



## Development of functional cookies using flax seed flour

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### Abstract

A study was carried out to develop omega-3 fatty acid enriched functional cookies. The omega 3 fatty acid ( $\alpha$ -linolenic acid (ALA) is supplemented using flaxseed to cookies. Apart from omega 3 fatty acids, flaxseed is a good source of protein (20.74g/100g) and total fibre (18.07g/100g). The flaxseed flour is incorporated at various levels and along with different ratio of wheat flour. The control and omega 3 enriched cookies were prepared using various percentage of substitution level of flaxseed 10%, 12% and 15%. The proximate analysis of flaxseed cookies and control samples were analyzed. Among two variants, 10% flaxseed was highly accepted by the sensory panelist. Among the different functional cookies 10% flaxseed substituted cookies were found to be satisfactory

**Keywords:** Flax seed, omega 3 fatty acid, shelf life

### Introduction

Baking industry is one of the largest organized processed food industries in our country. The main advantage of bakery products is fortification with cereals, millets or other functional ingredients. Bakery products such as biscuit have high consumer acceptance and are important for delivering bioactive compounds into the human diet (Alpaslan and Hayta, 2006) [13]. Flax seed has a pleasant nutty flavor with few or no significant side effects. Ground or whole flaxseed can be added to almost any baked product to add a nutty flavour to bread, waffles pancakes and other products. US Institute of Medicine's Food and Nutrition Board recommends ALA intakes of 1.1 g/day and 1.6 g/day for women and men. Flax protein helps in the prevention and treatment of heart disease and in supporting the immune system. The use of flaxseed in food can increase the content of  $\alpha$ -linolenic acid and long chain  $\omega$ -3 fatty acids in both blood plasma and erythroplastid fat, and reduce the content of cholesterol. Daleprane *et al.* (2010) [6]. Flaxseed contains approximately 28 percent fiber, of which one third is soluble and has proved to reduce cholesterol. The remaining two thirds of insoluble dietary fiber can increase fecal mass, reducing transit time in the lumen, preventing constipation (Aguir et. al. 2010) [1].

Hence, the study was carried out with the aim of using flaxseed as a functional ingredient in cookies, its effect on physico chemical characteristics, fatty acid profile and sensory attributes of cookies.

### Materials and methods

The study was carried out in the College of Food and Dairy Technology, Tamil Nadu Veterinary and Animal Sciences University, Koduvelli, Alamathi, Chennai – 600052.

#### 1. Preparation of cookies

The refined wheat flour and baking powder were mixed well in a dough mixer. Powdered sugar and vanilla essence were

creamed together for 5 minutes to get bright and fluffy mass. Vegetable oil was added in to the mass and mixed well for 5 min. The cookie dough was sheeted to 8 mm thickness and cut into circular shape using 42 mm diameter cutter. The cookies were then baked at 150°C for 15 min. The cookies were cooled for 10 minutes, then wrapped in aluminium foil and packed in polyethylene bag. The functional cookies were prepared by substituting 10, 12, 15 per cent of refined roasted flaxseed flour by replacing wheat flour. The ratio of the ingredients is presented in table 1.

#### 2. Evaluation of sensory properties

The cookies packed in LDPE stand up pouches and then the materials stored at ambient temperature. The sensory panellists (20 semi trained) were academic staff and students of college of food and dairy Technology, Koduvelli. The panellist were instructed to assess the quality of cookies on the basis of sensory attributes such as appearance, flavour, texture and overall acceptability using 9-point hedonic scale where 9 = like extremely, 8 = like very much, 7 = like moderately, 6=like slightly, 5= nither like or dislike, 4 = dislike slightly, 3 = dislike moderately, 2 = dislike very much and 1 = dislike extremely The analysis of two different treatments in six replications were done, and the results were reported as average.

