EFFECT OF INCORPORATION OF CORN BYPRODUCTS ON QUALITY OF PAN BREAD FROM WHEAT FLOUR [6]

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ABSTRACT

In the present study, corn milling by-products especially with high protein or fiber content (i.e. corn and corn gluten meal) were used in replacing part of wheat flour to the production of pan bread. The effect of blending level (0, 5, 10, 15 and 20%) of corn bran, corn gluten meal and mix of them with wheat flour on the physico-chemical properties (protein, crude fiber, fat, ash and total carbohydrates), baking properties of pan bread were investigated. Blending of wheat flour and corn gluten meal and mix of (corn bran, corn gluten meal) significantly increased the protein, dietary fiber, fat and ash contents of pan bread samples, while blending of corn bran increased dietary fiber, fat and ash contents of pan bread. Blending of wheat flour and corn by-products especially corn bran decreased total carbohydrates and energy (Energy cal./100gm). Breads from mix of (corn bran, corn gluten meal) blends had higher loaf volume as compared to corn bran and corn gluten meal pan breads. Acceptable pan bread products could be produced by blending corn byproducts with wheat up to 20% level.

Keywords: Corn bran. Corn Gluten meal. Wheat flour. Pan bread.

Corn is processed either by wet or dry milling to separate the fractions. Byproducts like bran, germ and gluten are used for animal feed only. The utilization of these byproducts for human consumption is an additional nutritional source and is profitable. Neuman and Wall (1984) and Springsteen et al. (1977) reported that these byproducts have substantial amount of fiber, protein and minerals. Polizotto et al. (1983) reported that corn bran had 5.0% protein, 0.5% fat, 17.7% non fiber carbohydrate, 0.5% ash and 76.3% ENDF (Enzymatic neutral detergent fiber) and 86.4% EIR (Enzymatic Indigestible residue) and 7.7% moisture. Corn gluten is the concentrated protein co-

product (70% protein, db) obtained from wet milling of corn after the germ, oil, bran and starch are extracted. It had 69.4% protein, 4.3% fat, 17.5% starch, 0.6% fiber, 1.9% ash and 7.3% carbohydrate (Neuman and Wall 1984). Purich et al. (1989) also reported a high level of phosphorus, iron and calcium in corn germ.

Corn Gluten Meal is a high protein concentrate typically supplied at a 60% protein, 2.5% fat and 1% fiber. It is a valuable source of methionine. Corn gluten meal also has a level of xanthophylls, which offers the poultry feed formulators an efficient yellow pigmenting ingredient. Corn gluten meal also is an excellent cattle feed providing a high level of rumen bypass protein (Minnesota Nutrition Conference, 2001).

Corn bran is the tough fibrous outer layer or hull of the corn kernel, also known as the pericarp. Corn bran constitutes approximately 5.3% of the corn kernel. Corn fiber is a lignocellulosic material which is a heterogeneous complex of lignin and carbohydrate polymers (Gaspar, et al. 2007). The major components of the corn fiber are hemicelluloses (35%), cellulose (18%), and other starch (20%). Cellulose is a glucose polymer with a specific structure that makes it water insoluble and resistant to depolymerization.

Corn fiber is a by-product of the corn milling industry which has long been used in livestock feed, but has the potential to be a source of dietary fiber which could be added to human foods. Some processing methods result in a product that leaves a gritty texture in the finished food product that subsequently results in degradation of the dough properties. (Inglett, 2005).

Sharma, et al., (2012), reported that blending of corn bran, defatted germ and gluten at 5 and 10% with wheat flour resulted in satisfactory bread, cookie, and muffin score and significantly increased the protein, crude fiber, phosphorus, iron and calcium contents.

MATERIALS AND METHODS

*** Materials:**

1- Corn by-products: Samples of corn by-products (corn bran and corn gluten meal) were obtained from Starch and Glucose Factory, Cairo, Egypt.

