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THE EFFECTS OF ALLELIC VARIATION FOR GLUTENIN HMW-GS ON DOUGH QUALITY IN SOME BREAD WHEAT CULTIVARS

Altinawi, E. [١]**; W. Al-Ek** [٢]**; S. Lawand** [٣] **and A. Altaher**[١]

١- Biotechnology Dept. of the General Commission for Scientific Agric. Res. Douma, P.O. Box ١١٣, Damascus, Syria.

٢- Field Crops Res. Administration of the General Commission for Scientific Agric. Res. Douma, P.O. Box ١١٣, Damascus, Syria.

٣- Fac. of Agric., Damascus Univ., Syria.

ABSTRACT

The end-use quality of bread wheat is sensitive to cultivar (genotype) and the dominated extreme environmental conditions during the grain filling, as they effect on syntheses and accumulation of storage proteins (gliadin and glutenin) in grain. A field trials were carried out for three bread wheat cultivars (bohoth٦, cham٤ and cham٦) at the four different environment zones in Syria for two seasons ٢٠٠٧ and ٢٠٠٨ to study the effects of the allelic variation in each studied cultivar (genotype) and effect of the dominant environmental conditions at each zone on gluten content and dough quality. Glutenin protein were analyzed by sodium dodecyl sulphate polyacrylamide gel electrophoresis SDS-PAGE that demonstrated presence some allelic variations and the absence (deletion) of some alleles at loci on the chromosomes. Three different allelic were identified at (Glu-A١ and Glu-B١) loci. The gluten content was the best in bohoth٦, because there were no any allelic deletion at loci in comparison cham٤ and cham٦. So, the gluten content reduced when air temperature was raised above ٣٠ ºC for long duration coincident with water deficit during the grains filling period. The gluten quality was analyzed by Farinograph test (development time, stability and mixing tolerance), this test confirmed that bohoth٦ has the best allelic group for syntheses and accumulation of glutenin in grains. bohoth٦ at zone٢ and zone٤ gave a dough strength ranging from the strongest in season ٢٠٠٧ to the medium grade in season ٢٠٠٨ as a result of effect the unusual extreme climatic conditions. The results indicated that bohoth٦ was more tolerant to these extreme environmental conditions than cham٤ and cham٦.

Keywords: Glutenin, SDS-PAGE, Gluten content, Bread wheat quality, Environmental conditions, Farinograph test and Dough quality.

INTRODUCTION

In Syria, wheat is the most important field crop. The majority of grown wheat is durum wheat (*T. durum*) and bread wheat (*T. aestivum*). Bread wheat is the most widely grown food crop in the world and distinguished for its dough quality and bread making properties. There is significant relationship between the different environmental conditions, syntheses and accumulation of storage protein, and the dough quality, which suggests that climatic conditions and weather models, climatic zones and genotype could be useful or not useful in predicting grain quality (Peterson *et al.,* ١٩٩٨). The total protein content and the glutenin and gliadin ratio also affect on dough and baking properties (Uthayakumaran *et al*., ٢٠٠٤). The wheat storage protein genes exhibit a co-dominant Mendelian inheritance (Gupta and Shepherd, ١٩٩٠, Wrigley, ١٩٩٦).

Three genetically unlinked loci Glu-A١, Glu-B١, and Glu-D١ present on homeologous chromosomes ١A, ١B, ١D control the synthesis of the HMW glutenins (MacRitchie and Lafiandra, ٢٠٠١, Gálová *et al*., ٢٠٠٢). Correlation studies (Gupta and MacRitchie, ١٩٩٤) have indicated that dough 'strength' and bread-making potential of flour are positively related with subunits ٥+١٠, ٧+٨, ١٧+٨, ١ and ٢* and negatively associated with subunits ٦+٨, ٢+١٢ and ٢٠ Goesaert *et al*., ٢٠٠٥; Lagrain *et al*., ٢٠٠٦. It was also observed that, where subunits ٧+٨ and ٢* occurred together (Khatkar *et al.*, ١٩٩٦). Mir Ali, (١٩٩٥) reported that the studied lines were characterized by having higher SDS sedimentation values due to the presence of subunits ١٧+١٨ at *Glu-B*١ when compared to those that has subunits ٧+٨. SDS page separation of HMW glutenins from several wheat cultivars have demonstrated a number of alleles at each loci (Payne & Lawerence, ١٩٨٣; MacRitchie and Lafiandra, ٢٠٠١). Although grain protein composition depends primarily on genotype, it is significantly affected by the environment factors and their interactions (Triboï *et al*., ٢٠٠٠; Daniel and Triboï, ٢٠٠٢**;** Zhu and Khan, ٢٠٠١). For certain varieties, flour, dough, and baking quality parameters were reported to be altered in response to a short period of heat stress >٣٥ °C, and some of these effects have been linked to an increased gliadins-to-glutenins ratio (Blumenthal *et al*., ١٩٩١**,** ١٩٩٣*;* Wardlaw *et al*., ١٩٩٥, ٢٠٠٢). The water deficits severely effect end-use quality for several cultivars of wheat (Guttieri *et al.*, ٢٠٠١). This study will focus on, ١- Study of the allelic variations at loci of glutenin subunits HMW-GS and their effect on total protein and gluten contents in three bread wheat cultivars and define the suitable environmental zones to each cultivar. ٢- Study the effect of the deletion of some important alleles on the end-use quality (dough). Define the most tolerant cultivar to extreme environmental conditions (heat and drought stress).

MATERIALS AND METHODS

Seeds of three bread wheat cultivars Bohoth٦, Cham٤ and Cham٦ were sown in three replicated trials at four zones with different environmental conditions for two seasons ٢٠٠٧ and ٢٠٠٨. These zones were zone١: (Ghab research center, Hama), zone٢: (Himo research center, Al-Hassake), zone٣: (Idleb research center, Idleb), zone٤: (Malikieh research center, Al-Hassake) in each zone, the daily meteorological data was recorded (air temperature and rainfall) during the grain filling period from ١٥ April to ٣٠ May (Table ١). The climatic stress was calculated as number of daily extreme temperature ≥ ٣٠ °C during the grain filling period at each zone. The grain filling period was defined based on the average maturity of cultivars grown in the trials.

