Original Article

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Formulation and Evaluation of Peanut Cookies Enriched with Sesame Seed and Flax Seed

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Abstract

Baked goods are popular snack items among children and adults alike, and they are typically high in fat and sugar but not other essential nutrients making them unhealthy choices. Development of commercially viable cookies/biscuits with healthful components is highly desirable. Hence, the objective of the study was to formulate peanut cookies enriched with sesame seeds and flax seeds and evaluate their nutritional composition, sensory quality and shelf stability. The control product was prepared with refined wheat flour, sugar, peanut powder, butter, milk, baking powder. To this either sesame seed or flax seeds were added at two levels for experimental variations. The results indicated that the oilseeds incorporated cookies were rich source of protein (12.3-13.0%) as well as fiber (9.1-10.3%). The fat content ranged between 19.3-20.4%). The average sensory scores for both types of cookies for all attributes ranged between 5.37 to 6.63. There were no significant differences between the quality attributes of control and experimental cookies in both sets of sample indicating that incorporation of sesame seed as well as flax seed was accepted well by all panel members. The cookies were stable up to 60 days as judged by free fatty acids and peroxide value. It can be concluded that sesame seed and flax seed can be incorporated to peanut cookies with no significant differences in quality parameters.

Keywords: Nutritional composition; Sensory quality; Storage stability; Free fatty acids; Peroxide value.

Introduction

Bakery products have been known to people since time immemorial and have good shelf life and taste. With the increase in consumer demand for ready to eat processed foods at reasonable price, better shelf life and high sensory qualities, baked products have gained momentum. The word biscuits and cookies are used as one in many countries. They are also known as sweet biscuits, plain buns and quick breads. However, the word 'cookie' came from a Dutch word 'keokje' which means 'little cake'. Cookies are enjoyed around the world; they can be eaten at anytime of the day, on special occasion as treat or even as a mid night snack.[1] Cookies are smaller, dryer version of cake and the texture may range from soft to chewy, hard, brittle, light or dense. Besides texture, taste, flavour and the ingredients used may differ from one kind of cookie to another.

Though baked cereal products represent one of the most consumed foodstuffs in the world [2], they are poor source of protein and other nutrients. They can be used as a medium to reduce the nutritional deficiencies especially in developing countries.[3] The enrichment of cereal based foods with protein rich oilseeds and legumes has received considerable attention.[4] Because of their taste and high acceptability, cookies can be an attractive option to be given to children at feeding programs, for elderly and low income groups. Baked goods are a popular food among children and adults alike, but they are typically high in fat/sugar but not other essential nutrients making them unhealthy. Therefore

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Table 1: Formulation of Peanut Cookies

Ingredients (g)	Control	Sesame seeds		Flax seeds	
		Level 1	Level 2	Level 1	Level 2
Maida	135	135	135	135	135
Sugar	135	135	135	135	135
Peanut powder	140	120	100	120	100
Unsalted butter	45	45	45	45	45
Milk	40	20	40	40	40
Baking powder	2	2	2	2	2
Salt	0.4	0.4	0.4	0.4	0.4
Sesame seed powder	-	20	40	-	-
Flax seed powder	-	-	-	20	40

the development of a commercially viable biscuit attractive to children and adults that will have significant amount of nutrients especially protein with fewer calories is highly desirable.[5]

Encouraging trends in consumption of bakery products by population of lower and middle income groups in India indicate vast scope for consideration of nutritional enrichment of bakery products.[6-8] The low moisture content of cookies/biscuits ensures that they are generally free from microbiological spoilage and confers a long shelf life on the products, provided they are protected from the uptake of moisture from the damp environment. The low moisture content also gives cookie a relatively high energy density compared with other baked goods. They can be a vehicle for enhancing nutrition because of its convenience and long shelf life. The objective of the study was to develop nutritious cookies incorporating oilseeds and evaluate their nutritional composition, organoleptic quality and shelf stability.

Methodology

Materials

Ingredients needed for preparation of cookies namely, refined wheat flour (*Triticum aestivum*), shortening (unsalted butter, manufactured by Amul India Ltd.), peanut, sesame seeds, and flax seed (*Linum usitatissimum*), salt, sugar, baking powder and milk were procured from local super market. All the chemicals used for analysis were of analytical grade and were procured from E-Merck, Mumbai, India and Qualigens Fine Chemicals, Mumbai, India. Glass double distilled water was used for all experiments and all analysis was carried out in triplicates.

