ±0.15	79.09 <sup>cf</sup> ±0.42	79.47 <sup>a</sup> ±1.03
Ukrainian wheat	79.57 <sup>c-c</sup> ±0.38	80.08 <sup>a-d</sup> ±0.35	80.10 <sup>a-d</sup> ±0.20	78.17 <sup>g</sup> ±1.37	80.57 <sup>a</sup> ±0.76	79.70 <sup>a</sup> ±1.06
Interval mean ± SD	78.99 <sup>a</sup> ±0.79	79.43 <sup>a</sup> ±1.07	79.09 <sup>a</sup> ±0.91	79.34 <sup>a</sup> ±1.33	79.36 <sup>a</sup> ±0.95	79.24 ±1.01

**LSD 0.05**

Among [Origin (O.)]	Among [interval (I.)]	Interaction (O. X I.)
0.82**	0.80ns	0.63**

• Data are expressed as means (3 replicates) ±SD

• Averages of origin in the same column having the same superscripts are not significantly different, same averages in interval row which having same superscripts are not significantly different at P≤0.05.

The ranges of Romanian wheat was considered as good wheat as these results are in line with the results of **Protic et al. (2007)** who found that test weight was under 80 kg hl<sup>-1</sup>. The test weight of this wheat was also same to the Egyptian wheat which ranged from 77-78 kg hl<sup>-1</sup> (**Geoff Honey, 2010**).

**EOS (2015)** states that Test weight should not less than 74 kg.hl<sup>-1</sup>, and the results indicated that all wheat from Ukraine, Russia, Romania and France were acceptable imported wheat, and the Ukrainian wheat was the highest, comparing to all other wheat originated from France, Romania and Russia.

### Shrunken and Broken Grains

Shrunken and broken grains of wheat samples, imported from four origin countries including France, Romania, Russia and Ukraine, within five importing intervals including 1<sup>st</sup> interval (July-August/2014), 2<sup>nd</sup> interval (September-October/2014), 3<sup>rd</sup> interval (November-December/2014), 4<sup>th</sup> interval (January-February/2015) and the 5<sup>th</sup> interval (March-April/2015) were all

recorded as percentage and were presented in Table 2. Minimum Shrunken and broken grains percentage was obtained by the French wheat sample especially in the fifth interval with score (0.048%). Shrunken and broken grains percentages of the imported French wheat were in the range of 0.048 to 0.917% and an average of 0.658%.

Shrunken and broken grains of Romanian and Ukrainian wheat showed ranges of 0.849 to 1.403% and 0.746 to 1.925% and an average of 1.210 and 1.115% respectively.

Maximum Shrunken and broken grains were obtained by the Russian wheat samples with a range of 1.143 - 2.613% and an average of 1.681%, and maximum Shrunken and broken grains were that of 2<sup>nd</sup> interval (2.613%).

Fifth interval was the least average 0.959% in Shrunken and broken grains followed by third and fourth intervals and maximal scores were those of the first and second intervals with scores of 1.407 and 1.320%, respectively. This results are in agreement with the results of **Michael et al. (2005)** who reported a range of 1.4 to 1.6%

