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Utilization of Millet for the Preparation of High Nutritional Foods for Gluten Allergy Patients

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The aim of this study was to preparation high-quality gluten-free biscuits. The chemical makeup composition, minerals components, and amino acids of the materials used were assessed using millet and chickpea flour in various amounts. By analyzing the chemical composition of these for biscuits prepare of millet and chickpea flour and comparing them to biscuits produced solely from millet flour as a control biscuits, researchers were able to blends with various percentages of the substances under investigation. By studying the physical properties of gluten-free biscuits, the results showed an increase in length, width, thickness, spread ratio and hardness compared to biscuits prepare from millet flour only. The gluten-free biscuits made from millet flour and sham chickpeas scored the highest in evaluation the sensorial properties, which included the color, texture, taste, flavor and general acceptance. The research demonstrates the possibility of using millet in the preparation of high-quality gluten-free baked goods.

Keywords: Gluten free, millet flour, chickpea flour**,** Biscuits, Celiac**,** amino acids.

Introduction

Celiac disease is a chronic comorbidity caused by intolerance to gluten, and more specifically to certain proteins called prolamins, that cause atrophy of the intestinal villi and malabsorption and clinical symptoms that can appear in both childhood and adulthood **(Osella *et al*., 2014).** The poisonous parts take different names, depending on the grain: gliadin in wheat, avidin in oats, secalin in rye, or

hordine in barley. The brules of wheat, barley and rye are characterized by their high proline content. These proteins, which are the main components of gluten, contain toxic sequences that can lead to celiac disease **(Tsatsaragkou *et al*., 2012).**

Cereals are the most important food source on the earth, and they play a vital role in human diets all across the globe. Millet is a significant source of carbohydrates and proteins for people living in Africa and Asia's semi-arid tropics, where it is widely grown as one of the most important drought-resistant crops. Furthermore, because of its significant contribution to national food security, millet grains are now receiving increased attention from food scientists, technologists and nutritionists **(Saleh *et al*., 2013).**

Millet is the world's sixth most-produced cereal grain and one of the most important drought-resistant crops. Millet has pest and disease resistance, a short growing season, and a good output during droughts when compared to other cereals. **(Devi *et al*., 2011).**

Millets are high in phytochemicals and micronutrients as well **(Singh *et al*., 2012).** Millet belongs to the Poaceae family and is a modest subsistence grain crop. Millet is an important crop in many developing countries' economies. Millet is a staple food for a vast number of underprivileged communities in Africa, East Asia, and the Indian subcontinent. Millet's nutritional value is equivalent to that of other staple grains like wheat and rice. They have a low phytic acid content and are high in

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vitamin B, calcium, iron, and dietary fibre **(Chandrasekara *et al*., 2012).**

Besides nutrients, millet grains contain an abundance of phytochemicals, especially phenolic compounds **(Shahidi and Chandrasekara, 2013).** Many of the potential health benefits of millet such as preventing cancer, cardiovascular disease, and lowering blood pressure have been shown to be traced back to these phenols **Saleh *et al*., (2013). Chandrasekara and Shahidi (2011).** Both the soluble and binding sections of millet have been demonstrated to have a wide spectrum of phenolic and antioxidant components. In addition to their antioxidant qualities, millet, particularly finger millet, includes polyphenols that have antibacterial, anti-inflammatory, antiviral, anticancer, antiplatelet, and cataract inhibitory characteristics. **(Viswanath *et al*., 2009).**

Chickpea (*Cicer arietinum* L.) is one of the most well-known and extensively consumed vegetables on the planet due to its high protein content and versatility as a nourishing grain. It is the second most frequently farmed vegetable in the earth. **(FAO, 2008).** Chickpeas are a high-protein and high-carbohydrates food. It has a high protein level than other veggies like pigeon pea and green grams. **(Kaur and Singh, 2005).**

Biscuits are a ready-to-eat, simple, and inexpensive snack that is enjoyed by people of all ages in many nations. Biscuits are a staple of the daily diet, and consumers place a great value on their quality and sensory evaluation. However, due to the lack of gluten, the goodness of gluten-free Biscuits is likely to differ from that of typical Biscuits **(Bolarinwa *et al*., 2016).** The aim of the research is to prepare gluten-free biscuits for gluten-sensitive patients from pearl millet and chickpeas flour**.**

Materials and Methods

Materials

1-pearl millet (shendawil) (*Panicum miliane*) were obtained from Field Crops Dep.,Agr.Res. Center, Giza, Egypt.

