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Physicochemical, Sensory and Functional Properties of Gelatinized Corn - Triticale Flour Composite Tortilla

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Abstract: This study was focused on substituting a part of gelatinized corn flour (GCF) with Triticale flour (TF) and both of them in Tortilla bread, as an attempt to solve the problem shortage in wheat production. Chemical, rheological, Diffraction Scanning Colorimeter (DSC**),** Starch crystalline**,** functional compounds of GCF, TF and their mixtures by FT-IR, color parameters, stalling, baking quality and sensory properties of Tortilla bread were evaluated. The incorporation of TF and GCF into Tortilla bread improved protein, fat, fiber, ash, total carbohydrate and minerals (Mg, Ca, P, K, Na, Cu and Fe). Blending TF with GCF gave lower rheological parameters, and lightness of bread was reduced. Sensory properties of aroma, rollability, firmness and dryness were not significantly affected, but a significant difference was observed in taste, color and overall acceptability at different replacement levels. The results also, showed that amide I fragments were assigned to absorption bands in the region of 1642-1653 cm^{-1} and bands of carboxyl group of protein were exhibited at the region of 3407-3426 cm^{-1}. Triticale and corn flour were characterized with specific fingerprints at 1242 cm^{-1} (N-H in plane, C=N stretching), 1016-1020 cm^{-1}(C-C stretching of carbohydrate) and 849-861 cm^{-1} (C-C stretching of pyranose ring, C-O-H and O-C-H deformation) and C=O stretching of ester at 1742-1743 cm^{-1} , respectively. Generally, TF supplementation with GCF (50:50%) not significantly affected the technological quality of Tortilla bread and improved its nutritional values.

Key words: Triticale flour**,** Gelatinized corn flour**,** Tortilla bread**,** Chemical, Rheological, Diffraction Scanning Colorimeter, Baking quality**,** stalling and Sensory properties

INTRODUCTION

Corn is considered as one of the principle crops in Egypt and its production is increasing steadily; however, the majority of the crop is directed for animal and poultry feeding, in spite of the shortage in the cereal-based foodstuffs. Therefore, it would be beneficial to introduce new manufactured corn products to the Egyptian food market such as Tortillas. Corn tortillas are a fundamental food for Mesoamerican countries, being highly consumed in Central America and in countries where tortilla chips, taco shells and snacks are demanded as well. In Mexico, there is currently a consumption of 800 million tortillas per day (Ayala-Rodríguez *et al.*, 2009) which is equivalent to approximately 8 units of 33 g each, providing about 70% of the calories and 50% of the protein consumed daily (Flores-Farías *et al*., 2000). Additionally seven billion pounds of corn and wheat tortillas (almost one tortilla per person each day) has been reported as an average consumption in United States (Pascut, Kelekci, & Waniska, 2004). Since ancient times, tortillas have been manufactured from the so called "nixtamalized corn dough" which is traditionally prepared through a process consisting in cooking the corn in a boiling lime solution and steeping it overnight, but this activity is gradually being replaced by the use of nixtamalized corn flour. Indeed, it is estimated that 60% of the daily production of tortillas is elaborated through this process (Ayala-Rodríguez *et al*., 2009).

In the last decade the volatility of corn prices, consequence of a continuous increase in biofuels production as well as oil price rise and speculation (Ajanovic, 2010), has caused the increase in the production costs of nixtamalized corn flour. An alternative for the nixtamalized corn flour industry that could solve this problem would be to use other cereals expressing functional properties similar to those of the corn used to make tortillas.

Triticale (*triticosecale wittmack*) is the first man-made cereal produced by crossing wheat (*Triticum spp*.) and rye (*Secale cereal L*.). The future of this crop is bright because it is environmentally more flexible than other cereals and shows better tolerance to diseases, drought, and pests than its parental species (Darvey *et al*., 2000). Triticale world production has steadily increased during the past 20 years. Global production in 1980, 1990 and 2000 was estimated in 1.29, 5.44 and 9.6 million metric tons, respectively. Interestingly, average yield improved from 1980 to 2000 from 2.02 to 3.5 tons/ha. In 2002, 3 million hectares were harvested, yielding a

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total production of 10.3 million metric tons (FAO, 2003). According to Serna-Saldivar *et al*. (2004), the price of triticale is lower than that of wheat.

From the nutritional point of view, triticale has valuable dietary characteristics such as higher amounts of soluble dietary fiber and better total amino acid composition, in particular higher lysine as compared to wheat (Morey & Evans, 1983; Varughese *et al.,* 1996). Triticale has been reported to contain 10.2-13.5, 53.0-63.0, 2.3-3.0, 1.1-1.9, 4.3-7.6 and 1.8-2.9%, protein, starch, crude fiber, ether extract, sugars and ash, respectively (Heger & Eggum, 1991).

Triticale's properties for milling and baking, the two main uses of its parent species, have been examined widely. Some studies have shown that triticale flours produce weak dough due to its low gluten content, weak gluten strength and high levels of alpha-amylase activity (Amaya and Peña, 1991; Macri, Balance, & Larter, 1986). Potential of triticale as a substitute in wheat tortilla production has been reported by Serna-Saldivar, Guajardo-Flores, and Viesca-Rios (2004). Triticale could be acceptable as a partial substitute of corn for making tortillas, because gluten protein related factors, which are deficient in triticale, are not critical for the development of tortilla characteristics. In that sense, the aim of this research was to evaluate the effect of triticale flour as a partial substitute for commercial nixtamalized corn flour on chemical, rheological, functional properties of dough and tortillas.