Methods

Pre-Processing of the Materials

Peanut powder was prepared by first roasting the peanut for 10 min on slow flame with continuous stirring till the distinct raw taste disappears. It was then deskinned and ground to a slightly coarse to fine powder in a grinder. Similarly, sesame seeds and flax seeds were roasted separately for about 3 min on slow flame and ground to fine powder in a mixer. Sugar was also ground to a fine powder.

Preparation of Cookies

The cookies were prepared using a basic peanut cookie recipe. First in a bowl whole egg was beaten and sugar was blended in. Flour, baking powder and peanut flour were mixed in a separate bowl and added to egg and sugar mixture alternating with melted butter. Based on the dryness or wetness, milk was added and the mixture was kneaded to a mass. The dough was then shaped into small marble sizes, flattened and placed on greased baking trays. It was baked in a preheated oven at 175°C for 8 minutes. The proportion of ingredients used for different blends is given in Table 1. The control was prepared with 140g of peanut powder along with the other ingredients mentioned earlier. For the cookies prepared with sesame seeds and flax seed, there were two levels in which the seed powders were incorporated. First, 20g of

peanut powder was replaced with 20g of sesame seed powder and secondly 40 g of peanut powder was replaced with 40g of sesame seed powder. Likewise, 20g and 40g peanut powder was replaced by 20g and 40g of flax seed powder. Rest of the process was similar to the basic product.

Analysis of Nutritional Composition

Cookies were analyzed for nutritional composition following standard procedures as follows : moisture content by oven drying and weighing method (method 926.12, 41.1.02), total ash by incinerating the sample in a muffle furnace at 600°C for 3-5 hrs and weighing (method 942.05, 4.1.10), fat in a Soxhlet distillation apparatus by repeated extraction of ether extractives using petroleum ether (method 948.22, 40.1.05), protein by Kjeldahl distillation procedure for determination of nitrogen which was converted to protein using appropriate conversion factors (method 960.52, 12.1.07).[9] For insoluble and soluble dietary fiber the method of Asp *et al*, was followed which is based on the separation of non-starch polysaccharides by enzymatic and gravimetric method.[10] This method measures the dietary fiber equivalent to physiologically unavailable fiber. Total ash solution was used for estimation of iron, calcium and phosphorus. Iron was determined colorimetrically making use of the fact that ferric iron gives a blood red color with potassium thiocyanate.[11] Calcium was precipitated as calcium oxalate, the precipitate dissolved in hot dilute sulphuric acid and titrated against standard potassium permanganate.[12] Phosphorus analysis was carried out by measuring the blue color, which is formed when the ash solution is treated with ammonium molybdate and the phosphomolybdate formed is reduced and read colorimetrically.[13]

Sensory Evaluation of Cookies

The sensory evaluation was conducted to determine the consumer acceptance of peanut cookies and the incorporation of sesame seed and flax seed powder into the cookies. The evaluation was carried on different days. On each day only one sample with two levels with control was evaluated. The samples were coded with random three-digit numbers and presented before the panel members. A group of 30 panel members were recruited, no training for sensory evaluation was provided. It was made sure that they had no allergies with any of the ingredients present in the cookies, especially peanut, gluten and egg. The evaluation was conducted in the foods laboratory. The product evaluation was based on a 10 point grade scale where 1-2 was fair, 3-4, satisfactory, 5-6, good, 7-8, very good and 9-10, excellent.[14] The panel members used the scale to evaluate the cookies on the following attributes: appearance, colour, texture, taste, aroma and overall quality. Responses for descriptive quality using free choice profiling were also obtained.[15]

Storage Stability

All cookies were stored for 60 days in PET (Polyethylene terephthalate) containers at room temperature. Samples were withdrawn at 0, 15, 30, 45 and 60 days and analyzed for free fatty acids (FFA) and peroxide value (PV). For determination of FFA and PV as indicative of keeping quality, the fat from the baked products was extracted in petroleum ether (boiling point, 60-80°C) and subjected to analysis using following standard procedures. [16] FFA is indicated by the number of milligram of potassium hydroxide required to neutralize the free fatty acids present in one gram of oil or fat under prescribed conditions. The acidity of oil or fat indicated by its acid value is frequently expressed as free fatty acids present in the sample. The peroxide value of an oil or fat is the amount of peroxide present and expressed as milli equivalents of peroxide per 1000g of sample.

