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Chemical And Technological Evaluation For Producing Gluten-Free Cake

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Abstract

Celiac disease (CD) is a disorder of the small intestine caused by an inappropriate immune response to wheat gluten and similar proteins of barley and rye in genetically susceptible individuals. CD can be also referred to as celiac sprue, nontropicalsprue, gluten-sensitive enteropathy, or idiopathic steatorrhea. Eleven formulas were conducted to produce gluten-Free cake, chemical, physical, sensory evaluation and (Av and TBA) were determined. Results showed that, formula 12(100% soy flour) was the highest value in fat, ash, protein and crude fiber with values of means ± SD were 4.93±0.20, 3.92±0.12, 45.61±0.91 and 3.78±0.08 respectively. While, it was the lowest value in moisture and carbohydrate with values of mean ± SD were 8.25±0.25 and 45.54±1.23 respectively. Also, formula 11 was the highest values in chemical composition of baked cake. There were no significant differences (P≤0.05) between control and formulas4 and 5 in weight and specific volume properties, while there were significant differences between control cake and other all formulas in sensory evaluation. Data showed that, there were no significant differences (p≥0.05) between formula 1 as a control and all other formulas in acid value at zero time. Formula 11 was the highest value in avid value at(zero, 5 and 10 days) of storage for cakes storage, while formula 5 was the lowest value in acid value.

Conclusion: gluten-Free cakes made with rice flour were more acceptability than other flours.

Key words: gluten free- sensory and physical properties- TBA and AV.

Introduction:

Celiac disease (gluten sensitive enteropathy) is a disorder of digestive functions of the small intestine caused by the intake of gluten. People with celiac disease after consumption of gluten containing food exhibit symptoms typical for digestive disorders. In a longer period of time it results in a damage of small intestine vile **(Fasano and Catassi, 2001; Magalotti*et al*., 2003; Hotmeier and Caspary, 2006 and Kagnoff, 2007).**

Holtmeier and Caspary, (2006) reported that celiac disease (CD) is a disorder of the small intestine caused by an inappropriate immune response to wheat gluten and similar proteins of barley and rye in genetically susceptible individuals. CD can be also referred to as celiac sprue, nontropicalsprue, gluten-sensitive enteropathy, or idiopathic steatorrhea. Disease onset requires the individual to be sensitive to wheat gluten, ingest wheat gluten, and the mucosa integrity to be impaired through stress, infection, or mechanical injury to set off a pathological event **(Wieser and Koehler, 2008).** The first description of the disease was made more than 100 years ago by Samuel Gee, as a “celiac disorder”, defined as a chronic indigestion occurring in people of all ages, particularly in one-to- five years old children **(Sdepanian*et al*., 1999).** The general prevalence of CD is estimated to be one in 300 **(Collin *et al*., 1997)** although recent population-based screening studies suggest that the prevalence may be even higher (one in 100) **(Mustalahti*et al*., 2002).** Once thought to be a rare condition, Celiac disease is now understood to affect as many as 1:133 people in the US **(Fasano*et al*., 2003)** and 1:266 people worldwide **(Fasano and catassi, 2001).** It is a multifactorial disease associated with numerous nutritional deficiencies as well as reproductive issues and increased risk to thyroid disease, kidney failure and cancer. (**Samsel andSeneff, 2013**). An acceptable treatment is strict adherence to a 100 g/100 g gluten-free diet for life, which results in clinical and mucosal recovery. Nevertheless, the manufacture of bread without gluten results in major problems for bakers, and currently, many gluten-free products available on the market are of low quality **(Rosell, 2011).**

Treatment with a GFD (gluten free diet) in symptomatic patients has been shown to improve the symptoms, signs and complications of celiac disease. However, the effects of a GFD on diabetic control are less well established. **(Scaramuzza*et al*., 2013**).

The study focuses on production of Free-gluten bakery products (cakes) for celiac patients (special children) using raw materials available in

Egypt, such as corn, rice and soybean flour and in their blends at different levels.