**Table (2): Shrunken and broken grains of four imported wheat in five intervals from Jul. 2014 to Apr. 2015 (%)**

Origin	Interval					Interval mean $\pm$ SD
	Jul. Aug.	Sep. Oct.	Nov. Dec.	Jan. Feb.	Mar. Apr.	
French wheat	0.741 <sup>hi</sup> $\pm$ 0.006 <sup>1</sup>	0.705 <sup>i</sup> $\pm$ 0.016	0.917 <sup>7i</sup> $\pm$ 0.040	0.880 <sup>8i</sup> $\pm$ 0.059	0.048 <sup>l</sup> $\pm$ 0.013	0.658 <sup>c</sup> $\pm$ 0.328
Romanian wheat	1.351 <sup>c-f</sup> $\pm$ 1.008	1.216 <sup>d-g</sup> $\pm$ 0.253	0.849 <sup>9i</sup> $\pm$ 0.126	1.403 <sup>c-e</sup> $\pm$ 0.061	1.233 <sup>d-g</sup> $\pm$ 0.093	1.210 <sup>b</sup> $\pm$ 0.446
Russian wheat	1.610 <sup>b-d</sup> $\pm$ 0.080	2.613 <sup>a</sup> $\pm$ 0.147	1.260 <sup>d-g</sup> $\pm$ 0.032	1.143 <sup>e-h</sup> $\pm$ 0.061	1.779 <sup>bc</sup> $\pm$ 0.026	1.681 <sup>a</sup> $\pm$ 0.543
Ukrainian wheat	1.925 <sup>b</sup> $\pm$ 0.055	0.746 <sup>hi</sup> $\pm$ 0.006	1.056 <sup>ci</sup> $\pm$ 0.007	1.075 <sup>ci</sup> $\pm$ 0.058	0.775 <sup>hi</sup> $\pm$ 0.041	1.115 <sup>b</sup> $\pm$ 0.444
Interval mean $\pm$ SD	1.407 <sup>a</sup> $\pm$ 0.627	1.320 <sup>ab</sup> $\pm$ 0.817	1.021 <sup>c</sup> $\pm$ 0.174	1.125 <sup>b</sup> $\pm$ 0.202	0.959 <sup>c</sup> $\pm$ 0.664	1.166 $\pm$ 0.570
<b>LSD 0.05</b>						
	Among [Origin (O.)]	Among [interval (I.)]	Interaction (O. X I.)			
	0.285**	0.278**	0.436**			

- Data are expressed as means (3 replicates)  $\pm$ SD
- Averages of origin in the same column having the same superscripts are not significantly different, same averages in interval row which having same superscripts are not significantly different at  $P \leq 0.05$ .

**EOS (2015)** states that Shrunken and broken grains should not exceed 5% max, and the obtained results assured that all imported wheats from Jul. 2014 to Apr. 2015 and all wheats from Ukraine, Russia, Romania and France are acceptable. French and Ukrainian wheat achieved lowest level with an average of 0.658 and 1.115%, respectively.

### **Insect Damaged Kernels**

Insect damaged kernels of wheat samples, imported from four origin countries including France, Romania, Russia and Ukraine, within five importing intervals including 1<sup>st</sup> interval (July-August/2014), 2<sup>nd</sup> interval (September-October/2014), 3<sup>rd</sup> interval (November-December/2014), 4<sup>th</sup> interval (January-February/2015) and the 5<sup>th</sup> interval (March-April / 2015) were all recorded as percentage and were presented in Table 3.

Minimum insect damaged kernels was obtained by the French wheat sample in fourth interval with score 0.026% and with a range of 0.026 to 1.233% and an average of 0.402%. Maximum insect damaged kernels were that of 3<sup>rd</sup> interval (Jan. /Feb, 2015) 1.233%.

Insect damaged kernels of Russian wheat came below French of all with range of 0.154% to 1.148% with an average of 0.434% comparing to averages of 0.761 and 0.843% for Ukrainian and Romanian wheat samples, respectively. Within the Russian wheat samples, 1<sup>st</sup> and 2<sup>nd</sup> intervals got low insect damaged kernels with similar score 0.154% while 3<sup>rd</sup> interval was the maximum insect damaged kernels 1.148%.

Insect damaged kernels of the imported Ukrainian wheat was in the range 0.651 to 0.883% with an average of 0.761%. Within this wheat origin (Ukraine) first interval scored the minimum insect damaged kernels 0.651%. Maximum insect damaged kernels were scored by sample of third interval with score 0.883 %.

Maximum insect damaged kernels were obtained by the Romanian wheat samples with a range of 0.440 to 1.192% and an average of 0.843%, and minimum insect damaged kernels were that of 1<sup>st</sup> interval 0.440%. This results are in agreement with the results of **Michael *et al.* (2005)** who reported a range of 0.7 to 1.0%.

