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Doaa Omar Mohamed Gouda

Lecturer of Nutrition and Food Science – Faculty of specific education- Sohag University

كلية معتمدة

مجلة البحوث في مجالات التربية النوعية

معرف البحث الرقمي DOI: 10.21608/JEDU.2023.201365.1856

المجلد التاسع . العدد 46 . مايو 2023

الترقيم الدولي

P-ISSN: 1687-3424 E- ISSN: 2735-3346

موقع المجلة عبر بنك المعرفة المصري https://jedu.journals.ekb.eg/

موقع المجلة http://jrfse.minia.edu.eg/Hom

العنوان: كلية التربية النوعية . جامعة المنيا . جمهورية مصر العربية

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Abstracts:

Cookies represent one of the most bakery products. These are important food products consumed by children and adults as a snack in daily diet, this study aimed to produce healthy free gluten cookies from rice flour and tiger nut flour. rice flour (100%) was the control sample and substituted by 20, 40 and 60 % of tiger nut powder. The chemical composition, amino acid, total phenolic compound and sensory characteristics of cookies were determined, the results showed that an increase in protein 6.16-6.62%, nitrogen 0.96-1.06%, ash 1.27-1.63%, calories 529.06-540.38, essential amino acid 361.12-404.15mg/g protein and phenolic compound 3.06-3.73mg GAE/g, a decrease of carbohydrates 57.98-49.05% by increase tiger nut powder in cookies sample compered to control sample recorded 5.89%, 0.95%, 1.03%, 505.08 calorie, 339.33 mg/g protein and 2.69mg GAE/g respectively for each compound.

The sensory evaluation of tiger nuts cookies (all mixtures) was highly acceptable and had good sensory attributes.

Conclusion. The obtained results indicate that blends of rice flour and tiger nut powder could be used for gluten free formulation, the organoleptic properties of tiger nut cookies found acceptable good sensory quality.

Key words: Celiac disease - gluten-free diet – tiger nuts-cyperus esculentus- gluten free cookies

Introduction

Celiac disease is an inflammatory condition of the small intestine which affects approximately 1% of the global population ***(Vici et al., 2016).*** Intestinal symptoms can include diarrhea, abdominal cramping, pain and distention and untreated celiac disease may lead to vitamin and mineral deficiencies, osteoporosis and other extra intestinal problems ***(Seraphin and Mobarhan, 2002)***.

The gluten free diet remains until now the only treatment for Celiac disease ***(Seraphin & Mobarhan, 2002)*** , so all the products from wheat, rye, barley and oat must be replaced with corn, rice, millet equivalents and various types of starch (corn, rice and potato) or appropriate mixtures ***(Moore et al.,2006; Lazaridou et al., 2007).***

Mandala, and Kapsokefalou (2011) reported that developing gluten-free products requires an extension, because the celiac patient nutritional needs are not fully covered by existing products.

van Hees et al. (2015) mentioned that patients with celiac disease following a gluten-free diet for a long time were found to have a lower level of essential amino acids in biological fluids compared with healthy subjects**.**

Drabinska (2022) reported that many gluten-free products are deficient in amino acids, especially in essential amino acids. Therefore, the incorporation of additives rich in free amino acids into gluten-free products can be a promising strategy to alleviate certain symptoms of celiac disease associated with essential amino acids deficiencies.

Plant proteins can now be regarded as functional ingredients or as biologically active components more than as essential nutrients. Because functional properties of protein often have a tight relationship with its amino acid profile, so the amino acid composition represents the potential quality of a plant protein as mentioned by ***Jing et al. (2013)***.

