World Journal of Dairy & Food Sciences 13 (2): 63-73, 2018
ISSN 1817-308X

DOI: 10.5829/idosi.wjdfs.2018.63.73

Chemical and Technological Characteristics of white Dent Maize (*Zea mays* Var. *Identata*) Grains as Affected by Different Treatments. 2- Physicochemical, Technological Properties, Phytate Phosphorus, Phytic Acid Contents of Wheat Toast Bread and their Mixtures with Treated Whole white Dent Maize Grains Flour

Manal A.M. Hassan

Food Science and Technology Department,
Faculty of Agriculture, Assiut University, Assiut 71526, Egypt

Abstract: The present investigation aims to study the utilization of whole maize flour in the production of wheat toast bread, which is made from wheat flour, in addition to whole maize flour at percent 10%, 20% and 30%. The study included estimating the chemical composition, phosphorus compounds, phytic acid in the composite flours and consequently in the resulting bread. The results of chemical composition showed that the contents of ash, crude oil, crude fiber and total carbohydrates were increased significantly in composite flours when compared with wheat flour (control). On the other hand, the protein content was decreased significantly in all flour mixtures. Also the results showed that the contents of ash, crude oil and crude fiber increased significantly in the toast bread made from the flour mixtures with values ranging from 1.56-2.07%, 3.61 - 4.27%, 1.07 - 1.77% when compared to those in bread control 1.45% and 3.27% % and 0.93% (g/100g D.W) respectively, this is due to the higher percentages of it in the flour mixtures. Phytate phosphorus (PP) in composite flours was found in different amounts significantly via increase or decrease comparing to wheat flour. For phytic acid there were significant differences in the content of phytic acid, whether the decrease or increase between wheat flour and flour mixtures with maize flour. For total phosphorus (TP), phytate phosphorus (PP) and inorganic phosphates (IP), their contents (mg/100g D.W) were highly significant, ranging from 193.59 - 237.13, 81.54 - 96.65, 112.05 - 140.48 in maize bread samples when compared to those of control 142.17, 65.70 and 76.47 respectively. In comparing the values of the phytic acid in bread with the same in flour mixtures, it decreased by 24.66 - 45.81%, which confirms the occurrence of decomposition of the phytic acid during fermentation and baking. The samples of maize bread recorded significantly lower values in the loss of freshness compared to control. The sample of bread produced from untreated maize flour at 10% gave the lowest values in loss of freshness: 1.85, 6.83 and 8.85% during 1, 2 and 3 days of storage, respectively. The toast bread produced from maize flour incorporated with wheat flour gave good results, acceptable to the consumer, especially bread made from treated maize by soaking for 18 hours and this is a good indication of the importance of the using whole maize flour in bread.

Key words: Soaking · Phytic Acid · Gluten · Total Carbohydrates · Staling · Physical and Sensory Characteristics

INTRODUCTION

Maize (*Zea mays* L.) ranks as the third most important cereal grain in the world. Traditional criteria for selecting maize hybrids have been based primarily on agronomic factors, including grain production, disease resistance, drought tolerance and storage characteristics. Because of its importance, the genetic improvement of maize has played a key role in the development of genotypes with high technological and nutritional values. Specialty maize hybrids are the result of selection for improved chemical composition of the grain compared to standard hybrids [1].

Corresponding Author: Manal Abdel Hamid Mahmoud Hassan, Food Science and Technology Department, Faculty of Agriculture, Assiut University, Assiut 71526, Egypt. E-mail: manal.hassan@agr.au.edu.eg.

Whole maize flour contains 12% moisture, 10% protein, 4.5% fat, 70% carbohydrates and 2% ash. It is provides raw materials to starch industry and also used for making of bakery products. Maize is an important starch crop forming the staple source of carbohydrate in the diet of hundreds of millions of people [2].

Bread is a very common food all over the world and consists mainly of wheat flour which is supposed to be less than 14% moisture and has good properties in terms of color and public accessibility. Bread is made from wheat flour, yeast, salt and water in several steps, starting with mixing the ingredients, kneading, fermentation and cutting, ending with the baking process [3, 4].

The maize grains are higher in fat, iron, fiber contents when compared with wheat and rice. Therefore the use of maize flour for production of baked goods would help lower the dependency of developing nations on imported wheat [5].

Whole grain flour and products prepared from it are desirable, mostly due to their taste and nutritional benefits. However, upon milling, the raw whole grain flour results in rapid deterioration, largely due to enzymatic activities, especially those of lipase, lipoxygenase, peroxidase and polyphenoloxidase, which are associated with the lipid component. Stabilized whole grain maize flour with extended storage stability can be obtained by treating the grain with direct heat sufficient to deactivate enzymes. The consequences of the temperature treatment are modified functional properties, improved processing tolerance, improved dough properties and enhanced flavor [6, 7].

The process of treating grains with nixtamalization has many benefits as it facilitates the milling of grains as well as improving the aroma, flavor and reducing mycotoxins, which leads to the use in food processing, giving better results than untreated grains. These benefits make nixtamalization a crucial preliminary step for further processing of grains into food products [8].

For phytic acid, it is possible to reduce its quantity during storage, germination and food processing, either through hydrolysis chemically or by phytase, which turns into fewer fractions of inositol phosphates. On the other hand, the most important methods used in food processing, such as soaking and fermentation, is to activate the internal phytase enzyme, which in turn analyzes the phytic acid, while some of the heat processing methods cause self-decomposition of phytic acid such as blanching, sterilization, frying and baking [9, 10]. During fermentation process of bread dough, the endogenous phytase enzyme, which is naturally present in the grain flour, activates the phytic acid to break down to lower inositol phosphates and inorganic phosphorus, which improves the nutritional value of the bread [11].

