CHEMICAL, PHYSICAL, MICROBIOLOGICAL AND ECONOMICALLY ESTIMATIONS OF GLUTEN, LEGUMES, FENUGREEK AND TURMERIC BASED PAN BREAD

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ABSTRACT

The current study was carried out to utilize of whole meal wheat flour (control), some legumes (chickpea, lupin and fenugreek), turmeric and vital gluten for preparation of pan bread in order to enhance the chemical, physical, and microbiological properties of pan bread.

The chemical analysis of the raw materials showed that, the highest protein content was noticed in vital gluten and legumes (lupin, fenugreek and chickpea, respectively). Mineral contents were varied in the raw materials, but in general, turmeric and fenugreek seemed to be the superior in most of the determined minerals. On the other hand, the lowest amount of fiber in the tested materials was found in case of the vital gluten. The germination process led to a slight significant decrement in protein content and ether extract. Cooking process of germinated chickpea, lupin and fenugreek resulted in a noticeable significantly increment in fiber. The results showed that wet and dry gluten in vital gluten were significantly higher than that found in whole meal wheat flour and pan bread blends. Loaf volume was increased as a result of vital gluten addition compared with control (whole meal wheat flour). Loaf volume of pan bread was increased due to the water absorption increment. The highest significant protein content was noticed in pan bread prepared by whole meal wheat, vital gluten and chickpea flour blend, whole meal wheat, vital gluten and lupin flour blend, whole meal wheat, vital gluten and fenugreek blend and whole meal wheat ,vital gluten and turmeric flour blend than that found in those prepared from the other blends. Mineral contents (Zn, Fe, Ca and Mn) in most of pan bread blends were significantly higher than that found in control blend, on contrary of Na, Cu and Mg contents. The total bacterial count (TBC) and yeast/mold in pan bread prepared with turmeric were significantly lower than that found in all the other tested blends whereas the coliform groups were undetected in all the produced pan bread.

In general, the tested pan bread seemed to be more preferable due to it showed the highest degree consumer acceptable with respect to all organoleptic properties.

Key words: whole meal wheat flour, legumes, fenugreek, turmeric, chemical composition, loaf volume, microbiological and economically estimated.

INTRODUCTION

Legumes play an important role in human nutrition since they are rich sources of protein, calories, certain minerals and vitamins. In African diets legumes are also, the major contributors of protein and calories for economic and cultural reasons (EL-Maki *et al.*, 2007). Legumes are generally consumed after processing into various products, like milling into dehulling, puffing or roasting into snack food, grinding into flour for different food preparation or as germinated grains. Heat processing, in general, improves the nutritive value of legume proteins, by inactivating trypsin and growth inhibitors (Tharanathan and Mahadevamma, 2003).

Lupin seeds (*lupinus albus*) are employed as a protein source for animal and human nutrition in various parts of the world, not only for their nutritional value (high in protein, lipids and dietary fiber), but also for their adaptability to marginal soils and climates. Therefore, human consumption of lupin increased in recent years in various forms. For instance, lupin flour is added to bakery and pastry products for its nutritive value and also to provide functional properties to such products (Sanchez *et al.*, 2005).

Chickpea (*Cicer arietinum*) is one of the most world's important legume crops (Hawkins and Johnson, 2005). Liu and Hung (1998) reported that chickpea proteins have good nutritional qualities and could be incorporated in some food systems.

Fenugreek (*Trigonella foenum* graecum) is an annual herb belonging to the leguminous family, widely grown in India, Egypt and Middle Eastern countries (Flammang *et al.*, 2004). On the other hand, Hooda and Jood (2005) reported that, fenugreek seed flour has a great potential, due to its high and good quality proteins (20-25%), lysine

(5-6% from protien), soluble (20%) and insoluble dietary fiber and also possesses hypochlesterolemic and hypoglycemic properties. Hence, development and consumption of such therapeutic bakery products would help to raise the nutritional status of the population.

The dried powder of the *Curcuma longa* rhizome, commonly called turmeric, is widely used as a coloring agent and spices in many food items in several Asian countries. It has been also used for centuries as a traditional remedy for the treatment of inflammation and other diseases (Pfeiffer *et al.*, 2003). Turmeric, specially its major component namely curcumin, is related to many therapeutic properties (EL Hamss *et al.*,1999).

Wheat (*Triticum aestivum*) is the world's most important cereal crop in terms of production and consumption (Dhingra and Jood, 2001). On the other hand, Sidhu *et al.*, (1999) reported that wheat and wheat products (bread and bakery products) are long recognized as a major staple and source of calorie and are contributed as significant quantities of other nutrients (vitamins, minerals and dietary fiber) in the people diets.

Wheat gluten is a readily available protein source that has been extensively used in baked products (Barber and Warthesen, 1982). Hemstad (2005) reported that vital gluten is a unique water- insoluble protein and carbohydrate complex that is extracted from wheat by wet processing. It is a creamy to tan colored, when dried, free flowing powder and containing a minimum of 75% protein on a dry basis.

Germinated legumes utilization improved nutrient characteristics and increase the protein content of the blends (Marero *et al.*, 1988). It is generally known that the germination process improves the nutritional quality of legumes, not only by the reduction of antinutritive compounds, but also by augmenting the levels of free amino acids, available carbohydrates, dietary fiber and other components (Lopez-Amorós *et al.*,2006). Dried and milled grains may be also used as an ingredient for hot dishes and bakery products (Trugo *et al.*, 1993). On the other hand, Gonzalez-Galan, *et al.*, (1991) reported that replacing part of wheat flour with rice flour and soy flour is likely to improve the nutritive value of the product due to the complimentary nature of the amino acid profiles derived from these raw materials. Nowadays, fenugreek is still used as a supplement in wheat and maize flour for bread-making in Egypt (Basch et *al.*, 2003).