Materials and Methods:

(a) Wheat flour (72% extraction) was purchased from the North Cairo Flour Mills Company.

(b) Rice flour :(*Oryza Sativa*), Shortening, sugar, vanilla, salt, eggs, and baking powder were obtained from the local market, Cairo, Egypt

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

(d) Soybean flour: (*Glycine max*)was purchased from Agric. Res. Center, Giza, Egypt.

(e) CMC: was purchased from Sigma Company.

Table (A) the mixtures used for the production of cake

formulas	Wheat flour (WF)	Gelatinized Corn flour (GCF)	Rice flour (RF)	Soybean flour (SF)
formula1 (control)	100%	---	---	---
formula2	---	75%	25%	---
formula3	---	50%	50%	---
formula4	---	25%	75%	---
formula5	---	---	100%	---
formula6	---	---	75%	25%
formula7	---	---	50%	50%
formula8	---	100%	---	---
formula9	---	50%	25%	25%
formula10	---	25%	50%	25%
formula11	---	25%	25%	50%

Chemical composition for raw materials and their blends, also for baked cake, physical properties, sensory evaluation, acid values and TBA were determined according to **A.O.A.C. (2000), A.A.C.C., (2000),Badr, (2009)**, **A.O.C.S., (1964)** and**Ottolenghi, (1959)** respectively.

Results and Discussions:

Table (1) contained the result of chemical composition of raw materials (wheat, rice, corn and soy flours) and their blends on dry weight basis. Results showed that, formula 12(100% soy flour) was the highest significantly in fat, ash, protein and crude fiber , while formula 5 was the lowest values of means ± SD were 4.93±0.20, 3.92±0.12, 45.61±0.91 and 3.78±0.08 VS. 0.71±0.02, 0.50± 0.02, 6.41±0.19 and 0.54±0.01 respectively. Besides that, formula 12 contained the lowest values in moisture and carbohydrate, formula 5 contained the highest values of moisture and carbohydrate 8.25±0.25 and 45.54±1.23 VS. 12.33 ± 0.12 and 92.38±0.23 respectively. On the other hand, there were significant differences (P≤0.05) between raw materials and their blends except between formula 1 and formula 2 in carbohydrate content. Also, results in table (1) illustrated that there were significant differences (P≤0.05) between all formulas except formulas 1 and 5 in fat content. While, there were no significant differences (P≥0.05) between formulas 1 and 5, 2 and 10, 3 and 6, and 7,8 and 9 in crude fiber content.

Our results were in agreement with those obtained by **Dewidar, (2001)** and **Abdel- Rahim, (2004)** they found that, wheat flour contained protein rang 11.57- 12.1%, carbohydrates 86.29- 82.15%, ash 0.56- 0.57%, fat 0.84-0.85% and crude fiber 0.74- 0.75%. also, **Mostafa (2014) and Hussein et al (2012)** they found that, chemical composition of gelatinized corn flour were 10.55- 12.52%, 8.43- 9.63%,4.39- 4.81%, 1.22- 1.47%, 3.07- 3.29% and 81.47-82.22% for moisture, protein, fat, ash, fiber and carbohydrate which nearest with our results. **Lovis, (2003)** and **Hammed *et al*., (2007)** studied chemical composition of rice flour and found that, it content 10.1%, 5.95-7.2%, .5- 1.42%, 0.4%, 0.5% and 80.13-91.9% for moisture, protein, fat, ash, fiber and carbohydrate respectively. Besides that, our results in the same line with **Asmaie, (1999)** and American Soybean Association (2003) they found that, soybean contained 13%, 38-51.11, 6.02-8.20, 2.90-7.52% and 28-36.53% for moisture, protein, ash, crude fiber and carbohydrates respectively. Wilde rang may be refer to climate, fertilizer, species and soil.

