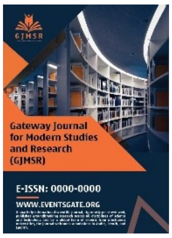
https://doi.org/10.61856/qg508e87



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Evaluation of Some Different Paprameters of Mixolab Device of Some Approved Syrian Soft Wheat Varieties

Wisal Ali Alhommada
Alfurat university-Syria
wisal.alhommad@gmail.com

Received: 8 Aug. 2024 – Accepted: 18 Oct. 2024 Available online: 27 Nov. 2024

ABSTRACT: This research aims to study some of different parameters of some Syrian soft wheat varieties recently approved for cultivation, using Mixolab device according to the ICC.No.173 method; The required samples of durum wheat varieties: Sham8, Buhouth8, and Doma2 were obtained from the Research Station of the Scientific Agricultural Research Center, at a rate of three replicates for each sample (variety). All analyzes were also conducted in the Grain Technology Laboratory at the College of Engineering. Agricultural, Al-Furat University. The results of estimating percentage of protein showed that there were significant differences between the studied varieties, reaching 9.8%, 13.2%, and 13.3% for bohouth8, Sham8, and Doma2, respectively. It was also shown that there was a significant difference in the average percentage of absorbed water among the varieties, and the average time of dough formation for the varieties also differed. The average time required for starch gelatinization differed significantly between the studied varieties, The results also showed that the average torque for the starch gel stabilization phase ranged between 1.61 N,m for the Doma 2 variety and 1.54 N,m for the Buhouth8 variety and 1.47 N,m for the Sham 8 variety, while the average fall number was characterized by a high rate for the studied varieties, which reached 356, 361, and 380 seconds for the Buhouth8, Sham 8, and Doma 2 varieties, respectively.

Keywords: Soft Syrian wheat varieties, falling number, Rheological properties, Mixolab device,Gelatinization

تقييم بعض المقاييس المختلفة لجهاز المكسولاب لبعض أصناف الأقماح السورية الطرية

وصال علي الحماده
جامعة الفرات- سورية
wisal.alhommad@gmail.com

الملخص: يهدف هذا البحث لدراسة بعض المقاييس المختلفة لبعض أصناف الأقماح السورية الطرية المعتمدة حديثاً باستخدام جهاز المكسولاب ووفقاً لطريقة ICC.No.173، وكانت الأصناف المختبرة هي شام8 وبحوث8 ودوما2، والتي تم الحصول عليها من محطة البحوث الزراعية، وبمعدل ثلاثة مكررات لكل صنف، وتم إجراء كافة التحاليل في مخبر تكنولوجيا الحبوب في كلية الزراعة في جامعة الفرات. بينت نتائج تقييم النسبة المئوية للبروتين وجود فروق معنوية بين الأصناف المختبرة وتراوحت بين 9.8% و13.2% و13.3% لكل من بحوث8 وشام8 ودوما2 على التوالي، وكذلك ظهرت فروق معنوية بين متوسط نسبة الماء الممتص، ومتوسط الزمن اللازم لجلتنة النشاء اختلفت معنويا بين الأصناف المدروسة، وكذلك أظهرت النتائج ان متوسط العزم لثبات جل النشاء تروح بين N,m1.61 للصنف دوما2 وN,m1,54 للصنف بحوث 8 و1.47 N,m للصنف شام8، بيما تميز رقم السقوط بمعدل مرتفع للصنف المدروسة، والتي بلغت 356 و 361 و 380 ثانية لكل من بحوث8 وشام8 ودوما2 على التوالي.

الكلمات المفتاحية: أصناف الأقماح الطرية، رقم السقوط، الخواص الريولوجية، جهاز المسكولاب، الجلتنة.