**Table (3): Insect damaged kernels of four imported wheat in five intervals from Jul 2014 to Apr 2015 (%)**

Origin	Intervals					Interval mean ± SD
	Jul. /Aug.	Sep. / Oct.	Nov. / Dec.	Jan. / Feb.	Mar. / Apr.	
French Wheat	0.044 <sup>h</sup> ±0.0009 <sup>1</sup>	0.352 <sup>g</sup> ±0.0082	1.233 <sup>a</sup> ±0.0663	0.026 <sup>h</sup> ±0.0053	0.357 <sup>g</sup> ±0.0023	<b>0.402<sup>b</sup>±0.4552</b>
Romanian wheat	0.440 <sup>ef</sup> ±0.0138	0.872 <sup>cd</sup> ±0.0095	1.192 <sup>ab</sup> ±0.0172	0.761 <sup>cd</sup> ±0.0601	0.949 <sup>bc</sup> ±0.0044	<b>0.843<sup>a</sup>±0.2561</b>
Russian wheat	0.154 <sup>gh</sup> ±0.0206	0.154 <sup>gh</sup> ±0.0057	1.148 <sup>ab</sup> ±0.0040	0.392 <sup>fg</sup> ±0.0046	0.322 <sup>fg</sup> ±0.0057	<b>0.434<sup>b</sup>±0.3821</b>
Ukrainian wheat	0.651 <sup>de</sup> ±0.0275	0.723 <sup>cd</sup> ±0.5730	0.883 <sup>cd</sup> ±0.0523	0.710 <sup>cd</sup> ±0.2247	0.837 <sup>cd</sup> ±0.0043	<b>0.761<sup>a</sup>±0.2500</b>
Interval mean ± SD	<b>0.322<sup>c</sup>±0.2494</b>	<b>0.525<sup>b</sup>±0.3858</b>	<b>1.114<sup>a</sup>±0.1477</b>	<b>0.472<sup>bc</sup>±0.3226</b>	<b>0.616<sup>b</sup>±0.2923</b>	<b>0.610 ±0.3910</b>
<b>LSD 0.05</b>						
	<b>Among [Origin (O.)]</b>	<b>Among [interval (I.)]</b>		<b>Interaction (O. X I.)</b>		
	<b>0.1643**</b>	<b>0.1603**</b>		<b>0.2516**</b>		

- Data are expressed as means (3 replicates) ±SD
- Averages of origin in the same column having the same superscripts are not significantly different, same averages in interval row which having same superscripts are not significantly different at P≤0.05.

EOS (2015) states that Insect damaged kernels should not exceed 1.5% max. The obtained results confirmed that all imported wheats from Jul. 2014 to Apr. 2015 are acceptable, but the first interval from Jul/Aug 2014 was the best one.

### Moisture Contents

Moisture contents of wheat samples, imported from four origin countries including France, Romania, Russia and Ukraine, within five importing intervals were all recorded as percentage and were presented in Table 4 and Fig. 1

The results indicated that, moisture contents of Ukrainian wheat was the least among all other wheat originated from France, Romania and Russia, as the Ukrainian wheat samples' moisture contents ranged from 10.88% to 12.43% with an average of 11.46% comparing to 11.57, 12.34 and 12.51% for Russian, Romanian and French wheat samples, respectively. Within the Ukrainian wheat samples, 1<sup>st</sup> interval got the lowest moisture contents (10.88%) while 3<sup>rd</sup> interval was the maximum moisture content (12.43%).

Russian wheat samples' moisture contents were in harmony to the Ukrainian wheat samples with an average of 11.57%. Third and fifth intervals got the lowest moisture contents (11.47 and 11.48%) respectively, while second interval was the maximum (11.70%).

Moisture contents of the imported Romanian wheat was in the range 11.44-12.65% within an average of 12.34%. Within this wheat origin country (Romania), first interval scored the minimum moisture contents (11.44%) followed by both second and fifth intervals with no significant differences with scores (12.48 and 12.54%), respectively, maximum moisture contents were scored by samples of third and fourth intervals with scores of 12.65 and 12.60%, respectively.

