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PRODUCING OF GLUTEN FREE BISCUITS FOR CELIAC PATIENTS

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ABSTRACT: *Free gluten corn biscuits were prepared from corn flour and partially substituted by different levels (5 , 7.5, 10, and 12.5%) of cocoa, turmeric and carob powder. The proximate composition , minerals content, physical properties and organolyptic attributes of the produced free gluten biscuits were evaluated. Non significant ($P > 0.05$) differences were noticed among all replacement levels of all type in density, thickness and specific volume. While ,significant ($P \leq 0.05$) increases in diameter, thickness and spread ratio were observed with cocoa and turmeric powder .Significant ($P \leq 0.05$) increases in fat, ash, and fiber contents were observed by increasing the substation levels. Carbohydrate contents of corn biscuits decreased significantly ($P \leq 0.05$) at 7.5 % and 12.5 % replacement levels. Generally, significant ($P \leq 0.05$) increases were observed in protein and fat content to replacing corn flour with different levels of cocoa powder . Mineral contents (Ca, K, and Zn) of gluten free corn biscuits increased by replacing corn flour with carob ,turmeric and cocoa powder compared to biscuits made from corn flour .The highest overall acceptability was recorded for the corn biscuits substituted with 10 % cocoa powder followed by 5% turmeric and 10% carob powder.*

Key words : *Celiac disease, gluten free, biscuits, cocoa, turmeric, and carob powder.*

INTRODUCTION

Celiac disease is a gluten–sensitive entheropathy with genetic, immunologic and environmental bass. People suffering from gluten intolerance (celiac disease) are diagnosed everywhere in the word (Al-Hassany, 1975; Bitar, *et al.*, 1970). The prevalence of this food allergy is now established from 1 to 250 persons. The ingestion of cereal proteins namely prolamins, especially from wheat caused celiac disease which leads to the inflammation of small intestine and to the mal-absorption of important nutrients such as calcium, Iron, folic acid and fat soluble vitamins The only effective treatment to avoid the disease is to keep the diet of patient free from gluten. As a result food containing gluten such as wheat, rye, barley, triticale and oats and food containing gluten derivatives as thickeners, fillers and binders should be avoided. (Feighery, 1999).

Gluten free diet means avoiding food contain wheat, rye, barley and possibly oats. On the other hand people can use potato, rice, corn soy or bean flour in their diet (Fasano *et al.* 2003) .

To satisfy the demand of high quality bread, gluten free bread must have quality characteristics similar to those of wheat flour bread (Ylimaki *et al.* 1991).The substitution of corn flour with rice flour improved all organoleptic characteristics of healthy gluten free pies. Hammed *et al,* (2007).

Ahlborn *et al* (2005) found that the gluten free rice bread had the highest scores for both moistness and overall freshness, while the low protein starch bread had the lowest scores for both attributes. All gluten free breads were significantly higher in loaf volumes compared to wheat bread . Also, gluten free breads were brittle after two days of storage. (Moore *et al,* 2004).

Cocoa is very important ingredient in several kinds of foods, such as cakes, biscuits, child- foods, ice-creams and sweets. Tafuri *et al* (2004).

Carob powder is an ideal cocoa substitute and sugar replacer for chocolate and confectionery recipes. Carob powder is a naturally sweet flavor product which is used to improve aroma and taste in numerous food products. Applications of this unique dietary fiber include baked goods, bars, snacks, cereals, and dairy products. Usage level varies, depending on the application of this product .The level ranges from 1%-5% in the finished product (Susan, 2004). Carob powder had an excellent water- binding capacity anti-caking properties, and can prolong the shelf life of the products. Also, this product used as texture improvement, increased flow ability, and enhanced coloring, quality and freshness (Linda, 2003).

Yasin and Ibrahim (2004) Stated that the substitution of wheat flour cake with carob powder improved all organoleptic characteristics significantly. The substitution of wheat flour with turmeric powder significantly improved all organoleptic characteristics of healthy crackers. Abd El Rahim *et.al.* (2003).

