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Physicochemical and Fatty Acid Profile of Development Dry Soup Mixes Properties Enriched with Germinated Flax, Chia and Psyllium Seeds

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ABSTRACT: In this study the properties of soups with germinated chia, flax and psyllium seeds' flour were evaluated. The chemical composition, fatty acids, the physical and sensory properties of the soup with germinated seeds were estimated. The chemical composition of the germinated seeds indicated that, the germinated flaxseed had significantly ($p<0.05$) the highest content of protein and fat (23.88 and 41.18%), while the psyllium contained the highest fiber content (36.51%). The soup of germinated chia, flax and psyllium showed the highest protein content (15.17, 32.14 and 16.29 %) compared to control (9.23%). it could be noted that, the ash and fiber content increased significantly in all treatments with adding the germinated seeds. It raised from 6.90% and 1.06% in control to 12.16% and 5.06% in soup with germinated psyllium seeds, respectively. The germinated seeds enhanced the fatty acid composition in soup especially omega-3 and omega-7 fatty acids from 13.91% in control to 14.87, 37.85 and 21.59% in soup with chia, flax and psyllium, respectively. Also polyunsaturated fatty acid/ saturated fatty (PUFA/SFA) ratio increased from 1.78 in control to 2.93 in flaxseed soup. Additionally, the germinated seeds improved the bulk density and solubility to become (0.72 g/ml and 35.83%) in flaxseed soup. All samples were close to the control in the sensory evaluation.

Keywords: Soup; Germinated chia seeds, germinated flaxseeds, germinated psyllium seeds, fatty acids.

INTRODUCTION

Soup is an instant liquid meal prepared from vegetables, fish or meat using water, juice, or broth and some thickening agents and falls under the heterogeneous food category. The thick soup is prepared by mixing grain powder or legume flour (Radha et al., 2015). Soup is a very fast cooking method. Dry soup mixes are now an established staple in global food markets. People lead busy lives because of urbanization in work, especially for women. They do not have enough time to cook their meals at home, so they resort to thinking about eating fast food. The majority of these fast foods are heavy in sugar, fat, and salt and lacking in protein, fiber, vitamins, and minerals. These foods cause malnutrition and nutrition-related disorders when consumed (Farzana et al., 2017; Sarah Priscilla & Vigasini, 2017).

Flaxseed (*Linum usitatissimum* L) Known as a potential functional food source having a bioactive components-omega-3 fatty acid (Kajla et al., 2015). It contains about 55% alpha-linolenic acid, high-quality protein, lignan, and soluble fiber. Many researchers have proven that the germination process has the ability to reduce levels of anti-nutritional factors and reduce susceptibility to cancer due to its high content of health-protecting phytochemicals. The germination process increases the bioactive compounds, nutritional value of the seeds, including phenolic compounds and mineral composition, along with increasing their bioavailability (Gómez-Favela et al., 2017; Pająk et al., 2019).

Chia (*Salvia hispanica* L.) is an annual herbaceous plant that has been studied in many study models for health and illness prevention. Chia seeds are abundant in omega-3 fatty acids, oil, protein, dietary fiber, minerals, and polyphenols, all of which contribute to their nutritional value (de Abreu Silva et al., 2021; Noshe & Al-Bayyar, 2017)

Psyllium is described as a short-stemmed annual herb (Jat et al., 2015). The United States Food and Drug Administration (USFDA) has approved the eating of psyllium-based foods (Leeds, 2009). Psyllium is made up of the husk, seeds, and whole plant, and is a good source of both soluble and insoluble fiber. The unique qualities of psyllium husks have prompted food manufacturers to create a number of psyllium-based functional meals. Psyllium husks have a total carbohydrate content of 84.98 percent, 0.94 percent protein, 4.07 percent ash, and 6.83 percent. Linoleic acid (40.6%) and oleic acid (39.1%) are abundant in plantain seed oil, but linolenic acid is present in just a minor fraction (6.9 percent). It relieves constipation and mild diarrhea symptoms, improves digestion and cleanses the colon, lowers hypercholesterolemia, lowers the risk of heart disease, aids weight loss, manages type 2 diabetes, and treats inflammatory bowel disease (ulcerative colitis) and hemorrhoids. It's used in baking and as a thickening agent in the food business (Shabbir, 2020).