Maximum moisture contents were obtained by the French wheat samples with a range of 12.15-13.00%, and an average of 12.51%. Minimum moisture contents was that of 4<sup>th</sup> and 5<sup>th</sup> intervals (12.15 and 12.21%) respectively, and maximum moisture content was that of the 1<sup>st</sup> interval (13.00%).



**Table (4): Moisture content of four imported wheat in five intervals from Jul. 2014 to Apr. 2015 (%)**

Origin	Interval					Interval mean $\pm$ SD
	Jul. / Aug.	Sep. / Oct.	Nov. / Dec.	Jan. / Feb.	Mar. / Apr.	
French Wheat	13.00 <sup>a</sup> $\pm$ 1.00 <sup>1</sup>	12.77 <sup>ab</sup> $\pm$ 1.08	12.42 <sup>a-c</sup> $\pm$ 0.07	12.15 <sup>b-e</sup> $\pm$ 0.18	12.21 <sup>b-d</sup> $\pm$ 0.05	12.51 <sup>a</sup> $\pm$ 0.66
Romanian wheat	11.44 <sup>fg</sup> $\pm$ 0.13	12.48 <sup>a-c</sup> $\pm$ 0.43	12.65 <sup>ab</sup> $\pm$ 0.09	12.60 <sup>ab</sup> $\pm$ 0.04	12.54 <sup>a-c</sup> $\pm$ 0.09	12.34 <sup>a</sup> $\pm$ 0.50
Russian wheat	11.63 <sup>d-f</sup> $\pm$ 0.25	11.70 <sup>d-f</sup> $\pm$ 0.03	11.47 <sup>e-g</sup> $\pm$ 0.13	11.58 <sup>d-f</sup> $\pm$ 0.05	11.48 <sup>e-g</sup> $\pm$ 0.08	11.57 <sup>b</sup> $\pm$ 0.15
Ukrainian wheat	10.88 <sup>g</sup> $\pm$ 0.06	11.85 <sup>c-f</sup> $\pm$ 0.06	12.43 <sup>a-c</sup> $\pm$ 0.62	11.23 <sup>fg</sup> $\pm$ 0.31	10.89 <sup>g</sup> $\pm$ 0.06	11.46 <sup>b</sup> $\pm$ 0.67
Interval mean $\pm$ SD	11.74 <sup>c</sup> $\pm$ 0.93	12.20 <sup>ab</sup> $\pm$ 0.68	12.24 <sup>a</sup> $\pm$ 0.55	11.89 <sup>a-c</sup> $\pm$ 0.57	11.78 <sup>bc</sup> $\pm$ 0.67	11.97 $\pm$ 0.70

LSD 0.05

Among [Origin (O.)]

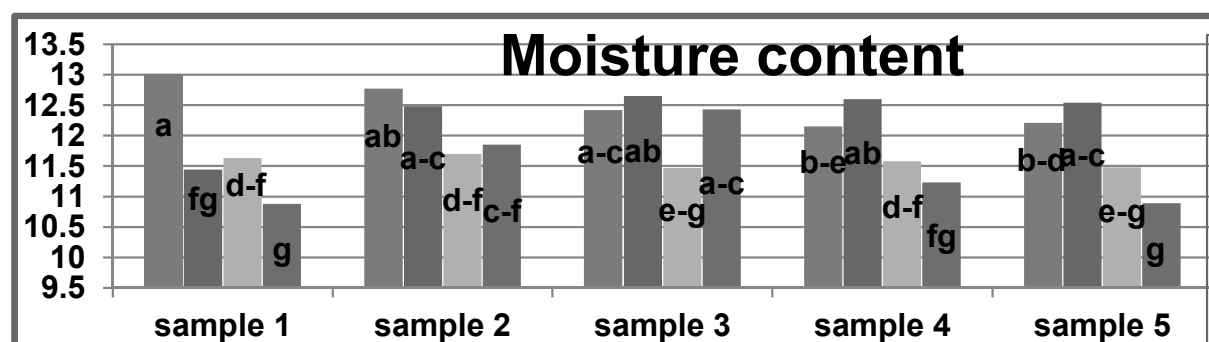
0.45\*\*

Among [interval (I.)]

