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THE USE OF VITAMIN C ON IMPROVING THE RHEOLOGICAL PROPERTIES OF SOME WEAK LOCAL WHEAT VARIETIES

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Abetract

Bread has been regarded for centuries as one of the most popular and appealing food product and consumed heavily in Iraq both because of its relative high nutritional value and its unique sensory characteristics especially texture, taste, and flavor. The result showed the percent of wet gluten was 29.0. The impact of adding ascorbic acid as improver on dough rheology and bread properties was investigated. The combined flour from (69% national wheat grain which was had very weak gluten, 25% Australian imported grain and 5% from Canadian imported grain) showed the weak quality of gluten and this effect the farinograph stability that was 2.1 min before adding ascorbic acid, and then increased to 2.7 after adding ascorbic acid as improver. The impact of adding ascorbic acid was more emphasized on extensographic properties compared to farinographic, regarding the effect on bread properties. Also it was found the best period of dough tolerance to fermentation time was 45 minutes. While the 135 minutes of fermentation produce very weak dough and ripped according to decreased the falling number and the dough softening in the extensographic reading. Results showed that adding ascorbic acid enhanced falling no. from 287 without adding to 300 after adding the improver regarding to effect on bread shape, color, texture and allover acceptance. Using ascorbic acid had positive effect on dough with medium dough strength, through improvement of bread volume and shape with satisfying crumb structure. However, ascorbic acid significantly enhanced viscoelastic properties of flours with strong dough with positive effect on bread shape, taste, color and overall acceptance parameters. The conclusion of this study is the guidance of the urgent need for the General Company of grain manufacture to use ascorbic acid as fortified wheat flour that distributed ration to consumers who are suffering from poor wheat flour quality and fluidity. In another way, it is possible to request the private sector to make small envelopes of ascorbic acid and sold separately after the media propaganda to inform women of using this substance during the process of baking.

Key words: Rheological dough properties-ascorbic acid–bread quality.

Introduction

Bread is a bakery product priced for its taste, aroma, texture, rich in calories and widely consumed in Iraq; as a part of the Iraqi culture, it is usually eaten at all meals. According to the Iraqi food standards legislation, bread is made from wheat flour only, contains liquids, yeast, salt and may contain other ingredients that do not change its characteristics. Wheat is the grain of choice in bread preparation due to its high gluten level. The quality of the wheat grain is the result of the interaction of the cultivation conditions (soil interference, climate, pests, crop and crop management), in addition to the interference of the harvest, drying and storage operations, factors that directly influence on the industrial use to be given to the final product, which is wheat flour (Maria, 2008). Wheat flour has either quality gluten (strong flour) or damaged gluten, (weak flour) (Pavlína, *et al.,* 2011). In recent years, the consumption of wheat bread has risen in many developing nations, including Iraq, as a result of increasing population, urbanization and changing food habits (Oloye, 2006). However, the tropical climate of many developing countries does not encourage commercial wheat cultivation, leading to reliance on wheat importation to support flour milling industries. Due to the variable technological quality of flour, the use of additives has become popular to standardize the flour in terms of gluten strength, color and ferment ability (Pecivová *et al.,* 2010; Nanditha and Prabhasankar, 2009). Also, the formation of a gluten network is essential for the production of bread with organoleptic qualities especially dough formation and

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bread quality such as color, taste and crumb texture. Likewise, the gluten network is responsible for dough elasticity, resistance and stability, while carbon dioxide production is due to the action of enzymes and yeast on sugar (Enriquez *et al.*, 2003; Aamodt *et al.*, 2003). Thus, to improve the gluten network formation, the baking industry has been using flour improvers, among the oxidizing agents, which act directly on the structure of the gluten proteins, reinforcing the gluten network by the formation of disulfide bonds (César, *et al.*, 2016). Among the oxidizing agent quite studied is ascorbic acid. It was stated that it has influence on the fermented dough behavior and the correlation with the flour composition, such as the elucidation of the mechanism as improver on bread (Hrušková and Novotná, 2003; Every *et al.*, 1999). Bread improver has been used to improve all sides of the bread and give bakers the required tolerance and flexibility during all stages of the baking process: mixing, fermentation, baking and shelf life. Additives are able not only to influence the development of dough but also to improve the qualitative characteristics such as color, texture, volume, taste and sensory properties of the final bakery products (Indrani, and Rao, 2006). Dough improvers are often consisted of oxidizing and reducing agent (Horvat, 2014). Ascorbic acid E300, used in bakery products due to oxidation that increased dough strength by oxidized sulfhydryl groups (-SH) to disulfide bond (S-S) that makes strengthening the gluten network to kept gas cells, softening crumb and increasing the bread volume (Waserman, 2008; Cauvain and Yong, 2005). Oxidation generally affects the resistance and extensibility of dough (Zahra, *et al.*, 2015).The objective of this study was: to evaluate the technological quality of domestic wheat grains as well as the flour obtained from these grains; and to study the effect of ascorbic acid on dough rheological properties and consequently bread quality. So it was argent trying to assist importing the ascorbic acid feeder instrument to the wheat flour factory to improve the quality of weak wheat flour by using domestic wheat instead of imported wheat in support of the Iraqi national product.