#### 3. Evaluation of Proximate composition

##### 3.1 Physico chemical characteristics of Cookies

Diameter (D), thickness (T) and Spread Ratio were analyzed as physical characteristics for control and cookies with flax seed added cookies. For the measurement of diameter (D), six cookies were placed edge to edge. The total diameter of the six randomly selected cookies were measured in mm by using a ruler. The cookies were rotated at an angle of 90° for duplicate readings. The average diameter was reported in mm. To determine the thickness (T), six cookies were

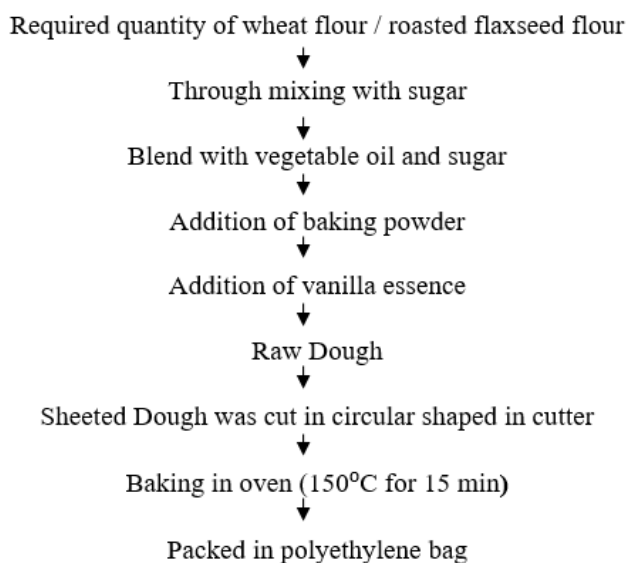
placed on top of another. The total height was measured in mm with the help of ruler. This was repeated thrice to get an average value and results are reported in mm. Spread ratio was determined with the help of standard formula.

$$\text{Spread Ratio} = \frac{\text{Average diameter (mm)}}{\text{Average thickness (mm)}} \times 10$$

The moisture content was determined using a Hot Air Oven

**Table 1:** Formulation of Control cookies and Flax seed Cookies (FC)

S. No	Ingredient	Control	FC <sub>1</sub>	FC <sub>2</sub>	FC <sub>3</sub>
1	Refined wheat flour (%)	100	90	88	85
2	Refined roasted flaxseed flour (%)	-	10	12	15
3	Sugar (%)	50	50	50	50
4	Vegetable oil (%)	6	6	6	6
5	Vanilla essence (%)	3	3	3	3
6	Baking powder (%)	0.5	0.5	0.5	0.5



**Fig 1:** Flowchart of the Preparation of Cookies

**Results and discussion**

**1. Assessment of physical characteristics of control and flax seed powder incorporated cookies**

**Table 1:** Physical characteristics of control and flax seed powder incorporated cookies

Treatment	Thickness (mm)	Diameter (mm)	Spread ratio
Control	50.33	286.75	5.70
FC <sub>1</sub>	51.33	288.5	5.62
FC <sub>2</sub>	54.33	290.25	5.34
FC <sub>3</sub>	55.23	295.75	5.35

FC<sub>1</sub> - Flax seed cookies incorporated with 10 % flax seed powder  
 FC<sub>2</sub> - Flax seed cookies incorporated with 12 % flax seed powder  
 FC<sub>3</sub> - Flax seed cookies incorporated with 15 % flax seed powder

The observations with regard to thickness, diameter and spread ratio of control and flax seed cookies are given in Table No.1. The thickness, diameter and spread ratio of control sample were 50.33, 286.75 and 5.70 respectively. The values of thickness, diameter and spread ratio of flax seed cookies incorporated with 10 % level of flax seed powder (FC<sub>1</sub>) were 51.33, 288.5 and 5.62 respectively. The values of thickness, diameter and spread ratio of flax seed cookies incorporated with 12 % level of flax seed powder

by measuring the mass of the food sample before and after moisture removal through evaporation. The ash content was analyzed using a Muffle Furnace, where the organic matter was incinerated, leaving behind the mineral residue. The protein content was assessed using the Kjeldahl Apparatus, which quantifies nitrogen content to estimate protein levels. The fiber content was measured using a Fiber Analyzer, while the fat content and fatty acid profile of cookies were determined.

(FC<sub>2</sub>) were 54.33, 290.25 and 5.34 respectively. The values of thickness, diameter and spread ratio of flax seed cookies incorporated with 15 % level of flax seed powder (FC<sub>3</sub>) were 55.23, 295.75 and 5.35 respectively.

The results of these studies indicated that there was a gradual increase in thickness and diameter of cookies in flax seed powder added samples than control. Protein influences the dough viscosity i.e the expansion of protein gluten in the making of cookies. The findings of present study are in accordance with (Miller and Hosoney, 1997) [13].

