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Studies on development and quality evaluation of cupcake fortified with flaxseed and chia seed flour

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Abstract

The present investigation was aimed to development of cupcake with incorporation of different proportion of flaxseed and chia seed flour, was assessed on the nutritional and sensory quality of cupcake. The flaxseed and chia seed as functional ingredient, roasted flaxseed and chia seed flour was incorporated by substituting refined wheat flour at 5%, 10% and 15% in cupcake formulations. 10% of these flour incorporated cupcake were found to be more acceptable than other by sensory evaluation. A novel fortified Cupcake was successfully produced and it was observed as the concentration of flaxseed and chia seed increased the moisture, fat, ash, protein and dietary fiber increased whereas carbohydrate content was decreased. Prepared cupcake then evaluated for organoleptic properties with respects to colour and appearance, flavour, texture, taste and overall acceptability using 9 point hedonic scale. The results revealed that cupcake prepared with supplementation of 10% Flaxseed and chia seed flour (C₂) secured highest score (i.e. 8.5) was superior as compared to rest of samples.

Keywords: Flaxseed, Chia seed, roasting, composite flour, nutritional composition, cupcakes

Introduction

The bakery products, cupcakes are most significant. These are an important food product used as snacks by children and adults in India. However these are most commonly relished by school going children, who need more protein per unit body weight than adults. These are popular among all age groups especially in children. Commercially available cookies are prepared from white flour that is nutritionally inferior to whole wheat flour.

Flax (*Linum usitatissimum*) belonging to family Lineaceae, is a blue flowering annual herb that produces small flat seeds varying from golden yellow to reddish brown color. Flaxseed possesses crispy texture and nutty taste (Morris 2007; Rubilar *et al.* 2010) ^[13, 16]. Flaxseed is also known as linseed and these terms are used interchangeably. Flaxseed is often used to describe flax when consumed by humans while linseed denotes when it is used specifically for industrial applications (Morris 2007) ^[13].

Name “chia” is derived from Aztec word “chian” meaning oily. The word “chia” creates a part of name of present Mexican state Chiapas, where the chia is produced in the highest volume. Chia (*Salvia hispanica* L.) is an annual herbaceous plant that belongs to the *Lamiaceae* family. Chia (*Salvia hispanica* L.) is a desert plant that was cultivated for centuries by the Aztecs of ancient Mexico. Chia seeds were a very important crop of the Aztec people, along with corn, as they incorporated these seeds into their daily diet (Ayerza and Coates, 2011) ^[3].

Chia seeds were eaten in Aztec epoch alone or blended with cereals, in whole or milled into flour. It is now widely cultivated and commercialized for its (omega) ω-3 alpha-linolenic acid (ALA) content and antioxidant properties (Jamboonsri *et al.*, 2012) ^[10]. Furthermore, chia is a good source of omega-3 for commercial food applications because it can be added straight to products without flavour alterations, commonly required in products containing added fish oil. Other oil seeds such as flax, with high concentrations of ALA, contain anti-nutritional and vitamin antagonistic factors. Chia seeds are not reported to have these anti-nutritional factors (Ayerza and Coates, 2005) ^[4].

Chia seed is a good source of dietary fibers containing about 5 percent soluble fiber which appears as clear mucilage when it is placed in water. These remain tightly bound to the seed and have a very large molecular weight, averaging 1.5 x 10⁶ Dalton (Lin *et al.*, 1994) ^[11]. The seeds are ground into meal and then processed into bread, biscuits, muffins, and cakes. The roasted seeds have a pleasantly nut-like flavor and used to improve the flavor of a large quantity of wheat by adding only a small amount of chia during milling (Bickford and Rich, 1984) ^[5]. Wheat based baked products are considered suitable vehicles for incorporation of

functional ingredients that can easily be accessible to masses especially in countries like India where wheat is staple diet (Jacob and Leelavathi, 2007) [9].

