Original Research Article

Development and evaluation of flaxseed butter

ABSTRACT

Aims: To investigate the proximates of developed flaxseed butter.
Place and Duration of Study: Department of Food and Nutrition,College of Community Science, Professor Jayashankar Telangana Agricultural University and Department of Biochemistry, Indian Institute of Oilseeds Research, Hyderabad, Telangana, Indiabetween January 2024 and August 2024.
Methodology: Three developed flaxseed butter with varying proportion of groundnut (75g to 60g) incorporated with groundnut oil and palm oil (1-3ml) was compared with control peanut butter to establish the nutritional profile as well as flaxseed butter made of 100% flaxseed was also compared to establish a baseline of its nutritional profile.
Results: The study have shown that there was a significant (P < 0.05) difference on the fat and protein content of the flaxseed butter as compared to control peanut butter whereas no significant difference was observed on the moisture and ash content.
Conclusion: The results of the current study indicate that the developed flaxseed butter improved the nutritional content.

Keywords: Flaxseeds butter; nut butter; seeds butter; proximates; peanut butter.

1. INTRODUCTION

Plant-based butter is typically made from a blend of vegetable oils like coconut, avocado, and/or olive oil. In comparison to conventional dairy butter, plant-based butter is free of cholesterol and has a lower content of saturated fats, thus rendering it a more heart-healthy alternative. Nut and seed butters are typically made by roasting, grinding, and refrigerating the ingredients to be consumed while still retaining their freshness (Gorrepati *et al.*, 2014). Certain types of plant-based butter also contain substances such as flaxseed oil or almond butter, thereby improving their nutritional composition by adding extra omega-3 fatty acids and essential nutrients. Although plant-based butter may possess a distinct flavor and consistency as compared to dairy butter, it presents a multifaceted alternative for culinary applications such as cooking, baking, and spreading on bread or crackers. Butter is a dairy product made up of fats, protein components of milk. Butter is most commonly used in form of spread on preferable breads (Joshi and Bisht, 2020).

Ground flax can be preserved from becoming rancid by refrigeration and storing it in sealed containers extended duration (Malcolmson *et al.,* 2000). Flaxseed, a plant-based ingredient produced from the flax plant (*Linum usitatissimum),* has gained popularity due to its high nutritional profile. It is rich in omega-3 fatty acids, dietary fibre, lignans, vitamins and minerals. The flaxseed is flat and oval with pointy extremities, ranges in colour from black to yellow and measures 2.5 x 5.0 x 1.5 mm (Freeman, 1995). Flaxseed has been recognized as a functional food because of its bioactive properties, and deoiled flaxseed protein hydrolysates have demonstrated promise as natural preservatives in food items (Ghosal *et al.,* 2022).Flaxseeds contain 53% α-linolenic acid (ALA), 17% linoleic acid (LA), 19% oleic acid, 3% stearic acid and 5% palmitic acid, providing a favourable n-6: n-3 fatty acid ratio of around 0.3:1 (Simopoulos, 2002). The nutritional composition of flaxseed consists 20.3% protein, 37.1% fat, 37.1% minerals, 4.8% crude fibre, 24.5% total dietary fibre and 28.9% carbohydrates (Morris, 2007; Gopalan *et al*., 2021; Payne, 2000). Flaxseed is the richest source of plant lignans (Thompson *et al*., 1996). Flaxseed contains about 75- 800 times more lignans than cereal grains, legumes, fruits and vegetables (Mazur *et al*. 2000; Meagher and Beecher, 2000; Murphy and Hendrich, 2002; Hosseinian, 2009). Flaxseed oil exhibits resistance to oxidation, suggesting its potential as a beneficial dietary and functional component (Ishag *et al.,* 2020).Thedevelopment of a flaxseed butter-based functional food product is gaining momentum at global level in supporting healthier dietary choices, as well as the growing demand for unique functional food options. Despite growing awareness of flaxseed's potential advantages, intake remains low when compared to other dietary sources. To overcome this gap and maximize flaxseed utilization, preparing a flaxseed butter-based functional food product is a novel and practical approach.