The spread ratio for different treated cookies gradually decreased as the flax seed flour level has increased. The reduction in spread ratio might be due to higher protein and dietary fiber contents of flax seed flour in cookies. The more water is available for sugar to dissolve and more the viscosity. The protein and fibre content of flax seed flour bind to water make it least available for the interaction with sugar. When more water is present in the dough, more sugar is dissolved during mixing. This lowers the initial dough viscosity and the cookie is able to spread at a faster rate during heating. The flour components that absorb large quantities of water reduce the amount of water that is available to dissolve the sugar in the formula. Thus, initial viscosity is higher and the cookies spread less during baking (Fustier *et al.* 2009) [7].

**2. Proximate analysis of control and flax seed powder incorporated cookies**

**Table 2:** Proximate composition of control cookies and flax seed cookies

S. No	Parameters	Control	FC <sub>1</sub>	FC <sub>2</sub>	FC <sub>3</sub>
1	Moisture (%)	4.85	5.92	5.66	6.53
2	Crude protein (%)	4.79	7.05	7.87	8.73
3	Crude fibre (%)	0.5	1.25	1.43	1.52
4	Ether extract (%)	11.11	12.55	13.86	15.32
5	Total ash (%)	0.39	0.60	0.69	0.78

FC<sub>1</sub> - Flax seed cookies incorporated with 10 % flax seed powder  
 FC<sub>2</sub> - Flax seed cookies incorporated with 12 % flax seed powder  
 FC<sub>3</sub> - Flax seed cookies incorporated with 15 % flax seed powder

The observations with regard to proximate analysis of control and flax seed cookies are given in Table No. 2. The values of proximate analysis (%) of Control sample for moisture, crude protein, crude fibre, ether extract and total

ash were 4.85, 4.79, 0.5, 11.11 and 0.39 respectively. The values of proximate analysis (%) of flax seed cookies added at level of 10 per cent (FC<sub>1</sub>) for moisture, crude protein, crude fibre, ether extract and total ash were 5.92, 7.05, 1.25, 12.55 and 0.60 respectively. The values of proximate analysis (%) of flax seed cookies added at level of 12 per cent (FC<sub>2</sub>) for moisture, crude protein, crude fibre, ether extract and total ash were 5.66, 7.87, 1.43, 13.86 and 0.69 respectively. The values of proximate analysis (%) of flax seed cookies added at level of 15 per cent (FC<sub>3</sub>) for moisture, crude protein, crude fibre, ether extract and total ash were 6.53, 8.73, 1.52, 15.32 and 0.78 respectively.

The effects of flaxseed flour on the proximate composition of cookies were presented in Table. revealed that all the parameters of proximate analysis were increased when compared to control with increase in flax seed flour levels of 10, 12 and 15 per cent. The findings of present study are in accordance with Jacob and Leelavathi, (2007) [11] and reported that the biscuits fortified with brown flaxseed bran had higher protein, mineral residue and moisture content, compared with biscuits made with wheat flour. Several other researchers reported similar results Rajiv *et al.*, (2012) [14]; (Masoodi *et al.*, 2012) [12]. According to Ganorkar and Jain (2014) [8] the refined wheat flour had 9.32% moisture, 0.48% ash 8.1% dry gluten and 8.7% protein and the roasted flaxseed flour had the chemical composition as 3.6% moisture content, ash 4.1%, protein 21.1%, fat 44.3% and crude fiber 12.3%. The increment in proximate composition might be due to the inherent nutritive components of flax seed flour.

### 3. Fatty acid profile of Control cookies and Flax seed cookies

**Table 3:** Fatty acid profile of control cookies and flax seed cookies

S. No	Parameters	Control	FC <sub>1</sub>	FC <sub>2</sub>
1	Myristic acid (S)	0.65	0.20	0.17
2	Palmitic acid (S)	15.46	11.50	10.83
3	Stearic acid (MUFA)	3.68	6.37	9.06
4	Oleic acid (MUFA)	33.26	38.22	41.19
5	Linoleic acid ( $\omega$ -6 PUFA)	2.38	3.08	3.56
6	Linolenic acid ( $\omega$ -3 PUFA)	Not detected	6.67	7.36

FC<sub>1</sub> - Flax seed cookies incorporated with 10 % flax seed powder  
FC<sub>2</sub> - Flax seed cookies incorporated with 12 % flax seed powder

