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Effect of Addition Corn Flour on Chemical, Physical, Rheological and Sensory Properties of Iraq Bread

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ABSTRACT

Wheat crop is considered one of the most important grain crop in food industry worldwide. In Iraq, there is shortage in wheat production, where there is food gab between wheat flour consumption and production. In light of this fact, there is an urgent need to produce bread with substitution of wheat flour with different levels of corn flour. Five blends of bread were prepared from wheat flour and corn flour. Studies were carried out to evaluate chemical, technological, and sensory properties of raw materials and the produced bread from the five blends and the control (100 % wheat flour). Result of chemical composition showed that the protein content was 11.28 % for wheat flour and 9.82 % for corn flour, while the high content of potassium was in corn flour. The farinograph-and-extenograph-assisted rheological studies showed that stability, extensibility, resistance to extension and strength of dough decreased with increasing the level on corn flour substitution in the blends, while the water absorption and dough weakening increased. The sensory evaluation showed that there is a slight differences between all sensory properties evaluated for fresh bread made from wheat flour (100 %) and the other prepared from corn flour substitution up to 30 %. Therefore: the study recommends using corn in bread making by replacing it with wheat flour in the proportions in question.

Keywords: Wheat flour, Corn flour, Iraq bread, Substitution, Technological.

INTRODUCTION

Bread is one of the oldest foodstuffs that man relied on and is the main food in many countries around the world, where all segments of society, rich and poor, depend on it. Its types may vary according to the financial situation of each of these groups, but everyone depends on it mainly (Khalil, *et al.*, 2021).

Wheat flour (*Triticum. aestivum*) is the most widely used around the world as it gives an ideal product with excellent sensory properties and acceptable to the consumer (Lockyer and Spiro, 2020). And because of his uniqueness with these qualities, the demand for it increased, which created a gap between what is produced of wheat in some countries and what is consumed, and this gap widened with the increase in the population of these countries (White, 2021).

The use of whole wheat flour may be a solution, but despite its nutritional benefits, it usually negatively affects technological and sensory qualities such as appearance, texture, taste and smell and thus is rejected by the consumer (Németh *et al.*, 2019). For these reasons that were mentioned, using other grains such as corn, rice and soybeans has become an inevitable matter because they are cheaper and have the ability to reduce the cost as much as possible in addition to overcoming these obstacles at the same time and these grains (Filipini *et al.*, 2021).

Corn ranks as the second most widely produced cereal crop worldwide. Because of the high productivity, corn is by far the most economical cereal to produce. Corn flour contains high levels of many important vitamins and minerals, including potassium, phosphorus, zinc, calcium, iron, thiamine, niacin, vitamin and foliate (Kumari, (2019). This investigation has den carried out to substitute a Bart of wheat flour with different levels of corn flour to produce acceptable bread.

MATERIALS AND METHODS

Materials:

Raw materials:

Wheat flour (72% extraction) and corn flour were purchased from the local market Mansoura-Dakahlia-Egypt. All ingredients such as dried yeast, sugar and salt used in preparing the bread dough were purchased from the local market, Mansoura-Dakahlia-Egypt.

All solvents, chemicals and reagents used in this study were analytical grade and were provided from El-Gamhouria Trading Chemicals and Drugs Co, Egypt.

Methods:

Preparation of flour blends:

The different flour blends of wheat flour substitution with different levels of corn flour are shown in the following form (form A).

Form A. Different flour blends of wheat flour substitution with corn flour.

No.	Wheat flour %	Corn flour %
1	100	-
2	80	20
3	70	30
4	60	40
5	50	50

Chemical analysis:

Moisture, protein content (calculated by multiplying total nitrogen by 5.95 for cereal), fat, ash and fiber contents were determined according to methods described in (A.O.A.C; 2011). Carbohydrates were calculated by difference.

Mineral analysis was carried out after digesting with mixture of concentrated sulfuric acid and percholoric acid as stated in A.O.A.C. (2011).