The milling of grain to give white flours reduces the levels of many nutrients as well as phytate (myo-inositol hexakisphosphate, InsP-6). In contrast, wholegrain products are known to have both high phytate levels and high nutrient content [12, 13]. Wholegrain products also have a wide range of benefits to human health, for example they are associated with reduced risk of many chronic diseases including heart disease and diabetes [14, 15]. Phytates can chelate and bind minerals, resulting in insoluble complexes that may lead to a decrease in mineral absorption and bioavailability and therefore the removal of phytates from baked goods has long been considered desirable [16].

The whole wheat flour has been shown by many researchers to be a rich source of these functional ingredients such as fiber, photochemical, minerals, essential amino acids that are located in the bran and fat soluble vitamins contained in the germ of the whole wheat grain [3]. Due to the high cost, geographical scarcity and high demand of wheat flour, efforts are been directed toward the provision of locally available alternative source of flour such as maize, cassava, oats. From a nutritional point of view, maize is excellent in composition compared with other grains, except protein content [17].

The aim of this investigation is to study the processing of toast bread by using mixtures of wheat flour, raw or treated whole maize (Single Hybrid Giza 10 variety) flour with replacement 10%, 20% and 30% from wheat flour. Evaluate the chemical composition, phosphorus compounds and total titratable acidity in wheat and maize composite flours, which used in bread preparation. As well as study the effect of the treatment of maize grains by boiling, soaking and nixtamalization before milling on the physicochemical, nutritional, stalling, loss of freshness and sensory properties of produced toast bread.

MATERIALS AND METHODS

Materials

Samples: The white dent maize kernels (Single Hybrid Giza 10) variety used in this research was purchased from the Agricultural Research Center, Giza, Egypt during February season 2017. Wheat flour, salt and yeast were obtained from local super market.

Preparation of Maize Samples: White maize kernels were prepared in four different ways. The details of sample preparation are given below:

Untreated Maize Kernels (UM): Untreated white maize (UM) refers to raw kernels as such; the UM sample was ground for 3 min in laboratory mill to obtain whole flour, which contains the germ and the pericarp, in addition to the endosperm. Nothing is separated out when milled. It stored at 4°C until analyzed.

Boiling (BM): Boiling refers to maize kernels which boiled in water (200 g kernels/ 300 ml H_2O) for 30 min. Boiled maize (BM) kernels were dried (50°C/24hrs) and then treated in the same way as UM.

Soaking (SM): Soaking refers to maize kernels which soaked in water (200 g kernels/ 300 ml H_2O) for 18 and 24 h at 20°C. Soaked maize (SM) kernels were dried (50°C/24hrs) and then treated in the same way as UM.

Nixtamalization (NM): Nixtamalization refers to cooking 200 g of white maize kernels with 400 ml calcium hydroxide solution 1.5% $Ca(OH)_2$ solution for 23 min and then left to steep at room temperature for 16 h according to Figueroa *et al.* [18]. The steep liquid was drained and the maize was rinsed three times with H_2O. Nixtamalized whole maize (NM) kernels were dried (50°C/24hrs) and then treated in the same way as UM.

Proximate Composition: Moisture, crude protein, crude l lipids, crude fiber and ash were determined as described in the AOAC methods [19]. Triplicate determinations were carried out for each sample and the means were reported. The total carbohydrates content was determined by difference according to Pellet and Sossy [20] as follows: Carbohydrate % = 100 – (protein % + ash % + lipid % + crude fiber %). The caloric value was calculated using value of 4 k.cal/g for protein, carbohydrates and 9 k.cal/g for fat according to Livesy [21]. Total phosphorus content was determined by spectrophotometer [22] after wet ashing following method described in AOAC [19]. Total phosphorus (TP) = Phytate phosphorus (Pp) + Inorganic phosphorus (Ip).

Total Titratable Acidity (T.T.A), pH and Wet Gluten: T.T.A (ml equivalents of NaOH 0.1N) and pH values of all samples slurry was determined according to the method described by AOAC [19].Wet gluten content was determined according to the AACC [23] method.

Determination of Phytic Acid: The phytic acid was determined by the method described by Kent-Jones and Amos [24], in which the phytic acid is precipitated with an iron-III solution of known iron content and the decrease in iron which found in supernatant is taken as a measure of phytate phosphorus content. The phytate was estimated by multiplying the amount of phytate phosphorous by a factor of 3.55 based on the empirical formula $C_6 P_6 O_{24} H_{18}$ [25].

Preparation of Toast (Pan) Bread: Toast bread was manufactured by Mostafa and Othman [26] method. Toast bread was supplemented with 10%, 20% and 30% whole white maize flours. The basic ingredients were: wheat flour (extration 72%), water, salt and yeast. The percentages of ingredients are shown in Table (1). The toast bread was manufactured as follows: All ingredients were mixed in the kneader dough for 10 minutes. Fermentation was performed at 30°C ± 2 for 135 minutes and relative humidity 80-85%. The dough pressed to release CO_2 and moulded with corn oil (about 1.5 g oil) in pans with dimensions: length 12 cm, width 6 cm and height 8 cm. Baking was carried out in an electric oven at 230-240°C for 20-25 minutes. The bread top was subjected to wet brush in order to enhance crust appearance immediately after removing from the oven.

Physical Characteristics of Bread: The weight (g) for bread was determined individually within two hours after baking the average was recorded, while the volume (cm^3) was determined by displacement method with clover seeds. Specific volume (cm^3/g) was calculated using the following Equation: Specific loaf volume (cm^3/g) = Volume (cm^3)/Weight (g) [26].

Staling Rate and Loss of Freshness: The staling rate of different prepared bread samples were determined after baking within one hour and after 1, 2 and 3 days of storage at room temperature by alkaline water retention capacity (AWRC %) according to AACC [23]. The loss of freshness was calculated by means of the following equation:

Loss of freshness (%) = [AWRC at 0-time – AWRC after interval (days)] X 100 /AWRC at 0-time.