The observations with regard to fatty acid profile of control and flax seed cookies are given in Table No.3. The values of fatty acids (%) of control sample for Myristic acid, Palmitic acid, Stearic acid, Oleic acid, Linoleic acid and Linolenic acid were 0.65, 15.46, 3.68, 33.26, 2.38 and not detected respectively. The values of fatty acids (%) of flax seed cookies added at level of 10 per cent (FC<sub>1</sub>) for Myristic acid, Palmitic acid, Stearic acid, Oleic acid, Linoleic acid and Linolenic acid were 0.20, 11.50, 6.37, 38.22, 3.08 and 6.67 respectively. The values of fatty acids (%) of flax seed cookies added at level of 12 per cent (FC<sub>2</sub>) for Myristic acid, Palmitic acid, Stearic acid, Oleic acid, Linoleic acid and Linolenic acid were 0.17, 10.83, 9.06, 41.19, 3.56 and 7.36 respectively.

Fatty acid profile of control cookies and 10 % and 12 % flax seed flour incorporated cookies are depicted in Table No.3. Comparison of fatty acid profile revealed that the saturated fatty acids decreased from control to flax seed incorporated cookies. While total polyunsaturated fatty acid content

(PUFA) increased. As a baking ingredient, ground flaxseed does not lose significant amounts of ALA during baking. Chen *et al.* (1994) [4] also reported that flaxseed lipid was stable during baking of flaxseed muffins. Bilek and Turhan (2009) [3] also reported that flaxseed flour can be used as functional ingredient in beef patties as ALA content of raw and cooked beef patties increased with the increase in flaxseed flour addition.

### 4. Sensory evaluation

**Table 4:** Sensory attributes of control and flax seed powder incorporated cookies

Sensory attributes	Control	FC <sub>1</sub>	FC <sub>2</sub>	FC <sub>3</sub>
Appearance	7.33	8.16	7.66	6.66
Flavor	7.50	8.00	7.83	6.83
Texture	7.16	8.33	7.33	6.33
Overall acceptability	7.33	8.22	7.66	6.50

FC<sub>1</sub> - Flax seed cookies incorporated with 10 % flax seed powder  
FC<sub>2</sub> - Flax seed cookies incorporated with 12 % flax seed powder  
FC<sub>3</sub> - Flax seed cookies incorporated with 15 % flax seed powder

The observations with regard to sensory evaluation of control and flax seed cookies are given in Table. No.4. The appearance, flavour, texture and overall acceptability of control sample were 7.33, 7.50, 7.16 and 7.33 respectively. The values of appearance, flavour, texture and overall acceptability of flax seed cookies incorporated with 10 % level of flax seed powder (FC<sub>1</sub>) were 8.16, 8.00, 8.33 and 8.22 respectively. The values of appearance, flavour, texture and overall acceptability of flax seed cookies incorporated with 12 % level of flax seed powder (FC<sub>2</sub>) were 7.66, 7.83, 7.33 and 7.66 respectively. The values of appearance, flavour, texture and overall acceptability of flax seed cookies incorporated with 15 % level of flax seed powder (FC<sub>3</sub>) were 6.66, 6.83, 6.33 and 6.50 respectively.

Among the three fortified samples, the second sample (10%) had highest overall acceptability compared to the control, 12 and 15 per cent flax seed incorporated cookies. it was observed that sensory attributes decreased at 12 % and 15 % incorporation level for each cookie. At these levels of incorporation, the colour was also affected i.e. the cookies developed dark colour as incorporation level increased and in flaxseed cookies bitterness was also found in at 15 % level by panel members. The findings of present study are in accordance with Chetana *et al.*, (2010) [5]. Similar findings were also reported by Hussain *et al.* (2008) [10] who stated that incorporation of flaxseed flour at 40% incorporation level was unacceptable in biscuit and decreased the sensory attributes of biscuits in terms of colour and flavor whereas 30% incorporation produced good results.

### Conclusion

The incorporation of flax seed flour in functional cookies resulted in increased thickness and diameter where as the spread ratio was decreased. The nutritional qualities has been improved in terms of proximate composition in cookies due to flax seed fortification. With regarding fatty acid profile, the amounts of omega 3- fatty acids were increased and saturated fatty acids such as myristic acid was decreased. The incorporation of 12% and 15% of flax seed flour affected the quality adversely, showed more browning and exhibited bitter taste. The functional cookies made by incorporating 10% level scored better in terms of all sensory attributes and proved to be best among all treatments.

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