Study of Bread Form Composite Flour of Maize Flour with Pregelatinized Starch (PGS)

Evan Butrus Ilia Halala Wrya Alikhan
College of Agriculture, University of Salahaddin, Erbil, Kurdistan Region Iraq
E-mail: evan.ilia@su.edu.ktd halalalily@yahoo.com

Abstract:- The study was conducted to arise and increase composite bread with maize flour and PGS to evaluate the quality parameters and properties of resulting dough and breads. Loaf breads were formed from composite flour containing 10, 15, 20, 25, and 30% of maize flour with 10% PGS(Recommended form pervious study) as constant for wholly samples and compared with wheat bread for various quality attributes of the developed products. Addition of maize flour negatively affected of doughrheology properties and baking properties, but the nutritional quality was improved in case of fat content. Replacement of 10% maize flour into wheat flour 10% PGS retained much of the nutritional and sensory properties and gave the bread with the good overall acceptability. The physical study showed that there was no significant difference between the wheat bread and bread with 10% maize flour. High positive correlate was found between specific loaf with texture, taste and overall acceptability but negatively correlated with hardness. Specific loaf volume, hardness and springiness decreased during storage with increasing level of maize flour in the composite flour formula.

Key words: - Wheat flour, Maize flour, Pregelatinized maize starch, Composite bread, Physico-chemical Composition.

1 Introduction

Bread is an important staple food in both developed and developing countries. Composite flour technology initially referred to the process of mixing wheat flour with cereal and legume flours for making bread. Bread wheat (*Triticumaestivum sp.*) is normally used for productions of variety breads. Many wheat varieties are cultivated in the region and a breeding program was established, research centres to continually improve the local varieties. The main ingredient of bread is wheat flour. The flour should have good amylase activity, the moisture content should be less than 14% and the color or appearance should be satisfactory [1]. 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 [2]. 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. Starch plays two roles in bread products, firstly in the creation of the sponge structure and secondly in the changes to the stored products, known as bread staling. The most important property of Pregelatinized starch is that it instantly hydrates and swells in water at room temperature. However, finely ground products of Pregelatinized starches are difficult to disperse in water homogeneously since they hydrate rapidly at contact with water and form lumps or fish eyes [3]. The hydration rate can be slowed down by premixing the Pregelatinized starches with other ingredients. Furthermore, the Pregelatinized starch showed cold water viscosity at 25˚C,while native wheat starch was not able to increase the viscosity under this condition .it also increased water absorption and swelling of the starch compared to its native counterpart as described by [4].
The aims of this study were to arise and increase maize flour based composite bread with presence of 10% PGS and compare with wheat flour bread in respect to physico-chemical properties, baking quality.

2- Materials and methods

Commercial bread wheat flour 80% extraction, was passed through sieve size 9xx (150 µ) produced by BETWATA Milling Co. Erbil-Kurdistan-Iraq. Maize flours were collected from local market, and Pregelatinized maize starch (PGS) supplied by SAVUNMAN STARCH- LTD, Turkey, the samples were conducted as shown in (Table 1). Moisture, Ash, Protein Content, Baking, Firmness and Staling of samples were determined according to procedures No.44-15, No.08 -01A, No. 46-10 Kjeldahl method, No. 10-10B, No. 74 -09 respectively [5]. Fat content was estimated as the methods of [6] and damaged starch of wheat flour blends with FM and GPS was determined according to [7].

Table 1: Flour Blends

Samples No.	Flour Type
No.1	Wheat flour (control)
No.2	Wheat Flour10% PGS
No.3	WheatFlour10% PGS + 10% Maize flour
No.4	Wheat Flour10% PGS+ 15% Maize flour
No.5	WheatFlour10% PGS + 20% Maize flour
No.6	Wheat Flour10% PGS + 25% Maize flour
No.7	Wheat Flour10% PGS + 30% Maize flour

Sensory evaluation:
Sensory evaluation of the composite bread samples were carried out by 10 panelists on a 9 point hedonic scale for different parameters such as crumb ,crust color, aroma, taste, texture and overall acceptability as described by [8]. The 10 untrained panelists were teachers of Food Technology of Salahaddin University shared together in evaluating the laboratory made breads.

3-Results and Discussion:

Chemical composition of composite flour with PGS and maize flour:

The results of chemical composition analysis of wheat and maize flour with PGS are presented in (Table 2).Maize flour has higher content of fat and ash, while lower content of moisture, protein, and damaged starch than that of wheat flour compare to others. Replacing a portion of wheat flours with Pregelatinized starch caused a decrease in moisture, ash, protein and fat content of flour blends this was due to the lower moisture 7.5 %, and ash 0.7 % content of PGS and due to the dilution effect of protein, these results agree with those found by [9].The substitution of Maize flour at different levels to wheat flour with 10% PGS samples caused a noticeable decrease gradually in moisture content by a range of 12.51 to 11.16 %, protein content (12.93% to 10.91) ,and damaged starch content (5.42% to 3.85) while there was also a increase in ash content with values ranged from (0.83% to 1.17%) and fat content (1.81% to 2.38%) as compared to wheat flour.

