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# Effect of Harvest Date, Varieties and Storage Methods on Wheat Grains Content of Amino Acids

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**Abstract:** Two field experiments were done in Researches and Production Station of National Research Centre, Al emam Malek Village, Nubaria District, Al behaira Governorate, Egypt during two winter seasons of 2014/2015 and 2015/2016. The aim of the work was to study effect of three factors which were harvest dates [130, 140 and 150 days from sowing DAS], three wheat varieties [Misr 1, Sakha 93 and Gemiza 9] and two storage methods [gut bags and silo] and their interactions on amino acids in grains.Amino acids content in grains were determined after six months storage and amino acids were arranged in five groups 1- Group A contain 6 amino acids which were [alanine - Serine - Glycine - Valine - Leucine - Cysteine] 2- Group B contain 4 amino acids [Aspartate - Theronine - Methionine - Iso-leucine] 3- Group C contain 4 amino acids [Glutamate - Proline - Lysine - Arginine] 4- Group D contain 3 amino acids [Phenylalanine - Tryosine - Tryptophane 5- Group E only contain one amino acid [Histidine]. It is clear fromthe data that Gemiza 9 surpassed Misr 1 and Sakha 93 varieties in contents of amino acids in most amino acids in five groups. Wheat harvest at 150 DAS recorded on the higestamino acidscontent than the other harvest dates in all groups of amino acids except for group A at 130 DAS which recorded the best contents. Silo storage method was better than gut bags in all amino acid groups studied in both seasons. It could be concluded from this study that wheat cultivars varied in their contents of different essential and non-essential amino acids according to the storage period and mean. Short storage period and Silo packing tool seemed to maintain higher amino acids content in wheat grains, consequently better nutritive value.

**Key words:** Wheat · Harvest date · Varieties · Storage method · Amino acids

## INTRODUCTION

Wheat (*Triticum aestivum* vulgare L.) is considered as a strategic cereal cropand the main food for the human. In Egypt, the total cultivated area of wheat reached about 1.425 million hectare and the total production exceeded 9.279 million tons with an average of 6.511 t/ha. [1]. Wheat containsmore protein [8-15% [grain] and 8-13% [flour]] than other cereals; it has significance in nutrition especially in glutein which is very essential for bakers. Wheat protein is rich in glutamic acid and proline, which are the dominating non essential amino acids. [2] reported the deficiency of lysine, tryptophan and methionine in wheat protein. Protein fraction from different cereals exhibit similarities in the proportions of the amino acids glutamine, proline, glycine and cysteine. Amino acids are the building block of a major structure functional component of cell, that is, proteins. Several subunits of amino acids ranging from two to thous and join together through peptide bond and form long chainprotein molecules. Proteins provide energy to the body as do carbohydrates, that is, 4 kcal/g [3]. In Egypt, there is a gap between wheat production and consumption therefore, National Program for Wheat Research developed new wheat varieties characterized with its higher yield and risist pests, such as Gemmiza 7, Giza 168, Sohag 3 and Sakha 93 [4]. High variation for yield components was also found among Egyptian wheat cultivars [5, 6, 7]. Moreover, yield increase is often obtained in detriment of grain quality. For example, Gemiza 9 was reported by [8] to have the highest grain yield and properties [dough development period and dough stability period]. Gemiza 9 had the highest number of spikes $m^2$, number of grains per spike, grain weight per spike and grain yield with

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substantial weight loss and reasonable germination damage [9]. In this respect, [10] showed that Gemiza-9 cultivar gave the longest observed and predicted number of days for physiological maturity at different sowing dates and Misr-1 cultivar gave the shortest observed and predicted number of days for physiological maturity date. Effects of climate factors on crop growth stages and development are inter-related within specific pattern. According to [11] when the grains are filling up environmental factors have a major impact on both yield and flour quality. Environmental variables [temperature, water and nutrient supply] couldaffect the duration and ratios of the growth and development of wheat, the accumulation of protein and the deposition of starch in unique ways, through various mechanisms. Meteorological conditions before and after flowering will influence to wheat yield and production [12, 13, 14] reported that days to heading and maturity, plant height, number of spike $m^2$, number of grain spike -1000 grains weight, grain and straw yield and harvest index were significantly affected by wheat cultivars.