The aims of this study are to produce high quality and high nutritious gluten-free biscuits for people suffering from celiac disease using corn flour, partially substituted with different levels from cocoa, turmeric ,and carob powder.

MATERIALS AND METHODS

Materials:

Corn flour was obtained from Egyptian - Italian corn Product Co., Ismaelia . Egypt. Cocoa powder; turmeric powder; carob powder, vanilla, baking powder and egg: were obtained from the Local market.

Methods:

Technological methods

Preparation of biscuits:

Biscuits were prepared according to the methods described by Smith , (1972). Briefly , shortening (150 g), and sugar (150 g) were mixed to mak

creamed in a Hobaret mixer for 15 min. Fresh egg (120g) were added and mixed for 3min . Five huneard grams of corn flour (or its blends) were sieved twice with leaving agent (8 g) and mixed for 4 min .Water (80 ml) was added and mixed for 12 min .Dough were sheeted 4 mm. Biscuits formed manually and baked at 180°C for 20 min in laboratory oven .The biscuits cooled at room temperature for 75 min . The corn flour used in biscuits formula (control) was substituted by different levels (5, 7.5 , 10 and 12.5%) of cocoa powder , turmeric and carob powder.

Physical properties of gluten free corn biscuits:

The diameter and thickness of six biscuits were measured by placing their edge to edge and by stacking one above the other. To obtain the average, measurements were made by rearranging and re-stacking biscuits . The average weight of six biscuits was recorded. The bulk density was calculated and expressed as g/L (Sai-Manohar and Haridas 1997) .

Specific volume (cm^3 /g) was calculated as follows : biscuits volume (cm^3) / biscuits weight (g).

Spread ratio was calculated as the average diameter / thickness A.A.C.C. (1995)

Chemical Analysis methods :

Proximate composition :

Moisture, protein, lipids, fiber and ash were determined for raw materials as well as for produced biscuits according to the methods described by A.O.A.C. (2000). Total carbohydrate was calculated by differences.

Minerals contents

Calcium (Ca); Zinc (Zn); iron (Fe) and potassium (k) were determined according to A.O.A.C. (2000) using The perkin Elmer 3300 (USA) atomic absorption spectrophotometer .While Phosphor (P) content was determined in the digested solution according to the method of Taussky and Shorr (1953).

Sensory attributes of gluten free corn biscuits.

Organoleptic characteristics were evaluated by 10 patients suffering from celiac disease for various quality attributes such as appearance =20 , taste =20 , texture =15 , crispincys =15 , color =10 , flaver =10 , mouth feel =10 and overall acceptability (100).The panelists were asked to use control biscuits as basic for determining acceptance by first assigning score to it and then evaluating each test biscuits in comparison to the control .

Statistical analysis:-

The results were compared using the least significant difference test (L.S.D) at the 5% level of probability as described by waller and Duncan (1969).

RESULTS AND DISCUSSION

Chemical composition of raw materials

The chemical composition and mineral content of corn flour, cocoa, turmeric, and carob powder are presented in Table (1). The cocoa powder had higher protein (14.75 %) and fat (13.27%) contents compared to other ingredient. The cocoa, turmeric, and carob powder contained high amounts of ash and fiber compared to corn flour. The lowest fat content was noticed in carob powder (0.77%). The highest value of total carbohydrate was observed in corn flour (85.95%) followed by carob powder, turmeric powder and then cocoa powder (81.79%; 74.09% and 59.80% respectively).

Data in the same table showed the mineral contents (Fe, Zn, P, Ca, and K) of corn flour, cocoa, turmeric and carob powder. The cocoa powder had the highest amount of Zn (6.9 mg/100g), and P (608 mg/100g) and the lowest value of Fe (1.85 mg/100g) The lowest amount of phosphor content (73.3 mg/100g). The turmeric powder contains 19.5 mg/100g Fe while, carob powder and corn flour contained 7.98 and 2.23 mg/100g, respectively. The obtained results are in good agreement with those obtained by Abd-El Rahim, *et. al.* (2003); Yasin and Ibrahim (2004); Zahran (2005). Ayaz *et al* (2007).

