Jordan Journal of Agricultural Sciences, Volume **15**, No.**4 2019**
DOI: https://doi.org/10.35516/jjas.v15i4.53

Nutritional Improvement and Rheological Characteristics of Tere (Rokak) Bread Supplemented with Inulin or Wheat Bran

Rafiq M.S. Rashed[1], Taqreed. A.Wahwah[2], Sheler. F.Ahmad[3], Mohammad. W.M. Saeed[4]

[1]Dept. Food Sciences and Quality Control, College of Agricultural Sciences, Sulaimani University, Sulaimani, I*raq,* Assistance Professor, rafiq.salih@univsul.edu.iq
[2]Dept. Food Sciences and Quality Control, College of Agricultural Sciences, Sulaimani University, Sulaimani, I*raq,* Assistance Professor, taghreed404@yahoo.com
[3]Dept. Food Sciences and Quality Control, College of Agricultural Sciences, Sulaimani University, Sulaimani, I*raq,* Lecturer, shlerahmad77@yahoo.com
[4]Dept. Food Sciences and Quality Control, College of Agricultural Sciences, Sulaimani University, Sulaimani, I*raq,* Professor, Muhammad.wagh@univsul.edu.iq

Received on 1/11/2019 and Accepted for Publication on 27/12/2020.

ABSTRACT

Nutritional, rheological, and sensory evaluation for Tere (Rokak) bread supplemented with 0, 2.5, 5, 7.5, and 10% of inulin or wheat bran were studied. The chemical composition of bread was slightly affected by these treatments, while energy values were reduced from 354.24 to 315.76 calories/100g. The results showed that Farinograph water absorption decreased from 70.2 to 50.3% and Mixing Tolerance Index from 34 to 0.00 BU with an increase in development time from 9.3 to 20 min, stability time from11-14.9 min, and quality number from 138-200 by increasing of inulin addition. The most pronounced effect of bran addition was on Farinograph stability and quality number which decreased from 9.3min and138 to 6.9min and 117 respectively. On the other hand, inulin decreased the Amylograph viscosity peak at heating from 840 t0 610 BU and the final viscosity at cooling from 1250 to 990 BU. Inulin addition significantly reduced the amount of required water to make Tere bread from 66% to 54% compared to control and bran. Inulin reduced about 3cm of bread diameter, while 7.5% of bran addition increased 3cm of Tere diameter. Also, the sensory evaluation showed that inulin and bran addition up to 10% had a slight effect on Tere bread compared to control , and their total acceptability was 70%-80%. No mold growth was observed on stored bread for three months which emphasized their resistance to any visible growth.

Keywords: Inulin, Wheat bran, Tere (Rokak) bread, Farinograph, Amylograph.

INTRODUCTION

Food enriched with dietary fiber is one of the most functional foods and ingredients with regard to the consumer´s demands on healthy nutrition (Bojnanska et al., 2015). Cereal products, especially bread, were the most suitable media for producing fiber-enriched food since this addition may somewhat fit with the physical properties of the final product. Some defects may appear on the high content fiber food especially their sensory properties such as color, taste, and texture which was the object of most of the researches that tried to treat these defects. However, there are different types of high-quality fiber-enriched foods such as bread, biscuit, cookies, noodles, and other products. Inulin and wheat bran or treated bran were intensely used in wheat products resulted in different successful degrees of product quality meaning there is a need for more research to improve the product quality or to find other local products that may be more suitable to enrich with dietary fiber. Inulin is a mixture of fructose polymers (fructan) of various lengths with β (2-1) glycosidic bonds, terminated generally by a single glucose unit, found in many various plants such as beet, artichoke, and chicory. Cecile and Gordon, (2012.) reported that inulin is used to increase the amount of dietary fiber or as a prebiotic ingredient in particular in dairy and bakery products. they also wrote that inulin addition causes a negative effect on dough rheology and bread quality, especially decreasing loaf volume darkening its crumb. Slavin, (2013) emphasized the evidence of prebiotic activity of inulin and oligo-fructose if consumed at a level of 5 – 15 g/day for a few weeks. On the other hand, wheat bran has many health benefits, as it is nutritionally rich in fiber, folic acid, vitamin B6, minerals, thiamine, and vitamin E. (Babu et al., 2018). Inulin and wheat bran influence dough and bread quality since their additions increase dough mixing and stability time but they decrease farinograph water absorption and softening degree. In bread, they produce a significant reduction in the loaf and specific volume in relation to the standard sample and the most evident effect is the increase of crumb firmness and the dark crumb appearance (Gajula, 2017, Luo et al., 2018). Terry or Rokak bread is special Kurdistanain bread which is prepared from wheat white flour or whole wheat flour by spreading to very thin sheet dough and wide diameter, more than 50-60 cm, almost without addition, or very little amount of yeast not exceed than 0.1% (Rashed and Mohamad, 1993).

