Preparation of biscuits from cassava, chickpeas and common beans flour for celiac disease patients

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Abstract

The current study was carried out to prepare gluten-free biscuits of high quality for celiac illness patients. Gluten-free biscuit blends contain cassava, chickpeas, and common beans flour is an innovative and highly nutritious food. The chemical analyses as minerals, and amino acids of cassava, chickpeas, and common bean flour were estimated. Also, chemically analyze for cassava chickpeas, and common bean flour were estimated and results showed that ash, protein, fat and fiber contents were higher in all raw materials. Also, lysine and isoleucine were higher in chickpea and common bean flour compared to cassava flour. Also, cassava flour contained a higher amount of valine, threonine, leucine , and phenylalanine.Therefore, all sensory characteristics of free gluten biscuit blends B1, B2, B3 and B4 prepared from cassava, chickpeas and common beans flour were appropriate for panelists. Also, blend (4) had the highest hardness compared to B1, B2 and B3, made from 40% cassava flour, 40% chickpeas flour and 20% common bean flour. As a result, it could prepare some bakery foods using raw materials free of gluten such cassava, chickpeas, and common bean flour with high quality that are suitable for celiac ailment patients.

Keywords: Chemical, Sensory ,properties, amino acid,minerals, Celiac biscuits.

1.Introduction

The small intestine's mucous membrane is damaged in people with celiac disease (CD), an autoimmune and chronic condition. In addition to gliadin in wheat prolamin, high molecular glutenin and gluten protein subunits also contribute to CD, which damages and inflames the small intestine and causes malnutrition **(Demirkesen *et al* .,2013).** Moreover, one out of every 200 people has been diagnosed with this illness, and according to some research, it affects one out of every 100 people globally (**El-Hadidy *et al*., 2022)**. The only known long-term remedy for this chronic illness is strict adherence to gluten-free foods. But given that many meals include gluten, this is difficult **(Motrena *et al* .,2011)**.

Products free of gluten are generally high in carbohydrates but low in protein, minerals, vitamins and fibers **(Saturni *et al*.,2010),** and generally have a high glycemic index **(Di Cairano *et al* .,2018).** Therefore, the beginning point for making good, healthy gluten-free biscuits would be to reduce the amount of carbohydrates while increasing the amount of protein and adding raw ingredients that supply all the nutrients required to maintain a balanced diet**.**

In addition, food that looks like conventional food and is consumed as part of a regular diet as functional food has been shown to have physiological benefits and/or lower the risk of chronic disease in addition to serving basic nutritional functions **(Roberfroid *et al.*, 2005).**

Many people with celiac disease, a chronic enteropathy characterized by an inadequate immune response to ingested gluten from wheat, barley, rye, and triticale, can benefit from using cassava flour (**Sciarini *et al.*, 2008)**. It would be preferable to cut back on or completely stop consuming gluten-free meals (**Turabi *et al.*,2008)**. Cassava flour(CF) is one of the most widely consumed foods made from cassava roots (**Ogunjobi, and Ogunwolu,2010)**. Additionally, cassava flour has continued to find more uses in the food, feed, and chemical industries (Balagopalan,2002). The majority of the time, proteins separated

from sources like legumes and dairy are added to gluten-free products **(Moore *et al*.,2006) .**

The third-most significant pulse crop, chickpeas (*Cicer arietinum* L.), are rich in fiber, protein, vitamins, and vital minerals. They also have a low glycemic index. Thus, chickpeas can help prevent or treat cancer, cardiovascular disease, diabetes, high cholesterol, and hypertension (**Sharma *et al*.,2017).** In order to promote general health and well-being, chickpea was suggested for the development of nutrient-dense meals (**Meng *et al*.,2010)**.Therefore, numerous research showed that chickpeas can be used in product formulations as either a functional food ingredient or as the primary component of new products (**Gupta *et al*.,2019)**. The range of chickpea protein's digestibility is 48 to 89.01% (**Rachwarosiak *et al*.,2015)**.

