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STUDIES ON PHYSICO-CHEMICAL AND NUTRACEUTICAL CHARACTERISTICS OF CHIA (*SALVIA HISPANICA* L.) SEED AND OIL

M. ABDUR RAHMAN[1*], A.K. SINGH[2], R.N. SHUKLA[2] AND K.S. GADHE[3]

[1,2,]Department of Processing and Food Engineering VIAET, SHUATS, Prayagraj 211 007, U.P., India
[3]Department of Food Technology, VNMKV, Parbhani 431 401 (M.S., India

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Abstract–Chia (*Salvia hispanica* L.) belongs to the mint family is excellent nutritional source essential components. Omega-3 fatty acids are abundant in chia seed oil which is necessary in nature to prevent the body from synthesizing and is a crucial part of the brain's cells, heart muscle cells and retina. Study was undertaken to evaluate the physico-chemical and nutritional qualities of chia seeds and oil. Bulk densities of Chia seeds was observed low (0.714 g/ml) and cent porosity was moderate (31.08 per cent). The per cent moisture and ash content was observed 6.76 and 4.38. phosphorus, magnesium and potassium in Chia seeds are 832, 994, 428 and 795 (mg/100g) respectively. Higher content of phosphorus, magnesium and potassium was observed in chia seeds. Specific gravity and refractive index of chia oil were 0.937g/cm^3 and 1.467. Free fatty acid content of Chia oil was observed to be 0.663 per cent while the acid value was 0.36 mg KOH/g. α-linolenic acid was major fatty acid component accounts for about 60% of the total amount of fatty acids in chia oil. Further, the total tocopherol content of Chia oil was 338.68 mg/kg whereas b-carotenoid was observed to be 89.78 mg/kg. From the results obtained in this study, it can be concluded that chia seed and oil are the good source of high quality antioxidants for potential use.

INTRODUCTION

'Chia' is a name of Spanish origin, which is used for several species of genus *Salvia*, usually for*Salvia hispanica* L. The genus *Salvia* L. belongs to the *Mint* family. Chia is known as super food as it contains highly concentrated amounts of essential fatty acids, dietary fibers, vitamins and antioxidants (Weber *et al.,* 1991). Providing a daily intake of 200 calories. The seeds also include phosphorus, manganese, calcium, potassium, salt, and other crucial minerals. The protein content of Chia seed is higher than that of other traditional crops such as wheat, corn, rice, oat, barley and amaranth (Ayerza and Coates, 2005). Analysis of chia seed press cake left after removal of oil has shown strong antioxidant activity (Taga *et al.*, 1984). The most important antioxidants in chia are chlorogenic acid and caffeic acid, although it also includes myricetin, quercetin and kaempferol flavonols. These compounds are both primary and synergistic antioxidants and make chia a very stable source of omega-3 fatty acids (Taga *et al.*, 1984; Castro *et al.*, 1986). This is the reason that chia does not require the use of artificial antioxidants such as vitamins. Over the past few years as natural products have become increasingly popular and the field of natural herbal remedies has flourished. Considering the aforesaid health advantages of the Chia seeds the study was conducted to analyze the physiochemical properties of the Chia seed and to optimize the extraction parameters for chia oil.

MATERIALS AND METHODS

The proximate compositions of the Chia seeds like Moisture, Crude Protein, Crude Fat, Ash and Total Carbohydrate were analyzed as per the methods given by the A.O.A.C. 1990. The physical properties of the Chia seeds like Color was analyzed by Lovibond Tintometer, 1000 kernel weight and

([1]Ph.D. Scholar, [2]Assistant Professor, [3]Associate Professor)

Porosity by the method given by Vilche *et al*., (2003). The Mineral content of the Chia seeds like Calcium, Phosphorus, Magnesium, were determined by the method given by Ranganna, (1985). The total polyphenol content of Chia seed was determined by Folin-Ciocalteu Reagent by following method as described by Singleton *et al*., (1999). It has been noted that the Specific gravity and the refractive index of Chia seed oil were 0.937g/cm^3 and 1.467, respectively. Extinction of oil is a measure of degree of oxidation and emulsification. Chia oil specific extinction was measured at 270 nm. The chemical parameter of oil like Free fatty acid, Peroxide value, Saponification value Acid value and Iodine value were also calculated by standard methods given in (A.O.A.C, 2000). Total tocopherol and carotenoids contents of oil of Chia seeds were measured by the standard methods (Ranganna, 1985). Fatty acid composition of Chia oil was determined as per the method given by the Christie, 2003.