Concerning chemical composition of control cakes and different types of baked cakes were determined and recorded in table (2). From data in the table (2) it could be observed that, formula 11 contained the highest values (P≤0.05) in chemical composition except carbohydrate content, while formula 5 was the lowest values except carbohydrate was the highest with values were 28.43±1.14,17.13±0.52, 2.39±0.10, 23.32±0.70, 2.18±0.09 and 54.98±1.48 *VS.*25.34±1.5, 11.32±0.68, 1.13±0.07, 5.44±0.16, 0.35±0.01, and 81.76±0.91 g/100g respectively. On the other hands, there were significant differences (P≤0.05) between all formulas in majority of chemical composition.

Concerning protein content results in table (2) showed that, formula 11 and 7 were the highest significantly (p≤0.05) with values 23.32±0.70 and 22.67±0.91 than other all formulas under study. Besides that, there were there no significant difference (p≥0.05) between formula 9 and formulas (6 and 10) with value were 15.36±0.31 and (16.01±0.80 and 14.71±0.74) respectively. Also, there were there no significant difference ($p \geq 0.05$) between formula 8 and (1 and 2) also, between 3 and (2 and 4) also, between 4 and 5 with value were 8.05±0.24 and (8.82±0.27 and 7.40±0.30) 6.74±0.34 (7.40±0.30 and 6.09±0.06) and (6.09±0.06 and 5.44±0.16) in protein content respectively.

Concerning carbohydrate results in table(2) showed that, there were no significant difference ($p \geq 0.05$) between formula 4 and formula 5, formula 1 and 3 with mean ± SD were 79.83±0.92 and 81.76±0.91, 78.66±0.81 and 77.89±0.94 respectively. Also, there were no significant difference ($p \geq 0.05$) between formula (10 and 6) and (11 and 7) with mean ± SD were (67.40±1.20 and 67.29±1.19) and (54.98±1.48 and65.91±1.47) respectively.

Besides that, there were significant difference ($p \leq 0.05$) between formulas 9 and other all formulas under study. Also, there were significant difference ($p \leq 0.05$) between formulas 5, 8 and formula 9 with mean ± SD were 81.76±0.91, 74.23±0.96, and65.47±1.22 respectively.

Formula 11 in cakes was the highest value in all chemical composition (moisture, fat, ash, protein and crude fiber) except carbohydrate it was the lowest value in it. Our results agreement with **Hussein *et al*., (2012)** in cake made from gelatinized corn flour they found that, moisture, protein and ash which contained 26.01, 7.44 and 1.76 respectively.

Besides that, our results of chemical composition for cake and their blends which produced with corn, rice and soybean were agreement with those obtained by **Rubio *et al*., (2006)** and **Hammed *et al*., (2007)** they reported that, the substitution of wheat, corn, rice flour by soy bean increased percentage of protein in produced cake and biscuits from corn or rice flour and mixture of them. the substitution of corn flour with 40% rice flour increased percentage of protein to 14.1% followed by that made from 50% rice which recorded (10.3%) whereas, the lowest percentage of protein was found in pies made from 70% rice flour.

Concerning physical properties (weight, volume and specific volume) results in table (3) showed that, there were significant differences ($p \leq 0.05$) in weight between formulas (1, 6 and 11) and formula 2 with means ± SD were (60.74±1.82, 60.93±3.05 and 61.54±3.08) and 56.51±1.13 respectively. On the other hand, the same results found that, there were no significant differences ($p \geq 0.05$) in weight of cakes between formulas 3, 4, 5, 7, 8, 9 and 10 and formulas 1, 11 and 6 values of mean ± SD were 57.54±2.31, 60.28±3.02, 60.41±1.82, 59.06±0.59, 58.70±1.18, 58.83±1.77and 57.83±2.32 and 60.74±1.82, 61.54±3.08 and 60.93±3.05 respectively.

Formula 1 of cake was higher than all other formulas in volume with value 165±5 cm^3, however formula 9 was lower than other all formulas with value was 125±6 cm^3respectively.

