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Exploring the nutritional characterization of linseed and sesame in cereal based products

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Abstract

Flaxseed or linseed (*Linum usitatissimum* L.) comes from the flax plant, an annual herb. Sesame (*Sesamum indicumis*) belongs to family *Pedaliaceae*. Scientific evidences support consumption of flaxseed for the high content in omega-3, omega-6 rich oil, α-linolenic acid, lignans, high quality proteins and fibers, compounds which are biologically active in the prevention of some chronic diseases such as many types of cancer, diabetes, cardiovascular diseases and cerebrovascular stroke. Along with being a good source of plant protein these both have great ability to lower blood pressure. They are also a rich source of many vitamins and minerals. For the purpose cookies were prepared with different concentrations of linseed and sesame. Five treatments were made including a control group. Mineral contents and physical analysis of cookies were performed to evaluate and characterize its effect. Sensory evaluation of cookies prepared by different ratios was performed. Textural analysis and color analysis were performed to check their color changes and strength. The obtained data was statistically analyzed to check the level of significance. Results declare that in sesame seed 28.29 mg GAE/100g, 43.42 g/100g, 23.61%. Following by this suitability of these two were checked by making cookies in different ratios. From the analysis it was cleared that an increasing trend in minerals content and other nutritional profile was recorded. In term of overall acceptability T_2 (8.30 on hedonic scale) was found best.

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Introduction

Previously, flaxseed was utilized as a food source in Asia and Africa (Berglund, 2002). Now, it is being introduced in various novel products in developed countries. Since 2005, new foods and personal care products are being prepared using flaxseed or its ingredients and are introduced in the US market implying the high growth potential of flax based products in functional food industry (Riaz *et al.*, 2020; Morris, 2007).

Phytochemicals like lignans are the richest component of flaxseed. They have good effect in prevention of cancers, diabetes and cardiovascular diseases. It protects our blood, heart, joints, brain and colon. Flaxseed is also helpful in treating lung inflammation and injury. Rich nutrient profile and health promoting properties of flaxseed have made it an important ingredient to be incorporated in human diet. Usage of food as a medicine is gaining popularity among consumers due to introduction of functional foods in the market (Tufail *et al.*, 2020). Flaxseed is one of the food items that are being utilized in functional foods due to existence of potential bioactive components in it. SDG is a lignan that is major phytochemical of flaxseed and has potential benefits in disease prevention (Ogborn and Clark, 2003).

After oil extraction, the residue contains about 35-40% protein that is used as livestock feed. Flaxseed proteins contain high amounts of arginine, lysine and branch chain amino acids. The amino acid profile has drawn considerable interests in value added use of flaxseed proteins isolated from defatted flaxseed meal (Hall *et al.,* 2006). It is an important source of both soluble and insoluble fiber that is important for the efficient digestive system. Soluble fiber in flaxseed is present as mucilage that serves as an effective cholesterol lowering agent while insoluble fiber is also helpful in preventing constipation and regulating bowel movements (Jhala and Hall, 2010). The richest dietary source of lignans is flaxseed in which SDG is major lignans while traces of matairesinol, pinoresinol, lariciresinol and isolariciresinol are also present SDG has potential (Barcelo Coblijn and Murphy, 2009).

In Pakistan, the total production of *Sesamum indicum* L. is about 0.680 million per year. During the year 2006, in Sindh, Punjab, KPK, and Balochistan area under cultivation was 3.4, 7.51, 0.1, and 3.4 thousand hectares while total production was 1.4, 3.41, 0.1 and 2.0 thousand tons respectively (Saleem *et al.*, 2008). The expressed cake is the rich source of protein for human. Small quantities of the hulled seeds are used as topping for bread and confectionary items.

The flour is used for thickening of soups especially in Nigeria. The young leaves are also being used in the preparation of vegetable soups. In fabricated foods it is also used. In areas where it's eaten dehulling of its seeds is necessary because they contain oxalic acid (2-3%) which can form complexes with calcium and reduces its availability.