Sensory Evaluation of Toast Bread: The sensory evaluation of toast bread was measured by a panel of ten judges from the staff of Food and Technology department, Faculty of Agriculture, Assiut University. The evaluation of bread samples was done by using scoring system [26]; Crust color (10), texture (10), crumb color (10), taste (10), graining of crumb (10) and odor (10).

Table 1: Formulation of toast bread containing whole white maize flours

Ingredients	Control	10%	20%	30%
Wheat flour (extraction 72%) (g)	100	90	80	70
Whole maize flours (g)	--	10	20	30
Water (ml)	60	60	60	60
Salt (g)	1	1	1	1
Yeast (g)	0.5	0.5	0.5	0.5

Statistical Analysis: The experimental data were subjected to an analysis of variance (ANOVA) for a completely randomized design using a statistical analysis system [27].

RESULTS AND DISCUSSION

Wet Gluten and Chemical Composition of Composite Flours: Wet gluten content and chemical composition of composite flours are illustrated in Table 2. The content of wet gluten was 21.38% in wheat flour but in the all composite flours was decreased significantly. The wet gluten was ranged from 17.57% to 20.03% in the composite flours. It is clear that the value of wet gluten in wheat flour was higher than its value in the flour mixtures. The value of gluten decreases by increasing the added quantity of maize flour, which does not contain gluten.

The moisture content in the studied flours was ranging from 10.93 to 12.89%. As shown in Table 2 the contents of ash, crude lipids, crude fiber and total carbohydrates were increased significantly in composite flours when compared with wheat flour (control). On the other hand, the protein content was decreased significantly in all flour mixtures. It could be noticed that the variations in the contents of constituents due to the difference in the chemical composition of untreated and treated maize flour, which led to the presence of these differences, both increase or decrease. For the caloric value, the contents were similar, ranging from 400.88 to 403.07 Kcal/100g in all studied samples. As a result of different values of oil, protein and carbohydrates, the caloric value varied.

T.T.A, pH and Phosphorus Fractions in the Composite Flours: The T.T.A, pH and phosphorus fractions in the composite flours are illustrated in Table 3. The T.T.A (mel equiv NaOH) contents in composite flour was significantly higher and ranged from 2.76 to 4.41 than wheat flour (2.59). It is clear that the T.T.A values in the samples of the flour mixtures with the treated maize flour were higher than their values for the mixtures with the untreated maize flour. This is because the treatment of corn grains with boiling, soaking and nixtamalization had an effect on the change of T.T.A and consequently increase of T.T.A in the mixtures. The pH contents of studied flours were ranged from 5.82 to 6.05 in the studied samples. It is clear that the high pH values were found in the flour mixtures with the nixtamalized 1.5% corn flour, which are treated with alkaline. This is due to the use of calcium hydroxide in the treatment, which increased the alkalinity of these mixtures when compared to the control (wheat flour). These results are consistent with previous studies [28].

As shown in Table 3 the total phosphorus in wheat flour was 140.69 mg/100g D.W, this value was significantly increased in flour mixtures with increment of added ratio from maize flour. The lowest TP content (mg/100g) was 196.02 in WF90%+BM10% flour but the highest was 234.89 in WF70%+UM30% flour. The increase in TP contents in flour mixtures due to high percentage of TP in corn samples: UM, BM30min, SM18hrs, SM24hrs and NM1.5%. Phytate phosphorus (PP) in composite flours was found in different amounts significantly via increase or decrease comparing to wheat flour. The content of phytate phosphorus (PP) in the samples were ranged from 109.06 in WF70%+BM30% to 176.86 in WF70%+UM30%, this difference is due to the PP values in the treated samples used in the composition of flour mixtures. The inorganic phosphorus content (mg/100g) in WF was 16.16 and it was increased significantly in all composite flours ranging from 58.03 to 99.62. As a result of As a result of the increase in the value of TP in flour mixtures, this led to increment in IP phosphorus because the TP minus PP gives IP so, the decrease in the content of the PP increase the amount of IP.

For phytic acid, the data in Table 3 shows that, there were significant differences in the content of phytic acid, whether the decrease or increase between wheat flour and flour mixtures with maize flour. Its contents (mg/100g D.W) ranged from 387.16 to 627.85 in all the studied samples. It is clear that flour mixtures with treated maize flour by boiling have significantly given the lowest values of phytic acid when compared to wheat flour (control) and the rest of samples. The highest value of phytic acid (627.85) was recorded for WF70%+UM 30% mixtures which maize flour not treated. Thus, the flour mixtures of the studied samples recorded differences in the values of phytic acid depending on the type of treatment used.

Table 2: Wet gluten, chemical composition (g/100g) of composite flours from wheat flour and whole white maize flours. *On dry weight basis

Composite flour samples	Wet gluten	Moisture	Ash*	Crude lipids*	Crude protein*	Crude fiber*	Total carbohydrates*	Energy (Kcal/100 g D.W.)
WF100% (Control)	21.38	12.12	0.63	1.57	12.85	0.82	84.13	402.05
WF 90% + UM 10%	19.25	12.05	0.73	1.81	11.45	0.91	85.10	402.49
WF 80% + UM 20%	18.36	11.89	0.77	2.14	11.03	1.25	84.81	402.62
WF 70% + UM 30%	17.61	11.72	0.86	2.43	10.63	1.47	84.61	402.83
WF 90% + BM 10%	19.74	11.96	0.70	1.74	11.68	0.96	84.92	402.06
WF 80% + BM 20%	18.67	11.81	0.73	2.01	10.90	1.06	85.30	402.89
WF 70% + BM 30%	17.95	10.93	0.75	2.35	10.43	1.42	85.05	403.07
WF 90% + SM18 10%	20.03	11.97	0.71	1.63	11.77	1.09	84.80	400.95
WF 80% + SM18 20%	18.56	11.63	0.74	1.68	11.09	1.14	85.35	400.88
WF 70% + SM18 30%	17.57	11.29	0.82	1.96	10.56	1.38	85.28	401.00
WF 90% + SM24 10%	19.84	11.85	0.69	1.64	11.47	1.01	85.19	401.40
WF 80% + SM24 20%	18.59	11.38	0.73	1.83	11.07	1.37	85.00	400.75
WF 70% + SM24 30%	17.69	10.95	0.84	2.01	10.69	1.59	84.87	400.33
WF 90% + NM 10%	19.09	12.51	0.69	1.73	11.40	1.07	85.11	401.61
WF 80% + NM 20%	18.07	12.74	0.74	2.14	10.94	1.28	84.90	402.62
WF 70% + NM 30%	17.69	12.89	0.81	2.28	10.43	1.56	84.92	401.92
LSD 0.05	0.43	0.21	0.01	0.02	0.11	0.01	0.32	1.13

