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EFFECT OF SOME CONVENTIONAL PROCESSING METHODS ON QUALITY OF SUBSTITUTED CAKE WITH CHICKPEA FLOUR.

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ABSTRACT: *Chickpea flour was subjected to soaking in distilled water for overnight at room temperature, cooking with microwave oven for 5 mins. at 10 power level and fried in corn oil at 170 °C for 1 min. Also, the substitution of soft wheat flour with raw and processed chickpea flours at levels of 5,10,15,20 and 25% to produce cake was studied. Chemical composition, protein fractions, protein solubility in water and 0.5 N NaCl and in-vitro protein digestibility (IVPD) of chickpea flours were determined. Baking, colour and sensory characteristics of cake samples were evaluated. The results showed that soaking increased protein, fat and ash contents in fried flour. While, total dietary fiber (TDF) increased in microwave cooked flour compared with other samples. All processing methods decreased the content of soluble dietary fiber (SDF) and increased insoluble dietary fiber (IDF) content except in fried flour samples. Protein fractions of soaked flour showed the highest values. Reductions in non-protein nitrogen and protein solubility values in both water and NaCl solution were observed in all processed flours as compared with the raw flour. Microwave cooked flour had the highest IVPD among all the studied samples. Weight, volume and specific volume of cakes increased in all samples as the level of substitution increased compared with the control. Cake samples had lower (L) lightness and higher (a) redness and (b) yellowness values than the control. Cakes substituted with different levels of raw and processed flours were higher in protein, fat, ash and fiber contents than the control. Cakes contained raw flour had high values of protein and increasing fat and ash contents in samples contained fried flour. Fiber content was increased in cakes contained microwaved flour as compared with other cake samples. Cakes at all levels of substitution with soaked flour had the highest scores for all sensory characteristics. While, highest values in colour, taste and flavour were occurred in cakes contained fried flour among samples produced with substitution.*

Key words: *chickpea flour, processing, cake.*

INTRODUCTION

Chickpea (*Cicer arietinum L.*) is an important and cheap source of vegetable protein which can be used as a substitute for animal protein.

Chickpea seed contains between 14.9 and 30.6% crude protein (Chavan et al., 1986). Total dietary fiber (TDF) of the whole dry seed ranged from 14.57 to 20.14% (Prosky et al., 1992). Recent studies have indicated that dietary fiber may be considered as protector against cardiovascular diseases, diabetes, obesity, colon cancer and other diverticular diseases (McPherson, 1992). Characterization of the different protein fractions of chickpea seed has been achieved. Globulins are the storage proteins, the major fraction being in the cotyledons (Singh et al., 1988 and Clemente et al., 1998 a). The albumin fraction is mainly compounded of enzymes and anti-nutritional factors, playing an important biological role in legume seeds. Chickpea seed is processed and cooked in a variety of forms depending upon traditional practices and taste preferences. Different domestic processing methods (decortication, soaking, sprouting, fermentation, boiling, roasting, parching, frying, steaming) were used to obtain a suitable texture for the consumer, improvement in the nutritional factors and increase the protein digestibility of chickpea seed (Attia, 1994). Soaking, usually an overnight operation, is an important previous step to cook, because it reduces the necessary time for reaching an adequate texture in the cooking process (Clemente et al., 1998 b). Cooking softens legumes and the determination of the most appropriate conditions to obtain a tender product in several legumes has been reported (Ghandi and Bourne 1991, Uzogara et al.1992). Studies have shown that microwave heating did not affect nutrient content in foods more than conventional cooking due to shorter preparation times and smaller amounts of water (Finot and Merabet, 1993, Lassen and Ovesen, 1995). There have been fewer investigation on the effect of microwave cooking on dietary fiber which was generally slight and less pronounced than the effects of conventional boiling (Nyman et al., 1994, Svanberg et al., 1995). The chemical composition and nutritive value of chickpea protein are both affected by processing methods (Singh, 1985). An increase of in-vitro protein digestibility of legume seeds after heat treatment has been reported, probably resulting from protein denaturation and inactivation of protease inhibitors (Tan et al., 1984, Khokhar and Chauchan, 1986, Salunke and Kadam, 1989). However, in spite of the general positive effect of cooking, the final protein digestibility seems to depend on the type of process applied (Barampama and Simard, 1994).