Effect of composite flour on baking properties:
The results showed that replacement of wheat flour with 10% PGS increased specific volume of loaf while with maize flour decreased the baking potential in terms of volume and specific volume of loaf. Loaf volume and specific volume of 20% to 30% maize flour substitution were significantly different from original wheat flour bread. It was clearly observed that increase of percent replacement of wheat flour caused the decrease of loaf volume and specific volume of composite bread as shown in Fig. 1.

Effect of composite flour with PGS and maize flour on bread stalling:

Crumb compressibility data were determined for wheat bread to show the effects of Pregelatinized starches and maize flour on the staling behavior of baked loaves. Avrami equation [10] was applied using modulus measurements as described by [11] and as below:
$E_t = E_\infty – [(E_\infty – E_0) \exp(–kt^n)]$
Where E_t is the elastic modulus at time t, E_∞ is the Limiting modulus at equilibrium, E_0 is the initial modulus at time 0 (fresh sample), t is the time, and the Avrami exponent (n) and rate constant (k). Since rate constants (k) cannot be calculated directly from Avrami equation, therefore non- linear least squares technique as described by [12] was used**.** Data in table (3) showed that the initial modulus E_0 and Limiting modulus E_∞, fresh bread compressibility of composite flours were positively correlated with maize flour while negatively correlated with PGS. This result indicating that the maize flour contains no gluten which is responsible for low specific volume. Bread Crumb firmness is strongly influenced by the bread volume**.**
Data in table (3) showed the compressibility data (staling rate K) of breads baked from wheat flour and their blends with MF and PGS, though the addition of PGS 10% to wheat flour was responsible for lower compressibility of bread crumbs ascompared to both the control and the bread containing flour maize, this finding was due to the role of PGS in increasing loaf volume and probably increasing moisture of bread crumbs. The above findings extremely agree with [13], as well as, the greater the specific volume the softer the crumb [14]. Results indicate that the staling rate K of composite bread was increased with the increase of substitution levels of maize flour and storage time.

There was no significant different in staling rate K of composite bread contain up to 20% maize flour. Bread produced from 10 to 15 % MF showed lower compressibility of bread crumbs as compared to composite bread contain up to 20 to 30 % MF, but 30% maize flour substitute level, the highest used in this study, bread gave highest staling rate K of composite bread, this finding was due to the maize flour cannot retain gas, it failed to give light textured spongy bread and smaller loaves were denser and had a tightly packed crumb structure, resulting in higher crumb hardness readings. Similar results were found by [15].

Effect of incorporation of pregelantizied starch and maize flour on the sensory evaluation of wheat bread:

Two hours after baking, the acceptability of composite wheat with 10% PGS and maize flour breads were determined in terms of sensory evaluation. Six parameters were considered under organoleptic tests including crumb crust colour, aroma, taste, texture and overall acceptability (Table4**) .**It was noted that most of organoleptic characteristics also decreased with the increase of substitution levels of MF**.** The panelists awarded higher scores for all of the sensory parameters of wheat bread than any combination of composite bread (Table 4). The panelists awarded higher scores for all of the sensory parameters of wheat flour with 10% Pregelatinized starch as compared to both the control and the bread containing 10, 15, 20, 25 % and 8% maize flour, this finding was due to the role of PGS in increasing loaf volume and probably increasing moisture of bread crumb which was more accepted by the consumer. These results were in agreements with those of [16]. Table shows that maize flour substitution with wheat flour10% PGS reduced the sensory quality of bread. The score for crust color, aroma and taste of 10% maize flour bread was not significantly different from control bread. Bread produced from 15 to 30% maize flour showed lower scores and significantly different from control bread and WF 10% GSP but not significantly different from each other. Based on sensory data, the results indicated that the overall acceptability of composite bread was decreased with the increase of maize flour. Several panelists indicated that the breads containing maize flour seemed to have a less astringent taste and texture of bread of higher level of maize flour substitution was hard, dry and sandy. The results may be due to maize flour contain no gluten which is responsible for bread sensory and baking quality.

4- Conclusion

This study has demonstrated that quality of composite bread has been negatively affected with the different substitution level of maize flour while positively affected with Pregelatinized maize starch at level 10 %. The addition of PGS at level 10% to wheat flours had a positive influence on the SLV and retarding the staling rate during storage .Low cost and low protein content, maize flour may be used in composite flour bread preparation at the level of 10% with acceptable physical and sensory attributes.

