Benefits of chia seeds as a replacement of eggs in making bakery products for vegetarians suffering from osteoporosis and its impact on final product quality

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ABSTRACT

Food alternatives are considered as the best choice of making a good diet. It includes carbohydrates, proteins, fats and calories. Chia seeds are one of the food alternatives, used as a replacer of eggs in food industry applications, because of its rich in omega-3 and omega-6, dietary fiber, ash, proteins, minerals, phytochemicals and a good source of calcium. It is an important component of the diet because of its chemical, nutritional and technological properties. It protects from obesity, osteoporosis, hypertension, Gluten allergy, cardiovascular diseases, cancer and diabetes. This research carried out to benefit from chia seeds as a replacer of eggs in making bakery products for vegetarians suffering from osteoporosis and its impact on final product quality. Cake, biscuit and pan cake were made by replacement eggs with 25% Chia seeds. Sensory evaluation results showed that no significant difference in taste, color, smell and overall acceptability (5, 4.86 and 4.66) compared to control samples (4.98, 4.92 and 4.92). Chemical composition results of chia seeds appeared a good source of boron, proteins, fiber, magnesium, calcium, potassium and phosphorus respectively, (1.116, 17.55, 32.82, 363.71, 621.81, 656.53 and 854.75), vitamins and antioxidants. **Conclusion: C**hia seeds could be used as a replacer to egg in cake, pan cake, biscuit for vegetarian people suffering from osteoporosis, because of its content of proteins, fiber, calcium, phosphorus, boron, magnesium and antioxidants.

Key words: Chia seeds, nutritional value, food alternatives, osteoporosis.

Introduction

Food alternatives are used for several purposes to improve nutritional value for vegetarian **(Liz Grauerholz and Nicole Owens, 2015 & Vegetarianism, 2016)**. Food industry can be develop by using an eggs replacer "chia seeds" or as a new ingredient into gluten free bakery products or to increase the nutritional value or for patients with obese, high cholesterol, diabetic patients and eggs allergy **(Korus et al, 2012)**. Chia is a herb in the mint family Labiatae growing in Laitin and South America, Mexico, Guatemala and Argentina, it used in the

preparation of medicines and foods **(Ixtaina et al., 2011 & Arctos Specimen Database, 2018)**, it is rich in vitamins (A, C, E, and B complex as B1, B2, B3, folic acid, ascorbic acid), fiber, carbohydrates, fat, ash , high protein compered to wheat, corn, rice, oat and barley , in additional its a good source of omega 3 and 6 **(da Silva et al., 2017 & Fortino et al., 2017)**, amino acids essential as leucine, lysine, isoleucine and valine **(Sandoval-Oliveros and Paredes-L´opez, 2013; Marineli et al., 2014)** and antioxidants as tocopherol, sterols, carotenoids, phenolic compounds, chlorogenic and caffeic acid, these compounds have prevention of cardiovascular diseases, immunodeficiency and some types of cancers **(Marcinek and Krejpcio, 2017),** increased the Interest by using the natural antioxidants as Chia seeds especially in bakery products as a replacement to the synthetic antioxidants because of its effects toxigenic, mutagenic and carcinogenic **(Guiotto et al, 2013 & Ellulu, 2017)** for example, using flax seeds and Chia seeds as an egg replacers in pumpkin pie, the results were acceptable in taste and texture compared to control sample **(April Sansevieri1 et al, 2018)** to increase nutritional value and make new bakery products as a functional foods **(Ahmet Dinçoğlu and Özge Yeşildemir, 2019)** or therapeutic foods **(Youseff et al, 2014)** or snack as biscuits and storage of biscuits **(Barrientos et al, 2012 & Divyashree et al, 2016)** , **cookies** and pies **(George Inglett et al, 2014 & Ullah,M et al, 2016)**, Pasta **(Oliveira et al, 2015)** and bread **(Hruˇskov´a and ˇSvec, 2015)**, also Chia seeds used as a supplements food in the breakfast cereals and biscuits in the USA, Latin America and Australia **(Ixtaina et al., 2011)**. **(Daria Romankiewicz et al, 2017)** proved high content of fatty acids and phenolic compounds in supplemented wheat bread with chia seeds. **(Dipika Agrahar Murugkar, et al, 2016)** develop a cake by using banana, Chia and soy milk powder as an egg replacer, the results explained no significant in color, texture and increasing nutritional value of proteins, iron and fats. **(Lorenza Rodrigues dos Reis Gallo, et al, 2020)** used Chia seeds gel as egg replacer in making chocolate cakes after frozen storage, the sensory evaluation results showed acceptable chocolate cake. According to **(Sibele Santos Fernandes and Myriam de las Mercedes Salas Mellado, 2017)** substitution of oil or egg yolk by Chia musilage as replacer mayonnaise, The results were higher sensory evaluation values compared to control mayonnaise, with reduction in lipid content, also Chia seeds can be added to salads, fruits and yogurts **(Vuksan et al., 2007). (Ullah et al., 2016)** studied calcium chemical composition in chia seeds which is higher than milk**,** also minerals content such as (calcium, magnesium, potassium, phosphor, iron, copper and zinc) in Chia seeds is high **(da Silva et al., 2017).** According to **(Ayerza and Coates, 2000**)