common bean (*Phaseolus vulgaris* L.,) is a vital source of numerous macro- and micronutrients, including proteins. As a result, its ingestion has positive impacts on human health and related pathologies, like lowering the risk of cardiovascular disease and type 2 diabetes, preventing various cancers, and managing some metabolic functions **(Hayat *et al*.,2014).** In addition, beans are a great source of protein for vegetarian, vegan, and gluten-free diets due to their unique qualities. Additionally, including beans in well-known industrial products, particularly snacks, may help draw customers and boost the use of legumes in different food preparations so that all consumer groups can make use of common beans' advantageous benefits. Additionally, they are a necessary and complete staple food in many developing countries, where the problem of "hidden hunger" is a severe problem and common beans are one of the most widely grown crops. **(Petry *et al*.,2015).**

Round bread cakes that are gluten-free biscuits are often leavened with baking soda, baking powder, or sometimes yeast. Additionally, cookies or crackers could be mentioned. Since they are often delicious and easy to transport, historically, travelers have used them **(Mehta *et al*.,2014).**

This investigation aimed to use cassava, chickpea and common bean flour in preparing gluten-free biscuits with high nutritional value for people suffering from celiac disease.

2.Materials and Methods

2.1. Materials

Cassava flour (*Manihot esculenta* Crantz), desi chickpeas *(Cicer arietinum)* and common beans (*phaseolus vaulgarisl*) were obtained from Agriculture Research Center, Giza, Egypt. Other ingredients that are used to prepare biscuits like sugar (sucrose), egg, baking powder,) butter and salt (sodium chloride) were bought from the supermarket in Giza city, Egypt. Chemicals and solvents were purchased from El-Gomhoria Company for Trading Drugs, Chemicals and Medical Instruments. Cairo, Egypt.

2.2.Preparation of raw materials

Desi chickpeas and common bean samples were deliberately cleaned from impurities, and afterward washed with faucet water. They were soaked in tap water for 12 hour at room temperature (25±2˚C). according to **Khattab and Arntfield, (2009).** Soaked samples were dried in an oven at 45˚C ± 5 for18 hour.

All prepared samples of dried desi chickpeas and common beans were grounded into fine flour utilizing an electric Brabender Duisburg roller mill, Germany and were kept in polyethylene bags and stored in at a refrigerator till utilized according to **Prasad *et al*.,(2012).**

2.3. Preparation of biscuits

The biscuit blends are presented in Table 1. The procedures outlined by **(El-Hadidy *et al*., 2022)** Sugar and butter were mixed in (a Kenwood blender) at a medium speed until plumped cream was formed, adjust egg and continue the mixing. Cassava flour, desi chickpeas flour and common bean flour were added to the blender and then salivate on a flat rolling board. Cut biscuits were placed on creamed baking trays and baked for 15 minutes in an electric oven at 160°C.

Table (1)Blends of biscuits for free-gluten

Ingredients	B1	B2	B3	B4
Cassava flour(g)	40	40	40	40
Desi chickpea flour (g)	55	50	45	40
Common beans flour(g)	5	10	15	20
Sugar (g)	30	30	30	30
Whole egg(g)	24	24	24	24
Baking powder (g)	01	01	01	01
Butter (g)	15	15	15	15
Vanillin (g)	0.3	0.3	0.3	0.3
skimmed milk (g)	0.5	0.5	0.5	0.5
Warm water(ml)	As needed			

2.4. Analytical methods:

2.4.1. Chemical analysis: Moisture, ash, crude fiber, ether extract and crude protein contents were estimated according to the procedure outlined by **(AOAC, 2010).**

Available carbohydrates were estimated by difference.

Available carbohydrates = 100 – (crude protein + ash + ether extract + crude fiber) **(FAO, 1998) .**

Total calories were calculated by the formula of **(Omobuwajo,2003).** as follows:

Total calories =Ether extract x 9 + Crude protein x 4 + Available carbohydrate x 4.