Therefore, the present work was carried out to study the incorporation of either legume, fenugreek or turmeric in wheat flour with wheat gluten in order to high protein and low carbohydrates bread making. Moreover, the maintaining good quality characteristics of their dough and pan bread were also studied.

MATERIALS AND METHODS

Materials:-

Wheat grain (*Triticum aestivum*, Skha 69 variety) was obtained from the Wheat Research Department, Field Crops Research Institute, Agricultural Research Center, Giza, Egypt. Chickpea (*Cicer arietinum*, Giza 1 variety), lupin (*lupinus albus*, Giza 1 variety) and fenugreek seeds (*Trigonella foenung raecum*, Giza 30 variety) were obtained from Legumes Research Department, Field Crops Research Institute, Agricultural Research Center, Giza, Egypt. Turmeric rhizome (*Curcuma longa*) was obtained from the local market at Giza, Egypt. Commercial wheat gluten was purchased from Crestar Co. 7 Rue Du Marechal, Jaffre, BP 109, France via Special Unit for Bakery Products, Faculty of Agricultural, Cairo Univ. Aladdin's Instant bakery's yeast was purchased from the local market at Giza, Egypt.

Methods:-

Preparation of raw materials:-

Germination process of chickpea and fenugreek seeds was carried out according to the method of Marero *et al.*, (1988). Lupin debittering processes were carried out in the laboratory by washing and soaking the lupin in tap water for 24 hours at room temperature, followed by germinating of whole seeds at ambient temperature in the dark for 3 days, followed by warming using boiled water for 30 min and submerging the lupin seeds in a running tap water at room temperature for 4 days (Trugo *et al.*, 1993). Chickpea and fenugreek seeds were boiled with sufficient amounts of water, till they became tender and well cooked. All such materials were dried at 55^{0} c for 12 hr, in an air forced oven. Wheat whole meal, turmeric rhizome plant, dried germinated fenugreek, chickpea and lupin seeds were milled with a labotoroy mill (MLW, Type: Sk1, watt100, West Germany).

Preparation of blends:

The ingredient amounts were schemed and trialed as follows:-

- Vital gluten powder was separately blended with whole meal wheat flour at different levels as 10, 20, 30, 40 and 50%.
- Whole fenugreek flour was separately blended as 5, 10 and 15%.
- Whole chickpea flour was separately blended as 5, 10, 15, 20, 25 and30%.
- Whole lupin flour was separately blended as 5, 10 and 15%.
- Turmeric flour was separately blended as 0.5, 1, 2 and 5%.

It was found, with respect to sensory evaluation, that the optimum gluten scheme amount was 30% (Mita and Matsumoto, 1981). Exactly 5, 5, 5 and 1% of fenugreek, lupin, chickpea and turmeric flour, respectively, were substituted (except the control blend) instead of a resemble amount of whole meal wheat flour to achieve the healthy impact (reported by Mohamed *et al.*, 2006, Hooda and Jood, 2005, Pfeiffer *et al.*, 2003 and Liu and Hung, 1998). Table (1): showed such different tests blends, their ingredients and percent:

Table (1) ingredient percent of pan bread blends.

Blend name	Ingredients	g/100g
Control	Whole meal wheat flour	100
WWG	Whole meal wheat flour vital gluten	70 30
WWGF	Whole meal wheat flour vital gluten whole fenugreek flour	65 30 5
WWGL	Whole meal wheat flour vital gluten whole lupin flour	65 30 5
WWGC	Whole meal wheat flour vital gluten whole chickpea flour	65 30 5
WWGT	Whole meal wheat flour vital gluten Turmeric	69 30 1

Preparation of pan bread:-

A straight dough bread making process was performed according to Wang *et al.*, (2002) at Special Unit for Bakery Products Faculty of Agricultural, Cairo Univ. Basic dough formula of 500g flour basis was consisted of; salt (5 g), compressed yeast (25 g), sugar (7.5 g), bread improver (5 g) and the required amount of water to reach 500 BU of consistency as well as gluten was added. The dough was put into greased fermentation bowel, and placed in a fermentation cabinet at 37°C and a relative humidity 80-85% for 20 min, and then dough piece was divided, hand–moulded then put in metal pans. The dough was proofed for 30 min in a fermentation cabinet under controlled temperature and a relative humidity and then baked for 25 min at 190° C in a baking oven. The pan bread was separated from the metal pans and the attributes were evaluated after cooling for 1hr at room temperature.

Analytical methods:

Determination of alkaline water retention capacity (AWRC) and loaf volume:-

Pan bread freshness was rheologically tested by AWRC determination according to the method described by Yamazaki (1953) and modified by Kitterman and Rubenthaler (1971). Loaf volume was measured by the rapeseed displacement method (Xie *et al.*, 2004).

Chemical analysis:-

Chemical analysis (moisture, ether extract, crude fiber and ash) of the tested samples was determined and total carbohydrates, calculated by difference according to AOAC (1990). Nitrogen contents, by using Kjeldahl method, was multiplied by a factor of 5.7 to determine protein content in wheat and vital gluten (AACC, 1983) and 6.25 to determine protein in chickpea, fenugreek, lupin and turmeric (AOAC, 1990). Caloric value was calculate as FAO/WHO, (1985) recommended. Mineral contents (zinc, iron, calcium, potassium, sodium, magnesium, manganese and copper were determined using a Pye Unicum SP1900 Atomic Absorption Spectroscopy instrument (Perkin Elmer model 4100ZL) as described by AOAC (1990).