Table ١: Environmental factors (the extreme high temperatures (heat stress) and rainfall (water stress) during the grain filling period

The dominant climatic conditions	Season ٢٠٠٧				Season ٢٠٠٨			
	zone١	zone٢	zone٣	zone٤	zone١	zone٢	zone٣	zone٤
Rainfall during filling period (mm)	٩٧,٤	٣٥,٢	٨٠,٠	٥٠,٥	٣٧,٨	٣,٥	٢٨,١	١٧,٢
Number days (≥ ٣٠ ºC)	٢٠	١٩	١٧	١٨	١٦	٣٢	١٨	٣٠

At the harvesting stage, the grains were harvested and brought to the seed biotechnology laboratory and biotechnology laboratory in General Commission for Scientific Agricultural Research, Douma, Damascus.

Near-infrared reflectance (NIR): the percentage of the total protein content (GPC) and wet gluten content (WG) and Sodium Dodecyle Sulphate sedimentation volume SDSs volume of sample grains was determined by Near-infrared reflectance (NIR) spectroscopy using an Infratec ١٢٤١ (Grain Analyzer, made in FOSS company, Tecator, Hö̤ganǎs, Sweden).

Milling of the Wheat flour for Farinograph test: Reduction flour was mixed to determine the dough strength of the flour by farinograph. Brabender Farinograph-E worldwide standard was used to assess the rheological properties of wheat flour in accordance (AACC ٥٤-٢١). Farinograph is measured in Brabender Units (BU), which refers to the dough resistance to mixing. The Farinograph was used to identify the gluten quality and to measure dough characteristics of flours during the test such as development time (FDT) is the needed time for dough and water to mix together to develop strength, dough stability (FST), dough mixing tolerance (MT). And the Farinograph results were interrelated in comparison to the Farinograph parameters (Table ٢).

Table ٢*:* Guidelines interpretation of the Farinograph parameters According to (Williams *et al* ., ١٩٨٦).

(Rating)	SDS sedimentation volume (ml)	FDT (min)	FST (min)	MT (BU)
Exceptionally weak	Less than ٢٠	-	-	-
Very weak	٢٠-٢٩	٠- ٢	٠- ٢	٢٠٠-٢٥٠
Weak	٣٠-٣٩	٢-٤	٢-٤	١٥٠-١٩٩
Near of weak	٤٠-٤٩	-	-	-
Medium strength	٥٠-٥٩	٤-٦	٤-٧	١٠٠-١٤٩
Near to strong	-	٦-٨	٧-١٠	-
Strong	٦٠-٦٩	٨-١٠	١٠-١٥	٥٠-٩٩
Very strong	٧٠-٧٩	Over ١٠	Over ١٥	٠-٤٩
Exceptionally strong	Over ٨٠	-	-	-

FDT, development time**; FST, Dough Stability, MT, Mixing Tolerance;** BU, Brabender Units.

Sodium Dodecyle Sulphate Polyacrylamid Gel Electrophoresis (SDS-PAGE): It is generally known that Gluten strength is associated with certain High Molecular Weight (HMW) Glutenin subunits. Thus, the High Molecular Weight (HMW) Glutenin composition of wheat is determined utilizing sodium dodecyle sulphate polyacrylamid gel electrophoresis (SDS-PAGE).

Preparation of Samples for SDS-PAGE Electrophoresis:

HMW-GSs were analyzed by SDS-PAGE method. Dual slab electrophoretic system Hoefer SE ٦٠٠ (gel size – ١٦ × ١٨ cm) was used for the analyses. Three grains of every cultivar were tested for four zones in two seasons ٢٠٠٧ and ٢٠٠٧. The remaining pellet after extraction of gliadin protein was extracted for the obtaining on glutenins according to a sequential procedure (Singh *et al.,* ١٩٩١). Electrophoresis of glutenin subunits was performed on SDS-PAGE according to (peňa *et al.,* ٢٠٠٧). Allele identification was by using the standard wheat varieties and respective HMW-glutenin profiles were Pavon: (٢*, ١٧+١٨ and ٥+١٠), Opata: (٢*, ١٣+١٦ and ٢+١٢) Liu *et al*., ٢٠٠٨, and Pitic٦٢: (١, ٧+٨ and ٢+١٢) Cornish, ٢٠٠٧. HMW glutenin alleles at *Glu-A ١, Glu-B ١* and *Glu-D ١* loci were identified and allelic variations were rated by numbering each HMW glutenin sequentially, based on mobility in SDS-PAGE and the classification of (Payne and Lawrence, ١٩٨٣).

RESULTS AND DISCUSSION

Analysis of HMW-GSs Protein: The effects of the HMW glutenin protein is evident from the results that were obtained by sodium dodecyl sulphate polyacrylamide gel electrophoresis SDS-PAGE Analysis in this study. Analysis results of the SDS-PAGE of the other cultivars demonstrated absence (deletion) of some alleles at loci on the chromosomes. Three different allelic were identified, two different alleles ٢*, null (N) were corresponded to the Glu-A١ locus, and two different alleles (٧+٨ and ١٧+١٨), were corresponded to the Glu-B١ locus and one allele ٢+١٢ was corresponded to Glu-D١ locus. This the last allele ٢+١٢ was present into three studied cultivars. The HMW proteins present in three studied cultivars (cham٤, cham٦ and bohoth٦) that were tested by using SDS-PAGE (Table ٣; Figure ١ and ٢).

Table ٣: Compositions and deletion of glutenin alleles HMW-GS in three studied cultivars (cham٤ cham٦ and bohoth٦).