The incorporation of germinated seeds into soup enhances the nutrition requirement. But there are no scientific data available on the nutritional values of germinated seeds-based soup mixtures. There are so many studies have already done on dried soup but there are no studies on soup with germinated chia, flax and psyllium seeds flour. This study aimed to investigate the properties of soups enriched with germinated chia, flax and psyllium seeds' flour by determined the chemical composition, fatty acids, the physical and sensory properties. Therefore, efforts have been geared towards the development of innovative food products enriched with Omega-3 PUFA from germinated flaxseed, chia, and psyllium for better eating habits and without much effort in preparation this product, which could elevate the omega-3 PUFA intake. And also it comes as a dry product assuring a longer period of a shelf life than broth. Therefore, this study aimed to incorporate germinated seeds (flaxseed, chia, and psyllium) to develop dry soup mixes with Omega-3 PUFA and enhances the nutrition requirement.

2. Materials and Methods

2.1. Raw Materials and Ingredients

Flaxseed, Chia, Psyllium, corn flour, potato starch, green pea, green chili, carrot, onion powder, garlic powder, black pepper and salt were obtained from local market in Cairo, Egypt.

2.2. Raw Material Preparation

The potatoes and carrots were cleaned, peeled, and sliced into cubes before being blanched in boiling water at 95°C for 5 minutes, then washed in cold water and hot air dried at 50°C. The flour was then ground and sieved (315 micron) into a fine powder. The green pea was blanched for 1 minute at 85°C and then soaked in cold water for 3 minutes before being dried, ground into flour, and sieved through a 315 m sieve at food science and technology laboratory of faculty of home economic, Al-Azhar University, Tanta (Abdel-Haleem & Omran, 2014).

2.3. Germination of chia, flax and psylium seeds

Seeds cleaned from dust, dirt and other foreign matter. Damaged seeds with damaged hull were discarded. The seeds were washed with distilled water and then placed in petri plates lined with wet filter paper and frequent watering was given throughout germination period. Germination was recorded when white radical emerges from the seed as shown in (Fig. 1). All the viable seeds germinated within 48 h at room temperature. After germination, the samples were taken out and dried using tray drier at 40 °C till steady weight. The samples were grounded to 0.2 mm particle size and packed in polythene pouches and stored at refrigerated temperature till further use (Kajla et al., 2017).

GChS, Germinated chia seeds; GFS, Germinated flaxseeds; GPsS, Germinated psyllium seeds
Fig. (1): Germinated seeds

2.4. Preparation of soup mix

To make the soup mix as a control sample, hand mixing of corn flour (40g), potato starch (8g), salt (4g), black pepper (3g), onion powder (9g), garlic powder (6g), dried green chilli (6g), and dry vegetable mix (peas, beans, and carrots with ratio 1:1:1) (24g) was done. The corn flour has been replaced by germinated chia flax and psyllium seeds flour. The dried soup mixes were then packed in Aluminum Laminated Pouches (ALP) (Sarkar et al., 2019).

2.5. Proximate composition

For determination of chemical composition of germinated seeds and soup, moisture was determined using hot air oven at 105°C, until fixed weight according to method (Association of Official Analytical Chemists; 952.08, AOAC (2016). Crude protein was determined using the Kjeldahl method 992.23, AOAC (2016). Total fat was determined using Soxhlet at 60°C according to method 948.15, AOAC (2016). Fiber was determined according to method 985.29, AOAC (2016). Ash was determined according to method

930.30, AOAC (2016), burned samples at 550°C, until fixed weight. Total carbohydrate was determined by calculation. The total energy value of the soup formulation was determined based on the carbohydrate, protein, and lipid contents multiplied by a factor of 4, 4, and 9 respectively, and then added the results together according to (Sharoba et al., 2013).