Hernandez and Sotelo (1987) reported that, tortillas were prepared from corn masa supplemented with 0-30% (w/w) chickpea flour. It was added either as cooked flour to the lime-treated masa or as raw flour to the corn flour before lime-treated. Tortilla protein and fat contents increased with levels of chickpea flour and being higher in samples of lime-treated masa contained cooked chickpea flour. Highest protein efficiency ratio was in samples of corn flour masa before lime- treated contained 20% raw chickpea flour. The acceptability of experimental tortillas was similar to that of the controls.

Davinder and Hira (1988) stated that chapatis (unleavened bread) and parathas (unleavened shallow-fried bread) were made from various combinations of durum (*Triticum durum*) and aestivum (*Triticum aestivum*) wheat to test their organoleptic acceptability. The best accepted durum / aestivum (40:60) combination was supplemented at 10, 20, 30 and 40% levels with bengal gram (*Cicer arietinum*) flour and soy protein (*Glycine max*) concentrate.

Barron and Espinoza (1993) reported that, the alkali-treated chickpea meal was used to fortify a commercial corn flour for tortilla preparation at levels 5, 10, 15, 20 and 25% (w/w). Fortified tortillas showed a significant increase in nutritional value with improved colour and texture when compared to the corn tortilla (control).

Duarte and Castell (1995) indicated that, fortification of dry corn masa flour with chickpea (up to 30%) and partially defatted peanut meals (up to 25%) in 6 combinations were stored as masa and composite doughs for 6 months. Fortifications increased protein contents of flour, but also increased fat and moisture contents and improved dough texture and manageability during frozen storage, producing a softer product.

Siddique et al. (1996) found that, supplementation of wheat flour with undecorticated chickpea flour at levels of 3, 5, 7 and 10% for chapati (unleavened wheat bread). Chapatis containing 10% chickpea flour were rated highly acceptable and the nutritional value of breads were improved.

The present work was carried out to study the effect of different processing methods (soaking, cooking with microwave and frying) on chickpea flour and evaluate the quality of produced cake substituted with raw and processed flours at levels of 5, 10, 15, 20 and 25%.

MATERIALS AND METHODS

Materials:

Chickpea (*Cicer aritinum, L.*) variety Giza 88 was obtained from the Field Crops Research Institute, Agricultural Research Centre, Ministry of Agriculture, Giza, Egypt. Soft wheat flour (72% extraction), was obtained from Mills of North Cairo Company. Trypsin enzyme which used for in-vitro protein digestibility (IVPD) was from bovine pancreas type III, 16.500 BAEF Umg-1, peptidase from porcine Intestinal Mucosa 50 Ug-1 and Chymotrypsin from bovine pancreas type II 44 Umg-1. All enzymes were purchased from Sigma Chemical Co. (St. Louis, USA).

Processing methods :

Soaking

Seeds free from broken seeds, dust and other foreign materials were soaked in distilled water (1:20, w/v) for overnight at a room temperature. The soaked seeds were drained and dehulled.

Cooking

Dehulled soaked seeds were cooked in distilled water (1:20, w/v) in beakers using microwave oven (Goldstar model. No. ER-535MO, 245OMHZ, 980w, Korea) with power level 10 for 5 min.

Frying

Dehulled soaked seeds were fried in corn oil using frying pan at 170°C for 1 min. After frying seeds were placed on filter paper to absorb oil residue. Fried seeds were defatted by the soxhlet procedure.

The soaked, cooked and fried seeds were mashed separately and dried at 50°C for 10h in an electric oven with a motor fan. Raw seeds after dehulling and processed seeds were ground to pass through a 30 mesh sieve and kept in polyethylene pouches until analysis.

Analytical Methods:

Moisture, protein, ash, fat and crude fiber contents were determined according A.O.A.C. (1995). Total carbohydrates were calculated by difference. Total dietary fibers (TDF) were determined according to the method described by A.O.A.C. (1995) using TDF-100A Kit from Sigma (Product No. TDF-C10, St. Louis, USA). The insoluble dietary fibers were determined by weight the dried residue that remained after the enzymatic treatment. The soluble dietary fiber values were obtained by the difference between the total and insoluble dietary fiber fractions.