Determination of gluten (Hand washing method)

The wet and dry glutens were determined in flour blends using the method of AACC (1983).

Microbiological evaluation of pan bread:-

Total plate count bacteria, molds/yeasts and detection of coliform groups were carried out according to APHA (1971), whereas, detection of yeasts and moulds was according to Galloway and Burgess (1952).

Costs estimation of the pan bread:-

The costs of the pan bread blend included costs for raw materials were estimated according to the current price of each material in local markets. Meanwhile, costs of preparation (2.2% of ingredient cost), processing (26.8% of ingredient cost), packaging (25% of total cost) of the produced pan bread, and profit (25% of total cost) were estimated according to Harper *et al.*, (1983).

Organoleptic evaluation:-

The organoleptic characteristics of the pan bread attributes were determined by a panel of Food Technology Research Institute (FTRI) staff member (15 judges) for crust color, crumb color, texture, grain, taste, flavor and overall acceptability, as suggested by Dhingra and Jood, (2001).

Statistical analysis:

Data analysis was performed using SAS (1987) software. All data were expressed as mean of three replicates and presented followed by the standard deviation. Analysis of variance was used to test for differences between the groups. Least Significant Differences (LSD) test was used to determine significant differences ranking among the mean values at $P< 0.05$.

RESULTS AND DISCUSSION

Chemical composition of raw, germinated and cooked materials:-

Data presented in Table (2) shows that protein amount was significantly higher in vital gluten than that found in legumes (chickpea and lupin), fenugreek, whole meal wheat flour and turmeric agreed with Xie *et al.*,(2004). Consequently, the vital gluten could be considered the best source of nutritive value, due to its higher protein content. The same Table showed that the highly significant protein content was noticed in the lupin flour (38.55%), which agreed with that found by Donangelo *et al.*, (1995) and Martinez –Villaluenga *et al.*, (2007).

Table (2): The major chemical compositions of raw, germinated and cooked materials (on dry weight basis).

Flour of whole	Protein	Ether extract	Ash	T.C*	Fiber
Ungerminated					
Chickpea	24.95 ±0.07	8.20 ±0.14	2.65 ±0.71	58.40 ±0.28	5.80 ±0.28
Lupin	38.55 ±0.07	5.70 ±0.14	3.50 ±0.14	36.20 ±0.28	16.05 ±0.21
Fenugreek	34.795±0.29	6.41 ±0.28	3.79 ±0.16	41.09 ±0.96	13.93 ±0.24
Germinated					
Chickpea	24.35 ±0.07	7.60 ±0.14	3.52 ±0.13	59.13 ±0.62	5.40 ±0.28
Lupin	38.05 ±0.07	4.66 ±0.02	3.57 ±0.07	37.87 ±0.09	15.85 ±0.07
Fenugreek	32.29 ±0.09	6.11 ±0.14	4.03 ±0.11	44.25 ±0.23	13.33 ±0.11
Cooked					
Chickpea	24.05 ±0.07	4.60 ±0.14	3.70 ±0.14	61.60 ±0.14	6.05 ±0.07
Lupin	38.0 1 ±0.07	4.25 ±0.21	3.35 ±0.21	37.80 ±0.57	16.59 ±0.07
Fenugreek	32.12 ±0.18	5.87 ±0.08	4.03 ±0.01	43.92 ±0.13	14.05 ±0.07
Whole meal wheat	13.25 ±0.07	2.58 ±0.04	2.13 ±0.04	78.50 ±0.14	3.55 ±0.71
Vital gluten	75.10 ±0.14	0.09 ±0.01	1.02 ±0.01	23.57 ±0.16	0.23 ±0.028
Turmeric	7.75 ±0.21	9.65 ±0.21	6.06 ±0.06	55.24 ±0.08	21.3 ±0.28

T.C*= Total carbohydrates calculated by difference
-Each value (an average of three replicates) is followed by the standard deviation.

It was followed by the ungerminated whole fenugreek flour (agreed with Ismail, 1996). The ungerminated chickpea flour contained a highest amount of protein compared to that found in whole meal wheat flour and turmeric. These results agreed with those obtained by Bhatty *et al.*, (2000), El-Nager, (2005) and Anonymous (2008), respectively.

The same data showed that all the germinated legumes (chickpea and lupin) and fenugreek flours possessed a significantly lower protein amount than the ungerminated ones. These results are agreed with Shaker *et al.*, (1995) who reported that nutrients loss may be attributed to leach of soluble nitrogen, mineral and other nutrients into desired solution. These results agreed, also, with Muzquiz *et al.*, (2004) who reported that, during germination of legume seeds, significant changes in the composition of protein could modify the nutritional value. The turmeric flour showed the lowest significant protein content compared to all of the other tested materials. The ether extract of the ungerminated whole chickpea, lupin and fenugreek flour seemed to be significant high than that found in the germinated samples. These findings are concurrent with that observed by Khalil and Mansour (1995). The higher amount of fat in the ungerminated chickpea sample than germinated ones could regard to the germination process. Such constituents are required in those processes to supply with some energy (from carbohydrates and fat). It could notice from Table (2) that the turmeric flour contained the highest fiber amount (21.30%). These results seemed to be closest to that found by Anonymous, (2008).

On the other hand, the monitoring of such cooked materials with respect to their components is one of the critical points to identify their benefits in final products. Therefore, the major chemical composition of the cooked materials was illustrated in Table (2).