2.6. Total fatty acids composition analysis

The fatty acid profile was determined using the GC-MS model GC-17A and the method 991.39, AOAC (2007). Samples of the oils taken from the samples were converted to their methyl ester counterparts. For 1 hour, the mixture was kept at 100 degrees Celsius. 0.5 mL distilled water was used to stop the process. After that, the fatty acid methyl esters were extracted and dissolved in heptane for GC analysis. HP Co., Amsterdam, The Netherlands) used a Hewlett–Packard5890 Series II gas chromatograph with a hydrogen flame ionization detector and a capillary column to analyses HP Inovax cross-linked PEG (30 m x 0.32mm x 0.25 lm film). The column temperature was designed to rise at a rate of 5 ^{o}C/min from 180 to 240 ^{o}C, while the injector and detector were set at 250 ^{o}C. The carrier gas was nitrogen. The percentage of individual fatty acids in the lipid fraction was calculated.

2.7. Physical parameters

***2.7.1.* pH**

The pH was measured according to 943.02, AOAC (2007). In a laboratory blender (POLYTRON, PT 300), 10 g of soup mix was homogenized in 50 ml of distilled water for 1 minute, and the pH was measured using a digital pH meter. (Ohaus Starter 3000 Parsippany, NJ 07054, USA).

***2.7.2.* Bulk density**

In a 10 ml graduated measuring cylinder, five grams of material were inserted and by dividing the mass of the mix by the volume occupied in the cylinder, the bulk density was obtained (Yetismeyen & Deveci, 2000).

***2.7.3.* Viscosity**

``Using a Brookfield Engineering laboratories DV-III Ultra Rheometer, the viscosity of soup samples was evaluated according to procedure 2.7.4 Manual (1998) The sample was placed in a tiny sample adaptor, and the temperature was maintained with a constant temperature water bath. The viscometer was turned between 10 and 60 revolutions per minute. For the measurement, the SC4-21 spindle was chosen

***2.7.4.* Rehydration Ratio (RR)**

The rehydration ratio was calculated according to Krokida and Marinos-Kouris (2003). 2 g dried soup mix was rehydrated in 20 ml distilled water in a water bath at a consistent temperature and agitated at a constant pace (100 rpm). After 10 minutes, the samples were removed from the bath and weighed. The weight of rehydrated samples to the dry weight of the sample was established as the rehydration ratio.

***2.7.5.* Solubility**

One gram of mix was disseminated in 100 mL distilled water by mixing for 5 minutes at high speed (13,000 rpm) with a blender, then centrifuged for 5 minutes at 3000 rpm. A 25 ml portion of the supernatant was pipetted and put to a pre-weighed aluminium dish, which was then oven dried for 5 hours at 105 °C. The drying process was maintained for another two hours, with the weight of the sample being taken every hour (Cano-Chauca et al., 2004).

2.8. Sensory evaluation of instant soup mixture

Soup samples were performed by 10 members of Food Science and technology Department, Faculty of Home Economic, Al-Azher Univ., Tanta. According to the method of Wang et al. (2009) as follow:

Twelve grams of dry soup mix were added to150 ml of slightly hot water and stirred slowly until it boils. After 5 min of boiling, get ready-to-drink soup. Equal amount / Volume of soup was served to the panelist with evaluation form. Samples were served in coded number bowls. Water was given between two samples to cleanse the mouth. Palatability tests were 6 items, colour (10), flavor (10), taste (10), appearance (10), consistency (10) and overall acceptability (10) for soup samples were carried out.

2.9. Statistical analyses

The obtained data from chemical composition and sensory evaluation were recorded as means and analyzed by (SPSS) Windows (Ver.10.1). One-way analysis of variance (ANOVA) and Duncan comparisons were tested to signify differences between different treatments

3. RESULTS AND DISCUSSION

3.1. Chemical composition of germinated chia, flax and psyllium seeds flour

Table 1 showed the chemical composition of germinated chia, flax and psyllium seeds flour, the data revealed that there were significant differences ($p<0.05$) between germinated chia, flax and psyllium seeds flour in the chemical composition. The germinated flaxseeds flour has the highest moisture, and fat content (6.97 and 41.18%, respectively). There is showed non-significant differences between flax and psyllium seeds flour in protein content (23.88 and 23.33%, respectively). The least amount of ash and fiber (5.09 and 10.18%, respectively) found in flaxseed flour. These results agree with (Kajla et al., 2017). On the other hand, the germinated psyllium seeds flour has the least moisture and fat content (5.98 and 0.93%, respectively) and the highest ash, fiber and soluble carbohydrate content (7.05, 36.51 and 26.2 %, respectively).