Table 3: The values of T.T.A pH and phosphorus fractions (mg/100g D.W) in the composite flours from wheat flour and whole white maize flour

Composite flour samples	T.T.A (mel equiv NaOH)	pH	Total phosphorus (TP)	Phytate phosphorus (PP)	Inorganic phosphorus (IP)	Phytate –p as % of total phosphorus	Phytic acid
WF100% (Control)	2.59	5.89	140.69	124.53	16.16	88.51	442.08
WF 90% + UM 10%	2.76	5.90	207.29	140.26	67.03	67.66	497.92
WF 80% + UM 20%	3.41	5.87	220.03	159.07	60.96	72.30	564.70
WF 70% + UM 30%	4.05	5.82	234.89	176.86	58.03	75.30	627.85
WF 90% + BM 10%	2.98	5.89	196.02	120.03	75.99	61.23	426.11
WF 80% + BM 20%	3.55	5.87	204.61	115.42	89.19	56.41	409.74
WF 70% + BM 30%	4.15	5.84	208.68	109.06	99.62	52.26	387.16
WF 90% + SM18 10%	3.17	5.91	203.61	134.07	69.54	65.85	475.95
WF 80% + SM18 20%	3.62	5.88	216.05	144.65	71.40	66.95	513.51
WF 70% + SM18 30%	4.29	5.84	227.84	157.01	70.83	68.91	557.39
WF 90% + SM24 10%	3.29	5.92	204.10	129.34	74.76	63.37	459.16
WF 80% + SM24 20%	3.87	5.89	217.13	136.78	80.35	63.00	485.57
WF 70% + SM24 30%	4.41	5.84	227.18	144.02	83.16	63.40	511.27
WF 90% + NM 10%	3.62	5.98	198.71	126.84	71.87	63.83	450.28
WF 80% + NM 20%	3.84	6.01	209.88	129.01	80.87	61.47	457.99
WF 70% + NM 30%	4.02	6.05	221.12	131.94	89.18	59.67	468.39
LSD 0.05	0.01	0.01	1.23	2.31	1.16	0.43	3.16

Table 4: Chemical composition of toast bread made from composite flours of wheat flour and whole white maize flour.*On dry weight basis

Bread samples	Moisture	Ash*	Crude lipids*	Crude protein*	Crude fiber*	Total carbohydrates*	Energy (Kcal/100 g)
WF100% (Control)	36.70	1.45	3.27	13.09	0.93	81.26	406.83
WF 90% + UM 10%	34.53	1.79	3.85	12.07	1.18	81.11	407.37
WF 80% + UM 20%	32.86	1.84	4.02	12.12	1.39	80.63	407.18
WF 70% + UM 30%	35.00	2.07	4.27	11.16	1.54	80.96	406.91
WF 90% + BM 10%	34.51	1.64	3.82	12.46	1.25	80.83	407.54
WF 80% + BM 20%	35.23	1.76	3.93	11.21	1.39	81.71	407.05
WF 70% + BM 30%	33.46	1.83	4.21	10.25	1.56	82.15	407.49
WF 90% + SM18 10%	36.05	1.68	3.61	11.25	1.09	82.37	406.97
WF 80% + SM18 20%	34.71	1.71	3.78	11.80	1.28	81.43	406.94
WF 70% + SM18 30%	36.12	1.97	3.89	10.14	1.57	82.43	405.29
WF 90% + SM24 10%	35.16	1.61	3.71	11.34	1.28	82.06	406.99
WF 80% + SM24 20%	36.01	1.82	3.84	11.26	1.52	81.56	405.84
WF 70% + SM24 30%	35.24	2.04	3.96	11.03	1.72	81.25	404.76
WF 90% + NM 10%	34.17	1.56	3.88	11.88	1.07	81.61	408.88
WF 80% + NM 20%	34.93	1.78	4.09	11.62	1.27	81.24	408.25
WF 70% + NM 30%	34.20	1.90	4.18	11.72	1.77	80.43	406.22
LSD 0.05	0.02	0.002	0.01	0.01	0.001	0.14	0.11

Chemical Composition of Toast Bread: Chemical composition of toast bread made from composite flours of wheat flour and whole white maize flour are illustrated in Table 4. The percentage of moisture in the studied bread samples was from 32.86 to 36.70%, where the highest percentage was found in bread control and then it decreased significantly in the rest of the samples. Also the results showed that the contents of ash, crude oil and crude fiber increased significantly in the toast bread made from the flour mixtures with values ranging from 1.56-2.07%, 3.61 - 4.27%, 1.07 - 1.77% when compared to those in bread control: 1.45% and 3.27% % and 0.93% (g/100g D.W) respectively, this is due to the higher percentages of it in the flour mixtures. While there was a significant decrease in the content of the protein in the bread produced from the mixtures compared to control, due to the low percentage of protein in the flour mixtures. For total carbohydrate and caloric value, there were slight significant differences in contents, ranging from 81.26 - 82.43% and 404.76 - 408.88 Kcal/100g respectively in the bread samples under study.