This research aims to compare the effect of wheat bran and inulin addition on the dough and tere bread quality characteristics and determine the suitability of tere bread for enriched by these two dietary fibers.

Materials and Methods

Material:

Wheat white flour (Jenan), salt (Zeer) were purchased from a local market. Wheat bran is brought from the national mill and sieved by 10W (1000 um) to discard all particles of endosperm and then is milled to about 150-200 microns. Inulin was purchased from Now Foods Company, 365 S. Glen Ellyn Rd. Bloomingdale, IL60108 USA, which its chemical compositions are: 96.43% total carbohydrate, 89.28% dietary fiber, and 3.57% non-carbohydrate materials.

Methods

Chemical Composition Determination: Moisture, Protein, Fat, Ash, Fiber percentages for flour, bran, and bread were determined according to AACC (2000) methods:44-15.02, 46-12.01, 30-10.01, 08-01.01, 32-10.01 Respectively. Total Carbohydrates, by difference (Nitrogen free carbohydrate), were determined according to AOAC (2012). Also, the nutritive value for samples with inulin was calculated as [protein% + (carbohydrate%- Inulin%) X4 + Inulin%X1.78 + fat%X9)

Rheological Tests: Amylograph and Farinograph tests for flour and the inulin or bran additions were achieved according to AACC (2000) methods: 61-01.01, 54-21.02 respectively.

Preparation of Bread: Tere bread was prepared according to Rashed and Mohamad (1993) which included sifting the flour then preparing the white wheat flour and either inulin or bran mixtures according to treatments; 0,2.5, 5.0,7.5, and 10.0% of inulin or bran. The dough was prepared by adding gradually the amount of water (30ºC) and 1.8% salt to reach the best dough consistency, after hand kneading, depending on the expert of kneader. Two hundred grams of dough was molded and sheeted by a wooden rod whose dimensions are about 70-75cm in length and 1.5- 2 cm in diameter. The thin circular sheeted dough was baked on heated concaved circular metal which its diameter is 80 cm. The final shape of this type of bread is circular very thin and quickly dried.

Determination of the Physical Properties of Tere Bread: According to Rashed and Mohamad (1993),

1- Percentage of required water to get optimal dough consistency was obtained from the farinograph development time minus 2% of required water.

2- The rehydration ratio was calculated by the equation: W_d/D_b since W_d is the weight of drained water of rehydrated bread sample while D_b is the weight of dehydrated bread samples.

3- Rehydration percentage was calculated as; wheat of water required to hydrate the bread/ weight of hydrated bread X100,

4- The thickness of the bread sheet (determined by digital Vernier)

5- Bread diameter was determined. Mold examination was performed by daily visual examination of bread for 90 days.

Sensory Evaluation: 25 panelists evaluated six sensory characteristics (Taste, Color, Odar, Thickness, Chewability, Total acceptability). The score for each characteristic is out of 20 points (Rashed and Mohamad, 1993).

Statistical Analysis: The results were submitted to analysis of variance (ANOVA). The standard deviation (±) and least significant difference (LSD) test ($p<0.05$) were used for comparison of means using the software SAS® 9.2, SAS (SAS, 2009).

Results and Discussion

Chemical Composition of samples: Chemical composition of flour, bran, inulin, and the treatments of Tere bread (table1) showed that the white wheat flour (67% extraction) contains the acceptable amount of protein 10.5%, the most important components in flour due to its role in gluten network formation. As it is known, the quality and quantity of protein is an effective factor that assists in the spread of flatbread (Miskelly, 2017). This percentage of protein was with the minimum agreement of Iraqi official Standards for bread flour which is 10% (Ayoob, 2014). The results showed that wheat bran had high percentages of proteins 14.1, fat 4.6, and fiber 43.5 which affected the composition of the final product Tere bread. On the other hand, most inulin composition is a carbohydrate, dietary fiber thus, its effect on tere bread composition and nutritive value slightly or moderately differed compared with bran addition. However, the addition of inulin significantly decreased protein, fat, ash, and nutritive calories while it increased the carbohydrate and fiber content of tere bread. These results were in agreement with Brasil, et al., (2011) who use 6 and 10% of inulin to study their effects on bread composition and quality. On the contrary, the addition of wheat bran increased protein, fat, ash, and fiber while the decrease of nutritive calories and carbohydrates was significantly clear in the final products of Tere bread. The differences in the chemical composition of Tere bread may attribute to the effect of chemical compositions of added inulin or bran to the composite flour of tere bread. Most of these results were in agreement with Abril, et al. (2014) about relationships between chemical composition and the quality of bread.