MATERIALS AND METHODS

I-Materials:

White corn (Pioneer 30 K8) was purchased from the Corn Breeding Section, Field Crops Department, Agric. Res. Center, Giza, Egypt.

Triticale (Saudi Strains triticale) was kindly provided by Dr. Ali Alderfasi, Plant Production Department, College of Food and Agricultural Sciences, King Saud University

Preparation of Gelatinized Corn Flour (GCF):

Laboratory process for preparing dry corn masa according to Vidal-Quintanar *et al*. (2001) with some modification as follows: The whole white corn grains (1kg) were soaked in 1% calcium hydroxide solution (1:3 w/w ratio) and then cooked for 95 min on an electronic stove adjusted to 95º C by the traditional cooking method (**Fig.1**). The nixtamal was steeped over night (15 h) at 24±1º C; Washing followed with excess (5L) tap water followed by decantation using a sieve. The washing process was repeated three times. The wet masa was spread on aluminum foil in a layer of 2.5 cm thickness and. dried in convection oven adjusted to 85 º C for about 6 h, with occasional mixing. The dry masa was electrically ground (Brabender mill (Junior) to pass a 60 mesh screen (0.0028 in sieve opening), and a minimum of 0.102±.0.06 cm of free space between the shaft and the stationary body of the mill. The masa prepared from grains were packed in Polyethylene bags from the Technopack Co., Cairo, Egypt, and the bags were stored in a refrigerator (4°C) until used.

Preparation of Triticale Flour (TF):

Triticale grains were cleaned, tempered to 15% moisture content, milled using Quadrumat Junior flour mill and sieved to obtain 62% extraction flour.

Preparation of Flour Blends:

GCF was well blended with TF to produce individual mixtures containing 10, 20, 30, 40 and 50% replacement levels. All samples were stored in airtight containers and kept at 5-7ºC until required.

Chemical Analysis:

Gross Chemical Composition:

GCF, TF and products were analyzed for moisture, crude protein (% N×6.25), ether extract, total ash and crude fiber according to methods described in A.O.A.C. (2000). Total carbohydrates were calculated by the difference (100-(fat+ protein+ ash+ fibers) on dry weight basis.

Minerals Content:

Magnesium, calcium, potassium, sodium, copper, iron and phosphorus in all raw materials were determined according to A.OA.C. (2000).

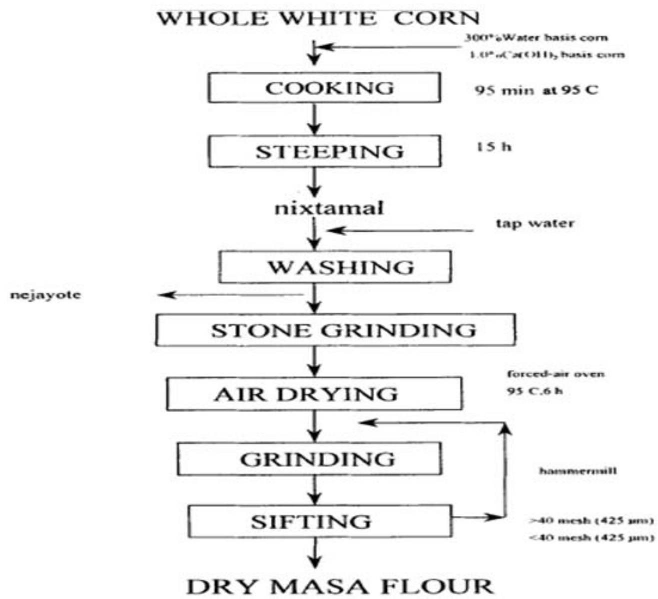


Fig. 1: Method for preparing lab made corn masa flours.

Rheological Properties:

Rheological properties of dough were evaluated using an amylograph (Brabender amylograph ; Duisburg Nr. 940053, type 680022) as described in (A.A.C.C., 2000). Falling number test was carried out according to AACC method No. 56-81B (2000).

Diffraction Scanning Colorimeter:

Thermal properties of gelatinized corn flour, tritical and their mixtures flour were measured by using a shimadzuDSC-50. The heating rate was 10ºC/min and the hold temperature was at 200ºC. The melting temperature TM and (ΔH) of the enthalpy was determined from the thermo grams.

Starch Crystallinity:

The crystallinity of starch was evaluated by X-ray diffraction patterns of samples using monochromatic Cuk radiation on a Philips X-ray diffract meter at 35 kv and 15mA (Central Lab, National Research Centre, Egypt). Lyophilized samples were placed on the l cm2 surface of a glass slide and equilibrated overnight at 91% rh and run at 2-32° (diffraction angle 2θ). The spacing was computed according to Bragg's law (Gomez *et al*., 1992)**.**

FT-IR:

All spectra of the selected samples were measured using FT-IR system model FT-IR-6100 Jasco, Japan (Central Lab, National Research Centre, Egypt). All spectral data were recorded from 400 to 4000 nm.

Preparation and Evaluation of Tortilla Bread:

Tortillas were prepared by mixing 100 g of different levels of GCF and triticale flour with water, until an adequate consistency for producing tortillas was achieved. The fresh dough was rounded and shaped into tortilla. The tortilla dough was baked at 400-500ºC for 1-2 min. The loaves of bread were allowed to cool on racks for about 1 h before evaluation. Tortilla bread loaves were evaluated organoleptically by 15 trained panelists according to Salem *et al* (1999). The tested characteristics were Taste (20), Aroma (20), Color (20), Rollability (10), Firmness (10), Dryness (10) and overall acceptability (10).