***References**:*

[1] Giami, G.Y., Amasisi, T. and Ekiyor, G. (2004). Comparison of bread making properties of composite flour from kernels of roasted and boiled African bread fruit (Treculiaafricana) seed. J. Mat. Res., 1(1):16-25.

[2] Dewettinck, K., Van Bockstaele, F., Kuhne, B., Van de Walle, Courtens, T. and Gellynck, X. (2008). Nutritional value of bread: Influence of processing, food interaction and consumer perception. Rev. J. Cereal Sci., 48:243-257.

[3] Steve, W. Cui., Liu, Q., and Sherry, X.X. (2005). Starch Modification and Applications .page 418 in: Food Carbohydrates: Chemistry, Physical Properties, and Application. Steve W. Cui, Ed .Taylor and Francis Inc, CRC Press.

[4] Majzoobi, M., Saberi, B., Farahnaky, A. and TongdangKarrila, T. (2012). Physicochemical Properties of Cross-linked Annealed Wheat Starch. Iran. Polym. J., 21: 513-522.

[5] AACC. (2000). Approved Methods of the American Association of Cereal Chemists. 10th Edition. The Association, St Paul Minnesota.

[6] AOAC (2000). In W. Horwitz, (Ed.), Official methods of analysis of AOAC International, (17th ed.). Maryland, USA: Association of Official Analytical Chemists.

[7] Boyacıa, I. H., Williams, P.C. and Koksel, H. (2004). A rapid method for the estimation of damaged starch in wheat flours. Journal of Cereal Science. 39:139–145.

[8] Ihekoronye, A.I. and Ngoddy, P.O. (1985). Integrated Food Science and Technology for the Tropics. 2nd ed. Macmillan Publishers Ltd. London.

[9] Alviola, J.N., Jondiko, T. and Awika1, J. M. (2010). Effect of Cross-Linked Resistant Starch on Wheat Tortilla Quality. Cereal Chem. 87(3):221–225.

[10] Avrami, M. (1939). “Kinetics of Phase Change. I: General Theory.” J. Chem. Phys. **7**: 1103.

[11] Cornford, S.J. (1964). The mechanism of fruit holding in high-ratio cake batters. Journal of the Science of Food and Agriculture. 12(10): 693–700.

[12] Fearn, T. and Russell, P.C. (1982). A kinetic study of bread staling by differential scanning calorimetry. The effect of loaf specific volume. J. Sci. Food Agric. 33:537-548.

[13] Iwata, K., Watanabe, M., Suzuki, T., Kobayashi, I. and Goto, M. (2006). Method for producing bread. J Oil Mills Inc.; Japanese Patent No. 2006101702 A.

[14] Maleki, M., Hoseney, R.C. and Mattern, P.J. (1980). Effect of loaf volume, moisture content, and protein quality on the softness and staling rate of bread. Cereal Chem. 57: 138-140.

[15] Khanitta, M. 2000. Effect of emulsifiers on composite wheat, rice and brown rice flour bread characteristics. AIT thesis no. PH-00-15. Pathumthani, Thailand.

[16] Miller, R.A., Maningat, C.C. and Hoseney, R.C. (2008). Modified wheat starches increase bread yield. Cereal Chem. 85:713-715.

Table 2: Chemical composition of Composite Flour of Maize Flour with Pregelatinized Starch.

Samples	Moisture%	Ash % 14mb	Protein %14 mb	Fat content %14 mb	Damage Starch %14 mb
Wheat flour (WF)	12.51 ±0.05	0.83 ±0.05	12.93±0.03	1.81 0.14	5.42 ±0.01
Maize flour (MF)	12.19±0.3	1.67±0.14	9.41±0.19	3.18±0.10	3.4 ±0.25
WF 10% PGS	11.96 ±0.25	0.78 ±0.01	12.24 ±0.16	1.47±0.22	5.86 ±0.04
WF10% PGS+ 10 % MF	11.84 ±0.02	1.16 ±0.02	12.06±0.22	2.05±0.10	4.72 ±0.05
WF 10% PGS+ 15 % MF	11.57 ±0.05	1.36 ±0.05	11.83±0.17	2.12±0.05	4.43 ±0.13
WF 10% PGS+ 20 % MF	11.32 ±0.19	1.09 ±0.05	11.44±0.05	2.34±0.02	4.45 ±0.05
WF 10% PGS+ 25 % MF	11.01±0.14	1.27 ±0.04	11.03±0.03	2.33 ±0.01	3.96±0.06
WF 10% PGS+ 30 % MF	11.16±0.02	1.17 ±0.03	10.91±0.02	2.38 ±0.14	3.85 ±0.02