2-Chickpeas *(Cicer arietinum*) and other biscuit making components such as baking powder, salt(Na Cl), and butter vegetarian were acquired from a local market in Dakahlia, Egypt. Chemicals and solvents were purchased from EL- Gomhoria Company.

Methods

Preparation of raw materials

Chickpea seeds were purposely cleaned of impurities before being rinsed with tap water. They were submerged at room temperature (25±2˚C) tap water for 12 h based on that **Khattab and Arntfield (2009).** Soaked seeds were dried in an oven at 45 C for 18 h .

Using an electric Bra bender Duisburg roller mill, Germany, Grind chickpea and millet seeds into fine flour and store in polyethylene bags in the refrigerator (5°C) until used. according to **Prasad et al.,(2012).**

Preparation of Biscuits:

Table 1 show the biscuit combination (1). Biscuits were preparation according to **El-Sharnouby *et al*., (2012).** sugar (sucrose) and butter were combined in (a Kenwood blender) at a medium speed until a plumped cream was created, then blended again. The flours of pearl millet and chickpea were lingeringly put to the blender, then salivated on a level rolling board. Cut biscuits were placed on creamed baking sheets and baked for 15 min in an electric oven at 160°C.

Proximate analysis of raw materials and Biscuits

AOAC (2005) was used to assess protein, moisture, ash, crude fibre, ether extract, minerals, and amino acids in pearl millet, chickpeas flour , and biscuits. Available carbohydrates were calculated by difference.

Available carbohydrates = 100 – (protein + ash + ether extract + crude fibre)

Computed protein efficiency ratio (C-PER):

C-PER was calculated as given by **Alsmeyer, *et al*., (1974)** following the equation: C-PER = 0.684+0.456(Leucine)-0.047(proline).

Computed Biological value(BV):

Biological value was calculated as described by **Farag, *et al*., (1996)** according following equation: Computed Biological Value (BV) =49.9+10.53C-PER.

Sensory Evaluation of Biscuits

Biscuit samples were organoleptically assessed for their organoleptic properties according to the method of **Alsenaien *et al*., (2015**). Samples were scored for appearance, color, odor, texture, taste and general acceptance by ten stuff members of the Food Technology Research Institute.

Hardness of Biscuits

The hardness of biscuits was determined using **AACC (2002)** techniques. A universal testing

equipment was used to determine the biscuit's hardness (PENETROMETER). A cylindrical screw with a diameter of 1 mm was employed. The drawing's hardness was determined in gram.

Physical characteristics of biscuits.

Width and length: A vernier calliper was used to measure the total width of six biscuits placed edge to edge (0.01 mm accuracy).The mean value was used to calculate the average width. showed that **Nouma (2003).** Similarly, the length of the biscuit was determined by placing six types of biscuit and taking the average value

Thickness:

The thickness was calculated by stacking six biscuits on top of one another and calculating the average thickness (cm). With the use of an innovative weighting balance, the weight of the biscuits was measured as the average of six estimations.

Volume:

Volume of biscuits was calculated using length. Width and thickness using the following formula: Volume(m^3) = L*W* T

L = average length of biscuits (cm)

W = average width of biscuits (cm)

T = average thickness of biscuits (cm)

Spread ratio

According to **Akubor and Ukwuru (2003).** the spread ratio was calculated. by using the following equations: Spread ratio = width ⁄ thickness

Statistical analysis

The SPSS version 16.0 software was used to evaluate the analytical data. Descriptive statistics were used to calculate the means and standard deviations. Analysis of one-way variance (ANOVA) and multiple range tests were used to make comparisons between samples. $P \leq 0.05$ was used to determine statistical significance.

Results and Discussion

Chemical composition of pearl millet and chickpea flour.

