

FLAXSEED POWDER AND ITS POTENTIAL UTILIZATION IN THE FORMULATION OF VEGAN CHOCOLATE

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ABSTRACT

Flaxseed is rich source of omega-3 fatty acid, alpha-linolenic acid, dietary fiber and it also possess heart-healthy effects. During past two decades consumer demand for vegan food products has increased considerably leading to new innovative and natural vegan products. Therefore, Flaxseed powder can be used as potential ingredient and an alternative option for milk powder to formulate vegan chocolate. The present study aims to investigate the formulation and quality evaluation of vegan chocolate formulated with Flax seed powder. The Flaxseed vegan chocolate samples were formulated with differing Flaxseed ratios (0-30%) with varying levels of cocoa powder (15, 20, and 25%) and standard quantity of coconut oil and Palm sugar. The formulated chocolates were evaluated for nutritional quality, sensory attributes, and total microbial load. The average calories derived from chocolate increased exponentially as the Flaxseed content increased. The maximum (452.6 Kcal) was found in vegan chocolates formulated with 30% Flaxseed and 25% cocoa powder. Furthermore, the Flaxseed chocolate also possessed the maximum protein (6.49g), dietary fiber (5.31g) and ash (1.66%) content. With respect to sensory attributes, the mean sensory score of variation formulated with 30% Flaxseed and 25% cocoa powder scored maximum overall acceptability and tasted very similar to control sample formulated with cow's milk powder. Therefore, it can be concluded that vegan chocolate formulated with 30% Flax seed and 25% cocoa powder alongside other ingredients can be considered for the manufacturing of good quality Flaxseed vegan chocolate at a commercial scale.

KEYWORDS: Flax seed, Cocoa powder, Vegan chocolate, Brown sugar, Lactose Intolerance.

INTRODUCTION

Non-dairy products are important globally due to the growing trend of the vegan lifestyle and the high incidence of lactose intolerance and cow's milk protein allergy among individuals all over the world (Suri *et al.*, 2019). The other disadvantages of consuming dairy products include their cholesterol content and adulteration which leads to emergence of newer section of non-dairy and plant based products (Pontonio & Rizzello, 2021). In recent years, plant-based and non-dairy foods are gaining popularity as functional foods and nutraceuticals due to their enormous nutritional and environmental benefits (Vahini & Many, 2021).

Chocolate is a confection made out of milk powder cocoa butter, cocoa mass, and sugar (Tiplea *et al.*, 2019). Throughout the world, chocolate is a popular food item consumed by individuals of all social classes and all ages. Due to its potential for evoking sensory pleasure and a positive emotional response, the food product has gained popularity over time (El-kalyoubi, Khallaf, Abdelrashid, & Mostafa, 2011).

Flaxseed (*Linum usitatissimum*), commonly known as linseed, is a plant in the Linaceae family that belongs to the genus *Linum*. Flaxseed is an ancient agronomic crop with over 300 kinds that have been farmed for food and fiber since ancient times (Kaur *et al.*, 2018). Flaxseed is grown in many regions of the world for fiber, oil, medical reasons, and as a nutritious product (Kajla, Sharma, & Sood, 2015). In recent years, consumer knowledge regarding the link between nutrition and health has raised a demand for the consumption of Flaxseed. Functional food items have gained popularity in the market, with a large variety of food products being produced and evaluated daily. Flaxseed is regarded as a possible functional food component since it delivers several health advantages in addition to nutritional value (Eyres, 2015). However, it is an underutilized crop that has gained prominence in recent decades because of its unusual nutritional profile, including omega-3 fatty acids, lignans, and fiber (Ganorkar & Jain 2013).

A rise in cow's milk protein allergies and lactose intolerance among consumers has led to an increased demand for dairy-free chocolate. Nuts and oil seeds powder can be considered and utilized as a potential raw ingredient for development of vegan Chocolate Henceforth, the present study focused on incorporating Flaxseed in vegan chocolate.

OBJECTIVES

1. To select and procure the raw ingredient needed for the development of Flaxseed vegan chocolate.
2. To formulate the Flaxseed vegan chocolate with Flaxseed powder, cocoa powder, brown sugar, coconut oil & vanilla essence in three variations.