The high values of chemical composition parameters and mineral contents in cocoa, turmeric and carob powder are expected to raise the nutritive value of corn flour used for gluten free biscuits.

proximate compositions of gluten free corn biscuits replaced by different levels of cocoa, turmeric, and carob powder

The proximate composition of gluten free corn biscuits produced by replacing corn flour with different levels (5, 7.5, 10, and 12.5%) of cocoa, turmeric and carob powder are presented in Table (2).

Corn biscuits formulated with different levels of carob, turmeric, and cocoa had significantly ($P \leq 0.05$) higher ash contents than corn biscuits . On the other hand, the fiber contents increased significantly ($P \leq 0.05$) by increasing the substitution levels. While, non significant ($P > 0.05$) differences were noticed in protein content among replacements. Significant ($P \leq 0.05$) increases in fat content of biscuits formulated with cocoa powder at level were noticed 10, 12.5% substitution. Non significant ($P > 0.05$) differences were observed in carbohydrate contents among all replacement levels of all types. Except for 10, 12.5% substitution levels of cocoa powder which showed significant decrease. This may be due to the high amounts of fat, ash, and fiber in the substituted ingredients. These results are similar to those found by Abd-El Rahim, *et. al.* (2003): Yasin and Ibrahim (2004).

Table (1): Proximate composition (on dry weight basis%) and mineral contents (mg/100g) of Corn flour as well as Cocoa, Turmeric, and Carob powder

Parameters	Corn flour	Cocoa powder	Turmeric powder	Carob powder
Moisture	11.82	4.25	8.53	9.2
Protein	10.132	14.75	7.73	6.9
Fat	1.78	13.27	9.78	0.77
Ash	0.892	6.84	5.97	3.6
Fiber	1.25	5.34	2.43	6.94
Carbohydrate	85.95	59.8	74.09	81.79
Calcium	80.79	144	225	298.74
Phosphor	298.8	608	483	73.3
Potassium	35.66	1507	3180	968
Iron	2.23	1.85	19.5	7.98
Zinc	2.01	6.9	3.5	4.75

Data in Table (3) shows the chemical composition content of corn biscuits replaced by 5, 7.5,10, and 12.5% of cocoa, turmeric, and carob powder . Carbohydrate content of corn biscuits was significantly ($P \leq 0.05$) decreased at 12.5% replacement level. Replacement of corn flour at 12.5% level showed significant ($P \leq 0.05$) increase in moisture, fat, fiber, and ash contents compared to corn biscuits. While, non significant ($P > 0.05$) differences were observed in protein content of corn biscuits formulated with different substitution levels. Generally, biscuits formulated with cocoa powder had higher ($P \leq 0.05$) protein and fat content compared to turmeric and carob biscuits . On the other hand carob powder biscuits was significantly ($P \leq 0.05$) higher in moisture, fiber and carbohydrate contents than biscuits formulated biscuits with cocoa and turmeric.

Mineral content of gluten free corn biscuits replaced by different levels of cocoa, turmeric, and carob powder.

Data illustrated in Table 4 indicated that the replacement of corn flour by different levels (5, 7.5, 10, and 12.5) of cocoa and turmeric powder increased Zn, Ca, and K contents of corn biscuits compared to biscuits made from corn flour. While, the cocoa powder caused slight decreased in Fe content. Replacement of corn flour by carob powder increased Fe, Zn, Ca, and K content of corn biscuits while it caused decreased phosphor content.

Results indicated that mineral contents increased as the level of supplementation increased. The high content of Ca, P, K, Fe, and Zn in ingredients are expected to raise the nutritive value of corn flour used for biscuits. These obtained results indicated that cocoa, turmeric, and carob powder are good sources for supplementation and suitable for enrichment biscuits with high minerals content.