Table 1. Chemical composition of germinated chia, flax and psyllium seeds

Components, %	GChS	GFS	GPsS
Moisture	**6.48±0.11[b]**	**6.97±0.13[a]**	**5.98±0.01[c]**
Crude protein	**19.40±0.15 [b]**	**23.88±0.20 [a]**	**23.33±0.13 [a]**
Crude fat	**32.98±0.71 [b]**	**41.18±0.33 [a]**	**0.93±0.021 [c]**
Ash	**6.83±0.04 [b]**	**5.09±0.02 [c]**	**7.05±0.06 [a]**
Fiber	**23.02±0.63 [b]**	**10.18±0.02 [c]**	**36.51±0.98 [a]**
Soluble carbohydrate	**11.29±0.12 [c]**	**12.70±0.42 [b]**	**26.2±0.88 [a]**

Where: means± std division, the [a,b] and [c] means in the same raw within the same item followed by different super scripts differ significantly at $p<0.05$ GChS=Germinated chia seeds; GFS= Germinated flaxseeds; GPsS=Germinated psyllium seeds.

The germinated chia seeds flour contained 19.40% protein, 32.98% fat, 6.83% ash, 23.02% fiber and significantly ($p<0.05$) the lowest content of soluble carbohydrate. These results are consistent with results (Gómez-Favela et al., 2017; Qiu et al., 2020).

3.2. Chemical composition of dry soup mixes

The chemical composition of dry soup mixes enriched with germinated chia, flax and psyllium seeds flour were determined in **Table 2**. There were significant differences ($p<0.05$) between soup mixes in composition. The moisture content in control soup was higher than other samples. It was 8.25% in control soup, followed by soup with germinated flax seeds flour 7.98%, soup with germinated psyllium seeds flour 7.88% and soup with germinated chia seeds flour 7.14**%.**

The protein content increased significant ($p<0.05$) by replacing the corn flour with germinated seeds flour from 9.23% in control soup to15.17, 16.29 and 32.14% in soup with germinated chia, psyllium and flax seeds flour, respectively. The highest protein content observed in soup with germinated flax seeds flour.

The daily intake of protein for child (female and male) aged (2- 3) year need 13g/ day, female aged (19- 30) year need 46g/ day. Meanwhile, daily intake of protein for male aged (19- 30) year need 56 g/ day (Meyers et al., 2006).

Each 100g of soup with germinated chia, flax and psyllium seeds flour covered 116.69, 247.23 and 125.31%, respectively from the daily intake of protein for child, 32.97, 69.87 and 35.41%, respectively from the daily intake of protein for female and 27.09, 57.39 and 29.09%, respectively from the daily intake of protein for male.

Table 2. Chemical composition of dry soup mixes enriched with germinated chia, flax and psyllium seeds flour

Components, %	S_0	S_1	S_2	S_3
Moisture	**8.25±0.12[a]**	**7.14±0.65[d]**	**7.98±0.34[b]**	**7.88±0.25[c]**
Crude protein	**9.23±0.56[c]**	**15.17±0.90[b]**	**32.14±1.00[a]**	**16.29±0.96[b]**
Crude fat	**27.75±1.05[b]**	**26.16±1.01[c]**	**28.99±0.54[a]**	**21.78±1.56[d]**
Ash	**6.90±0.87[d]**	**9.32±0.97[b]**	**8.92±0.69[c]**	**12.16±0.34[a]**
Fiber	**1.06±0.02[d]**	**4.22±0.05[b]**	**1.42±0.024[c]**	**5.06±0.045[a]**
Soluble carbohydrate	**52.82±2.56[a]**	**37.72±1.56[b]**	**17.75±1.02[d]**	**37.34±1.98[c]**
Total energy (Kcal)	**497.95±1.25[a]**	**447±0.95 [c]**	**460.47±0.75[b]**	**410.54±1.43[d]**