2-Wheat flour: Wheat flour (72% extraction) was obtained from south Cairo Mills Company, Cairo, Egypt.

*** Methods:**

1- Production of feed co-products from corn wet-milling was as the follow:

- The corn is sampled and quality approved.
- The corn is cleaned.
- The corn is soaked in steep tanks for 30-50 hours at 120 - 130°F in a dilute sulfur dioxide solution, this controlled process results in the softening of the corn kernels.
- Water is later evaporated to concentrate soluble nutrients, to become (Condensed Corn Fermented Extractives).
- Corn germ is removed from the water soaked kernel.
- The germ is further processed to recover the oil.
- The remaining portion of the germ, (Corn Germ Meal, wet or dried), is collected for feed use.
- After the germ has been removed, the rest of the corn kernel is screened to remove the bran leaving the starch and gluten protein to pass though the screens.
- The bran is combined with other co-product streams to produce (Corn Gluten Feed).

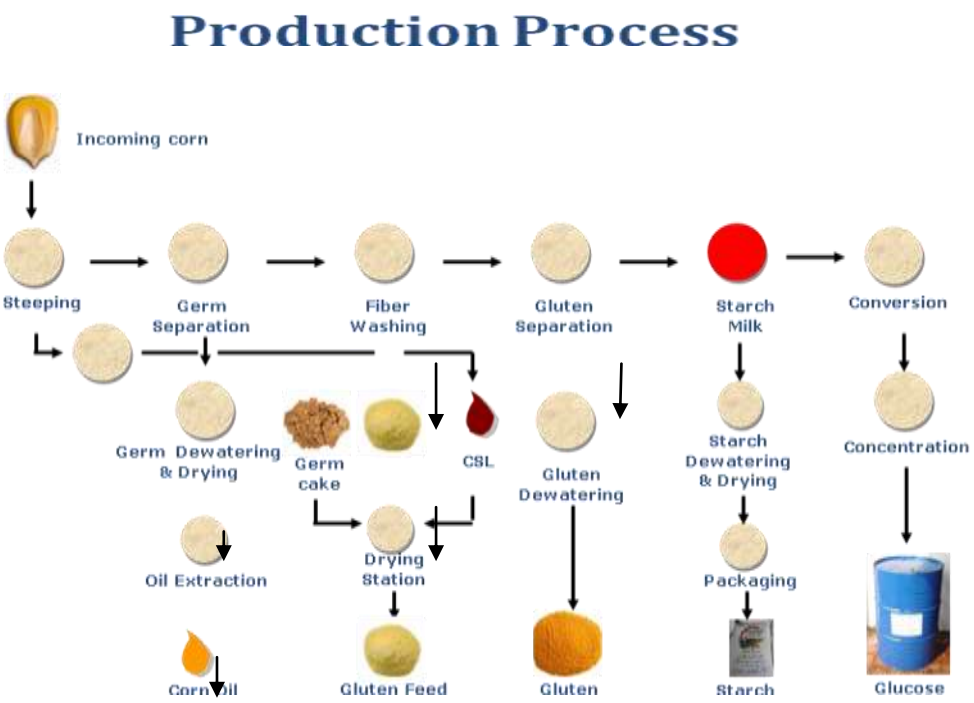

Fig.(1): Wet-milling Process of corn grains

- This starch and gluten slurry is sent to centrifugal separators, which causes the lighter gluten protein to float to the top and the heavier starch to the bottom. The gluten protein is concentrated and dried to form (Corn Gluten Meal, a 60% protein).
- Starch is washed and dried, or modified and dried and marketed to the food, paper and textile industries, or can be processed into sweeteners or ethanol.
- Wet-milling co-products represent about 25 – 30% of the corn processed.
- Corn bran and corn gluten meal were grinded and sifted to obtain fine particles powder of products.

2- Blending of samples: Wheat flour was replaced with corn bran and corn gluten meal at different levels (0, 5, 10, 15 and 20%).