Table 1 Proximate Analysis for Four, Bran, Inulin, and Bread treatments

Sample	Moisture%	Protein%	Fat%	Ash%	Carbohydrate (without fiber)%	Fiber%	Nutritive value Calorie /100g
Flour	10.05±0.3	10.5±0.1	1.2±0.05	0.45±0.0	75.00±0.56	2.8±0.08	352.8±2.82
Bran	10.40±0.45	14.1±0.14	4.6±0.13	3.4±0.08	24.00±1.34	43.5±0.54	193.8±5.70
Inulin	__	-	-	0.98±0.05	96.00±0.06	3.02±0.00	178.57±0.30
Bread							
Control	9.72±0.28	10.53±0.09	1.24±0.09	0.46±0.01	75.24±0.48	2.81±0.01	354.24±2.25
Treatments of % inulin addition							
2.5	9.67±0.32	10.23±0.15	1.21±0.03	0.44±0.02	75.57±0.54	2.88±0.01	348.45±2.73
5	9.58±0.33	9.98±0.12	1.18±0.08	0.43±0.01	75.88±0.55	2.95±0.03	342.96±2.75
7.5	9.39±0.05	9.71±0.05	1.15±0.02	0.41±0.00	76.32±0.12	3.02±0.00	337.82±0.60
10	9.35±0.15	9.54±0.12	1.12±0.06	0.40±0.01	76..48±0.35	3.11±0.01	331.96±0.61
Treatments of % bran addition							
2.5	9.23±0.21	10.61±0.15	1.32±0.02	0.52±0.03	74.56±0.44	3.76±0.03	352.56±2.2
5	9.55±0.48	10.70±0.09	1.41±0.10	0.59±0.01	72.96±0.68	4.79±0.01	347.33±3.4
7.5	9.30±0.39	10.83±0.11	1.49±0.07	0.67±0.00	71.90±0.57	5.81±0.00	344.33±2.85
10	9.55±0.54	10.95±0.07	1.58±0.02	0.75±0.03	70.34±0.68	6.83±0.02	339.38± 3.4
LSD, P>0.95	0.61	0.17	0.12	0.41	0.72	0.55	4.7

Rheological Test

Farinograph: The results of the effect of inulin and bran addition on Farinograph parameters for the mixture of flour (Table 2) shows that increasing inulin addition caused a significant decrease in water absorption due to the dilution effect of inulin on gluten. Substitution of flour by inulin may cause weakening of dough since it does not cooperate in gluten formation, therefore it must decrease the added water to keep on the dough consistency (Codina et al., 2018). The results also showed that increasing inulin increases development time which may attribute to the competition on the water between inulin and gluten causes slowing the formation of the dough gluten network. These results were in agreement with Iranshahi, et al., (2014) who used 3 and 6% inulin in composite flour. Stability time also increased with inulin increasing, which may attribute to two factors one of them due to the longtime of development of dough which is a part of stability time, secondly due to the viscosity of inulin that may assist to firm the consistency of dough. This conclusion was emphasized by the results of the next Farinograph parameters, Mixing Tolerance Time (MTI) and Time to Breakdown (TB). Decreasing MTI and increasing TB values, directly indicates the role of inulin to keep on and improve the dough consistency according to its properties in resistance to shear stress (Iranshahi, et al., 2014). However, the increase of inulin addition increased the Farinograph quality number from 138 for control to 200 for 5-10% of inulin. These results of Farinograph parameters were in agreement with Bojnanska, et al., (2015) until 10% of inulin addition, but they obtained an opposite result when they increased inulin from 15 to 25%.