2.4.2. Determination of minerals content

Minerals were determined according to the procedures outlined by **(AOAC, 2010).**

2.6. Determination of amino acids

Amino acids of cassava flour, common bean flour, desi chickpeas flour were determined according to the method outlined by **(AOAC, 2010).**

2.4.3. Determiation tryptophan

Tryptophan content of samples was measured calorimetrically according to the method defined by **(Miller,1967).**

2.4.4.Computed protein efficiency ratio (C-PER):

C-PER was assessed as outlined by **(Alsmeyer *et al.*, 1974)** following the equation:

C-PER = -0.684+0.456 (Leucine) -0.047 (proline).

2..4.5.Computed Biological value (BV):

Biological value was assessed as defined by **(Farag *et al* ., 1996)** according next equation: - BV =49.9+10.53C-PER.

2.4.6.Sensorial evaluation of biscuits

Biscuit blends were tested organoleptically for sensory evaluation. Twenty trained panelists from the Food Technology Research Institute judged the blends for appearance, color, odor, texture, taste, and overall acceptability. For sensorial evaluation, a numerical decadent scale ranging from 1 to 20 was used (1 being very bad and 20 being excellent) according to the methods outlined by **AACC,(2002).**.

2.4.7.Hardness of biscuits

The hardness of biscuits was measured according to the procedures of **AACC (2002).**

2.5.Physical Properties of Biscuits

The diameter and thickness of biscuits were determined with a venire caliper. The spread ratio was calculated from the ratio of diameter to thickness as described by **(Gains, 1991)** method. The average of weight the biscuit (5 piece) was determined in (g). Volume (cm^3) was measured by displacement of rapeseeds and specific volume was calculated by dividing volume (cm^3)/weight (g). Density was determined by dividing weight (g) out volume (cm^3) and expressed as (g/cm^3) according to the method outlined by **Sai Manohar, and Haaridas (1997)**. The specific volume of biscuits was calculated according to the method described in **AACC (2002)** .

2.6.Statistical Analysis:

Statistical analysis was prepared using SPSS software (version 16) and Duncan's multiple range tests was used for mean comparison. Duncan's multiple range tests at ($P \leq 0.05$) level were used to compare

3.Results and Discussions

3.1.Proximate chemical composition of raw materials

Common bean flour and chickpeas had considerably higher protein 23.82% and 21.19% compared to the cassava flour 6.69%. Fat and crude fiber were also higher in chickpeas flour than in common beans and cassava flour. The proximate compositions

obtained in this study were similar to literature values for desi chickpeas flour and common bean flour **(El-Dreny and El-Hadidy. 2020).**The high protein content of chickpeas flour and common beans flour makes it a useful protein supplement in cassava flour. Moreover, **El-Hadidy et al.,(2022)** reported that cassava flour contained 5 % ash; 7.00% crude protein; 1.50 % f at; 4.50% crude fiber; 80 % carbohydrates and caloric value was 361.50 kcal/100g.

Table (2) Chemical composition of cassava, desi chickpeas and common beans (on dry weight basis).

- a, b, c , d different superscript letters in the same rows are significantly different at LSD at ($p \leq 0.05$).

-Each value was an average of three determinations ± standard deviation.

Raw materials / Components%	Cassava flour	Chickpeas flour	Common bean flour
Crude protein%	6.69 ± 0.05^{c}	21.19 ± 0.25^{b}	23.82 ± 0.25^{a}
Ash%	4.89 ± 0.06^{a}	3.12 ± 0.02^{b}	2.21 ± 0.02^{c}
Ether extract%	1.52 ± 0.02^{b}	6.55 ± 0.05^{a}	1.37 ± 0.01^{c}
Crude Fiber%	4.70 ± 0.03^{b}	17.79 ± 0.15^{a}	2.73 ± 0.05^{c}
Available carbohydrates*%	82.2 ± 0.75^{a}	51.35 ± 0.55^{c}	69.87 ± 0.55^{b}
Caloric value (kcal/100g)	369.24 ± 0.55^{b}	349.11 ± 0.85^{c}	387.09 ± 0.95^{a}