Sanchez-Zapata et al (2012) reported that tiger nut *(Cyperus esculentus)* belongs to the family *cyperaceae* and the order, also called chufa sedge, underground walnut, nut grass, yellow nuts edge, tiger nut sedge, edible galingale, water grass or earth almond is a crop of the sedge family widespread across much of the world**,** because of its high yield and broad prospects for comprehensive utilization ***(Rubert et al. 2011),*** its cultivation in Egypt since the sixth millennium BC, It is very famous in Egypt and locally named (Hab Alaziz), where it is mainly consumed after soaked in water for tenderization or blanched as a traditional snack food or roasted and grinded in powder form as a drink***(Adel et al. 2015; Aamer, 2019 &Toungos and Babayola. (2019)***

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EL-Tellawy et al. (2009) showed that the defatted tiger nut flour had a relatively good amounts of protein (10.1%), good amounts of essential amino acids which indicate the high nutritional value of these flour, also showed replacement of wheat flour by 25, 50 and 75% of defatted tiger nut flour and effect of this replacement on the gross chemical composition, mineral and amino acid content. The sensory evaluation of cake and biscuit products (all mixtures) were highly acceptable and having good sensory attributes.

Aamer (2019) found that the defatted tiger nut flour contained high amounts of nitrogen free extract, dietary fiber total, as well as fairly good amounts of essential amino acids and certain minerals which indicated its high nutritional value.

Yu et al. (2022) reported that the tiger nut is the tuber of *Cyperus esculentus* has the radical scavenging ability, in vitro inhibition of lipid peroxidation, anti-inflammatory and anti-apoptotic effects and displays medical properties. It has been made to milk, snacks, beverages and gluten-free bread.

Thus, this study aimed to investigate the effect of substitution of gluten-free rice flour by some percentages of tiger nut powder as source of amino acid, minerals and phytochemical nutrients, on nutritional quality and sensory characteristics in gluten-free cookies.

Materials and methods

Materials

Tiger nut seed, commercial gluten- free rice flour, vanillin, egg, baking powder, powdered milk, butter, sugar powder and brown sugar were purchased from local market of Suhag City, Egypt.

Preparation of tiger nut powder

Tiger nut powder was prepared according to the method of ***Aamer (2019)*** meanwhile tiger nut seed were cleaned, washed with tap water and then rinsed, drained and air dried for 8 hour before crushing and milled by house mincer (Moulinex, Super Blender, France), then sieving, tiger nut powder were packed in polyethylene bags and kept until analysis use in the preparation of cookies.

Preparation and formulation of gluten free cookies sample:

After obtained approval from medical research ethics committee, faculty of medicine, sohag university under registration number:Soh-Med-23-05-03PD, gluten-free cookies samples were prepared according to ***A.A.C.C (2000)*** using the formula as described by ***EL-Tellawy et al. (2009)*** with some modifications. Table (1) summarized all cookies sample formulations; gluten rice flour was substituted by 0, 20, 40 and 60% of tiger nut powder. Meanwhile butter and sugar were creamed using an electric hand mixer at medium speed for 3 min, then egg, vanilla, powder milk were added and mixing well, then baking powder, salt and flours were added; the total time of mixing was 20 min. The dough was cut using a circular shaped cookies weight of 20 gm/cookies. Baking was carried out in at 180˚C, for 15-18 min. The baked cookies were cooled down at room temperature in a sealed plastic bag then stored refrigerator at 5^{o}C to analysis.

Table (1). Formulation of prepared cookies sample according to ***(EL-Tellawy et al., 2009)***

Ingredients	cookies sample			
	Control sample (0%)	Tiger nut flour (20%)	Tiger nut flour (40%)	Tiger nut flour (60%)
Rice flour gm	150	120	90	60
Tiger nut powder gm	-	30	60	90
Butter gm	100	100	100	100
Sugar gm	30	30	30	30
Brown suger gm	20	20	20	20
Egg gm	60	60	60	60
Bowder milk gm	20	20	20	20
Salt gm	.5	.5	.5	.5
Baking powder gm	2	2	2	2
Vanil gm	0.5	0.5	0.5	0.5

Nutritional analysis

Moisture, fat, crude protein, crude fiber and ash contents for all samples were determined as described in the ***A.O.A.C. (2010)***. Total carbohydrate was calculated by the difference.