Cultivars	HMW glutenin alleles		
	Glu-A١	Glu-B١	Glu-D١
Cham٤	-	١٧+١٨	٢+١٢
Cham٦	٢*	٧+٨	٢+١٢
Bohoth٦	٢*	١٧+١٨	٢+١٢

SDS-PAGE analysis was used to further verify the HMW-GSs protein allelic patterns of the studied cultivars in both seasons ٢٠٠٧ and ٢٠٠٨. But, when the gels of both seasons were compared together, the obtained results by electrophoresis to determine the responsible alleles from dough strength were similarly and they didn't change when the climatic conditions were changed at four studied environmental zones in season ٢٠٠٨. These results indicated the subunits (alleles) don't affect by the extreme climatic conditions, viz the responsible genes in genetic loci (Glu-A١, Glu-B١ and Glu-D١) on chromosome ١ expressed despite of the dominant bad climatic conditions in season ٢٠٠٨ at zone٢ and zone٤ (Table ١). This result was similar to that reported by Dupont *et al*., (٢٠٠٦). However, each studied cultivar included ٣–٥ bands of HMW-GSs. Cham٤ has subunit (null), ١٧+١٨ and ٢+١٢ at loci (Glu-A١, Glu-B١ and Glu-D١), respectively. Cham٦ has subunit ٢*, ٧+٨ and ٢+١٢ at loci (Glu-A١, Glu-B١ and Glu-D١), respectively. Also, Bohoth٦ has subunit ٢*, ١٧+١٨ and ٢+١٢ at loci (Glu-A١, Glu-B١ and Glu-D١), respectively (Figure ١, ٢ Table ٣).

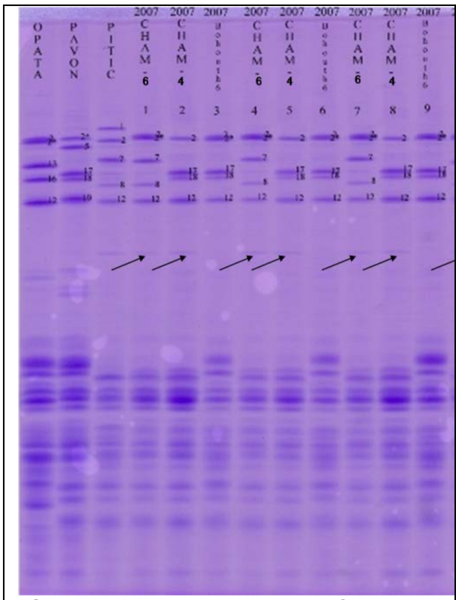

Figure ١: SDS-PAGE of HMW-glutenin subunits of the bread wheat cultivars Cham٤, Cham٦ and Bohoth٦ in four zones in season ٢٠٠٧ and standard wheat cultivars (Pavon, Opata and Pitic ٦٢). They were numbered according to Payne and Lawrence (١٩٨٣).

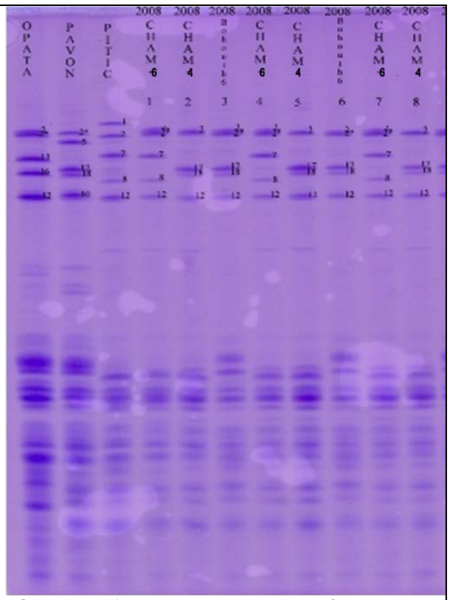

Figure ٢: SDS-PAGE of HMW-glutenin subunits of the bread wheat cultivars Cham٤, Cham٦ and Bohoth٦ in four zones in season ٢٠٠٨ and standard wheat cultivars (Pavon, Opata and Pitic ٦٢). They were numbered according to Payne and Lawrence (١٩٨٣).

When the comparison between loci to three cultivars was noticed that subunit ١٧+١٨ at Glu-B١ locus were present in both cham٤ and bohoth٦ and subunits ٢+١٢ at Glu-D١ locus were present in all studied three cultivars. Also, subunits ٧+٨ at Glu-B١ locus were present in cham٦ and subunits ٢* at Glu-A١ locus were present in both cham٦ and bohoth٦ (Figure ١ and ٢). However, the subunit ٢٠ Glu-B١ loci and subunits ٥+١٠ in Glu-D١ don't present in none from the three studied cultivars. This results indicated the HMW-GSs allelic pattern compositions in cham٤ (١٧+١٨ and ٢+١٢) are to bohoth٦, and in cham٦ are (٢* and ٢+١٢) are similar to bohoth٦ at same locus. However, all subunits significantly affected on some of the quantitative and qualitative traits of GPC and WG contents (Table ٤ and ٥). So that some tests like SDSs volume and Farinograph as (FAB, FDT, FST and MT) were affected with changing both quantitative and qualitative traits of GPC and WG. The (٢*, ١٧+١٨ and ٧+٨) are positively influenced on content of both traits and increasing of SDSs volume. This result was indicated by correlation studies to (Gupta and MacRitchie, ١٩٩٤) who have confirmed that dough 'strength' and bread-making potential of flours are positively related with subunits ١٧+٨, ٧+٨, and ٢* and negatively associated with subunits (null) and ٢+١٢. Also, the results in this study were similar to those by Gregova *et al*. (٢٠٠٦); Goesaert *et al*., ٢٠٠٥; Lagrain *et al*., ٢٠٠٦). Also, Branlard and Dardevet (١٩٨٥) confirmed subunits ٢* and ١٧+١٨ are associated with a strong dough. In general, when the alleles ٢* and ١٧+١٨ are together in bohoth٦, they show highest positive effects to GPC and WG. This result is explained that the wheat storage protein genes exhibit a co-dominant Mendelian inheritance (Gupta and Shepherd, ١٩٩٠).