3.2.Minerals content of cassava, chickpeas and common beans

Minerals are important for certain physicochemical processes which are essential to human life. Per day, greater than 100 mg of the macro-minerals (Na, Mg, K, Ca, P and Cl) and less than 100 mg of micro-minerals (Fe, Cu and Zn) are required **(Soetan *et al.*, 2010)**

As shown in Table 3**,** the minerals content were cassava, desi chickpeas and common beans containing high amount of (K, Na Ca and Mg) . Also, cassava, desi chickpeas and common beans have higher contents of microelements . These results are in accordance with those obtained by **(El-Dreny and El-Hadidy. 2020).** Furthermore, **El-Hadidy *et al.*, (2022)** reported that cassava flour contained K, Na, Ca ,Mg, Mn, Fe and Zn .

Table (3) Minerals content of cassava chickpeas and common bean (mg /100 g on dry weight basis)

Minerals ((mg /100g)	Cassava flour	Chickpeas flour	Common bean
Potassium (K)	464^{c}±1.23	1120^{b}±2.55	1760^{a}±2.25
Sodium (Na)	139^{a} ±0.75	27.53^{c}±0.45	81^{b} ±0.75
Calcium (Ca)	282±3.85	178.54±1.75	268±2.35
Magnesium (Mg)	179^{a} ±1.15	163.77^{b}±2.71	127^{c}±1.25
Manganese (Mn)	5.26^{a}±0.15	5.26^{a}±0.45	1.19^{b}±0.05
Iron (Fe)	3.54^{c}±0.05	6.56^{b}±0.55	13.32^{a}±0.25
Zinc (Zn)	1.83^{c}±0.01	3.52^{b}±0.07	4.75^{a}±0.35

- a, b, c , d different superscript letters in the same rows are significantly different at LSD at ($p \leq 0.05$).

-Each value was an average of three determinations ± standard deviation.

3.3.Amino acids composition of cassava, chickpeas and Common bean flour:

Amino acids are organic compounds that join together to form proteins; as such, they affect the quantity and quality of protein. Amino acids are divided into essential and non-essential. In addition to their contribution to anabolic properties in human muscle, it acts as neurotransmitters, and some act as starting materials for the biosynthesis of neurotransmitters, hormones, and other important biochemical compounds **(Monajjemi *et al.*, 2014).**

From the data given in Table 4 it could be noticed that, the amount of total essential amino acids content of cassava, chickpeas and common beans flour. On the other hand, lysine and isoleucine were higher in chickpea and common bean flour compared to cassava flour. Also, cassava flour contained a higher amount of valine, threonine, leucine and phenylalanine compared to the others. Similarly, the amounts of non-essential amino acids in cassava, chickpeas and common beans flour. These results are in agreement with **(El-Dreny and El-Hadidy. 2020).** It was found that the use of different types of flour leads to obtaining balanced products in amino acids.

Also, **El-Hadidy et al.,(2022)** presented that the total non-essential amino acids and total essential amino acids content of the cassava flour were 53.84and 43.61 g /100 g of crude protein, respectively. The comprise of indispensable amino acids displays that cassava flour had a higher ratio of leucine (8.73%),

phenylalanine (8.25%), and lysine (5.43%). Meanwhile dispensable amino acids contained glutamic and aspartic were 15.20 % and 9.42% followed by arginine 7.42%, meanwhile alanine, serine, glycine and proline were 6.74, 5.36,5.16 and 4.54 %, respectively.