0.44\*

Interaction (O. X I.)

0.69\*\*

• Data are expressed as means (3 replicates)  $\pm$ SD• Averages of origin in the same column having the same superscripts are not significantly different, same averages in interval row which having same superscripts are not significantly different at  $P \leq 0.05$ .**Fig. (1): Moisture content (%) of four imported wheat in five intervals from Jul. 2014 to Apr. 2015.**

Wheat or flour with high moisture content (greater than 14.5 percent) attracts mold, bacteria and insects, all of which cause deterioration during storage. Wheat or flour with low moisture content is more stable during storage. Moisture content can be an indicator of profitability in milling (Trajković *et al.*, 1983 Husejin, *et al.*, 2008). Temperatures between 30 and 35°C and moisture content in the grain above 15% are the conditions for the optimal development of fungi in storage (Chelladurai *et al.*, 2010).

EOS (2015) states that moisture content should not exceed 13.5% max, and the

results indicated that all intervals from Jul. 2014 to Apr. 2015 are acceptable imported wheat but the first interval from Jul./Aug 2014 is the best one.

### Falling Number

Falling Number is a test, gives an indication of the amount of sprout damage that has occurred within a wheat sample. Generally, a falling number value of 350 seconds or longer indicates a low enzyme activity and very sound wheat quality. As the amount of enzyme activity increases, the falling number decreases. Values below 200 seconds indicate high levels of enzyme activity (German, 2006).



Falling number of all imported wheat samples, imported from France, Romania, Russia and Ukraine, within five importing intervals around the year except the Egyptian wheat production intervals were all recorded in seconds and were presented in Table 5.

Results in Table 5 show that, falling number of Ukrainian and Russian wheat was the least among all other wheat originated with no significant differences between them, including wheat imported from France, Romania and Russia, Russia and Ukraine. Falling number of wheat samples imported from Ukraine was in the range of 322.0 to 412.0 sec with an average of 360.47 sec with no differences significantly with the Russian wheat which ranged from 324.67 to 397 sec with an average of 352.13sec which was both higher comparing to 325.60 and 290.40 sec for the Romanian and French wheat samples, respectively. Within the Ukrainian wheat samples, 5<sup>th</sup> interval got the maximum falling number score (412.0 sec) while 2<sup>nd</sup> interval got the minimum falling number score (322.0 sec).

Falling number of the imported Romanian wheat was in the range (273.33-399.0 sec) with an average of (325.60 sec.) of the Romanian wheat samples, first interval scored the maximum falling number (399.0 sec.) followed by both fourth and fifth intervals with no significant differences between them scores (325.33 and 317.0 sec.) respectively, minimum falling number were scored by samples of third and second intervals with scores of (273.33 and 313.33 sec.), respectively.

Minimum falling number were obtained by the French wheat samples with a range of 259.33-342.33 sec and an average of 290.40 sec. maximum falling number in the French wheat samples was that of the 3<sup>rd</sup>

and 5<sup>th</sup> intervals (342.33 and 314.0 sec.), respectively and minimum falling number was that of the 2<sup>nd</sup> interval (259.33 sec.).

Interval 5 had the highest ranges of falling number scores with an average of 360.00 sec while interval 2 was lower values with an average of 307.67 sec.

French wheat samples with its lowest falling number average (290.40 sec) was an average of quality because the standards of falling number ranges from 200 to 350 seconds as mentioned before, and our range (259.33-412.00) was in agreement with the data of **Finney (1985)** who reported a range of 222 to 450 seconds.

**EOS (2015)** states that falling number should not less than 230 sec, and the results indicated that all wheat's from Ukraine, Russia, Romania and France is acceptable imported wheats, and the Ukrainian wheat was the highest, comparing to all other wheat's originated from France, Romania and Russia, in the range of 322.0 to 412.0 sec with an average of 360.47 sec.