Regarding there were no significant differences ($p \geq 0.05$) between formula 8, formula 2, formula 10 and formula 9 in volume with values were(130±1, 125.67±2.52, 125.67±2.52 and 125±6) respectively. Also, there were no significant differences ($p \geq 0.05$) between formula 4 and formulas (5 and 6) with values were 151±2 and (155±8 and 145±3) in volume respectively. Moreover, there were no significant differences ($p \geq 0.05$) between formulas 6, 7 and 11 with means ±SD were 145±2, 138±4 and 140±4 respectively. Also, there were no significant differences ($p \geq 0.05$) between formulas 3 and (formulas 11 and 8) with values were 135±5 and (140±4 and 130±1) respectively.

Results indicated that formula 1 as control was the highest value in specific volume, while formula 9 was the lowest value 2.72±0.17 vs. 2.18±0.13 respectively. From data in table (3) it could be observed that, there were no significant differences ($p \geq 0.05$) between all formulas in specific volume of cakes except of formula 1, 4 and formula 5 which were significant between them with values were 2.22±0.09, 2.35±0.18, 2.38±0.17, 2.34±0.09, 2.21±0.07, 2.13±0.17, 2.17±0.13 and 2.27±0.18 for formula 2, 3, 6, 7, 8, 9, 10 and formula 11 vs. 2.72±0.17, 2.51±0.16 and 2.57±0.21 for formula 1, 4 and formula 5 respectively.

Our results nearest with results obtained by **Hussein et al (2012**) they found that, specific volume for cakes which made from wheat flour, gelatinized corn flour and rice flour were 2.69, 2.4 and 2.64 cm^3/g. our results indicated that, cake volume produced from wheat flour (as a control)was highest compared with other samples, while cake weight produced from (25% gelatinized corn flour+ 25% rice flour+50% soy flour) (formula 11) and (formula 6) which made from (75% rice flour + 25% soy flour) were highest compared with other samples. This effect may be due to high fiber content in soy flour. Fiber is characterized by their high water holding capacity. **Yaseen et al. (2010)** reported that loaf volume and specific volume were improved upon the addition of gums Arabic and pectin. For instance, when 3% pectin or gum Arabic were mixed with wheat – corn flour dough, the improvement of loaf volume and specific volume reached 27 and 29%, 25 and 24%, respectively.

The values of mouth feel in cakes were 14.59±0.50, 10.٧٧±٢.٢٧, ١١.٧٢±2.٨١, 2.38±0.025 and 2.35±0.025 respectively. While, there were significant differences ($p \leq 0.05$) between formula 11, 1 and formula 5 in acid value at 5 days with means ± SD were 2.68±0.08, 2.22±0.04 and 2.04±0.04 respectively.

Results indicated that, there were no significant differences (p≥0.05) between formula 11 and formula 7 in acid value in storage at 10 days with means ± SD were3.٥٢±0.٠٣and 3.٦٢±0.٠٧respectively. Also, there were no significant differences (p≥0.05) between formula 5 and formula 1 with means ± SD were 2.78±0.٠8 and 2.٦0±0.2 respectively. However, there were significant differences (p≤0.05) between formula 6 and formula 4 in acid value at 10 days with means ± SD were 3.30±0.٠3 and 3.08±0.06 respectively.

Formula 1 as control was the lowest value in thiobarbituric acid at (zero, 5 and 10 days) with means ± SD were 0.025±0.٠03, 0.034±0.001and 0.042±0.002 respectively. Our data revealed that, there were no significant differences (p≥0.05) between formula 11, 7 and formula 4 in thiobarbituric acid at zero time with means ± SD were 0.049±0.002, 0.048±0.004and 0.048±0.002 respectively. While, there were significant differences (p≤0.05) between formula 1 ,5 and 6 in thiobarbituric acid in zero time with means ± SD were 0.025±0.003, 0.035±0.002 and0.043±0.003 respectively. Formula 6 was the highest value in thiobarbituric acid at 5 days with means ± SD were 0.061±0.٠02.besides that, formula 7 was the highest value in thiobarbituric acid at 10 days with means ± SD were 0.124±0.٠28.