Materials and Methods

The flour was a composite of two hard winter wheat varieties which imported from (25% Australian and 5% Canadian flour), then added to 69% national weak flour which cultivated in middle and south of Iraq. Composite flour were well mixed together, then chemically analyzed at (Quality Control Laboratory/Grain processing company/Commercial Ministry/Iraq for; moisture content 11.5%, protein 11.8%, fat 1.9%, ash 1.2%, carbohydrates 73.6%, wet gluten 29% and falling number FN 287), dry instant yeast Levure Instantanee, edible salt, water and ascorbic acid (L-AA; Sigma-Aldrich).

Flour analysis

Moisture (44-16 A), ash (08-07), wet gluten (38-11) and falling number (56-81) were determined according to AACC-approved methods (AACC, 2000). Flour protein was tested using a Kjeltec auto protein tester (model 1030, Tecator Co., Hoeganaes, Sweden).

Determination of wet and dry gluten% in flour

About 20 g of each composite flour sample was weighed into a Petri dish of known weight and thoroughly mixed with 1 ml of water to form dough. The dough is kneaded under running water to remove starch and later put into Petri dish and weighed. It was then dried in an oven (LCON53CF, Genlab, England) and weighed after drying (method 38-10, AACC 2000). The % gluten is calculated as follows:

$$\%\,\text{wet gluten} = \frac{\text{Weight of gluten}}{\text{Weight of original flour}} \times 100$$

$$\%\,\text{dry gluten} = \frac{\text{Weight of dry gluten}}{\text{Weight of wet gluten}} \times 100$$

Determination of dough rheological properties

The rheological properties of each dough formulation were determined by moisture, gluten and farinograph tests. Analyses of wet, dry and index gluten were determined according to ICC standard method No 155, using the Glutomatic device (Perten Instruments, Huddinge, SWEDEN). Dough moisture was measured according to AACC method 44-15. The farinograph properties were determined using (AACC $_a$ 2000, method 54-21 using Brabender ® Brabender OHG, Duisburg, Germany). The criteria assessed were water absorption, dough development time, dough stability, tolerance index, time to exhaustion and farinograph quality. The analyses were performed in triplicate.

Farinograph water absorption

The farinograph water absorption (FWA) was determined for different blends to predict the hydration rate for bread making procedure. FWA is the volume of water, expressed in ml per 100 g of flour at 14.0% moisture content required to produce dough with a maximum consistency of 500 FU (Farinograph Units) under the operating conditions. The water absorption of flours and the mixing behaviour of dough were determined by Brabender Farinograph (Brabender, Duisburg, Germany) in accordance with ICC No 115/1. Farinogram evaluation was performed using software Brabender

Farinograph for Windows ver. 2.3.7. The stretching and elasticity characteristics of dough were measured by Brabender Extensograph (Brabender, Duisburg, Germany) according to ICC No 114/1 and extensogram evaluation was automatically performed using software Brabender Extensograph for Windows ver. 2.1.5.

Iraqi Flat Bread making procedure

All ingredients (based on flour weight) were: 100% flour, water according to the farinographic absorption, 2% salt and 2% fresh yeast. An oxidizing improver, L-ascorbic acid E300, were added to the flour at three levels (0.1, 0.2 0.3% W/W g) flour basis respectively. The flat breads were produced in a standardized manner by the straight dough method, in which the tap-water was used in this process. All the weighed ingredients were mixed in a kneading-machine (Mixer with spiral, model PHEBUS SPI 52 at two different speed) in order to form smooth, elastic, structured dough and able to imprison air. The operation is performed in two stages: the first one at medium speed (speed 1) for 3 minutes and the second at high speed (speed 2) during 6 minutes. Dough was divided, rounded and proofed for 50 min. (28°C, 87% RH) and baked at Roto oven (Miwe-roll-in) for 32 min. at a temperature gradient from 250 to 230ºC. Upon removal from the oven, baked breads are left in the open air for cooling, and then sensory properties were evaluated.