Table 2: Effect of Inulin and Wheat Bran Addition on Farinograph Parameters

Treatments	Water Absorption %	Development Time (min.)	Stability Time (min.)	Tolerance Index (MTI) (BU)	Time to breakdown (min.)	Farinograph Quality Number
Control	70.2±0.5	9.3±0.0	11.3±0.3	34±0.8	13.8±0.4	138±0.4
Treatments of % inulin addition						
2.5%	65.5±0.7	10.3±0.1	13.2±0.1	24±0.6	16.1±0.5	161±0.5
5%	60.3±0.4	13.0±0.5	14.9±0.5	13±0.2	>20.0±0.0	200±0.0
7.5%	55.6±0.9	16.0±0.2	14.4±0.7	0.0±0.0	>20.0±0.0	200±0.0
10%	50.3±0.3	20.0±0.0	11.1±0.0	0.0±0.0	>20.0±0.0	200±0.0
Treatments of % bran addition						
2.5%	69.2 ±0.0	2.0±0.0	11.1±0.1	17±0.0	13.3±0.6	133±0.6
5%	67.9±0.2	1.9±0.1	6.9±0.2	24±0.1	4.3±0.0	43±0.0
7.5%	68±0.1	9.8±0.3	12.1±0.5	32±0.9	14.1±0.3	141±0.4
10%	69±0.0	2.5±0.1	9.9±0.1	5.0±0.0	11.7±0.1	117±0.2
LSD P>0.95	0.79	0.6	0.81	1.5	1.1	1.8

Amylograph test: Table 3. shows the results of the effect of inulin and bran addition on the amylographic parameters for the inulin or bran composite flour treatments. The results of this test mainly depend on the availability of water which, the starch grains are required to swell and increase the viscosity at regulating increasing of temperature. Thus, among the treatments, only 5 and 10% inulin additions increased paste viscosity-temperature from 61.5ºC to 64.5ºC due to compete for the starch and inulin on the water. Paste viscosity is the indicator to the beginning of starch granules to absorb an adequate amount of water to increase the viscosity to be sensible. The results also showed that Peak viscosity values decreased by the addition of inulin and bran addition, although the decrease was not proportional with the percentage of additions. However, in general addition of inulin decreased the peak of viscosity, from 840 AU for control to 610 AU for 5% inulin, which may attribute to the balance between the viscosity of inulin and the loss of viscosity due to the substitution of starch also treatments (Codină et al., 2018). The effect of continuous heating of the flour paste at 95ºC for 20 min caused decreasing in viscosity from 840BU to 680BU namely there was a loss of about 160BU in the control sample. Using inulin ratios significantly decreased the losses in viscosity to reach about 130 – 80 BU for 2.5 and 10% inulin respectively. On the other hand, the addition of bran didn't have such a role as inulin did since the loss in viscosity remained high compared to inulin. This behavior of inulin may attribute to its ability to be a viscous material at this temperature, which can compensate for the loss in flour paste viscosity. The results also showed that the addition of inulin decreased viscosity at cooling more than bran did. The high value of viscosity at cooling is attributed to the intensity of starch retrogradation phenomenon whereas dilution of starch percentage in composite flour due to the inulin and bran addition, which they haven't the same ability to retrograde such as starch. The low value of viscosity at cooling is preferred because there is a relation between the high value and the staling of bread. The results also showed that the addition of inulin decreased Gel setback, which means that inulin, retard the staling and weakens the formed gel. The most effective of inulin at 10% addition since it decreases this parameter value from 410BU for control to 360BU for 10% inulin. On the other hand, the addition of bran hadn't a harmonic effect on this parameter which, 5 and 10% increased gel setback values whereas 7.5% decreased the value to 370 BU. As it is known that gel setback is the resultant of the difference between peak viscosity and viscosity at cooling therefore the difference in the effect on each of these parameters may it the reason for the instability of the effect of bran addition (Banu, et al., 2012).