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Iraq bread making:

The ingredients were placed in a 7 speed spiral mixer (Model KM 400, Kenwood, UK) and mixed for 2 min at 90 rpm and for 8 min at 180 rpm. Low speed is required for homogeneous ingredient dispersion and flour hydration (brief duration), whereas more extensive mixing required for optimum dough development. As soon as the dough was formed, it was placed in a baking pan and fermented at an incubation chamber (Bekso EB 1N, Bekso, Brussels and Belgium) set at 35°C and 80% relative humidity for 35 min. Then the dough was remixed for 1 min at 90 rpm and was separated in samples of 80 g, which are round shaped by hands, placed in aluminum baking pans (measuring 70 by 40 mm) and placed for refer mentation for another 35 min. Baking for each sample was conducted in a laboratory oven with air circulation (Terawatt TG103, Terawatt, Prehistory and Greece) at the temperature of 220°C for 30 min. The loaves were removed from the pans and cooled at room temperature. Baking, sensory and firmness characteristics were tested 1 h after the loaves were removed from the oven (time 0). Then the loaves were placed in polyethylene bags until tested for firmness (Zubaidi and Abbass, 2009).

Rheological properties of dough:

The dough rheological proportion were examined with Brabender farinograph , mixer type's 300 H (brabender , Duisburg and Germany) according to the content flow weight procedure(icc no 115/1992) and brabender extensograph (model 8600, bratendes, Duisburg, Germany) according to the official procedure (ICC no 114 \ 1 1992).

Baking characteristics:

Breads were weighted (g) and then their volume (cm^3) was determined by rapeseed displacement (Hallen *et al.*, 2004). Specific volume (cm3 /g) was calculated by dividing volume by weight.

Sensory Evaluation of Iraq bread loaves:

Iraq bread from different blends were subjected to sensory evaluation in terms of appearance, taste, crust color, separation of layers, crumb distribution and odor. Using to laboratory staff member as a panelists. Properties of bread were estimated using a ranking test according to Anonymous (1981). Data were statistically analyzed using the analysis of variance (ANOVA). The calculated mean values were compared using LSD test with significance defined at <0.05 according to Steet and Tornie (1980).

Moisture content and moisture loss of bread loaves:

The Moisture content and moisture loss of bread for each blend were determined after intervals of 0, 24, 48 and 72 hr. during storage at room temperature according to A.O.A.C, (2011). The moisture loss (%) was calculated based on the moisture content of bread immediately after baking.

Alkaline Water Retention Capacity (AWRC) test:

Freshness of bread loaves was tested after wrapping in polyethylene bags and storage at room temperature for 24, 48 and 72 hr. It was determined using Alkaline Water Retention Capacity test (AWRC) according to the method of Yamazaki (1953), modified by Kitterman and Rubenthaler (1971).

RESULTS AND DISCUSSION

Chemical composition:

Chemical composition of wheat and corn flours:

Chemical composition of wheat (72% extraction) and corn flours were determined and given in Table (1).

Table 1. Chemical composition of wheat (72% extraction) and corn flours (on dry basis).

Components Raw materials	Moisture %	Protein %	Fat %	Fiber %	Ash %	*Carbohydrates %
Wheat flour	10.85	11.28	1.60	1.93	1.24	83.95
Corn flour	8.89	9.82	4.26	2.14	1.35	82.43

**** Carbohydrates were determined by difference.***

Table (1) represents the commitments of wheat flour (72% extraction) containing 10.85% moisture, followed by corn flour which recorded 8.89 %, these results are in agreement with Khalil and Hussein (2003) who found that wheat flour (72% extraction) contained 10.60% moisture.

The obtained results in the same Table also indicated that values of protein were 11.28 % for wheat flour to 9.82 % for corn flour. These results are in agreement with those reported by Gomez *et al.* (2020) they found that protein content of wheat flour (72% extraction) was 10.33%, Salazar *et al.* (2020) reported that protein content of corn flour was 9.50%.

Table (1) also showed that the crude fat content of raw materials was highest in corn flour 4.26%, followed by wheat flour 1.6%. These results are in agreement with Abd El-Samed (2001) who mentioned that corn flour contained 4.26% fat. Also Ragab *et al.* (2005) mentioned that wheat flour (72% ext.) contained 1.2% fat.