Crude protein content showed a slight significant decrement pattern as a result of cooking process in the present study (Table2). The decrease in protein may be attributed to the solubility of these components in water during boiling and the loss percent was varied according to the degree of solubility in water for each compound (Ismail, 1996). Concerning ether extract contents, results revealed that there was a significantly downward model in the ether extract of chickpea, lupin and fenugreek due to the cooking process. Ash content of the chickpea and fenugreek flour was significantly increased in the cooked samples than that found in the raw. The same Table showed, also, that the carbohydrates were higher in the tested materials due to cooking process. The apparent increment of carbohydrates may be due to the decrement of other constituent materials. Meanwhile a slightly significantly increment of fiber could be detected as a result of the cooking process of chickpea, agreed with Donagelo *et al* .,(1995) .

Minerals content of raw, germinated and cooked materials:-

Data presented in Table (3) showed some minerals (i.e., Zinc, iron, calcium, potassium, sodium, magnesium, manganese and cupper) contents of the tested raw, germinated and cooked materials. It revealed that the highest significant Zn amount was noticed in germinated lupin followed by vital gluten, germinated chickpea, germinated fenugreek and turmeric flour.

On the other hand ,the germination process lead to a slightly increment in Zn and Fe content of both whole chickpea, fenugreek and lupin,such result agreed with Khalil and Mansour (1995), who reported that, the germinated Faba bean had higher Zn and Fe contents than the raw sample. The lowest amount of Zn (4.17mg/100gm) was found in case of whole meal wheat flour. The same Table showed that significant differences in Ca, K, Na, Mg, Mn and Cu contents were found among such tested materials. These results agreed with Dagnia *et al.*, (1992), who reported that the mineral contents increased during germination. On the other hand, all the tested minerals were generally decreased after cooking (through boiling process) due to the leaching process occurred during boiling in water for all the germinated materials concurrent with found by (Ismail,1999).

Table (3): Mineral contents of raw, germinated and cooked materials (calculated as mg/100g dry sample)

Flour of whole	Zn	Fe	Ca	K	Na	Mg	Mn	Cu
Ungerminated								
Chickpea	5.38 ±0.40	8.09 ±0.15	69.15 ±0.07	1409.6 ±0.71	242.3±1.41	172.3 ±0.71	2.85 ±0.07	0.35 ±0.00
Lupin	7.15 ±0.07	9.20 ±0.01	175.5 ±0.71	1012.0 ±0.71	54.8 ±0.71	285.9 ±0.15	2.39 ±0.01	1.025 ±0.00
Fenugreek	5.67 ±0.04	22.0 ±1.13	259.1 ±1.29	1349.6 ±0.78	50.7 ±0.67	151.8 ±1.41	4.15 ±0.06	1.70 ±0.14
Germinated								
Chickpea	6.05 ±0.07	8.80±0.14	55.15 ±0.07	1450.7 ±0.71	214.2 ±0.01	170.8 ±0.29	3.11 ±0.13	0.325 ±0.09
Lupin	7.80 ±0.14	9.40±0.13	172.1 ±1.35	1014.0 ±2.83	56.7 ±0.78	286.2 ±3.54	2.45 ±0.22	1.085 ±0.04
Fenugreek	5.80 ±0.14	22.76±0.21	251.4 ±0.74	1353.2 ±4.24	53.4 ±0.07	152.6 ±0.01	4.57 ±0.08	1.45 ±0.07
Cooked								
Chickpea	2.60 ±0.07	6.30 ±0.23	36.20 ±0.01	1260.0 ±0.27	27.5 ±0.57	48.4 ±0.49	1.02 ±0.01	0.225 ±0.04
Lupin	4.26 ±0.07	7.82 ±0.21	50.65 ±0.78	922.6 ±1.41	13.7 ±0.07	95.7 ±0.64	1.05 ±.014	0.31 ±0.01
Fenugreek	4.79 ±0.07	11.15 ±0.07	190.7 ±0.07	1232.4 ±0.78	42.3 ±0.71	130.8 ±0.71	2.68 ±0.71	0.57 ±0.14
Whole meal wheat	4.17 ±0.04	5.37 ±0.35	74.25 ±0.22	32.05 ±0.09	133.1 ±0.14	307.3 ±0.49	30.20 ±0.14	6.25 ±0.21
Vital gluten	6.18 ±0.04	4.78 ±0.02	77.09 ±0.04	160.6 ±0.75	36.4 ±0.16	53.7 ±0.14	1.60 ±0.08	0.30 ±0.08
Turmeric	5.03 ±0.09	41.55 ±0.07	183.9 ±0.08	2515.8 ±6.19	50.9 ±0.28	308.4 ±0.49	7.77 ±0.04	0.90 ±0.01

-Each value (an average of three replicates) is followed by the standard deviation.

Wet and dry gluten of vital gluten and the pan bread blends:-

The results presented in Table (4) showed that wet and dry gluten in vital gluten were significantly higher than that found in whole meal wheat flour and the suggested blends. The same Table revealed that the significantly highest wet and dry gluten were noticed in bread blends contain legumes (lupin, chickpea and fenugreek) and turmeric than that found in whole meal wheat flour one.

Chemical composition and caloric values of the produced pan bread:

Data presented in Table (5) showed the major chemical constituents and caloric values of manufactured pan bread of the suggested blends. The highest significantly protein content was noticed in the tested blends pan bread, than that found in pan bread prepared from whole meal wheat flour (control). The same Table revealed that the significant change in fiber and carbohydrates of all manufactured pan bread was noticed. These results agreed with EL Maki *et al.*, (2007) who reported that legumes play an important role in human nutrition since they are rich source of protein, calories, certain minerals and vitamins. Basch *et al.*, (2003) reported that, in modern Egypt, fenugreek is still used as a supplement component in wheat and maize flour for bread making. Barber and Warthesen (1982) reported that, the wheat gluten a readily available protein source that has been used extensively in baked products. Mohamed *et al.*, (2006), also, found that, vital gluten was to increase the bread protein content. The desired quality was accomplished by adding the type of protein that preserves the functional properties of wheat gluten to maintain the most essential quality component of wheat flour. The same Table showed that significant differences in caloric values were found among all the pan bread blends. The highest amount was noticed in case of pan bread manufactured from control blend.