Table 3 Effect of Inulin and Wheat Bran Addition on Amylograph Parameters

Treatments	Paste viscosity ºC	Peak viscosity AU	Peak viscosity temperature ºC	Heating stability during 20min. BU	Viscosity at cooling to 50°C BU	Gel Setback BU
Control(White flour)	61.5±0.0	840±5.0	95±0.0	680±5.0	1250±10.0	410±5.2
Treatments of % inulin addition						
2.5%	61.5±0.0	670±0.0	92±1.5	540±10.0	1130±5.0	460±2.5
5%	61.5±0.0	610±2.5	93±0.0	490±5.0	1030±10.0	400±5.5
7.5%	64.5±0.5	720±5.0	94.5±0.2	630±2.5	1120±0.0	400±2.5
10%	64.5±0.5	630±0.0	95±0.0	550±10.0	990±5.0	360±5.2
Treatments of % bran addition						
2.5%	61.5±0.0	780±5.0	94±0.5	600±12.5	1190±5.0	410±5.5
5%	61.5±0.0	780±2.5	93±0.1	600±0.0	1230±5.0	450±3.5
7.5%	61.5±0.0	820±5.0	93±0.0	660±5.0	1190±10.0	370±7.5
10%	61.0±02	670±0.0	92±0.0	500±0.0	1100±0.0	430±0.0
LSD p>0.95	0.05	6.75	0.15	13.50	12.55	8.76

The Quality of Tere Dough and Bread

Table 4. shows the results of some parameters to determine Tere dough and its bread, including the required water to bring the dough to the optimum consistency determined manually and depending on the expert of kneader, in addition to the rehydration rate and percentage of the dried bread. The results showed that the addition of inulin caused a decrease in water absorbance was consistency affected. The dough lost about 12% of its ability of water absorption due to the substitution of 10% of flour by inulin which may attribute to the softening effect of inulin that is necessary to reduce the addition of water. The results also showed that wheat bran had not a significant effect on water absorption. The results also showed that there are highly correlation coefficient values between Farinograph water absorption and manually determined required water which was r= 0.987 and r=0.976 for inulin and all treatments respectively. The addition of water to rehydrate the dried Tere bread showed that increasing inulin systemically decreased the rehydration ratio while the addition of wheat bran at 7.5 and 10% increased of rehydration ratio. These results were in agreement with Rashed, and Mohamad (1993) who used mixed flour to prepare Tere bread.

Table 4. water required to optimize dough consistency and bread structure

Treatments	Required water to get optimal dough consistency %	Bread Moisture %	Rehydration Ratio	Rehydration %	Moisture after rehydration %
Control	66.00	9.72	1.282	28.23	29.59
Inulin					
2.5%	62.00	9.67	1.253	25.28	27.90
5%	60.50	9.58	1.258	25.77	28.10
7.5%	56.00	9.39	1.232	23.22	26.47
10%	54.00	9.35	1.224	22.42	25.95
Bran					
2.5%	65.00	9.23	1.267	26.70	28.61
5%	66.50	9.55	1.274	27.42	28.82
7.5%	66.00	9.30	1.284	28.46	26.47
10%	67.00	9.55	1.294	29.40	25.95

Tere Bread Dimensions

Table 5. shows the effect of inulin on Tere bread dimensions compared with the bran effect which cleared that there were slightly increases in terminal thickness at 7.5 and 10% of inulin whereas the increase of central thickness was in all treatments of inulin. Compared to bran addition, Tere bread had thin thickness either in terminal or central of bread sheet.

Also, the results showed that the increase of inulin addition caused decreasing in bread diameter compared with control or some treatments of bran, especially 7.5% bran.

Zainnulabideen and. Al-Araj, (2008) found that the typical diameter of rokak bread produced from wheat white flour was 57 cm whereas the diameter was reduced when 30% of wheat flour was substituted by sorghum flour to be 47.7 -53cm. Also, these results were in agreement with Rashed, and Mohamad (1993) who found that using composite flour of wheat and soybean or triticale caused an increase of terminal or central thickness of Tere bread.

Table 5. Effect of Inulin and Wheat Bran Addition on Tere Bread Dimension

Treatments	Thickness averages of the circumference of T. bread mm	Thickness averages of central of T. bread mm	Diameter averages of small and big T. bread cm
Control	0.99	0.43	50 – 57
Treatments of % inulin addition			
2.5%	0.86	0.50	50 - 54
5% Inulin	0.93	0.57	44 - 52
7.5% Inulin	1.01	0.47	48 - 54
10% Inulin	1.03	0.49	48 - 54
Treatments of % bran addition			
2.5%	0.95	0.42	49 - 55
5%	0.98	0.46	51- 56
7.5%	0.97	0.37	52 - 60
10%	0.95	0.35	50 -54

Sensory Evaluation:

Figure 3. shows the results of sensory evaluation of Tere bread produced from Inulin or Bran and white wheat flour composite flour which indicated that there were significant differences between the sensory evaluation of Tere bread treatments in some characteristics. The results showed that although, the substitution of 2.5% bran increased bread taste score in general, an increase of inulin and bran additions caused a decrease in the evaluation score of this characteristic. Cecile and Gordon (2012) reported that the use of Inulin until 6% hadn't an effect on bread taste. The result also showed that the addition of inulin hadn't any effect on bread color, although 10% inulin improve this characteristic while the same percentage of bran in addition to other studied percentages decreased the color evaluation score which may be due to its content of inulin was free of free sugar, protein, and pigments whereas bran contains these three components in considerable amounts. Bread odor characteristic also showed that addition of inulin hadn't impact on this characteristic may due to that pure inulin was a blend or free of any odor and hasn't any possibility to form any odor during baking. The results also, showed that in general, the addition of inulin and bran caused increased bread thickness, and that leads to a decrease in its evaluation scores. An increase in bread content of fiber and dietary fiber may the reason for increasing its thickness. Substitution of wheat flour by inulin unsystematically influenced Tere bread chewability since the little substitution 2.5, 5% inulin decreased the evaluation, while substitution by 7.5 and 10% inulin didn't influence this sensory characteristic.

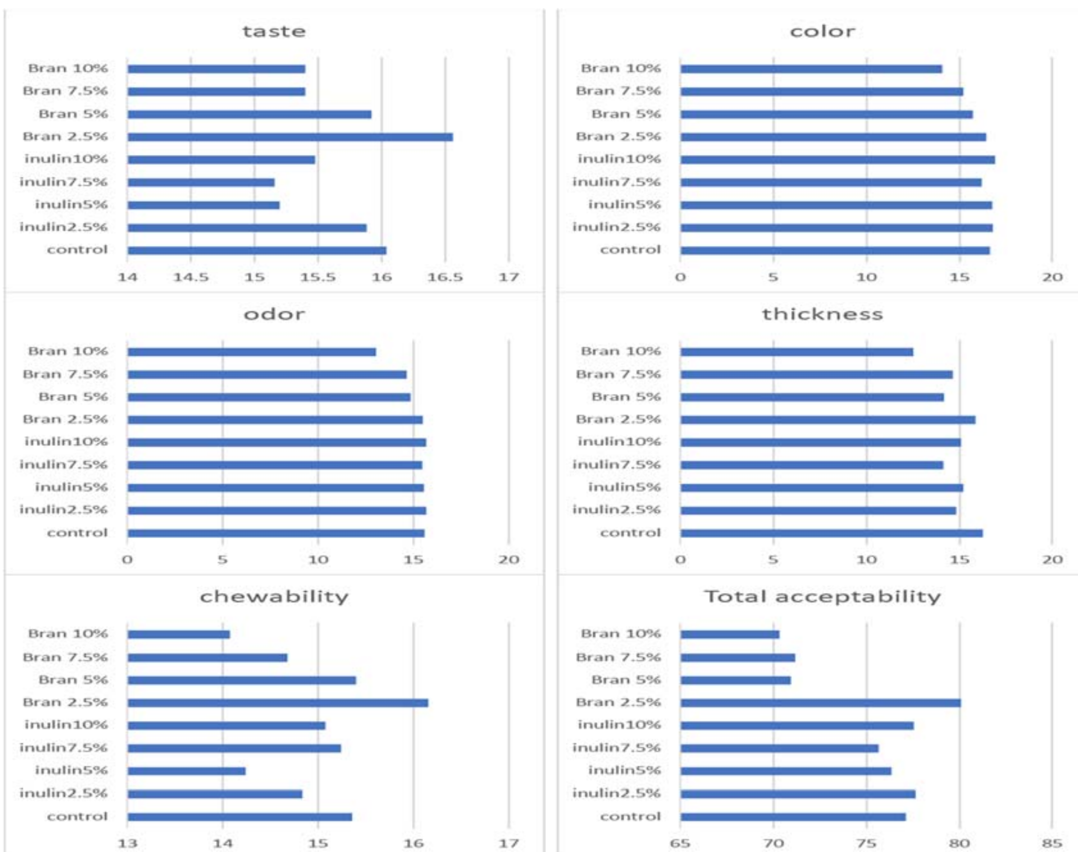

Figure 1 Sensory Evaluation for Tere bread without or with wheat bran or Inulin

On the other hand, substitution flour by bran decreased the evaluation scores of bread chewability. The evaluation scores of total acceptability were higher in the inulin content of Tere bread than in bran content which may be due to the bran content of color and crude fiber that decreased somewhat sensory characteristics of Tere bread. However, 2.5% bran obtained a high score of total acceptability compared with control.