Freshness of Bread:

Tortilla bread loaves freshness was tested after wrapping using polyethylene bags and storage at room temperature (1, 3 and 5 days) using Alkaline Water Retention Capacity test (AWRC) according to the method of Yamazaki [1953], as modified by Kitterman & Rubenthaler [1971].

Color :

Color of different samples was measured by using a Spectro Colorimeter (Tristimulus Color Machine) with CIF lab color scale (Hunter, Lab Scan XE, Germany).

RESULTS AND DISCUSSION

1. Chemical Composition of Raw Materials and Their Mixtures:

Data presented in Table (1) showed the gross chemical composition of GCF, TF, and their blends. There were no significant differences in moisture between GCF, TF, and their blends. Gelatinized corn flour gave the lowest protein value than TF and their blends. The lowest fat value was found in TF compared with GCF and their blends. Gelatinized corn flour was characterized with its highest crude fiber and β-glucan content (4.0 and 2.5 %, respectively). These values agreed with those reported by Hussein & Hegazy (2007) and Yassen *et al* (2007).

Table 1: Gross chemical compositions of raw materials and their mixtures (dry weight basis).

Constituents (%)	GCF	TF	GCF: TF 90:10	GCF: TF 80:20	GCF: TF 70:30	GCF: TF 60:40	GCF: TF 50:50
Moisture	9.1±0.01	10.30±0.31	9.40±0.08	9.66±0.05	9.82±0.22	10.0±0.11	10.12±0.21
Protein	10.62±0.11	13.90±0.16	11.02±0.09	11.56±0.18	12.00±0.31	12.50±0.17	13.06±0.21
Fat	4.00±0.22	1.33±0.01	3.72±0.11	3.33±0.06	3.13±0.11	3.02±0.07	2.76±0.01
Crude fiber	4.00±0.06	0.26±0.00	3.82±0.03	3.50±0.22	3.00±0.05	2.50±0.03	2.12±0.06
Ash	2.50±0.03	0.74±0.02	2.25±0.07	2.01±0.04	1.79±0.03	1.55±0.01	1.35±0.00
Carbohydrates	78.88±0.88	83.77±0.71	79.19±0.56	79.60±0.71	80.8±0.52	80.43±0.66	80.71±0.95

Data are average of triplicate analysis.

2. Minerals Content of Raw Materials and Their Mixtures:

Minerals content of the tested flours were also evaluated and presented in Table (2). Results indicated that TF was characterized with its highest phosphorus, potassium and iron (304, 256 and 4.14 mg/100gm, respectively), while GCF characterized with its highest value in calcium, copper and magnesium (141, 0.93 and 120 mg/100gm, respectively). The obtained results agreed with those reported by Hussein and Hegazy (2007), and Al-Mussali & Al-Gahri (2009).

Table 2: Minerals content of raw materials and their mixtures.

Minerals (mg/100g)	GCF	TF	GCF: TF 90:10	GCF: TF 80:20	GCF: TF 70:30	GCF: TF 60:40	GCF: TF 50:50
Magnesium	120.00± 0.41	106±0.23	119±0.13	116±0.11	114±0.16	112±0.24	110±0.32
Calcium	141.00± 0.19	44.00± 0.22	130±0.43	121±0.55	112±0.22	100±0.13	92±0.23
Potassium	160.0± 0.32	256.0± 0.29	169±0.33	180±0.46	191±0.52	201±0.65	210±0.82
Iron	3..50± 0.03	4.14± 0.01	3.6±0.05	3.69±0.06	3.76±0.04	3.86±0.07	4.0±0.09
Copper	0.93± 0.05	0.45±0.01	0.90±0.02	0. 83±0.00	0.76±0.06	0.70±0.01	0.62±0.03
Sodium	742.00± 0.22	630.18±0.13	732±0.15	7.23±0.18	712±0.22	700±0.33	692±0.26
Phosphorus	230.00± 0.19	304.65± 0.11	236±0.13	245±0.11	250±0.16	256±0.17	265±0.19

3. Pasting Properties of Dough:

The obtained data (table, 3) showed that, the replacement GCF with TF at 10, 20, 30, 40 and 50% tend to reduce temperature of transition from 72.5 to 69.5, 68, 66, 64.5 and 62°C respectively. Data in Table (3) indicated also that the presence of TF flour decreased the GCF viscosity, i.e. from 1420 to 520, 350, 190, and 120 BU for 10, 20, 30, 40 and 50% TF added. On the contrary, the viscosity at 50 ^{o}C was higher in corn flour that supplemented with TF. The breakdown and setback viscosity of this formula were also markedly low. All parameters of viscosity were decreased in formula. All corn samples supplemented with TF at different levels decreased in viscosity during cooling. The major factor in starch gelatinization in granule is swelling which depends on the strength and character of micellar net work within the granule, which in turn is dependent on the degree and kind of association (Bhattachary and Hanna, 1987) which greatly differs between starch types rather than in individual granules of each starch species. Therefore, it could be noticed that the gelatinization level varied according to the type of starch. The viscosity values of two starch types cooked in 1% lime. The viscosity values of two starch types cooked in 1% lime solution, no relationship could be established between viscosity of starch gelatinized in water and those gelatinized in the presence of lime. It seems that the presence of lime affected both viscosity peak profile and viscosity value.

