*J. of Food and Dairy Sci., Mansoura Univ., Vol. 13 (12):187-192, 2022*

# Journal of Food and Dairy Sciences

**Journal homepage & Available online at: www.jfds.journals.ekb.eg**

# Evaluation of Processing Untraditional Pudding Formula Wwith Added Chia Seeds Flour

Cross Mark

**Samaa M. Saleh***

Food Science Department, Faculty of Agriculture (Saba Basha), Alexandria University, Egypt


## ABSTRACT

This work aimed to study the effect of incorporating chia seeds flour with corn starch into pudding blends in different ratios ( 1.5:4.5, 3:3, 4.5:1.5 and 6:0 (g/g) per 100 g milk), whereas corn starch (6 g/100 g milk) was used as a control sample. Functional properties of raw materials, physicochemical properties, protein quality, textural properties and sensory properties of prepared pudding samples were evaluated. The incorporation of chia seeds flour resulted in higher functional properties. Additionally, the protein, fat, ash and crude fiber content of pudding increased by 1.3, 1.4, 1.2, and 11.8 times in blend P4 (6:0 (g/g) chia seeds flour per 100 g milk) compared to the control blend (P). Moreover, the sum of essential amino acids and the sum of non-essential amino acids content were increased from 1.23 to 2.06 (g/100 g sample), and from 2.17 to 4.03 (g/100 g sample), respectively by increasing the chia seeds flour level. Thereby, increasing chia seeds flour level in pudding formula caused increasing values of indicators of protein quality. For textural properties, the cohesiveness increased from 0.48 to 0.68, whereas the other texture parameters demonstrated the opposite behavior by increasing the chia seeds flour level. Sensory evaluation resulted that the blend formed with 3: 3(g/g) chia seeds flour: corn starch (P2) was nearer to those of the control blend in terms of overall acceptability. The study recommends that chia seeds flour could be used as a new way to improve the functional properties and nutritional value of pudding.

***Keywords*:** Chia seed flour; milk pudding; functional properties; nutritional value; texture properties

## INTRODUCTION

Recently, consumer focus on plant-origin products and healthy diets (Gramza-Michałowska *et al*., 2019). In this context, chia seed (*Salvia hispanica* L.) attracts attention, which resembles sesame seeds and the composition is similar to that of flaxseeds. Chia seeds are characterized by high nutritional value due to they are a good source of protein (19-23%). Moreover, they are a significant source of minerals and vitamins (Ixtaina *et al*., 2008 and Ayerza and Coates, 2011). Additionally, it is rich in dietary fiber that ranges from 34% to more than 50% than other grains (Capitani, *et al*., 2012). Chia seeds contain about 39% oil, which is rich in omega-3 up to 68% higher than flaxseed (57%) (Ayerza, 1995 and Sultana, 1996). Another attractive feature of chia seeds is that they contain biologically active compounds such as polyphenols and other antioxidants (Valdivia-Lopez and Tecante, 2015).

Moreover, chia seeds have the ability to raise the satiety index, and decrease the risk of cardiovascular diseases, diabetes, nervous system disorders, inflammation and dyslipidemia. Additionally, it has anti-blood clotting, antidepressant, laxative, immune improver effects and vision (Coelho and de las Mercedes Salas-Mellado 2015 and Ullah, *et al*., 2016).

Nowadays, Chia is utilized as whole seeds, ground, or mucilage to raise the product's nutritional value in numerous foodstuffs. There are many products containing chia seeds on the shelves in the markets, such as bakery products, muesli, ice cream, yogurt, fruit smoothies, salads or sausages even ham (Kulczyński *et al*., 2019).

Pudding is considered a semisolid food, smooth and easy to swallow, so it is consumed by several groups of consumers on an almost daily basis worldwide (Ares *et al*., 2009). It is composed of starch (hydrocolloids), sugar, colorings, and flavors, that dissolve in milk. Starch is commonly used at the rate of 4%–6% (Alamprese and Mariotti, 2011). Starch plays a vital role in the body controlling and oral sensation in pudding-type products, which during gelling agent gives the requisite texture, depending on the type and the used concentration (Doublier and Durand, 2008).

Pudding is considered a food rich in nutrients. Unfortunately, it is free of dietary fiber. Thereby, the fortification pudding with dietary fiber has major significance in enhancing the nutritional value and providing a variety of dairy products, particularly those concerning human health such as maintaining a wholesome weight and reducing the risk of diabetes and heart disease (Pang *et al*., 2015).