Protein fractions:

Protein fractions were determined according to the method described by Gheyassudin et al. (1970). Extraction solvents were distilled water, 5% NaCl, 70% ethanol and 0.2% NaOH. One g of each sample placed in beaker and equal volume of distilled water, 5% NaCl, 70% ethanol and 0.2% NaOH. One g of each sample placed in a breaker and added equal volume of distilled water into each beaker was added. The extraction was carried out at room temperature with continous stirring and then centrifuged at 3000 rpm for 30 min. The extraction was repeated by the same method three times and the supernatants obtained contained albumin. The same procedures were repeated on the above residues using extractants of 5% NaCl at pH7, 70% ethanol and NaOH at pH 11 for extracting globulins, prolamines and glutelins, respectively. The supernatants of each extraction were combined and made up to known volume with distilled water and used for total nitrogen determination.

Protein solubility :

Protein solubility of raw and processed flours was determined according to Clemente et al. (1998a) in water or in 0.5N NaCl at pH 7.0 and 1:20 (w/v) ratio was used. The pH was adjusted by 0.5 N HCl or 0.5 N NaOH. The suspension was shaken for 1h at room temperature and centrifuged at 6000 rpm for 15 min. Supernatant was analyzed for nitrogen by micro – kjeldahl method. Protein solubility is expressed as a percentage of the total protein content (N x 6.25) in each sample. Total nitrogen and non-protein nitrogen contents in samples were determined using a micro-kjeldahl method (A.O.A.C, 1995). Crude protein content was calculated using a factor of 6.25. An extraction of samples with 10% trichloroacetic acid (TCA) was carried out for determination of non-protein nitrogen (Singh and Jambunathan, 1981).

In-vitro protein digestibility (IVPD) :

The in-vitro protein digestibility of the various samples was determined using the multienzyme technique of Hsu et al. (1977). Ground samples were hydrated with enough distilled water to give a 6.25 mg protein / ml mixture for at least 1h at 4°C. The IVPD was calculated according to the regression equation: Y = 210.464-18.103X. Where: Y = in-vitro protein digestibility (%) and X = pH of the sample suspension after a 10 min. digestion with the multienzyme solution. The results were expressed on dry matter basis.

Cake preparation:

The cake formulations for use in this study were adapted from the work of Pyler (1973). Cakes were prepared containing 5, 10, 15, 20 and 25% of different forms of chickpea flour. Batter was poured into pans and baked in an electric oven for 25 min. at 175°C.

Cake properties:

The cake volume was measured by rape seed displacement method (Bennion and Bamford, 1973). The cake was weighed after one hour of baking and specific volume was estimated.

Colour evaluation:

Cake colour differences were measured by using a spectro-colorimeter (Tristimulus colour machine) with CIE lab colour scale (hunter, Lab scan XE, Reston VA.) calibrated with a white standard tile of Hunter Lab colour standard (LX NO.16379): X=77.26, Y=81.94 and Z=88.14 (L*=92.51, a*=-0.88, b*=-0.16). Colour difference (ΔE) was calculated from a, b and L parameters, using Hunter-Scotfield's equation (Hunter, 1975) as follows:

$$\Delta E = (\Delta a^2+\Delta b^2+\Delta L^2)^{1/2}$$

Where a = a-a°, b = b-b° and L = L-L°.

Subscript "o" indicates colour of the control. Hue angle (tg^{-1} b/a) and saturation index $\left[\sqrt{a^2+b^2}\right]$ were also calculated.

Sensory evaluation :

Sensory evaluation was done by a ten semi-trained panelists from the staff of the Food Technology Research Department, National Research Centre according to the method described by Bennion and Bamford (1973). Cake samples were evaluated for colour, taste, flavour, texture and tenderness.

Statistical analysis :

The results were statistically analyzed by the analysis of variance and least significant difference (L.S.D) at 0.05 level according to the method described by Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

Chemical composition of chickpea flours:

Data in Table 1 indicated that, raw flour was higher in protein and soluble dietary fiber contents than other flours. Soaking, microwave cooking and frying reduced the protein content of raw flour by 3.31, 8.49 and 12.54% respectively. El-Bedawey et al. (1989) found similar results; i.e., a reduction in protein content of soaked faba bean in tap water from 8-20h. Also, Alonso et al. (1998) stated that soaking of pea seeds in water for 12 h reduced their protein content. Total carbohydrates reached to the highest value (65.30%) in microwaved flour. Fried flour had higher values of both fat and ash compared with the other samples. Crude fiber, total dietary fiber and insoluble dietary fiber were increased to 2.77, 22.81 and 20.95%, respectively in microwaved flour which represented the highest values between the samples. The chemical bases for changes in the dietary fiber contents of foods during the cooking remain unclear. It has been proposed that the formation of resistant starch and Maillard reaction products together with condensed tannin-protein products could contribute to the increased dietary fiber as dry matter in lost during the cooking, where not all cooking water is absorbed by samples (Mongeau and Brassard, 1995). Retrograding amylose is the main component of resistant starch (Russel et al., 1989; Siljestrom et al., 1989). Legume starch has a high amylose content compared to other starchy foods. These results are in agreement with those obtained by Hidalgo et al. (1997). They reported that boiling of chickpea in water for 4 h increased markedly total dietary fibers to 25% and insoluble dietary fibers to 24%.

Table (1): Chemical composition of raw and processed chickpea flours (on dry weight basis).

Chickpea flour samples	Protein %	Fat %	Ash %	Crude Fiber %	TDF* %	IDF** %	SDF*** %	Total carbohydrates %
Raw	25.68	5.41	3.23	1.58	15.96	11.44	4.52	64.10
Soaked	24.83	5.66	2.98	1.94	17.62	13.69	3.93	64.59
Microwaved	23.50	5.88	2.85	2.47	22.81	20.95	1.86	65.30
Fried	22.46	8.12	4.61	1.32	12.85	10.53	2.32	63.49

*TDF=Total dietary fiber
**IDF=Insoluble dietary fiber
***SDF=Soluble dietary fiber

Protein fractions of chickpea flours:

From the data in Table 2 it could be observed that, globulin was the major fraction between chickpea protein fractions and ranged from 54.13 to 61.94%. Glutelin and albumin were found to be the second and the third protein fractions ranging from 14.69 to 16.83% and from 12.85 to 14.78%, respectively. Prolamin was the lowest protein fraction. Similar results obtained by Singh and Jambunathan (1981), Singh et al. (1988) and Clemente et al. (1998a). As they reported, globulins are the major seed protein, ranging between 60 and 80% and the albumin fraction from 12 to 23%. Raw flour contained high values of all protein fractions. The reduction in protein fractions contents of processed flours were ranged from 3.47 to 12.61%, 3.74 to 12.71%, 3.51 to 13.06% and 5.00 to 13.75% for globulin, glutelin, albumin and prolamin, respectively. Lowest values in protein fractions were observed in fried flour. These results may be due to the reduction in protein content of processed chickpea flour. (Attia 1994).

Table (2): Protein fractions in raw and processed chickpea flours.

Chickpea flour samples	Protein fractions %				Residue %
	Albumin	Globulin	Prolamin	Glutelin	
Raw	14.78	61.94	2.40	16.83	3.82
Soaked	14.26	59.79	2.28	16.20	7.05
Micowaved	13.46	56.61	2.17	15.36	11.32
Fried	12.85	54.13	2.07	14.69	14.86

Nitrogen compounds, protein solubility and IVPD values of chickpea flours:

The results obtained in Table 3 shows that high values of total nitrogen and non-protein nitrogen were presented in raw flour. Such phenomena may be due to its protein content which is higher than that in other flours and also due to the effect of processing methods on nitrogen compounds. El-Bedawey et al. (1989) reported similar observations for total protein and non-protein nitrogen in faba bean when soaked in tab water and saline solutions from at 8-20 hr. Generally, protein solubility values of all flours decreased in water and NaCl solution. The rate of decreasing ranged from 8.40 to 57.72% in water and from 16.50 to 50.23% in NaCl solution. Highest value of protein solubility was found in raw flour. Such findings obtained by Carbonaro et al. (1997). They found that, a marked reduction in protein solubility in water or in NaCl solution for soaked faba bean, lentil, chickpea and dry white bean seeds after cooking by an autoclave for 20 min at 120°C (1atm). IVPD value of microwaved flour represented the highest value between the flours. Processing methods increased the IVPD value of raw chickpea flour by 11.00 and 17.93% with soaking and microwave cooking, respectively, while the frying reduced the value of IVPD in the same flour by 9.36%. These results are in agreement with those obtained by Parihar et al. (1993). They reported that IVPD increased from 60% in faba bean (control) to 83 and 80% after autoclaving and pressure cooking for 15 min and 20 min, respectively. In the same respect Shashikala and Prakash (1995) found that, IVPD of microwaved and fried flour samples of green gram were 79.30 and 65.0%, respectively during the preparation of papads (a traditional Indian food) from decorticated green gram meal.