Table (1) show that fiber content was 2.14 % for corn flour, while was 1.93 % for wheat flour. These results are in agreement with results of opera *et al.* (2018) found that wheat flour (72% ext.) fiber content was 1.90%.

The obtained results in Table (1) also show that corn flour had 1.53 % of ash followed by wheat flour (1.24 %). These results are in agreement with those obtained by Ismail *et al.* (2001) they reported that corn flour contained 1.46% ash, and wheat flour (72% ext.) contained 1.12% ash (Al-sahlany and Al-musafer 2020).

Furthermore, the same results in Table (1) revealed that wheat flour contained highest value of carbohydrates 83.95 % followed by corn flour (82.83%). These results are in accordance with the results of Pahwa *et al.* (2020) they mentioned that percentage of carbohydrates in corn flour was 82.42% and Aly (2000) who reported that wheat flour (72% ext.) contained total carbohydrates between 72.99-84.33.

Mineral contents:

Mineral content of wheat flour (72% ext.) and corn flour. Were determined in table (2).

Table 2. Mineral content of flour raw materials used in making bread (on dry weight basis) (mg/100gm).

Minerals Raw materials	Ca	P	Fe	Zn	Na	K
Wheat flour	14.30	103	1.11	0.66	3.0	102.0
Corn flour	8.10	226	2.25	1.68	4.0	310.0

Data in Table (2) showed that calcium content was higher in wheat flour being 14.30 mg / l00g, than that in corn flour (8.10 mg / l00g). There results approximately agree with Abd EL-Hameed (2004) who found that calcium content in wheat flour (72 %.ext.) was 14.13 mg / l00g, while U.S.D.A. (2009) reported that calcium content in corn flour was 7.0 mg / l00g.

It could be conclude from Table (2) that the highest content of phosphors was in corn flour 226 mg/100gm followed by wheat flour 103 mg/100gm, These results are in accordance with the results of (U.S.D. A. 2009) which reported that phosphors content in corn flour and wheat flour (72% ext.) were 272 and 108 mg/100gm.

From the same table, it could be notice that the content of iron was in corn flour 2.25 mg/100gm and wheat flour (72% ext.) 1.11 mg/100gm. These results approximately agree with Abd El-Hameed (2004) who found that iron content in wheat flour (72% ext.) was 1.53 mg/100gm and U.S.D.A. (2009) which reported that iron content in corn flour and wheat flour (72% ext.) were 2.38 and 1.17 mg/100gm.

Data in Table (2) show that zinc content was higher in corn flour 1.68 mg/100gm than that in wheat flour (72% ext.) 0.66 mg/100gm, these results are in accordance with the results of (U.S.D. A. 2009) which reported that zinc content in corn flour was 1.73 % mg/100gm.

It can be conclude from the same Table that the highest content of sodium was in corn flour 4.0 mg/100gm. These results are in agreement with U.S.D.A. (2009) which reported that sodium content in corn flour and wheat flour was 5.0 and 2.0 mg/100gm.

From the same Table, it could be notice that the highest content of potassium was in corn flour 310 mg/100gm followed by wheat flour (72% ext.) 102 mg/100gm. On the other hand, these results are in agreement with Abd El-Hameed (2004) who found that potassium content in wheat flour (72% ext.) was 136 mg/100gm and U.S.D.A. (2009) which reported that potassium content in corn flour and wheat flour were 315 and 107 mg/100gm.

Chemical composition of wheat flour and wheat flour partially substituted with different levels of corn flour:

Chemical composition of wheat flour and wheat flour which partially substituted with 20, 30, 40 and 50% of corn flour presented in Table (3).