Limited information is available about the evaluation of the preparation of milk pudding by the replacement of corn starch with other raw materials to improve the pudding's functional properties. Some authors have used vegetable powders such as sweet potato, sweet corn, and pumpkin. They applied them in the pudding for the elderly. They reported that the highest amount of vegetable powder was 8% (w/w). This level of vegetable powder helped retain most pudding properties (Chimkerd and Winuprasith, 2018). Hendek Ertop *et al*. (2019) investigated the evaluation of using taro flour as a hydrocolloid to prepare milk pudding. They found that taro flour can be used to prepare pudding-type products, that due

* **Corresponding author.**
**E-mail address: Samaasaleh@alexu.edu.eg**
**DOI: 10.21608/jfds.2022.175087.1085**

to its high binding efficiency of water as other hydrocolloids and thickening ingredients such as starch and gums and no application detected for chia seed flour in the pudding formula.

So, the present study aimed to evaluate the effects of incorporating chia seed flour in pudding formulation on the functional, physicochemical, nutritional, textural and sensory properties of the produced pudding.

## MATERIALS AND METHODS

**Materials**

Chia seeds (*Salvia hispanica L.*) and the others ingredients used in pudding preparation were purchased from a local supermarket in Alexandria city, Egypt. All chemicals used in this investigation were of analytical quality from well-known manufacturers

**Preparation of milk pudding:**

Pudding was prepared using traditional ingredients as presented in Table 1. Chia seeds flour was incorporated with corn starch in order blends as shown 1.5:4.5, 3:3, 4.5:1.5 and 6:0 (g/g) (chia seeds flour:corn starch), whereas corn starch only (6 g/100 g milk) was used as a control sample. Then, each blend was added to 100 g milk. Pudding preparation was depended on the method described by Hendek Ertop *et al.* (2019).

**Table 1. Milk pudding formula**

| Raw materials | P* (g) | P1 (g) | P2 (g) | P3 (g) | P4 (g) |
|---|---|---|---|---|---|
| Corn starch | 6 | 4.5 | 3 | 1.5 | 0 |
| Chia seeds flour | 0 | 1.5 | 3 | 4.5 | 6 |
| Sugar | 25 | 25 | 25 | 25 | 25 |
| Cacao powder | 10 | 10 | 10 | 10 | 10 |
| Milk | 100 | 100 | 100 | 100 | 100 |
| Vanillin | 1 | 1 | 1 | 1 | 1 |

***P =6:0 (g/g) corn starch only as control blend, whereas P1, P2, P3 and P4 = the blends of chia seeds flour with corn starch =1.5:4.5, 3:3, 4.5:1.5 and 6:0 (g/g) respectively and each blend was used per 100 g milk.**

**Functional properties:**

**Water absorption capacity and oil absorption capacity and emulsifying activity**

Water absorption capacity (WAC) of pudding formulas as raw materials (the mixture of corn starch with chia seeds flour) was measured at ambient temperature (25 ± 2°C) by using the centrifugation method as described by Kaushal, *et al*. (2012). For this experiment, 3 g of sample was mixed with 25 ml of distilled water into pre-weighed centrifuge tubes. The suspensions were stirred periodically for 30 min, immediately they were centrifuged at 4,000 rpm for 25 min. The supernatant was removed, and centrifuge tubes were dried at 50 ºCfor 25 min in a hot air oven at 100 °C for 2 hours, and the sample was re-weighted.

Oil absorption capacity (OAC) was determined following method as described by Kaushal, *et al.* (2012). In a pre-weighed centrifuge tube was mixed a sample (0.5 g) with 6 ml of corn oil, and then centrifuged for 25 min at 4,000 rpm. The contents were vortexed for 1 min with a fin brass thread to scatter the sample in the oil. After a holding period of 30 min, the sample tubes were re-centrifuged for 25 min at 4,000 rpm. The separated oil was decanted, and the excess oil was removed by inverting tubes for 25 min and the tubes were re-weighted.

The capacities absorption of water and oil were expressed as a gram of water or oil bound per gram of the sample on a dry matter.

Emulsifying activity (EA) for blends of raw materials of the pudding was determined at room temperature (25 ± 2°C) following the presented method by Hayta, *et al*.(2002).

**Nutritional quality:**

**proximate chemical composition:**

The moisture, protein, fat, crude fiber and ash contents were determined according to the described methods by (AOAC, 2000). Total carbohydrate content (%) was calculated by the difference.

**Amino acids Profile of chia pudding:**

Amino acids determination was carried out by using amino acids analyzer Biochrom 30 as described by AOAC, (2005).

**Biological value of chia pudding:**

The biological value of chia pudding samples was calculated as indicated to the methods of Eggum, *et al.* (1979) as follows:

**Biological value%=39. 55+8. 89 ×lysine (g/100g protein)**

**chemical score of chia pudding:**

The chemical score of chia pudding was calculated according to the FAO /WHO (2007) as follows:

**Chemical score%= (essential amino acids of crude protein/ essential amino acids of FAO/WHO) ×100**

**Pudding textural properties:**

This test was performed using the method given by Abdo Qasem, *et al.* (2017). The pudding samples were stored overnight at ambient temperature after cooking and used for textural analysis test by measuring the maximum penetration force (g) using the texture analyzer (Brookfield CT3 No. M08-372-C0113, USA). The test speed was kept at 1.0 mm/s using a 5mm diameter probe.