Statistical Analysis

From the data obtained from sensory evaluation, statistical analysis was carried out. Mean and standard deviation was calculated

Table 2: Nutritional Characteristics of Cookies (per 100g)

Sample	Control	Sesame seed		Flax seed	
		20g	40g	20g	40g
Moisture (g)	2.29±0.003	2.49±0.007	2.43±0.009	2.29±0.001	2.15±0.003
Fat (g)	19.3 ±0.19	19.9±1.24	19.8±0.38	20.4±0.57	20.2±0.69
Protein (g)	12.98±0.03	12.46±0.02	12.28±0.04	12.46±0.01	12.28±0.02
Phosphorus (mg)	151±0.107	158±0.022	177±2.11	179±4.04	196±3.42
Iron (mg)	3.35±0.35	2.95±0.16	3.50±0.18	3.50±0.14	5.25±0.35
Calcium (mg)	31.9±2.02	80.8± 4.52	124.1±6.80	46.4±3.20	60.1±3.20
Total dietary fiber (g)	9.1	9.9	10.1	10.0	10.3
Soluble fiber (g)	2.1	2.5	2.8	3.8	4.5
Insoluble fiber (g)	7.0	7.4	7.3	6.2	5.8

Table 3: Mean Sensory Scores of Cookies Incorporated with Sesame Seed Powder

Sensory attributes	Control	Sesame seed [20g]	Sesame seed [40g]	ANOVA	
				'F' Ratio	'P' Value
Sesame seed					
Appearance	6.13 ±1.31	6.13±1.48	6.00±1.34	0.09	0.91
Colour	6.07±1.36	6.30±1.12	6.17±1.18	0.58	0.56
Texture	5.57±1.28	5.77±1.50	5.37±1.52	0.58	0.56
Taste	6.20±1.88	6.63±1.77	6.27±1.70	0.51	0.60
Aroma	6.57±1.87	6.50±1.78	6.43±1.55	0.04	0.96
Overall quality	6.40±1.50	6.63±1.61	6.23±1.65	0.48	0.62
Flax seed					
Appearance	6.77±1.65	6.27±1.62	6.23±1.50	2.61	0.08
Colour	6.97±1.54	6.47±1.70	6.50±1.48	0.94	0.39
Texture	5.27±1.14	5.63±1.12	5.57±1.006	0.96	0.39
Taste	7.00±1.51	6.27±1.51	6.20±1.50	2.61	0.07
Aroma	7.03±1.52	6.30±1.53	6.03±1.79	3.07	0.05
Overall quality	6.83±1.56	6.40±1.33	6.26±1.39	1.29	0.28

for the scores of each sensory attribute. Analysis of variance (ANOVA) was also carried out to determine whether the mean scores obtained for the attributes of different formulations were significantly different from each other.

Results and Discussion

Bakery products such as biscuits and cookies are usually high in fat and sugar, and have been identified as a food contributing to negative health. It is recommended that the intake of bakery product should be reduced. [5] However it is important to know that the contributing factor for taste and flavour in bakery products are fat and sugar. Without affecting these organoleptic qualities, functional ingredients such as nuts and oilseeds can be added to increase the nutritional quality. Therefore a product was developed to provide nutrient dense product to the consumers while retaining the traditional taste of cookies. The ingredients used for enriching the cookies were sesame seed powder and flax seed powder. The results of the study are summarized below.

Nutritional Composition of Cookies

The nutritional composition of peanut cookies with sesame seed and flax seed powder given in Table 2 shows that the moisture content ranged from 2.15 to 2.49%. The low moisture content helps the cookies to stay longer thus facilitating their storage and use. The fat content of the peanut cookies with sesame seed and flax seed powder were almost similar, as the ingredients chosen for incorporation were also oilseeds. Sesame seed cookies contained 19.85-19.95% fat whereas flax seed cookies contained 20.25-20.49% fat. The protein content was high in all cookies as

Table 4: Free Choice Profiling for Sensory Attributes of Cookies (No. of Responses)

