J. Agric. Sci. Mansoura Univ., 32 (12): 10245 - 10255, 2007

CHEMICAL, RHEOLOGICAL AND QUALITY PROPERTIES OF BISCUITS SUPPLEMENTED WITH FENUGREEK FLOURS

Hussein, A. M. S.
Food Technology Dept., National Research Centre, Dokki, Cairo, Egypt

ABSTRACT

Raw, soaked and germinated fenugreek flour were prepared. Wheat flour (72% extraction) was partially replaced by raw fenugreek (RF), soaked fenugreek (SF) and germinated fenugreek (GF) flours in ratios of 5, 10, 15 and 20 %, then used for manufacture of biscuit. Chemical composition of raw materials and biscuits was determined. Rheological properties of doughs, baking quality (weight, volume, specific volume, diameter, thickness and spread ratio), color attributes and sensory characteristics of prepared biscuits were evaluated. The results revealed that fenugreek flour is considered as a good source for protein, fat, fiber and minerals (Ca, P, Fe and Zn). Water absorption, arrival time, dough development time (DDT) and dough stability increased as a result of replacing wheat flour using the prepared fenugreek flours, meanwhile mixing tolerance index (MTI) and dough weakening decreased. Baking quality, color attributes and organoleptic evaluation revealed that wheat flour can be replaced using 10% RF, 15% SF and 20%GF flours to produce acceptable and high nutritional value biscuits.
Kewords: wheat flour, fenugreek, rheological properties, organoleptic and biscuits.

INTRODUCTION

Biscuits are the most popular bakery items consumed nearly by all sections of the society in Egypt. Some of the reasons for such wide popularity are low cost in compared with other processed foods (affordable cost), good nutritional quality and availability in different forms, varied taste and longer shelf-life. Bakery products are sometimes used as a vehicle for incorporation of different nutritionally rich ingredients(Gandhi *et al.*, 2001; Sudha *et al.*, 2007).

Fortification with high protein legume flours could provide a good opportunity to improve the nutritional quality of protein consumed by many people. Also, fortification of wheat flour with non-wheat proteins increases protein quality by improving its amino acid profiles [Stark *et al.*, 1975; Hoover, 1979].

Fenugreek seeds can be a good supplement to cereals because of its' high protein (25%), lysine (6.7 g/16 g N), soluble (20%) and insoluble (28%) dietary fiber besides being rich in calcium, iron and beta-carotene (NIN, 1987). The seeds are known to have hypoglycemic (Neeraja & Rajyalakshmi, 1996; Shashi Kala 1997) and hypocholesterolemic properties (Khosla *et al.* 1995). Various traditional recipes of North India namely Laddo, Methi, Suhali, etc. prepared from wheat-fenugreek blends, are mainly consumed by the diabetic and hypercholesterolemic people (Sharma 1986; Shashi Kala 1997). However, the seeds are bitter in taste due to presence of saponins, which limit their acceptability in foods (Sharma, 1986; Udayasekhera & Sharma, 1987). It has been possible to debitter fenugreek

seeds by employing various processing methods such as soaking, germination, roasting, etc. (Sharma, 1986; Shashi Kala 1997). As fenugreek seeds are rich in mucilaginous fiber and other dietary essentials, their use can be utilized as functional and nutritional foods as well as therapeutic agent.

Autio *et al.*, (1998) reported that the germination–induced very extensive microstructure changes of cell walls in dough's. The larger values of the area of visible cell walls of the germinated than for the native grains suggest that germination induces swelling of cell walls, but the smaller values suggest that germination causes fading of cell walls. However, the microstructure examination of dough section showed that germination caused two types of structural changes in the cell walls: (1) swelling and (2) fading of the blue fluorescence of cell walls. Moreover, doughs made from flours of germinated grains were always softer than dough's made from flours of native grains. Hence, development and consumption of such therapeutic bakery products would help to raise the nutritional status of the population. Information on incorporation of treated and untreated legumes flour in bakery products is scanty.