As traditional or modern, there are five main storage methods for the cereals, i.e., bulk storage, storage in underground pit, storage in sack, storage in warehouse and storage in silo. Each has many advantages and disadvantages during storage period of grains. Storage technologies for grains have been advanced with innovations on the main systems, such as aeration, refrigerated storage, modified atmospheric storage, hermetic storage systems in many developed countries [15] The method enables insects and other aerobic organisms in the grain or the grain itself to generate the modified atmosphere by reducing $O^2$ and increasing $Co_2$ concentrations through respiratory metabolism. Respiration activity of the living organisms creates an atmosphere containing about 1%-2% $O^2$ and about 20% $Co_2$. Insect control success due to the hermetic storage treatment is comparable to conventional fumigants [over 99.9% kill] and losses consequently , insect activity are minimal. Low $O^2$ and high $Co_2$ environment kills insect and mite pests and prevents aerobic fungi from growing [15] During storage, significantly qualitative and quantitative losses occur due to several factors, such as environmental factors [temperature, moisture content of grains, pH, humidity, etc], type of storage structure used, length and purpose of storage, method of storing grains and biological factors [insects, pests, microorganisms and rodents]. Nowadays, the grains are stored using the improved methods, such as in bags, silos, sheds, containers and even in piles on the ground managed as man-made ecosystems [15]. Storage proteins of wheat characterized with high proportion of glutamic acid and proline and low proportion of lysine, methionine and tryptophan, in some omega gliadine glutamic acid content is over the 50%, while contents of S-containing amino acids are low. Among the essential amino acid content in wheat grain determined also, cysteine [2.2 mg/ml], tyrosine [3.7 mg/ml], arginine [4.7 mg/ml] and histidine [2.0 mg/ml] [16]. Moreover, prolonging storage period with high seed moisture percentage significantly caused high reduction in storage efficiency [infested seeds, damage grains percentage, grains weight loss %], germination characters, seed viability and quality, accelerate seed aging [17, 18, 19, 20, 21]. Grains loss in storage condition due to biotic and abiotic factors accounts for 10 % per year, out of which insects are contributing about 2.5 to 5.0 %. Also, insects caused damage of stored grains and their products range from 5-10% in the temperate countries to 20-30% in the tropical zone. Stored wheat is vulnerable towards attack of insects and a possible infestation can deteriorate the quality as well as the quantity resulting in significant decrease in volume, substantial weight loss and reasonable germination damage [9]. In the same respect [22] revealed that storage duration of 12 months generally increased moisture and fat acidity, while decreased test weight and flour yield. Microbial, pest, enzymatic activities, mechanical effects, foreign matter damages and heat problems, which result in quality loss in grains during storage, can be prevented by right storage methods using proper machine and equipment. Due to insect attack, there occurs a considerable increase in humidity and temperature which in turn supports the development of fungus and partial germination of grains [23].

## MATERIALS AND METHODS

Two field experiments were done in Researches and Production Station of National Research Centre, Al emam Malek Village, Nubaria District, Al Behaira Governorate, Egypt during two winter seasons of 2014/2015 and 2015/2016.

The aim of the work was to study effect of three factors which were harvest dates [130, 140 and 150 days from sowing DAS], three wheat varieties [Misr 1, Sakha93 and Gemiza 9] and two storage methods [gut bags and silo] and their interactions on amino acids in grains.