Determination of amino acids

The amino acids composition of experimental samples were determined using the HPLC Pico-Tag method according to **Millipore *Cooperative (1987)***. The Pico-Tag method, was described by ***Heinrikson and Meredith (1984), White et al. (1986) and Cohen et al. (1989).***

Calculated the biological value (B.V) and protein efficiency ratio (P.E.R)

The biological value was estimated using the equation following by ***Oser (1959)***

B.V = 49.9 + 10.53 PER

Protein efficiency ratio of all gluten – free cookies was calculated as the equations described by ***Alameyer et al (1974)*** as fallow:

P.E.R = – 0.684 + 0.456 (leucine) − 0.047 (proline)

Determination of total phenolic contents

Total phenolic content was extracted from the dry powder samples of foods under study according to the method of ***Velioglu et al.* (*1998*)**. Each sample (200 mg) was extracted separately with 2 ml of methanol (80%) containing 1% HCl at room temperature in a shaker for 2 hours, then, centrifuged at 3000 rpm for 10 min. The upper layer was collected in different clean tubes and re-extraction of the residue was carried out using the same previous procedure. The second extract was added to the first and used for the determination of TPC. Total phenolics were determined colorimetrically in the extracted samples using Folin-Ciocalteu reagent **(*Singleton and Rossi, 1965*).** The reaction mixture contained 200 µl of extracted samples, 1000 µl of freshly prepared diluted Folin-Ciocalteu reagent and 800 µl of sodium carbonate solution (7.5%). Mixtures were mixed and kept in the dark at room temperature for 30 min to complete the reaction. Absorbance was measured at 765 nm using UVPC spectrophotometer. Gallic acid was used as a standard and results were calculated as mg gallic acid equivalent (GAE) per g of dry sample. The reaction was conducted 4 times and results were averaged.

Sensorial evaluation of prepared gluten -free cupcake

All cookies sample were cooled for 1-2 h at room temperature (25°C) in a sealed plastic bag. Sensory properties were evaluated for crust color, crumb color, crumb hardness, taste and flavor, overall acceptability according to ***(EL-Tellawy et al., 2009) .***

Statistical analysis

Data were analyzed using Statistical Package for Social Science (SPSS, 20), and data were reported as mean ± standard error of means (n = 3) for all chemical analyses and (n=7) for sensorial evaluation. Differences between means were determined by analysis of variance

(ANOVA) with LSD post hoc test,. Significance was declared at $P < 0.05$ and $P < 0.01$ ***(Pallant, 2005)***.

Results and discussion

Chemical composition of gluten- free cookies substitution with some percentages of tiger nut powder

The chemical composition of all gluten –free cookies sample are shown in Table 2, the results found high fat content of all cookies samples, this is may be due to fat added dough preparation this results agreed with ***(Nada et al., 2016).*** Also found increment in nitrogen and fiber content, and significant increase ($p \leq 0.01$) in moisture, ash, protein, fat and caloric value in all tiger nut cookies sample compared with control sample, and showed significant decrease ($p \leq 0.01$) in total carbohydrates.

These results are in agreement with ***Adel et al. (2015)*** observed that tiger nut tubers contain a high amount of dietary fiber (15.47%), rich source of carbohydrates (48.12%) moderate amount of protein (4.33%), 22.14% of oil and excellent source of energy (409 Kcal/100g).

Also, with ***Akujobi (2018)*** and with ***Ogunka-Nnka et al. (2020)*** how investigated changes in the nutrient and phytochemical composition of processed tiger nut, results of proximate analysis shows that EAF had the highest protein (8.37 ±0.12), carbohydrate (49.01 ±0.17) and ash (6.20 ±0.12). The highest lipid (7.55 ±0.06) and crude fiber (19.50 ±0.23) was recorded for tiger nut dehydrated, while the highest moisture content was recorded for tiger nut blanch (19.71 ±0.35). tiger nut fermented had significantly ($p<0.05$) improved mineral and amino acid contents; while processing generally reduced the phytochemical content when compared with the air- dried sample.

