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EFFECT OF FLOUR TYPE ON PHYTIC ACID DEGRADATION DURING BISCUIT MAKING

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Abstract

This study examined the effect of wheat natural phytase and baking in the degeneration of phytate during the process of making biscuits from some Iraqi mills flour. The concentration of phytate were (850, 802, 531 mg / 100g) for the flour of the Al-Brari, Al-Neser and Al-Doura mills respectively. At the end of the baking processes, the decrease in the concentration of phytate in the biscuits produced from the flour obtained from the three mills were (4.05, 5.55, 4.37%) respectively, while inorganic phosphorus concentration in all treatments increased by 18.36, 10.68 and 11.69%, respectively. It was establish that the activity of wheat natural phytase enzyme differ according to the kind of mill, while the enzyme has been ruined after the baking process for all treatments. Therefore, with the effect of wheat natural phytase enzyme and baking processes, the concentricity of phytate may be reduced when making biscuit for some mills by (4-5%).

Key words: Phytate, Wheat, Phytase, biscuit manufactured, Inorganic Phosphorus.

Introduction

The importance of grain crops as a staple food for most people has become well known. These crops are produced in large quantities because of their easy storage and transport, as well as being a cheap source of energy and protein. Wheat ranks first among all agricultural crops in terms of production, circulation and food use. Some of its varieties have unique properties in producing bread and other types of pastries. Grass family cereals, such as maize, wheat, rice, especially in their outer layer and embryos, contain anti-food agents, such as inhibitory agents and chelating agents, known as phytate ranging from 1.5 to 6.4% and have a negative effect on the bioavailability of positive metal ions such as Zn, Fe, Ca, Mg, Mn and Cu and positively charged elements such as protein and starch, by forming ionic and covalent bonds with phosphate aggregates associated with the inositol ring within the composition of the phytic acid molecule. Thus, the phytate content in the flour increases with increasing extraction rates (Schlemmer, 2009; Abadi, 2019).

Soft wheat flour is the main component of almost all types of biscuits and after the removal of the covers of wheat grain and fetus and reduces the size of endosperm particles. Soft wheat flour is characterized by low protein content (7-9%), moisture content is about 14%, starch content is about 70-75%, most of the endosperm particles are about 50 μm and less than 10% of particle size over 130 μm, while other types of wheat flour at different particles produce pies and bakeries with different rheological properties (Zucco *et al*., 2011; Mamat and hill, 2014).

Biscuits are a popular food product, produced using basic ingredients (flour of different types, sugar, fat and water) and can be mixed with secondary ingredients such as baking powder, skimmed milk and emulsifiers, to form dough containing a weak gluten network. The nature and quantity of the components determine the quality of the biscuits produced, taste, shell life and cost. Biscuits differ from other baked products such as bread and cakes with a low moisture content of less than 4% and thus have a long life span of up to six months or more (Manley, 1998; Penilaian *et al*., 2014).

Iraqi mills produce flour with a percentage of extraction 80-85%, which has a high ash content, which shows high proportion of phytic acid in it. This will lead to a higher proportion of phytic acid in pastries produced from this type of flour.

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Table 1: Biscuit mix used in the study.

Weight (g)	Raw materials
225	Flour (14%)
130	Crushed sugar
64	Fat Margarine
2.1	Salt
2.5	Soda
16 ml	Water
33 ml	Solution of glucose (8.9 g / 150 ml of water)

The present study aimed to determine the amount of phytic acid and inorganic phosphorus in the flour of local mills and the effect of the baking process in reducing the level of phytic acid in biscuits made from the flour of these mills.

Material & Method

Preparation of wheat flour

From three local mills flour was collected, all was kept in cooling (± 4°C). Later physical and chemical tests were performed: Proximate compositions of all samples were studied using AACC methods, 2010. Carbohydrate was calculated by difference.

Biscuits preparation

The biscuit making performances of the flours were determined using the straight dough AACC method No. 10-50 B (AACC, 2000) with a slight modification. The mixture used in the preparation of biscuits is shown in table 1.