Regarding the falling number, GCF had a higher falling number (450 s) than TF (170 s), indicating lower amylase activity (Table 3), consequently, addition of TF to GCF increased the amylolytic activity of the produced dough. Leon *et al.* (1996) reported falling number values of 62-134 s for 10 different TF. Low values of falling numbers compared with rye characteristics imply a high α-amylase activity (Darvey *et al.,* 2000; Serna-Saldiver *et al.,* 2004).

Table 3: Viscoamylograph parameters and Falling number of dough prepared from different formulas

Samples	Temp.of transition (°C)	Max. of Viscosity (BU)	Temp. of max. viscosity	Break down viscosity (BU)	Setback Viscosity (BU)	Falling No. (Sec)
GCF	72.5	1420	95	1400	4660	450
TF	54.5	210	65	40	100	170
GCF: TF 90:10	69.5	520	95	540	1400	420
GCF: TF 80:20	68	350	95	380	880	380
GCF: TF 70:30	66	190	87.5	200	640	350
GCF: TF 60:40	64.5	120	86	140	450	320
GCF: TF 50:50	62.0	120	85	120	440	300

4. Thermal Properties of GCF, TF and Their Blends Flour:

Fig (2), illustrated the differential scanning colorimeter (DSC) of GCF, TF and their blends. The overall gelatinization temperature of the flour samples were 78.82, 77.24, 75.25, 73.95 and 171.24 j/g in GCF, TF, their blends (GCF: TF 90:10), (GCF: TF 80:20), (GCF: TF 70:30), (GCF: TF 60:40) and (GCF: TF 50:50) samples, respectively. Lowest Δ H enthalpy was found in tritical, which may be due to the enthalpy of amylase-lipid complex formation during heating. Champagne *et al.* (1990) and Hussein *et al*.(2006) reported that starch gelatinization is affecting by the degree of milling and the percentage of non-starch lipids presented in rice sample. The crystallites with the amylopectin molecule and molecular weight and shape of the whole amylopectin molecule determine the onset of swelling and gelatinization (Tester and Morris, 1990). The differences in transition temperatures between the starches of the flour used may be attributed to difference in their degree of crystallinity which provides structure stability and make the granules more resistance to gelatinization. Also DSC parameters are also influenced by the molecular structure of the crystalline region which corresponds to the distribution of amylopectin short chain and not by the propagation of the crystalline region which corresponds to the amylase (Siau *et al*., 2004).

5. Effect of Tortilla Production on Starch Crystallinity:

Changes of organized crystalline raw starch granules during tortilla preparation by adding of different levels of TF could be demonstrated by x-ray –technique**.** Starch granules are known to vary in their proportion of amylose and amylopectin, crystallite type (Zobel, 1988) and extent of amylopectin branching (De Boer, 1991). So X-ray diffraction patterns of such granules are subsequently varied. According to X-ray diffraction data, the structure of starch can be grouped into four types; A, B, C and V (Zobel, 1988). Figs (3) show the diffractograms of analyzed samples and their

X – Ray Diffractograms of GCF, Tritical and their Blends:

Respective crystallinity value. X–ray diffraction trace of the raw GCF (fig. 3) shows sharp diffraction peaks around 2θ value of 74.49, 28.36 and 58.91%, corresponding to d-spacing of about 5.9, 4.5 and 3.9 A, respectively. This pattern closely matches reported values of A-type cereal starches (Zobel, 1988). However, additional peak was observed at 2θ value of 17.5˚A (5.8 A d-spacing value). The diffractogram of TF (fig. 3) shows similar peaks with some shifting where these peaks appeared at 2θ value of 42, 38 and 56.80%, indicating a d-spacing value of 5.9, 5.01 and 3.8˚A , respectively. Also, another peaks were observed at 2 θ value of about 55.96, 28.47 and 58.60 ˚A. Concerning blend1(90%GCF:10% Tritical flour) (fig. 3), the main peaks of A-type starches were observed with some shifts as well as additional peaks were recorded at d-spacing value of 5.9, 5.2 and 3.8 A. The diffractogram of (fig 3) revealed that structure of native starch granule is partially disrupted, where a less organized x-ray pattern is observed along with a development of diffractogram peak at about 2.9˚A (35˚A d-spacing value). This peak is the distinguishing feature of v-type starch (Arambula *el al*., 1998). Blends2 to blends5 displayed another amorphous X-ray pattern (Serna-Saldivar *et al*., 1990) with a peak around 5.9˚A to 2.6˚A. Accordingly, the material is no longer a rigid but rather exhibits the properties of a liquid **(**Chakravent & Kaleemulla, 1991). Sorghum tortilla chips displayed another amorphous X-ray pattern (Serna-Saldivar *et al .,* 1990) with a peak around 4.5˚A. The location of this peak was slightly displaced from the strong 4.4˚A peak characteristic of the v-type amylose-lipuid complex pattern (Gomez *et al.,* 1992).