3- Baking properties of blends: were assessed by preparing pan bread.

4- Chemical analysis of raw materials:

- Moisture, crude protein, ether extract, total ash and crude fiber contents of the materials under study were determined according to the methods described in A.O.A.C. (2005). All analysis was carried out in triplicate.
- Total dietary fiber (TDF) content was analyzed by the gravimetric method of the AOAC (2005) (method 43.A14-43.A20) based on digestion of the sample with a heat-stable α-amylase, protease and amyloglucosidase. The results were corrected for undigested protein (Kjeldahl N×6.25) and ash (ignition at 525°c for 8 hr) associated with the fiber.
- Determination of total carbohydrate was calculated by differences.
- Determination of total calories: Total calories were determined as mentioned by Dougherty et al., (1988) according to the following equation:-

  E= 4(%protein +carbohydrates)+9(% fat).

  Where: E=energy as calories per 100 gram of foods.

5 - Rheological properties:

- Farinograph test: Farinograph test was carried out to determine the water absorption arrival time, dough development time, dough stability and dough weakening of the resultant after 12min. according to the method described in AACC (2002).
- Extensograph test: Extensograph test was carried out to determine under curve with planimeter and report in(cm2) extensibility (mm), maximum

resistance to extension (B.U.) and proportional number according to the method described in the AACC (2002).

6 - Preparation of pan bread: Samples were prepared by straight dough method as described in AACC (2002). The control of pan bread recipe was used after replaced the wheat flour with corn bran and corn gluten meal or mix of them at levels 0, 5, 10, 15 and 20%.

7 - Sensory evaluation of pan bread: Types of pan bread were evaluated for their sensory characteristics by ten panelists from the staff of Bread and Pastry, Res. Dept., Food Technology Res. Institute, Agric. Res. Center, Giza.

- The scoring scheme was established as mentioned AACC (2002). as follows:-

Characteristics	Maximum score
o Appearance	20
o Color of crust	15
o Color of crumb	15
o Crumb texture	15
o Flavor	15
o Taste	20
o Over all acceptability	100

- The average of total score was converted to a descriptive category as follows:-

❖ Very good	90 - 100
❖ Good	80 - 89

- ❖ Satisfactory 70 - 79
- ❖ Questionable less than 70

8 - Statistical analysis: Data of the sensory evaluation of cakes were analyzed by the Analysis of variance (ANOVA) and using the statistical package for the social (SPSS, Chicago); $p<0.05$ was considered significant. Specific differences between treatments were determined by LSD test for each attribute. Results were tested for degree of significant level at $p < 0.05$ according the methods of Hills (1966).

RESULTS AND DISCUSSION

1- Proximate chemical composition of materials: Wheat flour 72% ext. and corn by-products i.e. corn bran and corn gluten meal were analyzed for moisture, protein, ether extract, ash, total dietary fiber and total carbohydrates. The obtained results are shown in Table (1).

Table (1): The proximate composition (%) of the raw materials (On dry weight basis).

Samples	Moisture %	On dry weight basis					
		Crude Protein %	Crude lipid %	Total dietary fiber %	Ash %	Total Carbohydrates %	Caloric (k.cal per100)
Wheat flour 72% Ext.	10.84c	11.96b	0.88c	0.70c	0.56c	85.9a	399.36
Corn gluten meal	11.67b	68.44a	6.08a	2.75b	1.58b	21.15c	413.08
Corn fiber	12.04a	9.24c	3.98b	59.61a	4.05a	23.12b	165.26
L.S.D	0.10	0.11	0.09	0.70	0.014	0.95	

Results presented in Table (1) showed that corn bran had the highest ash content (4.05%) followed by corn gluten meal (1.58) and finally wheat flour (0.56%). Concerning protein content, corn gluten meal was the highest

among corn milling by-products in protein content (68.44%). Wheat flour had protein content 10.87%, while corn bran was the lowest (9.24 %). For fat content (ether extract), corn gluten meal contained the highest percentage of ether extract (6.08%). On the other hand, wheat flour had the lowest fat content (0.88%).