Table (4): Wet and dry gluten of the intact vital gluten and the suggested blends dough.

Item	Wet gluten %	Dry gluten
Intact vital gluten	193.93[a] ±0.39	92.12[a] ±0.09
WWF	30.81[f] ±0.08	11.15[f] ±0.07
WWG	92.11[c] ±0.14	34.50[c] ±0.71
WWGC	99.15[b] ±0.07	35.52[b] ±0.12
WWGL	78.50[e] ±0.71	28.28[e] ±0.33
WWGF	78.55[e] ±0.21	30.50[d] ±0.71
WWGT	83.41[d] ±0.29	29.15[e] ±0.07

-Each value (an average of three replicates) within the same column, followed by the same letter is not significantly different at <0.05.
-Each value is followed by the standard deviation.
WWF = Whole meal wheat flour.
WWG = Whole meal wheat flour + vital gluten.
WWGC = Whole meal wheat flour + vital gluten + whole chickpea flour.
WWGL = Whole meal wheat flour + vital gluten + whole lupin flour.
WWGF = Whole meal wheat flour + vital gluten + whole fenugreek flour.
WWGT = Whole meal wheat flour + vital gluten + turmeric flour

Table (5): Chemical composition and caloric values of the produced pan bread (on dry weight basis).

Pan bread	Moisture	Protein	Ether extract	Ash	Fiber	T.C*	Caloric value
WWF	14.17^{a} ±0.07	13.17^{e} ±0.08	3.50^{a} ±0.01	1.95^{a} ±0.01	2.24^{f} ±0.01	79.14^{a} ±0.07	400.7^{a} ±0.36
WWG	6.61^{c} ±0.14	33.06^{d} ±0.06	3.09^{a} ±0.01	1.76^{c} ±0.01	3.06^{e} ±0.06	59.03^{b} ±0.12	391.4^{c} ±0.42
WWGC	5.66^{d} ±0.06	33.39^{c} ±0.11	3.20^{a} ±0.02	1.86^{b} ±0.01	4.05^{c} ±0.07	57.53^{d} ±0.13	392.4^{c} ±0.36
WWGL	7.26^{b} ±0.07	34.20^{a} ±0.14	3.20^{a} ±0.14	1.57^{d} ±0.01	4.57^{b} ±0.06	56.46^{e} ±0.20	390.4^{c} ±0.42
WWGF	7.38^{b} ±0.10	33.70^{b} ±0.14	3.18^{a} ±0.04	1.84^{b} ±0.04	5.35^{a} ±0.06	55.82^{f} ±0.21	386.7^{d} ±0.64
WWGT	7.19^{b} ±0.03	33.11^{d} ±0.01	3.17^{a} ±0.01	1.79^{c} ±0.03	3.55^{d} ±0.05	58.38^{c} ±0.02	394.5^{bc} ±0.01

T.C*= Total carbohydrates calculated by difference.
-Each value (an average of three replicates) within the same column, followed by the same letter is not significantly different at <0.05.
-Each value is followed by the standard deviation.
WWF = Whole meal wheat flour.
WWG = Whole meal wheat flour + vital gluten.
WWGC = Whole meal wheat flour + vital gluten + whole chickpea flour.
WWGL = Whole meal wheat flour + vital gluten + whole lupin flour.
WWGF = Whole meal wheat flour + vital gluten + whole fenugreek flour.
WWGT = Whole meal wheat flour + vital gluten + turmeric flour.

Mineral contents of pan bread produced from the tested blends

Results in Table (6) showed that the mineral contents of Zn, Fe, and Ca in WWGF pan bread blends were significantly higher than that found in pan bread from whole meal wheat flour. These results agreed with Ismail, (1996) who reported that, the boiled fenugreek seeds which remain after the boiling of seeds in water during preparing the hulba beverage contain considerable amounts of protein, lipid, carbohydrate and minerals. Iqbal *et al*., (2006) who reported that all types of legumes were also better suppliers of mineral matter, particularly potassium, phosphorus, calcium, cupper, iron and Zinc.

On contrary, K and Na contents were significantly higher in pan bread originated from whole meal wheat flour than that found in all the other pan bread blends. Zinc and cupper contents were unsignificantly in pan bread blends. These findings are concurrent with that found by Adam *et al*., (2003) who reported that whole wheat bread represents an important food to improve whole grain consumption and daily supply of fiber, minerals and other micronutrients. Table (6) showed that the highest Mg content was noticed in all the tested pan bread blends than that found in WWF blend.

Table (6): Mineral contents of pan bread (calculated as mg/100g dry sample) produced from the tested blends

