Zagazig J. Agric. Res., Vol. 35 No .(4) 2008 911-926

EFFECT OF WHEAT FLOUR SUBSTITUTION WITH MAIZE, CHICKPEA AND BARLEY FLOURS ON CHEMICAL AND RHEOLOGICAL PROPERTIES

Hassan H.M., F.A. Salem, K.M. El-Sahy, and A.M. Sulieman

Food Science Dept., Fac. Agric., Zagazig Univ., Egypt.

Accepted 25 /8/2008

ABSTRACT: Wheat flour substituted with maize, parboiled chickpea, barley flours and their blends at different levels effects on chemical characteristics of blend flours and reheological properties of dough prepared from them were studied. Results showed that protein, fat, ash and fiber content increased while total carbohydrate decreased with increasing parboiled chickpea substitution as well as participates with maize or barley flours blends. Farinogram data showed that water absorption and dough softening was increased while stability time decreased except at 30% parboiled chickpea substitution being 12.5 min. Extensograph parameters, Elasticity decreased at different levels of substitution except at 20% parboiled chickpea which was 615 (B.U) equal to control sample. Extensibility and energy decreased at all levels substitution. Visco-amylograph parameters, gelatinization temperature deceased but increased to 69 and 70°C at 20 and 30 % of maize substitution. Maximum viscosity decreased except at 30% barley and 20% barley plus 10% parboiled chickpea increased to 850 and 680 (B.U), respectively. Viscosity at 50°C decreased at different levels replacement but increased at 30 % barley substitution and set back decreased specially with increasing barley substitution.

Key words: Wheat, maize, parboild chickpea, barley, chemical and rheological properties.

INTRODUCTION

Wheat is one of the most used cereals in the world and the already low lysine content of this cereal is further reduced during milling of grain to make flour as well as during baking (Graham *et al.*, 1969).

Wheat flour is the ingredient that, more than any other influences the processing response of most dough, batters and determines the finished quality of most bakery products (Matz, 1991).

In Egypt, according to the limited area of cultivation land and the rapid increase in population, about 50% needs of wheat are annually imports to cover the demand for bread consumption. However, the local production of wheat in 2006 is about 8308000 ton (FAO, 2006) Therefore, other cereal than wheat must be utilized and incorporated in bread making to reduce the amount of the imported wheat in addition utilizing of other raw material in the process of bread have been triad to overcome part of such problem (cereals and legumes) or any suitable and available by product (Mohsen *et al.,* 1997).

In developing countries, Maize (*Zea mays L.)* is mainly used for human consumption. In Africa, maize is eaten boiled or roasted, but shelled maize also milled to flour, or semolina, which are used to make couscous porriolges or pastes. Maize consumption is increasing in developing countries of Africa and breading programs have been lunched to develop high performance varieties (Mestres *et al.,* 1991). The local production of maize in 2006 was record about 890000 ton (FAO, 2006).

Chickpea (*Cicer arietinum L.*) is the fifth most widely grown legume in the world (Chavan *et al.,* 1989). In addition to being an important source of protein; chickpea is also reported to be a good source of minerals (Nestares *et al.,* 1996). Supplementation of wheat flour with chickpea would significantly enhance the protein quality of the product. Considering its low cost of production and high nutritive value, the use of chickpea in more food products might be beneficial, especially in countries of high production of this crop and low animal protein consumption; (Hernandez and Sotelo 1984). Cereal-legume is the most used combination since the limiting amino acid of each one may be complemented by the amino acid content of the other.

Barley can be cultivated in a wide range of soils and climates that do not permit the survival of wheat. Therefore, barley is locally successfully cultivated in the new reclamated lands and desert causing an increase of the total barley yield (El-Farra *et al.,* 1985).

Wheat variety could be used as flour when mixed with hulless barley it could be used for balady bread prepared by the traditional Egyptian method and palatable for the consumer with excellent chemical, technical and biological properties (Mekhael, 2004).

This study aimed to investigate the effect of substitution by maize, parboiled chickpea and barley flours on the chemical and reheological properties of wheat flour.

MATERIALS AND METHODS

Materials

Wheat Flour

Commercial wheat flour (*Triticum asetivum*) extraction 82% was obtained from East Delta Milling Co.,Oraby mills, Zagazig, Shrkia Governorate, Egypt.