Therefore, this study was designed to evaluate the effect of adding raw, soaked and germinated fenugreek flours at ratios of 5, 10, 15 and 20% on the chemical, rheological properties of dough, baking quality, color attributes and sensory characteristics of biscuits made from these blends.

MATERIALS AND METHODS

I-Materials

Fenugreek seeds, wheat flour (72%), shortening, sugar, salt and sodium bicarbonate were obtained from local market, Cairo.

П-Methods:

1-Processing:

Soaking. Fenugreek seeds were first cleaned and freed from broken seeds**,** dust and other foreign materials and then soaked in tap water for 12 h at 37 °C. A seed to water ratio of 1:5 (w/v) was used. The unimbibed water was discarded. The soaked seeds were rinsed twice in distilled water and then dried at 55-60 ° C.

Germination. The soaked seeds were germinated in sterile Petri dishes lined with wet filter paper for 48 h at 37 °C with frequent watering. The sprouts were rinsed in distilled water and dried at 55-60 °C. The dried samples of raw, soaked and germinated seeds were ground to obtain fine powder (60 meshes) and then stored in plastic containers for further use.

Preparation of flour mixtures. Wheat flour (72% extraction) was well blended with fenugreek flour (raw, soaked, and germinated) at different ratios of 5, 10, 15 and 20%, then prepared mixtures were used to manufacture biscuit.

2-Rheological properties

Rheological properties of doughs were evaluated using Farinograph (Model Type No: 81010 (31, 50 and 63 rpm), Brabender OHG, Duisburg, 1979 Germany) as described in (A.A.C.C., 2000).

3-Preparation and evaluation of biscuits

Biscuits were prepared by mixing 100 g of wheat flour 72% extraction and fenugreek flours, 30 of sugar, 15g of shortening, 0.93g of salt, 1.11g of sodium bicarbonate, required of water and 14.66 ml of dextrose solution (5.93%) according to the method described in (A.A.C.C.,2000).

Weight, volume, specific volume, diameter, thickness and spread ratio of biscuits were recorded. Organoleptic characteristics of biscuits were evaluated with some modifications, according to Zabic and Hoojjat (1984) by 10 trained panelists. The tested characteristics were color (10), flavor (10), taste (10), texture (10), appearance (10) and overall acceptability (10).

4-Chemical evaluation

Gross chemical composition

RF, SF, GF, wheat flour, and prepared biscuits were chemically analyzed for moisture, crude protein, fat, crude fiber and ash according to methods described in A.O.A.C. (1990).Total carbohydrates were calculated by difference (100-fat, protein, ash, and fibers on dry weight basis).

Selected minerals content

Calcium, phosphorus, potassium, sodium, iron and zinc in all samples of biscuits were determined after dry ashing using atomic absorption spectrophotometer (Chapman&Pratt, 1978).

5-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).

6-Statistical analysis

Data of organoleptic evaluation of biscuits were subjected to analysis of variance and least significant difference (L.S.D) at 0.05 level according to the method described by McClave & Benson (1991).

RESULTS AND DISCUSSION

1-Chemical composition of raw materials, biscuits and biscuits fortified with fenugreek A-Gross chemical composition

Data presented in Table (1) show gross chemical composition of wheat flour (W) 72%, raw fenugreek (RF), soaked fenugreek (SF), germinated fenugreek (GF) and the prepared biscuits. It is clear that fenugreek flour is a good potential source for crude protein, fat, crude fibers, and total ash. Moisture, crude protein, fat, crude fiber, and ash contents increased with increasing the RF, SF and GF level in wheat flour, whereas total carbohydrates contents decreased in biscuits fortified with RF, SF and GF compared to the control. The increase in protein, fat, ash and fibers of fenugreek supplemented biscuits can be attributed to the high content of those ingredients in fenugreek. These results are confirmed with the results

of Eissa *et al* .,(2007) ; Hooda & Jood (2003) who reported higher protein content of biscuits prepared from blends of wheat-raw and germinated fenugreek flour. This was also consistent with findings of Sharma & Chauhan (2000) who also reported higher protein content of breads prepared from blends of wheat-fenugreek flours.