Pan bread of	Zn	Fe	Ca	K	Na	Mg	Mn	Cu
WWF	$4.26^{b} \pm 0.06$	$6.80^{b} \pm 0.14$	$74.6^{b} \pm 0.35$	$340.7^{a} \pm 0.64$	$125.7^{a} \pm 0.64$	$110.0^{d} \pm 0.07$	$20.5^{b} \pm 0.21$	$4.40^{a} \pm 0.28$
WWG	$4.65^{a} \pm 0.06$	$6.11^{c} \pm 0.07$	$75.2^{b} \pm 0.01$	$272.4^{d} \pm 0.58$	$104.6^{b} \pm 0.78$	$231.1^{a} \pm 0.34$	$21.9^{a} \pm 0.28$	$2.55^{b} \pm 0.07$
WWGC	$4.57^{a} \pm 0.07$	$6.20^{c} \pm 0.07$	$73.2^{c} \pm 0.11$	$319.2^{b} \pm 0.71$	$98.7^{d} \pm 0.08$	$217.8^{c} \pm 0.78$	$20.4^{b} \pm 0.28$	$4.55^{a} \pm 0.21$
WWGL	$4.66^{a} \pm 0.06$	$6.16^{c} \pm 0.05$	$73.6^{c} \pm 0.49$	$302.0^{c} \pm 1.21$	$98.1^{d} \pm 0.03$	$221.2^{b} \pm 0.68$	$20.3^{b} \pm 0.14$	$4.60^{a} \pm 0.14$
WWGF	$4.64^{a} \pm 0.13$	$7.45^{a} \pm 0.22$	$80.6^{a} \pm 0.66$	$317.2^{b} \pm 1.38$	$98.9^{d} \pm 1.06$	$222.4^{b} \pm 0.99$	$20.3^{b} \pm 0.07$	$4.65^{a} \pm 0.07$
WWGT	$4.74^{a} \pm 0.03$	$6.25^{c} \pm 0.21$	$75.4^{b} \pm 0.28$	$274.6^{d} \pm 0.35$	$103.1^{c} \pm 0.21$	$231.4^{a} \pm 0.28$	$21.5^{a} \pm 0.14$	$4.62^{a} \pm 0.03$

-Each value (an average of three replicates) within the same column, followed by the same letter is not significantly different at <0.05.
-Each value is followed by the standard deviation.
WWF = Whole meal wheat flour.
WWG = Whole meal wheat flour + vital gluten.
WWGC = Whole meal wheat flour + vital gluten + whole chickpea flour.
WWGL = Whole meal wheat flour + vital gluten + whole lupin flour.
WWGF = Whole meal wheat flour + vital gluten + whole fenugreek flour.
WWGT = Whole meal wheat flour + vital gluten + turmeric flour.

Data presented in the same Table showed also, that the highest Mg, Mn and cupper contents were highly significantly detected in WWGT pan bread blends. It was due to the highest proportion of vital gluten and turmeric ingredient in such blend. These findings agreed with Anonymous, (2008).

Pan bread freshness and loaf volume:-

Bread staling is a complex process that occurs during bread storage. It is delayed the deterioration progress of qualities such as taste, firmness, etc. The mechanism of bread staling is still not clear yet even though it has been studied for 150 years (Xie *et al.*, 2004). Alkaline water retention capacity (AWRC) of the pan bread loaves could be considered as an indication for staling and freshness. Therefore, it was estimated for different treatments at zero time and after storage periods (24, 48 and 72hrs.) as shown in Table (7). Results in Table (7) show that, AWRC was gradually decreased as the storage time increased of all baking bread resulted from the tested blends. The same Table showed that there were significant changes in impact of all the pan bread origin. Supplementation the pan bread with vital gluten, turmeric, chickpea and fenugreek and lupin flour led to extend shelf life. These results are in agreement with those obtained by Xie *et al.*, (2004) who cleared that their protein slowed down the bread staling process. Protein inhibited starch retrogradation by forming a complex with starch. The amide group of glutamine protein interacts with a glucose unit by a hydrogen bond in either the amylose or the amylopectin chain.

Data presented in Table (7) showed also that the significantly lowest loaf volume was noticed in pan bread prepared from whole meal wheat flour and there were significant changes in impact of all the tested blends under investigation on loaf volume. Loaf volume was increased as a result of vital gluten addition compared with control (whole meal wheat flour). Such increase in loaf volume of pan bread was due to the increasing in water absorption (EL-Saied, 1998). Doxastakis *et al.*, (2002) reported that the volumes of the breads increased as the level of triticale flour increased due to the fortification of the gluten structure by the triticale gluten added. Lower loaf volume subsequently has a negative affect on other quality attributes such as crumb grain and tenderness.

Microbiological assay of the manufactured panbread

The tested pan bread was subjected to the total bacterial (TBC), yeasts/moulds and coliform groups counts and the obtained results are shown in Table (8). The data revealed that the total bacterial count (TBC) in pan bread prepared from WWGT, followed by WWGF were significantly lower than that found in whole meal wheat flour. These findings are concurrent and confirmed with that found by Jayaprakasha *et al.*, (2005) who reported that, turmeric has been used for preserving food as antimicrobial chemical constituents agent of turmeric rhizomes include volatiles and non-volatiles. The non-volatile compounds of turmeric are the coloring agent and are found to be a rich source of phenolic compounds curcumin, demethoxy curcumin and bisdemethoxy curcumin. Srinivasan, (2005) also, reported that fenugreek seeds are bitter to taste and have long known for their medicinal qualities and preservative effects.

Table (7): Alkaline water retention capacity (AWRC) of the produced pan bread

Pan bread	AWRC after specific time (in hours)				Loaf volume (cm^3)
	Zero time	24	48	72	
WWF	$294^e \pm 0.28$	$263^f \pm 0.07$	$238^f \pm 0.71$	$222^f \pm 0.35$	$213^d \pm 1.40$
WWG	$363^a \pm 1.48$	$352^a \pm 0.84$	$321^a \pm 1.08$	$301^a \pm 0.62$	$396^a \pm 0.71$
WWGC	$331^c \pm 0.64$	$325^b \pm 1.36$	$309^b \pm 0.71$	$245^c \pm 0.21$	$396^a \pm 0.71$
WWGL	$331^c \pm 0.64$	$275^e \pm 0.35$	$267^d \pm 0.07$	$241^d \pm 0.35$	$370^b \pm 0.71$
WWGF	$303^d \pm 0.03$	$291^d \pm 0.39$	$274^c \pm 0.21$	$265^b \pm 0.02$	$370^b \pm 0.71$
WWGT	$346^b \pm 0.14$	$322^c \pm 0.21$	$260^e \pm 0.01$	$240^e \pm 0.35$	$361^c \pm 0.71$