Maize Flour

Commercial maize flour (*Zea maize*) variety 310 (97% extraction) was obtained from Agricultural Research Center, Sakha, Kafer -El-Shakh Governorate, Egypt.

Chickpea

Chickpea (*Cicer arietinum L.*) variety 159 was obtained from Agricultural Research Center-Giza- Egypt

Hulless Barley Grains

(Hordeum *vulgar*) variety Giza 131 was obtained from Agric. Reseach Center Giza- Egypt.

Chemicals

All used chemicals (analytical grade) were purchased from El-Gomhria Company for Chemical and Medical Material (Zagazig, Egypt)

Preparation of Parboiled Chickpea Flour

Raw chickpea was boiled for 30 min., dried at 50°C for 72 hrs. then milling by (Lab. Miller) to pass 20-mash as the method described by (Hallab *et al.*, 1974) with some modification.

Preparation of Flour Blends

The flours mixtures were prepared as described in Table 1.

Methods

Proximate Composition

Moisture, crud protein, ash, fat and crud fiber were determined according to the methods out-lined in A.A.C.C. (2000). The total carbohydrates were determined by difference.

Table 1. Wheat flour substituted with different levels of Maize, Parboiled chickpea and Barley flours

Sample No.	WF[1] 82% extraction	MF[2] 97% extraction	Pb.Chk[3] 82% extraction	BF[4] 82% extraction
1	100	-	-	-
2	80	20	-	-
3	70	30	-	-
4	80	-	20	-
5	70	-	30	-
6	70	20	10	-
7	70	10	20	-
8	60	30	10	-
9	70	-	-	30
10	70	-	10	20

1. WF. = Wheat flour.
2. MF. = Maize flour.
3. Pb.Chk. = parboiled chickpea.
4. BF. = barley flour.

Rheological Characteristics

The rheological assessments of different dough samples were carried out using Farinograph, Extensograph and Visco-Amylograph according to A.A.C.C. (2000).

Farinograph test

All wheat doughs were tested by (Barbender, Farinograph Nr 941020, type 810105001 made in Germany) at Food Technology Research Institute, Agricultural Research Center, Giza, for determination of water absorption, arrival time, development time, stability, and dough softening, according to A.A.C.C. (2000).

Extensograph test

Dough energy (cm2), extensibility (E, mm.) resistance to extension as Barbender unit (B.U.) and proportional number were determined by the Barbender extensograph apparatus (Barbender, Duisberg, Nr. 946003 type 860001 made in Germany) at Food Technology Research Institute, Agricultural Research Center, Giza, Egypt.

Amylograph test

Dough formulas were tested by (Barbender Visco-Amylograph of the type 680022 supplied with a sensitivity cartridge of 700 GRS/CM Nr, 940053 made in Germany) The Amylograph calibrated by using water to give viscosity of zero Barbender Amylograph units (B.U.) 65 grams flour placed in flask and 450 ml of distilled water was added. It was shaked for 30 second. The flour slurry was poured into the visco-amylograph bowel the temperature was adjusted to 30° C then raised to 95°C at a rate of 1.5°C per minute. This determination for maximum viscosity (B.U.), viscosity at 95°C (B.U.) and set back that according to A.A.C.C. (2000).

RESULTS AND DISCUSSION

Chemical Composition of Wheat, Maize, Parboiled Chickpea and Barley Flours

Data in Table 2 showed proximate composition of wheat, maize and chickpea flours and their blends. Wheat flour recorded the highest content of moisture 11.80% and the lowest content of fat 1.70% and fiber 1.35% while maize flour had the highest content of total carbohydrate 70.84% and lowest content of ash 1.10%. Parboiled chickpea flour possessed

Table 2. Chemical composition of Wheat, Maize, Barley, Parboiled chickpea flours and their blends