Where: means± std division, the [a,b,c] and [d] means in the same raw within the same item followed by different super scripts differ significantly at $p<0.05$. S_0: control sample; S_1: soup with germinated chia seeds flour; S_2: soup with germinated flax seeds flour; S_3: soup with germinated psyllium seeds flour

The replacement corn flour with germinated seeds led to increase the crude fat content. It was 27.75 in control soup increased significantly ($p<0.05$) to 28.99 in soup with germinated flax seeds flour and decreased significantly ($p<0.05$) to 26.16 and 21.78% in soups with germinated chia and psyllium seeds flour, respectively. This is likely due to the low fat content in germinated psyllium seeds

Ash content was increased significantly ($p<0.05$) by replacing the corn flour (6.90%) with germinated chia (9.32%), flax (8.92%) and psyllium (12.16%) seeds flour. The highest content of ash found in germinated psyllium seed soup followed by germinated chia seeds soup and germinated flaxseed soup compared to control.

The fiber content increased from 1.06% in control soup to 5.06% in germinated psyllium seed soup. On the contrary, the carbohydrate content decreased from 52.82% in control sample to 17.75% in in germinated flaxseed soup. The energy decreased from 497.95 Kcal in control sample to447, 460.47 and 410.54 Kcal in germinated chia, flax and psyllium seed soups, respectively it was may be due to the low fat and carbohydrate contents.

3.3. Fatty acid profile of dry soup mixes

Table 3 summarizes the content of saturated, monounsaturated, polyunsaturated fatty acids and ω-3/ω-6 polyunsaturated fatty acids ratio. Nine fatty acids in dried soup mixes were identified and quantified **(Table 3 and Fig 2).** Lauric acid (C12:0), myristic (C14:0), palmitic (C16:0) and stearic (C18:0) were the dominating saturated fatty acids in all dried soup mixes. Lauric acid is predominant saturated acid in soup with germinated psyllium seeds flour (15.89) while Palmitic acid is predominant saturated acid in soup with germinated chia seeds flour (15.33). Soup with germinated flaxseeds flour is a soup which has the lowest saturated fatty acids content (25.44% of total fatty acids). control sample and soup with germinated chia seeds flour have high amount of oleic and linoleic acids (9.07 - 8.05%, respectively) and (20.95 - 19.41%, respectively). According to studies, consuming a sufficient amount of oleic acid in one's diet can help to prevent the onset of atherosclerosis. It may also help to decrease cholesterol levels in the blood while also boosting antioxidant defenses (Vadász et al., 2005)

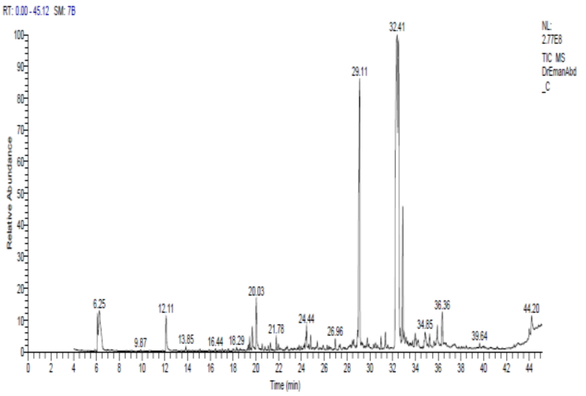
Table 3. Fatty acid profile of dry soup mixes enriched with germinated chia, flax and psyllium seeds flour

Fatty acids %	S_0	S_1	S_2	S_3
C12:0 Lauric	**12.67**	**8.94**	**8.89**	**15.89**
C14:0 Myristic	**8.26**	**5.85**	**5.69**	**8.50**
C16:0 Palmitic	**10.74**	**15.33**	**6.24**	**10.99**
C18:0 Stearic	**4.20**	**6.31**	**4.62**	**4.61**
Total saturated fatty acids	**35.87**	**36.43**	**25.44**	**39.99**
C16:1 (n-7) Palmitoleic	**20.20**	**21.24**	**24.47**	**22.43**
C18:1n9c Oleic	**9.07**	**8.05**	**5.31**	**6.21**
C18:2n6c Linoleic	**20.95**	**19.41**	**6.93**	**9.78**
C18:3(n-3) α-Linolenic	**13.91**	**14.87**	**37.85**	**21.59**
Total unsaturated fatty acids	**64.13**	**63.59**	**74.56**	**60.01**
PUFA/SFA ratio	**1.78**	**1.74**	**2.93**	**1.50**