Table 3. Chemical composition of wheat flour and wheat flour partially substituted with different levels of corn flour (on dry basis).

components Samples	Protein %	Fat %	Fiber %	Ash %	*Carbohydrates %
100% Wheat flour	11.28	1.60	1.93	1.24	83.95
80%wf** +20%corn flour	11.0	2.10	2.00	1.25	83.67
70%wf+30%corn f.	10.97	2.40	2.10	1.25	83.28
60%wf+40%corn f.	10.84	2.66	2.14	1.26	83.10
50%wf+50%corn f.	10.66	2.95	2.21	1.27	82.91

***carbohydrates* ****WF = wheat flour.**

These results indicated that as partially substituting levels of corn flour increased the ash and fat contents. The ash content was 1.25, 1.25, 1.26 and 1.27% for 20, 30, 40 and 50% of corn flour substituting levels. The fat content was 2.10, 2.40, 2.66 and 2.95% for 20, 30, 40 and 50% of corn flour substituting levels. However, the protein and total carbohydrate contents were decreased with increasing the substitution levels of corn flour protein contents were 11.0, 10.97, 10.84 and 10.66% for 20, 30, 40 and 50% of corn flour substituting levels. The fiber content showed increase in its values with increasing levels of corn flour.

The fiber content was 2.0, 2.10, 2.14 and 2.21% for 20, 30, 40 and 50% of corn flour substituting levels. These results are in agreement with those reported by Ramadan (1986) who stated that as the substituting levels of corn flour to wheat flour increased, the fat, ash and fiber content, whereas the protein content decreased.

characteristics of dough from wheat flour and wheat flour partially substituted with different levels of corn flour:

The properties of wheat dough reflect the amount and the strength of the protein in the flour. Moreover, any treatment on the flour which affects its gluten may change the physical characteristics of the dough (Beckett, 1995).

Physical characteristics of dough from wheat flour and wheat flour partially substituted with different levels of corn flour. The farinograph is an apparatus designed to measure and record the resistance of dough evaluates water absorption; determine the stability and other characteristics of dough during mixing (A.A.C.C, 2012). The farinograph parameters of wheat flour dough (72% ext.) and wheat flour partially substituted with corn flour at levels of 20, 30, 40 and 50% are given in Table (4).

Table 4. Farinograph parameters of wheat flour dough and wheat flour partially substituted with different level of corn flour.

corn flour substitution %	Water absorption (%)	arrival time (min)	dough development time (min)	Dough stability (min)	Mixing tolerance index (B.U)*	Dough weakening (B.U)
0	55.60	2.50	4.50	8.0	140	60
20	58.50	3.50	6.0	5.0	130	120
30	59.80	3.0	6.0	5.5	100	100
40	61.30	3.0	4.5	4.5	100	125
50	62.7	3.0	5.0	4.5	80	130

***B.U= brabender unit**.

Water absorption (%) is the measure of the water amount which be added to the flour in order to form good dough at 500 bra bender units line Date of the present study revealed that the water absorption (%) increased with increasing corn flour substitution levels. The water absorption increased from 55.6% for wheat flour by itself to 58.5, 59.8, 61.3 and 6.2.7% for corn flour substitution levels of 20, 30, 40 and 50% respectively. This increase in water absorption might be explained on the bases that corn flour contained damaged starch granules than that of wheat flour. The arrival time slightly increased with increasing corn flour substitution levels. The arrival time increased from 2-5 min for wheat flour to 3.50 min for the blend with 20% corn flour substitution levels and remained at 3 min for the other blends substitution with 30, 40 and 50% corn flour.

Results also showed that the dough development time (Mixing time) slightly increased as the corn flour substitution levels increased. Dough development time was 4.5 min for wheat dough and increased to 6 min the blend contained 20% corn flour then remained at 6.o min for the blend with 30% corn flour and decreased again to 5 min for both blend with 40 and 5o% corn flour substitution levels. These farenographe data indicate that the time needed to make dough increased by the presses of corn flour in blend. At the same time, increasing substitution level more than 30% of corn flour had a neglected effect on the development time.

The dough stability times decreased by increasing the substitution levels of corn flour in dough as well as the dough strength become weaker. The stability time decreased from 8 min for wheat flour dough to 5, 5.5, 4.5 and 4.5 min for blends with 20, 30, 40 and 50% corn flour substitution levels, respectively.