So here, present both the alleles ٢* and ١٧+١٨ together showed the highest positive effects to GPC and WG, accordingly both traits effected positively on SDSs volume and farinograph test (FDT and FST) and these results were confirmed by Mir Ali (١٩٩٥). Whereas, bohoth٦ has subunits ١٧+١٨ that contributed to increase SDSs volume more than cham٦ which has subunits ٧+٨ and ٢+١٢ together. Because subunits ٧+٨ and ٢+١٢ together have minimum positive effects on the mean of SDSs volume, and this also reported by Khatkar *et al*, (١٩٩٦). Thus, in our study, cham٦ that has subunits ٧+٨ showed minimum positive effects on the mean of SDSs volume in comparison with bohoth٦ that has subunits ١٧+١٨ that expresses a higher gluten contents than subunits ٧+٨ in cham٦. So, the deletions in the glutenin loci resulted in significantly (p<٠,٠٥) reduced the mean of GPC and WG by comparison between the means of three studied cultivars in each season alone (Table ٤ and ٥). The deletions to subunit ٢* at Glu-A١ as in cham٤, subunits ١٧+١٨ in cham٦ and subunits at Glu-B١ reduced the quality of GPC and WG in flours of both cultivars, because subunit ٢* and subunits ١٧+١٨ affect positively on the dough strength. So, bohoth٦ had a strong dough in its flour, because it has at both loci (Glu-A١ and Glu-B١) the positive subunits ٢* and ١٧+١٨ that result in a high dough strength. Gupta and MacRitchie (١٩٩٤) have indicated that dough 'strength' and bread-making potential of flour are positively related with subunits ٧+٨, ١٧+٨ and ٢*. Anyhow, the Farinograph tests had indicated significant effects of GPC and WG contents on dough strength at four studied environmental zones in both the seasons ٢٠٠٧ and ٢٠٠٨. Cham٤ which has a the deletion (null) and ١٧+١٨, cham٦ which has subunits ٢* and ٧+٨, and bohoth٦ which has subunits ٢* and ١٧+١٨. These cultivars in season ٢٠٠٧ were affected by the usually extreme climatic conditions at four studied zones, so cham٤ and cham٦ produced medium GPC and WG, but bohoth٦ produced high GPC and WG (Table ٤ and ٥). While, GPC and WG in Cham٤ and cham٦ in season ٢٠٠٨ lowed to medium, and GPC and WG in bohoth٦ lowed to the medium dough according to Farinograph tests (FDT, FST and MT) and SDSs volume and the studied cultivars means (Table ٢, Figures ٤, ٦, ٨, and ١٠). Because they were affected by the unusually extreme climatic conditions (Table ١). In fact, presence of the subunits ١٧+١٨ and ٢+١٢ together in the genomic material of bohoth٦ resulted in stronger dough than the dough which has subunits ٧+٨ and ٢+١٢ together as in cham ٦, perhaps because the subunits ١٧+١٨ are responsible of synthesis glutenin proteins more than subunits ٧+٨ as indicated by Mir Ali (١٩٩٥). The deletion in cham٤ to subunit ٢* at Glu-A١ locus negatively effected on the GPC and WG of flour, after that on the dough and bread quality. Because the deletion changes the composition of GPC and WG during duration synthesis and accumulate total proteins (gliadin and glutenin) during the grain filling period and consequently the end-use quality (Table ٤ and ٥). Shwery *et al*., (٢٠٠٣) demonstrated that allelic differences among genotypes affect the amounts and the properties of HMW-GS polymers of wheat gluten and the bread making properties of individual genotypes. Therefore, the deletion some alleles of glutenin subunits at Glu-A١ and Glu-B١ loci impacted negatively on the parameters of Farinograph test FDT, FST and MT and SDSs volume (Table ٣ and figures ٣, ٥, ٧ and ٩). The dough mixing strength was significantly reduced, because the deletion of subunits at Glu-A١ loci (null) and Glu-B١ loci (Table ٣).

The low amount of glutenins formed a weak gluten network was not able to extend itself, because it has the weak structure causes reduction to the dough stability and the network ruptures quickly. These results were agreed with (Branlard and Dardevet, ١٩٨٥; MirAli, ١٩٩٥; Gregova *et al*. (٢٠٠٦); Goesaert *et al*., ٢٠٠٥; Lagrain *et al*., ٢٠٠٦). Also, many studies reported that when some HMW glutenins are deleted, the dough mixing strength and bread making quality will be reduced (Lawrence *et al.,* ١٩٨٨; MacRitchie and Lafiandra, ٢٠٠١). The stability FST in bohoth٦ in both seasons (Figure ٥ and ٦). This results were similar to many results obtained by (Weegels *et al*., ١٩٩٤; Lafiandra *et al*., ١٩٩٩; Branlard *et al*., ٢٠٠١).In both seasons, the means of GPC and WG in bohoth٦ were better than the means in deleted cham٤ and cham٦ despite that the means of GPC and WG were reduced in season ٢٠٠٨.

Table ٤: Analysis of variances of total protein content (GPC) content in three studied cultivars at four environmental zones in two studied seasons ٢٠٠٧ and ٢٠٠٨ and the means of cultivars and zones.

Cultivars	Season	zone١	zone٢	zone٣	zone٤	Cultivar mean
Cham٤	٢٠٠٧	١٣,٠١Cc± ٠,٥١٥	١٦,٠Bc± ٢,٠٠٦	١١,٩Dc± ٠,٨٨٥	١٥,١Bc± ٠,٤٥٢	١٤,٥١d± ٠,٣٤٨
Cham٦		١٤,٠١Db± ٠,١٣٧	١٧,٠١Ab± ٠,١٥٤	١٤,٨٠Da± ١,٦٦٨	١٦,١Ad± ٠,٢٠١	١٤,٨٥C± ٠,٠٠١
Bohoth٦		١٤,٦Ca± ٠,٣٧٧	١٨,٠١Aa± ١,٨٥٢	١٢,٧Db± ٠,٧٨٢	١٦,٥Ba± ٠,٢٥١	١٥,٢٠a± ٠,٣٤٩
Means		١٣,٨٧± ٠,٩٨٠	١٧,٠١± ١,٦٥٣	١٣,١٣± ١,٧٢٠	١٥,٩٠± ١٠٤٧	
Cham٤	٢٠٠٨	١٣,٠٥Bc ±٠,٥٤٥	١٢,٠١Dc ±٠,١٤٩	١٣,١٥Ac ± ٠,٣١٢	١١,٩٠Dc ±٠,١٣٨	١٢,٣٥ ±٠,٧٢٢
Cham٦		١٤,٤٠Ab± ٠,١٧٨	١٢,٢٥Cb± ٠,٧١٨	١٤,٢٠Bb ± ٠,١١١	١٢,٢٥Cb± ٠,١٣٩	١٣.٤٦± ٠,٠٩٤
Bohoth٦		١٥,٥٠Aa± ٠,٣٦٧	١٢,٥٠Da± ٠,٥٦٩	١٥,٢٠Ba ± ٠,٢٠١	١٣,٣٠Ca± ٠,٠٠١	١٤,١٣± ٠,٨١٦
Means		١٤,٣٢± ١,٠٠٨	١٢,٢٥± ١,٠٥٦	١٤,١٨± ٠,٨٧٤	١٢,٤٨± ٠,٨٢٦	
Grand mean		١٤,١٣٨				
LSD ٠,٠٥ Cultivar X zone		٠,٠٣٥				
CV%		٠,٢				

LSD, Least significant difference of the means (٥٪ level); CV, Coefficients of variation.The numbers with superscript capital letters (A, B, C and D) refer to significant variation among varieties, while numbers with superscript small letters (a, b, c and d) refer to significant variation among zones.