Physical properties of gluten free corn biscuits.

Formulated by cocoa, turmeric and carob powder. Physical properties (weight, volume, specific volume, density, diameter, thickness and spread ratio) of gluten free corn biscuits at different levels are presented in Tables (5 and 6).

The results revealed that formulated by biscuits carob at 12.5% level had the highest ($P \leq 0.05$) weight. While, the highest volume was observed at 5% replacement with cocoa .Non significant ($P > 0.05$) differences were noticed among all replacement levels in the diameter of corn biscuits with cocoa powder. The highest increase in density was noticed at 10 % and 12.5% replacement level with carob .While, non significant ($P > 0.05$) differences were noticed among replacement level in specific volume and thickness.

These results may be due to higher values of fiber content of the turmeric and carob compared to corn flour which cause compacted cake. Also the carob powder contains gum which affect on biscuits density.

Table (2) : Proximate composition (on dry weight basis%) of gluten free corn biscuits replaced by different levels of Cocoa ,Turmeric, and Carob powder

Composition	Corn 100%	Cocoa powder				Turmeric powder				Carob powder			
		5%	7.5%	10%	12.5%	5%	7.5%	10%	12.5%	5%	7.5%	10%	12.5%
Moisture	2.852 i	3.012 hi	3.087ghi	3.492def	3.643 de	3.044 ghi	3.277 fgh	3.507cdef	3.758bcd	3.344efg	3.859abc	3.995 ab	4.123 a
Protein	6.85abcd	6.992abcd	7.06 abc	7.13 ab	7.2 a	6.78 bcd	6.74 bcd	6.71 cd	6.68 cd	6.76bcd	6.71 cd	6.66 d	6.61 d
Fat	19.35bc	19.69abc	19.88abc	20.04 a	20.21 a	19.59abc	19.72 abc	19.83 abc	19.94 ab	19.32bc	19.31 bc	19.29 c	19.78 c
Ash	0.766 h	0.944def	1.04 cd	1.127 a	1.22 a	0.92 efg	1.0 cde	1.08 bc	1.15 ab	0.848 gh	0.89 fg	0.94 efg	0.97 def
Fiber	0.78 g	0.906de	0.966 d	1.028 c	1.088bc	0.816 fg	0.836 fg	0.856 ef	0.872 ef	0.956 d	1.036 c	1.12 b	1.206 a
Carbohydrate	72.26 a	71.47abc	71.06abc	70.68 bc	70.28 c	71.9 ab	71.71 abc	71.53abc	71.36abc	72.12abc	72.06 ab	71.99 ab	71.94ab

Means in the same raw with different letters are significantly different ($P \leq 0.05$)

Table (3): Effect of replacing corn flour by different levels cocoa, turmeric, and carob powder on proximate composition (on weight basis %) of produced corn biscuits

Composition	Replacement level					L.S.D	Replacement type			L.S.D
	0%*	5%*	7.5%*	10%*	12.5%*		Cocoa**	Turmeric**	Carob**	
Moisture	2.884c	3.133 bc	3.297 b	3.661 a	3.806 a	0.2855	3.309 b	3.397 b	3.831 a	0.2396
Protein	6.85 a	6.81 a	6.954 a	6.837 a	6.83 a	0.2113	7.073 a	6.728 b	6.685 b	0.0783
Fat	19.35 c	19.73 ab	19.64 ab	19.73 ab	19.82 a	0.2612	19.96 a	19.77 b	19.31 c	0.1188
Ash	0.766d	0.904 c	977 b	1.049 ab	1.106 a	0.0727	1.083 a	1.038 a	912 b	0.0711
Fiber	0.83 c	0.78 d	0.95 bc	1.0014 b	1.054 a	0.092	0.997 b	0.845 c	1.0795 a	0.0588
Carbohydrate	72.26a	71.83ab	71.65 ab	71.74 ab	71.16 c	0.5518	70.9225 c	71.625 b	72.205 a	0.3509