1. Introduction

Wheat is the most cultivated type of grain in the world, and its production has increased significantly in the past fifty years, with global wheat production reaching about 654 million tons annually, China, India, the United States, Russia, France, Canada, and Australia areconsidered among the most important countries producing the wheat (FAO, 2010).
Recently Scientists in laboratories, agricultural research stations, and universities develop new varieties by hybridization, in which pollen grains from one variety are used to fertilize plants of another variety, and the result forms a new variety that carries some characteristics from both parents. The seeds resulting from the hybrid are grown for several generations, in order to increase the degree of Purity and ensuring the stability of the desired characteristics of the new variety (Wishart, 2004). During the last century, new varieties of wheat were adopted, differing from each other in productivity, growing season, ability to resist cold and drought, and the extent of their ability to tolerate diseases and insect pests. Some of these varieties are grown in plain areas, and some are grown in mountainous. Some of them grow well in hot climates and others in cold one. Until recently, it was possible to produce strains that have the ability to grow and produce in Alaska or Siberia, and among these varieties are those that are suitable for making bread. Some of them are suitable for producing various types of pasta or pastries (Hancockm 2004).
Wheat in Syria takes the first place among grains in terms of cultivated area and production. Production rose during the nineties of the last century from two million tons to more than four million tons for several reasons, including the adoption of new improved varieties with high yields and the application of modern agricultural techniques, The area cultivated with this amounted to The crop amounted to 1,7 milion tons, while reduced to 1.27 milion tons in 2018(ASC, 2018).
There are two types of wheat: hard wheat, 2n = 28, and soft wheat, 2n = 42 (Wishart, 2004). The proportion of the two types of wheat in global and local production varies depending on several factors, including climate conditions, the nature of the land, the productivity of varieties, resistance to pests, and the economic return of the farmer.
In the last decade, Syria has shifted to cultivating larger areas of soft wheat, at a rate of more than 50% of the total area allocated to this crop, as a result of farmers' tendency to cultivate modern, high-yielding varieties (ASC, 2018).
Anatomically, the wheat grain consists of three main parts: the embryo, which constitutes 2-4% , the pericarp, which constitutes 7-8%, and the endosperm, which constitutes 81-84% of the weight of the grain (Dewettinck et al., 2008); In terms of chemical composition, the grain consists of carbohydrates, protein, mineral elements, fibers, and lipids, which play an important role in the physical, chemical, and rheological properties (Alfien, 2004; AlSaleh, 1996).
Starch is considered one of most important components of carbohydrates in all types of grains. It consists of amylose and amylopectin chains, which in turn consist of glucose. Its percentage is about 65-68% of the weight of the wheat grain, and 78-82% of the flour (AlSaleh, 1996; Feillet, 2000), the process of starch gelatinization affects the dough's viscosity and rheological properties, giving it a major role in manufacturing processes that affect the final product specifications (Campbell, 1996).
Starch quality can be known by estimating the falling number, which expresses the degree of amylase enzymatic activity. Starch affects the characteristics of the foods that are included in its composition, as the decomposition of part of the amylose and amylopectin when appropriate conditions are available, such as high water content and temperature, leads to a change in the properties of starch and thus the specifications of the product made from it (AlSaleh, 1996). An increase in amylase enzymatic activity also leads to a decrease in Dough formation time (Banu, 2011).

The protein content of the wheat grain is affected by the genetic composition and climatic conditions during the period of growth and development of the grain, and the protein content in wheat ranges between 6-22% depending on the type and variety (AlSaleh, 1996; Al-Masry and Alkhyate, 1991); The proteins responsible for forming dough with high stability during the formation stage (Lazaridou, 2007), also considered basic measure for determining the quality of baking (Banu, 2011)

Soft wheat is characterized by its low content of proteins and starch, so it is used in the manufacture of cakes. and flat pies, biscuits, cakes and pastries (Watson, 1983; Gibson and Benson, 2002).

Several types of devices are used that depende on the principle of kneading to evaluate the quality of protein and starch for different types of grains. The farinograph and the extensograph devices specialize in studying the properties of protein. As for studying the properties of starch, other techniques must be used, such as the amylograph and the falling number devices that study the behavior of starch and its properties.

As for evaluating the suitability quality of the different types of the final product, researchers are forced to conduct different baking experiments or to manufacture pasta. Recently, a new technology was introduced that relies on estamiting the quality of the grains, including the rheological properties of the dough, especially with regard to the quality of the protein and what could take the place of farinographs and extensographs. As well asstudying the quality of starch, for which the amylograph technique was used. This device can also study the behavior of starch and protein, the two basic components of flour, under the influence of high heat up to 90°C, similar to baking experiments

The main advantage of the Mixolab device techniques is that it measures, for the first time, torque in real units (Newton .meter) over a real time, unlike the farinograph units that are considered virtual (the Brabender unit). It is also possible to estimate the fall number of grains, that is, estimate the enzymatic activity of amylase. Studies have also proven the existence of a significant correlation with an old techniques (Kahraman *et al*., 2008; Ţăin *et al*., 2008; Kokse *et al*., 2009). also there was highly correlated with the zeliny test (Banu *et al*., 2011), as results obtained from Mexolabwhich related to the texture, size, and shape of the bread and thus the quality of the resulting bread (Yan *et a*l., 2009).

