Nutritional Enhancement of Muffins Incorporated with Flaxseeds

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Abstract

An investigation was carried out to explore the possibilities of enhancing the nutritional value of muffins with fortification of flaxseeds and asses its effect on nutritional and sensory properties. Development of bakery products containing milled flaxseed could have potential health benefits due to its high antioxidant, lignin, omega-3 fatty acid and alpha linolenic acid content. Flaxseeds were roasted and further analyzed for its functional and nutritional profile content. The roasted flaxseed powder was further utilized in preparation of muffins at different proportions and evaluated organoleptically. The study reveals that muffins with flaxseed at 20% substitution for flour scored maximum for all the sensory quality attributes.

Keywords: Flaxseed, nutritional benefits, fortification, muffins, sensory quality etc.

I. Introduction

Flax seed (*Linum usitatissimum*) is an oilseed crop that has gained much attention since last few decades due to its unique nutrient profile particularly omega-3 fatty acid, lignans and fiber [1]. It has been important nutritive crop due to its high dietary fiber and protein content. Flaxseed has been gaining popularity as a functional food because of its high content of biologically active compounds, their health benefits and disease preventive properties. It contains approximately 21% proteins, 28% dietary fibers, 40% fat, 4% ash and 6% carbohydrates such as lignans, phenolic acids, hemicelluloses and sugars [2]. Bakery products such as cookies are used as a vehicle for incorporation of different nutritionally rich ingredients. The use of legume proteins is almost limited to the protein of soyabean seeds. Studies should now focus on a search for proteins from other sources [3].

In spite of having all the beneficial nutrients, flaxseed is not much popular as food ingredient in many parts of India. The growing consumer demand for food with nutritional and functional properties has called for research to develop new functional food products. Moreover, to enhance the utilization of flaxseeds in the daily diet of people, it is highly desirable to develop novel and value added food products from flaxseeds. The present investigation visualizes physico-chemical composition of flaxseed, effect of roasting treatment, optimization of flaxseed level incorporation in muffins and its overall consumer acceptability.

II. Materials and Methods

The required raw material i.e. Maida, Flaxseed, Margarine, Sugar, Egg, Milk powder, Baking powder, Calcium propionate, Essence were purchased from local market of Loni Kalbhor, Pune. Flaxseeds were roasted in open pan until a nutty flavour was developed. The seeds were cooled at room temperature and grinded. The flaxseed powder was packed in polyethylene bags, sealed and stored at 4^0 C until further use.

Sample Coding and preparation of muffins

Muffins were prepared from blends containing 0% (control), 10% (FM_1), 20% ($FM_{2)}$ and 30% (FM_3) of roasted flaxseed powder. Initially margarine and sugar powder were creamed using blender and egg was whipped until firm foam resulted. The egg foam was mixed with the creamed sugar and margarine. Then flour, milk powder, baking powder, calcium propionate and essence were added to the above and mixed thoroughly to attain the desired dropping consistency. Muffin batter (30g) was poured into muffins moulds (cupcakes) and baked in preheated baking oven at 145^0C for 20 minutes.

Physico-chemical and functional properties

The physical and functional properties were analyzed [4]. Raw materials (raw and roasted flaxseed powders) and products (control muffins and muffins with roasted flaxseed powders) were analyzed for their moisture, ash, protein and fat contents [5].

Sensory evaluation

The muffins were evaluated for sensory attributes by a panel of 10 semi-trained judges to determine acceptability of flaxseed enriched muffins. The sensory evaluation was carried out by using a 9 point Hedonic scale system for different parameters like color and appearance, taste, flavour, texture and overall acceptability [6].

Statistical analysis

The data obtained was analyzed statistically to determine statistical significance of treatments. Completely Randomized Design (CRD) was used to test the significance of results [7]. The experiments were conducted in triplicate and the mean values are reported.

III. Results and Discussion

Physical and functional properties of flaxseeds

Initially physical and functional properties of flaxseeds (raw and roasted) were evaluated and observations are depicted in Table 1.