**Sensory acceptability:**

Sensory acceptability of pudding blends using different levels of chia seeds flour was determined according to the procedures described by Abdo Qasem, *et al*. (2017), which were carried out by a panel of ten experienced guides were graduate students and staff members of Food Sci. Dept., Faculty Agric. Saba Basha, Alexandria Univ., Egypt. The panelists scored for each sample to evaluate external thickness, color, oral thickness, flavor, sweetness, and overall acceptability on a nine- point hedonic scale (1= disliked extremely, to 9 = like extremely).

**Statistical Analysis:**

The obtained data were analyzed for analysis of variance using the System (SAS) Program (SAS Institute, Carey, NC) (SAS, 1999). Significance was accepted at $P \leq 0.05$.

## RESULTS AND DISCUSSION

**Functional properties of pudding powder:**

Food quality is attributed to both properties water-holding capacity (WHC) and oil-holding capacity (OHC), so they are important functional properties (Ferreira, *et al*., 2015). The water holding capacity (WHC) and oil holding capacity (OHC) of different blends of pudding raw materials are presented in Table 2. It was noticed that there were varied significantly ($P \leq 0.5$) among the different types of blends.

Furthermore, WHC and OHC showed a great increase by using a high level of chia seed flour, which they were increased from 1.92 (g/g) to 5.69 (g\g) and from 0.97 (g/g) to 4.03 (g\g) respectively. This could be attributed to the high content of protein and mucilage (soluble dietary fiber) in chia seed flour. These properties show that chia seed flour is suitable as a bonding and carrier material for both hydrophobic and hydrophilic components in food. Moreover, the WHC value was higher than the OHC. This indicates the possibility of use as a hydrocolloid agent, particularly in the preparation of novel food products. Our results are in accordance with those stated by Mohammed, *et al.* (2019) who found that chia seeds meal is a good source of protein, dietary fibers, and polyphenols and they encouraged using it as a functional ingredient to prepare food products. Moreover, the obtained data are in line with those presented by Rocha, *et al.* (2020) who reported that chia mucilage showed high efficiency of water-holding capacity and emulsifying activity when used as a fat replacer to prepare the cookies.

Emulsification activity (EA) of different pudding blends as raw materials is shown in Table 2. It could be noted that there were significantly affected ($P \leq 0.05$) among blends. The highest EA value was observed in blend P4 (the highest level of fortification with chia seeds flour in the pudding). The high EA value is probably due high content of dietary fiber, which could raise the viscosity of the aqueous phase and decreased the tendency of the dispersed oil globules to migrate and coalesce, therefore increasing emulsion stability (Aydin and Gocmen, 2015). This attribute showed that chia seeds flour can bond hydrophilic and hydrophobic components in food materials. The obtained data are similar to that mentioned by Rocha, *et al*. (2020) who found that chia mucilage showed high values of water-holding capacity and emulsifying activity when used as a fat replacer to prepare the cookies.

**Table 2. Functional properties of different blends of raw materials of pudding:**

| Raw material blends | WHC* (g water /g sample) | OHC (g oil /g sample) | EA (%) |
|---|---|---|---|
| P | 1.92$^{e**}$ | 0.97$^{e}$ | 24.58$^{e}$ |
| P1 | 2.86$^{d}$ | 1.63$^{d}$ | 28.92$^{d}$ |
| P2 | 3.81$^{c}$ | 2.39$^{c}$ | 33.16$^{c}$ |
| P3 | 4.76$^{b}$ | 3.24$^{b}$ | 37.53$^{b}$ |
| P4 | 5.69$^{a}$ | 4.03$^{a}$ | 41.84$^{a}$ |

***WHC=Water Holding Capacity, OHC =Oil Holding Capacity and EA =Emulsification Activity. P =6:0 (g/g) corn starch only as control sample, whereas P1, P2, P3 and P4 = the blends of chia seeds flour with corn starch =1.5:4.5, 3:3, 4.5:1.5 and 6:0 (g/g) respectively and each blend was used per 100 g milk.**

****Means in the same column with different superscript letters are significant differences ($P \leq 0.05$).**

**Physicochemical analysis of chia seed pudding samples:**

The chemical compositions of different blends of chia seed pudding samples are presented in Table 3. The increased amount of chia seeds flour in blends significantly increased ($P \leq 0.05$) the content of crude protein, lipids, ash, and total fiber of the blends. The protein, fat, ash and crude fiber content of different blends of chia seeds pudding increased by 1.3, 1.4, 1.2, and 11.8 times in blend P4, which formed of 6 g of chia seeds flour as compared to the control sample (6g corn starch). This is an expected result because chia seeds flour is characterized as a rich source of protein, fat, and dietary fiber. The presented data are in accordance with those presented by Sung, *et al*. (2020) who found that the addition of chia seeds flour can compensate for the low nutritional value of most gluten-free products. A similar trend has been noticed by Kulczyński, *et al*. (2019) who declared that chia seeds are a good source of dietary fiber, proteins, polyunsaturated fatty acids, many minerals, and vitamins. So, using chia seed flour could be enhancing the nutritional value of the pudding.