-Each value (an average of three replicates) within the same column, followed by the same letter is not significantly different at <0.05.
-Each value is followed by the standard deviation.
WWF = Whole meal wheat flour.
WWG = Whole meal wheat flour + vital gluten.
WWGC = Whole meal wheat flour + vital gluten + whole chickpea flour.
WWGL = Whole meal wheat flour + vital gluten + whole lupin flour.
WWGF = Whole meal wheat flour + vital gluten + whole fenugreek flour.
WWGT = Whole meal wheat flour + vital gluten + turmeric flour.

Table (8): Microbiological estimation of the manufactured pan bread

Pan bread of	Total bacterial counts (cells/g sample)*	Yeasts and moulds (colons/g sample)	Coliform group
WWF	$1.75^a \times 10^2 \pm 7.07$	$6.0^a \times 10^2 \pm 70.71$	ND
WWG	$1.25^c \times 10^2 \pm 7.07$	$1.0^e \times 10^2 \pm 7.07$	ND
WWGC	$1.50^b \times 10^2 \pm 7.07$	$2.5^c \times 10^2 \pm 70.71$	ND
WWGL	$1.05^d \times 10^2 \pm 7.07$	$4.5^b \times 10^2 \pm 70.71$	ND
WWGF	$5.50^e \times 10 \pm 7.07$	$1.5^d \times 10^2 \pm 7.07$	ND
WWGT	$4.00^f \times 10 \pm 4.14$	$7.5^f \times 10 \pm 7.07$	ND

-ND =Not detected
-Each value (an average of three replicates) within the same column, followed by the same letter is not significantly different at <0.05.
-Each value is followed by the standard deviation.
WWF = Whole meal wheat flour.
WWG = Whole meal wheat flour + vital gluten.
WWGC = Whole meal wheat flour + vital gluten + whole chickpea flour.
WWGL = Whole meal wheat flour + vital gluten + whole lupin flour.
WWGF = Whole meal wheat flour + vital gluten + whole fenugreek flour.
WWGT = Whole meal wheat flour + vital gluten + turmeric flour.

With respect to yeasts/moulds count in the tested pan bread, it reached to $6x10^2$ colons/gm in pan bread prepared from whole meal wheat flour but it was lower in WWGT blend (7.5x10 colons/gm sample), this results agreed with Jayaprakasha *et al.*, (2005). On contrary, coliform group was undetected in all tested pan bread product either after 24 or 48 hr.

Organoleptic characteristics evaluation:-

One of limiting factor for consumer acceptability is the organoleptic properties. Therefore, crust color, crumb color, texture, grain, taste, flavor and overall acceptability of consumer were performance determined and data were found in Table (9). It confirmed that WWGC, WWGT and WWG possessed the best crust color, with no significant difference in between, but was significantly differed than the other pan bread. While WWF, WWGL and WWGF recorded the lowest value of crumb color. With respect to the texture of the tested pan bread, WWG, WWGT and WWGC were the most consumers preferable with no significant difference. Meanwhile, there were significant differences between the other tested samples including WWF pan bread.

Grain attribute of the tested pan bread showed that WWGT, WWGC, WWG and WWGL showed inter insignificant differences. On the other hand, WWGF and WWF showed the lowest score of grain attribute and were statistically differed than the other tested pan bread. Taste evaluation of the tested pan bread showed that WWGC and WWGT blends were the most preferable by the panelist followed by the WWG with no significant difference. The flavor and overall acceptability attributes seemed to follow the same pattern of the taste attribute, wherein, there were no significant difference among the tested pan bread samples except WWGF, which recorded the lowest value of flavor. In general, the tested pan bread blends seemed to be more preferable loaves than control, WWF, due to it showed the highest degree consumer acceptable with respect to all organoleptic properties. These results agreed with that found by Basch *et al.*, (2003) who reported that the fraction of fenugreek that contains the testa (i.e., the protein of the fenugreek seed with the peculiar smell and bitter taste), while Hooda and Jood, (2005) who reported that, the germinated fenugreek flour supplemented biscuits performed better than the other fenugreek–supplemented biscuits.

Table (9): Organoleptic characteristics of the manufactured pan bread

Pan bread of	Crust color (10)	Crumb color (10)	Texture (25)	Grain (10)	Taste (25)	Flavor (20)	Overall acceptability (100)
WWF	6.6^{d} ±0.79	6.8^{c} ±0.83	19.1^{d}±0.79	6.9^{c} ±0.90	21.0^{b} ±1.65	17.8^{ab}±1.36	78.2^{ab} ±3.68
WWG	8.3^{ab}±0.89	8.2^{ab} ±0.72	23.3^{a}±0.97	8.3^{a} ±0.89	22.5^{a} ±1.09	18.4^{a} ±1.24	88.9^{a} ±3.66
WWGC	8.7^{a} ±0.77	8.6^{a} ±0.90	22.8^{a}±0.62	8.3^{a} ±0.89	22.8^{a} ±0.83	18.1^{a} ±1.24	88.4^{a} ±4.48
WWGL	7.8^{bc}±0.96	7.5b^{c}±0.67	22.0^{b}±0.85	7.8^{ab} ±0.87	20.8^{b} ±1.47	17.8^{ab} ±0.75	83.8^{a} ±3.36
WWGF	7.3^{c} ±0.98	6.9^{c} ±1.08	21.3^{c}±0.89	7.3^{bc} ±0.65	20.1^{b} ±1.03	16.8^{b} ±1.70	79.7^{ab} ±4.74
WWGT	8.7^{a} ±0.89	8.4^{a} ±0.79	23.0^{a}±0.60	8.4^{a} ±0.90	22.6^{a} ±0.79	18.4^{a} ±0.67	89.8^{a} ±2.41