The mixing tolerance index (B.U.) decreased with increasing of corn flour substitution in the blend. The mixing tolerance index 140 (B.U.) for wheat dough and decreased to 130, 100, 100 and 80 (B.U.) in blends with 20, 30, 40 and 50% corn flour substitution levels respectively. The dough weakening (B.U.) increased with increasing corn flour substitution levels in the blend. The dough weakening increased from 60 BU for

wheat dough to 120, 100, 125 and 13 BU for blends with 20, 30, 40, and 50% corn flour substitution levels respectively.

It is clear from the above mentioned data that the dough lost its favorable characteristics gradually with increasing the corn flour substitution levels in the dough. This could be attribute to the dilution of gluten by other non-gluten flours such as corn flour, or the corn flour behaved as strengthening fillers as concluded by younis (1984) and Mohsen *et al.,* (1997).

Extensograph characteristics of wheat dough and wheat dough partially with different levels of corn flour:

The extensograph records a load-extension curve for test piece of dough stretched until it breaks. Characteristics of load-extension curves or extensgrams are used to assess general quality of flour and its response to improving agents (AACC, 2012).

Table 5. Extensograph parameters of wheat flour and wheat flour partially substituted with different levels of corn flour.

corn flour substitution %	Resistance To Extension (R) (B.U)	Extensibility (E) mm	Proportional No. (R/E)	Energy (cm^2)
0	740.0	90.0	8.22	72.0
20	530.0	71.0	7.46	42.0
30	380.0	87.0	4.37	38.0
40	440.0	60.0	7.33	29.0
50	460.0	54.0	8.52	26.0

Data of Table (5) showed that the wheat dough characteristics were affected by the substitution of corn flour at all levels used in this study. The dough strength (energy) as indicated with the area under extension curve decreased from 72 cm^2 for wheat dough to 42, 38, 29 and 26 cm^2 with corn flour substitution levels of 20, 30, 40 and 50% respectively. Also the resistance to extension (R) decreased from 740 BU for wheat dough to 530, 380, 440 and 460 BU for blends with 20, 30, 40 and 50% corn flour substitution levels respectively.

Extensibility (E) also dropped from 90 mm for wheat dough to 71, 87, 60 and 54 mm for blends with 20, 30, 40 and 50% corn flour substitution levels respectively. These drops in dough energy, extensibility and resistance to extension could be attributed to the gluten net that lost its strength and extension characteristics, and became weak and profligate, which was attention to the increasing levels of corn flour substitution in dough. Mohsen *et al.* (1997) stated that addition of corn flour to wheat flour dough at levels 10-25% decreased extensibility and resistance to extension.

Quality characteristics of Iraq bread prepared from wheat flour partially substituted with different levels of corn flour:

The weight, volume and specific loaf volume are important criteria in evaluating bread quality (pomeranz and shellenberger, 1971). The Iraq bread made from wheat flour (72% ext.) partially substituted with different levels of corn flour were presented in Table (6).

Table 6. Quality characteristics of Iraq bread prepared from wheat flour partially substituted with different levels of corn flour.

Characteristics Samples	Loaf weight (g)	Loaf volume (cm^3)	Specific Loaf volume (cm^3/g)
100% Wheat flour	162.50	365	2.25
80% Wheat flour +20% Corn flour	158	340	2.15
70% Wheat flour +30% Corn flour	156	334	2.14
60% Wheat flour +40% Corn flour	154	329	2.14
50% Wheat flour +50% Corn flour	152.50	325	2.12

Data showed that the loaf weight and loaf volume of bread prepared from 100% wheat flour (72% ext.) were higher than those of bread from substituted levels of corn flour blends. Results also showed an observed decrease in loaf weight and loaf volume of bread as the percentage of corn flour substitution increased. At the same time, the bread made from wheat flour had high specific loaf volume and tended to be decreased as the substitution levels of corn flour raised.

The loaf weight of bread from wheat flour (72% ext.) was 162.50g then decreased to 158.5, 156, 154 and 152.5g for corn flour substitution levels respectively. The same effect was observed on loaf volume and specific loaf volume. The loaf volume was 365 cm^3 for bread made from wheat flour (72% ext.) then decreased to 340, 334, 329 and 325 cm^3 for blends with corn flour substitution levels respectively.