2. Objective of the Research:

This research aims to estimiting the rheological characteristics of some Syrian soft wheat varieties (Sham8, Buhouth8, and Doma2) using the different parameters of the Mixolab device.

3. Research Materials and Methods:

3. 1. Sample Preparation:

The required samples of soft wheat: Sham 8, Buhouth 8 and Doma 2 were obtained from the Research Station of the Center for Scientific Agricultural Research, at a rate of three replicates for each sample (variety) and with a weight of 5 kg for each replicate. The samples for the different varieties were purified by sifting them on a slotted sieve. Size / 1 x 20 mm / used to purchase wheat at the General Organization for Grain Trade and Manufacturing (where only the economic part was isolated). Then the grains were purified manually, separating the rest of the particles and impurities to obtain a grain purity of approximately 99.9%. Then the grains were sterilized at a low temperature -23 °c for 72 hours to eliminate different insect stages.

All the various analyzes were conducted in the Grain Technology Laboratory at the Faculty of Agricultural Engineering, Al-Furat University. The samples were moistened in preparation for grinding by raising their water content to 16.5% in order to facilitate the process of separating the endosperm. Then they were ground using a Chopin CD2 grinder designated for soft wheat, with two passes for each sample, in order to conduct chemical and rheological tests.

3.2.The tests studied:

a. Physical tests:

Water content determination: Water content was determined according to AACC method 44-15A using a Chopin EM10 drying oven, at a temperature of 130°C for one hour.

b. Chemical tests:

Protein estimation: The protein content was estimated using a Gerhertvapodest 45s Kjeldahl device according to the AACC method 46-16, using the conversion factor (N×5.7).

c. **Rheological tests:**

Rheological tests for flour samples were conducted using the Mixolab device from Chopin, where the ICC.No.173 method was used in the tests according to the Chopin+ protocol .

This technique allows for evaluating the quality of flour by studying the quality of starch and protein of the samples, as approximately 50 g of the flour sample is used in the test (Collar *et al*., 2007; Ozturk *et al*., 2008), and thus this device allows studying the rheological properties of the dough through a standard curve consisting of many stages, each stage having a specific significance shown in Figure 1.

C1: showed the ability of the dough to absorb water.

C2: measurement of protein weakening under the influence of heat and mechanical action.

The previous two stages are similar to farinograph deviece, which determines the water absorption of flour, the stability and weakness of the dough (Hadnađeva *et al*., 2011).

C3: Explains the mechanism of starch gelatinization, and this stage represents the falling number device.

C4: Expresses the stability of the starch gel amd enzymatic activity.C5: shows the extent of starch decline during cooling, and these two stages represent to the (Hadnađeva *et al*., 2011).

α: slope of the curve between the end of the mixing phase at 30°C and C2; It gives an indication of how quickly a protein weakens due to heat.

β: the slope of the curve between stages C2 and C3; It shows the speed of starch gelatinization

γ: slope of the cure between stages C3 and C4; It gives an indication of the speed of decomposition and enzymatic damage to starch (Hadnađeva *et al*., 2011; Chopin Mixolab User's Manual, 2006; Mixolab applications handbook, 2006).

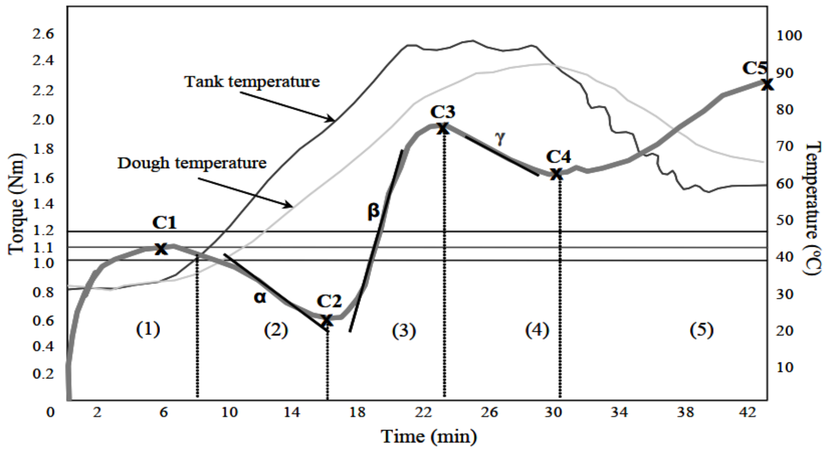

Figure 1 Standard curve recorded by the Mixolab device

4. Results and Discussion:

4.1. Chemical tests:

The results in Table 2 showed that there were significant differences in the average protein percentage for the different varieties, as this average reached 9.8, 13.2, and 13.3% for the Bohouth8, Sham8, and Doma2 varieties, respectively. The difference in the average protein percentage in the studied varieties may be due to the difference in the genetic structure of the varieties (AlSaleh1996; Al-Masry and Al-Khayat, 1991).