Table (4) Amino acids composition of cassava, chickpeas and common beans flour (g. amino acids /100g protein)

Amino acids	Cassava flour	Chickpeas flour	Common bean	FAO/WHO/UNU (1985) pattern
Essential amino acids (EAA)				
Lysine	5.54	7.64	7.56	5.80
Isoleucine	4.65	5.52	5.77	2.80
Leucine	8.75	7.45	8.65	6.60
Histidine	2.58	3.45	3.78	1.90
Phenylalanine	8.45	4.73	5.75	
Tyrosine	---	3.80	2.75	6.30
Tryptophan	ND	1.35	1.43	1.00
Valine	7.71	5.91	5.84	3.5
Threonine	4.57	3.43	4.73	3.40
Methionine	2.56	1.56	1.68	2.20
Cysteine	1.75	1.75	1.54	
Total (EAA)	46.76	45.99	49.48	
Non-essential amino acids (Non-EAA)				
Aspartic acid	9.45	10.61	12.53	
Glutamic acid	14.23	14.54	13.45	
Serine	5.46	6.33	5.30	
Proline	4.46	3.55	4.43	
Glycine	5.26	4.32	3.39	
Alanine	6.48	4.31	4.79	
Arginine	7.33	9.54	6.07	
Total (NEAA)	52.67	53.20	49.96	
C-PER	3.096	2.546	3.052	
BV	82.50	76.71	82.04	

C-PER = Computed protein efficiency ratio BV = Biological value

Total (EAA) = Total Essential Amino Acids Total (NEAA) = Total Non-Essential Amino Acids

3.4.Sensory evaluation of gluten free biscuits. :

Table 5 shows the sensory properties of biscuits made from cassava, chickpeas and common beans flour. The results showed that there are significant differences in appearance and color between the blends and the presence of no significant differences odor, texture and taste. The table indicated that all blends are acceptable. These results are in agreement with **El-Hadidy et al.,(2022)** showed that the addition of cassava flour to prepare biscuits for celiac illness patients was a suitable product and acceptable for sensory properties.

Table (5) Sensory evaluation of gluten free biscuits.

Samples	Appearance	Color	Odor	Texture	Taste	Overall acceptability
Blend (1)	17.08^{b} ±0.15	17.50^{b} ±0.25	17.20^{a} ±0.34	17.42^{a} ±0.28	16.94^{a} ±0.34	86.10^{b} ±0.26
Blend (2)	17.42^{b} ±0.22	17.78^{ab} ±0.35	17.40^{a} ±0.26	17.50^{a} ±0.25	17.20^{a} ±0.24	87.30^{b} ±0.24
Blend (3)	17.88^{ab} ±0.32	18.32^{a} ±0.37	17.62^{a} ±0.25	17.50^{a} ±0.27	17.44^{a} ±0.29	88.76^{ab} ±0.34
Blend (4)	18.54^{a} ±0.29	18.34^{a} ±0.28	17.72^{a} ±0.39	17.98^{a} ±0.26	17.64^{a} ±0.27	90.22^{a} ±0.34

B1=40 g cassava flour + 55 g chickpea + 5 g common bean.

B2=40 g cassava flour + 50 g chickpea + 10 g common bean.

B3=40 g cassava flour + 45 g chickpea + 15 g common bean.

B4=40 g cassava flour + 40 g chickpea + 20 g common bean.

- a, b, c , d different superscript letters in the same columns are significantly different at LSD at ($p \leq 0.05$).

-Each value was an average of twenty determinations ± standard deviation.

3.5.Physical measurements of gluten free biscuits:

Results presented in Table 6 showed that, The blends prepared from cassava, chickpeas and common beans flour are similar in some physical properties such as length, spread ratio, volume and width and different in thickness and weight. The reason for this is the difference in the blends used in preparing the mixtures. increased the weight of biscuits gradually in parallel with increasing the level of substitution. The increase in biscuits weight may be due to the increase in fiber contents which are characterized by containing higher water holding capacity as mentioned by **(Summaya and Sonkar, 2016).**

Table (6) Physical properties of gluten free biscuits.