Thiobarbituric acid at 5 days there did not significantly differences (p≥0.05) between formula 11, 5, 4 and formula 7 with means ± SD were 0.053±0.003, 0.053±0.003, 0.052±0.004 and 0.052±0.003 respectively. while, there were significant differences (p≤0.05) between formula 1 (as a control) and formula 6 in thiobarbituric acid at 5 days with means ± SD were 0.034±0.001 and 0.061±0.002 respectively.

As shown in table (5) there were no significant differences (p≥0.05) between formula 6, 11 and formula 5 at 10 days in thiobarbituric acid with means ± SD were0.٠٨7±0.٠١٠, 0.085±0.004and 0.083±0.0٠٥respe-ctively. Also, there were no significant differences (p≥0.05) between formula 4 and formula 1 in thiobarbituric acid in 10 days with means ± SD were0.٠56±0.٠03 and 0.042±0.002 respectively. However, there were significant differences (p≤0.05) between formula 7 and all other formulas 1 in thiobarbituric acid in 10 days.

Table (1): chemical composition of raw materials and their blends (on dry weight) g/100g.

Materials	Moisture	Fat	Ash	protein	Crude fiber	Carbohydrate
formula 1	11.18±0.45^{bc}	0.84±0.01^{k}	0.75±0.06^{i}	11.52±0.23^{e}	0.56±0.01^{g}	٨6.33±0.28^{d}
formula 2	11.79±0.47^{ab}	٣.١٢±0.10^{e}	1.10±0.06^{h}	8.37±0.25^{fg}	1.75±0.09^{d}	8٥.٦٦±0.40^{d}
formula 3	11.68±0.35^{ab}	2.32±0.07^{h}	0.88±0.02^{i}	7.72±0.16^{gh}	1.42±0.04^{e}	8٧.٦٦±0.25^{c}
formula 4	11.32±0.57^{bc}	1.52±0.05^{j}	0.59±0.02^{j}	7.06±0.28^{hi}	0.95±0.04^{f}	٨٩.٨٨±0.35^{b}
formula 5	12.33±0.12^{a}	0.71±0.02^{k}	0.50±0.02^{j}	6.41±0.19^{i}	0.54±0.01^{g}	9١.٨٤±0.23^{a}
formula 6	11.28±0.68^{bc}	1.77±0.07^{i}	1.75±0.05^{f}	16.21±1.81^{d}	1.35±0.07^{e}	٧٨.٩٢±0.93^{f}
formula 7	10.71±0.32^{c}	2.82±0.11^{f}	3.19±0.13^{c}	26.01±0.26^{b}	2.16±0.02^{c}	6٥.٨٢±0.50^{i}
formula 8	11.26±0.56^{bc}	3.92±0.12^{b}	1.43±0.04^{g}	9.02±0.18^{f}	2.14±0.06^{c}	8٣.٤٩±0.34^{e}
formula 9	10.53±0.42^{cd}	3.38±0.12^{d}	2.21±0.04^{d}	17.51±0.70^{c}	2.24±0.04^{c}	7٤.٦٦±0.86^{h}
formula 10	11.03±0.33^{bc}	2.57±0.09^{g}	1.95±0.06^{e}	16.87±0.85^{cd}	1.75±0.07^{d}	7٦.٨٦±1.00^{g}
formula 11	9.91±0.20^{d}	3.63±0.14^{c}	3.33±0.10^{b}	26.66±0.80^{b}	2.57±0.08^{b}	6٣.٨١±1.04^{j}
formula 12	8.25±0.25^{e}	4.93±0.20^{a}	3.92±0.12^{a}	45.61±0.91^{a}	3.78±0.08^{a}	4١.٧٦±1.23^{k}

Formula 1=100%wheat flour.formula 7= 50%rice +50%soy flour
Formula2= 75%Gelatinized corn flour+25% rice flour
Formula 3=50% Gelatinized corn flour+50% rice flour
Formula 4=25% Gelatinized corn flour+75% rice flour
Formula 5= 100% rice flour
Formula 6= 75% rice flour+ 25% soy flour
formula 8=100% Gelatinized Corn Flour
formula 9= 50% Gelatinized corn flour+25% rice+25%soy
formula 10=25% Gelatinized corn flour+50% rice+25%soy
formula 11=25% Gelatinized corn flour+25% rice+50%soy
formula 12= 100% soy flour

A,b.c,d,e: Mean within each row having similar letter (S) are not significantly different (P≤ 0.05).