3. To study the acceptability of the vegan chocolate incorporated with Flaxseed powder using nine-point hedonic scale.
4. To analyze the physical properties of the Flaxseed vegan chocolate.
5. To estimate the proximate principles and microbial content in the Flaxseed vegan chocolate.

MATERIALS AND METHODS

It was an experimental research study. The Flaxseed incorporated vegan chocolate was prepared according to the method suggested by (TIPLEA *et al.*, 2019) with slight modifications. The materials, procedures, experiments, and techniques that were used in the current study are described below.

Procurement of raw ingredients

Flaxseed powder, cocoa powder, brown sugar, coconut oil, and vanilla essence form the core ingredients in Flaxseed incorporated vegan chocolate. These ingredients are procured from local market in Chennai city.

Processing of Flaxseed

Primary Treatment of Raw Flaxseed

The procured Flaxseed was cleaned and stored properly at room temperature (28° to 35°C) in an airtight steel container before its use in an actual experiment (Patel, 2009).

Roasting of Flaxseed

The Flaxseeds are roasted under controlled conditions of heating. The chemical, minerals, and nutritional properties of the flax seed are generally influenced by the roasting process. Many research works has showed significant reduction in cyanogenic glycosides due to various preprocessing such as roasting, soaking and germination. The roasted Flaxseeds were ground in a domestic mixer for three minutes followed by preparation followed by the method suggested by Richa&Pratima, 2015. Flaxseeds were roasted under controlled conditions of heating. The chemical, minerals, and nutritional properties were significantly influenced by the roasting process. On the other hand, roasting can improve nutritional value and reduce anti-nutritional factors (Emet *et al.*, 2019). The cleaned Flaxseeds were ground in a domestic mixer for 3 minutes followed by roasting. The ground powder of Flaxseed was stored in clean air tight container and further for experimental work.

Formulation and Standardization of Flaxseed Vegan Chocolate

The flax seed powder is added with Melted coconut oil, brown sugar, cocoa powder, and vanilla essence in double boiler and whisked together until smooth and then, the chocolate mixture is transferred into a silicone mold and placed in the freezer for about an hour, after which it is removed and served.

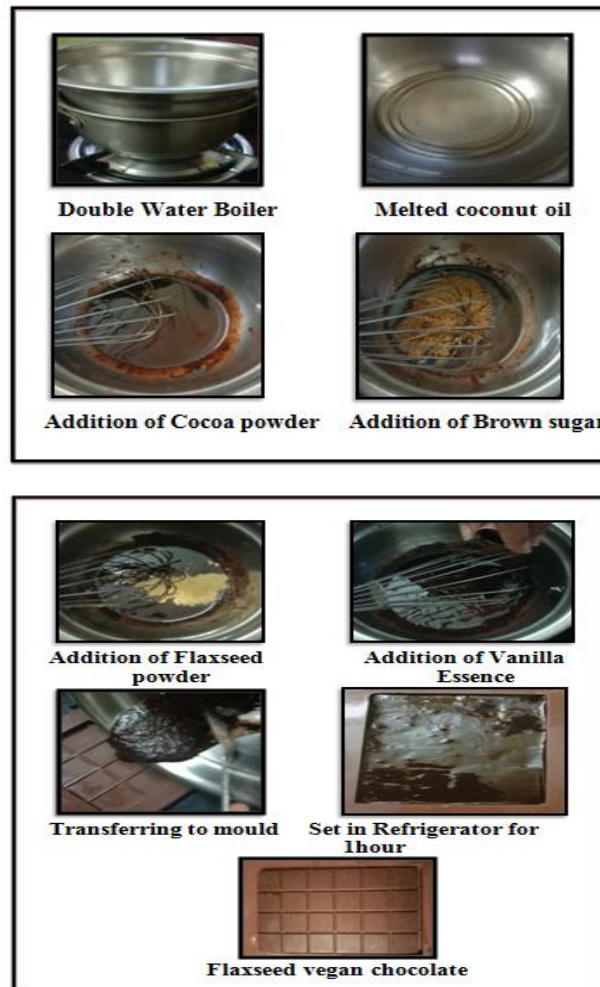


FIGURE 1 FORMULATION OF FLAXSEED VEGAN CHOCOLATE

Variations

The ingredients and its proportions utilized in the formulation of Control chocolate and as well as three different treatments (T₁, T₂, T₃) of the Flaxseed vegan chocolate is exhibited in Table 1.