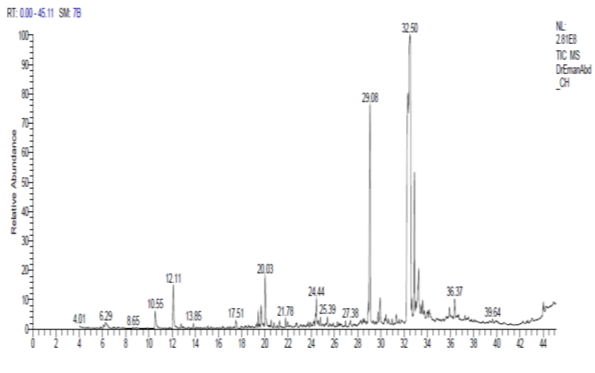
Whear: S_0 =control sample, $S_{1=}$ soup with germinated chia seeds flour, $S_{2=}$ soup with germinated flax seeds flour and $S_{3=}$ soup with germinated psyllium seeds flour

α-Linolenic acid was the predominant fatty acid in soup with germinated flaxseeds flour (37.85%) because linseed oil is one of the richest sources of α-linolenic acid, as confirmed by (Choo et al., 2007). followed by soup with germinated psyllium seeds flour (21.59%). Linoleic acid is required for the generation of a number of hormones that have a variety of activities, including blood clotting and lipid levels. Because ALA (omega-3) and linoleic acid (omega-6) cannot be produced in the human body, they are regarded strictly essential and must be received through the food (Aguiar et al., 2007). Omega-3 fatty acids have been shown to provide health benefits in the areas of cancer, inflammatory bowel disease, rheumatoid arthritis, psoriasis, and mental wellness (Simopoulos, 2011). The National

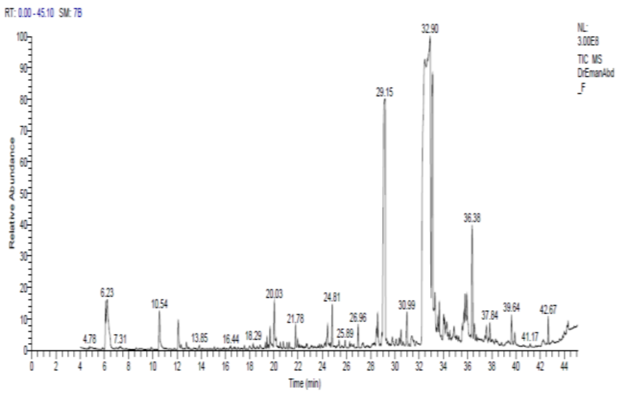
Academies' Medicine (2005) advises a daily intake of LNA of 1.6 g for men and 1.1 g for women.



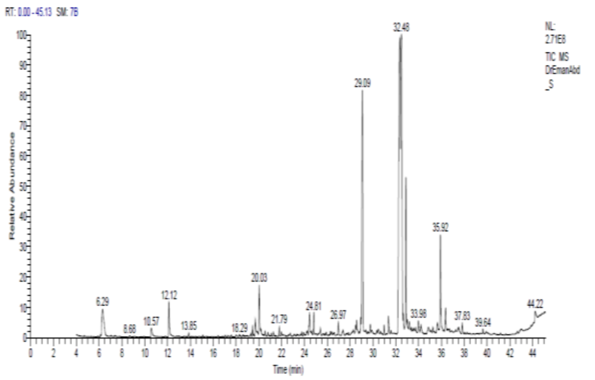
(a) control sample



(b) soup mixes with germinated chia seeds flour



(c) soup mixes with germinated flaxseeds flour



(d) soup mixes with germinated psyllium seeds flour

Fig 2. Fatty acid profile of dry soup mixes

Total PUFA/Total SFA of the soup with germinated flaxseeds flour = 74.56/25.44 = 2.93 Where flaxseed is considered a rich source of PUFA. While, Total PUFA/ Total SFA of the control sample, soup with germinated chia and psylium seeds flour were 1.78, 1.74 and 1.50 respectively. The minimum value recommended for PUFA/SFA in a range between 0.3 to 0.5 g/day (Kris-Etherton et al., 2002). Since value of the omega 3 enriched soup is higher than the recommended minimum value it can be suggested that the soup contains health friendly PUFA more than SFA.