Flaxseed has been used traditionally in breakfast cereals. Nutritional research on flaxseed has increased its potential to be explored as a new ingredient for breads, buns, muffins and other bakery products. The cholesterol-lowering effects of flaxseed may be due to the activity of single or multiple components, including α -linolenic or linoleic acids, total and soluble fiber and nonprotein constituents present in these seeds. As one of the richest source of plant protein, having protein content in the range of 20–25%, it is ideal for vegetarians (Escott-Stump and Mahan 2000) [7]. Flaxseed lignin content was unaffected by baking temperature and storage temperature at -25 °C when tested after incorporating flaxseed into rye breads, graham buns and muffins (Hyvarinen *et al.*, 2006) [8]. Flaxseed has been found to be stable under normal processing and storage conditions, and it is found that the linolenic acid remained stable during processing and cooking of spaghetti fortified with ground flaxseed (Manthey *et al.*, 2002) [12].

Adding Chia to bread and other bakery products could provide consumers with an easily obtainable, low cost food that would significantly increase their ω -3 intake without having to change their normal diet, or be faced with an allergic reaction which can occur when eating fish. As Chia becomes more of a mainstream source of ω -3 fatty acids its price will decrease, and if added to bakery products, it would provide a large percentage of the world's population with a low cost source of ω -3 fatty acids (Ayerza and Coates, 2008) [2].

The objective of this study was to develop Cupcakes with different level Flaxseed and chia flour to substitute wheat flour, and to evaluate the impact of this flour on the nutritional and sensory properties of prepared product.

Materials and Methods

The present investigation was carried out in Department of Food Chemistry and Nutrition in College of Food Technology, VNMKV, Parbhani during year 2019-2020.

Materials

The raw material used during this study such as refined wheat flour, Sugar, edible oil, Milk, Fresh whole egg, baking powder, Flaxseed and Chia seed were procured from Parbhani local market.

Chemicals and glass wares

The chemicals of analytical grade and glass wares used during this investigation were available in the Department of Food Chemistry and Nutrition, College of Food Technology, VNMKV, Parbhani.

Equipments and machinery

Equipments such as analytical weighing balance, hot air oven, grinder, muffle furnace, soxhlet apparatus and Microkjeldhal digestion and distillation unit were available in the Department of Food Chemistry and Nutrition, College of Food Technology, VNMKV, Parbhani.

Physicochemical composition of cupcake

Proximate composition of cupcake prepared with different incorporation levels of chia seed gel was examined according

to Official Methods of Analysis of A.A.C.C. (2000) [1].

Cake Preparation

Formulation used for cupcakes preparation are reported in table-1. Refined wheat flour were substituted with Flaxseed and chia seed flour at levels of 5%, 10%, 15% and 20%. All the other ingredients were weighed separately. A single bowl mixing procedure was used. All weighed ingredients were pooled and mixed for 10 minutes by manually up to incorporate maximum air in cake batter. After mixing cake batter transferred in cupcake moulders which are having butter paper then baking for 25 min at 180° C temperature and Cool it.

Table 1: Formulation for the preparation of cupcake incorporated with different levels of chia seed and Flaxseed Flour

Ingredient	C	C ₁	C ₂	C ₃
	(Control)	(5%)	(10%)	(15%)
Refined wheat flour(g)	27.5	26.11	24.75	23.48
Flaxseed + Chia Flour (g)	0	1.37	2.75	4.12
Sugar(g)	22	22	22	22
Oil(ml)	16.5	16.5	16.5	16.5
Baking Powder(g)	0.8	0.8	0.8	0.8
Egg(g)	13.8	13.8	13.8	13.8
Milk (ml)	16.5	16.5	16.5	16.5
Coca powder (g)	2	2	2	2