4.2.Rheological tests:

Using the Mixolab device to study the rheological properties of the studied flour samples enabled us to obtain curves for each of them Figure(2, 3, and 4), which are similar in general form to the standard curve (Figure 1).

Table (2) shows the results of the rheological tests for the soft wheat varieties used in the study. It is noted that the average percentage of water absorbed differs significantly according to the varieties, and the highest average was for the variety Bahouth 8 (63.8%), while the lowest average was for the variety Doma2 (57.3%), and this may be due to the percentage of absorbed water being affected by several factors, especially protein quality, starch characteristics (damaged starch, enzymatic hydrolysis) and the size of flour grains (Dapčević *et al.*, 2009).

Table (2) Mixolab curve results for the tested Syrian wheat varieties.

Category	Doma2	Bohouth8	Sham8	$LSD_{0.05}$
protein	13.3^{a}	9.8^{b}	13.2^{c}	0.02
Water absorption (M)	57.3^{c}	63.8^{b}	61.4^{a}	0.17
Dough formation time)	5.7^{c}	3.3^{b}	2.1^{a}	0.19
Stability (M)	7.0^{c}	4.6^{b}	2.7^{a}	1.02
Capacity (N.m)	0.07^{cba}	0.08^{b}	0.06^{a}	0.07
Falling number(S)	380^{cba}	356^{ba}	361^{a}	25.8

The average dough formation time for the studied varieties differed with a significant difference depending on the varieties, as this average reached 5.7, 3.3, and 2.1 minutes for the varieties Douma2, Bohouth8, and Sham8, respectively Table (2). This may be due to the difference in the protein content of the varieties studied Table(2), which the this time is affected by the properties and quantity of proteins, as this time increases with the increase in gluten content. This explained the ability of protein molecules to bind free water to a greater extent compared to varieties with low protein content (Chopin Mixolab User's Manual , 2005; CATTERAL , 1995; Rasper and walker, 2000).

As the average of stability of the dough for the studied varieties, it ranged between good values for the Doma 2 and Buhouth 8 varieties, which reached 7 and 4.6 minutes, respectively, and the stability value is weak for the Sham8 variety which was 2.7 minutes (Figures 2, 3, 4). This indicates the strength of the protein network, the quality of the protein, and its resistance to the kneading process (Dapčević et al., 2009; Catteral , 1995).

The results of Table (2) show the difference in the average capacity of the varieties, where the highest value was for the variety Bohouth 8 (0.08) N.m, compared to the varieties Doma 2 and Sham 8 (0.07 - 0.06) N. m, as a higher capacity indicates a higher elasticity of the dough, while average mechanical weakness of the different varieties also differed with a significant difference.