**Table 3. Physicochemical properties of chia seeds pudding blends:**

| Pudding blends | Moisture (g/100 g) | Crude protein (g/100 g) | Lipids (g/100 g) | Ash (g/100 g) | Total fiber (g/100 g) | Carbohydrates (g/100 g) |
|---|---|---|---|---|---|---|
| P* | 62.35$^{a**}$ | 2.70$^{c}$ | 3.24$^{e}$ | 0.79$^{c}$ | 0.10$^{e}$ | 30.82$^{a}$ |
| P1 | 62.30$^{a}$ | 2.93$^{bc}$ | 3.58$^{d}$ | 0.83$^{bc}$ | 0.37$^{d}$ | 29.99$^{ab}$ |
| P2 | 62.27$^{a}$ | 3.15$^{abc}$ | 3.92$^{c}$ | 0.88$^{abc}$ | 0.64$^{c}$ | 29.14$^{bc}$ |
| P3 | 62.23$^{a}$ | 3.37$^{ab}$ | 4.26$^{b}$ | 0.92$^{ab}$ | 0.91$^{b}$ | 28.31$^{cd}$ |
| P4 | 62.18$^{a}$ | 3.58$^{a}$ | 4.60$^{a}$ | 0.97$^{a}$ | 1.18$^{a}$ | 27.49$^{d}$ |

***P =6:0 (g/g) corn starch only as control sample, whereas P1, P2, P3 and P4 = the blends of chia seeds flour with corn starch =1.5:4.5, 3:3, 4.5:1.5 and 6:0 (g/g) respectively and each blend was used per 100 g milk. **Means in the same column with different superscript letters are significant differences ($P \leq 0.05$).**

**Amino Acids Profiles of chia seeds pudding blends:**

Determination of amino acids profiles of food products is an important parameter to determine protein quality. The essential amino acids are substantial for children's growth, building muscles and tissue maintenance. The data of essential amino acid and non-essential amino acid profiles of chia seeds pudding blends are given in Table 4. It was observed that the complete replacement of corn starch by chia seeds flour (blend P) in milk pudding formulations led to a remarkable increase in the sum of essential amino acids and the sum of nonessential amino acids. The sum of essential amino acids was risen from 1.23 to 2.06 (g/100 g sample), whereas the sum of nonessential amino acids was risen from 2.17 to 4.03 (g/100 g sample) by increasing the replacement level with chia seeds flour. This could be related to the fact that chia seeds flour is a rich source of protein, whereas corn starch is protein-free. These observations are consistent with Grancieri, *et al.* (2019) who stated that chia seed (*Salvia hispanica L.*) is considered a rich source of plant protein, which accounts for nearly 18–24% of their mass.

**Protein quality of chia seeds pudding blends:**

For determining the protein quality of pudding as a result of incorporating chia seeds flour in the milk pudding blends under study, different parameters were used, including biological value (BV) and chemical score (CS). The BV indicates the protein absorbed proportion from food to be combined into the proteins of the body (Ijarotimi, *et al*., 2015).

**Table 4. Amino acid profiles (g/100 g sample) of different blends of chia seeds pudding:**

| Amino acids | Pudding blends | | | | |
|---|---|---|---|---|---|
| | **P*** | **P1** | **P2** | **P3** | **P4** |
| Essential amino acids:- | | | | | |
| Isolucine | 0.18 | 0.23 | 0.26 | 0.29 | 0.32 |
| Leucine | 0.40 | 0.44 | 0.49 | 0.54 | 0.60 |
| Lysine | 0.10 | 0.11 | 0.12 | 0.13 | 0.14 |
| Methonine | 0.08 | 0.12 | 0.13 | 0.14 | 0.14 |
| Phenylalanin | 0.16 | 0.23 | 0.25 | 0.27 | 0.30 |
| Theronine | 0.14 | 0.19 | 0.21 | 0.23 | 0.25 |
| Valine | 0.17 | 0.23 | 0.25 | 0.28 | 0.31 |
| TEAA | 1.23 | 1.55 | 1.71 | 1.88 | 2.06 |
| Non- essential amino acids:- | | | | | |
| Alanin | 0.08 | 0.12 | 0.14 | 0.16 | 0.16 |
| Argnine | 0.10 | 0.16 | 0.19 | 0.21 | 0.23 |
| Aspartic | 0.24 | 0.34 | 0.37 | 0.41 | 0.44 |
| Cysteine | 0.05 | 0.08 | 0.08 | 0.09 | 0.10 |
| Histidine | 0.06 | 0.09 | 0.10 | 0.11 | 0.12 |
| Glutamic | 0.97 | 1.25 | 1.38 | 1.55 | 1.72 |
| Glycine | 0.05 | 0.08 | 0.09 | 0.10 | 0.11 |
| proline | 0.29 | 0.37 | 0.41 | 0.46 | 0.51 |
| Serine | 0.17 | 0.23 | 0.25 | 0.28 | 0.31 |
| Tyrosine | 0.16 | 0.22 | 0.26 | 0.30 | 0.33 |
| TNEAA | 2.17 | 2.94 | 3.27 | 3.67 | 4.03 |