Table ٥: Analysis of variances of wet gluten content (WG) in three studied cultivars at four environmental zones in two studied seasons ٢٠٠٧ and ٢٠٠٨ and the means of cultivars and zones.

Cultivars	Season	zone١	zone٢	zone٣	zone٤	Cultivar means
Cham٤	٢٠٠٧	٣٢,١Dc± ٠,٠١	٣٩,١٤Ab± ١,٨٣٧	٣٤,٨Bb± ٠,٨١	٣٤,٦Cc ± ٢,٦٥٧	٣٥,١٦± ٢,١٧٧
Cham٦		٣٥,١Db± ٠,٠٥٥	٣٧,٤Cc± ٢,٩٦٨	٣٩,٥Ba± ٢,٤٤٥	٤٠,٩Ab ± ٠,٥٧٨	٣٨,٢٣± ٠,٨٨٨
Bohoth٦		٣٥,٦Ca± ٠,٠٤٥	٤١,٩Ba± ١,١٣٢	٣٤,٢Dc± ٣,٢٥٥	٤٢,٨Aa ± ٢,٠٧٨	٣٨,٦٣± ١,٢٨٨
Means		٣٤,٢٧± ٣.٠٧٠	٣٩,٤٨± ٢,١٤٣	٣٦,١٧± ١,١٧	٣٩,٤٣± ٢,٠٩٧	
Cham٤	٢٠٠٨	٣٣,٢Ab ±٠,٦٥٢	٢٤,٠١cD ±٠,٢٥٨	٣٢,٠١Bc± ٠,٣٤٥	٣١,٥٥Cc± ٠,٥٦٥	٣٠,١٩± ٠,٤٥٠
Cham٦		٣٢,٥Bc± ٠,٤٥٦	٢٤,٢٥bC ±٠,٠٩١	٣٢,٥Bb ±٠,٢٦٢٥	٣٣,١٥Aa± ٠,٦٢٨	٣٠,٦٠ ± ٠,٠٧٨
Bohoth٦		٣٣,٤Ba± ٠,١٩٦	٢٤,٤٥aD ±٠,٣٤٩	٣٤,٠١Aa ±٠,٦٠٨	٣٣,١٠Cb± ٠,٠٦٢	٣١,٢٤ ± ٠,٥٦٢
Means		٣٣,٠٣± ٢,٣٥٦	٢٤,٢٤± ٦,٤٤١	٣٢,٨٤± ٢,١٦٢٥	٣٢,٦٠± ١,٩٢٢٥	
Grand mean		٣٣,٩٦١				
LSD ٠,٠٥ Cultivar X zone		٠,١٨٤				
CV%		٠,٣٥				

The interactions of subunit ٢* with subunits ١٧+١٨ in bohoth٦ resulted in the best composition and higher contents of the GPC and WG than cham٤ that has subunits ١٧+١٨, and cham٦ that has only subunit ٧+٨. These results in our study are a strong evidence on co-dominant to both subunit ٢* and subunits ١٧+١٨ together. Therefore, bohoth٦ which has subunits ٢*, ١٧+١٨ had larger means of GPC and WG than both of the cultivars cham٤ and cham٦ that have (subunits ١٧+١٨, subunits ٢* and ٧+٨) respectively. Peña *et al*., (١٩٩٥) confirmed common wheat varieties possessing five HMWG subunit components generally have stronger gluten character than the ones possessing three or four components. Too, the results in this study indicated bohoth٦ has next subunits ٢*, ١٧+١٨ and ٢+١٢ at (Glu-A١, Glu-B١ and Glu-D١) respectively, whereas it express the higher glutenin percentage into the extreme climatic conditions (high temperatures and water deficit). Also, other similar results to our results were confirmed by (Mir Ali, ١٩٩٥; Gregova *et al*., (٢٠٠٦); Goesaert *et al*., ٢٠٠٥; Lagrain *et al*., ٢٠٠٦).