The hull also contains indigestible fiber, which causes problem in the digestibility of protein and darkness the color of meal. Dehulling leads to the improvement in the color, flavor characteristics, reduces fiber contents and increases protein contents (Inyang and Ekanem, 2004).

In order to get more valuable health promoting effects from its active components like dietary fiber, omega 3 fatty acids and lignans, it should be grinded before adding to food stuff. Research revealed that whole and ground sesame seeds can be substituted with wheat flour to produce muffins, breads, pancake and cookies (Manthey *et al.*, 2002). The purpose of this study was to investigate and evaluate the effect of linseed and sesame addition in cookies. And further characterization of these nutritionally enriched cookies.

Materials and methods

Product development

Cookies were developed by adapting the method No. 10-54 mentioned in AACC by using samples according

to following treatment plan.

Mineral contents

Flaxseed and sesame powdered sample was subjected to mineral estimation according to the protocol of 0.5 g sample was heat digested along with HNO_3 and perchloric acid (7:3) on hot plate until 1-2ml colorless solution remained. Digested sample was diluted up to 100 ml and subjected to mineral analysis. Sodium, potassium and calcium were estimated through Flame Photometer-410 (Sherwood Scientific Ltd., Cambridge) whereas Atomic Absorption Spectrophotometer (Varian AA 240, Australia) was used to determine copper, iron, magnesium, manganese, phosphorus and zinc content (Lara *et al*., 2012).

Cookies analysis

Color

Color of cookies was checked by using colorimeter method Rodriguez Garcia *et al.* (2012).Color meter gives *L**, *a** and *b** values where *L** tells about lightness, *a** indicates (-a) for greenness and (+a) tells us about redness, *b** indicates (-b) for blueness and (+b) for yellowness.

Texture

Texture analysis of cookies was performed by using Texture Analyzer according to method described with some modifications interfaced with computer.

Three replications of each formulation was taken and mean values were calculated.

Sensory evaluation of cookies

Sensory appraisal of cookies were carried out by following the method Ramcharitar *et al.* (2005).

Statistical analysis

The data obtained about each factor was subjected to suitable statistical approach to measure the levels of significance by using SPSS version 23. After the result was interpreted according to Duncan's multiple range test at 5% probability level (Aigster *et al*., 2011).

Results and discussion

Minerals content

Zinc

The data in the table indicates that treatment affected the zinc content highly significantly (P<0.01). The data in the Table 2 illustrates that the mean values ranged between 9.24 and 43.53 mg/100g. The lowest value was observed in T_5 (9.24 mg/100g). Highest value was observed in T_1 (43.53 mg/100g). Our results were found similar to the Pradhan *et al.* (2010).

Table 1. Treatment plan.

Treatment	Sesame seed powder (%	Flaxseed powder (%)
T_0	-	-
T_1	-	100
T_2	25	75
T_3	50	50
T_4	75	25
T_5	100	-

Sodium

The data in the table indicates that treatment affected the sodium content highly significantly (P<0.01).

The data in the Table 3 illustrates that the mean values ranged between 11.49 and 34.60 mg/100g. The lowest value was observed in T_5 (11.49 mg/100g). Highest value was observed in T_1 (34.60 mg/100g). Our results were found similar to the Pradhan *et al.* (2010).

Table 2. Means for Zinc in cookies (mg/100g).

Treatment	Mean
T_0	31.76 ± 0.36^{a}
T_1	43.53 ± 0.78^{ab}
T_2	35.20 ± 0.35^{b}
T_3	27.31 ± 0.45^{b}
T_4	17.52 ± 0.53^{ab}
T_5	9.24 ± 0.07^{a}

Difference among means shows significant effect (P<0.05). Small letters represent comparison among interaction means and overall means.

Potassium

The data in the table indicates that treatment affected the potassium content highly significantly (P<0.01).

The data in the table 4 illustrates that the mean values ranged between 403.4 and 1010.1 mg/100g. The lowest value was observed in T_0 (403.4 mg/100g). Highest value was observed in T_1 (1010.1 mg/100g). Our results were found similar to the Pradhan *et al.* (2010).