Blends	Diameter (mm)	Thickness (mm)	Spread ratio	Weight (g)	Volume (Cm^3)	Specific volume (cm^3/g)	Density (g/cm^3)
Blend (1)	5.25^{ab} ±0.10	0.70^{d} ±0.03	7.50^{a} ±0.02	10.38^{a} ±0.15	62.46^{d} ±1.60	6.02^{d} ±0.03	0.166^{a} ±0.00
Blend (2)	5.25^{ab} ±0.10	0.72^{c} ±0.02	7.29^{a} ±0.28	10.31^{a} ±0.25	68.04^{c} ±0.16	6.60^{c} ±0.05	0.151^{b} ±0.02
Blend (3)	5.50^{a} ±0.15	0.76^{b} ±0.02	7.24^{ab} ±0.13	10.00^{b} ±0.06	75.24^{b} ±2.08	7.52^{b} ±0.07	0.132^{c} ±0.00
Blend (4)	5.50^{a} ±0.15	0.80^{a} ±0.02	6.88^{c} ±0.27	9.37^{c} ±0.15	79.2^{a} ±2.14	8.45^{a} ±0.04	0.118^{d} ±0.02

B1=40 g cassava flour + 55 g chickpea + 5 g common bean.
B2=40 g cassava flour + 50 g chickpea + 10 g common bean.
B3=40 g cassava flour + 45 g chickpea + 15 g common bean.
B4=40 g cassava flour + 40 g chickpea + 20 g common bean.

- Values followed by the same letter in columns are not significantly different at LSD at ($p \leq 0.05$).
- Each value was an average of five determinations ± standard deviation.

3.6.Color parameters of gluten-free biscuits.

Color is one of the most important quality attributes of bakery products. Preferred colors are closest to the original color of the samples. Color parameters of biscuits made from cassava, chickpeas and common beans flour were measured and the results were tabulated in Table 7. The results indicated that the lightness (L) and (b) value of biscuit samples were higher compared to (a) value. Blend (1) was higher but it's a value lower than blend (4). It could be noted that (a) values blend4 higher than blend (l).

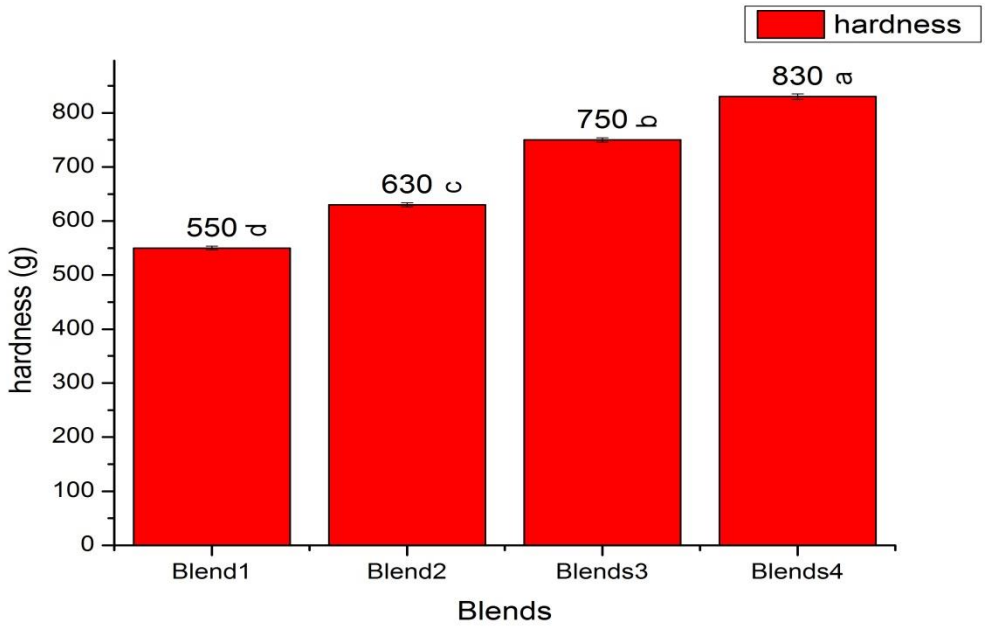
Table (7) Color parameters of gluten free biscuits.