***P =6:0 (g/g) corn starch only as control sample, whereas P1, P2, P3 and P4 = the blends of chia seeds flour with corn starch =1.5:4.5, 3:3, 4.5:1.5 and 6:0 (g/g) respectively and each blend was used per 100 g milk. TEAA= Total Essential Amino Acids, and TNEAA= Total Non Essential Amino Acids.**

The results of BV values of chia seeds pudding blends (Figure 1) ranged from 72.18 to 75.38%. The control blend (P) had the lowest BV value, whereas the pudding processed from a high level of chia seed flour (P4) had the highest. The same trend was noted concerning CS which varied from 63.32 to 69.43 %. Our findings are in agreement with Mohammed, *et al*. (2019) who reported that the biological value of local and imported of de-fatted chia seed flour was 69.4 and 71.6% respectively.

It could be concluded that the incorporating of chia seed to prepare milk pudding enhances the nutritive value of the produced novel pudding.

**Pudding texture properties:**

The texture is an essential attribute in dairy desserts such as pudding, due to its high effect on consumer acceptance (Choobkar, *et al*., 2022). Hardness and springiness parameters play a vital role in the acceptability of consumers and the quality of the product (Ngamlerst, *et al*., 2022). The results regarding to textural properties of chia seeds pudding are shown in Table 5. It was observed that the different levels of incorporation with chia seeds flour tended to significantly ($P \leq 0.05$) change in the texture parameters of samples pudding, including hardness, cohesiveness, springiness, gumminess and chewiness of blends pudding. The cohesiveness rose from 0.48 to 0.68, whereas hardness, springiness, gumminess and chewiness were reduced by increasing the chia seed flour level. This could be attributed to the use of chia seeds flour caused declines in the amount of starch in the formula which in turn decreased the amylose content in the pudding blend. Starch plays a vital role in the body controlling and oral sensation in pudding-type products, during gelling agent gives the requested texture, based on the type and the used concentration (Doublier and Durand 2008). Furthermore, pudding texture properties are affected by starch properties, especially its content of amylose, which is considered the main factor affecting starch gel properties. Therefore, gel hardness must mainly depend on amylose (Choobkar, *et al*., 2022). Our presented results are in good agreement with those obtained results by Abdo Qasem, *et al.* (2017) who reported that the texture properties showed decreases in hardness at using higher levels of okra extraction when used to fortify pudding with fiber.

Summarized, we can conclude that the softer gel of the chia seed flour pudding than the control sample is due to the lower amount of amylose, that attribute to less starch in the formulas.

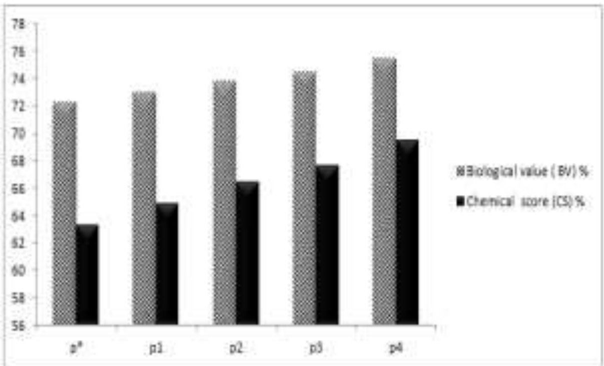


**Figure 1. Protein quality parameters of chia seed pudding samples:**

***P =6:0 (g/g) corn starch only as control sample, whereas P1, P2, P3 and P4 = the blends of chia seeds flour with corn starch =1.5:4.5, 3:3, 4.5:1.5 and 6:0 (g/g) respectively and each blend was used per 100 g milk.**

**Table 5. Textural properties of pudding with chia seeds flour:**

| Pudding blends | Hardness (N) | Cohesiveness | Springiness | Gumminess (N) | Chewiness (N) |
|---|---|---|---|---|---|
| P* | 0.64$^{a**}$ | 0.48$^{e}$ | 8.77$^{a}$ | 0.31$^{a}$ | 2.70$^{a}$ |
| P1 | 0.42$^{b}$ | 0.50$^{d}$ | 8.70$^{a}$ | 0.21$^{b}$ | 1.83$^{b}$ |
| P2 | 0.38$^{c}$ | 0.55$^{c}$ | 8.67$^{a}$ | 0.21$^{b}$ | 1.80$^{b}$ |
| P3 | 0.35$^{d}$ | 0.63$^{b}$ | 7.97$^{a}$ | 0.22$^{b}$ | 1.74$^{b}$ |
| P4 | 0.32$^{e}$ | 0.68$^{a}$ | 7.33$^{a}$ | 0.22$^{b}$ | 1.59$^{b}$ |

