Pak. J. Agri. Sci., Vol. 57(1), 229-235;2020
ISSN (Print) 0552-9034, ISSN (Online) 2076-0906
DOI: 10.21162/PAKJAS/20.6552
http://www.pakjas.com.pk

DEVELOPMENT OF ROASTED FLAX SEED COOKIES AND CHARACTERIZATION FOR CHEMICAL AND ORGANOLEPTIC PARAMETERS

Asif Ahmad[1,2,3,*], Sadaf Zulfiqar[3] and Zia Ahmad Chatha[4]

[1]Department for Management of Science and Technology Development & Faculty of Applied Sciences, Ton Duc Thang University, Ho Chi Minh City, Vietnam; [2]Faculty of Applied Sciences, Ton Duc Thang University, Ho Chi Minh City, Vietnam; [3]Department of Food Technology, PMAS-Arid Agriculture University, Rawalpindi - 46300, Pakistan; [4]Faculty of Agri. Engineering, University of Agriculture Faisalabad
[*]Corresponding author's e-mail: asif.ahmad@tdtu.edu.vn

Roasted flax seed is a good source of protein that can be blended with wheat flour for the development of protein enriched cookies. Protein quality is a huge issue in developing countries along with the nutritional deficiency in people. Flax seed possess great nutritional benefits and can also be used as part of functional food hence, making it a valuable addition to cereal based products. This study envisages the use of roasted flax seed flour at levels of 5 to 40% and is also compared with control cookies. Various physiochemical and sensory parameters like moisture, ash, fat, fiber and protein contents increased in the prepared cookies with increasing levels of roasted flaxseed in cookies. Although sensory parameters remain acceptable at all levels of replacement but little decline in all sensory parameters was evident with the increase in levels of roasted flax. Linear dendrogram indicated three distinct region of treatments in which 5% and 10% level were more close to control samples but varied at higher levels of flax incorporation. Significant effect of treatment levels was observed on physiochemical and organoleptic parameters. Results indicated that the cookies prepared with 5 to 15% roasted flaxseed possessed better chemical and organoleptic parameters.
Keywords: Wheat flour, roasted flaxseed flour, chemical properties, organoleptic properties, cookies.

INTRODUCTION

Cereal-based products are consumed all over the world and are liked by people of different age groups. These products serve as a good medium to increase nutrition of the agricultural food products. Apart from greater consumer acceptability, these products also have greater shelf life and can be consumed before and after meals. Several value added products can be produced including cookies. The word cookies are synonymously used for biscuits and this term is more acceptable in America and referred to the twice cooked bakery products. These products are suitable for people who have a hectic schedule and during calamity or wars. Owing to wide consumption, these can be fortified with protein and other nutrients (Gandhi *et al*., 2001).These characteristics make them more ideal for growing kids that always require elevated levels of protein and energy for their growing bodies, surely, it will be higher than required by adults for unit weight of the body (Hussain *et al.,* 2006). In past decades, similar protein enriched products are developed using beans that improve protein status of the products. Such protein enriched products may provide a solution in under developed countries to prevent protein deficiency diseases like: Marasmus and Kwashiorkor. Both of these protein deficiency diseases have serious consequences in form of muscular degeneration, edema, faulty immune system, loss of digestion capacity. These protein deficiency problems often appear in childhood stage in children have acute shortage of protein in their diets. Overall, these deficiencies lead to serious pathogenesis during malnourishment period (Kajla *et al*., 2015). The extent of disease in these children depends upon the amount of protein consumption on daily basis (Hayat *et al*., 2014). Certain other diseases that may include dry skin, anemia, recurring infection, heart attack due to wasting of heart muscle, depressed growth, stunting, hair discoloration, thinning, sluggish growth, and many more can be prevented using protein enriched food products (Hayat *et al*., 2014; Bartkiene *et al.*, 2016). Quantity and quality of the proteins is also important to meet nutritional requirements against these health problems. Protein quality is also an issue in developing countries. Flax seed can be used as efficient source of protein that may fulfill the quality and quantity of protein in people of all ages. Previously, various sources of proteins were explored to meet the quality and quantity standards of protein in food products but higher cost and limited supplies are two major factors that hamper the development of quality food products from animal proteins. Thus to eradicate massive protein deficiencies, scientists are exploring new ways to use legumes and other underutilized oil seed crops for the development of protein rich food products.