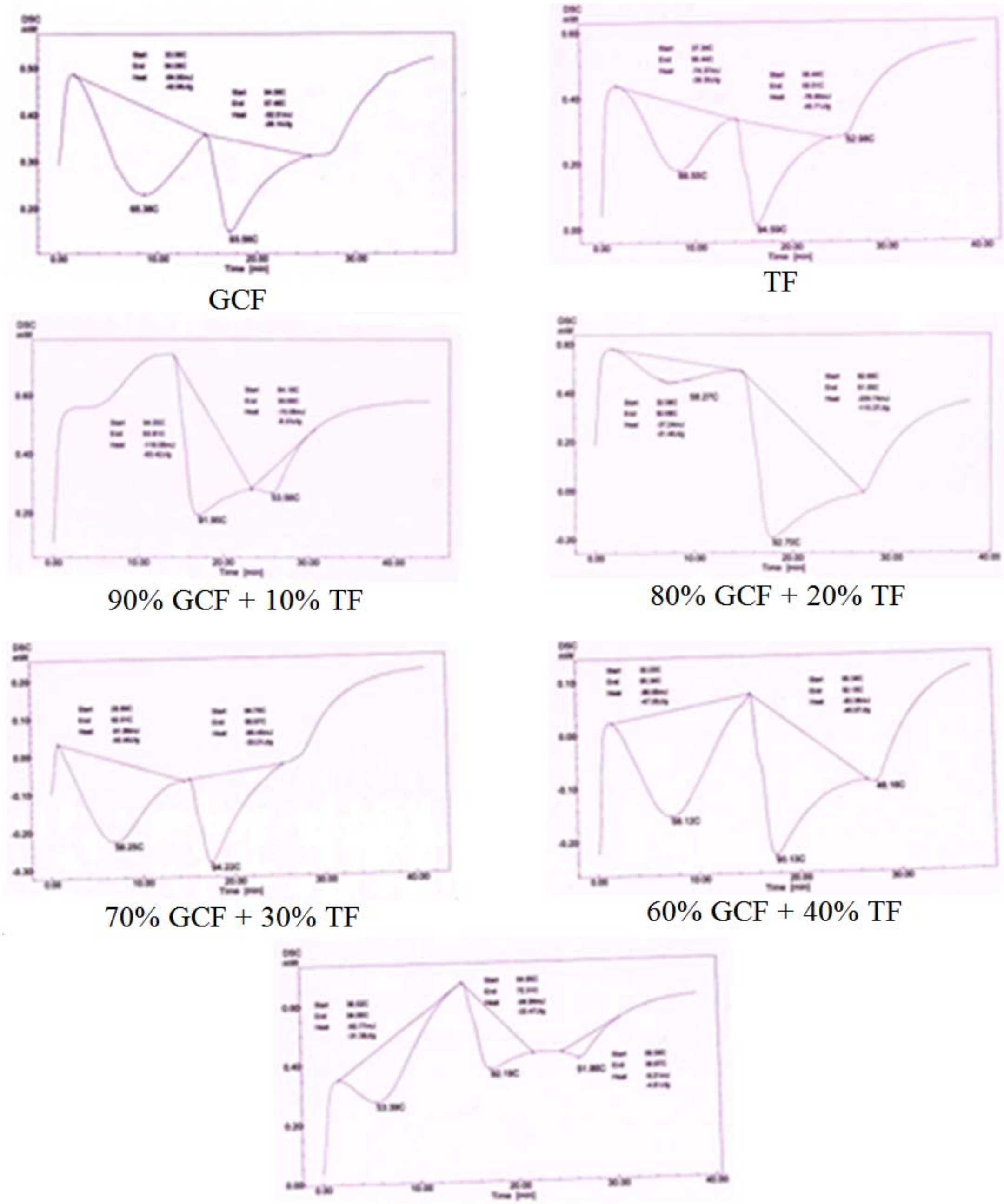
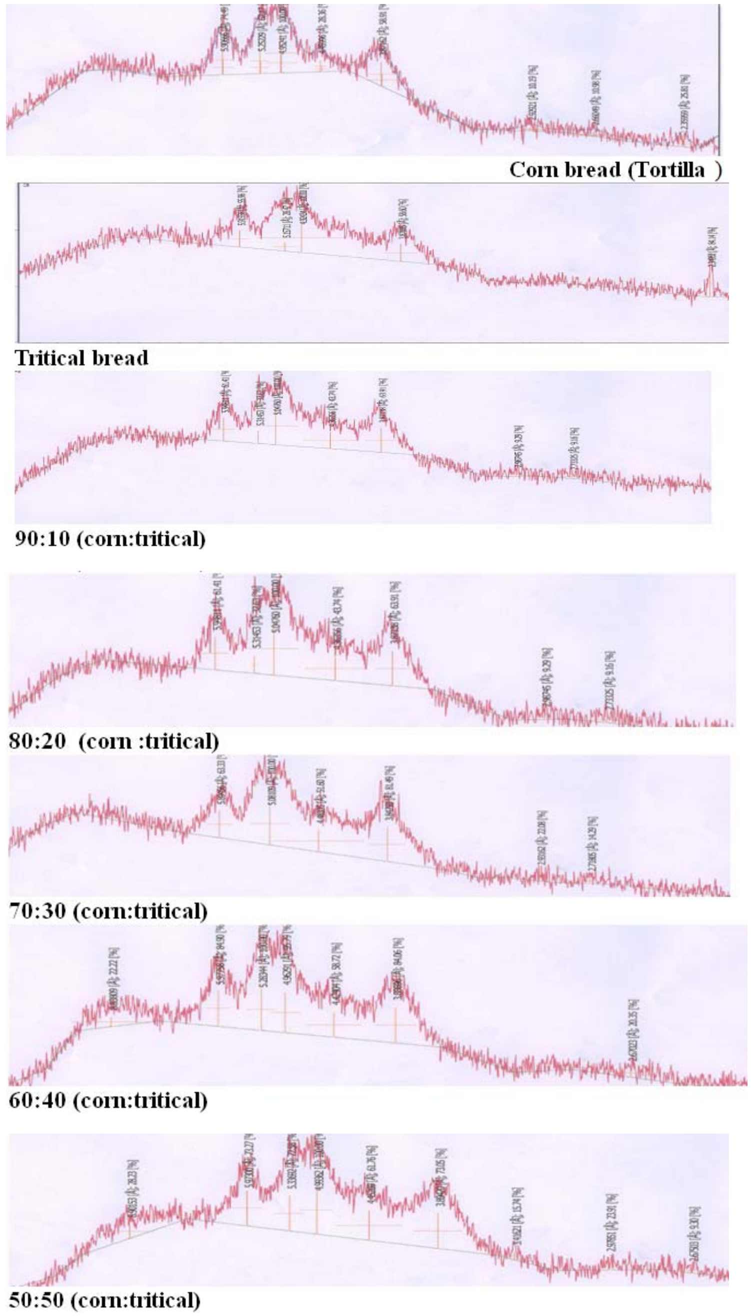