Table 1: Mechanical and chemical analysis of soil.

| Clay [%] | Silt [%] | Sand [%] | E.cmmhos/cm$^3$ | Ca Co$^3$ | O.M [%] | pH | N [ppm] | P [ppm] | K [ppm] |
|---|---|---|---|---|---|---|---|---|---|
| 4.6 | 3.1 | 92.3 | 0.3 | 1.3 | 0.3 | 7.4 | 8 | 3 | 19.8 |

Three wheat cultivars Misr 1, Sakha 93 and Gemiza 9] sown by broadcast method at seeding rate of 144 kg/ hectare under sprinkler irrigation system, sowing date was 3 and 5 November in both seasons. The experiment was executed in three replicates, area of each plot was 10.5 m$^2$. Treatments were 18 treatments in 3 replicates; experimental design was Complete Randomize Block Design.

Mechanical and chemical analyses of experimental soil arepresented in Table [1].

Allthe agronomic practices were applied according to the recommendations of wheat cultivation of Ministry of Agriculture during the growing season and wheat plants harvested in three times [130, 140 and 150 days from sowing DAS], then the obtained grainssubjected to storage treatments by two methods gut bags and silos. After 6 months amino acids in grains were determined according to method described by [24].

The composition of amino acids was determined after 24-h hydrolysis by means of high-performance liquid chromatography, with the use of 6N HCl and at the temperature of 110°C. The hydrolyses amino acids were separated using AAA-400 [INGOS, Prague, Czech Republic]. For the detection, a two wave length photometer [440 and 570 nm] was employed. The column was packed with ion exchanger Ostion LG FA [INGOS] and its length was 200 mm. The column temperature was maintained at 40-70°C and that of the detector - at 121°C. The prepared samples were analyzed using the ninhydrine method. Finally, amino acid composition was expressed in g amino acids/16 g N [24]..

**Statistical Analysis:** The data were subjected to standard analysis of variance technique as proposed by [25]. For means comparison Least significant difference at 0.05 level was applied.

## RESULTS AND DISSCUSSION

**Varietal Differences:** Data presented in Table [2] show the differences among wheat varieties in amino acids content. Amino acids arranged in five groups 1- Group A contain 6 amino acids which were [alanine - Serine - Glycine - Valine - Leucine - Cysteine] 2- Group B contain 4 amino acids [Aspartate - Theronine - Methionine - Iso-leucine] 3- Group C contain 4 amino acids [Glutamate - Proline - Lysine - Arginine] 4- Group D contain 3 amino acids [Phenylalanine - Tryosine - Tryptophane 5- Group E contain one amino acid [Histidine].

Concerning Group A [Serine - Glycine - Valine - Leucine - Cysteine] the amino acid contents of Gemiza -9 cultivar containedthe highest content of these amino acids compared to the other cultivars in both seasons 2014/2015 and 2015/2016, while the best content of alanine amino acid recorded by Sakha 93 in both seasons.

Similar trend wasrecorded for Group B and Gemiza 9 surpassedMisr 1 and Sakha 93 cultivaesin contents of amino acids [Aspartate - Theronine - Methionine - Iso-leucine in both seasons ], except for Iso-leucine.

Data of group C clear the superiority of Gemiza 9 in the four amino acids Glutamate - Proline - Lysine - Arginine. Sakha 93 and Misr 1 arranged in second and third order in both seasons.

The same trendwas recorded in three groups of amino acids A , B , C was reported also in Group D, three varieties arranged in descending order Gemiza 9 - Sakha 93 - Misr 1 for amino acids Phenylalanine - Tryosine - Tryptophane in both seasons.

To the of the amino acid Histidine reveal un-constant trend, Sakha 93 came in the first season followed by Misr 1 and Gemiza 9 but Gemiza 9 recorded high content in the second season followed by Sakha 93 and Misr 1.