While these results disagree with the results obtained by **Omowaye *et al. (2008)*** substituted wheat flour with tiger nut flour at varying proportions 0, 10, 20, 30, 40, 50%, found that the proximate composition of the flour samples showed a reduction of about 14 to 38% in protein content but with a significant enhancement in the fibre content (167 to 967%) depending on the level of substitution. The fat and ash contents increased with increase in the proportion of the tiger nut.

In these study, the increase of nitrogen, protein and ash in the tiger nut cookies sample may be due to different of varieties tiger nut and composite flour meanwhile ***Gyebi and Minnaar (2011)*** reported that composite flour is flour prepared by mixing or blending cereals, roots, tubers or legume flour at a predetermined ratio. The benefit of producing cereal- legume composite foods may be considered as twofold: First, there is an overall increase in protein content of the composite food as compared to when the cereal forms the base. Second, there is a better amino acid balance due to the contribution of lysine by legume and methionine by cereals.

Ejiofor and Deedam (2015) and ***Adekiya et al. (2020)*** reported that the nutritional value of tiger nuts and their products are dependent on varieties, soil, conditions, growth environment, cultivation techniques and storage conditions.

Table (2) Chemical composition of gluten- free cookies substitution with some percentages of tiger nut powder % on wet weight basis.

Sample	Nitrogen	Moisture	Ash	Protein	Fat	Fiber	Total carbohydrates*	Caloric value/100 g
Control sample	0.95 ±0.02	3.33 ±0.3	1.03 ±0.07	5.89 ±0.15	26.26 ±0.06	1.23 ±0.09	61.31 ±0.53	505.08 ±2.08
Tiger nut 20%	0.96 ±0.02	3.47 ±0.32	1.27 ±0.03	6.16 ±0.28	30.28** ±0.13	1.26 ±0.06	57.98** ±0.86	529.06** ±4.29
Tiger nut 40%	0.98 ±.03	4.40* ±0.21	1.6** ±0.11	6.4* ±0.03	31.70** ±0.33	1.28 ±0.03	53.60** ±0.65	525.49** ±0.051
Tiger nut 60%	1.06**±0.02	5.07** ±0.23	1.63** ±0.22	6.62** ±0.10	35.30** ±0.03	1.34 ±0.06	49.05** ±0.13	540.38** ±0.35

*****Carbohydrates were calculated by difference.

Values are presented as means ± standard error of the mean.

Significant $^{*}P < 0.05$, highly significant $^{**} P \leq 0.01$.

Amino acid content of gluten- free cookies substitution with some percentages of tiger nut powder

The results present in Table (3) recorded the amino acid content of gluten- free cookies substitution with some percentages of tiger nut powder, meanwhile results found increase of essential amino acid in all tiger nut 20, 40 and 60% cookies sample recorded 361.12, 360.55 and 404.15mg/g protein respectively compared with control sample recorded 339.33mg/g protein .

Meanwhile, the results showed increase content of lysine, methionine, isoleucine, leucine, cysteine and phenylalanine amino acid by increase of tiger nut flour in cookies sample compared with control sample

Also found a decrease in non- essential amino acid by increase substituted of tiger nut flour by 20, 40 and 60% in cookies sample recorded 590.46, 580.08 and 537.43mg/g protein respectively compared with control sample recorded 595.12mg/g protein

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The results obtained of this study are agreement with the results of ***EL-tellawy et al. (2009)*** how found that an increase in essential amino acids by increasing tiger nut flour except phenylalanine, while found decrease in cystine, histidine, glysine, alanine, glutamic and aspartic acids by increasing tiger nut flour in cookies and cake prepared by adding different levels from defatted tiger nut flour (0, 25, 50 and 75%, respectively) to wheat flour.