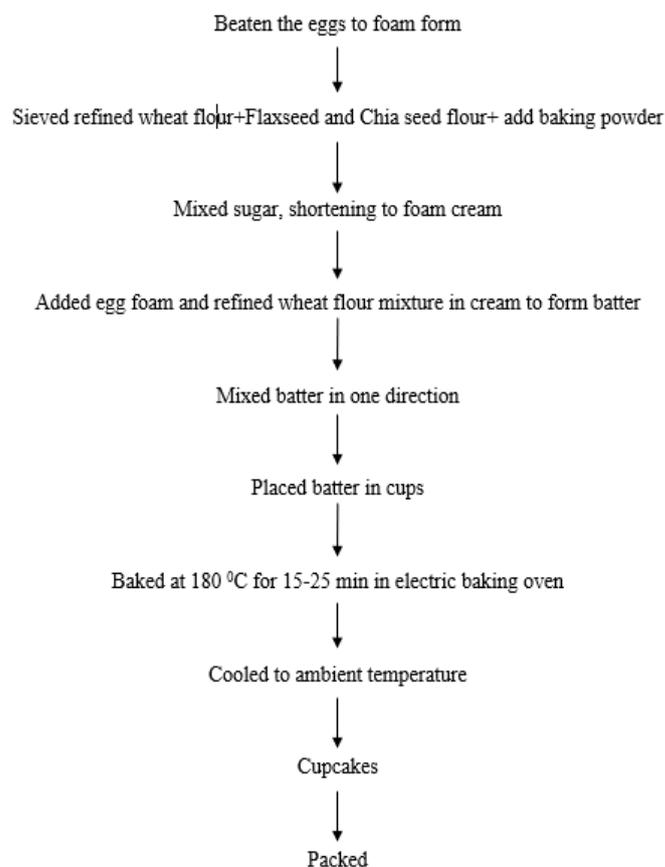


Fig 1: Flow sheet for preparation of cupcake

Results and Discussion

Chemical composition of Cupcake

The data pertaining to various chemical properties such as moisture, fat, carbohydrate, protein, ash and crude fiber of selected product were determined and results obtained and illustrated are Table.2 respectively.

Table 2: Chemical Composition of Cupcake

Sample (%)	Moisture (%)	Fat (%)	Protein (%)	Carbohydrate (%)	Ash (%)	Crude fibre (%)
Control	15.04±0.2	19.18±0.01	9.16±0.01	54.21±0.03	0.96±0.05	0.44±0.01
C1	16.13±0.21	20.13±0.02	10.20±0.04	53.34±0.01	1.12±0.07	1.23±0.05
C2	17.11±0.01	20.48±0.02	10.33±0.03	53.08±0.03	2.65±0.02	2.95±0.02
C3	18.21±0.3	21.23±0.21	11.74±0.02	52.12±0.2	2.85±0.04	2.58±0.01

*Each value is average of three determinations

The present investigation was carried out to study the suitability of flaxseed and chia seed flour incorporation on quality characteristics of cupcakes. Cupcakes were subjected to proximate analysis and the data pertaining to proximate composition of cupcakes are summarized in Table-2.

Data presented in Table 2 revealed that moisture content of cupcakes was increased significantly with increasing incorporation levels of flaxseed and chia seed flour. Moisture content was increased from 15.04 to 18.21 upon incorporation. Increase in moisture content might be due to the crude fibre present in flaxseed and chia seed which has strong affinity for water. Fat content of cupcakes was significantly increased with increasing levels of flour this may be due to both flaxseed and chia seed are oilseed and rich source of omega 3 fatty acid. Highest fat content was observed in treatment C3 (21.23%) and lowest fat content was observed in control sample (19.18%).

The protein content of cupcakes significantly increased with increasing levels of flaxseed and chia seed flour. Highest score was recorded for treatment C3 (11.74%) whereas lowest score was recorded for treatment control (9.16%). Increase in protein content might be due to the higher protein content in flaxseed and chia seed. Carbohydrate content of cupcake

significantly decreased with increasing in level of flaxseed and chia seed flour. The highest value was recorded for control sample (54.21%) followed by C1(53.34%) and C2 (53.08%). whereas lowest value were observed for C3 (52.12%).

Ash content of cupcakes was significantly increased with increasing levels of flaxseed and chia seed flour. Highest value of ash content was observed for treatment C3 (2.85%) whereas lowest value was recorded for control (0.96%). The increased amount of ash shows a higher mineral content of cupcakes which could be due to chia seed, since chia seed has higher mineral content. It could be observed from Table 2 that crude fibre was significantly increased with increasing levels of flaxseed and chia seed flour. Highest value of crude fibre was recorded for C2 (2.95%) whereas lowest value was recorded for control (0.44%). The results obtained were in close agreement with the findings of Nilesh *et al.*, (2018) ^[13].

Physical properties of cupcakes incorporated with flaxseed and chia seed flour

The data regarding weight, volume, bulk density, specific volume and height of cupcakes prepared with different levels of flaxseed and chia seed flour are presented in Table-3

Table 3: Physical properties of cupcake

Sample code	Weight (g)	Volume (cm ³)	Bulk density (g/cm ³)	Specific volume (cm ³ /g)	Height (cm)
Control	25.65	41.26	0.6414	1.578	3.8
C ₁	25.78	41.22	0.6409	1.588	3.4
C ₂	25.96	41.19	0.6345	1.594	3.5
C ₃	26.15	41.21	0.6315	1.598	3.1

*Each value is average of three determinations

Data presented in Table 3 revealed that there was gradual increase in weight with increasing incorporation levels of flaxseed and chia seed flour which was statistically non significant.