Samples	*Chemical composition					
	Moisture %	**Protein %	Fat %	Ash %	Fiber %	Total carbohydrate %
Wheat flour (82% extraction)	11.80	13.36	1.70	1.27	1.35	70.75
Maize flour (97% extraction)	10.50	10.75	4.53	1.10	2.24	70.84
Parboiled chickpea (82%extractio)	9.95	25.00	6.34	2.50	3.41	52.70
Barley flour (82 % extraction)	10.20	11.70	2.92	2.21	2.66	70.31
Treatments						
1) 80% WF[1] + 20% MF[2]	11.50	12.80	2.29	1.18	1.50	70.73
2) 70% WF[1] + 30% MF[2]	11.34	12.53	2.57	1.17	1.59	70.80
3) 80% WF[1] + 20% Pb.Chk.[3]	11.35	15.65	2.65	1.46	1.74	67.15
4) 70% WF[1] + 30% Pb.Chk.[3]	11.18	16.83	3.11	1.60	1.95	65.33
5) 70% WF[1] +20% MF[2] +10%Pb.Chk.[3]	11.29	11.81	2.75	1.09	1.71	71.35
6) 70% WF[1] +10% MF[2] +20%Pb.Chk.[3]	11.23	15.40	2.93	1.45	1.83	67.16
7) 60% WF[1] +30% MF[2]+10%Pb.Chk.[3]	11.17	13.72	3.03	1.30	1.81	68.97
8) 70% WF[1] +30% BF[4]	11.25	12.82	2.09	1.26	1.72	70.86
9) 70% WF[1] +10% Pb.Chk.[3] +20% BF[4]	11.23	14.15	2.43	1.30	1.46	69.43

* Means of three triplicates

** Wheat flour, maize flour, barley flour (N× 5.7) and parboiled chickpea (N× 6.25).

Total carbohydrate: Calculated by difference.

1. WF: Wheat flour.
2. MF: Maize flour.
3. Pb Chk: parboiled chickpea.
4. BF: barley flour

the highest content of protein 25.00%, fat 6.34%, ash 2.50% and fiber 3.41% while it had the lowest content of total carbohydrate 52.70%. Regarding wheat blends, the protein, fat, ash and total dietary fiber increased with increasing levels substitution of wheat flour by parboiled chickpea flour while total percent of carbohydrate was decreased as compared with control. That results were in agreement with (Assem *et al.*, 2002; Abd- El-Hamid 2004; Dahab 2006; Alajaji and El-Adawy 2006).

Rheological Properties

Rheological properties of wheat flour dough and its blends with maize, barley and parboiled chickpea flour at 20%, 30% and the other levels were measured using Barbender Farinograph, Extensograph and Visco-Amylograph instruments.

Farinograph tests

The results present in Table 3 showed the effect of substitution of wheat flour with 20 and 30% of maize flour, parboiled chickpea flour, 30% of barley flour and their mixture at 10, 20 and 30% on Farinograph parameters i.e., water absorption (%), arrive time, dough development time (min.), dough stability (min.) and degree of softening (B.U).

Data noticed that the water absorption ratio was increased with increasing replacement level of maize, parboiled chickpea, blends of them and barley flour compared with control (100% wheat flour), however, The highest water absorption ratio (64.4) was recorded in the` 30% replacement of parboiled chickpea. This result may be due to higher protein and fiber content in chickpea flour. Replacement of wheat flour with maize flour caused slight increase in water absorption compared with control. Substitution of wheat flour with 30% barley flour caused the slight increase in water absorption that may be due to the high content of fiber these results are in agreement with that reported by Yousseff (1976); El-Farra *et al.* (1985); Masoud (2001); Abd-El Hamid (2002); Kamal (2003); Abd El-Rahim (2005) and Yousif (2006).

The arrived time increased with increasing levels of substitution of wheat flour by maize flour and its blends with parboiled chickpea flour while decreased to 0.5 min at 30% barley flour replacement of wheat flour compared with 1.0 min for control. These results may be due to decreased in Hydrogen bond formation and that agreement

Table 3. Farinograph properties of wheat dough and blends dough of wheat, maize, parboiled chickpea and barley flours