Means in the same raw with different letters are significantly different ($P \leq 0.05$)

Values are means of different replacement level .** Values are means of different replacement type.*

Table (4) : Mineral contents (mg/100g on dry weight) of gluten free corn biscuits replaced by different levels of Cocoa , Turmeric, and Carob powder

Minerals	Corn 100%	Cocoa powder				Turmeric powder				Carob powder			
		5%	7.5%	10%	12.5%	5%	7.5%	10%	12.5%	5%	7.5%	10%	12.5%
Calcium	58.88	60.77	61.72	62.67	63.62	63.2	65.37	67.53	69.69	65.44	68.68	71.96	75.22
Phosphor	223.28	232.56	237.2	241.83	246.47	228.81	231.57	234.33	237.1	216.52	213.14	209.75	206.37
Potassium	49.4	93.54	115.61	137.68	159.75	143.73	190.9	238.06	285.23	77.37	91.36	105.34	119.33
Iron	1.74	1.73	1.72	1.72	1.71	2.26	2.52	2.78	3.01	1.9	2.0	2.09	2.17
Zinc	1.81	1.95	2.03	2.1	2.18	1.86	1.88	1.9	1.92	1.89	1.93	1.97	2.01

Table (5) : Physical properties of gluten free corn biscuits replaced by different levels of Cocoa , Turmeric, and Carob powder

properties	Corn 100%	Cocoa powder				Turmeric powder				Carob powder			
		5%	7.5%	10%	12.5%	5%	7.5%	10%	12.5%	5%	7.5%	10%	12.5%
Weight (g)	39.62b	36.82 c	35.14 e	34.5 f	32.45h	35.4e	34.28 f	34.35 f	33.27g	36.1d	36.9c	39.25b	40.25a
Volume (cm3)	72 a	72 a	69.2 b	69 b	59 f	69 b	68 bc	65 d	60 f	67 c	65 d	63.5de	62 e
Specific volume (v\w)	1.82 a	1.96 a	1.97 a	2.0 a	1.82 a	1.95 a	1.99 a	1.89 a	1.81 a	1.86 a	1.76 a	1.62 a	1.54 a
Density (w\v)	0.55 c	0.512 c	0.51 c	0.50 c	0.55 c	0.52 c	0.51 c	0.53 c	0.56 bc	0.54 c	0.57bc	0.62ab	0.65 a
Diameter (cm)	39.5 a	39.2 a	39.1 a	38.9 a	38.6 ab	38.4ab	38.68ab	38.83ab	38.8 ab	37.72 b	36.32c	35.5cd	w34.4d
Thickness (cm)	5.2 a	5.5 a	5.5 a	5.4 a	5.3 a	5.5 a	5.5 a	5.4 a	5.3 a	5.3 a	5.1 a	5.0 a	4.9 a
Spread ratio(%)	7.6 a	7.2 b	7.1 b	7.2 b	7.29 ab	6.98 b	7.04 b	7.19 b	7.3 ab	7.1 b	7.12 b	7.1 b	7.1 b

Means in the same raw with different letters are significantly different ($P \leq 0.05$)

Table (6): Effect of replacing corn flour by cocoa, turmeric, and carob powder on physical properties of corn biscuits