***P =6:0 (g/g) corn starch only as control sample, whereas P1, P2, P3 and P4 = the blends of chia seeds flour with corn starch =1.5:4.5, 3:3, 4.5:1.5 and 6:0 (g/g) respectively and each blend was used per 100 g milk.**
**** Means in the same column with different superscript letters are significant differences ($P \leq 0.05$).**

**Sensory evaluation of different blends of chia seeds pudding:**

Sensory evaluation data for properties such as the external thickness, color, oral thickness, flavor, sweetness and overall acceptability of different blends of pudding are listed in Table 6. From this data, it was noticed that the sensory properties of the pudding blend P3 (4.5 g of chia seed flour and 1.5 g of corn starch) were less accepted by panelists compared with the control blend (P), whereas the panelists disliked sensory properties for the pudding sample P4 (6g of chia seed flour or free of corn starch). Generally, there are numerous factors that influenced the decision of the panelists for sensorial properties of milk pudding fortified with chia seed flour, which recorded fewer scores for samples formed with higher levels of incorporation with chia seed flour from the level in the blend P2 (3 g of chia seed flour: 3g of corn starch). This may be attributed to the residues and the dark color of chia seed flour, moreover its high soluble fiber content (gel), which causes the softer structure and low sweetness of the produced pudding.

**Table 6. Sensory assessments for chia seed flour pudding:**

| Blends | External thickness | color | Oral thickness | Flavor | Sweetness | Overall acceptability |
|---|---|---|---|---|---|---|
| P* | 8.8[a**] | 8.9[a] | 9.0[a] | 8.7[a] | 8.8[a] | 8.8[a] |
| P1 | 8.6[ab] | 8.4[ab] | 8.3[ab] | 8.2[ab] | 8.5[a] | 8.4[a] |
| P2 | 7.7[b] | 7.9[b] | 7.8[b] | 7.6[b] | 6.5[b] | 7.5[b] |
| P3 | 6.3[c] | 6.0c | 5.3[c] | 5.7[c] | 6.2[bc] | 5.9[c] |
| P4 | 4.5[d] | 5.3c | 4.6[c] | 4.8[c] | 5.4[c] | 4.9[d] |

***P =6:0 (g/g) corn starch only as control sample, whereas P1, P2, P3 and P4 = the blends of chia seeds flour with corn starch =1.5:4.5, 3:3, 4.5:1.5 and 6:0 (g/g) respectively and each blend was used per 100 g milk.**

**** Means in the same row with different superscript letters are significant differences ($P\leq0.05$).**

## CONCLUSION

The findings of this study revealed that chia seeds flour has a good potential to be used to prepare new milk pudding formula. The incorporation of chia seed flour with corn starch improved the functional properties named WHC, OHC and EC of pudding raw materials. Thereby, the functional properties of the produced pudding will be improved. The contents of protein, lipids, ash and total fiber of the pudding blends were greatly increased with increasing chia seed flour ratios. In addition, the amino acids profiles of chia seeds flour pudding had remarkably increased by increasing the level of replacement with chia seed flour. Thereby, the biological value and the chemical score were greatly increased by using chia seeds flour. Increasing the amount of chia seeds flour was noticeably changed textural parameters that caused a softer texture comparison with those control blend. Our results suggest that the blend P3, which is formed of 3g of chia seeds flour with 3 g corn starch can be a valuable replacement to prepare milk pudding formula with desirable sensory attributes of the produced pudding.

## REFERENCES


AACC.(2000). Approved Methods of the American Association of Cereal Chemists. Ten[th] Edition.AACC, St. Paul, MN

Abdo Qasem, A. A.; Alamri, M. S.; Mohamed, A. A.; Hussain, S.; Mahmood, K. and Ibraheem, M. A. (2017). High soluble-fiber pudding: Formulation, processing, texture and sensory properties. Journal of Food Processing and Preservation, 41(3): e12931.

Alamprese, C., and Mariotti, M. (2011). Effects of different milk substitutes on pasting, rheological and textural properties of puddings. LWT-Food Science and Technology, 44(10):2019-2025.

AOAC.(2005). Official Methods of AOAC 18[th] Ed., 2005 current through revision I,Basic sensory methods for food Evaluation. IDRC, Ottawa Ontario, Canada.

Ares, G.; Baixauli, R.; Sanz, T.; Varela, P. and Salvador, A. (2009). New functional fiber in milk puddings: Effect on sensory properties and consumers' acceptability. LWT - Food Science and Technology, 42 (3): 710-716.