T.T.A, pH, Phosphorus Compounds and Physical Evaluation of Toast Bread: The contents of T.T.A (mel equiv NaOH), pH were recorded 2.21 - 2.88 and 5.06 - 5.43 in the all bread samples, respectively (Table 5). In addition, there was a significant decrease in the values of the P^H when compared to control. These values for the pH and T.T.A are within the permissible limits of the bread. The value of pH is of great importance, it expresses the active acidity and has an effect on the flavor taste or acceptability of the bread, which is supposed to range from 5-6 [28].

For total phosphorus (TP), phytate phosphorus (PP) and inorganic phosphates (IP), their contents (mg/100g D.W) were highly significant, ranging from 193.59 - 237.13, 81.54 - 96.65, 112.05 - 140.48 in maize bread samples when compared to those of control 142.17, 65.70 and 76.47 respectively (Table 5). This increase is due to the rise of these values in the flour mixtures and consequently rises in the resulting bread. When comparing the values of PP in the bread with their values in the mixtures, we find that there was a highly significant decrease in it, this because of decomposition of PP it means also phytic acid during the fermentation and baking. The proportions of PP in bread as a proportion of TP were ranged from 39.01 to 46.21%, while the same proportions in mixtures (Table 3) ranged from 52.26 to 88.51%. In the same way for the phytic acid, there was a significant increase in maize bread with values (mg/100g D.W) from 287.02 to 333.34 compared to 231.26 for the control bread produced from wheat flour. In comparing the values of the phytic acid in bread with the same in flour mixtures, it decreased by 24.66 - 45.81%, which confirms the occurrence of decomposition of the phytic acid during fermentation and baking. The obtained results are consistent with Lopez *et al.* [29] and Penella *et al.* [30] who reported that the amount of decomposed phytic acid after the baking process varies from 13 to 100% according to the bread type, the analysis of phytic acid is subject to many factors such as the phytase activity in flour, yeast and acidity of flour during fermentation and baking. The phytic acid in maize grains could be decomposed effectively after treated grains by nixtamalization, which soften and broke the cellular wall then phytic acid would be released [31, 32].

From the results in Table 5, there is a significant increase in the weight, volume and specific volume of the maize bread compared to the control. It could be noted that there was an increase in the weight (g) of bread with contents 132.65 - 144.90, while there was a decrease in volume (ml) with contents 319 - 414 when compared with the controls with values of 131.49 and 420 respectively, respectively, consequently the specific volume (ml/g) of maize bread was significantly decreased ranging from 2.03 - 3.12 against 3.19 for control. These results were in agreement with those obtained by Mettler and Siebel [33] who reported that the reduction of loaf volume was due to the dilution of gluten whereas the increase in bread weight was caused by high water retention.

Staling Rate and Loss of Freshness of Toast Bread: After the baking process and when the bread is cooled or stored, the bread staling is occurs. In which the structure of amylose and amylopectin chains in the gelatinized starch is altered in what is known as the phenomenon retrogradation, which due to increased viscosity and water separation from the polymers. These changes are of great importance in terms of the effect on bread quality and shelf life [34, 35].

The data in Table 6 shows that AWRC% (on dry weight basis) values for maize bread with different mixtures were significantly lower ranging 282.25 - 308.40% when compared to 339.55% for control bread. While during the storage period of bread for 3 days there were significant differences, either decrease or increase, in the AWRC% values for maize bread than control. It is noted that the AWRC% values occurs to decrease with the progress of storage period in the samples of bread studied, taking into account that the decreasing is due to

Table 5: T.T.A, pH, phosphorus compounds (mg/100g D.W) and physical evaluation of toast bread made from composite flours of wheat flour and whole white maize flour

Bread sample	T.T.A (mel equiv NaOH)	pH	Total phosphorus	Phytate phosphorus	Inorganic phosphorus	Phytate –p as % of total phosphorus	Phytic acid	Physical evaluation Volume (ml)	Weight (g)	Specific volume (ml/g)
WF100% (Control)	2.25	5.43	142.17	65.70	76.47	46.21	231.26	420	131.49	3.19
WF 90% + UM 10%	2.76	5.26	211.28	94.70	116.58	44.82	333.34	404	134.20	3.01
WF 80% + UM 20%	2.80	5.30	220.51	93.98	126.53	42.62	330.81	388	136.84	2.86
WF 70% + UM 30%	2.88	5.37	237.13	96.65	140.48	40.76	340.21	357	137.60	2.59
WF 90% + BM 10%	2.37	5.06	193.59	81.54	112.05	42.12	287.02	405	138.25	2.93
WF 80% + BM 20%	2.51	5.24	205.37	83.40	121.97	40.61	293.57	339	141.12	2.40
WF 70% + BM 30%	2.79	5.32	207.91	82.87	125.04	39.86	291.70	337	144.90	2.33
WF 90% + SM18 10%	2.33	5.17	206.21	86.42	119.79	41.91	304.20	414	132.65	3.12
WF 80% + SM18 20%	2.46	5.20	218.42	87.32	131.10	39.98	307.37	408	135.59	3.01
WF 70% + SM18 30%	2.83	5.23	226.15	88.22	137.93	39.01	310.53	395	140.95	2.80
WF 90% + SM24 10%	2.31	5.16	206.11	85.23	120.88	41.35	300.01	389	135.83	2.86
WF 80% + SM24 20%	2.42	5.22	220.34	89.28	131.06	40.52	314.27	388	137.82	2.82
WF 70% + SM24 30%	2.80	5.30	229.02	91.63	137.39	40.01	322.54	353	139.75	2.53
WF 90% + NM 10%	2.21	5.07	200.62	84.38	116.24	42.06	297.02	357	133.72	2.67
WF 80% + NM 20%	2.44	5.21	210.75	88.35	122.40	41.92	287.14	336	136.79	2.46
WF 70% + NM 30%	2.60	5.26	223.28	91.66	131.62	41.05	322.64	319	138.90	2.03
LSD 0.05	0.003	0.001	2.14	0.67	1.87	0.06	3.14	1.56	1.12	0.01