Table 2 shows the chemical composition of millet and chickpea flour and shows their content of protein, fat, ash, fiber and carbohydrates. The results show the high percentage of protein in chickpea and millet flour. These findings are consistent with **(El Gindy,2018)** who reported that millet flour content 12.10% protein, 5.54% fat**,** 2.22%fibre; 2.35%ash and 77.76% carbohydrates . **(Ghribi *et al*., 2015)** who reported values of 6.49 %fat; 25.04 % protein; 2.73%fiber; 2.96gm/100gm ash and 62.78% carbohydrates in chickpea flour.

Minerals content of pearl millet and chickpea flour

Table 3 depicts the situation. Major and minor minerals like calcium, sodium, magnesium, potassium, iron, zinc, phosphorus, and manganese were found in millet and chickpea flour. The findings show that chickpea flour and millet were a high in nutrients that the body need. These results are consistent with **(El Gindy,2018)** Millet is rich in minerals that the body needs. **(El-Dreny and El-Hadidy 2020).** chickpeas flour is rich in minerals that the body needs.

Amino acids composition of pearl millet and chickpeas flour. (g/100g protein).

Table 4 The content of millet and chickpeas flour from the essential and nonessential amino acids needed by the body. It was found that millet and chickpea flour is rich in essential amino acids such as leucine, theronine, phenylalanine, valine, isoleucine, lysine and non-essential acids As rginine, lanine, spartic acid and glutamic acid. The results indicate that chickpea and millet flour are rich in essential amino acids necessary for the body**.** These results are in a harmony with **(El-Dreny and El-Hadidy 2020).**

Sensory characteristics of gluten- free biscuits

The results presented in Table 5 indicate that the sensorial properties of the biscuits mixture are better than the control in appearance, color, texture, taste and general acceptance. It is clear from this that biscuits prepare of millet and chickpeas flour were better than biscuits prepare from millet flour only.

Chemical composition of gluten free biscuits.

Table 6 showed the chemical composition of gluten-free biscuits blends and their protein, fat, ash, fibre and carbohydrate content. The results showed a higher protein , Ether extract , Ash and Fibre content in the mixtures compared to Control.

Effect of pearl millet and chickpeas flour on the physical properties of gluten free biscuits.

The results of the physical properties of gluten-free biscuits prepared from pearl millet and chickpea flour mixture are shown in Table (7). The table indicates that the length, width, thickness, spread ratio, weight and volume increase in all mixtures of gluten-free biscuits compared to Control .

Hardness of biscuits

Figure (1) shows the degree of hardness of biscuits prepared from millet and chickpea flour and the effect of the proportions of these mixtures on the degree of hardness. A noticeable increase in hardness is observed from 370 g to 630 g. On the other hand, the use of biscuits increases with hummus. The data

showed that the mixture No.3 had the highest hardness value (630g) compared to the other samples and the control group (370 g).This may be due to the effect of chickpeas in the composition.

Table 1. Formulation for added ingredients for biscuits.

Ingredients	Control	Blend 1	Blend2	Blend 3
pearl millet flour	100	25	50	75
chickpeas flour	-	75	50	25
Sugar(sucrose)	36	36	36	36
Vanilla	0.25	0.25	0.25	0.25
Baking powder	5	5	5	5
Butter	80	80	80	80
water(ml)	As needed			

Table 2. Chemical composition of pearl millet and chickpeas flour (on dry weight basis).

Raw materials / Components%	pearl millet flour	chickpeas flour
Crude protein	12.81±0.03	22.65±0.33
Ether extract	5.50±0.02	6.50±0.04
Ash	1.50±0.04	2.89±0.03
Fibre	4.20±0.05	3.50±0.06
Available carbohydrates*	75.99±0.55	64.46±0.66

Available carbohydrates were calculated by difference.
Available carbohydrates = 100 – (protein + ash + ether extract + crude fiber)

Table 3. Minerals content of pearl millet and chickpeas flour (mg/100g on dry weight basis).