Table (1): proximate composition of raw materials and fenugreek supplemented biscuits (On dry weight basis)

Samples	Moisture	Protein	Fat	Crude fiber	Ash	Total carbohydrate
W	11.5	12.50	1.40	.92	0.82	84.36
RF	6.87	28.30	7.16	8.96	3.28	52.30
SF	8.17	26.18	6.88	9.00	3.35	54.59
GF	7.51	29.65	6.22	9.36	3.89	50.96
Control	3.56	9.51	21.12	2.12	1.80	65.36
W:RF						
95:5	3.71	10.81	21.20	2.36	1.83	63.80
90:10	3.95	12.6	21.32	2.68	1.90	61.50
85:15	4.15	13.88	21.40	2.96	1.96	59.80
80:20	4.42	14.66	21.52	3.07	2.00	58.75
W:SF						
95:5	3.66	10.51	21.18	2.30	1.80	64.21
90:10	3.72	11.56	21.22	2.55	1.84	62.83
85:15	3.88	12.62	21.25	2.62	1.88	61.63
80:20	3.96	13.55	21.32	2.76	1.86	60.51
W:GF						
95:5	3.8	11.0	21.16	2.60	1.86	63.38
90:10	3.96	12.30	21.05	2.77	1.94	61.94
85:15	4.25	13.86	21.10	2.84	2.06	60.14
80:20	4.50	15.00	21.15	2.96	2.15	58.74

Where:
W, wheat flour; RF, raw fenugreek; SF, soaked fenugreek; GF, germinated Fenugreek

b- Minerals content of biscuits and biscuits supplemented with fenugreek flour

Data presented in Table (2) show the minerals content of both biscuits (control) and biscuits fortified with RF, SF and GF flour at levels of 5, 10, 15 and 20%. It is noticed that control samples had a lower content of Ca, P, Fe and Zn than biscuits supplemented with RF, SF and GF flour. Minerals content is increased with increasing the ratio of substitution of RF, SF and GF flour in wheat flour. This might be attributed to higher minerals content in fenugreek flour compared to that in wheat flour (72%). RF supplemented biscuits manifested higher contents of Ca, P, Fe and Zn, followed by soaked and germinated fenugreek supplemented-biscuits. This could be attributed to the leaching out of total minerals in soaking water (Jooda & Kapoor, 1997).

Table (2): Minerals content (mg/100g) of biscuits (calculated on dry weight basis)

Samples	Calcium	Phosphorus	Potassium	Sodium	Iron	Zinc
Control	30.24	188.16	98.86	620.00	2.28	3.62
W:RF						
95:5	37.60	205.18	95.11	618.12	2.56	3.90
90:10	42.00	223.83	92.02	610.18	3.16	3.90
85:15	45.88	240.77	88.16	605.66	4.32	4.02
80:20	50.42	252.65	85.00	603.31	5.57	4.32
W:SF						
95:5	36.20	203.22	94.91	615.32	2.50	3.82
90:10	40.18	220.26	92.19	602.71	3.08	3.86
85:15	43.36	237.11	89.19	590.07	4.26	4.01
80:20	47.50	250.14	84.18	581.19	5.22	4.28
W:GF						
95:5	37.00	206.10	98.66	610.02	2.52	3.96
90:10	41.62	225.17	95.68	600.17	3.10	4.16
85:15	45.90	243.09	93.46	580.32	4.30	4.26
80:20	49.08	258.20	90.33	581.16	5.50	4.51

Where:
W, wheat flour; RF, raw fenugreek; SF, soaked fenugreek; GF, germinated Fenugreek

Influence of raw, soaked and germinated fenugreek flours on dough mixing properties of biscuits.