The specific loaf volume was 2.25 cm^3/g for wheat bread, decreased to 2.15, 2.14, 2.14 and 2.12 cm^3/g for blends with corn flour substitution levels.

These reductions in loaf volume, loaf weight and specific volume could be due to the increase of carbohydrate content. In contrast the protein content decreased as a result of wheat flour substitution with corn flour, this action reduced the gluten content and harmed the gluten net, which made it weaker to prevent the gas escaping during baking. Added carbohydrate played as a filler matter in gluten net and easy to lose free water from bread during baking. Foda *et al.* (1987) found that the loaf weight, loaf volume and specific loaf volume reduced as result of increasing the replacement levels of sorghum flour in the blends.

Sensory evaluation for Iraq bread made from wheat flour and wheat flour substituted with different levels of corn flour:

The Iraq bread from wheat flour and wheat flour substituted with different levels of corn flour, immediately after baking, subjected to sensory evaluation. Sensory evaluation included; appearance, taste, crust color, separation of layer, roundness, distribution of crumb and odor were evaluated to each bread loaf sample. The mean value of sensory evaluation scores for bread loaves were given in Table (7).

The results indicated that substituting levels of corn flour to wheat flour affected the sensory properties of produced bread. However, at 20 and 30% substitution levels of corn flour were almost less effective on the sensory properties and overall acceptance of the produced bread. The sensory properties of loaves, however, were the worst when 40 and 50% substitution levels of corn flour used in the blend.

In yeast bread, the structure is dependent on development of gluten, therefore, the dilution of gluten by adding low functional properties ingredients will effect of the yeast bread (Raidl and Klein, 1983).

Moisture content and moisture loss after baking of Iraq bread loaves made from wheat flour and wheat flour partially substituted with different levels of corn flour:

Moisture content and moisture loss were determined immediately after baking. The data of Table (8) showed that the moisture content after baking varied among the Iraq bread from different blends. The moisture content of bread from wheat flour were less than the other blends at same substituting levels of corn flour. This could be mainly due to the highest amount of water content in dough and also the high amount of fiber existed in corn flour, which held much

water during bread making. At the same time, moisture losses of these bread samples increased by increasing the substituting corn flour levels in the blend.

Table 7. Mean value of sensory scores* of Iraq bread made from wheat flour and wheat flour partially substitution with different levels of corn flour.

Corn flour substitution (%)	General appearance	Taste	Crust colour	Separation of layer	Roundness	Distribution of crumb	Odour	Total
0	3.90	3.73	3.65	3.81	3.81	3.75	3.48	26.13
20	3.73	3.73	3.65	3.65	3.65	3.56	3.65	25.62
30	3.56	3.65	3.23	3.31	3.31	3.23	3.48	23.77
40	1.81	1.73	1.55	1.65	1.56	1.81	2.23	12.34
50	1.65	1.56	1.40	1.65	1.56	1.40	2.15	11.37

*** Scale from 1 to 4, since 4 were the best and 1 was the worst.**

Table 8. Moisture content and moisture loss of bread made from different flours blends after baking.

Parameters	Wheat flour 100%	Corn flour substitution 20	30	40	50
Moisture of dought (%)	44.3	45.8	46.2	47.1	48.2
Moisture after baking (%)	25.6	24.5	23.7	23.7	24.4
Moisture loss during baking (%)	18.7	21.3	22.5	23.4	23.8

Table 9. Loss percentage of moisture content of Iraq bread prepared from different flour blends up to 72 hr of storage.

Storage time	Wheat flour 100%	Bread with Corn flour substitution % 20	30	40	50
24	21.3	22.1	21.9	27.7	27.8
48	36.2	35.8	35.9	39.1	39.4
72	37.6	38.9	38.6	41.0	42.3

Effect of wheat flour partially substituted with different levels of corn flour on alkaline water retention capacity as an indicator for Iraq bread freshness:

The alkaline water retention capacity (AWRC) was determined in Iraq bread after baking as a freshness indicator. The results of Table (10) showed that using of corn flour substitution in bread blends reduced the AWRC at zero time. Also, increasing the corn flour substitution levels in blends increased the reducing rate of AWRC. On the other hand, the AWRC was also reduced with the prolongation of storage time resulted in more reduction in freshness..