2. MATERIAL AND METHODS

Groundnut and flaxseed were roasted at 165°C for 45 minutes and 180°C for 8 minutes to develop the flaxseed butter. Flaxseed butters were prepared as given in the table1 by the given method for preparation of nut butter production (Shakerardekani *et al*., 2023).The six samples namely, G165 (Groundnut roasted), F180 (Flaxseed roasted), F0OO (Control peanut butter), F1GO (Flaxseed butter- 25:75 flaxseed: groundnut with groundnut oil), F1PO (Flaxseed butter- 25:75 flaxseed: groundnut with palm oil), F2GO (Flaxseed butter- 40:60 flaxseed: groundnut with groundnut oil), F6GO (Flaxseed butter- 100:0 flaxseed: groundnut with groundnut oil), F6PO (Flaxseed butter- 100:0 flaxseed: groundnut with palm oil) were analyzed for moisture, ash, protein and fat content.

Table 1.Ingredient proportion of flaxseed butter

Sl. No.	**Product ID**	**Groundnuts (g)**	**Flaxseeds (g)**	**Palm oil (ml)**	**Groundnut oil (ml)**	**Sugar (g)**	**Salt (g)**
1	F0OO	100	-	-	-	25	1.5
2	F1GO	75	25	1	-	25	1.5
3	F1PO	75	25	-	1	25	1.5
4	F2PO	60	40	3	-	25	1.5
5	F6GO	-	100	-	20	25	1.5
6	F6PO	-	100	20	-	25	1.5

2.1 Analytical

2.1.1 Moisture content

The moisture content of the samples was calculated as per AOAC, 2005. Butter sample (5.0 g) was weighed into a petri dish and was distributed uniformly for drying at 105°C in a hot air oven for two hours with the lid open in triplicates. After that, a desiccator was used to cool the petri dish. Then the weight of the petri dish with sample was noted. This was repeated for all the samples till constant weight was achieved.

$$\text{Moisture (\%)} = \frac{(W_2-W_1) - (W_3-W_1) \times 100}{(W_2-W_1)}$$

Where, W_1 = Initial weight of petri dish (g), W_2 = Weight of the petri dish with sample before drying and W_3 = Weight of the petri dish with sample after drying.

2.1.2Ash content

The 2.0 g of fat-free, moisture-free sample was weighed into the pre-weighted crucible. The sample was kept on flame for charring to remove the organic matter and then incinerated at 600°C for 3 hrs in muffle furnace (Make: KEMI Muffle furnace, Kadavil Electro Mechanical Industries, Kerala). After complete ashing of the sample, crucible was transferred into the desiccator, cooled and weighed (AOAC, 2005).

$$\text{Ash (\%)} = \frac{\text{Weight of the ash } (W_3\text{-}W_1)}{\text{Weight of the sample taken } (W_2\text{-}W_1)}$$

Where, W_3-W_1= Weight of the ash and W_2-W_1 = Weight of the sample taken.

2.1.3Fat content

Fat was estimated as crude ether extract of the dry material using automatic Soxtherm (Make: Soxtherm, C. Gerhardt GmbH & Co. KG, Germany) extraction unit (AOAC, 2003.06). 5.0 g of butter samples were weighed into thimbles, covered with fat-free cotton. Around 150.0 ml of hexane solvent was added. After the hexane was evaporated. The flasks were then dried, cooled and weighed.

$$\text{Fat content (\%)} = \frac{W_2 - W_1 \text{ X } 100}{\text{Sample weight (g)}}$$

Where, W_1= Weight of beakers and W_2= final weight of fat residue and beaker

2.1.4 Protein content

The protein content of the butter samples was assessed according to the Kjeldahl (Make: KelPLus, Kes 6L, Pelican Equipments, Tamil Nadu, India) method (Zhang *et al*., 1993).

$$\text{Protein (\%)} = \frac{\text{(Sample TV – blank TV) x 0.014 x 0.1N of HCL x 6.25 X 100}}{\text{Weight of the sample (g)}}$$

T.V =Titre value

N = Normality

2.1.5 Statistical analysis

All data were expressed as the mean and standard deviation (SD) and were subjected to one was analysis of variance (ANOVA). Mean values were compared at $p<0.05$ significance level by Tukey's HSD test using IBM SPSS 20 software package.

3. RESULTS AND DISCUSSION

In conducting the analysis along with F1GO, F1PO, and F2GO, the roasted seeds G165 and F180 and flaxseed butter made with 100% flaxseed were also analyzed to establish a baseline for the nutritional profile of pure flaxseed butter without incorporation of groundnuts.