Total dietary fiber content of raw materials could be arranged in the following descending order: 59.61, 2.75 and 0.70 percent for corn bran, corn gluten meal and finally wheat flour, respectively.

Carbohydrate content was determined by the difference between 100 and the summation of protein, fat, ash and Total dietary fiber. Data showed that corn bran and corn gluten meal contained the lowest level of carbohydrates (23.12%) and (21.15%), respectively, while wheat flour was the highest (85.9%) These results could be due to the highest content of dietary fiber and protein content of corn byproducts).

The above results are found to be closely near that obtained by (Dowedar, 2001; Abd el Khalek, 2003; Bedeir, 2004; Ibrahim, 2011 and Nasr, 2012) who reported that the composition of wheat flour from 10.93 to 12.5% protein, from 0.39 to 1.13% fat, from 0.61 to 1.16% crud fiber, from 0.47 to 0.56% ash and from 86.08 to 87.20% total carbohydrates.

The results of chemical analysis of corn gluten meal are found to be closely near that obtained by (Younis, 1992; Harstad and Pretlaken, 2001; Shukla and Cheryan,2001; Farag, 2003; Hill, 2004; Erickson, 2006; Davis, 2009 and Nasr, 2012) who reported that the composition of corn gluten meal

from 59.1 to 69.8% protein, from 2.5 to 6.38 % fat, from 1.02 to 3.17% crud fiber, from 1.1 to 3.35% ash and from 20.0 to 36.63% total carbohydrates.

From Minnesota Nutrition Conference, (2001): Corn gluten meal is a high protein concentrate typically supplied at a 60% protein, 2.5% fat and 1% fiber.

Polizotto et al. (1983) reported that corn bran had 5.0% protein, 0.5% fat, 17.7% non fiber carbohydrate, 0.5% ash and 76.3% ENDF (Enzymatic neutral detergent fiber) and 86.4% EIR (Enzymatic Indigestible residue) and 7.7% moisture.

2- Rheological properties of dough produced from wheat flour (72% ext.), corn gluten meal, corn fiber, and mix of them blends.

a) Farinograph parameters: The effect of replacing wheat flour with different levels of corn gluten meal, corn fiber, and mix of them, on mixing dough properties are presented in table (2)

Data present in Table (2) show that the water absorption of the control (wheat flour 72%showed a value of 69.1%, while wheat flour blended with 5n 10, 15 and 20 % corn gluten meal showed values ranged of 62.2 - 65.0%, this gradual decrease may be due to the dilution of wheat gluten protein content in the blends Uthayakumaran et al. (1999) reported that it was known that water absorption capacity of flour varied with both protein content and quality. Whereas the same results indicated that water absorption and arrival time increased due to the increase wheat flour substitution levels with corn fiber or with the mix of (corn gluten meal+ corn fiber). This might be due to the increase in the fiber levels in corn fiber blends and high water absorption of fiber.

Arrival time showed values were ranged from 0.5 to 3.5 min for wheat flour and blendes. Dough development time showed values were ranged from 1.5 to 4.0 min for wheat flour and blendes.

Dough stability increased due to the increase wheat flour substitution levels with corn fiber, while it decreased as wheat flour substitution levels with corn gluten meal or with the mix of (corn gluten meal+ corn fiber). Degree of weakening values were decreased as the levels wheat flour substitution levels with corn fiber were increased, while it increased as wheat flour substitution levels with corn gluten meal or with the mix of (corn gluten meal+ corn fiber). This might be due to increasing of fibrous materials which contribute gluten net development (Nasr, 2012).

Table (2): Farinograph properties of dough produced from wheat flour (WF) 72% ext., blended with corn gluten meal, corn fiber, and mix of them.