Table 6: Staling rate by AWRC% (on dry weight basis) and Loss of freshness of toast bread samples during storage period (days)

Bread sample	AWRC 0 time	1 day	2 days	3 days	Loss of freshness 0 time	1 day	2 days	3 days
WF100% (Control)	339.55	283.67	279.69	262.34	-----	16.46	17.63	22.74
WF 90% + UM 10%	282.25	277.02	263.27	257.26	-----	1.85	6.83	8.85
WF 80% + UM 20%	307.36	280.64	266.46	260.68	-----	8.69	13.31	15.19
WF 70% + UM 30%	308.40	280.31	267.42	260.40	-----	9.11	13.29	15.56
WF 90% + BM 10%	303.26	277.33	262.53	257.38	-----	8.55	13.43	15.13
WF 80% + BM 20%	305.89	279.07	265.24	259.13	-----	8.77	13.29	15.29
WF 70% + BM 30%	305.48	279.42	264.91	259.47	-----	8.53	13.28	15.06
WF 90% + SM18 10%	301.01	293.12	280.53	273.18	-----	2.62	6.80	9.25
WF 80% + SM18 20%	302.52	294.23	281.95	274.35	-----	2.74	6.80	9.31
WF 70% + SM18 30%	306.91	293.89	274.16	266.26	-----	4.24	10.67	13.25
WF 90% + SM24 10%	305.12	290.61	270.92	264.14	-----	4.76	11.21	13.43
WF 80% + SM24 20%	304.95	292.22	284.05	272.37	-----	4.18	6.85	10.68
WF 70% + SM24 30%	304.69	290.77	283.88	271.12	-----	4.57	6.83	11.02
WF 90% + NM 10%	299.14	286.64	276.88	259.28	-----	4.18	7.44	13.33
WF 80% + NM 20%	299.28	289.40	279.52	261.52	-----	3.30	6.60	12.62
WF 70% + NM 30%	299.62	288.02	278.26	259.74	-----	3.87	7.13	13.31
LSD 0.05	2.45	1.25	0.98	0.87	-----	0.94	1.10	1.12

the nature of treatments and adding ratio used in the composite flours. As a result, this will affect the loss of freshness, which ranged in bread control from 16.46 to 22.74% during the storage period (3 days). On the other hand, samples of maize bread recorded significantly lower values in the loss of freshness compared to control. The sample of bread produced from untreated maize flour at 10% gave the lowest values in loss of freshness: 1.85, 6.83 and 8.85% during 1, 2 and 3 days of storage, respectively. For the rest of the maize samples (except for 10% UM), loss of freshness values were being 2.62 - 9.11%, 6.60 - 13.43%, 9.25 - 15.56% during 1, 2 and 3 days of storage, respectively.

As noted above, the responsible for bread staling is starch. Due to the different nature of the treatments used with maize samples (via boiling, soaking, nixtamalization) and their effect on starch gelatinization, which it mentioned previously in the first part of the study,

Table 7: Sensory evaluation of toast bread made from wheat flour and its mixtures with whole maize flour (WMF)

		Crumb					
	Crust color	Color	Graining	Texture	Taste	Odor	Total score
Bread sample	(10)	(10)	(10)	(10)	(10)	(10)	(60)
WF100% (Control)	9.25	9.30	9.35	9.25	9.30	9.40	55.85
WF 90% + UM 10%	8.25	8.35	8.20	8.25	8.20	8.30	49.55
WF 80% + UM 20%	7.95	8.00	7.95	7.80	7.85	7.95	47.50
WF 70% + UM 30%	7.15	7.25	7.05	7.15	7.10	7.05	42.75
WF 90% + BM 10%	8.25	8.45	8.13	8.25	8.15	8.00	49.23
WF 80% + BM 20%	8.10	7.80	7.45	7.30	7.30	7.65	45.60
WF 70% + BM 30%	7.60	7.45	7.50	7.15	7.05	7.40	44.15
WF 90% + SM18 10%	9.15	9.00	9.05	9.15	9.05	9.05	54.45
WF 80% + SM18 20%	8.95	8.75	8.43	8.30	8.30	8.75	51.48
WF 70% + SM18 30%	7.75	7.76	7.58	7.38	7.48	7.58	45.53
WF 90% + SM24 10%	8.69	8.56	8.55	8.56	8.48	8.13	50.97
WF 80% + SM24 20%	8.43	8.06	8.30	8.10	8.30	8.00	49.19
WF 70% + SM24 30%	7.53	7.39	7.50	7.50	7.33	7.50	44.75
WF 90% + NM 10%	8.35	8.50	8.15	8.45	8.30	8.25	50.00
WF 80% + NM 20%	7.95	8.05	7.60	7.50	7.95	8.05	47.10
WF 70% + NM 30%	7.55	7.50	7.45	7.15	7.30	7.15	44.10
LSD 0.05	0.01	0.02	0.01	0.02	0.03	0.01	0.04