The effect of replacing wheat flour (72% extraction) using RF, SF and GF flours at different levels (5, 10, 15 and 20%) on the rheological properties of doughs as measured by Farinograph are shown in Table (3). Addition of RF, SF and GF flours mainly enhanced the water absorption. By increasing the ratio of addition from 5% to 20%, water absorption increased from 65 to 75% for RF, 67 to 77% for SF and 64.5 to 75% for GF flour. Similar effects on water absorption were observed by Sudha *et al.* (2007) when wheat bran or rice bran was added to wheat flour as a source of fiber. Eissa *et al.*, (2007) reported that the differences in water absorption are mainly caused by addition of legumes flours as a source of protein and fiber. The extent of increase in dough development time (DDT) and dough stability which indicates the dough strength was higher in the case of addition of each of RF, SF and GF flours. Greater effects were obtained on the mixing tolerance index (MTI) values, which decreased with increasing the supplementation level from 5% to20%. Similar results were reported by Hussein & Hegazy (2007), when they added aleurone flour to wheat flour as a source of protein and fiber. The results showed that weakening of dough decreased with increasing the level of RF, SF and GF flours from 5% to20%.

Water absorption and arrival time increased by increasing the level of RF, SF and GF flours. Similar findings were observed by other authors (Rosell *et al.*, 2001; Doxastakis *et al.*, 2002; Sudha *et al.*, 2007). The increasing water absorption might be due to that RF, SF and GF flour containing more fiber, sugars and protein content, which retained more water.

Table (3): **Effect of supplementation of wheat flour (72%) biscuit with different levels of raw, soaked and germinated fenugreek flours on Farinograph reading.**

Samples	Water absorption (%)	Arrival time (min)	Development time (min)	Stability time (min)	Weakening (BU)	Mixing tolerance index (MTI)
Control	63.0	1.00	2.00	3.00	80	50
W:RF						
95:5	65.0	1.50	3.00	6.00	70	40
90:10	68.0	2.00	4.50	9.00	60	30
85:15	72.0	3.00	6.00	12.00	60	25
80:20	75.0	3.50	8.00	16.00	40	20
W:SF						
95:5	67.0	2.00	3.50	7.00	60	40
90:10	69.0	2.50	5.00	11.00	50	35
85:15	72.0	3.50	7.00	14.00	50	30
80:20	77.0	4.00	9.00	17.00	40	25
W:GF						
95:5	64.5	2.00	2.50	6.50	70	35
90:10	67.5	2.50	6.00	10.00	70	30
85:15	71.0	3.00	9.00	12.00	60	30
80:20	75.0	4.00	10.00	15.00	40	25

Color characteristics

Color characteristic is one of the major parameters that affect the quality of the final product. The fortified flours blends showed a difference in color in relation to their control (100% wheat flour). The slight improvement in color was interpreted as an intense color and it was dependant on the fortification level. Table 4 shows Hunter values of whiteness (L), redness (a) and Yellowness (b) measured for crumb and crust colors. All fortified samples had slightly lower L values for crust than the control and therefore a slightly darker crumb color. Similar findings were also obtained by Barron & Espinoza, (1993) and Eissa *et al.*,(2007), as they reported that,(L) value are declined in all fortified samples using legumes flour compared to control. It was confirmed that the RF, SF and GF flour biscuits were getting darker, more red (a-values) and with higher browning index (BI) than with germinated legumes flour and control samples. The results showed that the a-values (redness) are getting higher in the fortified biscuit samples with enhanced levels of RF, SF and GF flour from 5% to20% (Table 4). These results are consistent with those obtained by Ahmed (1999) and Kenny *et al.* (2000).

Table (4): Color characteristics of biscuits supplemented with raw, soaked and germinated fenugreek flours.