Sensory attribute	Quality	Control	Sesame		Control	Flax seed	
			20g	40g		20g	40g
Appearance	Appealing	29	29	27	30	28	25
	Not appealing	1	1	3	0	2	5
Colour	Attractive	27	26	27	28	25	20
	Not attractive	3	4	3	2	5	10
Texture Crust	Firm	7	15	7	2	9	2
	Hard	18	12	22	28	19	25
	Crumbly	5	3	1	0	2	3
Texture Interior	Soft	3	6	5	1	3	2
	Crumbly	27	24	22	28	25	26
	Sticky	0	0	3	1	2	2
Taste	Delicious	11	15	15	19	18	16
	Appetizing	16	13	12	10	11	12
	Tasteless	3	2	3	1	1	2
Aroma	Appetizing	27	1	22	27	25	24
	Strong	3	7	6	2	4	5
	Off-flavour	0	2	2	1	1	1
After taste	Yes	20	22	21	15	10	12
	No	10	8	9	15	20	18

oilseeds are a good source of protein and have a great potential in overcoming protein energy malnutrition in the world. No significant difference was seen in the total ash content of the cookies. Peanut cookies with 20g of flax seed powder contained the highest amount of phosphorus 179mg/100g, followed by 177 mg/100g in 40g sesame seed incorporated cookies. The least amount of phosphorus was seen in control cookies 151 mg/100g. On the other hand cookies with 40g of flax seed has the highest amount of iron content 5.25 mg/ 100g; the remaining cookie variation had similar iron content. Likewise the calcium content in cookies with 40g sesame seed powder was highest i.e. 124mg, followed by 80.8 mg/100g in cookies with 20g sesame seed powder. Sesame seeds are a very rich source of calcium, hence their incorporation increased the calcium content significantly. Cookies with flax seed powder also showed a higher content of calcium in comparison to control cookies, which was least with 31.9mg /100g. Finally, the dietary fiber analysis of the cookies showed that the total dietary fiber content of the peanut cookies with sesame

Fig 1: Effect of Storage on Free Fatty Acid Content of Cookies (%)

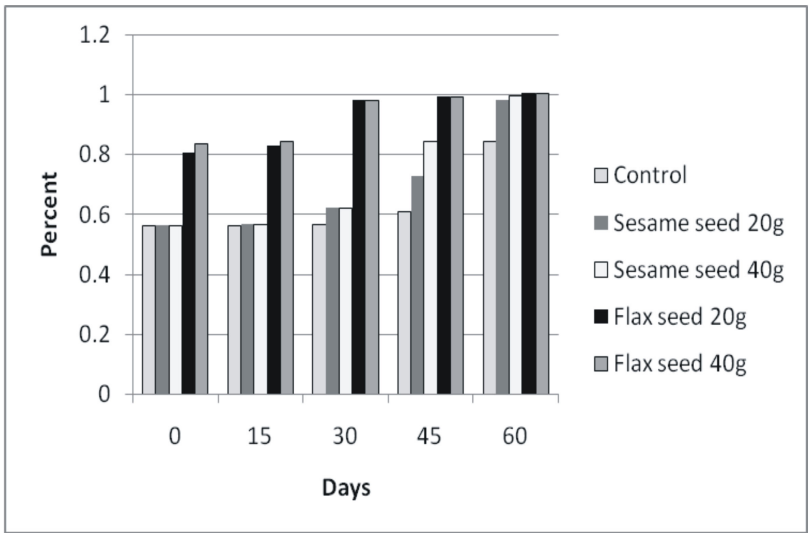
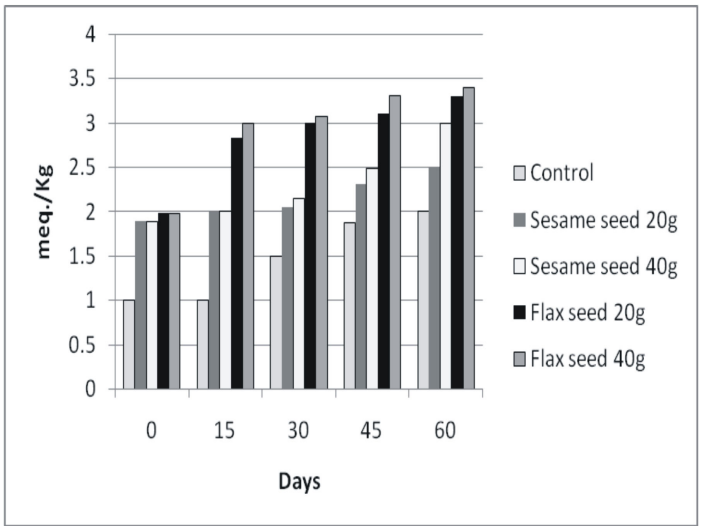