### Protein Contents

Wheat samples imported from France, Romania, Russia and Ukraine within July 2014 to April 2015 imported to Egypt in five intervals are analyzed for their protein contents percentages and recorded in Table 6. The protein contents were determined because it is one of the main quality characteristics for the evaluation of imported wheat especially because it is mainly used to produce baladi bread and especially gluten is a key factor in producing bread. Hard and high protein-containing wheat is of high quality and suitable for making bread (**Snape et al., 2005**).

Results in Table 6 demonstrat that, protein content of the imported wheat was

**Table (5): Falling number (sec) of four imported wheat in five intervals from Jul. 2014 to Apr. 2015.**

Origin	Interval					Interval mean ± SD
	Jul. / Aug.	Sep. / Oct.	Nov. / Dec.	Jan. / Feb.	Mar. / Apr.	
French Wheat	260.33 <sup>l</sup> ±2.52 <sup>1</sup>	259.33 <sup>l</sup> ±1.15	342.33 <sup>de</sup> ±9.50	276.00 <sup>h</sup> ±4.58	314.00 <sup>g</sup> ±5.29	290.40 <sup>c</sup> ±34.11
Romanian wheat	399.00 <sup>ab</sup> ±8.54	313.33 <sup>g</sup> ±17.21	273.33 <sup>hi</sup> ±7.23	325.33 <sup>fg</sup> ±4.04	317.00 <sup>g</sup> ±3.61	325.60 <sup>b</sup> ±43.04
Russian wheat	354.67 <sup>d</sup> ±4.51	336.00 <sup>ef</sup> ±3.61	324.67 <sup>fg</sup> ±4.16	348.33 <sup>de</sup> ±7.02	397.00 <sup>b</sup> ±6.24	352.13 <sup>a</sup> ±25.94
Ukrainian wheat	385.67 <sup>c</sup> ±8.96	322.00 <sup>g</sup> ±2.00	336.67 <sup>ef</sup> ±3.51	346.00 <sup>de</sup> ±10.82	412.00 <sup>a</sup> ±11.36	360.47 <sup>a</sup> ±35.18
Interval mean ± SD	349.92 <sup>b</sup> ±56.86	307.67 <sup>d</sup> ±31.27	319.25 <sup>c</sup> ±29.02	323.92 <sup>c</sup> ±30.97	360.00 <sup>a</sup> ±47.22	332.15 ±43.91
<b>LSD 0.05</b>						
	Among [Origin (O.)]	Among [interval (I.)]		Interaction (O. X I.)		
	8.54**	8.33**		13.07**		

- Data are expressed as means (3 replicates) ±SD
- Averages of origin in the same column having the same superscripts are not significantly different, same averages in interval row which having same superscripts are not significantly different at P≤0.05.

**Table (6): Protein content (%) of four imported wheat in five intervals from Jul. 2014 to Apr. 2015.**

Origin	Interval					Interval mean ± SD
	Jul. / Aug	Sep. / Oct	Nov. / Dec	Jan. / Feb	Mar. / Apr.	
French Wheat	11.53 <sup>l</sup> ±0.13 <sup>1</sup>	11.48 <sup>l</sup> ±0.22	11.11 <sup>m</sup> ±0.11	11.54 <sup>l</sup> ±0.09	11.02 <sup>m</sup> ±0.03	11.34 <sup>c</sup> ±0.26
Romanian wheat	13.34 <sup>b</sup> ±0.16	13.23 <sup>bc</sup> ±0.12	13.05 <sup>cd</sup> ±0.04	12.71 <sup>c</sup> ±0.05	12.17 <sup>jk</sup> ±0.05	12.90 <sup>a</sup> ±0.45
Russian wheat	12.03 <sup>k</sup> ±0.09	12.40 <sup>gh</sup> ±0.20	12.31 <sup>h-j</sup> ±0.03	12.38 <sup>hi</sup> ±0.05	12.45 <sup>f-h</sup> ±0.08	12.32 <sup>b</sup> ±0.18
Ukrainian wheat	12.21 <sup>i-k</sup> ±0.12	12.61 <sup>ef</sup> ±0.03	12.93 <sup>d</sup> ±0.10	12.57 <sup>cg</sup> ±0.06	13.67 <sup>a</sup> ±0.06	12.80 <sup>a</sup> ±0.52
Interval mean ± SD	12.28 <sup>b</sup> ±0.70	12.43 <sup>a</sup> ±0.67	12.35 <sup>ab</sup> ±0.81	12.30 <sup>b</sup> ±0.48	12.33 <sup>ab</sup> ±0.99	12.34 ±0.72
<b>LSD 0.05</b>						
	Among [Origin (O.)]	Among [interval (I.)]		Interaction (O. X I.)		
	0.12**	0.11**		0.18**		