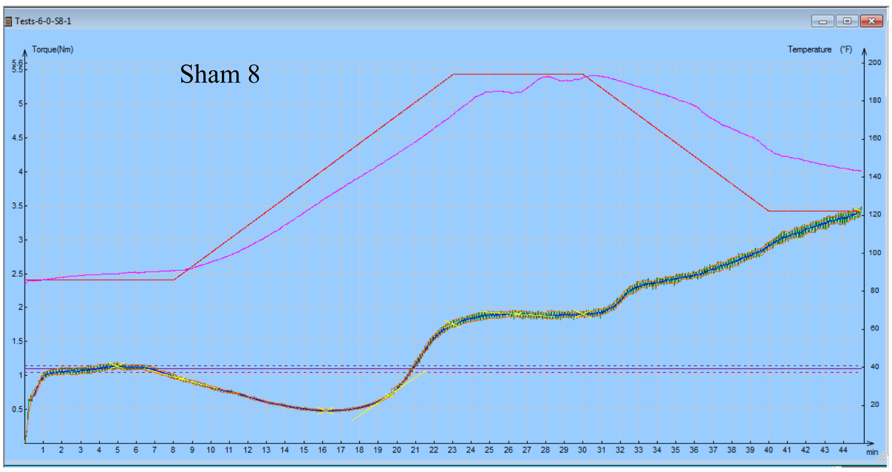

Figure 2 The curve produced by the Mixolab device for the Sham 8 variety

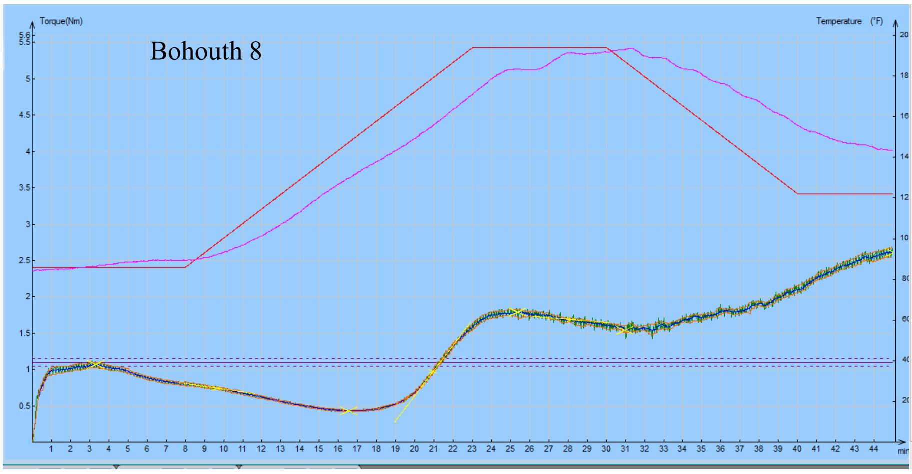

Figure 3 The curve produced by the Mixolab device for the Bohouth 8 variety

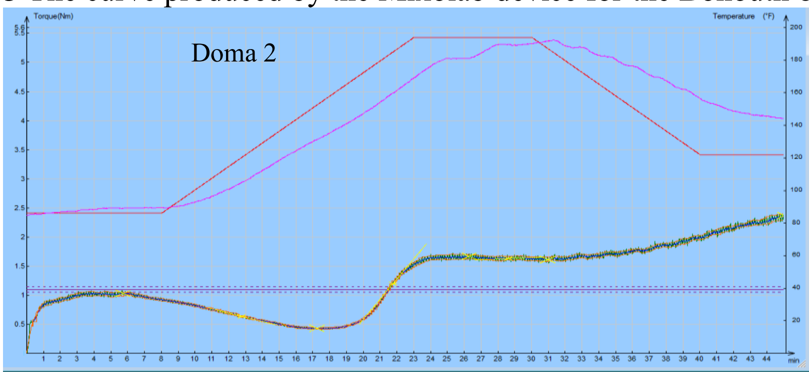

Figure 4 The curve produced by the Mixolab device for the Doma 2 variety

While value of falling number as in the Table (2) was characterized by an increase in the studied varieties, which was 356, 361, and 380 seconds for the varieties Bohouth 8, Sham 8, and Doma2, respectively, without observing any significant differences. This indicates as a decrease in the amylase activity of these varieties, and in general this is what distinguishes Syrian varieties due to the coincidence of their harvest date with dry weather (Alsaleh, 2006)
The results of Table (3) show that torque of the C2 stage, which indicates the extent of the protein's weakness, ranged between 0.43 N. m for the Doma2 and Bohouth8 varieties and 0.38 N. m for the Sham8 variety. As the temperature rises, the protein is destroyed and large amounts of water are released, which leads to a decrease in the stability of the protein network. in this stage, the proteolytic enzymes are at their peak activity (Stoenescu *et al*., 2010; Haros *et al*., 2006). As for time of this stage C2, it differed significantly between the studied varieties, and with regard to the average thermal weakness, no significant difference was observed between the varieties, and the differences in the average weakness resulting from high temperature may be due to its type and quality of protein.
In the third stage, C3, which expresses the state of the starch (physical and chemical properties) with an increase in temperature (Rosell *et al*., 2007; Huange *et al*., 2010), where the starch's absorption of water liberated from the denatured proteins leads to the swelling of the granules and the release of Amylose and thus higher torque (Thomas *et al*., 1999).