Mold Examination: Mold examination was performed by daily visual examination of bread for 90 days. Bread examination showed no mold growth on the bread surface. This observation was in agreement with Al-Mohizea, et al., (1987) who found that Saudi Arabian Korsan bread (similar to Rokak or Tere bread) had a long shelf life. Hussain and Jamil (2012) also reported that it can increase the shelf life of bread at low content of moisture.

REFERENCES

AACC, American Association of Cereal Chemists, (2000). *Approved methods of the American Association of Cereal Chemists*. 10. ed. Saint Paul.

Al-Mohizea, I.S., Mousa, E.I. and Fawzi, N.M. (1987). Microbiological studies on two common types of bread in Saudi Arabia. *Cereal Foods World* 32(9):610 - 612.

AOAC. (2012). *Official Methods of Analysis of AOAC international*. 19th edition. AOAC 53 International, Gaithersburg, Maryland, USA.

Ayoob, M. H., (2014). Estimates of heterosis, gene action, heritability and genetic advance of flour ,content and some good characters of 2 hybrids grain from diallel crosses in bread wheat (Triticum aestivum L.). *J. of Mesopotamia Sciences*, 25(1):40-56.

Abril, A. P., O.R. Sández, A., Baranzini, L. R., Quintanar, R. L. V., García, M.G. S., (2014). Relationships between Chemical Composition and Quality-Related Characteristics in Bread-Making with Wheat Flour–Fine Bran Blends. *Journal of Food Quality* 38 (1):30–39.

Banu I., G., Stoenescu, V., Ionescu, S., Aprodu, I., (2012). Effect of the Addition of Wheat Bran.Stream on Dough Rheology and Bread Quality, *Food Technology* 36(1) 39-52.

Bojnanska, T., Tokar, M. and Vollmannova, A., (2015). *Rheological parameters of dough with inulin. addition and its effect on bread quality. Journal of Physics*, 1st International Conference on Rheology and Modeling of Materials: Conference Series 602.

Brasil, J. A., da Silveira, K. C., Salgado, S. M., Livera, A. V. S., de Faro, Z. P., Guerra, N. B., (2011). Effect of the addition of inulin on the nutritional, physical, and sensory parameters of bread. *Brazilian Journal of Pharmaceutical Sciences*, 47, (1):56-60.

Cecile, M. and Gordon, M., (2012). The effect of inulin and fructooligosaccharide supplementation on the textural, rheological, and sensory properties of bread and their role in weight management: A review. *Food Chemistry*, 133 (2): 237-248.

Codina, G. G., Zaharia, D., Mironeasa, S., Dabija, A., and Ropciuc, S., (2018). The Influence of Native Inulin and Oligofructosis Addition to Flour and Its Effects on the Rheological Characteristics of the Dough. *International Journal of Food Engineering*, 4, (1):1-6.

Gajula, H., (2017). Effect of wheat bran on gluten network formation as studied through dough development, dough rheology, and bread microstructure. A dissertation submitted in partial fulfillment of the requirements for the degree of doctor of philosophy. Department of Grain. Science and Industry College of Agriculture Kansas State University Manhattan, Kansas.

Hussain, S. and Jamil, K. (2012). Studies on the shelf life enhancement of traditional leavened bread. *Pak. J. Biochem. Mol. Biol.*, 45(2): 81-84.

Iranshahi, M. S., Ardebili, M. S., Ardakani, S. A. Y. (2014).

Effect of Inulin and β-glucan on The Physicochemical, Rheological, and Sensory Properties Barbari Bread. *Int. Journal of Engineering Research and Applications*, 4 (6):90-97.

Luo, D., Kou, X., Zhang, T., Nie, Y., Xu, B., Li, P., Li, X., Han, S., Liu, J., (2018). Effect of inulin on rheological properties of soft and strong wheat dough. *International Journal of Food Science &Technology*, 53(7):

Miskelly, D., (2017). *Optimization of End-Product Quality for the Consumer*. In Cereal Grains (Second Edition). Assessing and Managing Quality, Edited by: Colin Wrigley, Ian Batey and Diane Miskelly. Chapter 24, Pp: 653–688. A volume in Woodhead Publishing Series in Food Science, Technology, and Nutrition.