Samples	L	a	b	∆E
Control	74.12	2.74	25.51	76.75
W:RF				
95:5	69.65	5.27	28.21	73.64
90:10	70.11	5.35	30.65	75.01
85:15	64.17	7.67	34.50	71.57
80:20	66.20	7.07	30.31	71.46
W:SF				
95:5	70.51	5.65	29.31	74.88
90:10	67.01	7.79	32.25	73.07
85:15	61.37	10.26	35.50	69.95
80:20	60.68	10.31	36.79	70.02
W:GF				
95:5	67.29	6.54	30.03	72.28
90:10	62.94	7.36	30.26	68.52
85:15	55.85	10.04	31.85	63.38
80:20	57.28	10.15	29.54	63.54

Influence of raw, soaked and germinated fenugreek flours on physical characteristics of biscuits

Some physical characteristics of biscuits, such as thickness, diameter and spread ratio, were affected by increasing the level of RF, SF and GF flour (Table 5). The changes in diameter and thickness were reflected in spread ratio which was decreased consistently from 6.5-5.5 in RF, 6.5-5.2 in SF and 6.5-5.6 in GF flour at 20% level. These results indicated that the addition of RF, SF and GF flour adversely affected the thickness and diameter of consequently spread ratio of the supplemented biscuits. Kirssel & Prentice (1979) reported that cookies having higher spread ratios are considered most desirable). Other research workers reported that the thickness of supplemented biscuits increased, whereas the diameter and spread ratio decreased with the increasing level of rice bran-fenugreek blends, fenugreek flour and different bran blends (Sharma & Chauhan, 2002; Sudha *et al.*, 2007; Eissa *et al*, 2007). Reducing spread ratios of RF, SF and GF fortified biscuits could be attributed to the fact that composite flours apparently form aggregates with increased numbers of hydrophilic sites available for competing for the limited free water in cookie dough (McWatters, 1978). Rapid partitioning of free water of these hydrophilic sites occurs during dough mixing and enhanced dough viscosity, thereby limiting cookie spread and top grain formation during baking.

Table (5): physical characteristics of fenugreek supplemented biscuits

Samples	Diameter(w)	Thickness(t)	Spread ratio	Weight	Volume	Specific volume
Control	6.5	0.8	8.12	30.5	70	2.30
W:RF						
95:5	6.3	0.85	7.41	31.5	65	2.06
90:10	6.1	0.88	6.93	32.0	63	1.97
85:15	5.8	0.90	6.44	32.5	60	1.85
80:20	5.5	0.94	5.85	33.0	55	1.66
W:SF						
95:5	5.9	0.81	7.28	32.5	65	2.00
90:10	5.6	0.83	6.75	34.0	60	1.76
85:15	5.35	0.85	6.29	35.0	57	1.63
80:20	5.20	0.88	5.91	35.5	55	1.55
W:GF						
95:5	6.4	0.84	7.62	32.5	66	2.03
90:10	6.2	0.91	6.81	34.0	63	1.85
85:15	5.8	0.93	6.24	35.0	60	1..71
80:20	5.6	0.97	5.77	36.5	58	1.59

Sensory characteristics of biscuits

The effects of RF, SF and GF supplementation on the sensory characteristics of biscuits are presented in Table (6). With the increase in the level of fenugreek (RF, SF and GF) in the formulation, the sensory scores for color, odor, taste, texture, appearance and overall acceptability of biscuits decreased sharply. Replacement of wheat flour with 15% and 20% fenugreek flour (RF, SF and GF) impaired the taste of biscuits (control samples) had 8.4 score, which decreased significantly from 7.2 to 5.5 for RF, 7.8 to 6.6 for SF and 7.7 to 7.2 for GF. Thus, might be due to the bitter taste of fenugreek flour.

The appearance and overall acceptability score for control was 8.6 and 8.4 on a 10-point hedonic scale. Biscuits made from blends containing 5% level of RF and 10% level of SF flours did not differ significantly ($p<0.05$) from the control. At 15% and 20% levels of substitution, the appearance and overall acceptability was decreased. The GF flour-supplemented biscuits performed better than the other RF and SF flours. Similar observationwere also reported with supplementation of raw and germinated legumes flour-supplemented biscuits (Eissa *et al*, 2007) and rice bran-fenugreek blends flour (Sharma & Chauhan, 2002).