Table (3): Nitrogen protein solubility and IVPD value in of raw and processed chickpea flours.

Chickpea flour samples	Protein %	Total nitrogen %	Non-protein nitrogen %	Protein solubility %		In-vitro protein digestibility (IVPD)
				In water	In 0.5N NaCl	
Raw	25.68	4.11	0.52	82.59	53.71	68.93
Soaked	24.83	3.97	0.40	75.60	44.85	76.51
Microwaved	23.50	3.76	0.31	48.30	37.64	81.29
Fried	22.46	3.59	0.23	34.92	26.73	62.48

Baking quality of cakes :

Results In Table 4 shows that, cake samples contained raw and processed chickpea flours at all levels of substitution had higher values of weight, volume and specific volume than the control. The rate of increasing in weight and volume of cakes reached to maximum values in cakes substituted with soaked flour. Maximum values of specific volume occurred in cakes substituted with microwaved flour. The same results were obtained by Mustafa et al. (1986). They reported that, cowpea flour was used to replace 10, 15 and 20% of wheat flour in bread. Cowpea replacement at 10% improved the specific volume and other characteristics of bread slightly. In this respect, Figuerola et al. (1987) found that, supplementation of wheat flour with chickpea flour at levels ranged from 5 to 15% increased weight and volume values of bread.

Table (4): Baking quality of cakes substituted with raw and processed chickpea flours.

Cake samples	Weight (g)	Volume (cm^3)	Specific volume (cm^3/g)
Control	120	364	3.03
Cake substituted with raw chickpea flour at levels of :			
5%	122	380	3.11
10%	125	398	3.18
15%	127	411	3.24
20%	130	429	3.30
25%	132	444	3.36
Cake substituted with soaked chickpea flour at levels of :			
5%	127	391	3.08
10%	130	406	3.12
15%	132	419	3.17
20%	135	437	3.24
25%	138	456	3.30
Cake substituted with microwaved chickpea flour at levels of :			
5%	124	389	3.14
10%	127	407	3.20
15%	130	423	3.25
20%	132	438	3.32
25%	135	457	3.39
Cake substituted with fried chickpea flour at levels of :			
5%	123	381	3.10
10%	126	398	3.16
15%	129	414	3.21
20%	131	430	3.28
25%	133	446	3.35

Colour values of cakes:

Hunter colour values of cakes (L*) lightness, (a*) redness and (b*) yellowness are presented in Table 5. Results showed that cakes contained soaked flour tended to be less lighter, while red and yellow colours tended to increase with increasing the level of substitution and represent the nearest colour values to the control results. The same trend was observed in colour values of cakes contained raw, microwaved and fried chickpea flours. Minimum values of (L*) lightness and maximum values of (a*) redness and (b*) yellowness were present in cakes substituted with fried chickpea flour at all levels. On the other hand, colour difference (ΔE) increased as the substitution level of chickpea flour increased. Great changes in colour difference (ΔE) values occurred in cakes contained fried flour. These results are in agreement with those reported by Singh et al. (1993). They studied the effect of composite flours prepared from wheat, green gram, bengal gram and black gram flours on manufacture of biscuits. They found that, colour of biscuits was adversely affected.

Table (5): Hunter colour values of cakes substituted with raw and processed chickpea flours.