- Data are expressed as means (3 replicates) ±SD.
- Averages of origin in the same column having the same superscripts are not significantly different, same averages in interval row which having same superscripts are not significantly different at P≤0.05.

in three categories, highest level was noted in both Romanian and Ukrainian wheat with an average of 12.90 and 12.80% respectively, without significant differences between them. Romanian wheat contained 12.17-13.34% of protein content and Ukrainian wheat contained 12.21-13.67% of protein content.

Protein content in the Russian wheat was less than both Romanian and Ukrainian wheat with an average of 12.32% with a range between 12.03-12.45%. While French wheat samples scored least protein content among other wheat samples as the average of protein content in different intervals was 11.34% and it was in the range of 11.02-

11.54% interval two which was between September to October contained highest levels of protein content (12.43%) without significant differences with third and fifth intervals, while lowest protein content was scored in the first interval (12.28%) without significant differences with fourth interval.

Protein content of the discussed samples was in the range of 11.02-13.67% and all samples considered as good wheat in producing bread, which was in line with the findings of **Khan *et al.* (2013)**, who studied wheat of different sources in Pakistan and found it to contain 10.4-14.6% of protein content.

Ukrainian wheat protein content ranged from 12.21% to 13.67% with an average of 12.80% comparing to 12.32, 12.90 and 11.34% for Russian, Romanian and French wheat samples, respectively. Within the Ukrainian wheat samples, 5<sup>th</sup> interval got the biggest protein content (13.67%) while 1<sup>st</sup> interval was the minimum protein content (12.21%).

Protein content of the imported Russian wheat was in the range 12.03 - 12.45% with an average of 12.32%. Within this wheat origin country (Russia) first interval scored the minimum protein content (12.03%) followed by both third and fourth intervals with significant differences with scores (12.31 and 12.38%) respectively, for third and fourth intervals, maximum protein content was that of the 5<sup>th</sup> interval (12.45%).

Romanian wheat samples' protein content were not significantly different than those of Ukrainian wheat samples with an average of 12.90%. Protein content of the imported Romanian wheat was in the range 12.17-13.34%. Within this wheat origin country (Romania) first interval scored the maximum Protein content (13.34%) followed by both second and third intervals with significant differences (13.23 and 13.05%), respectively for second and third intervals, minimum

Protein content was that of the 5<sup>th</sup> interval (12.17%).

Protein content of the imported French wheat were in the range 11.02 - 11.54% within an average of 11.34%. Within this wheat origin country (French) fourth interval scored the maximum protein content (11.54%) followed by first and second intervals with significant differences with scores 11.53 and 11.48%, respectively for first and second intervals, minimum protein content was that of the 5<sup>th</sup> interval (11.02%).

**EOS (2015)** states that Protein content should not less than 11%, and the results indicated that all wheat's from Ukraine, Russia, Romania and France is acceptable imported wheat's, and both Romanian and Ukrainian wheat's achieved highest level with an average of 12.90 and 12.80%, respectively.

## Conclusions

The study focused on putting our fingers on some sorts of wheat that Egypt import, recognizing how these freights correspond with the Egyptian standards and scientifically know, the best kinds of wheat for human consumption and organizing the exporting countries up to the best quality for making a loaf of bread in Egypt. and obtained results indicated that the Ukrainian wheat was the best among all other wheat originated from France, Romania and Russia, followed by French wheat, Russian wheat and lastly Romanian wheat in most tests used (moisture content, test weight, falling number, and came in the second step in protein content and Shrunken and broken grains and came in the third step in insect damaged kernels). Finally it is recommended to increase importing Ukrainian wheat, with an alert on the application of the exact fumigation doses of containers for shipments from Ukraine to avoid the insect loss.