Minerals ((mg/100g)	pearl millet flour	chickpea flour
Calcium (Ca)	16.80	165
Sodium (Na)	4.70	30.5
Magnesium (Mg)	145	165
Potassium (K)	270	805
Iron (Fe)	4.70	6.10
Zinc (Zn)	3.10	5.20
Phosphorous (P)	340	275
Manganese (Mn)	1.20	3.10

Table 4. Amino acids composition of pearl millet and chickpeas flour (g. amino acids /100g protein).

Amino acids (g/100g protein)	pearl millet flour	chickpeas flour
Essential amino acids (EAA)		
Lysine	3.01	6.70
Isoleucine	4.50	5.50
Valine	6.30	3.50
Methionine	2.70	1.20
Cysteine	1.30	1.60
Phenylalanine	5.20	5.60

Tyrosine	2.85	3.80
Theronine	4.30	3.70
Tryptophan	2.50	1.30
Leucine	11.50	7.60
Histadine	2.40	3.27
Total (EAA)	46.56	43.77
Non-essential amino acids (Non-EAA)		
Arginine	4.30	10.40
Alanine	9.70	4.30
Aspartic acid	9.20	11.19
Glutamic acid	15.91	17.10
Glycine	3.15	4.01
Proline	4.73	3.65
Serine	3.95	5.08
Total (N-EAA)	50.94	55.73
C-PER	5.71	3.98
BV	109.98	91.79

Table 5: Sensory characteristics of gluten- free biscuits contained different levels of pearl millet and chickpeas flour .

samples	Appearance (10)	Color (10)	Taste (10)	Odor (10)	Texture (10)	overall acceptability (10)
Control	8.33c ± 0.61	8.27b ± 0.43	8.14b ± 0.41	9.62a ± 0.18	8.61 b ± 0.43	8.59c ±0.54
Blend1	9.72a ± 0.59	9.57a ± 0.31	9.89a ± 0.47	9.61a ± 0.13	9.20a ± 0.32	9.60a ±0.38
Blend 2	9.68a ±0.64	9.56a ± 0.44	9.86a ± 0.50	9.40b ±0.41	9.11ab ±0.34	9.52a ± 0.37
Blend 3	8.60c ±0.36	9.30a ± 0.55	8.98b ± 0.26	9.30 b ± 0.38	9.01ab ± 0.36	9.03b ±1.25

Means in the same column with different letter are significantly different *(P ≤ 0.05)*

Each value was an average of ten determinations ± standard deviation.

Table 6. Chemical composition of gluten - free biscuits (mg/100g on dry weight basis).

Components / Samples	Crude protein	Ether extract	Ash	Fibre	Available carbohydrates
Control	12.17d ±0.12	12.86c ±0.32	1.68c ±0.19	3.87b ±0.09	68.52a ±2
Blend 1	19.96a ±0.16	17.68a ±0.13	3.06a ±0.12	3.34c ±0.19	55.96d ±0.43
Blend 2	17.16b ±0.23	17.28ab ±0.19	2.23b ±0.12	3.55c ±0.1	59.75c ±0.42
Blend 3	14.33c ±0.32	17.13b ±0.14	2.04b ±0.06	4.22a ±0.1	62.28b ±0.54

Means in the same column with different letter are significantly different *(P ≤ 0.05)*

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

Table 7. Physical properties of gluten free biscuits.

Samples	Length (cm)	Width (cm)	Thickness (cm)	Spread ratio	Weight (g)	Volume (m^3)
Control	8.77a ±0.32	3.21a ±0.45	0.62b ±0.42	5.81a ±0.52	9.36b ±0.25	23.98b ±0.64
Blend 1	9.15a ±0.26	3.34a ±0.34	0.64b ±0.34	5.23ab ±0.28	9.68b ±0.35	25.81b ±0.56
Blend 2	9.01a ±0.45	3.31a ±0.43	0.64b ±0.52	5.71a ±0.43	9.54b ±0.26	24.98b ±0.78
Blend 3	8.99a ±0.56	3.24a ±0.23	0.63b ±0.42	5.14a ±0.27	9.48b ±0.35	24.83b ±0.54

Means in the same column with different letter are significantly different *($P \leq 0.05$)*