The variances of GPC and WG means at studied environmental zones were noticed (Table ٤ and ٥). In season ٢٠٠٧ at zone٢ and zone٤ the means of GPC were ١٧,٠١٪ and ١٥,٩٪ respectively, and WG were ٣٩,٤٨٪ and ٣٩,٤٣٪ respectively, the means of GPC at zone٢ and zone٤ were higher than the means ١٣,٨٧٪ and ١٣,١٣٪ of both zone١ and zone٣ respectively, Also, the means of WG at zone٢ and zone٤ were ٣٤,٢٧٪ and ٣٦,١٧٪ of both respectively, (Table ٤ and ٥), despite there wasn't any significant difference between the means at zone٢ and zone٤. But, in season ٢٠٠٨ the means of GPC at zone٢ and zone٤ were ١٢,٢٥٪ and ١٢,٤٨٪ respectively, they were lower than the means ١٤,٣٢% and ١٤,١٨٪ of both zone١ and zone٣, respectively. But, the means of WG at zone٢ and zone٤ were ٢٤,٢٤٪ and ٣٢,٦٪ respectively, they were lower than the means ٣٣,٠٣٪ and ٣٢,٨٤٪ of both zone١ and zone٣ respectively (Table ٤ and ٥). Depend on this the results confirmed that the extreme environmental conditions (heat and water stress) that was dominant at zone٢ and zone٤ in season ٢٠٠٨ affected on syntheses and accumulations of total protein and gluten (storage proteins), because storage proteins accumulate from approximately ٦ day to the end of grain-filling (Panozzo *et al*., ٢٠٠١). Also, the extreme environmental conditions that was dominant in season ٢٠٠٨ at zone٢ and zone٤ maybe resulted in shorten the grains filling period. Jamieson *et al*., (٢٠٠١) has confirmed such as the fact, whereas reported that high temperature and/or drought effect the balance of protein fractions. Was reported by Blumenthal *et al*., (١٩٩٣) that for certain varieties, flour, dough**,** and baking quality parameters are altered in response to a short period of heat stress >٣٥ °C, and some of these effects have been linked to an increased gliadins-to-glutenins ratio (Blumenthal *et al*., ١٩٩١) and decreases in the proportion of the high molecular weight glutenins (HMW) (Wardlaw *et al*., ٢٠٠٢). So that, the means of GPC% and WG% in all studied zones in season ٢٠٠٧ were high, but they decreased in season ٢٠٠٨ in generally (Table ٤ and ٥). Was noticed that the decreasing average of the means GPC and WG when the comparison between the means at zone١ and zone٣ in both seasons was very little. While the decreasing average of the means of GPC and WG in zone٢ and zone٤ in both seasons was very high when the comparison between these means. Anyway, the percentage of GPC and WG in bohoth٦ at zone٢ and zone٤ were ((١٢,٥٪ and ١٣,٣٠٪), (٢٤,٤٥٪ and ٣٣,١٥%), respectively higher than the percentages of GPC and WG in both cultivars cham٤ and cham٦, whereas the percentages of GPC in cham٤ were ((١٢,٠١٪ and ١١,٩٪), respectively and to WG were (٢٤,٠١٪ and ٣١,٥٥٪)) respectively, and cham٦ were ((١٢,٢٥٪ and ١٢,٢٥٪), respectively and to WG were (٢٤,٢٥٪ and ٣٣,١٥٪)), respectively (Table ٤ and ٥). Thus, this results confirmed that bohoth٦ is distinguished from cham٤ and cham٦, because the first cultivar has the improving alleles to dough strength at both Glu-A١ and Glu-B١ loci and it is more tolerant to extreme environmental conditions as that was dominant at zone٢ and zone٤ in season ٢٠٠٨. In this results, the interaction between cultivar (genotype) and the extreme environmental conditions indicated bohoth٦ was the distinguished cultivar. Other studies similar to our study reported that although grain protein composition depends primarily on genotype, it is significantly affected by environment factors and their interactions (Triboï *et al*., ٢٠٠٠; Zhu and Khan, ٢٠٠١).

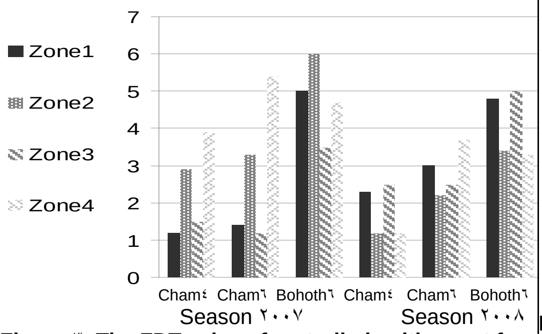

Figure ٣. The FDT values for studied cultivars at four zones in two seasons.

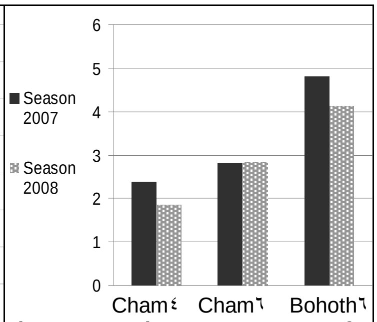

Figure ٤. The FDT means for studied cultivars at four zones in two seasons.

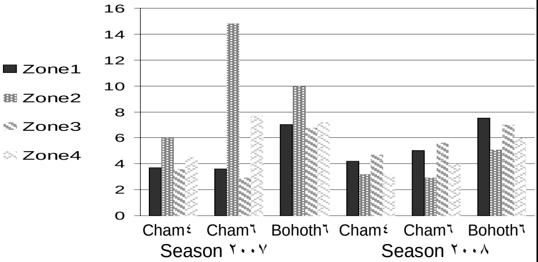

Figure ٥. The FST values for studied cultivars at four zones in two seasons.

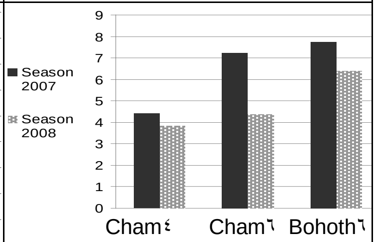

Figure ٦. The FST means for studied cultivars at four zones in two seasons.

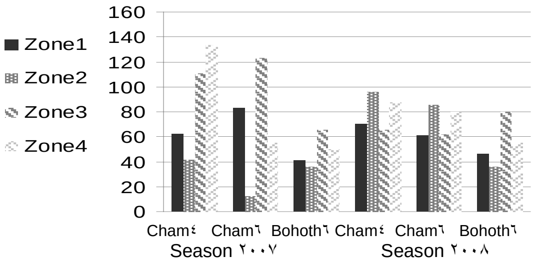

Figure ٧. The MT values for studied cultivars at four zones in two seasons.

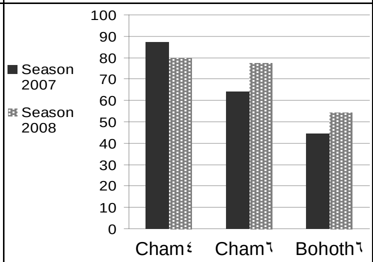

Figure ٨. The MT means for studied cultivars at four zones in two seasons.

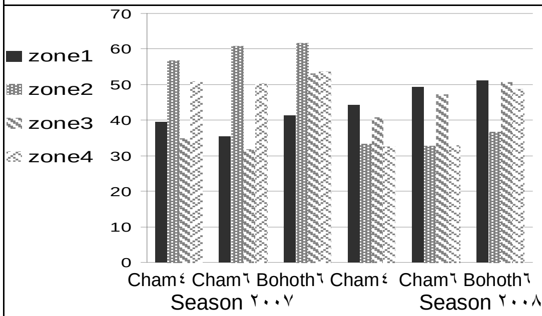

Figure ٩. SDSs volume to studied cultivars at four zones in two seasons.

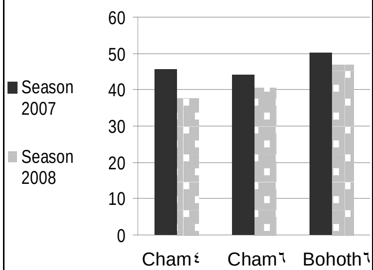

Figure ١٠. The means of SDSs volume to studied cultivars at four zones in two seasons.