Fig. 2: DSC of GCF, TF and their blends.

6-Identification of Functional Compounds of GCF, TF and their Blending Samples by using FT-IR Technique:

Spectra of FT-IR region have well resolved bands that can be assigned to functional groups of the components of food. The spectra of corn, triticale flour and their blending samples observed between 3700-600 cm^{-1} show three zones: 3426-2857 cm^{-1}, 1742-1379 cm^{-1} and 12451-861 cm^{-1}. In the first region, broad band at 3408-3426 cm^{-1} assigned to N-H and O-H vibration, 2925-2929 cm^{-1} was attributed to C-H stretching asymmetric vibration and 2855-2857 cm^{-1} for C-H stretching symmetric vibration. Dalgleish and Hunt (1995) stated that hydrogen bonds are formed between dipolar groups (acid and amide groups) in the protein and involved the sharing of a hydrogen atom between two such groups. Maltais *et al*. (2008) noted soya protein isolate component located at 1636 cm-1 is attributed to β-sheet structures, while the peak located at 1651 cm-1 is assigned to α-helical portions and can also be generated by protein unordered structure.



2^o Bragg Angle (Theta) 32^o

Fig. 3: x-ray diffractograms of GCF,TF and their blends.

Furthermore, functional compounds of amide primary in protein isolates matrix was supported by Jackson and Mantsch (1992) that amide primary is the major protein absorption band located at 1650 cm-1, and occurs predominantly from the C=O stretching vibration of the protein amide groups. Spectral bands of C=O stretching vibration of ester (1742-1743 cm^{-1}), amide I: C=O stretching, N-H wagging (1642-1653 cm^{-1}), amide II: C-N stretching with N-H bending (1540-1546 cm^{-1}) and δ-C-H_2- vibration of carbohydrates at (1375-1379 cm^{-1}) were identified in the second region (Bhattacharjee *et al*., 2005 and Fabian & Schultz, 2000)**.** the third region corresponds to the spectral region of carbohydrate content in corn, triticale flour and their blending samples, particularly carbohydrates show intense and characteristic bands in the region between (1251-861 cm^{-1})are assigned to N-H in-plane bend, C-N stretching, C-O-C stretching of starch, C-C stretching vibration, C-C stretching of starch, stretching C-O ring and pyranose ring and C-O-H, C-C-H, O-C-H deformation and these results in agreement with (Naumann, 2001). Corn flour was characterized with specific fingerprints at (3425 cm^{-1}, 1742 cm^{-1} and 1084 cm^{-1} which appear in blending samples with triticale with different concentration (10-50% with triticale). A molecular structure of corn flour is well known by the presence of hydroxyl (-OH) groups and attributed to broad bands located at 3425 cm^{-1} (Table x and Figure x). This data was strongly confirmed by Zhang *et al*., (2001) that corn flour spectra are dominated by a broad band assigned to the stretching vibration modes of -OH groups and water at about 3396 cm^{-1}. This hydroxyl groups were laid on characteristically by methyl groups located at 2925-2926 cm^{-1} which is attributed to –CH stretching vibration (Table x). Xiao *et al*. (1999) confirmed the stretching peaks of –CH of methyl at 2920 cm-1. Table (4) shows triticale flour was characterized with characteristic spectral bands at 1242 cm^{-1} 1018 cm^{-1} and 858 cm^{-1} and also found in blending samples only. A molecular structure of corn flour is well known by the presence of hydroxyl (-OH) groups and attributed to broad bands located at 3425 cm^{-1} (Table 4 and Figure 4). This data was strongly confirmed by Zhang *et al*., (2001) that corn flour spectra are dominated by a broad band assigned to the stretching vibration modes of -OH groups and water at about 3396 cm^{-1}. This hydroxyl groups were laid on characteristically by methyl groups located at 2925-2926 cm^{-1} which is attributed to –CH stretching vibration (Table 4). Xiao *et al*. (1999) confirmed the stretching peaks of –CH of methyl at 2920 cm-1

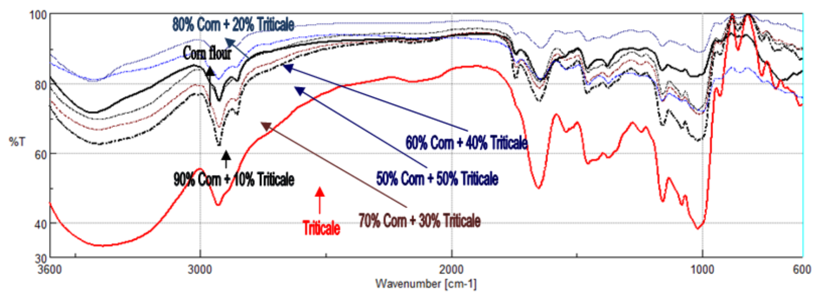


Fig. 4: FTIR spectra of GCF, TF and their blends.