Samples		Water absorption %	Arrival time (min)	Dough development (min)	Stability (min)	Degree of softening (B.U)
control		69.1	1.50	3.0	10.0	55
5%	**Corn gluten meal**	65.0	1.50	2.50	6.0	70
10%		63.5	1.50	2.50	5.50	95
15%		62.8	0.50	1.00	6.00	110
20%		62.2	1.50	2.50	6.50	110
5%	**Corn fiber**	71.0	2.00	2.50	10.5	40
10%		76.0	1.00	1.50	11.5	30
15%		75.0	1.00	1.50	12.5	20
20%		81.5	2.00	2.50	13.0	20
5%	**Mix**	69.0	1.5	2.00	7.50	110
10%		72.5	3.50	4.0	6.00	90
15%		76.5	3.50	4.00	8.00	70
20%		79.0	2.50	3.00	9.00	50

b) Extensograph parameters: The effect of replacing wheat flour with different 0, 5, 10, 15 and 20% levels of corn fiber, corn gluten meal and mix of (corn gluten meal+ corn fiber) on the Extensograph parameters are presented in table (3).

Table (3): Extensograph properties of dough produced from wheat flour (WF) 72% ext., blended with corn gluten meal, corn fiber, and mix of them.

Samples		**Elasticity (B.U)**	**Extensibility (mm)**	**P . N**	**Energy (C m2)**
control		685	142	4.82	98
5%	Protein	750	100	7.50	106
10%		650	95	6.84	85
15%		480	130	3.69	74
20%		470	85	5.52	42
5%	Fiber	260	110	2.36	35
10%		190	110	1.74	40
15%		200	140	1.44	33
20%		100	100	1.00	23
5%	Mix	220	150	1.46	61
10%		280	110	3.55	39
15%		130	80	1.62	31
20%		90	120	0.75	24

Extensograph results indicated that dough elasticity (resistance to extension), dough extensibility and energy were decreased with each increment of wheat replacement with corn fiber, corn gluten meal or with mix of (corn gluten meal+ corn fiber). From the results it could be observed that flour replacement was deteriorative to dough properties, which is related to the protein quantity and quality. Proportional number R /E values were

ranged from 0.75 to 7.5, the results are found to be closely near that obtained by (Nasr, 2012)

3- Sensory evaluation: Baking quality and sensory evaluation of pan bread prepared with varying levels of corn fiber, corn gluten meal or with mix of (corn gluten meal+ corn fiber) blends are shown in table (4).

Table (4): Sensory characteristics and physical properties of pan bread produced from wheat flour (WF) 72% ext., blended with corn gluten meal, corn fiber, and mix of them on sensory evaluation of pan bread.

Addition percent		General Appearance 20	Crust color 15	Crumb color 15	Texture 20	Taste 15	Flavor 15	Over all acceptability 100
Control		20.0 a	15.00a	15.00a	20.00a	15.00a	15.00a	100.0a
5%	Corn gluten meal	15.33c	13.33b	12.78b	19.11ab	13.28bc	12.50c	86.33bcd
	Corn fiber	15.06c	13.56b	13.56 b	19.59 a	13.39bc	12.33c	87.49 bc
	Mix of Corn gluten meal and corn fiber	14.57c	13.00b	13.28 b	19.83 a	13.11bc	14.00b	87.79b
10%	Corn gluten meal	14.59c	12.94b	13.27b	16.59cde	12.72bc	12.50b	82.61d
	Corn fiber	16.66b	12.67b	12.56b	15.48e	12.5c	11.84c	81.71e
	Mix of Corn gluten meal and corn fiber	15.45c	13.22 b	13.44b	16.15de	12.67bc	12.17c	83.10de
15%	Corn gluten meal	14.93c	13.33b	12.44b	16.51cde	12.67bc	12.17c	82.05e
	Corn fiber	15.17c	13.00b	12.55b	17.85bc	13.28bc	12.00c	83.85bcde
	Mix of Corn gluten meal and corn fiber	15.14c	12.89b	12.56b	17.33cd	13.89ab	11.84c	83.65cde
20%	Corn gluten meal	14.56c	12.67b	12.5b	15.89de	12.13c	12.06c	79.87e
	Corn fiber	14.68c	12.5b	12.78b	15.71de	13.22c	12.33c	81.22e
	Mix of Corn gluten meal and corn fiber	15.28c	13.06b	12.56b	16.41cde	13.06bc	12.26c	82.63de
L.S.D.		1.02	0.85	1.18	1.65	1.33	0.95	4.11