Procedure

The sugar was mixed first in the Kenwood dough bowl for only three minutes to form a soft cream. Then add the water and glucose solution. Mix for 2 minutes. Finally dry ingredients (flour, salt and soda) were added after mixing well using a 30 µm sieve. Mix for one extra minute. Make dough that is not coherent in small lumps and sprinkle on the butter paper with a thickness of 6 mm by a rolling-pin. Then cut the dough into 6 pieces with a 60 mm cookie cutter. After removing the rims (Scraps), roast in the oven at 175°C for 10 minutes and then left to cool at room temperature for 60 minutes, wrapped in a plastic film and then stored at room temperature (20°C). The spread factor of the biscuit was calculated by dividing the width of six pieces at the thickness of six pieces. The treatments included in this experiment were:

T1: AL-Brari flour mill with the basic ingredients.

T2: Al-Neser flour mill with the basic ingredients.

T3: Al-Doura flour mill with basic ingredients.

• Sensory Evaluation of Biscuit : The evaluation form aforesaid in (Alzubaidy, 2009) was used.

• Determination of phytic acid (PA): Phytate was evaluated according to the method described by (Latta and eskin, 1980) indicated to by (Almihyawi, 2018).

• Determination of inorganic phosphorus: Inorganic phosphorus was evaluated according to the method cited by (Chen *et al*., 1956) indicated to by (Almihyawi, 2018).

• Determination of wheat - phytase activity in dough: The enzyme activity was specified according to (Sedaghati *et al*., 2011). The enzyme activity units are defined as the amount of enzyme that releasing one µg of inorganic phosphorus per ml of sodium phytate solution beneath experimental conditions.

• pH measurement for flour and dough: AACC method 02-52 (AACC, 1976) was adopted.

• Remove the Fat from the Biscuits Before Determent the Phytate: The method of (10) was applied to remove the fat from biscuits, using the cold method.

Results and Discussion

Chemical composition of flour forms

Table 1, shows the concentration of the chemical compositions of the flour used. The concentration of moisture in the AL-Brari, Al-Neser and Al-Doura flour 12.1, 11.7 and 11.6% respectively, is the preferred concentration of bakeries 11.5-15.2% (Zain El-abideen, 1979). The concentration of protein was 11.9, 11.4 and 10.3%, respectively and it is of major importance in determining the quality of the produce. It is noted from the table that the first and second treatment flour excels in the ratio of this component compared to the third treatment type, the results agreed with what said (Ramadhan, 2017), who indicated that the proportion of soft wheat protein ranges between 9.5-12%. The protein content of grains are a quality characteristic affected by the environment. It is also considered to be one of the basic criteria for wheat quality, which is based mainly on the genetic factors of class and species and on the climatic and agricultural conditions prevailing during the growth stage of the wheat crop.

The same table indicates that ash ratio was 1.33, 1.20 and 0.78%

Table 2: The chemical compositions of the flour from AL-Brari, Al-Neser and AL-Doura mills.

Mills	Carbohydrate (%)	Ash (%)	Protein (%)	Fat (%)	Moisture (%)
AL-Brari	73.22	1.33	11.9	1.45	12.1
Neser	74.73	1.20	11.4	1.35	11.7
AL-Doura	76.68	0.78	10.3	1.03	11.6

Table 3: Concentration of phytic acid and Inorganic phosphorus in the flour from AL-Brari, Al-Neser and Al-Doura mills (mg / 100g).

Mills	AL-Brari	Al-Neser	AL-Doura	L.S.D.
Phytic acid	850	802	531	103.66*
Inorganic phosphorus	6.03	7.26	10.10	2.094*

respectively, which is comparable to that of (Požrl *et al.*, 2009). Ash content is an important measure of flour color and purity. The efficiency of the grinding process are determined by the knowledge of the flour content of the ash, which are mainly associated with the amount of bran in the grain of wheat, which is usually about 2.0-0.4% (Halverson and zeleny, 1988). Bread made from flour with high ash content tends to dark color (Iuliana *et al.*, 2010).

The table also shows that the fat ratio were (1.45, 1.35, 1.03%), respectively. Several studies have certain the importance of flour fat in bread making and the rheological characteristic of dough, although their quantity are minimal than other flour ingredients. (Iuliana *et al.*, 2010) found that the concentration of carbohydrates for wheat and the general average was (65-75%) and was conformable to what were found in the flour of the treatments beneath study.