Samples	Farinograph parameters				
	* water absorption %	arrival time /min	Development time /min	dough stability /min	degree of softening/ B.U.
1)Wheat flour (82% extraction)	52.0	1.0	1.5	9.0	50
2) 80% WF[1]+ 20% MF[2]	55.1	1.5	4.0	6.0	120
3) 70% WF[1]+ 30% MF[2]	56.5	2.5	4.0	5.5	125
4) 80% WF[1]+ 20% Pb.Chk.[3]	62.2	3.0	5.5	7.0	80
5) 70% WF[1]+ 30% Pb.Chk.[3]	64.4	1.0	3.0	12.5	50
6) 70% WF[1]+20% MF[2]+10% Pb.Chk.[3]	54.6	2.0	3.0	5.0	100
7) 70% WF[1]+10% MF[2]+20% Pb.Chk.[3]	55.7	3.0	4.0	5.0	60
8) 60% WF[1]+30% MF[2]+10% Pb.Chk.[3]	53.3	3.0	4.0	3.0	90
9) 70% WF[1]+30% BF[4]	55.4	0.5	1.0	5.5	110
10) 70% WF[1]+10% Pb.Chk.[3]+20% BF[4]	58.5	1.0	2.0	7.5	70

1. WF: Wheat flour.
2. MF: Maize flour.
3. Pb Chk: parboiled chickpea.
4. BF: barley flour

*Water absorption (Expressed on 14% moisture basis)

with the resulted by Mobarak (2000) and Yousif (2006). While the increasing replacement wheat flour with parboiled chickpea from 20 to 30% that led to decrease in arrive time from 3 min. to 1 min. that result may be due to the increasing in water absorption that led to increasing in Hydrogen bond formation.

Dough development time increased at levels substitution of wheat flour with maize and parboiled chickpea flour and blends of them while decreased at 30% barley flour replacement to 1.0 min compared with 1.5 min for control. Mobarak (2000) found that addition corn four at level 15 and 25 increased the development time to 4.0 and 4.5 min. respectively. While Yousif (2006) found that substitution of wheat flour with 20% barley decreased development time to 1.0 min. compared with 1.5 min for control.

Dough stability time is an important index for the dough strength based on the quantity and quality of dough gluten. Data showed that the dough stability time decreased with all blends flours especially with dough prepared from blends 60% wheat flour + 30% maize flour and 10% parboiled chickpea flour up to 3.0 min. except replacement by parboiled chickpea flour at 30% caused highly increase in dough stability up to 12.5 min. compared with control dough (9.0 min.) the higher of dough stability of dough prepared from 70%wheat flour and 30% parboiled chickpea flour may be due to high protein content of chickpea flour. The obtained results were agreement with those reported by Yousseff (1976); Yousif (2006) and Dahab (2006).

Softening of the dough is a result of the break down of gluten net work after elapsing an appropriate mixing time. Substitution by maize flour caused highly increase of dough softening. It was 120 and 125 (B.U) for 20% and 30% maize flour respectively. This result due to dilution of wheat gluten. Increasing of substitution level of chickpea flour caused decrease of dough softening from 80 (B.U) to 50 (B.U) for 20% and 30% substitution level respectively, which may be due to interaction between wheat gluten and chickpea protein. These results agree with Mekhael (2004) and Yousif (2006).

Extensgraph tests

Data present in Table 4 showed the effect of substitution of wheat flour with maize, parboiled chickpea and barley flours on Extensogram parameters *i.e.* extensibility (mm),

Table 4. Extensograph properties of wheat dough and blends dough of wheat, maize, parboiled chickpea and barley flours

Samples	Extensograph parameters			
	Elasticity/B.U.	Extensibility /mm	Proportional number.	Area under curve./cm^2
1)Wheat flour(82%extraction)	615	105	5.9	67.0
2) 80% WF[1]+ 20% MF[2]	380	95	4.0	39.0
3) 70% WF[1]+ 30% MF[2]	340	80	4.3	33.0
4) 80% WF[1]+ 20% Pb.Chk.[3]	615	65	9.5	44.0
5) 70% WF[1]+ 30% Pb.Chk.[3]	600	50	12.0	43.0
6) 70% WF[1]+20% MF[2]+10% Pb.Chk.[3]	170	95	1.8	21.0
7) 70% WF[1]+10% MF[2]+20% Pb.Chk.[3]	270	75	3.6	26.0
8) 60% WF[1]+30% MF[2]+10% Pb.Chk.[3]	140	80	1.8	16.0
9) 70% WF[1]+30% BF[4]	200	55	3.6	10.0
10) 70% WF[1]+10% Pb.Chk.[3]+20% BF[4]	440	50	8.8	28.0

1. WF: Wheat flour.
2. MF: Maize flour.
3. Pb Chk: parboiled chickpea.
4. BF: barley flour.

elasticity (B.U.), proportional number and energy (cm^2).