Also, ***Oge et al. (2018)*** assayed the nutritional composition of fresh and dried tiger nut milk by determining the proximate composition and amino acid profile using standard analytical methods, the results revealed that, tiger nut is rich in essential amino acids such as leucine, isoleucine, lysine, valine and arginine. also revealed that lysine, the most limiting amino acid in cereals is found in appreciable amounts in all samples of tiger nut.

Meanwhile, ***(Amir et al., 2013; Noorfarahzilah et al., 2014 and Ogur, 2014)*** reported that cereal proteins are deficient in some essential amino acids such as lysine and threonine.

Fortification of wheat flour with various sources of tubers, legumes, cereals and fruit flour to improve the nutritional values of bakery products**.**

Also ***van Hees et al. (2015)*** reported that the gluten-free diet, based mainly on corn and rice starches, does contain amino acids too; however, compared to a wheat-based diet, the amounts of several essential amino acids such as lysine and tryptophan are limited.

Jing et al. (2013) mentioned that tiger nut protein contains 18 kinds of amino acids, of which the essential amino acids account for 46.03%, largely exceeding the value specified in the WHO/FAO model (36%), higher than soy protein (41.3%). According to the literature, lysine is the first limiting amino acid of some nuts (Brazil nuts, macadamia nuts and almonds and some cereal grains (rice, white flour, corn, etc.). However, the amounts of lysine in tiger nut are much greater.

Salama et al. (2013) indicated that tiger nut flour contained 8 indispensable amino acids beside 9 dispensable amino acids. The major indispensable amino acids were phenylalanine (290 mg/100g), leucine (200 mg/100g) and lysine (200 mg/100g protein). Tigernut flour contained tyrosine (140 mg/100 g protein) which was not present in casein.

Omeje et al. (2021) determined the nutritional composition of the yellow variety of tiger nuts and found that tiger nuts are rich in essential amino acids, minerals, some vitamins and are recommended to persons with nutritional deficiencies as it is cheap and available all year round.

Table (3): Amino acid content of gluten free cookies substitution with some percentages of tiger nut powder.

Amino acid	Amino acid mg/gram protein			
	Control sample	Tiger nut 20%	Tiger nut 40%	Tiger nut 60%
Essential amino acid				
Lysine	44.55	59.51	49.22	74.28
Threonine	40.40	40.10	40.42	28.99
Valine	59.86	61.79	63.28	62.74
Methionine	37.05	43.57	38.25	43.42
Isoleucine	60.17	43.27	49.69	65.93
Leucine	50.54	59.15	58.63	61.14
Cysteine	14.07	16.25	17.05	19.80
Phenylalanine	32.69	37.48	44.01	47.83
Total	**339.33**	**361.12**	**360.55**	**404.15**
Non- Essential amino acid				
Histidine	49.83	43.27	40.20	51.32
Glutamic acid	139.06	154.40	137.75	96.42
Tyrosine	32.67	31.54	34.36	65.43
Glycine	33.90	37.33	38.54	34.15
Aspartic acid	96.21	103.06	98.34	79.07
Arginine	62.42	58.20	57.35	59.44
Serine	64.30	67.54	67.72	56.51
Alanine	78.39	72.36	76.32	52.53
Proline	38.34	22.76	29.50	42.56
Total	**595.12**	**590.46**	**580.08**	**537.43**

Biological value (B.V) and protein efficiency ratio of gluten-free cookies substitution with some percentages of tiger nut powder

Table (4) shows the biological value and protein efficiency ratio of different gluten-free cookies. As shown in **Table (4)**, increase in biological value and protein efficiency ratio by increased tiger nut flour in cookies sample compared with control sample.

These results are in agreement with the results obtained with ***Barakat (2022)*** who showed gradually increase of biological value and protein efficiency ratio by increase of tiger nut flour in biscuit fortified with 10, 20 and 30% tiger nut compared with biscuit control.