CONCLUSION

This study indicated that bohoth٦ has the subunits ٢*, ١٧+١٨ and ٢+١٢ at (Glu-A١, Glu-B١ and Glu-D١) respectively, and cham٦ has the subunits ٢*, ٧+٨ and ٢+١٢ at (Glu-A١, Glu-B١ and Glu-D١) respectively, so cham٦ expressed lower glutenin than bohoth٦, but it was higher than cham٤ which has the subunits ١٧+١٨ and ٢+١٢ at (Glu-B١ and Glu-D١) respectively. The deletions in the glutenin loci resulted in significant (p<٠,٠٥) reduction of the mean of GPC and WG by comparison between the means of three studied cultivars and bohoth٦ was the best one cham٤ and cham٦ that have the deletion at their loci. Also, bohoth٦ had a strong dough result to the increasing of the GPC and WG content. Farinograph test and SDSs volume had indicated a presence to significant effects of the GPC and WG contents on dough strength at four studied environmental zones in both seasons. Bohoth٦ was more tolerant to these extreme environmental condition than cham٤ and cham٦, so it gave the highest content of GPC and WG and best dough strength at same both zones (zone١ and zone٢). Thus suggests that bohoth٦ can perform better than cham٤ and cham٦ if it grows in regions of Syria having similar extreme environmental conditions to the one dominated in both zone٢ and zone٤ during season ٢٠٠٨ season**.**

REFERENCES

Blumenthal, C.S.; E.W.R. Barlow and C.W. Wrigley (١٩٩٣). Growth environment and wheat quality: the effect of heat stress on dough properties and gluten proteins. J Cereal Sci ١٨: ٣–٢١.

Blumenthal, C.S.; I.L. Batey; F. Bekes; C.W. Wrigley and E.W.R. Barlow (١٩٩١). Seasonal changes in wheat-grain quality associated with high temperatures during grain filling, Australian Journal of Agricultural Research ٤٢:١. ٢١ – ٣٠.

Branlard, G. and M. Dardevet (١٩٨٥). Diversity of grain protein and bread wheat quality. II. Correlation between high molecular subunits of glutenin and flour quality characteristics. J. Cereal Sci. ٣: ٣٤٥-٣٥٤.

Branlard, G.; M. Dardevet; R. Saccomano; F. Lagoutt and J. Gourdon (٢٠٠١). Genetic diversity of wheat storage proteins and bread wheat quality. Euphytica ١١٩, ٥٩–٦٧.

Daniel, C. and E. Triboï (٢٠٠٢). Changes in wheat protein aggregation during grain development: effects of temperatures and water stress. European Journal of Agronomy ١٦, ١–١٢.

Dupont, F. M.; W. J. Hurkman; W. H. Vensel; C. Tanaka; K. M. Kothari; O.K. Chung and Altenbach (٢٠٠٦). Protein accumulation and composition in wheat grain: effects on S. B. mineral nutrients and high temperature. Eur. J. Agron., ٢٥:٩٦-١٠٧.

Gálová, Z.; I. Michalik; H. Knoblochova, and E. Gregova (٢٠٠٢). Variation in HMW glutenin subunits of different species of wheat. Rostilinna Vyroba. ٤٨: ١٥-١٩.

Goesaert, H.; K. Brijs; W.S. Veraverbeke; C.M. Courtin; K. Gebruers and J.A. Delcour (٢٠٠٥). Wheat flour constituents: how they impact bread quality, and how to impact their functionality, Trends Food Sci. Tech. ١٦:١٢-٣٠.

Gregova, E.; J. Hermuth; J. Kraic and L. Dotlacil (٢٠٠٦). Protein heterogeneity in European wheat landraces and obsolete cultivars. Additional information II. Genetic Resour. Crop Evol., ٥٣: ٨٦٧–٧١.

Gupta, R. B. and F. MacRitchie (١٩٩٤). Allelic variation at glutenin subunit and gliadin loci Glu-١, Glu-٣ and Gli-١ of common wheats. II. Biochemical basis of the allelic effects on dough properties. J. Cereal Sci. ١٩:١٩-٢٩.

Gupta, R.B. and K.W. Shepherd (١٩٩٠). Two-step one-dimensional SDS-PAGE analysis of LMW Subunits of glutenin. ١. Variation and genetic control of the subunits in hexaploid wheats. Theoretical and Applied Genetics, ٨٠:٦٥-٧٤.

Guttieri, M.J., J.C. Stark; K. O'Brien and E. Souza (٢٠٠١). Relative sensitivity of spring wheat grain yield and quality parameters to moisture deficit. Crop Science ٤١, ٣٢٧–٣٣٥.

Jamieson, P.D.; P.J. Stone and M.A. Semenov (٢٠٠١). Towards modelling quality in wheat—from grain nitrogen concentration to protein composition. Aspects of Applied Biology ٦٤, ١١١–١٢٦.

Khatkar, B.S.; A.E. Bell and J.D. Schofield (١٩٩٦). A Comparative Study of the Inter-Relationships - Between Mixograph Parameters and Bread-Y I Making Qualities of Wheat Flours and Glutens. J Sci. Food Agric ١٩٩٦, ٧٢:٧١-٨٥.

Lafiandra, D.; S. Masci; C.S. Blumenthal and C.W. Wrigley (١٩٩٩). The formation of glutenin polymer in practice. Cereal Foods World ٤٤, ٥٧٢–٥٧٨.

Lagrain, B.; K. Brijs and J.A. Delcour (٢٠٠٦). Impact of redox agents on the physicochemistry of wheat gluten proteins during hydrothermal treatment, J. Cereal Sci. ٤٤ , pp ٤٩-٥٣.

MacRitchie, F. and D. Lafiandra (٢٠٠١). The use of near-isogenic wheat cultivars to determine protein composition-FDSnctionality relationship. Cereal Chem. ٧٨(٥): ٥٠١-٥٠٦.

Mir Ali, N. (١٩٩٥) .Performance of high-protein mutant lines of Triticum aestivum (L.) under semi-arid conditions of Syria Field Crops Research, Volume ٤١:٢, ١٠١-١٠٨.