From the obtained data it could be noticed that the elasticity and extensibility of wheat flour dough was decreased as resulted of increase substitution level with maize, parboiled chickpea, barley flours and blends. The elasticity was 615 B.U. at 20% parboiled chickpea substitution that equal control but it decreased to 600 B.U. at 30% parboiled chickpea substitution that result may be due to the increasing dilution of wheat gluten. while the lowest elasticity was 140 (B.U) at level replacement of wheat with 30% maize flour + 10% parboiled chickpea flour while the lowest extensibility was 50 mm at substitution wheat flour with 30% parboiled chickpea and replacement the wheat flour with 20% barley flour + 10% parboiled chickpea flour. These results agree with Seleem (2000), Abd-El Hamid (2002) and Yousif (2006).

The proportional number which calculated by diving the value of the resistance to extension (B.U.) of the value of the extensibility. The result in the same table showed that the value of proportional number was decreased with all substitution levels except at levels substitution 20% barley flour +10%parboiled chickpea, 20 and 30% parboiled chickpea flour were increased to 8.8, 9.5 and 12.0 respectively compared with 5.9 for control sample. That result may be due to increased of elasticity as result of high protein content of chickpea flour. These results agreement with (Abd-El Hamid, 2002) who mention that proportional number increased with increasing level of chickpea flour.

Energy (cm^2) area under curve was decreased at all different levels of substitution of wheat flour with maize or parboiled chickpea or barley or their blends compared with control. These results were in agreement with Masoud (2001), Abd-El Hamid (2002) and Dahab (2006).

Visco-amylograph parameters

Data in Table 5 showed that, the transition temperature and temperature at maximum viscosity were slightly increased at the replacement level of wheat flour with maize flour. The highest transition temperature was 70.0°C at 30% maize flour substitution level while the highest temperature at maximum viscosity was 96.0°C at 20% maize flour replacement of wheat flour. This may be due to gradual increased of maize starch granules which is more rigid than the wheat starch granules.

Table 5. Barbender visco-amylograph properties of wheat dough and blends dough of wheat, maize, parboiled chickpea and barley flours

Samples	Amylograph parameters						
	Transition temp. (C°)	Temp. at maximum viscosity (C°)	Maximum viscosity /B.U.	Viscosity at 95C / B.U.	Viscosity at 95° after 15 min./B.U.	Viscosiy at50c° /B.U.	Set back/ B.U.
Wheat flour(82%extraction	67.5	90.0	525	510	410	960	435
1) 80% WF[1] + 20% MF[2]	69.0	96.0	290	280	230	580	290
2) 70% WF[1] + 30% MF[2]	70.0	94.5	260	260	235	640	380
3) 80% WF[1] + 20% Pb.Chk.[3]	63.0	91.5	305	300	260	600	295
4) 70% WF[1] + 30% Pb.Chk.[3]	63.0	91.5	250	250	230	495	245
5) 70% WF[1] +20% MF[2]+10% Pb.Chk.[3]	67.0	94.5	235	235	215	540	305
6) 70% WF[1] +10% MF[2]+20% Pb.Chk.[3]	64.5	94.5	230	230	220	500	270
7) 60% WF [1]+30% MF[2]+10% Pb.Chk.[3]	67.5	88.5	370	320	295	780	410
8) 70% WF[1] +30% BF[4]	60.0	87.5	850	600	520	1005	155
9) 70% WF[1] +10% Pb.Chk.[3]+20% BF[4]	57.0	88.5	680	460	440	880	200

1. WF: Wheat flour.
2. MF: Maize flour.
3. Pb Chk: parboiled chickpea.
4. BF: barley flour

Therefore it requires more heat energy to a chivied complete swelling meanwhile the transition temperature and temperature at maximum viscosity were decreased at levels replacement of parboiled chickpea and its blends with maize and barley flour. The lowest transition temperature and temperature at maximum viscosity were 60.0°C and 87.5°C respectively at 30% barley flour level replacement compared with 67.5 and 90.0°C respectively for control. These results agreement with Mobarak (2000) who found that the replacement wheat flour with 15, 25 and 25 corn flour caused an increased in gelatinization temperature, temperature at maximum viscosity and decreased the maximum viscosity, viscosity at 95°C, viscosity at 50°C and set back compared with control sample.