Organoleptic evaluation revealed that wheat flour can be replaced using 10% RF, 15% SF and 20%GF flours to produce acceptable and high nutritional value biscuits.

Table (6): Organoleptic evaluation of fenugreek supplemented biscuits.

Samples	Color (10)	Odor (10)	Taste (10)	Texture (10)	Appearance (10)	Overall acceptability (10)
Control	7.5^{ab}± 1.434	8.2 ^{a}± 1.549	8.4 ^{a}± 0.699	8.1^{a}± 1.523	8.6 ^{a}± 0.966	8.4 ^{a}± 0.843
W:RF						
95:5	7.7^{ab}±1.567	6.9 ^{abc} ±0.994	7.2 ^{bcd}±1.814	8.1 ^{a} ±0.738	8.2 ^{ab} ±1.135	7.7 ^{abc}±0.823
90:10	7.8 ^{ab} ±1.168	6.7 ^{abc}±1.418	5.7 ^{de} ±1.494	7.8 ^{ab}±0.422	7.4 ^{bc} ±1.074	6.3 ^{de} ±1.418
85:15	7.9 ^{ab}±1.101	6.8 ^{bc}1.317	5.6 ^{e} ±0.843	7.3 ^{ab}±2.163	7.4 ^{bc} ±1.350	6.0 ^{e} ±1.247
80:20	8.5 ^{a} ±0.972	7.0 ^{abc} ±1.491	5.5 ^{e}±1.841	7.7 ^{ab}±0.948	7.3 ^{bc} ±1.567	5.6 ^{e} ±1.838
W:SF						
95:5	8.5 ^{a}± 0.972	7.1^{abc}± 1.449	7.8 ^{ab}± 0.632	7.6 ^{ab}± 0.843	8.0 ^{abc}± 1.155	7.7 ^{abc}± 0.949
90:10	8.0^{ab}±0.943	6.8 ^{bc}±1.229	7.1 ^{bcd}±0.876	7.1 ^{ab} ±0.876	8.2 ^{ab} ±1.033	7.7 ^{abc} ±0.675
85:15	7.1 ^{b} ±1.449	6.7 ^{bc} ±1.059	6.3 ^{de} ±1.636	7.3 ^{b}±0.823	8.0 ^{abc}±0.816	7.5 ^{abc} ±0.707
80:20	8.3 ^{ab}±1.059	7.0 ^{abc} ±1.414	6.6 ^{cde} ±1.265	7.5 ^{ab}±0.707	7.6 ^{bc} ±0.843	7.5 ^{abc}±0.527
W:GF						
95:5	8.0 ^{ab}± 1.247	7.6 ^{ab}± 1.578	7.7 ^{abc}± 1.059	7.6 ^{ab}± 0.843	7.9 ^{abc}± 0.994	8.0 ^{ab}± 0.816
90:10	7.9 ^{ab}±1.449	6.8 ^{bc} ±1.229	7.3 ^{abcd} ±1.059	7.8 ^{ab}±0.789	7.9 ^{abc} ±0.876	7.5 ^{abc}±0.707
85:15	7.1 ^{b}±1.728	6.3 ^{c} ±1.703	7.2 ^{bcd} ±0.789	7.5 ^{ab}±0.849	7.1 ^{c} ±0.738	7.4 ^{bc}±0.843
80:20	8.0 ^{ab}±1.154	6.5 ^{bc} ±1.179	7.2 ^{bcd} ±0.789	7.6 ^{ab} ±0.843	7.4 ^{bc} ±0.843	7.0 ^{cd} ±0.667
LSD at 0.05	1.203	1.889	1.105	0.949	0.963	0.906

Where:
LSD: Least Significant Difference

Conclusion

This present study confirmed that fenugreek flour could be incorporated up to 10% level in the formulation of biscuits without affecting their overall quality. The chemical, physical and sensory properties, in general, revealed that biscuits containing 15% germinated fenugreek flour were the best among all the composite fenugreek flour biscuits. Baking quality, color attributes and organoleptic evaluation revealed that wheat flour can be replaced using 10% RF, 15% SF and 20%GF flours to produce acceptable and high nutritional value biscuits.