Many researchers indicated the differences among cultivars under Egyptian conditions [5, 6, 7] reported that there were high variation for yield components found among Egyptian wheat cultivars. [5, 6, 7] clear high variation for yield components among Egyptian wheat cultivars also, [4] showed that the developed new Egyptian wheat varieties are characterized with its higher yield and persist pests, such as Gemiza 7, Giza 168, Sohag 3 and Sakha 93. [8] reported that Gemiza 9 have the highest grain yield and properties [dough development period and dough stability period] also, Gemiza 9 had the highest number of spikes m$^2$, number of grains per spike, grain weight per spike and grain yield and was substantial weight loss and reasonable germination damage. In the same respect [13, 14] reported that days to heading and maturity, plant height, number of spike m$^2$, number of grain spike -1000 grains weight, grain and straw yield and harvest index were significantly affected by wheat cultivars. The differences between Egyptian varieties in most morphological, yield and yield components may be

Table 2: Varietal differences in wheat grain contents of amino acids 2014/2015 and 2015/2016 seasons

| Varieties | Misr 1 | | Sakha 93 | | Gemiza 9 | |
|---|---|---|---|---|---|---|
| Amino acids | 1st Season | 2nd season | 1st Season | 2nd season | 1st Season | 2nd season |
| Group A [Alanine] | | | | | | |
| 1- Alanine | 3.34 | 3.36 | 3.36 | 3.38 | 3.35 | 3.36 |
| 2- Serine | 4.49 | 4.55 | 4.38 | 4.36 | 4.67 | 4.65 |
| 3- Glycine | 3.75 | 3.74 | 3.75 | 3.75 | 3.85 | 3.87 |
| 4- Valine | 3.13 | 3.15 | 3.18 | 2.97 | 3.20 | 3.28 |
| 5- Leucine | 6.99 | 7.01 | 7.16 | 7.17 | 7.27 | 7.29 |
| 6- Cysteine | 10.77 | 10.78 | 10.84 | 10.84 | 10.86 | 10.86 |
| Group B [Aspartic Acid] | | | | | | |
| 1- Aspartate | 5.81 | 5.81 | 5.86 | 5.84 | 5.88 | 5.87 |
| 2- Theronine | 2.67 | 2.67 | 2.78 | 2.77 | 2.83 | 2.84 |
| 3- Methionine | 1.2 | 1.2 | 1.22 | 1.23 | 1.29 | 1.27 |
| 4- Iso-leucine | 3.83 | 3.84 | 3.76 | 3.74 | 3.88 | 3.88 |
| Group C [Glutamic Acid] | | | | | | |
| 1-Glutamate | 28.38 | 28.41 | 28.64 | 28.65 | 28.91 | 28.89 |
| 2- Proline | 9.97 | 9.98 | 10.14 | 10.14 | 10.29 | 10.32 |
| 3- Lysine | 2.61 | 2.65 | 2.68 | 2.71 | 2.81 | 2.78 |
| 4- Arginine | 4.67 | 4.67 | 4.71 | 4.7 | 4.72 | 4.72 |
| Group D | | | | | | |
| 1- Phenylalanine | 4.49 | 4.49 | 4.56 | 4.57 | 4.66 | 4.64 |
| 2- Tryosine | 2.45 | 2.49 | 2.67 | 2.67 | 2.80 | 2.79 |
| 3- Tryptophan | 1.14 | 1.51 | 1.22 | 1.2 | 1.23 | 1.23 |
| Group E | | | | | | |
| 1- Histidine | 2.08 | 2.04 | 2.09 | 2.04 | 2.08 | 2.09 |

indicate to superiority of Gemiza 9 on other two varieties in chemical contents especially amino acids as reported in results under trial condition when compare to tested varieties Misr 1 and Sakha 93, results may be due to genetic effect of Gemiza 9.

**Harvest Date:** It is clear from data in Table [3] that results of Group A showed un-consistant trend so, harvest date at 130 days after sowing DAS recorded the best content of alanine - Glycine - Cysteine in both seasons 2014/2015 and 2015/2016 but the best content of Valine in the 2nd season only. Harvesting at 140 DAS recorded the highest content of Serine in both seasons and Valine in 1st season only while harvest date at 150 DAS had in the highest contents of Leucine in both seasons and Serine in 2nd season only.