Table 3. Means for Sodium in cookies (mg/100g).

Treatment	Mean
T_0	31.98 ± 0.04^{a}
T_1	34.60 ± 0.61^{a}
T_2	28.30 ± 0.44^{b}
T_3	23.39 ± 0.52^{ab}
T_4	16.88 ± 0.21^{b}
T_5	11.49 ± 0.40^{a}

Table 4. Means for Potassium in cookies (mg/100g).

Treatment	Mean
T_0	403.4 ± 4.02^{a}
T_1	1010.1 ± 3.63^{a}
T_2	883.3 ± 8.80^{b}
T_3	602.1 ± 3.04^{b}
T_4	471.5 ± 2.45^{a}
T_5	471.5 ± 3.13^{b}

Magnesium

The data in the table indicates that treatment affected the magnesium content highly significantly ($P<0.01$) (Table 5). The data in the table illustrates that the mean values ranged between 145.31 and 352.04 mg/100g. The lowest value was observed in T_0 (145.31 mg/100g). Highest value was observed in T_5 (352.04 mg/100g). Our results were found similar to the Pradhan *et al.* (2010).

Table 5. Sample × Treatment interaction Means for Magnesium in Cookies (mg/100g).

Treatment	Mean
T_0	145.31 ± 0.89^{ab}
T_1	151.01 ± 0.80^{b}
T_2	201.69 ± 1.66^{a}
T_3	254.51 ± 3.16^{b}
T_4	305.64 ± 4.00^{a}
T_5	352.04 ± 1.18^{b}

Iron

The data in the table indicates that treatment affected the iron content highly significantly ($P<0.01$) (Table 6). The data in the table illustrates that the mean values ranged between 5.093 and 14.903 mg/100g. The lowest value was observed in T_0 (5.093 mg/100g). Highest value was observed in T_5 (14.903 mg/100g). Our results were found similar to the Pradhan *et al.* (2010).

Table 6. Means for Iron in cookies (mg/100g).

Treatment	Means
T_0	5.093 ± 0.08^{b}
T_1	6.043 ± 0.06^{ab}
T_2	8.550 ± 0.13^{b}
T_3	10.580 ± 0.36^{a}
T_4	13.163 ± 0.16^{a}
T_5	14.903 ± 0.28^{b}

Calcium

The data in the table indicates that treatment affected the calcium content highly significantly ($P<0.01$) (Table 7). The mean values for samples have been given in table 7. The data in the table illustrates that the mean values ranged between 33.4 and 1016.4 mg/100g. The lowest value was observed in T_0 (33.4 mg/100g). Highest value was observed in T_5 (1016.4 mg/100g). Our results were found similar to the Pradhan *et al.* (2010).

Table 7. Means for Calcium in Cookies (mg/100g).

Treatment	Mean
T_0	33.4 ± 0.13^{ab}
T_1	246.6 ± 2.70^{b}
T_2	437.0 ± 1.64^{b}
T_3	626.1 ± 1.95^{a}
T_4	814.5 ± 0.60^{ab}
T_5	1016.4 ± 2.32^{b}

Sensory evaluation of cookies

Taste

The data in the table indicates that treatment affected the taste content highly significantly ($P<0.01$)(Table 8) and the mean values ranged between 6.30 and

8.40. The lowest value was observed in T_5 (6.30). Highest value was observed in T_2 (8.40). Our results were found similar to the Hussain *et al.* (2008).

Table 8. Means for taste of cookies.

Treatment	Mean
T_0	8.30 ± 0.63^{a}
T_1	6.50 ± 0.52^{c}
T_2	8.40 ± 0.67^{a}
T_3	6.70 ± 0.52^{bc}
T_4	7.20 ± 0.63^{b}
T_5	6.30 ± 0.67^{c}

Overall acceptability

The data in the table indicates that treatment affected the overall acceptability content highly significantly ($P<0.01$) (Table 9). The data in the table illustrates that the mean values ranged between 6.30 and 8.30.