Fig 2: Effect of Storage on Peroxide Value of Cookies (meq/Kg oil)



seed and flax seed powder was within the range of 7.9-10.3%. The soluble fibre content in cookies with 40g flax seed was highest at 4.5% and least in control cookies with 2.1%, whereas, the insoluble fiber was highest in cookies with 40g sesame seed powder with 7.3%, followed by 7% in control and 20g sesame seed cookies. The least amount of insoluble fibre was seen in cookies with 40g flax seed powder i.e. 5.8%. An attempt has been made by different scientists to increase the fiber content of products by addition of various fiber sources. Romjaun and Prakash incorporated carrot powder and wheat bran to muffins at different levels and reported a significant increase in both soluble and insoluble fiber content.[8] Ridge gourd peel, a bio-waste material was incorporated to diamond cuts, a refined flour based fried product to increase the fiber content tremendously.[17]

A study conducted by Zucco *et al*, on the nutritional composition of cookies baked with pulse flour showed that the cookies were higher in protein content and also showed increased antioxidant activity compared to control.[18] Overall analysis indicated that cookies with acceptable physical characteristics and improved nutritional profile could be produced with partial or complete replacement of the wheat flour. Alobo suggested that protein content of cookies were significantly increased by replacement of wheat flour with sesame seed flour.[3] Nochera *et al*, studied the effect of dietary fiber on colon tumour in rats and concluded that the insoluble fiber of wheat bran and soluble fiber of flax seed and soy reduced the size and number of colon tumour. [19]

Sensory Quality of Cookies

Sensory quality is a primary factor which determines the acceptability of any food product, which has a highest impact as far as market success of product, is concerned. The organoleptic evaluation of cookies was carried out using a score card of grading scale 1-10. The results revealed that there were no significant differences between the control cookies and those enriched with sesame seed powder and flax seed powder. The mean sensory scores of cookies incorporated with sesame seed and flax seed powder and the statistical analysis (ANOVA) are shown in Tables 3. The appearance of cookies enriched with sesame seed powder at two levels was more or less the same with the control cookies, with a mean of 6.13. There were no significant differences in appearance of the enriched cookies with control cookies (P-value e”0.05). The score for colour was increased from 6.07 to 6.3 in the cookies incorporated with 20g of sesame seed. Cookies containing 20g of sesame seed powder scored highest in colour and

texture. The texture of the sesame seed cookies decreased in the cookies incorporated with 40g of sesame seed powder. The taste and aroma of the sesame seed cookies were good and the overall quality which is an important parameter in organoleptic estimation, showed that it has the highest score in the first level of sesame seed powder incorporated. Statistically there were no significant differences in any of the quality attributes evaluated. The sensory data of flax seed incorporated cookies showed similar results where ANOVA indicated that there were no significant differences ($P > 0.05$) in relation to control and the two levels of flax seed powder incorporated in the peanut cookies for any of the sensory attributes. The mean scores of the sensory attributes like appearance, taste, texture, aroma and overall quality of flaxseed cookies at the first level (i.e. 20g of flax seed powder) had higher scores than compared to mean scores of the flax seed at second level. The results obtained from the statistical analysis showed that the incorporation of the oilseed powders at different levels did not cause any change in the sensory attributes.

The healthful properties of flax seed make its flour a desirable ingredient for baking goods. Flax seed flour was successfully incorporated in the preparation of muffins.[20] Whole wheat muffins were prepared with flax seed flour added at 2 levels (2% and 5%) and addition of flax seed flour up to 5% in whole wheat muffins did not affect important visual, sensory and physicochemical characteristics of muffins. In another study Metwal *et al*, developed a functional ingredient mix for cookies comprising of debittered fenugreek seed powder (70%) and flax seed powder (30%).[21] The sensory evaluation was conducted for the cookies with functional ingredient mix of 10%, 20% and 30% respectively. The results showed that the overall quality of cookies with 20% mix was the optimum as the texture, flavour and mouth feel scores were affected beyond 20% addition of the mix.

Free choice profiling is a technique which utilizes untrained panel for descriptive sensory analysis. It has the ability to bring forth the discriminative ability of judgment while describing the particular characteristics of a sensory attributes. The panel members were also asked to evaluate the descriptive quality of cookies with the help of a score card. The data collected were analyzed for number of responses and the frequency distribution of responses are presented in Table 4. The sensory attributes like appearance, aroma, flavour and overall liking were moderately liked as indicated by the sensory panels. As can be seen from the table, the respondents found the control cookies to be appealing in appearance, cookies with 20g sesame seed and flax were also found to be appealing by majority whereas, a slightly lesser number found the cookies with 40g incorporation to be appealing too. For the quality of colour, the responses were similar, wherein the sesame seed cookies had same response of attractive and flax seed cookies had slightly lesser score for the 40g sample. This could have been due to slightly darker colour imparted to flax seed cookies because of incorporation. In a study conducted by Alobo on the effect of adding sesame seed flour to millet biscuits on sensory quality showed that biscuits were highly rated for flavour and crispness but considered poor in colour.[3] Howard *et al*, carried out sensory evaluation of peanut flour cracker varieties to determine the consumer acceptability.[22] The results showed that peanut flour crackers were consistently softer in texture than commercial crackers but the colour was significantly affected by the addition of flavoured powders like cheddar cheese, garlic and blackened Cajun.