Table 1-Proportions of Different Treatments of Flaxseed Chocolate

S.No	Ingredients	Control	T1 (%)	T2 (%)	T3 (%)
1	Flaxseed powder	-	20	25	30
2	Milk powder	20	-	-	-

3	Cocoa powder	20	25	20	15
4	Brown sugar	30	20	20	20
5	Butter	25	-	-	-
6	Coconut oil	-	30	30	30
7	Vanilla essence	5	5	5	5

The Flaxseed vegan chocolate was prepared with ingredients including Flaxseed powder, cocoa powder, brown sugar, coconut oil, and vanilla essence. The vegan chocolate was prepared in three varying ratios and coded as T₁, T₂ and T₃ with difference in flax seed composition. To each variation, 20 g of brown sugar, 30 ml of coconut oil, and 5 ml of vanilla essence were added.

Preparation of Control Sample

The control chocolate was formulated as by the method suggested by Joel et al., 2013 with slight modifications. The control sample was formulated with 20 grams of milk powder, 20 grams of cocoa powder, 30 grams of brown sugar, 25 grams of butter, and 5 ml of vanilla essence.

Quality Evaluation

The formulated vegan chocolate was subjected to organoleptic evaluation using nine-point hedonic scale. The mean scores of variations and control sample were calculated for appearance, color, taste, texture, mouthfeel, and overall acceptability. The shortlisted one variation of vegan chocolate will be further subjected to other quality evaluation such as nutrient analysis, microbial and cost evaluation and compared with the control sample formulated with dairy based chocolate. Since the study involved human subjects, The Ethical clearance was obtained from the Institutional Human Ethics Committee of Shrimathi Devkunvar Nanalal Bhatt Vaishnav College for Women (SDNBVC/HSC/IHEC/2020/09) as per the guidelines for biomedical research on human subjects. The pH and the viscosity of the product was measured using Digital pH meter and Brookfield Viscometer. The nutrient composition of the formulated Flax seed vegan chocolate was analyzed employing standard AOAC methods, (2012). The total Bacterial Count & Yeast and Mold Counts of were analyzed as per the standard procedure mentioned by Kolapo&Oladimeji, (2008). The results obtained were statistically analyzed using mean and standard deviation in SPSS software.

RESULTS AND DISCUSSION

Sensory Evaluation of Flaxseed Vegan Chocolate

Sensory evaluation is one of the factors used to assess the acceptability of a food product using senses such as sight, smell, touch, taste, and hearing. The sensory evaluation for the formulated Flaxseed incorporated vegan chocolate was performed with 10 semi trained panel members (College girls) to evaluate acceptance on the criteria of appearance, taste, flavor, texture, and overall acceptability using a nine-point hedonic scale method.

Table 2 - Sensory Evaluation of the Flaxseed Vegan Chocolate

S.No	Product	Appearance	Color	Taste	Texture	Mouthfeel	Overall acceptability
1.	Control	8.45±0.60	8.55±0.51	8.65±0.48	8.3±0.47	8.55±0.51	8.5±0.22
2.	T ₁	7.05±0.51	7.1±0.71	7.05±0.60	7.7±0.65	7.2±0.69	7.87±0.62
3.	T ₂	7.25±0.63	7.15±0.67	7.8±0.69	7.9 0.64	7.9±0.78	8.0±0.59
4.	T ₃	8.65±0.58	8.35±0.67	8.0 ±0.85	8.3±0.73	8.2±0.83	8.24±0.62

All values are means of triplicate determinations ± standard deviation (S.D)

Sensory evaluation measures the reaction to stimuli resulting from the consumption of a food or food product (Mihafu, Issa, & Kamiyango,2020). Table 2 displays the results of the sensory evaluation of the three formulated variants. A detailed analysis of the table revealed that Flaxseed vegan chocolate treatment T₃ had greater organoleptic scores in terms of all sensory aspects such as appearance, color, taste, texture, mouthfeel, and overall acceptability than the control sample and other treatments (T₁, T₂, T₃). The results concluded that the variation T₃ with 30 percent of flax seed powder scored high score and therefore the variation T₃ will be further subjected to other quality evaluation.

Evaluation of the Physical Properties of the Flaxseed Vegan Chocolate

The physical properties of Flaxseed vegan chocolate have been evaluated and exhibited in Table 3, the results of which were also compared to the control sample.