Cake samples	L	a	b	a/b	Saturation	Hue	ΔE*
Control	66.71	19.52	49.30	0.40	53.02	68.40	—
Cake substituted with raw chickpea flour at levels:							
5%	60.68	20.27	50.72	0.40	54.62	68.22	6.24
10%	58.71	21.30	52.18	0.41	56.36	67.79	8.69
15%	57.50	23.73	53.39	0.44	58.43	66.04	10.92
20%	55.94	24.65	54.58	0.45	59.89	65.69	13.05
25%	54.83	25.48	55.67	0.46	61.22	65.41	14.74
Cake substituted with soaked chickpea flour at levels:							
5%	62.52	19.79	49.72	0.40	53.51	68.30	4.22
10%	60.90	20.54	50.63	0.41	54.64	67.92	6.05
15%	59.65	21.62	51.40	0.42	55.76	67.19	7.66
20%	57.48	22.80	52.57	0.43	57.30	66.55	10.33
25%	56.37	23.96	53.16	0.45	58.31	65.74	11.90
Cake substituted with microwaved chickpea flour at levels:							
5%	58.42	21.62	51.45	0.42	55.81	67.21	8.82
10%	56.74	23.35	53.89	0.43	58.73	66.57	11.62
15%	55.86	24.21	54.61	0.44	59.74	66.09	12.96
20%	54.95	25.64	56.57	0.45	62.11	65.62	15.12
25%	53.58	26.79	58.32	0.46	64.18	65.33	17.51
Cake substituted with fried chickpea flour at levels:							
5%	55.69	23.56	52.94	0.45	57.95	66.01	12.29
10%	54.28	25.10	54.23	0.46	59.76	65.16	14.49
15%	52.74	26.03	55.78	0.48	61.90	64.31	17.05
20%	50.37	28.39	57.29	0.50	63.87	63.64	20.24
25%	49.15	30.47	59.68	0.51	67.01	62.95	23.15

* Colour difference

Chemical composition of cakes:

From Table 6 it could be concluded that, protein, fat, ash and fiber contents of cakes substituted with chickpea flours at all levels were higher than the control. Values were increased by 2.29-30.43%, 0.98-8.94%, 4-55% and 2.52-38.36% for protein, fat, ash and fiber, respectively. Highest values of protein and fibers were presented in cakes contained raw and microwaved flour, respectively. Ash and fat contents were higher in cakes contained fried flour as compared with other substituted cakes. Similar findings were observed by Figuerola et al. (1987), who reported that supplementation of wheat flour with chickpea flour at 5, 10 and 15% levels increased protein, fiber, ash and fat values of bread. These results are in agreement with those reported by Dodok et al. (1993), who studied the effect of supplementation of wheat flour with 10 or 20% chickpea meal in bakery products. They found that bread and biscuits containing 10-20% chickpea meal had higher nutritional value than those made from wheat flour alone.

Table (6): Chemical composition of cakes substituted with chickpea flours (on dry weight basis).

Cake samples	Protein %	Fat %	Ash %	Fiber %	Total carbohydrates %
Control	11.37	22.48	2.00	1.59	62.56
Cake substituted with raw chickpea flour at levels of :					
5%	12.06	22.70	2.17	1.65	61.42
10%	12.72	22.94	2.29	1.71	60.34
15%	13.40	23.27	2.46	1.80	59.07
20%	14.16	23.51	2.60	1.90	57.83
25%	14.83	23.80	2.78	1.96	56.63
Cake substituted with soaked chickpea flour at levels of :					
5%	11.89	22.81	2.12	1.69	61.49
10%	12.57	23.10	2.23	1.78	60.32
15%	13.26	23.39	2.38	1.89	59.08
20%	13.92	23.62	2.56	2.00	57.90
25%	14.68	23.83	2.70	2.09	56.70
Cake substituted with microwaved chickpea flour at levels of :					
5%	11.74	22.93	2.08	1.72	61.53
10%	12.42	23.24	2.16	1.83	60.35
15%	13.10	23.57	2.29	1.95	58.54
20%	13.65	23.78	2.47	2.10	58.00
25%	14.32	23.94	2.61	2.20	56.93
Cake substituted with fried chickpea flour at levels of :					
5%	11.63	23.12	2.21	1.63	61.41
10%	12.39	23.33	2.43	1.70	60.15
15%	12.96	23.72	2.65	1.78	58.89
20%	13.54	24.13	2.87	1.84	57.62
25%	14.16	24.49	3.10	1.91	56.34

Sensory characteristics of cakes:

Data in Table 7 represent the mean scores for colour, taste, flavour, texture and tenderness for prepared cakes substituted with raw and processed chickpea flours at different levels. The highest values for all sensory characteristics were observed in control sample. Cakes substituted with fried flour at all levels were found to be the highest values of colour, taste and flavour. The same trend for texture and tenderness was noticed in cakes substituted with soaked flour at all levels. There were no significant differences in colour between cakes substituted with soaked flour at of levels 5-15% and all substitution levels of microwaved flour and fried flour. Also, the same observation for colour was found between cakes substituted with all levels of raw flour and 25% soaked flour. In regard to taste, the substitution of cakes with raw flour at levels of 10-25% and 25% soaked flour had no significant differences between them. The same trend for tast was observed between levels of 5, 10 and 15% and levels of 10, 15 and 20% for

cakes substituted with soaked and microwaved flours, respectively. Cakes contained fried flour at all substitution levels had no significant differences in taste.