RESULTS AND DISCUSSION

Physio-chemical properties of Chia seeds

It is recorded from Table 1 that the seed colour was black which indicates good quality. Bulk densities of Chia seeds was low 0.714g/ml. Low value of bulk density is may be due to volume of Chia seeds. This factor is important because it determines the storage capacity, packaging and transport systems (James, 2005). The per cent porosity of sample was found to be moderate (i.e. 31.08 per cent) and in the same order as reported for quinoa (Vilche *et al*., 2003) and coriander (Coskuner and Karababa, 2007). Porosity is a factor dependent on size, shape and boldness of seeds. Angle of repose represents the smoothness of seed surface and has marked effect on transportation of seeds. In the current investigation 18^o was observed value for angle of repose of Chia seeds. Angle of repose is also an indicator of free flowing nature of seeds and is important for designing of processing equipment's (Barbosa *et al*., 2006). The moisture content of sample was observed to be 6.76 per cent, while the ash value was found to be 4.38 per cent. The ash content represents the total amount of minerals. It may be due to the chia may contain higher amount of minerals. The protein, fat and carbohydrate content of Chia seeds were found to be 24.06, 29.50 and 12.35 per cent respectively. Crude fibre content was observed to be 22.91 per cent, which is comparable with findings reported by Tosco (2004). These values are comparable with Gopalan *et al.* (2006) reported the total carbohydrate and crude fibre content of sunflower seeds to be 17.9 and 34.9 per cent respectively.

Table 1. Physio-chemical properties of Chia (*Salvia hispanica L.*) seed

Sr. No.	Physical Parameters	Mean Value
1	Colour	Black
2	Bulk density (g/ml)	0.714
3	Porosity (%)	31.08
4	Angle of repose (^{o})	18 ^{o}
5	Moisture (%)	06.76
6	Crude Fat (%)	29.50
7	Total carbohydrates (%)	12.35
8	Crude Protein (%)	24.06
9	Ash (%)	4.380
10	Crude Fiber (%)	22.91
11	Polyphenol Extract (mg Gallic acid /g of extract)	
I) Crude Extract ii) Hydrolyzed Extract		0.90050.8840

* Each value represents the average of three determinations

Mineral content of Chia seed

The data presented in Table 2 showed that level of calcium, phosphorus, magnesium and potassium in Chia seeds are 832, 994, 428 and 795 (mg/100g) respectively. The higher potassium content (795 mg/100g) of Chia seeds may act as a source of dietary potassium and hence in fortification of food stuffs. The findings of the present investigation are well in accordance with the results of Ayerza and Coates (1999) who reported that phosphorus is dominant mineral in Chia seed followed by calcium, magnesium and potassium.

Physical parameters of Chia oil

Vegetable oil colour is associated to the total pigment content. Chia oil that had been extracted was pale yellow in colour with clear appearance which is in close proximity with the findings of color measurements reported by Meléndez *et al.* (2006). The specific gravity and refractive index of Chia oil can be used to assess the purity of the substance. It was noted that the obtained Chia oil specific gravity and refractive index were 0.937g/cm^3 and 1.467$\pm$ 0.006 respectively. The specific gravity of the fat is less than 1 (about 0.86). The higher value for specific gravity of Chia oil may be attributed to unsaturated of the fatty acid chains (Jain, 2005). Chia oil induction period was discovered to ne 2.38 ± 0.1 hours.

Table 2. Mineral content of Chia seeds

Minerals	Available quantity (mg/100g)	Recommended Dietary Allowance (mg/day)**			
		Children (7-10 years)	Male	Female	Pregnant & lactating mothers
Calcium	832	800	800	800	1200
Phosphorus	994	800	800	800	1200
Iron	3.28	10	10	15	13
Potassium	795	1600	2000	2000	2000
Magnesium	428	170	350	280	355
Sodium	2.05	400	500	400	500

* Each value represents the average of three determinations
** Source: Food and Nutrition Board, Institute of Medicine. National Academy of Sciences. Dietary Reference Intake: Elements (2001). www.nap.edu (Retrieved on 11/03/2011)

Table 3. Physical parameters of Chia oil

Physical Parameters	Mean value
Colour	Pale yellow with clear appearance
Specific gravity (g/cm^3)	0.937
Refractive index	1.467±0.006
Induction time (h)	2.38± 0.1

* Each value represents the average of three determinations.

Chemical properties of Chia oil

Knowledge of chemical properties is essential in judging the suitability of oil in food preparation. The important chemical properties judging the suitability of Chia oil are determined and compared with that of flaxseed oil.