Table 2.Proximate values of roasted seeds, control and flaxseed butters

Proximates	Moisture (%)	Ash (%)	Fat (%)	Protein (%)
F0OO	0.21^{b}±0.03	4.55^{a}±0.32	54.58^{b}±0.12	27.11^{a}±0.62
F1GO	0.27^{b}±0.03	4.60^{a}±0.14	51.59^{c}±0.73	24.03^{b}±0.94
F1PO	0.28^{b}±0.01	4.57^{a}±0.07	52.18^{bc}±1.46	24.16^{b}±0.60
F2GO	0.29^{b}±0.05	4.18^{ab}±0.12	52.04^{bc}±1.40	23.25^{b}±1.55
F6GO	0.60^{a}±0.08	3.63^{b}±0.13	61.81^{a}±1.46	18.28^{c}±0.72

F6PO	$0.60^{a}\pm0.02$	$3.74^{b}\pm0.50$	$62.26^{a}\pm1.05$	$18.03^{c}\pm0.55$
G165	$0.09^{c}\pm0.01$	$4.49^{a}\pm0.17$	$54.74^{b}\pm0.25$	$27.47^{a}\pm0.48$
F180	$0.09^{c}\pm0.01$	$3.76^{b}\pm0.25$	$42.28^{d}\pm0.84$	$18.64^{c}\pm1.25$
Mean	0.30	4.19	53.94	22.62
SE	0.04	0.09	1.25	0.77
CD	0.07	0.43	22.27	67.82
CV%	12.61	5.96	71.93	9.00

**Ondry weight basis*
*** Each value in the table represents the mean of three replicates±SD. Mean values followed by the same letter within each row are not significantly different at P<0.05.*

3.1 Moisture Content

The analyzed samples were found to have varying moisture content, with F2GO (0.29%) demonstrating the highest level among the selected samples (Table 2) when compared to control F0OO (0.21%) followed by F1PO (0.28%) and F1GO (0.27%). The 100% flaxseed butter F6PO and F6GO had similar moisture level of 0.60% which was higher than control F0OO and roasted groundnuts G165 and roasted flaxseeds F180 also had similar moisture content of 0.08% but found to be lower than the moisture content of control F0OO. The results have shown that there was no significant ($p<0.05$) difference on moisture content on the flaxseed butters as compared to control but the likely cause of the rise in moisture levels with the decreasing proportion of groundnut substitution could be attributed to the elevated fiber content resulting from the addition of flaxseeds (Shoukat Bashir *et al*., 2006). The dietary fiber content of flaxseed hull is divided roughly equally between an insoluble fiber component and a highly soluble, intermittent mucilaginous fiber component. This composition contributes to the flaxseed hull's ability to effectively absorb water, bind moisture, and provide lubrication (Daniel, 2004). In contrast, Man *et al*. (2021) noted that the inclusion of roasted flaxseed flour as a partial replacement for wheat flour at levels of 10%, 25%, and 40% resulted in a notable decrease in the moisture content of biscuits. Similar contradictory results were demonstrated in studies conducted by Khouryieh and Aramouni (2012), Solanki *et al*. (2023), and Kaur *et al*. (2017).

3.2Ash Content

The samples F1GO and F1PO exhibited the highest ash content at 4.60% and 4.57% respectively, when compared to control F0OO (4.55%), on the other hand, F2GO had a lower ash content of 4.18% as compared to control F0OO (Table 2), the slight variation in the ash content of F1GO and F1PO might be due to the variation of flaxseed and groundnut variety in the mixture. F6GO (3.63%), F6PO (3.73%) and F180 (3.76%) had lower ash content than control F0OO (Table 3). The results have shown that there was no significant influence ($p<0.05$) on the ash content of the developed flaxseed butters as compared to control peanut butter. The slight decrease in ash content observed in flaxseed butter can be attributed to the incorporation of lesser proportion of groundnuts which has slightly higher amount of ash content than flaxseed. These results are consistent with the findings of a study by Belete and Bayissa (2020), which reported an ash content of 4.41 to 4.80% for groundnuts which is higher than the ash content of flaxseeds 2.41% as reported by Mancharka *et al*. (2020). Masoodi *et al*. (2012) found that the incorporation of flaxseed powder (ranging from 11% to 43%) in biscuits resulted in an increase in ash content (from 1.84% to 2.64%) as compared to control biscuits made of wheat flour which had an ash content of 0.83%.