Table (4): Biological value and protein efficiency ratio of all gluten – free cookies:

Sample	Biological value	protein efficiency ratio
Control sample	266.40	20.56
Tiger nut 20%	315.47	25.22
Tiger nut 40%	309.57	24.66
Tiger nut 60%	315.26s	25.20

Total phenolic content (TPC) of gluten free cookies substitution with some percentages of tiger nut powder

The data in **Table (5)** showed that total phenolic content of different cookies sample, the results showed that high significant increase at $p \leq 0.01$ in total phenolic content in all tiger nut cookies sample compared with control sample, also results showed that gluten free cookies subtitled with 60% tiger nut flour had the highest amount of total phenolic content recorded 3.78±0.11 compered with control sample recorded 2.69±0.03.

These results agree with the results obtained from ***Abdel-Samie and Abdulla (2016)*** who showed that replacing 10, 20, 30 and 40% of wheat flour by tiger nut flour in crackers increased the total phenolic contents to be 1.33, 1.39, 1.44 and 1.51 mg GAE/g, respectively compared to that of control sample (1.29 mg GAE/g).

Olukanni et al. (2022) analyzed the chemical constituents in the ethanolic and aqueous extract of tiger nut and found ethanolic extract of tiger was attributed to its high levels of phytosterols and phenolic compounds.

Razola-Diaz et al. (2022) determine the phenolic compounds and compare the phenolic profile of two tiger nut by-products. Found tiger nut by-product has been demonstrated to be richer in phenolic acids and other polyphenols and has higher antioxidant activity.

Table (5): Total phenolic content (TPC) of gluten free cookies substitution with some percentages of tiger nut powder

	Control sample	Tiger nut 20%	Tiger nut 40%	Tiger nut 60%
TPC (mg GAE/g sample)	2.69±0.03	3.06**±0.18	3.16**±0.09	3.78**±0.11

Values are presented as means ± standard error of the mean.
Significant $^{*}P < 0.05$, highly significant $^{**}P \leq 0.01$.

Sensory characteristics of cookies produced from rice flour substitution with some percentages of tiger nut powder

Table (6) summarizes the sensory evaluation including crust color, crumb color, crumb hardness, taste and flavor, and overall acceptability of all gluten free cookies. The results found that no significant deference at P<0.05 and P≤0.01 between gluten free control sample and gluten free tiger nut sample. Generally, all cookies sample were accepted by the panelists. The description of the overall acceptability by the panelists was extremely acceptable.

Meanwhile, ***Gyebi and Minnaar (2011)*** reported that composite flour between cereal and tubers or legumes affects not only nutritional quality but also functional, sensory and phytochemical quality of the final food product**.**

these results agreement with **Omowaye *et al. (2008)*** revealed that bread from pure wheat flour and those produced from composite flour with 10% and 20% tiger nut flour were rated alike in almost all the quality attributes evaluated indicating the feasibility of adding tiger nut to baked goods, and suggested that potential application of tigernut flour either as full fat or defatted flour in baking industry

The same results obtained by ***Salama et al. (2013)*** found no significant deferent in all organoleptic properties of potato chips fried in tiger nut tubers oil and potato chips fried in sunflower oil.

Also, ***Abdel –Samie and Abdulla (2016)*** how studied that adding tiger nut flour at different levels (10-40%) on the acceptability of the crackers, showed good overall acceptability scores of the prepared crackers of different levels (10- 40%), color, taste, aroma and texture of all crackers samples were acceptable for consumer. ***Akujobi (2018)*** how evaluated the chemical and sensory properties of cookies produced from cocoyam and tiger nut flour blends, one hundred percent (100%) cocoyam flour served as control while tiger nut flour was substituted at 30% and 50% and was labeled as a sample, the results found there was no significant difference (p>0.05) in the colour, texture, flavour, taste and overall acceptability of all the cookies produced. The substitution of cocoyam flour with tiger nut flour in the production of cookies improved its nutritional quality.