Chia seeds contain up to 39% of oil as α -linolenic acid (up to 68%). **(Meyer & Groot, 2017 & Mariana Grancieri et al, 2019)** mentioned that Chia seed is proteins and bioactive peptides source, it is consumed due to health benefits for blood pressure **(Creus et al., 2016)**, obesity, cardiovascular diseases, diabetes **(Katarzyna Marcinek and Zbigniew Krejpcio, 2017)** and cancer because of antioxidants, proteins, omega-3, fiber and flavonoids high content, also Chia seeds can be used in the juice and consumed as refreshing juices **(Vuksan et al., 2007).** Chia seeds have nutritional and therapeutic properties and health promoting properties such as obesity, hypertension, cardiovascular diseases, cancer, diabetes and inflammation because of its nutritional value and activity of antioxidants enzymes **(Katarzyna Marcinek and Zbigniew Krejpcio, 2017 & Bárbara Pereira da Silva et al, 2019)**. According to **(Evelyn M. Montes Chañi et al, 2018)** "explained that" rats fed on Chia seeds led to increase bone mineral content, bone mineral density and improved hepatic and intestinal morphology, so Chia seeds is a source of functional foods, it is known as a new gold because of its nutritional values and healthy benefits and its importance in the food industry **(Ahmet H. Dinçoğlu and Özge Yeşildemir, 2019)**. So, this study was carried out to use Chia seeds as an eggs replacer for vegetarians suffering from osteoporosis and their impact on the quality of final product.

Materials and Methods

The ingredients used in bakery products formulation were as in **Table 1.** Chia seeds and wheat flour is used to make cake, biscuit and pan cake. Salt, sugar, baking powder, batter, milk, egg and vanilla essence were obtained from a local market from Cairo, Egypt **(Agrahar Murugkar and Jha 2009; Ghavidel and Prakash 2007)**.

Table (1): Composition of ingredients in cake, biscuit and pan cake

Ingredients (gm)	Cake		Biscuit		Pan cake	
	A	B	A	B	A	B
White flour	150	150	300	300	150	1 cup
Egg	75	_	50	_	25	_
Milk	200 ml	200 ml	_	_	200 ml	200 ml
Baking powder	25	25	5	5	_	_
Vanilla essence	10	10	10	10	10	10
Salt	0.1	0.1	0.1	0.1	0.1	0.1
Sugar	100	100	50	50	10	10
Butter	75	75	75	75	10	10
Chia seeds	_	30	_	20	_	10

A: control *B: Replacement with chia*

Bakery products preparation

Formulations presented in **Table 1** and **figure 1, 2, 3, 4, 5 and 6** used to make control of cake, biscuit, pan cake and test products. The control samples were made with egg, but test samples were made with chia seeds as egg replacer. Dry ingredients were sifted for good mixing, the liquid ingredients as batter, eggs (replacing eggs by 10 g chia seeds/ 1 egg in test samples after soaked in 2.27 gm water for 10 min) and sugar were mixed good by using electric mixer to obtain creamy mixture, then add flour, salt, vanilla and baking powder and well mixing to get up creamy mixture, and then it was baked in an oven at (180- 200°C) for 30 min, but pan cake was baked on fire directly with a little butter. Study of **Gallo et al, (2014)** achieved the aim of research by using chia gel in chocolate cakes as an egg alternative, microbial and sensory qualities after storage conditions, and reduce fat in cakes **(Felisberto et al, 2015)**.

Chemical analysis of control and chia seeds products

The samples were analyzed in food technology research institute to determine vitamins, minerals and natural antioxidants contents in chia seeds and products according to **AOAC, (1990)**.

Statistical analysis

Statistical analyses system ANOVA procedure of data were by using randomized complete block design according to **Püskülcü and I. kiz, (1989)**. The results were analyzed as mean values with standard deviations by one-way analysis of variance and Duncan test at level of $P<0.05$.