Table (3) Mixolab curve results for the tested Syrian wheat varieties**.**

Category	Sham8	Bohouth8	Doma2	$LSD_{0.05}$
Mechanical weakness (Nm)	1.2^{a}	0.3^{b}	0.09^{c}	0.003
Torque C2 (Nm)	0.38^{a}	0.43^{ba}	0.43^{cba}	0.19

C2 time (d))	16.8^{a}	16.5^{b}	17.3^{c}	0.22
Thermal weakness	0.4^{a}	0.4 ^{ba}	0.51^{cba}	0.17
Torque C3 (Nm)	1.54^{a}	1.79^{b}	1.67^{cba}	0.19
C3 time (d)	24.6^{a}	25.4^{ba}	26.3^{cb}	1.50
Gelatinization onset temperature (ºC)	54.6^{a}	54.3^{ba}	55.2^{cba}	1.70
C3-C4 torque (Nm).	0.1^{a}	0.25 ^{b}	0.06 ^{ca}	0.14
Temperature C3 (ºC)	82.9^{a}	84.1^{ba}	82.8^{cba}	1.70
Torque C4 (Nm	1.47^{a}	1.54^{ba}	1.61^{c}	0.14
C4 time (d)	32.3^{a}	30.9^{ba}	^{cba}30. 9	1.57
Temperature C4 (ºC)	87.6^{a}	89.4^{b}	88.8^{c}	2.10
Torque C5 (Nm)	2.08^{a}	2.61^{b}	2.37^{c}	0.18
Retrogradation torque (Nm)	0.6^{a}	1.07^{b}	0.76^{c}	0.001
α (Nm/min).	-0.044^{a}	-0.038^{b}	0.072^{c}	0.0003
β (Nm/min).	0.316^{a}	0.346^{b}	0.346^{cb}	0.0001
γ (Nm/min)	-0.024^{a}	-0.022^{b}	0.012^{c}	0.0001

Significant differences were found between two varieties, Buhouth 8 and Sham 8, while there was no significant difference between the variety Doma 2 and the two varieties Buhouth 8 and Sham 8. As for time required for starch gelatinization, it reached 26.3, 25.4, and 24.6 minutes for the varieties Doma 2, Buhouth 8 and Sham 8, respectively, and without significant difference except for Doma 2 Sham8, the differences were significant, and the average temperature required for starch gelatinization was 54.6, 54.3, and 55.2°C for the varieties Sham8, Bohouth8, and Doma2, respectively.

Temperature at the beginning of the gelatinization process was close for all studied varieties, around 55°C, with no significant differences between the averages, while the moment of destruction (the gelation was destroyed) differed according to the varieties and the highest value was in Sham 8 variety with 0.1 N. m, and the lowest in Doma 2 variety with 0.06 N. m. This stage related with the quality of starch.

The results of Table (3) also show that torque for the C4 starch gel stabilization phase ranged between 1.61 N.m for the Doma 2 variety and 1.54 N.m for the Bohouth8 variety and 1.47 N.m for the Sham8 variety, as the decrease in torque results from the physical destruction of the starch granules due to the mechanical and thermal stress applied to them (Rosell *et al.*, 2007), while the average time for the starch gel was 32.3 m for the Sham8 variety and 30.9 m.for the two varieties of Bohouth 8 and Doma 2 and without significant differences, while the stability temperature of the starch gel differed according to the varieties, but without any significant differences between these varieties.

The value of torque at the C5 stage ranged between 2.6 to 2.08 N.m for two varieties, Bohoth8 and Sham8, respectively, with significant differences between the averages of the different varieties, as the increase in torque at this stage is associated with an increase in temperature and a rearrangement of the crystalline structure of the starch (Thomas *et al*., 1999).The retraction torque was the lowest in the Bohouth 8 variety and the highest in the Doma 2 variety, with significant differences between the different varieties (Table 3).

Table 3. showed that Doma2 variety has the highest α value for the Doma variety (0.072) Nm/min compared to the Sham8 and Bohouth8 varieties (-0.038, -0.044) Nm/min. As for the β values, the Sham8 variety was characterized by a lower degree of tendency that reached 0.316 N.m/min compared to the two varieties, Bouhouth 8 and Doma 2, with significant differences between the means, except for the two varieties Bohouth 8 and Doma 2. As for the values of γ, they differed according to the varieties, reaching (0.012, -0.022, -0.024) N.m/min for Douma 2, Bouhouth 8, and Sham 8, respectively. And this meenntion in (alhommada *et al*., 2020)