Blends	L (Lightness)	a(Redness/ greenness)	b(Yellowness/ blueness)
Blend (1)	68.88^{a} ±.0.15	6.27^{d} ±.0.07	42.03^{a} ±.0.01
Blend (2)	63.29^{b} ±.0.09	8.29^{c} ±.0.09	39.45^{b} ±.0.20
Blend (3)	61.75^{c} ±.0.13	10.21^{b} ±.0.10	38.88^{c} ±.0.06
Blend (4)	59.25^{d} ±.0.05	10.59^{a} ±.0.06	38.43^{c} ±.0.08

B1=40 g cassava flour + 55 g chickpea + 5 g common bean.
B2=40 g cassava flour + 50 g chickpea + 10 g common bean.
B3=40 g cassava flour + 45 g chickpea + 15 g common bean.
B4=40 g cassava flour + 40 g chickpea + 20 g common bean.
- Values followed by the same letter in columns are not significantly different at LSD at ($p \leq 0.05$).
- Each value was an average of three determinations ± standard deviation.

3.7.Hardness of gluten free biscuits

The importance of texture in consumer acceptance is highly recognized. **Karaoğlu and Kotancilar (2009)** showed that hardness is the most important in the evaluation of baked goods, because of its close association with human perception of freshness. The data in Figure 1 presented the hardness of biscuit blends . The results showed that blend (4) had the highest hardness compared to other blends. This may be due to the effect of common beans flour in formulation. This might have outcome from combination of protein rich flour or fiber which requires more water to get good biscuits dough, and the biscuits made from high-absorption dough resort to being highly hard.



Fig(1)Hardness of biscuits

Conclusion

The found results of this study showed that biscuits were prepared from cassava, chickpeas, and common bean flour at different ratios. The final biscuits were rich in crude protein, crude fiber, ash and ether extract. These products were a rich source of indispensable amino acids particularly lysine, isoleucine, leucine and minerals principally potassium, calcium, magnesium and iron. The sensorial attributes of prepared biscuits from cassava, chickpeas and common beans flour were acceptable of products. These biscuits were free of gluten therefore; they are very a suitable for celiac illness patients. Finally, it could make some bakery foods using raw materials free of gluten such cassava, chickpeas and common beans flour with high quality that is suitable for celiac ailment patients.

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إعداد بسكويت من دقيق الكسافا وحمص الشام ودقيق الفاصوليا لمرضى السيلياك

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أجريت الدراسة الحالية لإعداد بسكويت خالي من الجلوتين بجودة عالية لمرضى السيلياك. البسكويت الخالي من الجلوتين والمصنع بالكسافا و دقيق حمص الشام ودقيق الفاصوليا هو يعد غذاء مبتكر ومغذي للغاية. وأظهرت النتائج أن محتوى الرماد والبروتين والدهن والألياف كانت أعلى في جميع المواد الخام. أيضا ، كان الليسين والأيزولوسين أعلى في الحمص ودقيق الفاصوليا مقارنة بدقيق الكسافا. كما احتوى دقيق الكسافا على نسبة أعلى من الفالين وثريونين وليوسين وفينيل ألانين ، ,وأوضحت النتائج ايضا أن الخصائص الحسية لخلطات البسكويت الخالي من الجلوتين كانت مناسبة للمحكمين. أيضا ، خلطة (4) لديها أعلى صلابة مقارنة مع B1 ، B2، B3 ،المعده من من 40٪ دقيق الكسافا ، 40٪ دقيق الحمص و 20٪ دقيق الفاصوليا. لذلك ، يمكن أن تصنع بعض الاغذية المخبوزة باستخدام مواد خام خالية من الجلوتين مثل الكسافا و حمص الشام و الفاصوليا بجودة عالية مناسبة لمرضى السيلياك

الكلمات المفتاحية : الكيماوي ، الخواص الحسيه، الأحماض الأمينيه، المعادن، السيلياك ،البسكويت .