Determination of Phytic acid and Inorganic phosphorus in Flour Types

The results of the statistical analysis indicated that there were significant differences below the probability level ($P \leq 00.05$) in the values of phytic acid (PA) and phosphoric acid content in the flour types under study. It was observed from the table 2, that the values of phytic acid concentration in flour mills (Al-Brari, Al-Neser and AL-Doura) were 850.32, 802.14, 531.84 mg / 100g, respectively. The values of inorganic phosphorus were (6.03, 7.26, 10.10) mg /100 g, respectively. Where the highest content of the phytate have been recorded for the flour mill AL-Brari and the lowest in flour mill AL-Doura. The reason for the difference in these percentages may be due to the difference in the quality of wheat used during grinding, extraction rate and agricultural, environmental and genetic conditions of the wheat variety, as the extraction ratio increases, the ratio of phytic acid in the resulting flour increases. The values of organic phosphorus were highest in flour mill AL-Doura and lowest in the flour mill of the AL-Brari and this shows that the increase in the quantity of phytate corresponds to a decrease in the amount of phosphorus inorganic free.

These results of phytate content were comparable to those of the published studies. (Požrl *et al.*, 2009) Noted that the content of phytate in whole flour extract was 946 mg /100g. While (Didar, 2011) found that the content of phytic acid (894.66 mg / 100 g) in flour with an extraction rate of 98%. The results of phosphorus was lower than that found by (Almihyawi, 2018), which found that the percentage of organic phosphorus in the whole flour of the varieties (Iba 99, Rasheed, Tamos, Abu Ghraib, Turkish flour "Moamal") were (29.18, 25.15, 23.89, 20.85, 22.83 mg /100 g), respectively.

Determination of Phytic acid and Inorganic phosphorus in the standard biscuit manufactured from Iraqi flour mills

Table 3, indicates the amount of phytic acid (mg / 100g) in the types of biscuits manufactured from Iraqi flour mills before and after the baking process. Phytic acid was found in the dough of the types of treatments (T1, T2, T3) in the preparation hour (314.25, 291.24, 199.14) mg / 100 g respectively. It is noted that the highest percentage of phytic acid in the dough at zero hour was in T1 treatment dough and the lowest in the dough of T3 treatment (the differences between the treatments were significant at the probability level ($P \leq 0.05$). While the amount of PA after the baking process was (301.52, 275.07, 190.43) mg / 100 g, respectively. It is noted from the same table that the low rate of phytic acid degradation for all treatments after the baking process, which were (4.05, 5.55, 4.37%), this may be due to the use of soda (sodium bicarbonate) in the manufacture of biscuits, leads to making the dough alkaline, which leads to a decrease in the effectiveness of natural phytase. In addition, the low humidity in the biscuits leads to poor effectiveness of natural phytase and other enzymes (Almihyawi, 2018; Sedaghati *et al.*, 2011).

Table 4: Phytic acid and Inorganic phosphorous content (mg / 100 g) in the treatments under study before and after baking process.

Mills	PA Zero time	PA after baking	Hydrolysis ration of Pa (%)	Inorganic phosph-orous Zero time	Inorganic phosph-orous after baking	The rate of increase of inorganic phosphorous (%)
Al-Brari	314.25	301.52	4.05	12.47	14.76	18.36
Al-Neser	291.24	275.07	5.55	16.58	18.35	10.68
Al-Doura	199.14	190.43	4.37	25.14	28.08	11.69
L.S.D	35.89*	41.77*	-	3.28*	4.09*	-

Table 3, shows the amount of inorganic phosphorus (mg / 100g) in the types of biscuits manufactured from Iraqi flour mills before and after the baking process. Inorganic phosphorus found in the dough of treatments (T1, T2, T3) in the preparation hour (12.47, 16.58, 25.14)

Table 5: pH values in the dough and biscuit (after baking) for three treatments under study.

Treatments	Dough Zero hr.	After baking
T1	8.63	10.12
T2	8.35	10.18
T3	8.88	10.14

mg / 100 g respectively and after the baking process was (14.76, 18.35, 28.08) mg /100 g respectively. This significant difference between the treatments may be due to the variation in the effectiveness of the phytase in the alkaline conditions as well as the different extraction ratios.