Dough prepared with 5 and 10% substitution level of corn gluten meal, corn fiber, and mix of them were extremely similar to control in consistency and handling characteristics. The water absorptive properties showed

gradually increase with raising the substitution levels of wheat flour with corn fiber and mix of (corn fiber & corn gluten meal) blends, thus, these dough were much drier and more firm than the control, and therefore, it was more difficult to shape and handle.

Results of sensory quality evaluation show that all organolyptic attributes of pan bread produced from different levels of corn gluten meal, corn fiber, and mix of them wheat flour substitution were significantly affected by these substitution. The overall acceptability was decreased with each increment of wheat flour replacement with corn gluten meal, corn fiber, and mix of them. Devin, et al., (2010) reported that research on the utilization of corn-milling co-products in food products began with the addition of corn bran to breads, cakes and muffins with the aim of increasing the dietary fiber content of widely consumed foods. Unfortunately, this resulted in undesirable changes in product quality: bread containing corn bran at 200 g kg−1 flour showed a 20% reduction in loaf volume, layer cakes containing corn bran at 300 g kg−1 flour showed decreases in most sensory scores, including texture, color and flavor and corn bran at 250 g kg−1 flour in muffins resulted in significant decreases in flavor, mouth feel, texture and overall acceptability compared with muffins containing the same level of wheat bran.

Pan bread prepared with substitution levels 20% of corn gluten meal and corn fiber had the lowest scores of all organolyptic attributes. All samples of pan bread from flour blends were ranged from good to satisfactory. Similar results were obtained by Sharma, et al., (2012), who reported that blending of corn bran, defatted germ and gluten at 5 and 10% with wheat flour resulted in satisfactory bread, cookie, and muffin score.

4- Physical measurements: Pan bread samples were subjected to physical measurements including weight, volume, and specific volume. Measurements of flour substituted pan bread at various levels are shown in table (5).

Table(5): Effect of addition corn gluten meal, corn fiber, and mix of them on physical properties of pan bread

Addition percent		Weight	Volume	Density	Specific volume
Control		108.27	410	0.27	3.79
5%	Corn gluten	111.1	295	0.38	2.66
	Corn fiber	113.0	295	0.38	2.61
	Mix of Corn gluten and corn fiber	110.64	383.75	0.29	3.47
10%	Corn gluten	113.21	318.75	0.36	2.82
	Corn fiber	112	376.25	0.30	3.36
	Mix of Corn gluten and corn fiber	113.06	371.25	0.31	3.29
15%	Corn gluten	114.21	287.5	0.40	2.52
	Corn fiber	112.08	278.75	0.40	2.49
	Mix of Corn gluten and corn fiber	111.04	318.75	0.35	2.87
20%	Corn gluten	113.38	281.25	0.41	2.48
	Corn fiber	111.82	221.25	0.51	1.98
	Mix of protein and fiber	112.65	266.25	0.42	2.37
L.S.D.		0.83	6.29	0.004	0.063

Results indicated that specific volume (which relates with good texture) of wheat flour substituted pan bread samples was lower than that of control sample. A negative relationship could be noticed between flour substitution level and pan bread specific volume. Pan bread specific volume of control

sample was 3.79cm³/gm and ranged from 2.61 to 3.47cm³/gm, from 2.82 to 3.36cm³/gm, from 2.49 to 2.87cm³/gm, and from 1.98 to 2.48cm³/gm for pan bread samples containing wheat flour replacement at levels 5, 10, 15 and 20% of corn byproducts (corn gluten meal, corn fiber, and mix of them), respectively. Similar results were obtained by Devin, et al., (2010) reported that bread containing corn bran at 200 g kg−1 flour showed a 20% reduction in loaf volume.