Table 3 - Evaluation of Physical Properties of Flaxseed Vegan Chocolate

S.NO	Analysis	Control	Flaxseed vegan chocolate
1.	Viscosity (cp)	363±1.69	344±2.94
2.	PH	4.14±0.03	4.53±0.02

Each value is mean observation in triplicate ± Standard Deviation.

The pH of the selected Flaxseed vegan chocolate and control sample were found to be 4.53±0.02 and 4.14±0.03 respectively. Both control and sample exhibited a similar pH value. The pH of the selected Flaxseed vegan chocolate was lower than the value 6.62±0.016 obtained for pH in the previous study by Erukainureet *al.*, (2010) in dates chocolate. The viscosity of the formulated Flaxseed vegan chocolate and control sample were found to be 344±2.94 and 363±1.69 cP respectively. Almost similar viscosity value was observed in control and vegan chocolate. The viscosity of the chocolate directly depends on the sugar and fat content of the chocolate. In particular, Sugar and fat contribute to the mouthfeel when consuming the product.

Evaluation of Proximate Composition of Flaxseed Vegan Chocolate

The results of proximate composition of the formulated flax seed vegan chocolate and control sample is presented in Table 3.

Table 4 - Proximate Composition of Control and Flaxseed Vegan Chocolate

S.NO	Nutrients	Control	Flaxseed vegan chocolate
1.	Ash (% w/w)	1.15±0.04	1.66±0.04
2.	Moisture (% w/w)	3.14±0.03	4.56±0.02
3.	Energy (Kcals)	500.8±0.04	452.6±0.02
4.	Carbohydrates (g)	67.4±0.20	70.04±0.36
5.	Protein (g)	6.42±0.06	6.49±0.03
6.	Fat (g)	32.40±0.02	16.28±0.19
7.	Dietary fibre (g)	0.50±0.04	5.31±0.05

All values are means of triplicate determinations ± standard deviation (S.D)

The ash content of Flaxseed vegan chocolate (1.66 ± 0.04) was found to be a little higher when compared to the control group (1.15 ± 0.04). The ash content of the Flaxseed vegan chocolate (1.66 ± 0.04 %) shows the higher amount of mineral content present in the formulated vegan chocolate. The ash content of Flaxseed vegan chocolate was found to be high when compared with the ash content in the study (Joel *et al.*, 2013) in dairy based chocolate. The result reflected that the abundant nature of minerals (Ash) present in the Flaxseed such as phosphorus, magnesium and calcium (Kajla *et al.*, 2015).

The moisture content of the control sample and Flaxseed vegan Chocolate was found to be 3.14 ± 0.03 % and 4.56 ± 0.02 % respectively. The moisture content of the Flax seed vegan chocolate was also found to be higher when compared to the control sample. The study conducted by Hargreaves & Zandonadi, (2018) on Flaxseed and chia seed gel on characteristics of gluten-free cake, showed an increase in moisture content as well and Fernandes & Salas-Mellado (2017) stated that flax seed has higher water absorption capacity which might lead to higher moisture content in flax seed incorporated products.

The energy content of newly formulated Flaxseed vegan chocolate was 495.8 ± 0.04 kcal. Whereas, the energy value of the standard chocolate (control) was found to be 500 ± 0.02 Kcal per 100 grams. There is a decrease in energy content of the flax seed vegan chocolate when compared with a control group and this could be attributed to the replacement of milk powder and butter with Flaxseed powder and coconut oil. The energy content of chocolate obtained in this current study was less from the values reported by Ekantariet *et al.*, (2019).

Flax seed protein's amino acid pattern is comparable to that of soybean protein, which is regarded as one of the most nutritious plant proteins (Rabetafika, Van Remoortel, Danthine, Paquot & Blecker, 2011). The protein content of the Flaxseed vegan chocolate was found to be 6.49 ± 0.03 g whereas, the protein value of the control was found to be 6.42 ± 0.06 g per 100 grams. The Flaxseed vegan chocolate was found to possess a similar protein value to that of control chocolate formulated with cow's milk powder. A similar value of protein content was also reported by Erukainure, Egagah, Bolaji & Ajiboye (2010) in formulation of dates powder incorporated chocolate. The carbohydrate content of the formulated Flaxseed vegan chocolate was 70.04 ± 0.36 g whereas, the carbohydrate content of control chocolate was found to be 82.4 ± 0.20 g per 100 grams. As Flaxseed generally possess very low level of carbohydrates (1 g/100 g) as it is rich in protein and fat and thus contributing to less amount of carbohydrates composition in the formulated vegan chocolate.