3.4. Physical properties of dry soup mixes

The physico-chemical properties of powdered soups are presented in **Table 4.** The pH values of the samples were varied between 5.82 and 6.37. Control sample had a lower pH than soup with germinated chia, flaxseed and psyllium seeds flour. This characteristic is significant because of its relationship to water solubility indices, which show that higher pH levels result in a higher water solubility index. (Sreerama et al., 2012; Tivana et al., 2013). The results obtained indicate that bulk density increased in soup with germinated flaxseeds flour. This may be due to the proportion of some ingredients added. Bulk density of soup with germinated psyllium seeds flour was 0.61 g/ml and that of soup with germinated chia seeds flour was 0.59 g/ml. Control sample had the lowest (0.47 g/ml) bulk density value.

Table 4. Physico-chemical properties of dry soup mixes enriched with germinated chia, flax and psyllium seeds flour

Parameter	S_0	S_1	S_2	S_3
pH	5.82	6.37	6.13	6.09
Bulk density, g/ml	0.47	0.59	0.72	0.61
Viscosity, cP	1210	750	960	688
Rehydration Ratio (RR), %	2.65	4.96	3.90	4.37
Solubility, %	28.50	32.20	35.83	30.80

Whear: S_0 =control sample, $S_{1=}$ soup with germinated chia seeds flour, $S_{2=}$ soup with germinated flax seeds flour and $S_{3=}$ soup with germinated psyllium seeds flour

The ability to understand the rheological behavior of foods during processing is useful for process and quality control. In many areas of food preparation, viscosity is a significant feature of liquid meals. In comparison to the formulations in which Corn flour was substituted with chia, flaxseed, and psylium, the control sample had the highest apparent viscosity and the lowest fiber content (1.06 percent). Soup with germinated psyllium and chia seeds flour, which had higher fiber content than the other formulations, had low viscosity values. Previous research has shown that using cellulose-containing fibers can reduce perceived viscosity (Malucelli et al., 2015). Many items' rehydration features, rehydration rate, and rehydration capacity are significant characteristics to consider when preparing them for consumption. The rehydration capacity of the dried product was employed as a quality feature (Velić et al., 2004), expressed as the rehydration rate-RR (Lewicki, 1998). Table 4 shows that compared to soup with control sample, soup with germinated chia and psyllium seeds flour affected the RR (4.96, 4.37) respectively (2.65). It's possible that this is due to the lower water content. Products with a high rehydration capacity are tastier and preserve their fresh appearance, according to Jokić et al. (2009). Soup with germinated flaxseeds flour had the highest water solubility among the treatments. The high water solubility of soup from flaxseed can be attributed to the presence of higher amount of protein and lower moisture and water activity (Hager et al., 2012).

3.5. Sensory evaluation of dry soup mixes

The overall sensory quality of powdered soups samples enriched with germinated chia, flax and psyllium seeds observed in **Table 5**. It is evident from the table that the best samples in all sensory evaluation were the soup containing stimulant flaxseed, which indicates that the germination and drying process led to the improvement of the unwanted flax flavor, followed by control and soup with germinated pysllium seeds flour. This table indicates that there were significant differences ($p<0.05$) between soup mixes in colour and the numerical score varied from 7.0 for soup with germinated chia seed flour to 9.43 for control sample.