REFERENCES

A.A.C.C. (2000). Approved Method of the AACC. 10th ed., American Association of Cereal Chemists, INC. st., Paul, Minnesota, USA.

A.O.A.C. (1990). Official Methods of Analyses of the Association of Official Analytical Chemists 15 th . ed., Arlington, Virginia 22201, USA.

Ahmed, Z. S. (1999). Effect of hydrocolloids in Egyptian balady bread. II. Baking quality. J. Agric. Sci. Mansoura Univ., 24: 3535–3544.

Autio, K.; Fabritius, M. & Kinnunen, A. (1998). Effect of germination and water content on the microstructure and rheological properties of two rye doughs. Cereal Chem., 75:10-14.

Barron, J. & Espinoza, A. (1993). Fortification of maize tortilla with alkali-treated Chickpea flour. Int. J. Food Sci. Technol., 28: 505–511.

Chapman, H.D. & Pratt, P.F. (1978). Methods of analysis for soil, plants and water. P.50.Univ. of California, Div. Agric. Sci., Priced Publication 4034.

Doxastakis, G.; Zafiriadis, I.; Irakli, M.; Marlani, H. & Tananaki, C. (2002). Lupine, Soya and triticale addition to wheat flour doughs and their effect on rheological properties. Food Chem., 77:219–227.

Eissa, H.A.; Hussein, A.S. & Mostafa, B.E. (2007). Rheological properties and quality evaluation of Egyptian balady bread and biscuits supplemented with flours of ungerminated and germinated legume seeds or mushroom. Pol. J. Food Nutr. Sci., 57: 487–496.

Gandhi, A.; Kotwaliwale, N.; Kawalkar, J.; Srivastava, D.; Parihar, V. & Raghu Nadh, P. (2001). Effect of incorporation of defatted soy flour on the quality of sweet biscuits. J. Food Sci. Technol., 38: 502–503.

Hooda, S. & Jood, S. (2003). Effect of soaking and germination on nutrient and antinutrient contents of fenugreek *(TRIWNELLA FOENUM GRAECUM* L.). J.Food Biochem., 27: 165-176.

Hoover, W. (1979). Use of soy proteins in baked foods. J. Am. Oil Chem. Soc., 56: 301–305.

Hussein, A. M. S. & Hegazy, N. A. (2007). Effect of adding aleurone flour at different levels on pan bread quality. Minufiya J. Agric. Res., 32: 1349-1363.

Kenny, S.; Karina, W.; Catherine, S. & Elke, A. (2000). Incorporation of dairy ingredients into wheat bread: effects on dough rheology and bread quality. Eur. Food Res. Technol., 210: 391– 396.

Jooda, S. & Kapoor, A.C. (1997). Improvement in chickpea and blackgram through processing and cooking techniques. Intern. J. Food Sci. Technol., 48*:* 307-312.

Kirssel, L. & Prentice, M. (1979). Protein and fiber enrichment of cookie flour with brewer's spent grains. Cereal Chem., 50: 261– 265.

Khosla, P.; Gupta, D.D. & Nagpal, R. K. (1995). Effect of *Trigeonella faenurn* Graecum (fenugreek) on serum lipids in normal and diabetic rats. Ind. J. Pharm., 27:89-93.

McClave, J.T. & Benson, P.G.(1991).Statistics for business and economics. Maxwell Macmillan International Editions. Dellen Publishing Co.USA, pp:272-295.

McWatters, K. (1978). Cookie baking properties of defatted peanut, soybean and field pea flours in baking powder biscuits. Cereal Chem., 55: 853–863.