Sham8

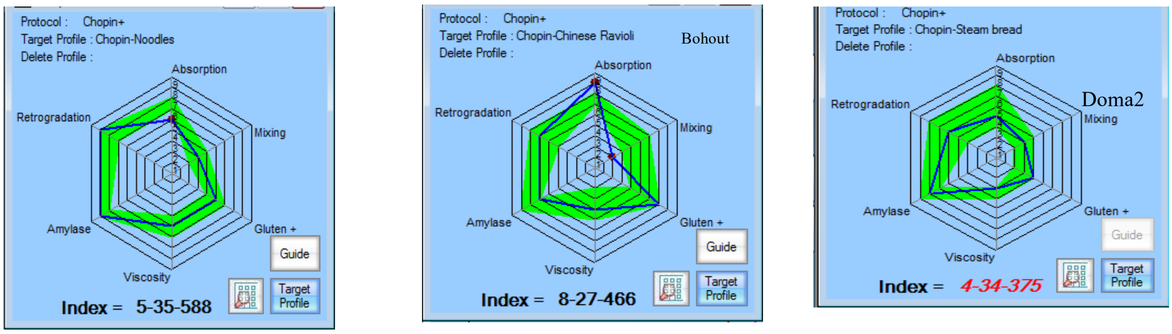

Figure 5 the best end usess for the diffferent studies varieties

The software of the Mixolab device also allows displaying the rheological properties of all the studied varieties, which facilitates their comparison. The final use of the three varieties combined can also be compared (Figure 5) (Alhommada *et al*., 2020).

Sham8 varieties was the best manufaturing and baking for Noodles with Hexagonal grid and prediction using Maxolab as showen in Figure 5, and Bohouth 8 must directing its industry to Ravioli، and the Doma2 varieties was the best end use for steam bread.

5. Conclusions

The percentage of absorbed water increased in the Bohouth 8 variety compared to the Sham 8 and Doma 2 varieties, which indicates the quality of starch and protein. And Doma 2 has highiest protien percentage wich make it very easy for Insect infestation. Addition Doma 2 variety is characterized by a high falling number, which indicates low enzymatic activity. And The Mixolab technique can be used to study rheological properties, which gives an idea about the quality of starch and protein of samples in one test. Then Noodles can be making from sham 8 with the best tast and witth out any manufatinng defets.

References

Alhommada, W. A., delly Ibrahim, T., Gergi, R. S., & El-Masry, M. (2020). Study of some Rheological Properties and Determine the Optimal Use of Mixtures of Wheat Flour and some Types of Legumes Flour. *Journal of Agricultural Environmental and Veterinary Sciences*, *4*(1), 54-67. Doi: 10.26389/AJSRP.W110919

Agricultural Statistical Collection, (2018). Statistics Department, Ministry of Agriculture and Agrarian Reform, Syria.

Alfien F.(2004). Grain Milling Technology (Theoretical). Al-Baath University Publications. 237 pp.

Al-Masry Suleiman; Al-Khayat Ghassan, 1991. Cereal Chemistry and Processing. Damascus University Publications.

AlSaleh A.(1996). Grain Technology (Theoretical). Aleppo University Publications. 210 pp.

Banu, I.; Stoenescu, G.; Ionescus, V. and Aprodu, I., (2011). Estimation of the Baking Quality of Wheat Flours Based on Rheological Parameters of the Mixolab Curve. *Czech Journal of Food Science,* (29) 1, 35–44.

Campbell, G.M.; Webb, C. and Mckee, S. L., (1996). Cereals Novel Uses and Processes, *Plenum Press*, New York, ISBN 0-306-45583-8, p298.

Catteral, P., (1995). Flour Milling. IN. Edited by CAUVAIN, S., and YOUNG, L. S., 2007. Technology of Breadmaking (Second Edition), Aspen Publishers, Inc., Gaithersburg, 296-329

Chopin Mixolab User's Manual: *Tripette & Renaud Chopin*, France. (2005).

Collar, C.; Bollain, C. and Rosell, C.M., (2007). Rheological behavior of formulated bread doughs during mixing and heating. *Food Science and Technology International*, (13), 99-107.

Dapčević, T.; Hadnađev, M. and POJIĆ, M.,(2009). Evaluation of the Possibility to Replace Conventional Rheological Wheat Flour Quality Control Instruments with the New Measurement Tool – Mixolab, *University of Novi Sad, Institute for Food Technology*, Serbia, Agriculturae Conspectus Scientificus, (74)3, 169-174.

Dewettinck, K.; Van Bockstaele, F.; Kuhne, B.; Van, DE.; Walle, D.; Courtens, T. M. and Gellynck, X.(2008). Nutritional value of bread: Influence of processing, food interaction and consumer perception. 48, 243-257.