Sensory evaluation

Sensory assessment: Sensory evaluation was conducted on the breads to the study possible effects of treatments on the sensory profile of each type of bread. The sensory bread attributes were evaluated using the flat bread evaluation method described by Rajabzadeh (1991). Sensory evaluation was performed by 10 trained panelists and the overall quality of bread was evaluated using a ranking scale with scores ranging from 1 (least pleasure) to 5 (best pleasure). In this study, some sensory properties including odor, taste and flavor, upper surface properties and overall quality (total acceptance) of flat bread were evaluated. In this study, some sensory properties including taste, flavor, texture and overall quality (total acceptance) of flat bread were evaluated.

Table 1: Additives amount utilized in the breads formulations.

Form 4	Form 3	Form 2	Form 1	Additives
0.3	0.2	0.1	-	Ascorbic acid

Without additives (-) as control; Form (formulation); Form 2, 3, 4. Are indicated the amount of additives to 100g of flour.

Statistical analysis

The Statistical Analysis System- SAS (2012) program was used to effect of difference factors in study parameters. Least significant difference –LSD test (ANOVA) was used to significant compare between means in this study.

Chemical analysis

Wheat gluten forms a three-dimensional network and its properties such as extensibility and elasticity determine properties of wheat flour dough (Wieser, 2007). Gluten proteins are collectively designated as gliadins and glutenins. Glutenins are polymeric proteins in which the individual subunits are linked by disulphide bonds that improve elasticity and consistency. While, gliadins are monomeric proteins that consist of single chain polypeptides and contribute to the viscous properties of dough (Mendichi *et al.,* 2008). Both (glutenins and gliadins) create a viscoelastic profile of gluten. Rheological behavior of the mixtures of wheat flour and water is established by the presence of gluten phase (Angioloni and Dalla, 2007). Results of this study showed there were no significant in moisture content. The ash content was the only parameter in which samples of flours produced from native wheat grains showed more satisfactory results (high values) when compared to those obtained for flours produced from imported grains. High ash contents in flours can indicate low extraction, with inclusion of bran, which is undesirable due to the fact of providing a darker color; lower cooking and interfering in the continuity of the gluten network (FANAN *et al.*, 2006). On the other hand there were a significant differences ($P<0.05$) in gluten content compared with imported flour

Table 2: Dough rheology of the formulations based on the farinograph analysis.

LSD value	Form 4 (0.3) of AA addition	Form 3 (0.2%) of AA addition	Form 2 (0.1%) of AA addition	Form 1 (zero) as Control	Parameters
3.479 NS	59.5	60.0	60.5	61.2	Water absorption (%)
0.368 *	2.5	2.4	2.1	1.8	Development time (min)
1.052 *	4.1	3.9	3.2	2.9	Stability (min)
17.366 *	490	500	510	520	Tolerance index (BU)
——	10-14.2	10-13	10-11	10-14	Breakdown time (min(

* ($P<0.05$)., Form (formulation). The form 1 comprises the control formulation.

Table 3: Effect of ascorbic acid on farinograph properties of Iraqi flat bread.

Farinographic Properties					Ascorbic
FN	$G_{max\ (AU)}$	Ds (min)	DDT (min)	WA	Acid%
287	70.0	2.1	3.2	61.8	Control (0.0)
295	146	2.6	3.5	62.2	0.1
300	155	2.6	3.3	62.3	0.2
299	161	2.7	3.8	61.7	0.3
19.52 NS	23.63 *	0.502 *	0.446 *	3.69 NS	LSD value

* (P<0.05), WA=Water absorption%, DDT=Dough development time, Dough stability, $G_{max=}$Gelatinization at maximum level and FN= Falling number.

Table 3: Moisture content and gluten analysis of the formulations.

LSD value	Form 4 (0.3%) of AA addition	Form 3 (0.2%) of AA addition	Form 2 (0.1%) of AA addition	Form 1 (zero) as control	Native wheat	Parameters
1.96 NS	12.8	12.5	12.8	12.8	12.5	Humidity (%)
0.442 *	1.0	1.0	0.99	0.85	1.5	%Ash
3.07 *	30.5	30.5	30.5	30.5	26.4	Wet gluten (%)
3.29 *	24.0	24.0	24.0	24.0	20.5	Dry gluten (%)

Form (formulation, 69% national wheat grain, 25% Australian imported grain and 5% from Canadian imported grain). The form 1 comprises the control formulation. The form 2, 3 and 4 comprises the supplemented form with 0.1, 0.2 and 0.3% with ascorbic acid.

that elevate the wet and dry gluten from 26.4 and 20.5% to 30.5 and 24.0% respectively.

Form (formulation, 69% national wheat grain, 25% Australian imported grain and 5% from Canadian imported grain). The form 1 comprises the control formulation. The form 2, 3 and 4 comprises the supplemented form with 0.1, 0.2 and 0.3% with ascorbic acid.