Properties	Replacement levels					L S.D	Replacement type			L.S.D
	%*0	%*5	%*7.5	%*10	%*12.5		**Cocoa	**Turmeric	**Carob	
Weight (g)	39.62 a	36.112b	35.469 b	36 032 b	35.435 b	2.0393	34 728 b	34.33 b	38.13 a	1 2247
Volume (cm3)	72 a	69.34 b	67.4 c	65.84 c	60 34 d	1.8686	67.3 a	65 5 a	64.38 a	3.2515
Specific volume (v\w)	1.82 a	1.924 a	1.907 a	1.837 a	1.72 a	0.3194	1.9375 a	1.9075 a	1.695 a	0 2924
Density (w\v)	0.55 ab	0 524 b	0.53 b	0 55 ab	0 587 a	0.0442	0.518 b	0.53 b	0.595 a	0.0373
Diameter (cm)	39 5 a	38.26ab	38.056 b	37.63 b	37.364 b	1.4187	38 817 a	38.695 a	36.058 b	0.7194
Thickness (cm)	5 2 ab	5 434 a	5.367 ab	5.267 ab	5.077 b	0.3548	5.425 a	5.427 a	5.075 b	0.3145
Spread ratio(%)	7.6 a	7 0934b	7.082 b	7 157 b	7.039 b	0.2231	7 16 a	7.0123 a	7.08 b	0.1691

Means in the same raw with different letters are significantly different ($P \leq 0.05$)
Values are means of different replacement level ** Values are means of different replacement type.*

Yasin and Ibrahim (2004) reported that increasing the level of addition of carob powder (2.5, 5 and 7.5 %) to wheat flour increased specific volume . Which means that the higher values of specific volume the lighter cake is this in turn positively affects both texture and tenderness (EL- Azab, and Bothayna, 1997).

Data in Table (6) showed the physical properties of corn biscuits as influenced by replacement with different levels and types of cocoa, turmeric and carob powder. Non significant ($P > 0.05$) differences were noticed among replacement levels in density, thickness and specific volume. Biscuits weight, volume, and spread ratio were decreased significantly ($P \leq 0.05$) at all levels of replacement. While significant ($P \leq 0.05$) increases in diameter, thickness, and spread ratio were observed with cocoa, and turmeric powder. Significant ($P \leq 0.05$) increase was also, noticed in weight, and density with carob powder.

These results may be due to the effect of gums and high amount of fibers in carob powder as compared to cocoa and turmeric powder

Sensory properties of gluten free corn biscuits replaced by different levels of cocoa , turmeric and carob powder.

Organoleptic characteristics (taste, appearance, texture, crispincys, color, flavor, mouth feel and overall acceptability) of gluten free corn biscuits formulated with different levels of cocoa, turmeric and carob powder were evaluated by 10 celiac patients (Tables 7 and 8).

Replacing corn flour cocoa at 7.5 % and 10% levels ,turmeric at 5% level , and carob powder at 10% level showed the highest ($P \leq 0.05$) overall acceptability compared to other replacement. On the other hand significant ($P \leq 0.05$) reduction in overall acceptability was noticed in 10 and 12.5% turmeric and 12.5% carob powder (Table 7) .

These results may be due to the effect of cocoa and carob powder which had valuated components and phenollic component caused good color of biscuits. (Linda, 2003 and Susan, 2004).

Replacing of corn flour with 12.5% of cocoa, turmeric, and carob powder resulted in significant ($P \leq 0.05$) decrease in taste, crispiness and overall acceptability of corn biscuits. While, non significant ($P > 0.05$) differences were noticed among all replacement in texture, flavor, mouth fell and color compared to corn biscuits.

Biscuits formulated by different levels of carob powder showed significant ($P \leq 0.05$) decrease in the appearance. Also, the taste, color, flavors, mouth fell and overall acceptability were lower in biscuits formulated turmeric powder than cocoa ,and carob powder. Whereas, Significant ($P \leq 0.05$) increases were noticed in crispines s, and textureof biscuits formulated with for cocoa powder compared to turmeric and carob powder (Table 8).

These results may be due to the effect of turmeric powder which had bad taste in mouth with increasing the level of replacement.

From the above results it could be noticed that the best quality of gluten free corn biscuits were at 10% replacement level with cocoa and carob powder as well as 5% replacement level with turmeric powder.