-Each value (an average of three replicates) within the same column, followed by the same letter is not significantly different at <0.05.
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WWF = Whole meal wheat flour.
WWG = Whole meal wheat flour + vital gluten.
WWGC = Whole meal wheat flour + vital gluten + whole chickpea flour.
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WWGF = Whole meal wheat flour + vital gluten + whole fenugreek flour.
WWGT = Whole meal wheat flour + vital gluten + turmeric flour.

Costs evaluation:-

Cost of any product is one of the limiting factors in the distribution and consuming of the product. Therefore, it is of importance to compare the blends costs with respect to its raw materials prices.

On the other hand, it should put in mined the manufacturing cost (preparation, processing and packaging as well as additional cost as profit for this issue). Both of raw materials prices and manufacturing cost for 100 gm of the tested pan bread are calculated according to Harper *et al.*, (1983) and data were presented in Table (10).

It was noticed that the highest total costs was found in WWGC blend. It was due to the higher raw materials price as a result of the higher price of chickpea and vital gluten. WWF blend pan bread was the lowest cost since it was free vital gluten, which is very high price.

Finally, some of the tested material could be considered as a good tool, in spite of the high cost, to prepare high protein pan bread with high quality and long shelf life and it should estimated with respect to its health impacts.

Table (10): Cost prices, in piaster, of the manufactured pan bread.

Ingredient	Pan bread prepared blends from											
	WWF		WWG		WWGC		WWGL		WWGF		WWGT	
	g/100g	Price	g/100g	Price	g/100g	Price	g/100g	Price	g/100g	Price	g/100g	Price
Whole meal	100	30	70	21	65	20	65	20	65	20	69	21
Gluten			30	42	30	42	30	42	30	42	30	42
Chickpea					5	4						
Lupin seed							5	3.5				
Fenugreek									5	3		
Turmeric											1	1.5
Sucrose	1.5	0.45	1.5	0.45	1.5	0.45	1.5	0.45	1.5	0.45	1.5	0.45
Salt	1	0.05	1	0.05	1	0.05	1	0.05	1	0.05	1	0.05
Yeast	5	2.5	5	2.5	5	2.5	5	2.5	5	2.5	5	2.5
Bread improver	1	0.45	1	0.45	1	0.45	1	0.45	1	0.45	1	0.45
Ingredient cost		33.45		66.45		69.45		68.95		68.45		67.95
Preparation		0.73		1.50		1.52		1.51		1.5		1.49
Processing		8.96		17.8		18.6		18.47		18.34		18.21
Packaging		10.78		21.4		22.4		22.23		22.07		21.9
Profit		13.84		26.78		27.99		27.79		27.59		27.93
Total costs		67.4		133.93		139.26		138.95		137.95		136.93

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التقييم الكيميائى والطبيعى والميكروبيولوجى والاقتصادى لخبز القالب المصنع من الجلوتين والبقوليات والحلبة والكركم

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الهدف من الدراسة هو الاستفادة من حبة القمح الكاملة وبعض البقوليات لتجهيز خبز القالب وتقييمه من حيث صفاته الكيميائة والطبيعية والميكروبيولوجية. وقد اتضح من التقييم الكيميائى إحتواء الجلوتين التجارى والبقوليات (الحلبة- الترمس-الحمص) على نسبة عالية من البروتين ومع اختلاف فى كمية المعادن فى المواد الخام .وبصفةعامة أظهرت الحلبة والكركم ارتفاعهم فى معظم العناصر المعدنية .ومن ناحية اخرى إحتواء الجلوتين التجارى على نسبة منخفضة من الالياف.

وقد أدت عملية الانبات إلىنقص بسيط فى البروتين والدهن ولكن أدت عملية الطبخ للبقوليات التى سبق إنباتها إلى زيادة فى الالياف. وأظهرت النتائج إرتفاع الجلوتين الرطب والجاف فى عينة الجلوتين التجارى وخلطات الخبز الناتج بالمقارنة بدقيق حبة القمح الكاملة. وأظهرت النتائج زيادة حجم الرغيف نتيجة إضافة الجلوتين بالمقارنة بالعينة الكنترول(خبز القمح من الحبة الكاملة) وذلك كنتيجة لزيادة إمتصاص الماء. كما لوحظ وجود إرتفاع معنوى للبروتين فى الخلطات المحتوية على الحمص-الترمس-الحلبة-الكركم بالمقارنة بالكنترول وكذلك إرتفاع معنوى فى المعادن من زنك وحديد وكالسيوم ومنجنيز فى معظم الخلطات بالمقارنة بالخبز الكنترول علي العكس منه في حالة الصوديوم والنحاس والماغنسيوم. وكان الخبز المحتوى علىالكركم أكثر إنخفاضا فى العدد الكلى للبكتريا والخمائر والفطريات و لم تكتشف بكتريا مجموعة القولون فى كل الخلطات. وعموما فقد أظهرالخبز المختبر أكثر قبولاً نتيجة أرتفاع درجات القبول الحسى.

وعامة فانه ينصح باستخدام دقيق الحبة الكاملة والجلوتين التجارى والبقوليات والحلبة والكركم في تجهيز وجبات تغذوية صحية مقبولة ومفضلة من الناحية الحسية.