Results and Discussion:

The data presented in **table 2** and **figure 1, 2, 3, 4, 5 and 6** explained the sensory evaluation mean of control and test samples, cake, biscuit and pan cake replaced with Chia seeds were different significantly in taste, color, flavor, texture and overall acceptability at $P<0.05$, but it was acceptable, biscuit and pan cake recorded (25.00, 23.4 and 23.4) compared with control sample (24.9, 24.9 and 24.6) respectively, sensory evaluation mean was (5.00, 4.68 and 4.68) compared to control sample (4.98, 4.98 and 4.92) respectively. These results agreed with **(Kara collire et al, 2013)** indicated that Chia seeds not change the texture, color, moisture and flavor in bread banana, but it was sensually acceptable and high in fiber and omega-3 content**.** According to **(Ahmet and Özge Yeşildemir, 2019)** reported that chia seeds are a source of functional food and it is a suitable for the food industry as bakery products, sweets and pasta and it is acceptable in taste**(Natalia Naumova et al, 2017)** because of gel forming and foam enhancer . According to (**Bouchra Sayed Ahmad et al, 2015)** said that addition of chia seed with high percent, improved the antioxidant activity and nutritional value

especially Chia cakes, but it led to darker breads without significantly effect on acceptability. **(Matheus Rodrigues Oliveira et al, 2015)** mentioned that pasta with 7.5% chia flour was a high in nutritional value, technological characteristics and a high acceptability in the flavor value, compared to the control pasta**.**

Table (2): Sensory evaluations mean of control and test samples

Samples / Sensory evaluation	Cake		biscuit		Pan cake	
	A	B	A	B	A	B
Taste	5.00	5.00	5.00	4.8	4.9	4.8
Color	5.00	5.00	5.00	4.5	5.00	4.6
Flavor	4.9	5.00	4.9	4.7	4.8	4.6
Texture	5.00	5.00	5.00	4.6	4.9	4.6
Pores	5.00	5.00	5.00	4.8	5.00	4.8
Overall acceptability	24.9	25.00	24.9	23.4	24.6	23.4
Mean	4.98	5.00	4.98	4.86	4.92	4.68

A: Control sample *B: Sample with Chia seeds*

The data presented in **Table 3** showed Chia seeds nutritional value of protein, fat, ash, carbohydrate and dietary fiber. Proteins content were recorded (17.55 g/100g), this results agreed with **(USDA, 2018)** determinate protein, oil and fatty acid content in Chia seeds, fats content were (29.91 g/100g), according to **(Ayerza and Coates, 2011),** ash was (4.19 g/100g) and carbohydrates were (41.48 g/100g), according to **(Sargi et al, 2013)** estimated the antioxidant capacity, Chia seeds rich in omega-3, carbohydrates, and fiber content was (32.82 g/100gm) according to (**USDA, 2018). (Maira Rubi Segura Campos et al, 2014)** reported that Chia seed is an excellent natural source of gum or gel, which it has characterizes of good physicochemical and functional, also excellent source in dietary fiber, so it recommended using it in food industry.

Table (3): Nutritional value of Chia seeds

Nutrients	Chia seeds (g/100g)
Protein	17.55
Fat	29.91
Ash	4.19
Carbohydrate	41.48
Dietary fiber	32.82

Data in presented in **table 4** showed vitamins and minerals content in Chia seeds. The vitamins (B1, B2, Niacin, C, E and Folate) were recorded respectively (0.612, 0.198, 8.781, 1.583, 0.456 and 47.894

mg/ 100g), according to the study of **(Bartosz Kulczyn´ski et al, 2019)** reported that Chia seeds is a good source of vitamins as vitamin B1 (0.6mg), B2 (0.2mg) and niacin (8.8mg) /100g, also Chia seeds are a good source in phytocompounds. The content of calcium, phosphorus, potassium, magnesium, iron, selenium, manganese, zinc and boron were estimated respectively (621.81, 854.75, 656.53, 363.71, 22.68, 74.21, 2.57, 3.97 and 1.116 mg/100g) respectively. These data agreed with **(Bolaños et al, 2016 &Bartosz Kulczyn´ski et al, 2019)** mentioned that Chia seeds is a good source of protein and minerals as phosphorus (860–919 mg), calcium (456–631 mg), potassium (407–726 mg), magnesium (335–449 mg) and boron (1.12±0.02 mg) / 100gm **(Barbara Pereira DA Silva, 2016)** and it is an important ingredient for bone health, decreased alveolar bone loss in statuses osteoporosis and it helps metabolize calcium, magnesium, manganese, and phosphorus **(Hulya Toker et al, 2016).**

Table (4): vitamins and mineral content in Chia seeds

Vitamins	Vitamins content (mg/100g)	Mineral	Mineral content (mg/100g)
B1	0.612	Calcium	621.81
B2	0.198	Phosphorus	854.75
Niacin	8.781	Potassium	656.53
C	1.583	Magnesium	363.71
E	0.456	Iron	22.68
Folate	47.894 µg/100g	Selenium	74.21
_	_	Manganese	2.57
_	_	Zinc	3.97
_	_	Boron	1.116±0.02

The data presented in **table 5** explained antioxidants content in Chia seeds. polyphenols, Chlorogenic acid and Caffeic acid content according to High Pressure Liquid Chromatography (HPLC), it were respectively (0.987, 0.252 and 0161 mg/g), these results agreed with the study of (**Bartosz Kulczyn´ski et al, 2019)** reported that Chia seeds is a good source of minerals and vitamins, also bioactive compounds “phytochemicals" especially polyphenols and tocopherol, which it has a high antioxidant activity.