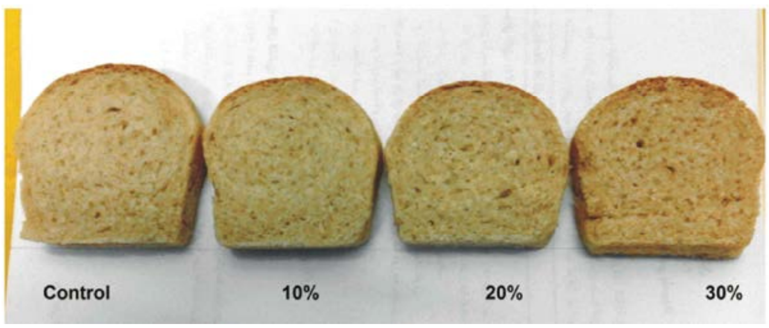

Fig. 1: Untreated maize whole flour

Fig. 2: Boiling 30 min maize whole flour

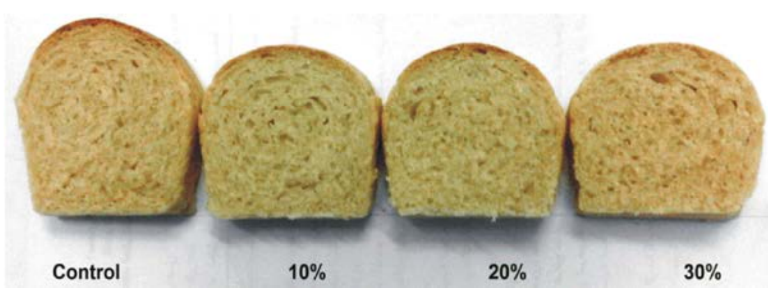

Fig. 3: Soaking 18 hrs maize whole flour

Fig. 4: Soaking 24 hrs maize whole flour

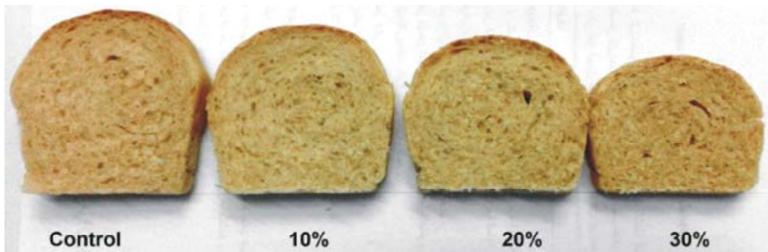

Fig. 5: Nixtamalization 1.5% maize whole flour

it is clear why maize bread is more fresh than the controlled bread made from wheat flour only. The maize bread made from mixture WF90%+SM18 10% (soaking for 18 hrs) considered the best in loss of freshness, when compared to the rest of the maize bread made with treated by boiling and nixtamalization and soaking for 24 hours as well as control.

Sensory Evaluation of Toast Bread Made from Wheat Flour and its Mixtures with Whole Maize Flour (WMF): Sensory evaluation finds a wide application in product development, matching of products with competitors, determination of consumer acceptance, improvement of a product and conduction of shelf life studies as well as storage stability [36]. Sensory evaluation of toast bread made from wheat flour and its mixtures with whole maize flour (WMF) are presented in Table 7 and Figures 1-5. The crust color, crumb properties, texture, taste, odor, over all acceptability scores of bread control and 10%, 20% and 30% WMF bread were significantly different (Fig. 1-5). Incorporation of WMF recorded lowest scores for all quality attributes of replacement 10%, 20% and 30% than bread control. Moreover, color appeared to be a very important criterion for initial acceptability of the baked product by the consumer. The crust and crumb color of the toast bread was significantly affected by the addition of WMF. Among the maize bread samples, bread produced from WF 90%+SM18 10% recorded the highest value in overall total score being 54.45 compared to the other samples of maize bread, followed by 51.48 for WF 80%+SM18 20% and 50.97 for WF90%+SM24 10% then 50.00 for WF90%+NM 10%. From the above mentioned data it concluded that the toast bread produced from maize flour incorporated with wheat flour gave good results, acceptable to the consumer, especially bread made from treated maize by soaking for 18 hours and this is a good indication of the importance of the use of whole maize flour.

In order to produce bread that would match consumer expectations, it is important to understand the relationship between flour quality, the characteristics of the baked bread, the importance of sensory testing for routine quality control functions such as raw material control, evaluation of new sources for raw material, process control, product grading and evaluation of process changes and multi-plant quality coordination [36].

CONCLUSION

The results of this study indicate that the production of toast bread from wheat flour and their mixtures with whole maize flour gave good results in terms of physical, chemical properties and the loss of freshness. The treatment of the maize grains before milling gave good results in reduction of phytic acid content and increasing of nutrients in the resulting bread, which confirms the importance of using these treatments. In addition, consumer's acceptance of this bread had a good degree in all sensory attributes.