F. A. O. 2010: Bulletin of statistics. Vol. 1. Rome. .1

Feillet, P., (2000). Amidon, pentosanes et lipides in Le grain de blé. Eds, INRA edition 147rue de l'université 75338 Paris Cedex 07, 57-90. IN. Dubat, A., 2004. The Importance And Impact Of Starch Damage and Evolution Of Measuring Methods. *Chopin SAS.*

GIBSON, L. and BENSON, G., 2002- Origin, History, and Uses of Oat (Avena sativa) and Wheat (Triticum aestivum). *Iowa State University*, Department of Agronomy,USA.

Hadnađeva, T. D.; TORBICA, A. and HADNAĐEV, M., (2011). Rheological properties of wheat flour substitutes/alternative crops assessed by Mixolab. *International Congress on ngineering and Food (ICEF11)*, (11), 328 – 334.

Hancock, J. F.(2004). Plant Evolution and the Origin of Crop Species. Second Edition, *CABI Publishing*, Cambridge, 313 Pp.

Haros, M.;ferrer, A. and rosell, C. M., 2006. Rheological behavior of whole wheat flour. *IUFoST 13th World Congress of Food Sciences Technology*, Nantes, France, p1139-1148.

Huang, W.; Li, L.; Wang, F.; Wan, J.; Tilley, M.; Ren, C. and Wu, S., (2010). Effects of Transglutaminase on the Rheological and Mixolab Thermomechanical Characteristics of Oat Dough. *Food Chemistry*, (121)4, ISSN 0308-8146, p934-939.

Kahraman, K.; Sakiyan, O.; Ozturk, S.; Koksel, H.; sumnu, G. AND Dubat, R., (2008). Utilization of Mixolab to predict the suitability of flours in terms of cake quality. *European Food Resarch technology*, (227) 2, p565-570.

Koksel, H.; Kahraman, K.; Sanal, T.; Ozay, D. S. and Dubat, A.,(2009). Potential Utilization of Mixolab for Quality Evaluation of Bread Wheat Genotypes. *Journal Cereal Chemistry,* (86)5, 522-526.

Lazaridou, A.; Duta, D.; Papageorgiou, M.; Belc, N. and Biliaderis, C. G. (2007). Effects of Hydrocolloids on Dough Rheology and Bread Quality Parameters in Gluten-free Formulations. *Journal of Food Engeneering*, 79, 1033-1047.

Mixolab applications handbook, (2006). Rheological and Enzymatic Analysis. *Chopin Applications Laboratory*. France.

Ozturk. S.; Kahraman, K.; Titik, B. and Koksel, H.,(2008). Predicting the cookie quality of flours by using Mixolab. *Eurbian Food Resarch Technology*, (227), p1549–1554

Rasper, V. F. and Walker, C. E., (2000). Quality Evaluation of Cereals and Cereal Products. IN. Edited by Kulp, K., and Ponte, J. G., 2000. Handbook of Cereal Science and Technology, (Second Edition) Revised and Expanded, Marcel Dekker, New York, 505-538.

Rosell, C. M.; Collar, C. and Haros, M., (2007). Assessment of hydrocolloid effects on the thermo-mechanical properties ofwheat using the Mixolab. *Food Hydrocoll*, (21), 452–462.

Stoenescu, G.; Ionescu, V. and Vasilean, I., (2010). Prediction the Quality of Industrial Flour Using the Mixolab Device. *Bulletin UASVM Agriculture*, 67(2), p429-434.

Ţăin, A.E.; Zincă, G. and Banu, I., (2008). Studies about Obtaining Safe and Healthy Bakery Products Using the Beneficial Properties of Enzymes. *Chemical Bulletin of "POLITEHNICA" University of Timisoara*, (53,67)1-2, p110-114.

Thomas, D. J. and Atwell, W. A., (1999). Starches, Eagan Press Handbook series, ISBN1891127012, St. Paul, MN, USA

Watson, M.A., (1983). Agricultural Innovation in the Early Islamic World. *the diffusion of crops and farming techniques*, Cambridge University Press, 260 Pp.

Wishart, D.J.(2004). Encyclopedia of the Great Plains. *University of Nebraska Press*, 56 Pp.

Yan, Z.; Yan-FEI, W.;Xin-MIN, C.; DE-SEN, W.;Humieres, G. D. ; Feng JIAN-JUN And HU, H.,(2009). Relationships of Mixolab Parameters with Farinograph, Extensograph Parameters, and Bread-Making Quality. Actaagronomicasinica, (35)9, pp. 1738-1743.