Table 5: Antioxidants content in Chia seeds (mg/g).

Antioxidants	**Chia seeds (mg/g)**
Polyphenols	0.987
Chlorogenic acid	0.242
Caffeic acid	0.161

Conclusion:

Chia seed is rich in dietary fiber, proteins, omega-3 fatty acids, and biological-active compounds "phytochemicals". It is used in food

industry as functional foods as frozen, bakery products, beverages, sweets, pasta, and sausages because its health benefits of dyslipidemia, inflammation, cardiovascular diseases and insulin resistance. In this research Chia seeds were used as substitute egg in cake, biscuit and pan cake for vegetarian people suffering from osteoporosis and its impact on final product quality. Chia seeds products were sensory acceptable compared to control products and it may improvement the levels of Ca, P, bone mineral density (BMD) and bone mineral concentration (BMC) in blood, due to the high content of minerals and polyphenolic compounds.

Control and Chia seeds products

Fig. 1: Cake control

Fig. 2: Cake with chia seeds

Fig. 3: Biscuit control

Fig. 4: Biscuit with Chia seeds

Fig. 5: Pan Cake control

Fig. 6: pan cake with Chia seeds

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الاستفادة من بذور الشيا كبديل للبيض في إعداد منتجات مخابز لدى الأشخاص النباتيين اللذين يعانون من هشاشة العظام وأثرها على جودة المنتج النهائى

الملخص العربي:

تعتبر بدائل الطعام مثل الكربوهيدرات والبروتينات والدهون والسعرات الحرارية أفضل الطرق لاتباع نظام غذائي جيد، و تعتبر بذور الشيا من البدائل الغذائية التي تستخدم كبديل للبيض في تطبيقات الصناعات الغذائية، وذلك لاحتوائها على نسبة عالية من أوميجا ٣ ، أوميجا ٦ ، الألياف الغذائية ، الرماد ، البروتينات، المعادن ، المواد الكيميائية النباتية ومصدر جيد للكالسيوم؛ فبذور الشيا تعتبر من المكونات الهامة للنظام الغذائي بسبب خصائصها الكيميائية، الغذائية والتكنولوجية، حيث تمتلك خصائص الوقاية من السمنة ، هشاشة العظام ، ارتفاع ضغط الدم ، حساسية الجلوتين ، أمراض القلب والأوعية الدموية ، السرطان والداء السكري. و تم إجراء هذا البحث للاستفادة من بذور الشيا كبديل للبيض لإعداد منتجات مخابزللأشخاص النباتيين الذين يعانون من هشاشة العظام وتأثيرها على جودة المنتج النهائي؛ فتم تصنيع كيك، بسكويت وبان كيك بنسبة ٢٥٪ من بذور الشيا بدلاً من البيض ، وأظهرت نتائج التقييم الحسي عدم وجود اختلاف معنوي في الطعم واللون والرائحة والقبول العام (٥ ، ٤.٨٦ و ٤.٦٦) مقارنةً بالعينات الضابطة (٤.٩٨ ، ٤.٩٢ و ٤.٩٢) ، كما أنها مصدر جيد في البورون، البروتينات، الألياف، الماغنسيوم، الكالسيوم، البوتاسيوم و الفوسفور علي التوالى (٨٥٤.٧٥ and ٦٥٦.٥٣ , ٦٢١.٨١ ، ٣٦٣.٧١، ٣٢.٨٢، ١٧.٥٥، ١.١١٦) علي التوالي، ومصدر غنى في الفيتامينات ، مضادات الأكسدة. **الخلاصة:** يمكن استخدام بذور الشيا كبديل للبيض في الكيك والبان كيك والبسكويت للنباتيين الذين يعانون من هشاشة العظام ، وذلك لاحتوائها على البروتينات، الألياف ، الكالسيوم ، الفوسفور ، البورون ، المغنيسيوم ومضادات الأكسدة.

الكلمات المفتتاحية: بذور الشيا ، القيمة الغذائية ، البدائل الغذائية ، هشاشة العظام.