To the results of Group B of amino acids data clear that the longest growing period 150 DAS produced the highest content of Theronine - Methionine - Iso-leucine in both seasons but the shortest period 130 DAS produced the highest content of Aspartate amino acid in both seasons.

Data of Group C revealed that the harvest date at 150 DAS produced the highest content of Glutamate - Proline - Lysine in both seasons but Arginine in the 1st season only, while harvest at 140 DAS produced the highest content of Arginine in 2nd season only.

Comparison between three harvest dates for contents of amino acids in Group D it is clear that wheat harvest at 150 DAS came in the first order in Phnylalanine and Tryptophane in both seasons and 140 DAS came in the second order and 130 DAS in the third order but 140 DAS came in the first order in Tyrosine in both seasons.

Harvest date at 150 DAS recorded the highest content of Histidine amino acid in 1st season only but 140 DAS produced the highest content in 2nd season only.

The duration between sowing and maturity date differed due many factors affected on wheat cultivars under Egyptian conditions, little trials gave importance for harvest date in Egypt for example, [10] showed that Gemiza-9 cultivar gave the longest observed and predicted number of days for physiological maturity date at different sowing dates and Misr-1 cultivar gave the shortest observed and predicted number of days for physiological maturity date. Effects of climate factors on crop growth stages and development inter-related within specific pattern. According to [11] when the grains are filling up environmental factors have a major impact on both yield and flour quality. Environmental variables [temperature, water and nutrient supply] affect the duration and ratios of the growth and development of wheat, the accumulation of protein and the deposition of starch in unique ways, through various mechanisms.

Table 3: Effect of harvest dates on wheat grain contents of amino acids [mean of Misr 1, Sakha 93 and Gemiza 9 varieties] 2014/2015 and2015/2016 seasons

| Harvest date | 130 Days | | 140 Days | | 150 Days | |
|---|---|---|---|---|---|---|
| Amino acids | 1st Season | 2nd season | 1st Season | 2nd season | 1st Season | 2nd season |
| Group A [Alanine] | | | | | | |
| 1- Alanine | 3.41 | 3.40 | 3.35 | 3.37 | 3.29 | 3.33 |
| 2- Serine | 4.51 | 4.50 | 4.52 | 4.54 | 4.52 | 4.51 |
| 3- Glycine | 3.80 | 3.80 | 3.79 | 3.79 | 3.76 | 3.77 |
| 4- Valine | 3.13 | 3.18 | 3.21 | 3.13 | 3.17 | 3.09 |
| 5- Leucine | 7.07 | 7.08 | 7.15 | 7.16 | 7.17 | 7.21 |
| 6- Cysteine | 10.88 | 10.87 | 10.81 | 10.85 | 10.79 | 10.76 |
| Group B [Aspartic Acid] | | | | | | |
| 1- Aspartate | 5.89 | 5.86 | 5.81 | 5.82 | 5.86 | 5.83 |
| 2- Theronine | 2.70 | 2.68 | 2.78 | 2.77 | 2.80 | 2.82 |
| 3- Methionine | 1.21 | 1.22 | 1.20 | 1.21 | 1.28 | 1.27 |
| 4- Iso-leucine | 3.81 | 3.81 | 3.82 | 3.81 | 3.84 | 3.84 |
| Group C[Glutamic Acid] | | | | | | |
| 1-Glutamate | 28.36 | 28.36 | 28.76 | 28.77 | 28.82 | 28.82 |
| 2- Proline | 10.07 | 10.10 | 10.14 | 10.15 | 10.20 | 10.19 |
| 3- Lysine | 2.70 | 2.70 | 2.64 | 2.69 | 2.75 | 2.75 |
| 4- Arginine | 4.67 | 4.68 | 4.72 | 4.73 | 4.72 | 4.69 |
| Group D | | | | | | |
| 1- Phenylalanine | 4.51 | 4.53 | 4.58 | 4.56 | 4.62 | 4.62 |
| 2- Tyrosine | 2.63 | 2.64 | 2.65 | 2.66 | 2.64 | 2.66 |
| 3- Tryptophan | 1.13 | 1.17 | 1.20 | 1.16 | 1.25 | 1.24 |
| Group E | | | | | | |
| 1- Histidine | 2.03 | 2.00 | 2.05 | 2.09 | 2.08 | 2.08 |