Table (7): Sensory characteristics of cakes substituted with raw and processed chickpea flours.

Cake samples	Colour	Taste	Flavour	Texture	Tenderness	Total
Control	9.3^{a}	9.4^{a}	9.2^{a}	9.5^{a}	9.6^{a}	47
Cake substituted with raw chickpea flour at levels:						
5%	7.6^{c}	7.9^{bc}	7.7^{cd}	8.5^{bc}	8.8^{ab}	40.5
10%	7.4^{c}	7.7^{c}	7.5^{de}	8.3^{c}	8.6^{ab}	39.5
15%	7.3^{c}	7.6^{c}	7.3^{de}	8.1^{c}	8.4^{ab}	38.7
20%	7.1^{c}	7.4^{c}	7.1^{de}	7.9^{c}	8.2^{ab}	37.7
25%	6.9^{c}	7.2^{c}	6.8^{e}	7.6^{cd}	8.1^{bc}	36.6
Cake substituted with soaked chickpea flour at levels:						
5%	8.5^{ab}	8.4^{abc}	8.3^{bc}	9.3^{ab}	9.4^{ab}	43.9
10%	8.3^{ab}	8.2^{abc}	8.1^{c}	9.1^{ab}	9.2^{ab}	42.9
15%	8.2^{ab}	8.1^{abc}	8.0^{c}	8.8^{ab}	9.0^{ab}	42.1
20%	8.0^{bc}	7.9^{bc}	7.7^{cd}	8.5^{bc}	8.8^{ab}	40.9
25%	7.8^{c}	7.7^{c}	7.5^{de}	8.2^{c}	8.6^{ab}	39.8
Cake substituted with microwaved chickpea flour at levels:						
5%	8.8^{ab}	8.6^{ab}	8.7^{ab}	8.1^{c}	8.2^{ab}	42.4
10%	8.6^{ab}	8.5^{abc}	8.6^{ab}	7.9^{c}	8.0^{bc}	41.6
15%	8.5^{ab}	8.3^{abc}	8.4^{bc}	7.7^{cd}	7.8^{c}	40.7
20%	8.3^{ab}	8.1^{abc}	8.3^{bc}	7.6^{cd}	7.6^{c}	39.9
25%	8.2^{ab}	8.0^{bc}	8.1^{c}	7.3^{de}	7.5^{c}	39.1
Cake substituted with fried chickpea flour at levels:						
5%	9.1^{ab}	9.2^{ab}	9.0^{ab}	7.4^{de}	7.6^{c}	42.3
10%	8.9^{ab}	9.0^{ab}	8.9^{ab}	7.1^{de}	7.4^{c}	41.3
15%	8.8^{ab}	8.9^{ab}	8.7^{ab}	7.0^{de}	7.1^{c}	40.5
20%	8.6^{ab}	8.7^{ab}	8.6^{ab}	6.8^{de}	6.9^{c}	39.6
25%	8.4^{ab}	8.6^{ab}	8.4^{bc}	6.5^{e}	6.7^{c}	38.6
$LSD_{0.05}$	1.29	1.38	0.77	0.94	1.46	

As shown in the same table, no significant differences in flavour were detected in cakes contained 10-20% raw flour and 25% soaked flour. Similar result was noticed for flavour between substituted levels (5-10%) of microwaved flour and levels of 5-20% of fried flour. Soaked flour improved the texture values of cakes from between the processed flours. Cakes contained soaked flour at levels of 5, 10 and 15% were the nearest to the

control. Minimum values in texture occurred in cakes substituted at levels of 25% and all levels of microwaved and fried flours, respectively.