The maximum viscosity was decreased with increasing levels substitution of maize and parboiled chickpea flour and blends of them. The lowest maximum viscosity was 230 (B.U) at 10% maize + 20% parboiled chickpea flour level substitution of wheat flour while the highest maximum viscosity was 850 (B.U) at 30% barley flour replacement of wheat flour compared with 525 (B.U) for control (100% wheat flour). These results agreement with (Yousif, 2006) who found that transition temperature decreased and maximum viscosity increased with increasing barley flour substitution.

Viscosity at 95°C, viscosity after 15 min. at 95°C and viscosity at 50°C were decreased at all levels replacement of wheat flour with maize and parboiled chickpea and blends while their increased to 600, 520 and 1005 (B.U) respectively with 30% barley flour substitution compared with 510, 410 and 960 (B.U) for control (100% wheat flour).

The set back decreased at all level substitution of maize, parboiled chickpea, barley and blends of them. The lowest set back was 155 (B.U) at 30% barley flour substitution compared with 435 (B.U.) for control sample.

In conclusion replacement wheat flour with parboiled chickpea caused increasing protein, fat and dietary fiber that supported the nutritive value of products with increasing levels replacement. This study recommended substitution wheat flour with (maize flour at 20% plus

10% parboiled chickpea flour), and barley flour at 20% plus 10% parboiled chickpea for bread making.

REFERENCES

A.A.C.C. 2000. American Association of Cereal Chemists Approved Method of A.A.C.C. Published by American Association of Cereal Chemists. 25th Paul Minnesota. USA.

Abd El-Rahim, E.A. 2005. Effect of bang process on the quality of flat bread prepared from some cereal flour blend. Egyptian J. Nutrition Vol. xx No. 1:179-194.

Abd-El Hamid, H. 2002. Utilization of some dried legumes in bakery products. M. Sc. Thesis Fac. Agric., Ain Shams Univ., Cairo, Egypt

Abd-El-Hamid, M.A. 2004. Studies on yellow corn flour fortified with some dairy products and use it in some cereal product, M.Sc. Thesis, Fac. of Agric. Moshtohor, Zagazig University.

Alajaji S.A. and T.A. El-Adawy. 2006. Nutritional composition of chickpea (Cicer arietinum L.) as affected by microwave cooking and other traditional cooking methods. Journal of Food Composition and Analysis 19:806–812

Assem, Nadia H.A., M. Abd El-Motaleb, Nadia and A. Afaf. 2002. Effect of germination and gelatinization of hullless barley on produced balady bread. presentation at the International Conference, Food Exhibition for Food Industries, Quality control, Food quality, Alex., Egypt.

Chavan, J.K., S.S. Kadam and D.K. Salunkhe. 1989. Chickpea in Handbook of world food legumes: nutritional chemistry, processing technology and utilization. Boca Raton, c,f chemical Abstract, 1: 247- 288.

Dahab, D.B.O.M. 2006. Utilization of different cereal flour mixes in the preparation of some bakery products M.Sc. Thesis, Food industry Dept. Agric. Fact. Minufiya Univ., Egypt.

El-Farra, A.A., M.M. Mostafa and H.K. El-Manawaty. 1985. Baking quality of barley flour. Egypt. J. Sci., 13(2):129-139.

FAO. 2006. Food and Agriculture Organization of United Nation. http:/www. Fao.org. Statistics, production, Egypt.

Graham, G.G., R.P. Placko, G. Acevedo, E. Morales and A. Cordano. 1969. Lysine enrichment of wheat flour evaluation in infants. American J. of Clinical Nutrition. 22: 1459-1468.

Hallab A.H., H.A. Khatchadourian and I. Jabr .1974. The nutritive value and organoliptic properties of white Arabic bread supplemented with soy bean and chickpea. Cereal Chem., 51:107-112.

Hernandez, M. and A. Sotelo. 1984. Nutritional evaluation of wheat flour cookies supplemented with chickpea, cheese whey and amino acids. Nutrition Reports International. 29(4):845-858.