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## الملخص العربي

### الخصائص الفيزيائية والكيميائية لأربعة أقماح مستوردة لمصر

أيمن حمدان النجار<sup>١</sup>، محمد عبد الشافي عبدالسميع<sup>٢</sup>، سمير إبراهيم غنيم<sup>٢</sup>

١- الحجر الزراعي، وزارة الزراعة واستصلاح الأراضي، مصر.

٢- قسم علوم وتكنولوجيا الأغذية والألبان، كلية العلوم الزراعية البيئية، جامعة العريش، مصر.

يعتبر القمح من أهم المحاصيل الغذائية في مصر بالإضافة إلى أنه يتم استهلاكه بمستوى عالي داخل مصر وذلك لخصه مقارنة بالمصادر الأخرى، والانتاج المحلي من القمح لا يكفي احتياجات المستهلكين وبالتالي تزداد الفجوة من القمح، والهدف الرئيسي من الدراسة مقارنة الأقماع المستوردة لمصر من دول مختلفة، حيث تم في هذه الدراسة مقارنة أربعة أقماح من أربعة دول هي (أوكرانيا - روسيا - فرنسا - رومانيا) خلال خمسة فترات، الفترة الأولى (يوليو - اغسطس/٢٠١٤)، الفترة الثانية (سبتمبر - أكتوبر/٢٠١٤)، الفترة الثالثة (نوفمبر - ديسمبر/٢٠١٤) الفترة الرابعة (يناير - فبراير/٢٠١٥) الفترة الخامسة (مارس - ابريل/٢٠١٥) وتم مقارنة هذه الأقماع باستخدام عدة اختبارات هي (محتوى الرطوبة - الوزن النوعي - رقم السقوط - محتوى البروتين - الحبوب الضامرة والمكسورة - الحبوب المصابة بالأفات) وجاءت النتائج كما يلي تفوق القمح الأوكراني على جميع الأقماع المستوردة من (روسيا - فرنسا - رومانيا)، حيث حقق القمح الأوكراني المركز الأول في ثلاث اختبارات هي محتوى الرطوبة حيث حقق ١٠,٨٨ - ١٢,٤٣% بمتوسط ١١,٤٦%، والوزن النوعي حيث حقق ٧٨,٧٧ - ٨٠,٥٧ كجم/هيكوليتير بمتوسط ٧٩,٧٠ كجم/هيكوليتير، ورقم السقوط حيث حقق ٣٢٢ - ٤١٢ ثانية بمتوسط ٣٦٠,٤٧ ثانية، وجاء في المركز الثاني في اختبارين هما محتوى البروتين حيث حقق ١٢,٢١ - ١٣,٦٧% وبمتوسط ١٢,٨٠%، والحبوب الضامرة والمكسورة حيث حقق ٠,٧٤٦ - ١,٩٢٥% وبمتوسط ١,١١٦%، وجاء في المركز الثالث في اختبار واحد هو الحبوب المصابة بالأفات حيث حقق ٠,٦٥١ - ٠,٨٨٣% وبمتوسط ٠,٦٧٠%.

**الكلمات الاسترشادية:** القمح - الخواص الفيزيائية والكيميائية - الوزن النوعي - الحبوب الضامرة والمكسورة - الحبوب المصابة بالأفات - المحتوى الرطوبي - رقم السقوط - المحتوى البروتيني.

## المحكمون:

- ١- أ.د. عبد الرحمن سليمان
- ٢- أ.د. أحمد عبد الغنى

- أستاذ بقسم علوم وتكنولوجيا الأغذية، كلية الزراعة، جامعة الزقازيق، مصر.
- أستاذ المحاصيل، كلية الزراعة، جامعة الزقازيق، مصر.