The data also showed that the AWRC values in Iraq bread from 20 and 30% corn flour substitution levels in blends were lower than those of the Iraq bread made from 40 and 50% corn flour substitution levels, during the storage period. The variation of AWRC values between Iraq bread made from wheat flour alone and Iraq bread from wheat and corn flour blends become very close after 48 and 72 hr. This means that the major changes in freshness or staling occurred during the first 24 hr. after baking.

Faridi and Rubenthaler (1984) stated that the AWRC was sharply decreased during the first 8 hr. of storage. The decrease was minimal when bread was stored for the next day. The AWRC related the closest to the initial pasting viscosity and percent amylase of soluble starch. They also reported that the AWRC is a simple and quick test; it may be useful following up the staling and shelf-life by predicting the amylase and the initial pasting viscosity of bread crumb.

Table 10. Alkaline water retention capacity (%) of Iraq bread made from wheat flour partially substituted with different levels of corn flour.

Storage time (hr.)	Wheat flour (100%)	Corn flour substitution (%) 20	30	40	50
0.0	336.0	308.5	306.0	282.0	270.0
24	309.5	289.5	283.0	250.0	230.0
48	290.5	277.0	272.0	242.5	220.0
72	256.5	240.0	235.5	205.5	190.5

CONCLUSION

It can be conclusion Iraq bread produced from different blends were more or less have the same attitude of their nutritive value and organoleptic evaluation compared with those from wheat flour, especially from substituted levels 20 % or 30 % corn flour with added 5 % defatted soy flour + 0.5 % lecithin. From aforementioned results, it should be recommended to substituted corn flour and added defatted soy flour for prepared good Iraq bread.

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تأثير اضافة دقيق الذرة على الخواص الكيميائية ,الفيزيائية, الريولوجية والحسية للخبز العراقي..

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يعد القمح من أهم محاصيل الحبوب في عالم الغذاء حول العالم. ونتيجة للاستهلاك اليومي الضروري للمحصول على المستوى القطري , يعاني العراق من فجوة غذائية بين أنتاج القمح واستهلاكه. وعلى ضوء ذلك , تولدت هنالك حاجة ماسة لإنتاج الخبز من خلال استبدال دقيق القمح ب دقيق الذرة تم تصنيع خمس خلطات من دقيق القمح ودقيق الذرة. حيث اجريت دراسات لتقييم الخصائص الكيميائية والتكنولوجية والحسية للمواد الخام .والخبز المنتج من خلال النماذج الخمسة والعينة الرئيسية (100% دقيق قمح). أظهرت نتائج تحليل تلك التركيبة الكيميائية ان نسبة البروتين الموجودة وصلت الى 11.28% في دقيق القمح بينما كانت النسبة في دقيق الذرة 9.82 . وقد تبين ايضا ان النسبة الاعلى من البوتاسيوم كانت في دقيق الذرة. الى ذلك , وعلى ضوء الدراسات الريولوجية عبر استخدام جهازي قياس الفارينوكراف والاكستينسوكراف فقد بينت الدراسة ايضا ان هنالك انخفاض ملحوظ في كل من قيم الثباتية والمطاطية ومقاومة الشد وقوة العجين مصحوب ذلك بزيادة في نسبة في احلال دقيق القمح بدقيق الذرة في مزيج التركيبة الخماسية. وقد تبين ايضا حدوث زيادة في كمية الماء الممتص فضلا عن وجود ضعف في العجينة. أظهرت نتائج التقييم الحسي وجود فروق معنوية لتقييم الخبز الناتج حتى نسبة استبدال 30 % من دقيق الذرة وذلك مقارنه مع مثيلاتها المصنع من دقيق القمح فقط. وتحقيقا لما تقدم , توصي الدراسة باستبدال دقيق القمح بدقيق الذرة بالنسب التي بينها البحث.