Neeraja, E. A. & Rajyalakshmi, P. (1996). Hypoglycemic effect of processed fenugreek seeds in humans. J. Food. Sci. Technol., 33:427-430.

NIN Report. (1987). Use of fenugreek seed powder in the management of non insulin dependent diabetes mellitus. NIN, ICMR, Hyderabad, India.

Rosell, C.; Rojas, J. & Benedito, B. (2001). Influence of hydrocolloids on dough rheology and bread quality. Food Hydrocoll., 15: 75–81.

Sharma, R. D. (1986). Effect of fenugreek seeds and leaves on blood glucose and serum insulin responses in human subjects. Nutr. Res., 6: 1353-1364.

Sharma, H. & Chauhan, G.(2000). Physicochemical and rheological quality characteristics of fenugreek *(Triwnella foenum graecum* L.) supplemented with wheat flour. Int. J. Food Sci. Technol., 37: 87-90.

Sharma, H. & Chauhan, G. (2002). Effects of stabilized rice bran-fenugreek blends on the quality of breads and cookies. J. Food Sci. Technol., 39: 225–233.

Shashi, Kala (1997). Management of non insulin dependent diabetes mellitus by using traditional medicinal plant products. Ph.D. Thesis. Haryana Agric. Univ., Hisar, India.

Stark, A.; Satterlee, L. & Kendrick, J. (1975). Computer blending and laboratory evaluation of added food proteins for specific functional and nutritional properties. Food Prod. Devel., 9: 38–42.

Sudha, M.; Vetrimani, R. & Leelavathi, K. (2007). Influence of fiber from different cereals on the rheological characteristics of wheat flour dough and on biscuit quality. Food Chem., 100: 1365– 1370.

Udayasekhera, P. & Sharma, R.D.(1987). An evaluation of protein quality of fenugreek seeds and their supplementary effect. Food Chem., 24:1-5.

Zabik M E & Hoojjat P (1984). Sugar-shap cookies prepared with wheat-navybean sesame seed flour blends. Cereal Chem., 61: 41–4.

الخواص الكيماوية والريولوجية و الجودة للبسكويت المدعم بدقيق الحلبة

أحمد محمد سعيد حسين

قسم الصناعات الغذائية – المركز القومى للبحوث – القاهرة- مصر

اجري البحث بهدف دراسة إمكانية الاستبدال الجزئي لدقيق القمح استخلاص ٧٢% بدقيق الحلبة الخام والمنقوعة والمنبتة فى إنتاج بسكويت مرتفع القيمة الغذائية٠حيث تم إعداد دقيق الحلبة الخام والمنقوعة والمنبتة واستبدال دقيق القمح استخلاص ٧٢% بنسب ٥ ,١٠ , ١٥ ,٢٠% من الدقيق المعد كلا علي حدة فى إنتاج البسكويت٠ تم إجراء التحليل الكيماوي للمواد الخام والبسكويت الناتج بالإضافة إلي تقييم الخواص الريولوجية وخواص الجودة في الخبيز واللون والخواص الحسية للبسكويت الناتج٠ وقد اوضحت النتائج المتحصل عليها أن دقيق الحلبة مصدر جيد للبروتين و الدهن و الألياف والمعادن(كالسيوم- فوسفور- حديد - زنك)٠ زيادة معدل امتصاص الماء و زمن الوصول و زمن تكوين العجينة ودرجة الثبات مع زيادة نسبة الاستبدال فى حين قلت قيم إل MTI وضعف العجينة فى الدقيق المدعم بالحلبة مقارنة بالكنترول٠اوضح اختبار ا للون وجودة الخبيز والتقييم الحسي للبسكويت الناتج أن النسب ١٠, ١٥ و٢٠% من دقيق القمح يمكن أن تستبدل بدقيق الحلبة الخام و المنقوعة والمنبتة على التوالي وتستعمل في إنتاج بسكويت مقبول حسيا وذو قيمة غذائية عالية (مرتفع في نسبة البروتين والألياف والأملاح المعدنية) ٠