Table (2): chemical composition of baked cakes and their blends (on dry weight) g/100g.

Cake from:	Moisture	Fat	Ash	protein	Crude fiber	Carbohydrate
formula 1	26.16±0.52[bc]	10.83±0.50[g]	1.24±0.04[fg]	8.82±0.27[d]	0.45±0.01[g]	78.66±0.81[bc]
formula 2	26.51±0.80[abc]	13.73±0.41[cd]	1.53±0.08[de]	7.40±0.30[ef]	1.48±0.03[d]	75.86±0.95[cd]
formula 3	26.91±1.61[abc]	12.93±0.52[de]	1.40±0.09[ef]	6.74±0.34[fg]	1.04±0.05[e]	77.89±0.94[bc]
formula 4	25.97±1.3[c]	12.13±0.61[ef]	1.26±0.09[fg]	6.09±0.06[gh]	0.69±0.03[f]	79.83±0.92[ab]
formula 5	25.34±1.5[c]	11.32±0.68[fg]	1.13±0.07[g]	5.44±0.16[h]	0.35±0.01[h]	81.76±0.91[a]
formula 6	27.1±1.08[abc]	13.82±0.28[cd]	1.78±0.21[cd]	16.01±0.80[b]	1.1±0.01[e]	67.29±1.19[e]
formula 7	28.34±0.57[ab]	16.32±0.49[a]	2.26±0.07[a]	22.67±0.91[a]	1.84±0.04[b]	56.91±1.47[g]
formula 8	27.13±0.27[abc]	14.53±0.58[bc]	1.46±0.26[cd]	8.05±0.24[de]	1.73±0.07[c]	74.23±0.96[d]
formula 9	26.65±1.87[abc]	15.43±0.78[b]	1.96±0.12[b]	15.36±0.31[bc]	1.78±0.09[bc]	65.47±1.22[f]
formula 10	26.85±0.81[abc]	14.63±0.15[bc]	1.82±0.09[bc]	14.71±0.74[c]	1.44±0.04[d]	67.40±1.20[e]
formula 11	28.43±1.14[a]	17.13±0.52[a]	2.39±0.10[a]	23.32±0.70[a]	2.18±0.09[a]	54.98±1.48[g]

Table (5): Effect of storage at different time (zero, 5 and 10 days) on AV (acide value) and TBA(thiobarbituric acid) on cakes and their blends.

formulas	AV			TBA		
	zero time	5 days	10 days	zero time	5 days	10 days
formula 1	**1.50± 0.0٣٠a**	**2.22± 0.0٤c**	**2.6± 0.2d**	**0.025± 0.003d**	**0.034± 0.001c**	**0.04٢± 0.002c**
formula 4	**1.52± 0.015a**	**2.3٥± 0.02٥b**	**3.٠٨± 0.0٦c**	**0.048± 0.002a**	**0.052± 0.004b**	**0.05٦± 0.00٣c**
formula 5	**1.5± 0.03a**	**2.04± 0.04d**	**2.7٨± 0.٠٨d**	**0.035± 0.002c**	**0.053± 0.003b**	**0.083± 0.0٠٥b**
formula 6	**1.53± 0.015a**	**2.38± 0.025b**	**3.٣٠± 0.٠3b**	**0.043± 0.003b**	**0.061± 0.002a**	**0.٠٨7± 0.٠١٠b**
formula 7	**1.54± 0.045a**	**2.39± 0.05b**	**3.٥٢± 0.٠٣a**	**0.048± 0.004a**	**0.052± 0.003b**	**0.124± 0.02٨a**
formula 11	**1.56± 0.035a**	**2.68± 0.08a**	**3.٦٢± 0.٠٧a**	**0.049± 0.002a**	**0.053± 0.003b**	**0.085± 0.004b**