Table 1 Physical and functional properties of flaxseeds

Treatments	Physical Properties				Functional Properties			
	Bulk Density (g/ml)	True Density (g/ml)	Porosity (%)	Angle of Repose (^{0})	WAC (ml/g)	OAC (ml/g)	FC (ml)	FS (ml)
Raw	0.71	1.11	36.03	22.61	4.72	0.68	2.00	1.00
Roasted	0.73	0.98	32.91	20.12	4.90	0.56	1.04	0.57
SE±	0.002	0.005	0.363	0.150	0.321	0.026	0.016	0.013
CD	0.006	0.017	1.094	0.451	0.968	0.082	0.049	0.041

* Each value represents the average of three determinations.

It is indicated from Table 1 that the bulk density was found to be 0.71 g/ml in raw flaxseed and 0.73 g/ml in roasted flaxseed. The bulk density values recorded in this work showed that it increases with roasting [8]. The raw flaxseed was observed to have comparatively higher true density as 1.11g/ml than roasted flaxseed as 0.98 g/ml. The raw flaxseed was having the porosity of 36.03% while roasted flaxseed was having about 32.91%. Angle of repose was found to be 22.61^0 and 20.12^0 in raw and roasted flaxseeds respectively. The moisture and fat content directly affects the angle of repose. Higher the moisture content, higher is the angle of repose.

In this study WAC was higher in roasted flaxseed flour (4.90 ml/g) than raw flaxseed flour (4.72 ml/g). The OAC is an important parameter in food formulations as it helps to improve flavour and increases the mouth feel of foods. OAC was 0.68 ml/g in raw flaxseed and 0.56 ml/g in roasted flaxseed. The foam capacity was found to 2.00 ml and 1.04 ml in raw and roasted flaxseed respectively. The foam stability was found to 1.00 ml in raw flaxseed and 0.57 ml in roasted flaxseed. The result showed that foam capacity and stability decreased in roasted flours as compared to non roasted flours [4].

Proximate composition of flaxseeds

Proximate composition of flaxseed was analyzed and results are presented in Table 2.

Table 2 Proximate composition of flaxseeds

Treatments	Proximate Composition (%)					Mineral Composition (mg/100g)			
	Moisture	Crude Fat	Crude Protein	Crude Fibers	Ash	Ca	P	Mg	Fe
Raw	6.80	39.80	21.25	6.20	2.55	191	520	418	4.35
Roasted	6.17	38.57	20.53	6.34	2.62	187	503	409	4.13

SE±	0.019	0.004	1.182	0.001	0.006	0.381	0.577	0.144	0.002
CD	0.058	0.013	0.549	0.004	0.019	1.149	1.738	0.434	0.008

* Each value represents the average of three determinations.

It is visualized from Table 2 that roasting pre-treatment significantly affects moisture content of flaxseed flour. The moisture content (6.80%) in raw flaxseed was decreased to (6.17%) in roasted flaxseed. The protein content of raw flaxseed was highest (21.25%) than roasted flaxseed (20.53%). The decreased protein content may be due to the fact that roasting has destroyed some of the protein content. The crude fat content was 39.80% in raw flaxseed and 38.57% in roasted flaxseed. The decreased fat content is might be due to the destruction of fat during the treatment process. The table shows that crude fiber and ash content in flaxseed flour significantly increases with the roasting treatment.

The results showed that roasting has not significantly affected the mineral contents of the flaxseed. Calcium content of raw flaxseed powder was found to be 191 mg/100gm which was reduced to 187 mg/100g after roasting. Phosphorus, magnesium and iron content of raw flaxseed powder were reduced to 503, 409 and 4.13 mg/100g due to roasting pre-treatment [8].

Based on the values showed in Table 7, it is clear that flaxseed could be important in contributing to the overall daily dietary intake of essential elements. Roasting of flaxseed helps to improve flavour, physico-chemical and functional properties of flaxseed. Thus, further roasted flaxseed powder was utilized in the preparation of muffins.

Proximate composition of flaxseed enriched muffins

Proximate composition of flaxseed enriched muffins such as moisture content, fat, protein, crude fiber, ash and carbohydrates were analyzed and results are reported in Table 3.

Table 3 Proximate composition of flaxseed enriched muffins

Treatment	**Proximate composition (%)**					
	Moisture	**Crude fat**	**Crude protein**	**Crude fiber**	**Ash**	**Carbohydrate**
Control	16.80	25.53	8.07	0.23	0.81	48.56
FM_1	17.50	27.16	9.12	1.02	1.02	44.18
FM_2	18.60	29.07	10.02	1.64	1.19	39.48
FM_3	19.80	31.00	10.90	1.89	1.37	35.04
SE ±	0.253	0.189	0.539	0.035	0.027	0.309
CD @ 5%	0.763	0.571	1.623	0.106	0.083	0.930

* Each value represents the average of three determinations.