Determination of pH in biscuits and prepared dough

Table 4, shows pH values in the dough and biscuit for three treatments under study. The pH values of dough at the preparation time were (8.63, 8.35, 8.88) respectively. At this range of high pH (alkaline conditions), the efficacy of the phytase was very low for all treatments. The phytase enzyme does not work very efficiently except in acidic conditions and as a result, the amount of liberated phosphorus is very low (Table 3).

After the baking, high pH values were observed for all treatments (10.12, 10.18 and 10.14). This increase was due to the decrease in humidity due to the use of high temperatures, which led to a higher concentration of salts and other alkaline components and thus higher pH values.

Determination of phytase activity in the dough and biscuit in the treatments under study

Table 5, shows differences in the values of the activity of wheat natural phytase enzyme in the dough of the three treatments under study, this may be due to pH variation of the dough and flour extraction rates. This is proven by many previous studies, which showed high activity of phytase enzyme at higher extraction rates of flour (Almihyawi, 2018; Sedaghati *et al.,* 2011). The phytase activity rate when preparing the dough for the three treatments (2, 1.5, 1) unit / gram dough respectively.

The increase in inorganic phosphorus released from the breakdown of phytic acid during the biscuit manufacturing period is directly related to increased enzyme activity. The rate of hydrolysis of phytate after the process of manufacturing and baking biscuits in the three treatments were (4.05, 5.55, 4.37%) respectively. This is due to the variance in the extraction rate of the flour used and the difference in pH values during the makings process. Similar finding was mentioned by (Almihyawi, 2018; Didar, 2011).

Table 6: The activity of wheat natural phytase enzyme in the dough of the three treatments under study.

Preparation hours	Al-Brari mill	Al-Neser mill	AL-Doura mill
Zero hr.	2	1.5	1
Biscuit	0	0	0

Table 7: The values of thickness, width and spread factor for biscuit pieces of the three treatments.

Treatments	Thickness (cm)	Width (cm)	Spread factor
T1	5.5	41.9	7.618
T2	5.8	42.5	7.327
T3	5.8	44.2	7.620
L.S.D.	0.662 NS	2.960*	0.523 NS

The effect of the enzyme was significantly reduced in biscuit and disappeared in all treatments because the enzyme was affected by the baking heat (175^{o}C /10 min).

Spread factor of biscuits manufactured from Iraqi flour mills

Table 5, indicates the values of thickness, width and spread factor for biscuit pieces of the treatments. The results of the width of 6 pieces of biscuit were (41.9, 42.5, 44.2) cm, respectively. These values showed significant differences between treatments, where the highest value was in T3 and lowest in T1. The thickness of 6 pieces of the biscuit was (5.5, 5.8 and 5.8 cm) respectively. These values did not show any significant differences, T1 recorded the lowest values. These results were reflected on the values of the spread factor of the product. There were no significant differences between the treatments. The table shows a decrease in the spread factor of T2 compared to T1and T3 treatments. This may be due to the fact that the flour produced by the mills is subject to the mixing process of several varieties of wheat grain and the extraction rates of flour is different between them, which is reflected on the quality of the finished product.

Sensory evaluation of biscuits manufactured from Iraqi flour mills

Table 5, shows the values of the sensory evaluation of the biscuits made from the treatments under study.

Table 8: The values of sensory evaluation for biscuit pieces of the three treatments.

Characteristics	Degree	T1	T2	T3	L.S.D.
External appearance and homogeneity	20	17	18	17	2.16 NS
Crack the top surface	10	8	8	8	1.33 NS
Biscuit softness	10	8	8	8	1.33 NS
Taste and aroma	20	14	16	15	2.08 NS
Color of crumb	10	7	8	9	1.75*
Spreading	20	19	19	19	2.48 NS
Specific volume	10	7.62	7.33	7.62	1.63 NS
Total	100	80.62	84.33	83.62	6.52 NS

The results indicated that there were no significant differences between all the characteristics of the sensory evaluation, except for the color of the crumb, the results of color were (Alzubaidy, 2009; Almihyawi, 2018), respectively. Biscuits of T3 was whiter compared to other treatments and this may be due to lower flour extraction rate, which reduced the amount of ash in flour which negatively affects the color of the finished product. The general acceptance values of biscuits were (80.62, 84.33, 83.62%) respectively. There were no significant differences between the treatments, although biscuits for T2 were more favorable because it was more fragrant and better tasting and flavoring.

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