Results of tenderness in the same table indicated that, all levels of substitution for cakes with soaked flour, 5-20% raw flour and microwaved flour were not significant differences betweed them. Similar result was presented between levels 25 and 10% for cakes substituted with raw and microwaved flour, respectively. There was no noticeable change due to the substitution with microwaved flour at levels of 15-25% and all levels of fried flour regarding tenderness evaluation. Such findings were reported by Figuerola et al. (1987). They found that, the supplementation of wheat flour with chickpea flour at 5, 10 and 15% levels did not seriously affect quality even at 15% substitution level. The addition of 10% chickpea flour allowed the preparation of a spongy bread with good quality. In this respect, Singh et al. (1993) reported that, acceptable biscuits can be prepared from wheat flour supplemented with green gram, bengal gram and black gram flours at a level of 15%. These results are in agreement with those reported by Sharma et al. (1995). They prepared flat breads from wheat flour and chickpea flour substituted at levels of 10 and 20%. Sensory evaluation revealed that acceptable quality flat breads could be produced by supplementation of wheat flour by chickpea flour up to 20% level.

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تأثير بعض طرق المعاملات التقليدية على جودة الكيك المدعم بدقيق حمص الشام.

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الملخص العربي

الهدف من هذا البحث هو دراسة تأثير معاملات النقع في الماء طوال الليل علي درجة حرارة الغرفة و الطبخ بالميكروويف و كذلك التحمير في زيت الذرة للعينات المعاملة بالنقع علي مستوي طاقة ١٠ لمدة ٥ دقائق ، ١٧٠°م لمدة دقيقة علي الترتيب لدقيق حمص الشام و استخدامه في عمل كيك بمستويات إحلال ٥، ١٠، ١٥، ٢٠، ٢٥% لدقيق القمح و تم تقدير التركيب الكيماوي ومحتوي مكونات البروتين والإذابة في الماء ومحلول كلوريد الصوديوم وقياس هضمية البروتين لجميع أنواع دقيق حمص الشام المستخدمة كما تم تقدير صفات الخبيز واللون وإجراء التقييم الحسي للكيك. وقد دلت النتائج علي أن الدقيق الخام كان الأعلى في محتوى البروتين مع زيادة محتوي الدهن والرماد في الدقيق المعامل بالتحمير بينما الطبخ بالميكروويف زاد من محتوي الألياف الغذائية الكلية بالمقارنة بباقي العينات. لوحظ أن جميع المعاملات أدت إلي خفض محتوي الألياف الغذائية الذائبة بينما ارتفع محتوي الألياف الغذائية الغير ذائبة في جميع العينات ماعدا الدقيق المعامل بالتحمير. أوضحت النتائج زيادة محتوي مكونات البروتين للدقيق الخام مقارنة بجميع العينات كما لوحظ انخفاض محتوي النتروجين غير البروتيني والإذابة للبروتين في الماء ومحلول كلوريد الصوديوم للدقيق المعامل بمعاملات النقع و الطبخ بالميكروويف والتحمير مقارنة بالدقيق الخام وكانت الهضمية للبروتين عالية في الدقيق المطبوخ بالميكروويف عن باقي العينات. أظهرت نتائج صفات الخبيز زيادة وزن وحجم الكيك بزيادة مستوي الإحلال وكان الكيك المحتوي على دقيق معامل بالنقع والطبخ بالميكروويف أعلى في الوزن والحجم على الترتيب بالمقارنة مع باقي العينات بينما زاد الحجم النوعي للكيك عن الكنترول بزيادة مستوي الإحلال لجميع العينات واتضح من نتائج قياس اللون للكيك بجهاز Hunter إنخفاض قيم L (lightness) وارتفاع قيم a (redness)، b (yellowness) عن الكنترول. اظهر التركيب الكيماوي للكيك المصنع بالإحلال بمستويات مختلفة من دقيق حمص الشام الخام و المعامل زيادة محتواه من البروتين و الدهن و الرماد و كذلك الألياف عن الكنترول. وكانت العينات المحتوية على دقيق خام عالية في البروتين مع زيادة محتوى الدهن والرماد للعينات المحتوية على دقيق معامل بالتحمير بينما الإحلال بالدقيق المطبوخ بالميكروويف أدى إلى زيادة محتوي الألياف في عينات الكيك. أوضحت نتائج التقييم الحسي أن الكيك المحتوي على دقيق معامل بالنقع بكافة نسب الإحلال سجل أعلى القيم لكافة الصفات الحسية وأعلى قيم للقوام والطراوة بعد الكنترول بينما كانت جميع عينات الكيك المحتوية على دقيق معامل بالتحمير عالية في قيم اللون والطعم والنكهة بالمقارنة بباقي عينات الكيك المصنعة بالإحلال.