REFERENCES

1. Zilic, S., M. Milasinovic, D. Terzic, M. Barac and D. Ignjatovic-Mici, 2011. Grain characteristics and composition of maize specialty hybrids. Spanish Journal of Agricultural Research, 9(1): 230-241.
2. Imran, A., 2015. Effect of Germination on Proximate Composition of Two Maize Cultivars. Journal of Biology, Agriculture and Healthcare, 5(3): 123-128.
3. Dewettinck, K., F. Van, Bockstaele, B. Kuhne, C.T. Van De Walle and X. Gellynck, 2008. Nutritional value of bread: Influence of processing, food interaction and consumer perception. Rev. J. Cereal Sci., 48: 243-257.
4. Giami, G.Y., T. Amasisi and G. Ekiyor, 2004. Comparison of bread making properties of composite flour from kernels of roasted and boiled African bread fruit (*Treculia africana*) seed. J. Mat. Res., 1(1): 16-25.
5. Begum, R., M.J. Uddin, M.A. Rahman and M.S. Islam, 2013. Comparative study on the development of maize flour based composite bread. J. Bangladesh Agril. Univ., 11(1): 133-139.
6. Häkannson, B. and M. Jägerstad, 1990. The effect of thermal inactivation of lipoxygenase on the stability of vitamin E in wheat. J. Cereal Sci., 12: 177-185.
7. South, J.B. and A.R. Ross, 1993. Evaluation of Cereal Quality for Micronising. In: Aspects of Applied Biology, Vol. 36, L. Alexander, S. Cooper, J. Croos, R. Glass, B. Margi, T. Robinson, D. Stock, B. Taylor, P. Walklate, J. van de Zande (Eds.), Association of Applied Biologists, Warwick, UK, pp: 433-442.
8. Sefa-Dedeh, S., B. Cornelius, E. Sakyi-Dawson and E.O. Afoakwa, 2004. Effect of Nixtamalization on the Chemical and Functional Properties of Maize. Food Chemistry, 86: 317-324.
9. Konietzny, U. and R. Greiner, 2002. Molecular and Catalytic Properties of Phytate-Degrading Enzymes (Phytases). Int. J. Food Sci. Technol., 37: 791-812.
10. Servi, S., H. Ozkaya and A.S. Colakoglu, 2008. Dephytinization of Wheat Bran by Fermentation with Bakers' Yeast, Incubation with Barley Malt Flour and Autoclaving at Different pH Levels. J. Cereal Sci., 48: 471-476.
11. Urbano, G., P. Aranda, E. Gomez, S. Frejnagel, J.M. Porres, J. Frias, C. Vidal-Valver and M. Lopez–Jurado, 2003. Nutritional Evaluation of Pea Protein Diets after Mild Hydrothermal Treatment and with and without Added Phytase. J. Agric. Food Chem., 51: 2415-2420.
12. Fardet, A., 2010. New hypotheses for the health-protective mechanisms of wholegrain cereals: what is beyond fibre? Nut. Res. Rev., 23: 65-134.
13. Stevenson, L., F. Phillips, K. O'Sullivan and J. Walton, 2012. Wheat bran: its composition and benefits to health, a European perspective. Int. J. Food Sci. Nutr., 63: 1001-1013.
14. Jones, J.M., 2011. The whole-grain conundrum. Cer. Foods World., 56: 124-127.
15. Mellen, P.B., A.D. Liese, J.A. Tooze, M.Z. Vitolins, L.E. Wagenknecht and D.M. Herrington, 2007. Whole-grain intake and carotid artery atherosclerosis in a multiethnic cohort: the insulin resistance atherosclerosis study. Am. J. Clin. Nutr., 85: 1495-1502.
16. Kumar, V., A.K. Sinha, H.P.S. Makkar and K. Becker, 2010. Dietary roles of phytate and phytase in human nutrition: a review. Food Chem., 120: 945-959.
17. Mejía, D., 2003. MAIZE: Post-Harvest Operation, Food and Agriculture Organization of the United Nations (FAO), pp: 30.
18. Figueroa, J.D.C., A. Rodr´ıguez-Chong and J.J. V´eles-Medina, 2011. Proceso ecol´ogico de nixtamalizaci´on para la producci´on de harinas, masa y tortillas integrales. Mexican patent number 289339.
19. AOAC, 2000. Association of Official Analytical Chemists. Official Methods 965.33. Official Methods of Analysis, 17" Ed., Gaithersburg, MD.
20. Pellet, P.I and S. Sossy, 1970. Food Composition Tables for Use in the Middle East. American University of Beirut, Beirut- Lebanon.
21. Livesey, G., 1995. Metabolizable energy of macronutrients. American Journal of Clinical Nutrition, 62: 1135S- 1142S.
22. Jackson, M.L., 1967. Soil Chemical Analysis. Printice-Hall of India. Private Limited, New Delhi.
23. AACC, 2000. Approved methods of American Association of Cereal Chemists (10th ed.). Published by American Association of Cereal Chemists, Ins. Saint Paul, Minnesota, USA.
24. Kent -Jones, D.W. and A.J. Amos, 1957. Modern cereal chemistry, V ed.-Liverpool: The Northern Publication Company, pp: 574.
25. Wheeler, E.L. and R.E. Ferrel, 1971. A method for phytic acid determination in wheat and wheat fractions. Cereal Chemistry, 48: 312-320.
26. Mostafa, M.K. and M.A. Othman, 1986. Changes in fermentation times and its relation to bread characteristics. Fac. Agric., Ain Shams University Research. Bull., 1614, Nov.

27. SAS, 2000. SAS Users Guide. Statistical Analysis System, 2000 ed. SAS Institute, Inc., Cary, N.C., M.S. Taga, E.E Miller and D.E. Pratt, 1984. Chia seeds as a source of natural lipid antioxidants. Journal of American Oil Chemical Society, 61: 928-993.
28. Bhatt, S.M. and R.K. Gupta, 2015. Bread (composite flour) formulation and study of its nutritive, phytochemical and functional properties. Journal of Pharmacognosy and Phytochemistry, 4(2): 254-268.
29. Lopez, H.W., V. Krespine, C. Guy, A. Messager, C. Demigne and C. Remesy, 2001. Prolonged fermentation of whole wheat sourdough reduces phytate level and increases soluble magnesium. Journal of Agricultural and Food Chemistry, 49: 2657-2662.
30. Penella, J.M. and C. Collar, 2008. Effect of wheat bran and enzyme addition on dough functional performance and phytic acid levels in bread. Journal of Cereal Science, 48: 715-721.
31. Bressani, R., J.C. Turcios and A.S. De Ruiz, 2002. Nixtamalization effects on the contents of phytic acid, calcium, iron and zinc in the whole grain, endosperm and germ of maize. Food Sci. Technol. Int., 8: 81-86.
32. Bressani, R., J.C. Turcios and A.S. De Ruiz, 2004. Effect of processing conditions on phytic acid, calcium, iron and zinc contents of lime-cooked maize. J. Agric. Food Chem., 52: 1157-1162.
33. Mettler, E. and W. Seibel, 1993. Effects of emulsifiers and hydrocolloids on whole wheat bread quality: A response surface methodology study. Cereal Chemistry, 70(4): 373-377.
34. Hoover, R., T. Hughes, H.J. Chung and Q. Liu, 2010. Composition, molecular structure, properties and modification of pulse starches: a review. Food Res. Int., 43: 399-413.
35. Karim, A.A., M.H. Norziah and C.C. Seow, 2000. Methods for the study of starch retrogradation. Food Chem., 71: 9-36.
36. Hubbard, M.R., 2003. Sensory Testing in Statistical flour. Quality Control for the Food Industry. 3 edition. Kluwer Academic/Plenum Publishers, pp: 187-199.