Table (3): physical propertiesof cakes and their blends.

formulas	Weight (g)	Volume (cm^3)	Specific volume (volume/weight)
formula 1	60.74±1.82^{a}	165±5^{a}	2.72±0.17^{a}
formula 2	56.51±1.13^{b}	125.67±2.52^{g}	2.22±0.09^{cd}
formula 3	57.54±2.31^{ab}	135±5^{ef}	2.35±0.18^{bcd}
formula 4	60.28±3.02^{ab}	151±2^{bc}	2.51±0.16^{abc}
formula 5	60.41±1.82^{ab}	155±8^{b}	2.57±0.21^{ab}
formula 6	60.93±3.05^{a}	145±3^{cd}	2.3٨±0.17^{bcd}
formula 7	59.06±0.59^{ab}	138±4de	2.34±0.09^{bcd}
formula 8	58.70±1.18^{ab}	130±1^{fg}	2.21±0.07^{d}
formula 9	58.83±1.77^{ab}	125±6^{g}	2.13±0.17^{d}
formula 10	57.83±2.32^{ab}	125.67±2.52^{g}	2.1٧±0.13^{d}
formula 11	61.54±3.08^{a}	140±4de	2.2٧±0.18^{cd}

Table (4): sensory properties of cakes and their blends.

formulas	mouth feel	crust character	crumb color	Texture	Flavor	softness	crumb brightness	appearance	Overall acceptability
	15	**10**	**10**	**10**	**15**	**10**	**10**	**20**	**100**
formula 1	14.59±0.50[a]	9.73±0.46[a]	9.86±0.35[a]	9.68±0.48[a]	14.68±0.48[a]	9.82±0.39[a]	9.64±0.49[a]	19.59±0.50[a]	97.5٩±١.١٥[a]
formula 2	10.77±2.27[b]	6.95±1.53[d]	7.95±1.21[cd]	7.68±2.08[bc]	٩.٨٦±٣.٣١[e]	٧.٠٩±2.2٩[de]	٦.95±٢.١٠[ef]	١٣.٢٣±٤.١٠[d]	٧٠.٤٨±١٢.٩٦[de]
formula 3	11.72±2.8[cd]	8.36±1.05[b]	8.14±1.5[bcd]	7.64±1.50[bc]	1٠.٧٣±٣.٠٩[cde]	7.86±1.55[bcd]	٧.٨٦±١.٦١[bcde]	1٤.٢٣±٣.٦٤[cd]	٧٦.٥٤±١٠.٤[cd]
formula 4	11.68±2.2[cd]	8.55±1.44[b]	8.95±1.09[b]	8.32±1.39[b]	١٢.٢٣±٢.٠٥[bc]	8.68±1.21[b]	8.٠5±١.٥٣[bcd]	1٥.٦٤±٣.٠٨[bc]	8٢.١٠±٩.٣٠[bc]
formula 5	13.05±1.33[b]	8.41±1.33[b]	8.41±1.22[bc]	8.05±1.33[bc]	1٢.١٨±٢.٤٨[bc]	8.5٥±1.٣٧[bc]	8.٢٧±1.٣٥[bc]	1٧.٠٩±1.٧٧[b]	8٤.٠١±٨.٨٩[b]
formula 6	12.55±1.5[bc]	8.00±0.98[bc]	7.95±1.25[cd]	8.00±1.35[bc]	١١.٧٣±٢.٤٩[bcd]	8.0٠±1.٢٣[bcd]	٨.٦٨±1.٠٩[b]	1٥.٦٤±٢.٩٨[bc]	8٠.٥٥±٨.٦٥[bc]
formula 7	10.50±2.79[d]	7.23±1.41[cd]	7.36±1.40[de]	7.14±1.64[cd]	1١.٩١±٣.١٠[cde]	7.٢٧±1.4٥[de]	7.3٦±1.4٧[cdef]	1٤.٤١±٣.٣٨[cd]	٧٣.١٨±١٢.٦[de]
formula 8	10.86±1.17[d]	7.91±1.06[bc]	6.95±1.53[e]	6.27±1.72[d]	١٠.٨٦±1.٦١[cde]	6.4١±1.18[e]	٦.٦٨±١.٢٥[f]	1٣.٢٧±٣.٣٠[d]	٦٩.٢١±٨.٦٨[e]
formula 9	10.54±1.69[d]	6.68±1.21[d]	7.82±1.37[cd]	6.23±1.58[d]	1٠.١٤±1.٤٩[de]	7.٦٤±1.٤٧[cd]	٧.٠٥±1.٤٦[ef]	1٣.٧٣±٢.٥١[cd]	٦٩.٨٣±٦.٢٥[de]
formula10	10.31±3.50[d]	7.23±2.11[cd]	7.45±1.79[de]	7.09±2.31[cd]	1٠.٠٩±٣.٧٨[de]	7.2٣±2.٥٤[de]	7.١٤±1.8٣[def]	1٣.٣٢±٣.٩٧[d]	٦٩.٨٦±1٨.٢٢[de]
formula11	10.09±1.19[e]	8.05±0.84[bc]	8.36±1.05[bc]	8.05±1.21[bc]	1٣.٢٧±1.٩١[ab]	7.٨٢±1.١٨[bcd]	6.8٦±1.0٤[f]	1٤.٠٥±1.٢٥[cd]	7٦.٥٥±3.٧8[cd]