Highest value of weight was recorded for treatment C3 (26.15) and lowest value for Control sample (25.65). Increase in weight might be due to the increase in moisture content of cupcakes upon incorporation of flaxseed chia seed flour. There was non-significantly decrease in volume with increasing level of flaxseed chia seed flour. Highest volume was recorded in Control sample (41.26) whereas lowest volume was observed in sample C3 (41.21). Bulk density of cupcakes decreased significantly with increasing levels of flaxseed chia seed flour. Highest value was recorded for Control sample (0.6414) whereas lowest bulk density was recorded for sample C3 (0.6315). As bulk density is directly proportional to volume and as volume was decreased, the bulk density was also decreased with incorporation of flaxseed and chia seed flour. Data revealed that specific volume of cupcakes were increased significantly with increasing levels of flaxseed and chia seed flour. Highest value was recorded

for sample C3 (1.598) and lowest value was recorded for control sample (1.578).

Height of cupcakes was decreased significantly with increasing levels of flaxseed and chia seed flour. Highest score of height was recorded for control sample (3.8) whereas lowest score was recorded for sample C3 (3.1). There was no significant difference in height up to 10% incorporation. These results are corresponds with the results report by Rafael *et al.*, (2010) ^[14].

Organoleptic evaluation of cupcake

The four treatments (T1, T2 and T3) and control were made differently with equal proportion of flaxseed and chia seed flour to achieve a highly acceptable product. The organoleptic evaluation of cupcake carried out by a 10 semi trained panel member based on 9 point hedonic scale and the score were given by evaluating the sensory attributes for cupcake such as color, appearance, texture, taste and overall acceptability which was compared with control sample and expressed table 4.

Table 4: Sensory evaluation of cupcake

Sample Code	Sensory Characteristics				
	Color and Appearance	Texture	Taste	Flavour	Overall acceptability
Control	8.0	8.5	8.1	8.1	8.1
C ₁	7.5	7.2	7.6	7.0	7.0
C ₂	7.9	7.9	7.7	7.5	8.0
C ₃	6.5	6.1	6.0	6.7	6.5

*Each value is average of three determinations.

The three treatment control C₁, C₂, and C₃ were made. Sensory analysis was carried out using 9 point hedonic scale. The data presented in table 3 revealed that there was significant decrease in color and appearance of cupcake. The highest score was recorded for control sample (8.0) followed by C₂ (7.9) whereas lowest score was recorded for C₃ (6.5). Texture of cupcake slightly decreases with the increase in level of flaxseed and chia seed flour. The highest value was recorded for control sample (8.5) followed by C₂ (7.9) whereas lowest value recorded for C₃ (6.1). It could be observed that taste of cupcake decreased with an increasing level composite flour. Highest score was recorded for control sample (8.1) whereas lowest score was recorded for C₃ (6.0). Flavor of cupcakes significantly decreased with increasing level of flaxseed and chia seed flour. It could be observed that the overall acceptability scores for cupcakes significantly decreased with increasing levels of these flours. Highest score was recorded for control sample (8.1) whereas lowest score was recorded for treatment C₃ (6.1). The sensory evaluation also revealed that cupcakes with flaxseed and chia seed flour incorporation up to 10% (treatment C₂) were overall acceptable. Results of sensory evaluation are in close agreement with the results reported by Chellamboli *et al.*, (2019) [6].

Conclusion

It could be concluded from the results that cupcake prepared with (90:10) proportions of flaxseed and chia seed flour was found highly acceptable and recorded maximum score in case of all sensory attributes. It can be concluding that good quality cupcake can be prepared by using flaxseed and chia seed as they are rich source of omega 3 fatty acid and contain high quality protein and fiber has beneficial effect on human health. Addition of chia and flaxseed flour in bakery products is a useful strategy to increase the consumption of fibre and omega-3 fatty acid in human diet. New formulation could be therefore tasted aiming at the development of foods fortified with higher amount of functional and nutritional ingredients.

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