Free fatty acid content of Chia oil was observed to be 0.663 per cent whereas the acid value of was 0.36 mg KOH/g. The iodine value for Chia oil was observed to be 113.65 g/100 kg which indicates the presence of unsaturated fatty acids. Higher iodine value indicates lower degree of saturation and vice versa (Jain, 2005). The peroxide value of oil represents the degree of oxidative rancidity which is found to be lower than that of flaxseed oil. This property of Chia oil may be attributed to presence of various minor bioactive components preventing oxidative rancidity (Castro *et al.*, 1986; Taga *et al*., 1984). Saponification number gives an indication of nature of fatty acids in the fat, longer the carbon chains the less acid is liberated per gram of fat hydrolysed. The saponification number of Chia oil was observed to be 171, which is lower than that of flaxseed oil. Unsaponifiable matters were found to be 1.85 per cent. All these parameters signify better quality characteristics of Chia oil over flaxseed oil (Ayerza, 2002).

Table 4. Comparison between chemical properties of Chia oil and flaxseed oil

Chemical Parameters	Chia oil	Flaxseed oil**
Free fatty acid (%)	0.663	0.550
Peroxide value (meq/kg)	5.83	6.04
Saponification number	171	188 – 196
Acid value (mg KOH/g)	0.36	0.32
Iodine value (g/100kg)	113.65	170 – 203
TBA (mg/kg of oil)	0.070	0.056
Unsaponifiable material (%)	1.85	1.5

* Each value represents the average of three determinations

Fatty acid profile of Chia oil

It is revealed from the Table 5 that Chia oil is composed predominantly of unsaturated fatty acids of which α-linolenic was the major component and accounts for about 60% of the total amount of fatty acids present in the oil. The rest is composed of linoleic, oleic, palmitic, stearic, and eicosanoid acids in decreasing order *viz.* 19.8, 8.20, 6.20, 3.00 and 1.00 per cent respectively. On account of polyunsaturated fatty acids content, Chia seed oil can prevent cardiovascular disorders (Bushway *et al*., 1981; Taga *et al.*, 1984; Ayerza, 1999). Similar results are

Table 5. Fatty acid profile of Chia oil

Sr. No.	Fatty acid	Mean value (% of total fatty acid)
1	Palmitic C16:0	6.20
2	Stearic C18:0	3.00
3	Oleic C18:1	8.20
4	Linoleic C18:2	19.8
5	Linolenic C18:3	63.4
6	Eicosanoic C20:0	1.00

reported for fatty acid composition of Chia by Ayerza (1999) with slight differences which are possibly due to different strains of Chia (Bushway *et al.*, 1981).

Functional components of Chia seed oil

The information shown in Table 6 showed that total tocopherol content of Chia oil was 338.68 mg/kg, while b-carotenoid content was observed to be 89.78 mg/kg. The outcomes are equivalent. With the findings of Meléndez-Martínez *et al.,* (2006). Based on the data, it can be said that a higher amount of total tocopherol and b-carotene, which are natural antioxidants may be responsible for imparting functional properties to Chia oil. Ayerza and Coates (2001) reported that tocopherol content together with myricetin and quercetin is principally responsible for enhancing the shelf life of Chia oil. New research has found that a combination of antioxidant vitamins such as vitamin E and β-carotene, blunt the rise in high density lipoprotein (HDL) cholesterol levels.

Table 6. Functional components of Chiaoil

Sr. No.	Functional components	Mean value
1	Total Tocopherol (mg/kg oil)	338.68
2	b-Carotene (mg/kg oil)	0.561±0.06
3	Chlorophylls	ND

* Each value represents the average of three determinations
ND: Not Detected

CONCLUSION

It is revealed that Chia seeds are a rich source of potassium, calcium, phosphorus and magnesium along with trace amounts of sodium and iron. Low sodium content of Chia is advantageous, in view of its use as a component with beneficial properties in food for hypertension subjects. Chia oil is composed predominantly of unsaturated fatty acids of which α-linolenic is the major component and accounts for about 60 per cent of the total amount of fatty acids present in the oil. The Chia oil has a number of useful ingredients *viz.* Total tocopherol, carotenoids, unsaturated fatty acids and thymoquinone. On the basis of observation it could be concluded that chia oil contain higher amount of total tocopherol and b-carotene which are high-quality antioxidants in nature could be the source of the functional qualities.

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Conflict of interest

The authors declare that there is no conflict of interests regarding the publication of this article.

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