It is revealed from above table that moisture content of control muffins was 16.80% and it gradually increases according to addition of roasted flaxseed powder. Highest moisture content of 19.80% was found in FM_3 sample as compared to others. This indicates that fibers in flaxseed help for moisture retention in

muffins. The fat content in muffins was found to increase from 25.53% to 31.00% with the increase in flaxseed powder addition. The increased fat content in muffins was due to the high fat content of flaxseed. Control sample was found to have 8.07% protein which was further increased up to 10.90 % in FM_3 sample. The crude fiber was increased from 0.81% to 1.37% due to increase in addition of flaxseed powder. The ash content in muffins ranged from 0.81 % to 1.37%. During the present work it was found that carbohydrate was decreased from 48.56% to 35.04%.

The data indicates that with the increase in addition of flaxseed powder from 10 to 30% in treatments, a progressive increase in moisture, crude fat, crude protein, crude fibers, ash and decrease in carbohydrate content of muffins was recorded [9].

Sensory evaluation of flaxseed enriched muffins

The effects of incorporation of roasted flaxseed flour at different levels on the sensory parameters of muffins were analyzed and the results are presented in Table 4.

Table 4 Sensory evaluation of flaxseed enriched muffins

Treatments	Sensory attributes				
	Colour & Appearance	Taste	Flavour	Texture	Overall acceptability
Control	7.7	7.8	7.6	7.8	7.7
FM_1	7.6	7.9	7.8	7.7	7.8
FM_2	7.5	8.1	8.0	7.6	7.9
FM_3	7.3	7.6	7.4	7.5	7.4
SE ±	0.056	0.028	0.031	0.028	0.052
CD @ 5%	0.168	0.084	0.095	0.084	0.156

* Each value represents the average of three determinations.

Colour and Appearance

The average quality score of colour for different muffins treatment is shown in Table 8, according to which the score decreased significantly with increasing percentage of flaxseed addition. The highest score was obtained by control sample (7.7) while significantly lowest by FM_3 (7.3). The probable reason for these results could be the brownish colour of flaxseed. Dark colour increased in direct relation to the amount of flaxseed added in muffins.

Taste

Taste score for muffins was significantly influenced due to flaxseed addition. The treatment FM_2 has got maximum rating (8.1) for taste. It might be due to fact that only wheat flour has quite familiar and unique light taste as compared to flaxseed which upon addition in muffins gives different taste. The

minimum taste score obtained by FM_3 (7.6) due to comparatively more percentage of flaxseed addition in muffins.

Flavour

At moderate level of flaxseed addition in muffins was found to be appreciable and treatment FM_2 received highest score (8.0), even more than control. Although flaxseed has a unique flavour profile, its acceptability is influenced by individual preferences [10].

Texture

Texture score values also showed significant variation across the treatments as the level of flaxseed flour was increased in muffins. This might be due to specific textural properties at specific ratios of flaxseed and wheat flour. Control muffins got significantly highest score (7.8) while lowest score was obtained in the FM_3 muffins (7.5). With respect to the texture, judges accepted muffins prepared from all the treatments of the flour containing flaxseed flour. Flaxseed considerably influences the volume and texture of breads, muffins, cookies and other baked goods [11].

Overall Acceptability

The overall acceptability of different treatments of muffins revealed that quality score varied widely for different treatments due to individual preferences and also a change in general trend and acceptability criteria in comparison with whole wheat flour bakery products. It is observed from above table that overall acceptability of FM_2 sample i.e. muffins prepared with 20% flaxseed is more (7.9) than other samples. However flaxseed addition at moderate levels has resulted in acceptable products with good scores which were comparable with control sample.

IV. Conclusion

As Flaxseed contains good nutritional profile, it could be exploited for nutrition and food formulation. Flaxseed can be incorporated in commercial flours which are low in protein as composite flour that can be utilized in preparation of bakery products. In the light of scientific data of present investigation it can be concluded that muffins fortified with 20% roasted flaxseed powder were found to have high overall acceptability. Consumption of food products fortified with flaxseed flours would be an important step toward relieving protein malnutrition.

V. References

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