Rashed, R.M.S., and Mohamad, J.J., (1993). *Evaluation of the Possibility of Using Mixed Flour in Producing Tere Bread (Kurdish Bread). Zanco*, Special Issue Proceeding of 2nd Scientific Conference of the University of Salahaddin- Erbil, 24- 25Aprill, 1993. SAS Institute, 2009. Base SAS® 9.2: procedures guide. 2nd ed. Cary. 1704 p.

Slavin, J., (2013). Fiber and Prebiotics: Mechanisms and Health Benefits. *Nutrients*; 5(4):1417–1435.

Zainnulabideen M.W. Al-Araj, R. F., (2008). Effect of Sorghum and Wheat Composite Flour on Dough Fermentation and Quality of Some Bakery Products. *Mesopotamia Journal of Agriculture*, 36(4):122-128

تحسين القيمة الغذائية والخواص الريولوجية لخبز التيري (الرقاق) المدعم بالانيولين أو نخالة الحنطة

رفيق محمد صال رشيد[1]، تغريد عبد وحواح [1]، شلير فائق أحمد[1]، محمد وجيه محمد سعيد[1]

[1] قسم علوم الأغذية والسيطرة النوعية، كلية هندسة العلوم الزراعية، جامعة السليمانية، السليمانية، العراق. rafiq.salih@univsul.edu.iq

[2] قسم علوم الأغذية والسيطرة النوعية، كلية هندسة العلوم الزراعية، جامعة السليمانية، السليمانية، العراق taghreed404@yahoo.com

[3] قسم علوم الأغذية والسيطرة النوعية، كلية هندسة العلوم الزراعية، جامعة السليمانية، السليمانية، العراق shlerahmad77@yahoo.com

[4] قسم علوم الأغذية والسيطرة النوعية، كلية هندسة العلوم الزراعية، جامعة السليمانية، السليمانية، العراق mwajieh@yahoo.com

تاريخ استلام البحث 2019/11/1 وتاريخ قبوله 2020/12/27.

ملخص

درست القيمة الغذائية والخواص الريولوجية والتقويم الحسي لخبز التيري (الرقاق) المدعم بنسب 2.5 ,5 ,7.5, 10 ٪ من الانيولين أو نخالة الحنطة، تأثر التركيب الكيميائي للخبز تاثرا طفيفا بهذه المعاملات بينما انخفضت قيم الطاقة من 354.24 إلى 315.76 سعرة / 100 غم. ولقد لوحظ أن زيادة الانيولين أدت إلى تقليل قيم امتصاصية الماء من 70.2% إلى50.3% ومعامل تحمل العجن من 34 إلى 0.00 وحدة فارينو وزيادة زمن نضج العجين من 9.3 إلى 20 دقيقة واستقراريته من 11 إلى 14.9 دقيقة ورقم الجودة من 138 الى 200. وأما التأثير الأكبر للنخالة فهو تقليل قيمة الاستقرارية ورقم الجودة من 9.3 دقيقة و138 إلى 6.9 دقيقة و117 ,على التوالي. ومن ناحية أخرى كان للانيولين تأثيرا هاما في تقليل ذروة اللزوجة عند التسخين من 840 إلى 610 وحدة برابندر واللزوجة النهائية عند التبريد من1250 إلى 990 وحدة برابندر المقاسة بالاميلوجراف. وإن إضافة الانيولين كان له تأثير مهم في تقليل احتياج العجين للماء من 66 الى 54٪ مقارنة بالنخالة، والتجربة الضابطة، وكذلك قللت إضافة الانيولين من قطر الخبز بمقدار 3 سم في حين أن معاملة 7.5٪ نخالة زادت القطر بمقدار 3 سم. وأظهرت نتائج التقويم الحسي أيضاً إن إضافة الانيولين والنخالة ولحد 10٪ أثرت تأثيراً صغيراً في تقييم خبز التيري مقارنة مع التجربة الضابطة كما كانت قيمة القبول العام بين 70–80٪. ولم يلاحظ أي نمو للاعفان على الخبز خلال ثلاثة أشهر من التخزين ممّا يؤكد مقاومته لأي نمو مرئي.

الكلمات الدالة: الانيولين، نخالة الحنطة، خبز التيري (الرقاق)، الفارينوكراف، الاميلوكراف.