3.3Fat Content

The fat content of the flaxseed butters F1GO (51.59%), F1PO (52.18%) and F2GO (52.04%) were measured to be lower than the control F0OO (54.58%) but F6PO and F6GO had higher fat content of 61.81% and 62.26%, respectively. The fat content of roasted seeds G165 and F180 was measured to be 54.74% and 42.28%, respectively (Table 2). The results have shown that there was a significant difference ($p<0.05$) in the fat content of flaxseed butter which may be due to the decreasing proportion of groundnut and incorporation of oil in different quantities. As indicated by Arya *et al*. (2016) the fat content in groundnuts is 49.24g, while the fat content in peanut butter per 100g is approximately 51.1g according to USDA (2020); comparatively, the fat content of flaxseed ranges from 37g to 45g per 100g, as noted by Kajla *et al*. (2014), which is consistent with the findings of Naik *et al*. (2020) that the fat content of whole flaxseed is 41.1g and ground flaxseeds is 40.7g. This demonstrates that the fat content of flaxseed is lower than that of groundnuts and that the difference in proportion of groundnut also influence the fat content in the samples. In contrast, Zarzycki (2020) found that the fat content in flaxseed pasta and cake varied from 0.73% to 3.08%, exceeding the fat content in control (0.5%) semolina durum pasta. Masoodi *et al*. (2012) also found that adding flaxseed powder at levels of 11% to 43% in biscuits caused an increase in fat content from 10.16% to 11.55%, compared to control biscuits made solely of wheat flour at 4.04%. Similarly, Solanki *et al*. (2023) and Siva Kumar *et al*. (2017) observed a similar increasing trend in fat content in food products incorporating flaxseed flour compared to control products made of wheat flour.

3.4Protein Content

F2GO has the lowest protein content at 23.25% followed by F1GO at 24.03% and F1PO at 24.16% when compared to control F0OO (27.11%) (Table 2). The control F0OO also had higher protein content than F180 (18.07%), F6GO (18.03%) and F6PO (18.27%). The roasted groundnut G165 (27.47%) had higher protein content than roasted flaxseed F180. The results have shown that there was asignificant (p<0.05) difference on the protein content of the developed flaxseed butter as compared to control peanut butter which might be due to the varying proportion of groundnut which had higher protein content as compared to flaxseed. Salve and Arya (2018) found that the Indian peanut variety has a protein content ranging from 36.89-42.09% and Singh *et al*. (2011a) found that the protein content of roasted flaxseeds may range from 17.7% to 23.19% which indicates that flaxseeds generally contain less protein than groundnuts and can lead to conclusion that the reduction in protein content in flaxseed butter may be due to the incorporation of a lower quantity of groundnuts in the product and also may be due to the processing of the nuts. In contrast, Zarzycki (2020) found that both flaxseed cake and pasta exhibited higher protein content (ranging from 14.14% to 18.06%) in comparison to the control pasta (13.37%). Similar findings were reported by Solanki *et al*., 2023, who observed a rising trend in protein content of flaxseed flour incorporated paneer at levels of 5% to 15% in comparison to control dairy paneer. Masoodi *et al*. (2012) similarly discovered a contrasting pattern, wherein the inclusion of flaxseed powder in biscuit formulations ranging from 11% to 43% resulted in an increase in protein content from 9.09% to 10.84%, as compared to the protein content of control biscuits made solely from wheat flour, which measured at 8.74%.

4. CONCLUSION

In conclusion, it can be said that the developed flaxseed butter may be a nutrient-rich substitute for peanut butter. The flaxseed butter, which did not contain any added groundnuts had a good nutritional profile. This nutritional composition was preserved while the protein content increased in the flaxseed butter that was developed with the addition of groundnuts. The results of the current study indicate that the flaxseed butter could be a viable choice for individuals of all ages, as it can easily be incorporated into a typical dietary regimen. Additional research could concentrate on improving its formulation to its desirable sensory and textural properties.

Disclaimer (Artificial intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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