The fat content of the control chocolate was found to be double fold higher 32.21 ± 0.02 g than that of Flaxseed chocolate 16.28 ± 0.19 g. concerning the fat composition of the Flaxseed vegan chocolate, the results are in line with the fat composition observed in the study (Ergönül *et al.*, 2010). Flaxseed possess approximately 30 % of fat in which 53 % are alpha linolenic acid (ALA), 17 %

linoleic acid, 19% oleic acid, 3% stearic acid and 5% palmitic acid, which provides an excellent n-6:n-3 fatty acid ratio of approximately 0.3:1 (Simopoulos, 2002). Flaxseed also contains appreciable quantities of water-soluble and fat-soluble vitamins (Kajla, Sharma and Sood, 2015).

The dietary fiber of Flax seed vegan chocolate and control chocolate was observed to be 0.50 ± 0.04 g and 5.31 ± 0.05 g respectively. The high dietary fiber content of the formulated chocolate can be considered as added advantage of consuming vegan chocolate over traditional dairy chocolate. In general, Flaxseeds are an excellent source of soluble fiber (Kajla, Sharma and Sood, 2015). The dietary fiber content of the Flaxseed vegan chocolate is high when compared with the dietary fiber content observed in the study by Joel *et al.*, (2013).

Microbial Analysis of Flaxseed Vegan Chocolate

The total bacterial count of flax seed vegan chocolate is exhibited in the Table 5.

Table: 5- Total bacterial count of Flaxseed vegan chocolate

S.No	Products	log colony-forming unit/ gram-1		
		0 th day	3 rd day	5 th day
1.	Control	Nil	1.9×10^1	2.0×10^1
2.	Flaxseed vegan chocolate	Nil	1.2×10^1	1.4×10^1

The total bacterial count of the Flaxseed vegan chocolate was represented in the Table 5. The microbial analysis showed that there was nil bacterial count was observed in both control and Flaxseed chocolate on the 0th day. During storage, slight increase in total bacterial count was noticed among both control and vegan chocolate on 3rd and 5th day. Nevertheless, the bacterial count was within the limit, this could be attributed to good hygienic conditions practiced during preparation by the researcher. Therefore, the results concluded that the Flaxseed vegan chocolate was found to be microbiologically safe for consumption.

Yeast and Mold Count of Flaxseed Vegan Chocolate

The total yeast and mold growth of the flaxseed vegan chocolate is exhibited in table 6.

Table: 6- Yeast and mold growth of flaxseed vegan chocolate

S.No	Products	log colony-forming unit/ gram-1		
		0 th day	3 rd day	5 th day
1.	Control	Nil	1.2×10 ¹	2.3×10 ¹
2.	Flaxseed vegan chocolate	Nil	1.0×10 ¹	1.9×10 ¹

The total yeast and mold count of the flaxseed vegan chocolate was represented in the table 6. The control and flaxseed vegan chocolate were analyzed for microbial growth for total bacterial count and yeast and mold count for 0th, 3rd, and 5th day. The microbial analysis showed that there was nil yeast and mold count was observed in both control and Flaxseed chocolate on the 0th day. During storage, slight increase in yeast and mold count was noticed among both control and vegan chocolate on 3rd and 5th day. The bacteria grew that was gram-positive bacteria (*Bacillus subtilis*) and the reason for bacterial growth was not mishandling or improper packaging, the bacteria were grown because these confectionary having high sugar content (Soni & Jatav, n.d, 2013).

CONCLUSION

The current study concludes that the formulation of vegan Flaxseed incorporated chocolate was successful and can be considered as effective alternative to dairy based chocolate. The formulated chocolates were found to have higher nutritional value in terms of protein and dietary fiber and also exhibit appreciable sensory scores. The formulated dairy free Flaxseeds chocolates are rich in heart healthy fats and low in carbohydrate and can be considered as healthy option for population suffering from lactose intolerance and cow's milk protein allergy. Furthermore, Flaxseed-based value-added products can be marketed in the future for the benefit of the community.

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