Ascorbic acid is one of the most commonly used as baking improvers due to its properties, which lead to increase the dough strength and consequently in bread volume (Aamodt *et al.*, 2003), acting specifically on the final rise of dough (Hrušková and Novotná, 2003). This oxidizing agent acts directly on the structure of gluten proteins, enhancing the gluten network through the formation of disulfide bonds (Nakamura and Kurata, 1997). Bread obtained from studied formulation containing only ascorbic acid as improver has the volume visually higher and a more homogeneous alveolar structure as compared with the control which was identical with before researcher. Results of this study showed there were no significant differences on water absorption by adding ascorbic acid. But, there were significant differences (P<0.05) in development time, stability time, tolerance index and breakdown time as shown in table 2.

Effect of ascorbic acid on farinographic properties

Dough stability and gelatinization and falling number as a degree of softening, which resulted in a lower quality group (Table 3). Addition of an oxidizing improver generally increased dough energy and disturbed R/EXT ratio as result of increasing dough resistance and decreasing extensibility. The rheological properties of input flours especially with weak kinds are very important when considering which type of improver should be used. L-ascorbic acid (E300) strengthened the structure of dough through oxidation of S-H groups into S-S bridges**.** Their effect is more pronounced on the extensogram through increasing dough resistance and decreasing extensibility. The effect of addition improver on farinographic dough properties were shown in Table 1. Water absorption, dough development time and stability of flours haven't been significantly affected by improver addition in comparison to the control. Added improver had significant (P<0.05) effect on degree of softening what resulted in lower quality group of those cultivars.

Effect of ascorbic acid on extensographic properties

The impact of improver was more emphasized on extensographic properties compared to farinographic. The improver addition significantly (P<0.05) increased dough resistance measured after 5 min and resistance at curve maximum. The elasticity of dough, expressed as R/EXT, was a significant disturbed by improver addition as result of dough resistance increased and extensibility decreased Table 4.

Sensory attributes of the Iraqi flat bread

Ascorbic acid addition increased bread volume and its shape significantly. Improver addition was significantly (P>0.05) influence on loaves shape, color, taste and the overall acceptance as shown in table 5. (Control, 0.1, 0.2, and 0.3% of ascorbic acid addition).The quality of the bread by adding ascorbic acid was very accepted. Most acceptable bread was the one with 0.3% ascorbic acid added which had a fine taste, yellow color, good aroma and fresh appearance. While, control sample received ripped bread shape, difficulty chewing due to high elasticity, bad taste, and overall acceptability scores. Results that obtained from sensory tests almost match with finding of (Zahra *et al.,* 2015; Horvat, *et al.*, 2009).

Table 4 : Effect of ascorbic acid on extensographic properties of Iraqi flat bread

R/EXT	EXT(MM)	R5min(BU)	E(EU)/cm²	Control
0.4	51	20	6	(0.0)
0.6	76	47	8	s0.1
0.6	102	63	10	0.2
1.7	191	259	76	0.3
0.553 *	15.39 *	17.94 *	7.82 *	LSD value

* (P<0.05), E= energy; R= resistance after 5 min; EXT= extensibility; R/EXT= resistance to extensibility ratio, Average values marked with the same level are not significantly different at 0.05 levels.

Table 5: Effect of ascorbic acid on sensory properties of Iraqi flat bread

Ascorbic Acid	Texture	Aroma	Color	Taste	Overall Acceptance
0.0	2.2	2.5	1.5	2.0	2.5
0.1	3.3	3.0	2.5	3.0	3.5
0.2	4.0	4.2	4.5	5.0	4.0
0.3	4.0	4.5	5.0	4.5	4.5
LSD value	1.07 *	1.67 *	1.64 *	1.98 *	1.16 *

* (P<0.05).

Conclusion

The obtained results showed that extensographic parameters are good indicators of dough strength and should be taken into consideration before the decision about improvers' quantity is made. Ascorbic acid is a good index as bread improver that had a positive effect on flour with medium dough strength through improvement of bread volume, shape and other sensory properties with satisfying crumb cell characteristics. However, addition improver significantly enhanced viscoelastic properties of flours with weak dough through positive effect on bread shape, color, taste, aroma etc. Therefore, it should be emphasized that the use of ascorbic acid in the fortification of flour ration of food distributed monthly to Iraqi citizens, who are always complaining of the reluctance of flour distributed to them, as well as for more than a century and the use of ascorbic acid globally to improve wheat flour weak which it is having a weak gluten and that's effect on bread quality, likewise mills Iraqi's mills still lacks these reinforcements. In another way, it is possible to request the private sector to make small envelopes of ascorbic acid and sold separately after the media propaganda to inform women of using this substance during the process of baking.

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