Table 4: FT-IR assignments and absorption regions of corn fortified with triticale flour.

GCF	TF	GCF:TF 90 :10	GCF:TF 80 :20	GCF:TF 70:30	GCF:TF 60:40	GCF:TF 50 :50	Peak assignment
3425		3408	3426	3407	3420	3416	Broad band, resulting from vibration of N-H with O-H group
2925	2929	2926	2926	2926	2926	2926	C-H stretching vibration asymmetric
2855		2856	2857	2857	2857	2856	C-H stretching vibration symmetric
1742		1743	1742	1743	1742	1742	C=O stretching vibration of ester
1642	1653	1651	1643	1650	1647	1650	Amide I (C=O stretch, N-H wag)
1542	1540	1540	1544	1544	1541	1546	Amide II (C-N stretching with N-H bending)
1458	1455	1458	1457	1457	1456	1456	C-H bending vibration
1379	1375	1375	1376	1375	1375	1376	δ(-C-H_2 -) of carbohydrates
	1242	1243	1251	1246	1247	1243	N-H in-plane bend, C-N stretch
1159	1158	1159	1159	1159	1159	1159	C-O-C stretching of starch
1084		1080	1082	1082	1082	1081	C-C stretching vibration
	1018	1020	1017	1016	1017	1019	C-C stretching of starch
930	930	929	930	930	931	930	Stretching C-O ring
	858	861	860	857	849	859	(C6-C5-O5-C1-O1) ring and C-O-H, C-C-H, O-C-H deformation

7. Color Attributes of Raw Materials and Tortilla Bread as Affected by Adding Tritical Flour:

The color parameters of raw materials and tortilla bread samples were evaluated as shown in Table (5). Tortilla bread of blended mixed GCF and with TF was darker than tortilla bread of control sample, where lightness (L^*) and redness values (b^*) decreased as the level of TF increased. The same trend was observed in case of yellowness (a^*) and the total color difference (ΔE) of tortilla bread samples, where their values were getting higher as TF level was increased. This result could be attributed to the darkness of TF (lower L^*) than

GCF, so, darkness increased as a result of the presence of TF in Tortilla bread. Such findings are in-agreement with Kim *et al*. (1997), Kordonowy &Young (1985) and Ramy *et al*. (2002).

8- Baking Quality of Tortilla Bread:

The physical characteristics of the produced tortilla bread are presented in Table (6). Loaf volume increased as TF level increased while loaf weight increased as TF level increased. This effect may be due to high protein contents in TF. Proteins are characterized by its higher water holding capacity. From the same table, specific loaf volume of Tortilla bread containing TF had higher values compared with that of control sample. On the other hand, the addition of TF to wheat flour increased loaf weight, loaf volume and specific loaf volume compared to those of the control.

Table 5: Mean Hunter color values of blends and tortilla bread produced from them

Samplse	L		a		b		ΔE	
	Flour	Bread	Flour	Bread	Flour	Bread	Flour	Bread
GCF	84.50	64.14	0.88	3.08	11.78	14.23	85.32	65.77
TF	91.90	50.87	0.29	7.63	7.14	18.26	92.18	54.58
GCF: TF 90:10	85.20	61.88	0.76	5.29	11.0	18.14	85.91	64.70
GCF: TF 90:10	85.50	59.64	0.68	6.85	10.22	19.48	86.11	63.11
GCF: TF 90:10	86.06	53.92	0.60	10.28	9.56	18.18	86.59	57.82
GCF: TF 90:10	86.52	53.26	0.56	10.57	9.02	19.24	86.99	57.60
GCF: TF 90:10	87.22	42.13	0.50	11.20	8.52	17.10	87.63	46.83

9. Freshness of Tortilla Bread:

The effect of storage period (0-48 hrs) at room temperature on freshness of tortilla bread was evaluated. Table (6) showed that, the bread sample containing TF had the highest values of alkaline water retention capacity which were declined during 0, 24 and 48 hrs of storage to 350, 220 and 295%, respectively. However, tortilla produced from GCF caused a noticeable decrease in alkaline water retention capacity values at the same storage period. Such effect might be related to the difference in quantitative distribution of protein fractions and physicochemical properties of starch of TF and GCF. Such limited information is not sufficient to explain staling. Further research is needed to elucidate why triticale bread stales much faster than wheat bread (Yaseen *et al*., 2007).

Table 6: Effect of adding triticale flour on the baking quality and freshness of tortilla bread stored at room temperature.