Panozzo, J.F.; H.A. Eagles and M. Wootton (٢٠٠١). Changes in protein composition during grain development in wheat. Australian Journal of Agricultural Research ٥٢, ٤٨٥–٤٩٣.

Payne, P. I. and G. J. Lawerence (١٩٨٣). Catalogue of alleles for the complex gene loci, Glu-A١, Glu-B١, Glu-D١ which code for high-molecular-weight subunits of glutenin in hexaploid wheat. Cereal Res. Communs. ١١: ٢٩-٣٥.

Peña, R.J.; J. Zarco-Hernandez, and A. Mujeeb-Kazi, (١٩٩٥). Glutenin subunit compositions and breadmaking quality characteristics of synthetic hexaploid wheats derived from Triticum turgidum × Triticum tauschii (coss.) Schmal Crosses, Journal of Cereal Science, ٢١:١, ١٥-٢٣.

Peterson, C.J.; R.A. Graybosch; D.R. Shelton and P.S. Baenziger (١٩٩٨), Baking quality of hard winter wheat: Response of cultivars to environment in the Great Plains, Euphytica ١٠٠: ١٥٧–١٦٢.

Shwery, P.R.; N.G. Halford and D. Lafiandra (٢٠٠٣). Genetics of wheat gluten proteins. Advances in Genetics. ٤٩: ١١١-١٨٤.

Triboï, E.; A. Abad; A. Michelena; J. Lloveras; J.L. Ollier; C. Daniel (٢٠٠٠). Environmental effects on the quality of two wheat genotypes. ١. quantitative and qualitative variation of storage proteins. European Journal of Agronomy, ١٣, pp ٤٧–٦٤.

Uthayakumaran, S.; I.L. Batey; and C.W. Wrigley (٢٠٠٤). On-the-spot identification of grain variety and wheat-quality type by Lab-on-chip capillary electrophoresis. J. Cereal Sci. ٤١: ٣٧١-٣٧٤.

Wardlaw, I.F. and L. Moncur, (١٩٩٥). The response of wheat to high temperature following anthesis:I The rate and duration of kernel filling. Aust J Plant Physiol ٢٢: ٣٩١-٣٩٧.

Wardlaw, I.F., Blumenthal C., Larroque O., Wrigley C.W. (٢٠٠٢). Contrasting effects of chronic heat stress and heat shock on kernel weight and flour quality in wheat. Functional Plant Biology ٢٩, ٢٥–٣٤.

Weegels, P.L., R.J. Hamer and J.D. Schofield (١٩٩٤). Functional properties of wheat glutenin. J. Cereal Sci. ٢٣: ١-١٨.

Williams, P.H.; F. Jaby El-Haramein; H. Nakkoul and S. Rihawi (١٩٨٦). Crop quality evaluation methods and guidelines, International center for agricultural research in the dry zones, Technical manual No.١٤, pp ٢-٣١.

Wrigley, C.W. (١٩٩٦). Gaint proteins with flour power. Nature. ٣٨١: ٧٣٨-٧٣٩.

Zhu, J. and K. Khan (٢٠٠١). Effects of genotype and environment on glutenin polymers and breadmaking quality. Cereal Chemistry, ٧٨, ١٢٥–١٣٠.

تأثير التغيرات الأليلية للجلوتينين على نوعية العجين لبعض أصناف القمح الطري

عماد التيناوي[١]، وليد العك[٢]، سلام لاوند[٣]و عبد الله الطاهر[١]

١- قسم التقانات الحيوية في الهيئة العامة للبحوث العلمية الزراعية-دوما-دمشق-سورية.

٢- إدارة المحاصيل في الهيئة العامة للبحوث العلمية الزراعية-دوما-دمشق-سورية.

٣- كلية الزراعة-جامعة دمشق-سورية.

تعتبر نوعية الناتج النهائي للقمح الطري حساسة للصنف والظروف البيئية السائدة خلال فترة امتلاء الحبة حيث يؤثران على اصطناع وتكدس بروتينات التخزين في الحبة. نفذت الاختبارات الحقلية لثلاثة أصناف قمح طري (بحوث٦، شام٤ وشام٦) في أربع مناطق مختلفة بيئياً لموسمين زراعيين ٢٠٠٧ و٢٠٠٨ لدراسة تأثيرات التغيرات الأليلية في كل صنف مدروس وتأثيرات الظروف البيئية السائدة في كل منطقة على محتوى الجلوتين ونوعية العجين. حللت بروتينات التخزين بطريقة SDS-PAGE التي أوضحت وجود بعض التغيرات الأليلية وغياب بعض الأليلات من مواقعها على الكروموزومات. الأليلات الثلاثة المختلفة كانوا محددين في المواقع (Glu-A١ and Glu-B١). أفضل محتوى للجلوتين كان في البحوث٦ بسبب عدم وجود أي حذف أليلي في مواقعه الوراثية مقارنة مع الشام٤ والشام٦. أيضاً انخفض محتوى الجلوتين عندما ارتفعت درجة الحرارة إلى ٣٠مْ وما فوق لفترة طويلة مترافقة مع نقص الماء خلال فترة امتلاء الحبة. أجريت تحاليل باختبارات الفارينوغراف (وقت تطور العجينة وثبات العجين والقدرة على تحمل العجن)،أثبت هذا الاختبار أن البحوث٦ يملك أفضل مجموعة أليلية لاصطناع وتكديس بروتين الجلوتين في الحبوب. أعطى البحوث٦ في المنطقين البيئيتين قوة عجين تراوحت بين القوة في الموسم ٢٠٠٧ إلى المتوسطة في الموسم ٢٠٠٨ نتيجة لتأثير الشروط المناخية الشديدة عيرالاعتيادية. بينت النتائج أن الصنف بحوث٦ أكثر تحملا للجفاف من الصنفين الآخرين شام ٤وشام٦.

الكلمات المفتاحية: جلوتينين، SDS-PAGE، محتوى الجلوتين، نوعية القمح الطري، الظروف المناخية، اختبار الفارينوغراف ونوعية العجين.

قام بتحكيم البحث

أ.د / مسعد عبد العزيز أبو رية	**كلية الزراعة – جامعة المنصورة**
أ.د / خالد على أبو شادى	**مركز البحوث الزراعية**