5- Chemical composition: The chemical composition of pan bread produced from wheat flour and blends of wheat flour with replacement at levels 5, 10, 15 and 20% of corn byproducts (corn gluten meal, corn fiber, and mix of them),are presented in table (6) and figures (1and 2)

Table (6): Chemical composition of pan bread produced by substituted wheat flour 72%ex. (WF) with 5, 10, 15 or 20 % corn gluten meal, corn fiber, and mix of them.

Samples		Energy cal./100gm On dry weight basis	Moisture %	As a dry basis				
				Protein %	Fat %	Total dietary fiber %	Ash %	Total carbohydrate %
Control		395.66	30.53	11.13	2.70	2.79	1.67	81.71
95% WF + 5% corn gluten meal	5%	396.68	30.62	13.41	2.92	2.76	1.72	79.19
% change from control		0.26	0.29	20.50	8.15	-1.10	2.99	-3.08
95% WF + 5% corn fiber		386.59	31.34	10.99	2.83	5.07	1.82	79.29
% change from control		-2.29	2.65	-1.26	4.81	81.72	8.98	-2.96
95% WF + 5% mix of gluten & fiber		391.64	31.00	12.2	2.88	3.92	1.77	79.23
% change from control		-1.02	1.54	9.61	6.70	40.50	5.99	-3.04
90% WF + 10% corn gluten	10%	397.85	31.40	15.70	3.14	2.72	1.76	76.68
% change from control		0.55	2.85	41.10	16.30	-2.51	5.39	-6.16
90% WF + 10% corn fiber		377.65	32.17	10.85	2.97	7.34	1.96	76.88
% change from control		-4.55	5.37	-2.52	10.0	163.1	17.37	-5.91
90% WF + 10% mix of gluten &fiber		387.69	31.80	13.28	3.05	5.03	1.86	76.78
% change from control		-2.01	4.16	19.32	12.96	80.30	11.38	-6.03

ConTable (6):

Samples		Energy cal./100gm On dry weight basis	Moisture %	As a dry basis				
				Protein %	Fat %	Total dietary fiber %	Ash %	Total carbohydrate %
85% WF + 15% corn gluten	15%	398.83	31.40	17.98	3.35	2.69	1.79	74.19
% change from control		0.80	2.85	61.55	24.10	-3.58	7.20	-9.20
85% WF + 15% corn fiber		368.61	33.10	10.71	3.09	9.62	2.09	74.49
% change from control		-6.84	8.42	-3.77	14.44	244.8	25.15	-8.84
85% WF + 15% mix of gluten &fiber		383.75	32.30	14.34	3.23	6.15	1.95	74.33
% change from control		-3.00	5.80	28.84	19.63	120.43	16.77	-9.03
80% WF + 20% corn gluten	20%	399.81	32.04	20.25	3.57	2.67	1.84	71.67
% change from control		1.05	4.95	81.94	32.22	-4.30	10.18	-12.30
80% WF + 20% corn fiber		359.67	33.28	10.57	3.23	11.88	2.24	72.08
% change from control		-9.10	9.00	-5.03	19.63	325.81	34.13	-11.79
80% WF + 20% mix of gluten &fiber		379.72	33.00	15.42	3.40	7.28	2.04	71.86
% change from control		-4.03	8.09	38.54	25.93	160.93	22.16	-12.10

From the previous results in Table (6) and figures (1) and (2) it could be concluded that the chemical composition and caloric values of pan bread produced from substitute wheat flour with 5, 10, 15 and 20% corn gluten meal, corn fiber, and mix of them blends are differed from control by differ flour substitution level.