The lowest value was observed in T_5 (6.30). Highest value was observed in T_2 (8.30). Our results were found similar to the Hussain *et al.* (2008).

Table 9. Bran × Treatment interaction means for overall acceptability of cookies.

Treatment	Mean
T_0	8.20 ± 1.13^{a}
T_1	6.50 ± 0.96^{b}
T_2	8.30 ± 0.51^{a}
T_3	6.50 ± 1.42^{b}
T_4	6.80 ± 0.75^{b}
T_5	6.30 ± 0.36^{b}

Physical parameters of product

Color

L value*

Color analysis of cookies was performed by colorimeter. The data in the table indicates that treatment affected the *L** content non significantly ($P>0.05$) (table 10) andthe mean values ranged between 58.47 and 62.37.

The lowest value was observed in T_4 (58.47). Highest value was observed in T_0 (62.37). The results obtained by our study were slightly similar to the study conducted by Roy *et al.* (2009).

a value of cookies*

The data in the table indicates that treatment affected *a** content highly significantly ($P<0.01$) (Table 11) and the mean values ranged between -1.60 and 0.65. The lowest value was observed in T_1 (-1.60). Highest value was observed in T_2 (0.65). Our results were found similar to the Gambus *et al.* (2004).

Table 10. Bran × Treatment interaction means for *L** value of cookies (g/100g).

Treatment	Mean
T_0	62.37 ± 0.45^{a}
T_1	58.85 ± 0.36^{b}
T_2	60.52 ± 0.89^{ab}
T_3	60.72 ± 0.23^{ab}
T_4	58.47 ± 0.12^{b}
T_5	59.32 ± 0.19^{ab}

Table 11. Means for *a** value of cookies.

Treatment	Mean
T_0	-1.3167 ± 0.15^{f}
T_1	-1.60 ± 0.21^{f}
T_2	0.65 ± 0.24^{a}
T_3	0.39 ± 0.16^{b}
T_4	0.17 ± 0.19^{d}
T_5	0.31 ± 0.19^{c}

b value of cookies*

The data in the table indicates that treatment affected the *b** content highly significantly ($P<0.01$) and the mean values ranged between 25.41 and 29.65.

The lowest value was observed in T_4 (25.41). Highest value was observed in T_1 (29.65). Our results were found similar to the Gambus *et al.* (2004).

Table 12. Means for *b** value of cookies.

Treatment	Mean
T_0	27.84 ± 0.63^{bc}
T_1	29.65 ± 0.74^{a}
T_2	26.84 ± 0.12^{cd}
T_3	28.55 ± 0.17^{ab}
T_4	25.41 ± 0.19^{d}
T_5	28.12 ± 0.21^{abc}

Texture of cookies

The data in the table indicates that treatment affected the texture content highly significantly (P<0.01) (Table 13) and the mean values ranged between 17.75 and 25.15.

Table 13. Means for texture value of cookies.

Treatment	Mean
T_0	17.75 ± 0.67^{d}
T_1	22.26 ± 0.70^{b}
T_2	25.15 ± 0.69^{a}
T_3	22.37 ± 0.15^{b}
T_4	19.75 ± 0.18^{c}
T_5	17.81 ± 0.21^{d}

The lowest value was observed in T_0 (17.75). Highest value was observed in T_2 (25.15). Our results were found similar to the Gambus *et al.* (2004).

Conclusion

Cookies were analyzed for their proximate composition and moisture in the range of 6-7%, fat was determined between 28-30%, protein between 16-20%, ash between 5.5-7% and fiber up to 10%. Similarly, minerals profile of cookies was raised due to addition of sesame and flaxseed proportion which are considered as rich source of minerals including zinc, iron, calcium, magnesium etc. Sensory evaluation by panel of judges was performed and T_2 consisting of 25% sesame and 50% flaxseed powder addition was found best in term of taste and overall acceptability.

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