Under the sensory attribute of texture, the respondents were asked to give their opinion on two parameters, namely the crust and the interior. The texture of an ideal cookie is firm or hard at the surface and should crumble from inside. For the crust texture of sesame cookies, the responses varied between firm and hard for all samples including control, whereas for the flax seed cookies, most of respondents categorized it as hard. The interior of all cookies was rated as crumbly by majority

of respondents indicating that textural quality of all cookies was excellent and hence, acceptable. The taste quality of cookies was measured as delicious, appetizing or tasteless. For the cookie in the first set the responses were distributed for delicious and appetizing, whereas for the second set with flax seed, majority of responses were for the attribute classed as delicious followed by a small number of appetizing. The attribute of aroma (Table 4) was categorized as appetizing for all cookies by majority of respondents (21-27). However a small number detect the aroma as strong for sesame incorporated cookies (6-7) and flax seed cookies (4-5). This could be due to the characteristic aroma of oilseeds which was prominent in cookies.

The presence of after taste was evaluated as either 'yes' or 'no'. For the control cookies, 15-20 panel members indicated the presence of after taste. This could be because the control cookies also had peanuts in it. The after taste was also felt by 21-22 panel members on incorporation of sesame seed. However, for the flax seed incorporated cookies, lesser number found the presence of after taste with the majority giving the response as 'no'. The overall responses for the descriptive quality indicate that the sesame and flax seed incorporated cookies were found to be acceptable using the descriptive quality as criteria and were similar to the peanut control cookies in all respects.

Storage Stability of Cookies

The effect of storage of cookies on free fatty acid (FFA) content is presented in Fig. 1. The control cookie had FFA content of 0.562% which showed a very slight, almost negligible increase on storage to 0.846% after 60 days indicating that cookies were very stable up to 60 days of storage. Cookies incorporated with sesame seed had similar FFA content on 0 day and up to 15 days, after which their FFA content was slightly more than control cookies at 0.62-0.622% after 30 days and 0.987-1.128% after 60 days. However the increase was of a very low order indicating that lipid peroxidation was minimal in cookies even during storage. The flax seed incorporated cookies had a higher FFA content initially with 0.806-0.838% in comparison to control and showed a very gradual increase on storage to 0.9806% 0n 30 days, 0.991% after 45 days and 1.00% after 60 days. Here also, the values were negligible indicating that cookies can be stored up to 60 days with no increase in rancidity.

The effect of storage of cookies on peroxide value (PV) content is presented in Fig 2. The control cookies had PV content of 1.00% which showed a very slight increase on storage after 60 days to 2.00%. This increase in the PV content is negligible. It also indicates that the cookies were stable up to 60 days of storage at room temperature in air tight PET jars. Cookies incorporated with 20g and 40g of sesame seed powder had similar PV content on 0 day and 15 days, after which the PV content was slightly more than control cookies at 2.05-2.15% after 30 days and 2.30-2.49% after 45 days. On 60th day of storage the PV content was known to be 2.50 and 3.00%. The increase was very low indicating that the lipid peroxidation was minimal in cookies even during storage. The peanut cookies incorporated with 20g and 40g of flax seed powder had higher peroxide value content compared to control and sesame seed cookies. Initially the PV at 0 day was 0.829-0.838% and gradually increased to 2.83-3.00% on 15 days, and 3.00-3.31% after 45 days of storage. Finally on 60 days of storage the PV was seen to be 3.29-3.40% where the increase was negligible. This indicates that cookies can be stored up to 60 days without spoilage.

Conclusion

It can be said that though peanut cookies are energy and protein dense products, their nutritional quality can be further enhanced by incorporation of other oilseeds such as sesame seeds and flax seeds. Such incorporation can improve the calcium and dietary fiber content of products. The incorporation of alternate oilseeds did not affect the sensory quality and storage stability

of cookies and cookies could be stored up to 60 days with no averse flavor.

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