Samples	Baking quality			Water retention capacity (Freshness)		
	Weight (g)	Volume (cc)	Specific volume	Zero time	After24hrs	After 48hrs
GCF	130	280	2.15	320	300	270
TF	135	310	2.30	355	320	280
GCF: TF 90:10	131.5	280	2.13	325	300	282
GCF: TF 90:10	132.5	285	2.15	330	305	285
GCF: TF 90:10	133	290	2.18	340	310	290
GCF: TF 90:10	134	295	2.20	345	312	295
GCF: TF 90:10	135	300	2.22	350	320	295

10. Effect of Blending Triticale Flour with GCF on Sensory Properties of Tortilla Bread:

The influence of blending TF and GCF on the organoleptic properties of tortilla bread were evaluated and illustrated in Fig.(5) and Table (7). The obtained results indicated that, increasing the level of TF increased sensory scores of tortilla bread for taste, crust color, odor, rollability, Firmness, dryness and overall acceptability of tortilla bread samples were not affected significantly in case of using triticale flour when compared with control bread sample. A significant difference was detected when TF level was increased over than 10%. The TF level was proportional to higher scores in taste, crust color and odor. These effects may be due to a higher protein content of TF which affect color and taste of Tortilla. As the level of TF in blends was increased, crust color of breads changed from white creamy to dull brown. A significant difference in crust color was observed in all blended breads. The data suggested that the darkest color was observed in bread prepared from TF with GCF blended flours. The darker crust color may be due to millard reactions between reducing sugars and proteins (Raidi &Klein, 1983). Furthermore, Doxastakis *et al*. (2002) and Naeem *et al*. (2002) stated that, acceptable pan bread can be produced by using 1:1 wheat and triticale flour blend.

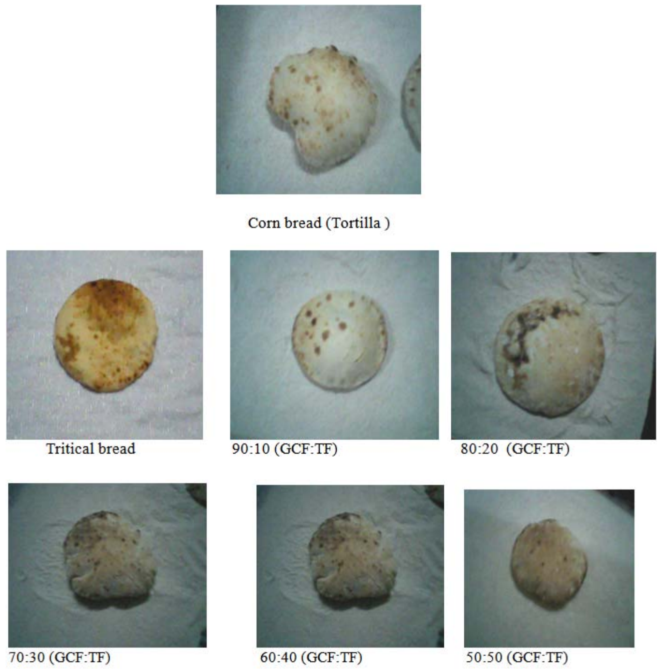


Fig. 5: Tortilla bread photos produced from GCF, Triticale and their blends.

Table 7: Organoleptic properties of tortilla bread.

0.1	Taste (20)	Aroma (20)	Color (20)	Rollability (10)	Firmness (10)	Dryness (10)	Overall acceptability (10)
GCF	17.5^{a}±0.28	17.0 ^{a}±0.99	17.5^{a}±0.57	7.8 ^{a}±0.77	8.5 ^{a}±0.63	8.5 ^{a}±0.71	7.9 ^{abc} ±0.57
TF	16.0^{b}±0.71	18.0 ^{a}±0.82	16.0^{b}±0.63	8.3 ^{a}±1.03	9.0 ^{a}±0.88	8.9 ^{a}±0.32	7.9 ^{abc}±0.99
GCF:TF	15.8^{b}±0.88	17.0 ^{a}±0.65	16.5^{b}±0.16	7.9 ^{a}±0.62	8.7 ^{a}±0.25	8.0 ^{a}±0.84	7.5 ^{abc}±0.22
GCF:TF	17.7^{a}±0.65	18.0 ^{a}±0.52	16.8 ^{b}±0.22	8.0 ^{a}±0.81	8.9 ^{a}±0.77	8.0 ^{a}±0.26	8.5 ^{ab}±0.62
GCF:TF	17.6^{a}±0.48	17.0 ^{a}±0.56	17.5 ^{a}±0.63	8.2 ^{a}±0.79	9.0 ^{a}±0.72	8.1 ^{a}±0.45	8.8 ^{ab}±0.65
GCF:TF	18.0^{a}±0.33	17.0 ^{a}±0.37	18.0 ^{a}±0.18	8.5 ^{a}±0.92	9.2 ^{a}±0.35	8.3 ^{a}±0.66	8.7 ^{ab}±0.82
GCF:TF	18.3^{a}±0.77	18.0^{a}±0.96	18.2 ^{a}±0.15	9.0 ^{a}±0.30	9.5 ^{a} ±0.56	8.5 ^{a}±0.39	9.0 ^{a}±0.36
LSD at 0.05	0.051	NS	0.05	NS	NS	NS	0.03

Conclusion:

From the previous results it could be concluded that, TF could be replaced with GCF at level 50 % without drastically affecting the bread quality (technological and sensory properties); and at the same time gave higher nutritive values. Using such level of blended TF and GCF could close the gap between production and consumption of wheat flour.

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