Table 4: Effect of storage method on wheat grain contents of amino acids 2014/2015 and 2015/2016 seasons.

| Storage method | Silo | | Gut bags | |
|---|---|---|---|---|
| Amino acids | 1st season | 2 nd season | 1st season | 2 nd season |
| Group A [Alanine] | | | | |
| 1- Alanine | 3.37 | 3.39 | 3.33 | 3.34 |
| 2- Serine | 4.55 | 4.59 | 4.48 | 4.45 |
| 3- Glycine | 3.82 | 3.83 | 3.75 | 3.74 |
| 4- Valine | 3.17 | 3.08 | 3.17 | 3.18 |
| 5- Leucine | 7.16 | 7.18 | 7.12 | 7.13 |
| 6- Cysteine | 10.86 | 10.87 | 10.79 | 10.78 |
| Group B [Aspartic Acid] | | | | |
| 1- Aspartate | 5.89 | 5.87 | 5.82 | 5.81 |
| 2- Theronine | 2.79 | 2.78 | 2.73 | 2.73 |
| 3- Methionine | 1.24 | 1.24 | 1.23 | 1.23 |
| 4- Iso-leucine | 3.87 | 3.87 | 3.77 | 3.77 |
| Group C [Glutamic Acid] | | | | |
| 1-Glutamate | 28.71 | 28.7 | 28.58 | 28.6 |
| 2- Proline | 10.16 | 10.18 | 10.11 | 10.12 |
| 3- Lysine | 2.75 | 2.76 | 2.65 | 2.67 |
| 4- Arginine | 4.75 | 4.76 | 4.66 | 4.64 |
| Group D | | | | |
| 1- Phenylalanine | 4.60 | 4.61 | 4.54 | 4.52 |
| 2- Tyrosine | 2.64 | 2.65 | 2.80 | 2.79 |
| 3- Tryptophan | 1.22 | 1.22 | 1.17 | 1.17 |
| Group E | | | | |
| 1- Histidine | 2.07 | 2.06 | 2.04 | 2.06 |

Meteorological conditions before and after flowering will influence to wheat yield and production [12 13, 14] reported that days to heading and maturity and harvest index were significantly affected by wheat cultivars.

**Storage Method:** Data in Table 4 showed that group A had the highest values of amino acids Silo storage method recorded higher content of all amino acids [alanine - Serine - Glycine - Valine - Leucine - Cysteine] than that found in gut bags in both seasons but Valine recorded the same content under the two storage method silo or gut bags.

Due to Silo storage method recorded the best contents of Group B of amino acids [Aspartate - Theronine - Methionine - Iso-leucine] in both seasons as well as Group C [Glutamate - Proline - Lysine - Arginine] in both seasons.

It is clear from the same table that Silo storage method recorded the higher content in Phenylalanine and Tryptophan in both seasons but gut bags was the best in Tyrosine in both seasons.

Group E of amino acids show that Silo storage method surpassed gut bags in Histidine in both seasons.

## CONCLUSION

It could be concluded from this study that wheat cultivars varied in their contents of different essential and non-essential amino acids according to the storage period and mean. Short storage period and Silo packing tool seemed to maintain high amino acids content in wheat grains, consequently better nutritive value.

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