Results showed that protein content of pan bread was increased from 11.13% for control sample to 13.41, 15.70, 17.98 and 20.25 % for pan bread

with 5, 10, 15 and 20% corn gluten meal, respectively and to 12.12, 13.28, 14.34 and 15.42% for pan bread with mix of (corn gluten meal+ corn fiber) at replacement levels 5, 10, 15 and 20%, respectively. Whereas, the protein content of pan bread was decreased for 10.99, 10.85, 10.71 and 10.57% for pan bread with corn fiber at replacement levels 5, 10, 15 and 20%, respectively.

Protein content increment (compared to control) percentage ranged from 20.5 to 81.9% for corn gluten meal and from 9.61 to 38.54% for mix of (corn gluten meal+ corn fiber) at replacement levels ranged from 5 to 20%, respectively. While protein content percentage decreased (compared to control) from -1.26 to -5.03% for pan bread with replacement levels ranged from 5 - 20% corn fiber.

From the same results it could be noticed that fat contents of pan bread (compared to control sample) increased from 8.15 to 32.22% for corn gluten meal, from 4.81 to 19.63% for con fiber and from 6.7 to 25.93% for mix of (corn gluten meal+ corn fiber) at replacement levels ranged from 5 to 20%, respectively.

The increment in total dietary fiber contents (compared to control) percentage ranged from 81.72 to 325.81% for corn fiber and from 40.5 to 160.93% at replacement levels ranged from 5 to 20%, respectively.

Ash contents increased (compared to control) by percentage ranged from 2.99 to 34.13% by differ the types and levels of replacement.

It could be noticed that protein, fat, total dietary fiber and ash contents of pan bread increased by increasing the level of replacement of wheat flour

with mix of (corn gluten meal+ corn fiber), this mainly due to high content of these components in the replacing ingredients.

From the same results it could be noticed that total protein content increased by about 1.2 to 1.82 times like control, by replacing wheat flour with 5 to 20% corn gluten meal, whereas, total dietary fiber increased by about 1.82 to 4.26 times like control by replacing wheat flour with 5 to 20% corn fiber. Similar results were obtained by Sharma, *et al*., (2012), who reported that blending of wheat flour and corn byproducts significantly increased the protein, crude fiber, phosphorus, iron and calcium contents.

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تأثير الاستبدال الجزئى لدقيق القمح ببعض المنتجات الثانوية لطحن الذرة على جودة الخبز القوالب

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المستخلص

تهدف هذه الدراسة الى أنتاج خبز (دقيق أستخلاص ٧٢%) مدعم ببعض المنتجات الثانوية مثل جلوتين الذرة وقشرة الذرة الناتجة من الطحن الرطب للاذرة الصفراء فى صناعة النشا والجلوكوز.

وقد استخدمت المنتجات الثانوية بنسب احلال ٥%، ١٠%، ١٥%، ٢٠% مع دقيق القمح من كل من جلوتين الذرة والياف الذرة وخليط من الجلوتين والالياف على التوالى ودراسة مدى تأثيرها على الخواص الفيزوكيماوية (البروتين – الالياف الغذائية – الدهون – الرماد – الكربوهيدرات الكلية). ايضا تأثير الاستبدال بنفس النسب على خواص الخبز

وقد أظهرت النتائج أن إضافة جلوتين الذرة وخليط من جلوتين وألياف الذرة أدى الى زيادة ملحوظة فى البروتين والألياف الغذائية والدهون والرماد فى عينات الخبز بينما إضافة الياف الذرة أدت الى زيادة الالياف الغذائية والدهن والرماد وانخفاض الكربوهيدرات والطاقة لعينات الخبز.

بينما الخبز الناتج من خلط جلوتين وألياف الذرة معا تتميز بزيادة حجم الرغيف مقارنة بالخبز الناتج من جلوتين الذرة وألياف الذرة منفردين.

الكلمات المفتاحية: قشرة الذرة – جلوتين الذرة – دقيق القمح – الطحن الرطب للذرة