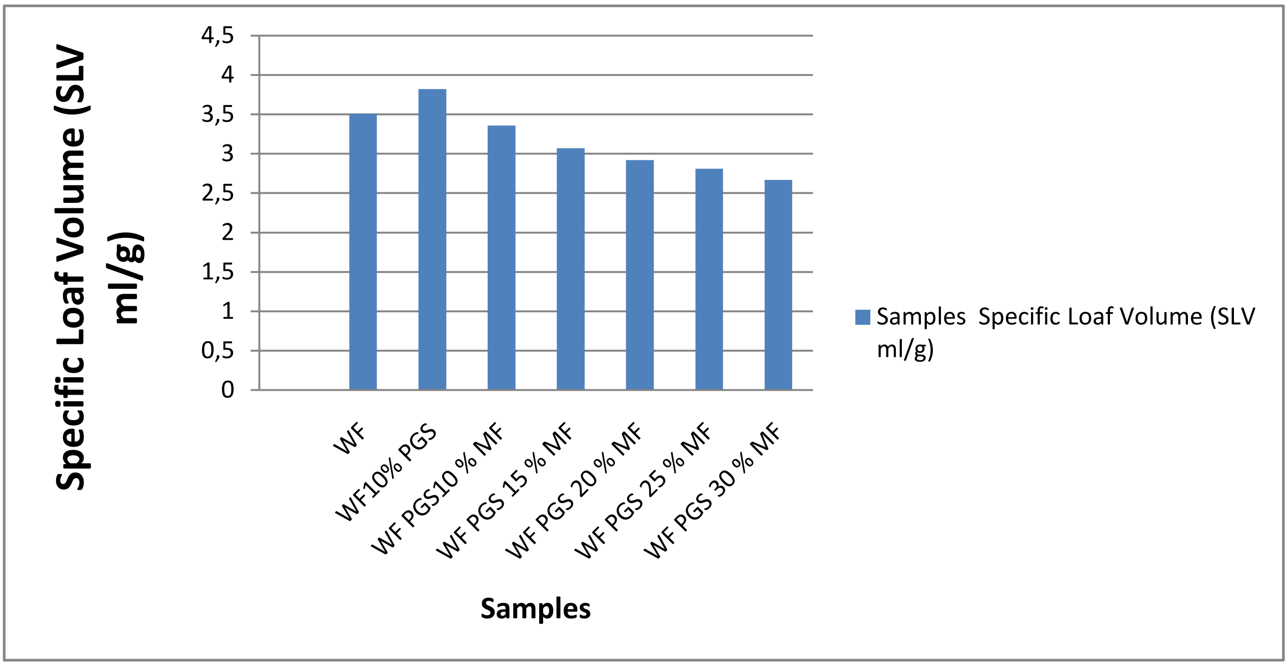

Figure 1: Specific volume of composite flour bread containing PGS and maize flour

Table 3: Effect of composite flour with PGS and maize flour on loaf volume and bread staling:

Samples	Specific Loaf Volume (SLV ml/g)	Bread Crumb Compressibility Data		
		Initial modulus (E_0) (g)	Limiting modulus (E_∞) (g)	Rate constant (K)
Wheat flour (WF)	3.51 ±0.05	230	1040	0.493
WF 10% PGS	3.82 ±0.25	204	998	0.443
WF 10% PGS+ 10 % MF	3.36 ±0.02	213	1013	0.461
WF 10% PGS+ 15 % MF	3.07 ±0.05	215	1000	0.469
WF 10% PGS+ 20 % MF	2.92 ±0.19	222	1024	0.619
WF 10% PGS+ 25 % MF	2.81±0.14	242	1084	0.624
WF 10% PGS+ 30 % MF	2.67 ±0.22	247	1086	0.651

Table 4. Sensory evaluation of composite flour bread with PGS:

Samples	Crumb	Crust color	Aroma	Taste	Texture	Overall acceptance
Wheat flour (WF)	8.4	8.2	7.1	8.2	8.5	8.4
WF 10% PGS	9.0	8.3	8.1	8.5	8.7	8.7
WF 10% PGS+ 10 % MF	7.3	8.0	7.4	8.1	7.7	7.3
WF 10% PGS+ 15 % MF	6.6	7.2	6.8	6.2	7.2	6.8
WF 10% PGS+ 20 % MF	6.4	6.3	6.8	5.9	6.0	6.4
WF 10% PGS+ 25 % MF	5.9	6.6	5.8	5.2	5.8	5.7
WF 10% PGS+ 30 % MF	5.0	4.8	5.3	4.9	4.2	4.8

Mean of 10 scores for each sensory characteristics