Aydin, E. and Gocmen, D. (2015). The influences of drying method and metabisulfite pre-treatment on the color, functional properties and phenolic acids contents and bioaccessibility of pumpkin flour. LWT-Food Science and Technology, 60(1): 385-392.

Ayerza, R. (1995). Oil content and fatty acid composition of chia (*Salvia hispanica L.*) from five northwestern locations in Argentina. Journal of the American Oil Chemists' Society, 72(9): 1079-1081.

Ayerza, R. and Coates, W. (2011). Protein content, oil content and fatty acid profiles as potential criteria to determine the origin of commercially grown chia (*Salvia hispanica L.*). Industrial crops and products, 34(2): 1366-1371.

Capitani, M. E. A., Spotorno, V., Nolasco, S. M., and Tomás, M. C. (2012). Physicochemical and functional characterization of by-products from chia (*Salvia hispanica L.*) seeds of Argentina. LWT-Food Science and Technology, 45(1): 94-102.

Chimkerd, C. and Winuprasith, T. (2018). Functional properties of vegetable powder and the application in pudding for elderly. Journal of Food Science and Agricultural Technology, 4: 67-72.

Choobkar, N.; Daraei Garmakhany, A.; Aghajani, A. R. and Ataee, M. (2022). Response surface optimization of pudding formulation containing fish gelatin and clove (*Syzygium aromaticum*) and cinnamon (*Cinnamomum verum*) powder: Effect on color, physicochemical, and sensory attributes of the final pudding product. Food Science and Nutrition, 10(4): 1257-1274.

Coelho, M. S., and de las Mercedes Salas-Mellado, M. (2015). Effects of substituting chia (Salvia hispanica L.) flour or seeds for wheat flour on the quality of the bread. LWT-Food Science and Technology, 60(2): 729-736.

Doublier, J. L. and Durand, S. (2008). A rheological characterization of semi-solid dairy systems. Food Chemistry, 108(4):1169-1175.

Eggum, B. O.; Villegas, E. M. and Vasal, S. K. (1979). Progress in protein quality of maize. Journal of the Science of Food and Agriculture, 30(12): 1148-1153.

FAO/ WHO. 2007. Energy and protein requirement. In Geneva, nutrition report series No.935.

Ferreira, M. S.; Santos, M. C.; Moro, T.; Basto, G. J.; Andrade, R. and Gonçalves, É. C. (2015). Formulation and characterization of functional foods based on fruit and vegetable residue flour. Journal of food science and technology, 52(2): 822-830.

Gramza-Michałowska, A.; Bueschke, M.; Kulczyński, B.; Gliszczyńska-Świgło, A.; Kmiecik, D.; Bilska, A.; Purłan, M.; Wałęsa,L.; Ostrowski, M., Filipczuk, M. and Jędrusek-Golińska, A. (2019). Phenolic compounds and multivariate analysis of antiradical properties of red fruits. Journal of Food Measurement and Characterization, 13(3):1739-1747.

Grancieri, M.; Martino, H. S. D. and Gonzalez de Mejia, E. (2019). Chia seed (*Salvia hispanica* L.) as a source of proteins and bioactive peptides with health benefits: A review. Comprehensive Reviews in Food Science and Food Safety, 18(2): 480-499.

Hayta, M.; Alpaslan, M. and Baysar, A. (2002). Effect of drying methods on functional properties of Tarhana: A wheat flour-yogurt mixture. Journal of Food Science, 67(2): 740-744.

Hendek Ertop, M.; Atasoy, R. and Akın, Ş. S. (2019). Evaluation of taro (*Colocasia Esculenta* (L.) Schott] flour as a hydrocolloid on the physicochemical, theological, and sensorial properties of milk pudding. Journal of Food Processing and Preservation, 43(10): e14103.

Ijarotimi, O. S.; Nathaniel, F. T. and Osundahunsi, O. O.(2015). Determination of chemical composition, nutritional quality and anti-diabetic potential of raw, blanched and fermented wonderful kola (Bucholziacoriacea) seed flour. Journal of Human Nutrition and Food Science, 3(2): 1060-1073.

Ixtaina, V. Y., Nolasco, S. M., and Tomás, M. C. (2008). Physical properties of chia (*Salvia hispanica L.*) seeds. Industrial crops and products, 28(3): 286-293.

Kaushal, P.; Kumar, V. and Sharma, H. K. (2012). Comparative study of physicochemical, functional, antinutritional and pasting properties of taro (*Colocasia esculenta*), rice (*Oryza sativa*) flour, pigeonpea (*Cajanus cajan*) flour and their blends. LWT-Food Science and Technology, 48(1): 59-68.

Kulczyński, B.; Kobus-Cisowska, J.; Taczanowski, M.; Kmiecik, D. and Gramza-Michałowska, A. (2019). The chemical composition and nutritional value of chia seeds—Current state of knowledge. Nutrients, 11(6): 1242.