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التقييم الكيميائى والحسى لكيك منتج خالى من الجلوتين

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الملخص العربى

مرض حساسية الجلوتين عبارة عن خلل فى الأمعاء الدقيقة يحدث نتيجة لاستجابة الجهاز المناعى للجلوتين فى الحبوب (القمح- الشعير- الشوفان). أعراض مرض حساسية الجلوتين تتمثل فى مغص معوى، إسهال مصحوب بمخاط، آلام بالبطن.

تم إعداد (١١) خلطة منها خلطة كنترول و ١٠ خلطات خالية من الجلوتين مكونة من دقيق الذرة المجلتن، والأرز، ودقيق فول الصويا بنسب مختلفة، وتم تقدير كل من التركيب الكيميائى للمواد الخام (خلطات) ومخبوزاتها، والتقييم الفيزيائى والحسى ورقم الحموضة وأخيرا حمض الثاروبيوتريك للكيك.

أظهرت النتائج المتحصل عليها ما يلى : كانت العينة رقم ١٢ (١٠٠% صويا) أعلى القيم فى الدهون، والرماد، والبروتين، والألياف بقيم ٤.٩٣، ٣.٩٢، ٤٥.٦١، ٣.٧٨ على التوالى فيما كانت الأقل فى المحتوى من الرطوبة والكربوهيدرات ٨.٢٥، ٤١.٧٦ أيضا خلطة رقم (١١) كانت الأعلى فى التركيب الكيمائى فى الكيك المخبوز، كما أظهرت النتائج عدم وجود فرق معنوي ($p \geq .05$) بين الكنترول، العينات ٤، ٥ فى الوزن والحجم النوعى بينما أظهرت النتائج وجود فروق معنوية بين الكنترول وكل الخلطات فى الإختبار الحسى.

كما أظهرت النتائج عدم وجود فرق معنوى بين العينة الضابطة وجميع الخلطات فى رقم الحموضة عند بداية الخبيز وكانت عينه (١١) الأعلى قيمة فى رقم الحموضة عند صفر ، ٥، ١٠ أيام من تخزين الكيك المخبوز عند درجة حرارة الغرفة وكانت العينة ٥ الأقل محتوى فى رقم الحموضة.

لذا من الممكن إعداد خلطات كيك مخبوز خالى من الجلوتين يقترب فى صفاتة الحسية والفيزيائية من الكيك المصنع بواسطة دقيق القمح.

الكلمات الكاشفة: خالى الجلوتين، الخواص الحسية والفيزيائية، رقم الحموضة وحمض الثايوبيوتريك.