Each value was an average of sixdeterminations ± standard deviation

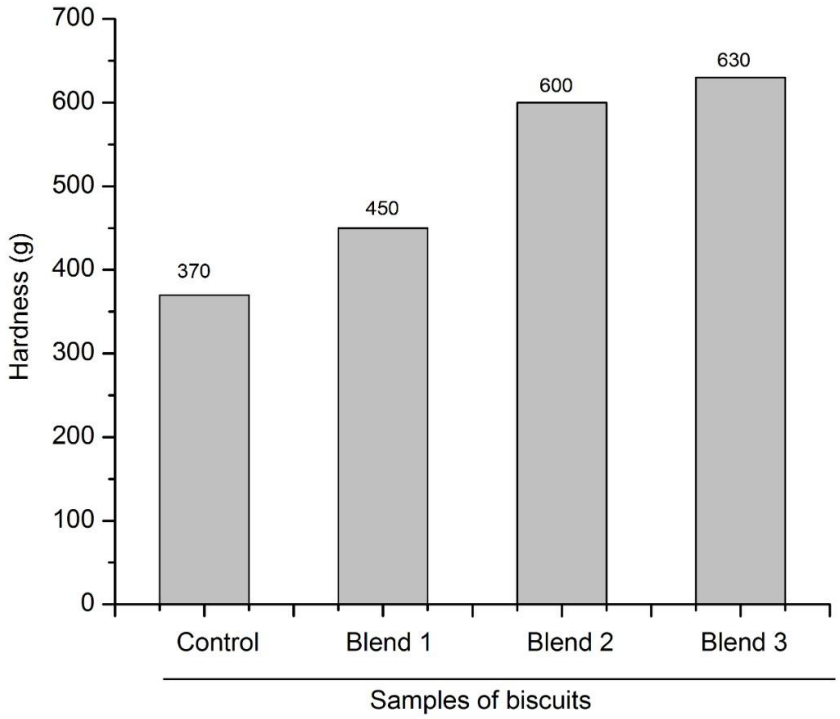

Fig. 1. Hardness of prepared biscuits blends.

Conclusion

The findings of this investigation indicated that millet and chickpeas flour might be used to prepare gluten-free biscuits. Gluten-free biscuits are high in protein, raw fibre, minerals, and important amino acids, including potassium, calcium, magnesium, and iron. The sensorial properties of the biscuits were almost identical to those of biscuits made with wheat flour. Because this product is gluten-free, it is ideal for gluten-sensitive individuals.

Finally, Some gluten-free bakeries products, such as biscuits, can be made using high-quality gluten-free ingredients such as millet and chickpea flour and are safe for gluten-sensitive patients.

1. Conflicts of interest

"There are no conflicts to declare".

2. Formatting of funding sources

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الاستفادة من الدخن لإنتاج أغذية عالية القيمة الغذائية لمرضى حساسية الجلوتين

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تمت إجراء الدراسة الحالية لإعداد البسكويت الخالي من الجلوتين بجودة عالية. باستخدام دقيق كلا من الدخن و الحمص بنسب مختلفة وتم تقدير التركيب الكيماوي والعناصر المعدنية والاحماض الامينية في المواد المستخدمة. وتم أعداد خلطات بنسب مختلفة من هذه المواد تحت الدراسة وبدراسة التركيب الكيماوي لهدة الخلطات للبسكويت المكون من دقيق الدخن ودقيق الحمص ومقارنتها بالبسكويت المعد من دقيق الدخن فقط كعينه ضابطه وجد أن البسكويت الخالي من الجلوتين مرتفع في محتواه من البروتين والدهن والالياف والعناصر المعدنية مقارنة بعينة البسكويت المعد من دقيق الدخن فقط . وبدراسة الخواص الفيزيائية للبسكويت الخالي من الجلوتين أظهرت النتائج زيادة فى قيم كلا من الطول والعرض والسمك وزيادة في spread ratio والصلابة مقارنة بالبسكويت المعد من دقيق الدخن فقط . هذا وقد سجل البسكويت الخالي من الجلوتين المصنع من دقيق الدخن ودقيق حمص الشام أعلى الدرجات في تقييم الخواص الحسية والتى شملت كلا من اللـون والقوام والطعم والرائحة ودرجة القبول العام أيضًا.