Mohammed, O.; Bekhet, M.; El-Razek, A.; Amal, M. and Moharram, Y. (2019). Evaluation of Chia (*Salvia Hispanica* L.) Seeds Meal as a Source of Bioactive Ingredients. Alexandria Science Exchange Journal, 40: 177-189.

Ngamlerst, C.; Prangthip, P.; Leelawat, B.; Supawong, S. and Vatthanakul, S. (2022). A Vital Role of High-Pressure Processing in the Gel Forming on New Healthy Egg Pudding through Texture, Microstructure, and Molecular Impacts. Foods, 11(17): 2555.

Pang, Z.; Deeth, H.; and Bansal, N. (2015). Effect of polysaccharides with different ionic charge on the rheological, microstructural and textural properties of acid milk gels. Food research international, 72: 62-73.

Rocha, M. C.; da Penha Píccolo, M.; de Abreu, W. C.; Maradini Filho, A. M. and Barcelos, M. D. F. P. (2020). Physicochemical properties and use of chia mucilage (*Salvia hispanica* L.) in the reduction of fat in cookies. Brazilian Journal of Development, 6(9): 69019-69034.

SAS Institute, Inc. 1999. PC-SAS users guide version 8. North Carolina: statistical analysis system institute, Inc.

Sultana, C. (1996). Oleaginous Flax. In: Karleskind A and Wolff JP (eds) oils and fats manual, 157 –160. Paris: Lavoisier

Sung, W. C.; Chiu, E. T.; Sun, A. and Hsiao, H. I. (2020). Incorporation of chia seed flour into gluten-free rice layer cake: effects on nutritional quality and physicochemical properties. Journal of food science, 85(3): 545-555.

Ullah, R.; Nadeem, M.; Khalique, A.; Imran, M.; Mehmood, S.; Javid, A. and Hussain, J. (2016). Nutritional and therapeutic perspectives of Chia (*Salvia hispanica L.*): a review. Journal of food science and technology, 53(4): 1750-1758.

Valdivia-López, M. Á., and Tecante, A. (2015). Chia (*Salvia hispanica*): A review of native Mexican seed and its nutritional and functional properties. Advances in food and nutrition research, 75: 53-75.


# تقييم تصنيع بودينج غير تقليدي باضافة دقيق بذور الشيا


**سماء محمد صالح**

قسم علوم الاغذية – كلية الزراعة سابا باشا – جامعة الاسكندرية – مصر


## الملخص


اجري هذا البحث لدراسة تأثير اضافة دقيق بذور الشيا مع نشا الذرة لعمل بودينج وذلك باستخدام نسب مختلفة مثل 6: 0 ، 4.5: 1.5 ، 3: 3 ، 1.5: 4.5 ( جم / جم) على التوالى وتم استخدام نشا الذرة كعينة كنترول 6: 0 (جم / جم) و تمت اضافة مكونات كل خلطة الى100جرام من الحليب و تم دراسة تأثيره على الخصائص الوظيفية للمواد الخام والصفات الغذائية والخواص الفيزيائية والكيميائية والخصائص التركيبية والخواص الحسية للبودنج و اوضحت النتائج ان استخدام دقيق بذور الشيا ادى إلى تحسين الخصائص الوظيفية للمواد الخام . كما انها عملت على زيادة المحتوى من البروتين والدهون والرماد والألياف الخام بمقدار 1.3 و 1.4 و 1.2 و 11.8 مرة في العينة البودينج P4 مقارنة بالعينة الكنترول (P ). بالاضافة الى ذلك فقد زاد إجمالي محتواه من الأحماض الأمينية الأساسية وإجمالي محتواه من الأحماض الأمينية الغير أساسية من 1.23 إلى 2.06 (جم / 100 جم عينة) ، ومن 2.17 إلى 4.03 (جم / 100 جم عينة) على التوالى وذلك بزيادة نسب اضافة التدعيم بدقيق بذور الشيا. ايضا أدت زيادة نسبة دقيق بذور الشيا في عينات البودنج إلى زيادة قيم دلائل جودة البروتين. بالنسبة لخصائص قوام البودنج فقد ارتفع قيم التماسك من 0.48 إلى 0.68 ، في حين أظهرت باقي صفات القوام نتيجة مختلفة مع زيادة مستوى التدعيم بدقيق بذور الشيا في البودنج. أظهرت نتائج التقييم الحسي أن العينة المكونة من 3: 3 (جم / جم) دقيق بذور الشيا: نشا الذرة لكل 100 جرام من الحليب كان أقرب إلى عينة التحكم من حيث القبول العام. لذا توصي الدارسة بامكانية استخدام دقيق بذور الشيا كطريقة جديدة لتحسين الخصائص الوظيفية والجودة الغذائية لبودنج الحليب.



***الكلمات الدالة:*** دقيق بذور الشيا، البودنج ، الخصائص الوظيفية، القيمة التغذوية، القوام