Also, ***Barakat (2022)*** investigated the nutritional quality of biscuit blends fortified with varying amounts of tiger nut flour at three levels, (10, 20 and 30%).showed that replacement of tiger nut flour until 30% is acceptable, while biscuits fortified with 20% tiger nut flour recorded the highest overall acceptability.

Table (6): Sensory characteristics of gluten free cookies substitution with some percentages of tiger nut powder

cookies sample	**Sensory attribute**				
	crust Color	**Crumb Color**	**Crumb Hardness**	**taste and flavor**	**Overall acceptability**
Control sample	4.86±0.14	4.42±0.30	4.29±0.29	4.86±0.14	4.71±0.18
Tiger nut (20%)	4.71±0.18	4.71±0.18	4.57±0.30	4.86±0.14	4.86±0.14
Tiger nut (40%)	4.43±0.20	4.71±0.18	4.43±0.20	4.86±0.14	4.71±0.18
Tiger nut (60%)	4.43±20	4.86±0.14	4.43±0.20	4.57±0.30	4.57±0.20

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تحسين القيمة الغذائية والحسية لكوكيز الأرز الخالي من الجلوتين باستخدام مسحوق حب العزيز

دعاء عمر محمد جودة

مدرس التغذية وعلوم الأطعمة- قسم الإقتصاد المنزلي- كلية التربية النوعية- جامعة سوهاج

المستخلص

يعد الكوكيز واحد من أكثر منتجات المخابز شيوعا، حيث يعتبر من أهم المخبوزات الخفيفة التي يتناولها الأطفال والكبار، هدفت الدراسة الحالية إلي إنتاج كوكيز خالي من الجلوتين بإستخدام دقيق الأرز ودقيق حب العزيز، تم إستبدال دقيق الأرز في العينة الأساسية بدقيق حب العزيز بنسبة 0، 20، 40، 60 %. تم تقدير التركيب الكيميائي، الأحماض الأمينية ، المركبات الفينولية، تم حساب القيمة الحيوية والكفاءة الغذائية للأحماض الأمينة للبروتين وكذلك دراسة تأثير إستبدال دقيق الأرز بدقيق حب العزيز علي الخواص الحسية في الكوكيز الناتج.

لوحظ من نتائج الدراسة وجود علاقة طردية بين إضافة دقيق حب العزيز وإرتفاع مستوي البروتين 6.16-6.62%، الرماد1.27-1.63% والنتروجين0.96-1.06%، السعرات الحرارية 529.06-540.38 سعر حراري والأحماض الأمينية 361.12-404.15جم/جم بروتين والمركبات الفينولية 3.06-3.73 GAE/ g، إنخفاض في نسبة الكربوهيدرات57.98-49.05% في عينات الكوكيز التي تم فيها إستبدال دقيق حب العزيز بدقيق الأرز وذلك مقارنة بالعينة الأساسية التي سجلت 5.89%، 0.95%، 1.03%،505.08 سعر حراري، 339.33مج/جم بروتين و 2.69 GAE/ g علي التوالي من العناصر السابقة، كذلك وجدت النتائج أن إستبدال دقيق الأرز بدقيق حب العزيز لاقي قبولا لجميع المؤشرات الحسية للكوكيز الناتج، ظهر ذلك خاصة في الكوكيز المستخدم به مسحوق حب العزيز بنسبة 20 و 40%.

ولذلك فقد أوصي هذا البحث بتدعيم المخبوزات الخالية من الجلوتين بدقيق حب العزيز لرفع قيمتها الغذائية وتحسين صفات الجودة بها.

الكلمات الرئيسية: مرض السلياك – الغذاء الخالي من الجلوتين - كوكيز خالي الجلوتين- حب العزيز.