Kamal, H.M. 2003. Production and quality of multi-grain balady bread. Ph. D. Thesis, Fac. of Agric., Ain Shams Univ., Egypt.

Masoud, M.A. 2001. Study on some technological methods to improve quality for some bakery products. Ph.D. Thesis, Fac. of Agric., Moshtohor, Zagazig University, Egypt.

Matz, S.A. 1991. Bakery technology and engineering 3rd ed. Van No. strand Rainhold, New York, NT 10003.

Mekhael, E.K. 2004. Biolchemical and Technological studies on balady bread made from durm wheat mixed with some cereal and cereal by products. Ms.C. Thesis, Cairo Univ., Egypt.

Mestres, C., L. Lexander, F. Matencio and A. Lahau. 1991. Dry milling properties of maize. Cereal Chem. 68:51-56.

Mobarak, E.A. 2000. Technological studies on some cereal products. Ph.D. Thesis, Faculty of Agriculture, Zagazig University, Egypt.

Mohsen, S.M., A. Hussien, Assa and M. Salem Eman. 1997. balady bread characteristics as affect by addition of corn, barley or soy bean flour. C.F. Dahab, D.B.O.M. 2006. Utilization of different cereal flour mixes in the preparation of some bakery products M.Sc. Thesis, Food industry Dept. Agric. Fact. Minufiya Univ., Egypt..

Nestares T., M. López-Frías, M. Barrionuevo and G. Urbano. 1996. Nutrition assessement of raw and processed chickpea *(Cicer arietinum* L.) protein in growing rats. J. Agric. Food Chem. 44 (9), 2760 -2765.

Seleem, H. 2000. Studies on addition of some corn and sorghum varieties to wheat flour on balady bread characteristic. Ph. D. Thesis, Fac. of Agric., Cairo Univ., Egypt.

Yousif, M.R. 2006. Effect of using rice, barley, and corn flours on cakes quality, M.Sc. Thesis Fac. Agric., Ain Shams Univ., Cairo, Egypt.

Yousseff, S.A.M., A. Salem and A. Abd El-Rahman. 1976. Supplementation of bread with soybean and chickpea flour. J. Food Technology, 11 (6): 599-605.

تأثير استبدال دقيق القمح بدقيق الذرة والحمص والشعير على الخواص الكيميائية والريولوجية

حمادة محمد حسن- فوزى أحمد سالم -
كمال محفوظ الصاحى - عبدالرحمن محمد سليمان

قسم علوم الأغذية - كليه الزراعة - جامعة الزقازيق

تم دراسة تأثير استبدال دقيق القمح بنسب مختلفة من دقيق الذرة و الحمص المسلوق ودقيق الشعير ومخاليطهم على الخواص الكيميائية والريولوجية لدقيق القمح. أوضحت النتائج حدوث زيادة فى محتوى البروتين والدهن والرماد و الألياف و بينما تنخفض الكربوهيدرات الكلية بزيادة الحمص المسلوق المستبدل وكذلك عند مشاركته فى مخاليط الذره والشعير. أوضحت بيانات الفارينوجرام زيادة الماء الممتص وضعف العجين بينما يقل زمن الثبات فيما عدا عند مستوى استبدال 30% حمص مسلوق فكانت ق. وعن خواص الاكستنسوجراف فتنخفض المرونه عند كل مستويات الاستبدال عدا عند 20% حمص مسلوق فكانت 615 (وحدة باربندر) وتتساوى فى ذلك مع العينة الكنترول. وتقل المطاطيه والطاقه عند كل مستويات الاستبدال. وعن خواص الفيزكو- اميلوجراف تنخفض درجة الجلتنه الا أنها تزداد الى 69 و70 درجة مئوية عند مستوى استبدال 20 و30% دقيق ذره على الترتيب وتقل اللزوجه القصوى عدا عند مستويات استبدال 30% دقيق شعير وعند 20% دقيق شعير + 10% دقيق حمص مسلوق حيث تزداد إلى 850 و680 (وحدة باربندر) على الترتيب. وتقل اللزوجة عند 50 درجة مئوية عند كل مستويات الاستبدال لكنها تزداد عند مستوى استبدال 30% شعير وتقل درجة لزوجة الرجوع خاصة بزيادة الاستبدال بدقيق الشعير.