Table (7) : Sensory evaluation of gluten free corn biscuits replaced by different levels of cocoa , turmeric, and carob powder

properties	score	Corn 100%	Cocoa powder 5%	Cocoa powder 7.5%	Cocoa powder 10%	Cocoa powder 12.5%	Turmeric powder 5%	Turmeric powder 7.5%	Turmeric powder 10%	Turmeric powder 12.5%	Carob powder 5%	Carob powder 7.5%	Carob powder 10%	Carob powder 12.5%
Appearance	20	17.15de	17.9bcd	18.5 ab	18.88a	16.375 f	17.5 d	17.45 cd	16.75 ef	17.88bcd	16.3 f	18.38abc	17.88bcd	15.13 g
Taste	20	16.66bc	17.4b	18.3 a	18.5 a	17.38 b	18.5 a	17.25 b	14.5 d	11.25 e	16.5 bc	18.75 a	18.98 a	16.16 c
Texture	15	12.5 de	12.9cd	13.15bc	13.94a	13.25 bc	13.5ab	12.69 d	9.7 g	11.5 f	12.5 de	12.13 e	12.13 e	12.2 e
Crispness	15	12.27bc	12.6abc	13.1ab	13.36 a	12.95 abc	12.7 abc	12.25 c	12.88abc	10.63 d	12.7abc	11.13 d	12.13 c	10.88 d
Color	10	8.63def	8.8bcde	9.23ab	9.08abcd	9.25 abc	9.6 a	8.68cdef	8.13 f	6.25 f	8.2 f	8.94bcde	8.78 def	8.6 def
Flavor	10	7.84 d	8.16bcd	8.13cd	8.37abcd	8.75 a	8.4 abc	8.69 abc	6.3 f	6.25 f	8.7 ab	8.6 abc	8.7 ab	7.13 e
Mouth feel	10	7.75 bc	8.12ab	8.14ab	8.51 a	7.38 c	8.2 ab	7.63 bc	5.63 d	5.13 d	8.6 a	8.13 ab	8.9 a	8.63 a
Overall acceptability	100	82.8 f	85.88c	88.55b	90.64 a	85.34 cd	88.4 b	84.64de	73.89 h	68.89 i	83.5 ef	86.06 c	87.5 b	78.65 g

Means in the same raw with different letters are significantly different ($P \leq 0.05$)

Table (8): Effect of replacing corn flour by different levels cocoa, turmeric, and carob powder on sensory evaluation of corn biscuits

properties	score	Replacement levels %0	%5	%7.5	%10	%12.5	L.S.D	Replacement type **Cocoa	**Turmeric	**Carob	L.S.D
Appearance	20	17.15 bc	17.24abc	17.96 a	17.83 ab	16.462 c	0.8007	17.934 a	17.47 ab	16.918 b	0.8896
Taste	20	16.66 a	17.466 a	18.167 a	17.25 a	14.93 b	1.618	17.945 a	15.375 b	17.59 a	1.5878
Texture	15	12.5 ab	12.967a	12.693ab	11.924 b	12.306 ab	.927	13.3767 a	11.8495 b	12.2317 b	0.7842
Crispness	15	12.27 a	12.67 a	12.29 a	12.79 a	11.465 b	0.7131	13.0025 a	12.115 b	11.769 b	0.6635
Color	10	8.63 ab	8.87 a	8.984 a	8.53 ab	8.034 b	0.718	9.115 a	8.165 b	8.53 ab	0.6754
Flavor	10	7.84 ab	8.42 a	8.47 a	7.76 ab	7.377 b	0.745	8.35 a	7.41 b	8.258 a	0.692
Mouth feel	10	7.75 ab	8.43 a	7.97 ab	7.55 ab	7.099 b	0.9301	8.0415 a	6.683 b	8.465 a	0.7131
Overall acceptability	100	82.8 a	85.29 a	86.13 a	84.27 a	77.487 b	4.422	86.546 a	78.928 b	84.165 a	4.4702

Means in the same raw with different letters are significantly different ($P \leq 0.05$)

Values are means of different replacement level .** Values are means of different replacement type *

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