Table 5. Sensory evaluation of dry soup mixes enriched with germinated chia, flax and psyllium seeds flour

Parameters	S_0	S_1	S_2	S_3
Colour	**9.43±0.54**	**7.00±1.0**	**9.20±0.44**	**8.14±1.10**
Flavor	**8.40±1.14**	**7.87±1.30**	**9.00±0.70**	**8.34±1.09**
Taste	**8.40±0.54**	**7.87±0.83**	**9.00±0.45**	**8.34±0.83**
Appearance	**9.64±0.37**	**7.10±0.75**	**9.20±0.28**	**8.80±0.50**
Consistency	**7.80±0.88**	**9.14±0.69**	**9.71±0.38**	**9.71±0.79**
Acceptability	**9.29±1.12**	**7.8±0.83**	**9.00±0.44**	**8.71±0.55**

Where: means± std division S_0 =control sample, $S_{1=}$ soup with germinated chia seeds flour, $S_{2=}$ soup with germinated flax seeds flour and $S_{3=}$ soup with germinated psyllium seeds flour

The flavor and taste of soup with germinated flax seeds flour was the most acceptable among the samples and was followed by control sample, while the lowest score was given by soup with germinated chia seeds flour. the results showed that control sample has highest appearance score among the samples tested and was followed by soup with germinated flax seeds flour while soup with germinated chia seeds flour secured the lowest score. All samples containing germinated seeds were better than control in consistency properties. Where control sample gave 7.80 and samples containing germinated seeds were 9.14, 9.71 and 9.71 in samples with germinated chia, flax and pysllium seeds, respectively. As a result, experts are actively looking at healthier options to replace traditional flour sources, with an emphasis on consumer health advantages (Andualem & Gessesse, 2013; Park et al., 2012).

4. CONCLUSION

Soup is considered one of the important fast ready meals as it requires short time for preparation. In current study, developed soup preparations were evaluated applying; germinated chia, flax and psyllium seeds to increase the protein content from 19.40% to 23.88% and un saturated fatty acids from 64.13 to 74.56 especially omega-3 fatty acids. Furthermore, the germination process improved the sensory properties. These soup products can be recommended as healthy alternatives for fast food which can enhance malnutrition.

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الملخص العربى

الخصائص الفيزيوكيميائية والأحماض الدهنية لخلطات الشوربة الجافة المطوره الغنيه ببذور الشيا والكتان والسيليوم المنبتة

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فى هذه الدراسة تم تقييم خصائص الشوربه المحتويه على دقيق بذور الشيا ، الكتان و السيليوم المنبتة. تم تقدير التركيب الكيميائي والأحماض الدهنية والخصائص الفيزيائية والحسية للشوربه المحتويه على البذور المنبتة. أظهر التركيب الكيميائي للبذور المنبتة أن بذور الكتان احتوت على أعلى نسبة من البروتين والدهون (23.88 و 41.18٪)، بينما احتوت بذور السيليوم على أعلى محتوى للألياف (36.51٪). أظهرت الشوربه المحتويه علي بذور الشيا، الكتان والسيليوم المنبته اعلي محتوي من البروتين (15.17 ، 32.14 و 16.29٪) مقارنة بالكنترول (9.23٪). ويلاحظ أن محتوى الرماد والألياف زاد في جميع المعاملات بإضافة البذور المنبته. حيث ارتفعت نسبة الرماد والألياف من 6.90٪ و 1.06٪ في الكنترول إلى 12.16٪ و 5.06٪ في الشوربه المحتوية على بذور السيليوم المنبته على التوالي. عززت البذور المنبتة تكوين الأحماض الدهنية في الشوربه وخاصة أحماض أوميغا 3 وأوميغا 7 الدهنية من 13.91٪ في الكنترول إلى 14.87 و 37.85 و 21.59٪ في الشوربه المحتوية على الشيا والكتان والسيليوم على التوالي. كما زادت نسبة الأحماض الدهنية المتعددة غير المشبعة / الدهون المشبعة (PUFA / SFA) من 1.78 في الكنترول إلى 2.93 في الشوربه المحتوية على بذور الكتان. بالإضافة إلى ذلك، حسنت البذور المنبته الكثافة الظاهرية والقابلية للذوبان لتصبح (0.72 جم / مل و 35.83٪) في الشوربه المحتوية على بذور الكتان. جميع العينات كانت قريبة من الكنترول في التقييم الحسي.

.الكلمات المفتاحية: شوربة، بذور الشيا المنبته، بذور الكتان المنبتة، بذور السيليوم المنبته، أحماض دهنية