Addition of flax seed in cereal based products is an efficient strategy to improve nutritional status of the cereal based food products. Flaxseed *(Linum usitatissimum)*, is a valuable oil seed crop being used as functional food and are documented in ethnobotanical records. Flax seed use in traditional dishes or even in bakery products can be seen in different part of the world including Indian or Chinese recipes. Richness in fats and proteins make it suitable for various dishes. Presence of α-linolenic acid makes it ideal as nutraceutical source for various industrial food products. In addition to fats and proteins, flaxseed is also a good source of crude and dietary fiber having laxative properties and is also good for diabetic patients and weight watchers. Overall, this miraculous food source is rich in fat, protein, fiber and essential minerals thus a great choice for nutritionists and researchers to develop value added food products by including it as raw material.

The technology of incorporation of powdered flaxseed is initially referred to the process of blending of wheat flour with legume and cereal flours for making bread and biscuits (Gambus *et al*., 2003; Conforti and Davis, 2006).Various bakery products such as cookies, bread, muffins, cakes can be prepared by addition of raw flaxseed but often these products are susceptible to enzymatic and oxidation reactions thus causing the low shelf life of the products. Roasting of flaxseed prior to addition in food product may inactivate most of the oxidation enzyme and may increase the shelf life of the product in addition to the increasing digestibility quality of protein. Addition of this protein source may also bring about some chemical and sensory changes in the final product. To minimize these changes, often the concept of composite flours or blending is widely used. Developed countries are already using composite flour technology to fabricate new nutritious food products. New variants of bakery products including biscuits and cookies can be developed through the blending techniques that may attain huge consumer attention in rural and urban vicinities and may be liked by people of all age groups (Agarwal, 1990).

The study was aimed at exploring the levels of flaxseed flour that may be suitable for making blends or composite flours for cookies making and may also enhance the nutritional status of cookies. Moreover, a new method of microwave roasting was used to improve the functionality of the product. Various Chemical and organoleptic characteristics of the cookies were evaluated along with correlation among the organoleptic parameters while using the composite flours at different levels.

MATERIALS AND METHODS

Flaxseed of single field was gifted by Oil Seeds Research Institute, Faisalabad, Pakistan. After dry cleaning of the flax seed, sample of 100 grams in batches was roasted in a microwave oven for 3 minutes with operating frequency of 2450 MHz and 400 Watts output parameters and stored in air tight glass bottles until used (Yang *et al.,* 2004). Another major source for making blended flour was wheat flour that was gift from Sunny Flour Mills Lahore, Pakistan. The wheat variety Inqalab-90 was used to make straight grade wheat flour (SGF) to use in this study.

***Processing of roasted flaxseed into flour*:** Pin Mill commonly known as "China chakki" was used to mill the roasted flaxseed into powder flour. These flours were immediately shifted and stored in air tight sealed glass jars until used.

***Composite flour formation*:** Aforementioned wheat flour and roasted flaxseed powder flour were mixed into planned blends as per requirement of each treatment at different levels for the purpose of making supplemented cookies. A plan of composite flour formation is shown in Table 1.

Table 1. Percentage composition of composite flours (wheat flour + flaxseed flour).

Treatments	Wheat flour (%)	Flaxseed flour (%)
T_o – Straight grade flour (SGF)	100	0
T_1	95	5
T_2	90	10
T_3	85	15
T_4	80	20
T_5	75	25
T_6	70	30
T_7	65	35
T_8	60	40

T_0 = 100% SGF, T_1 = 95% SGF+05% flaxseed flour, T_2 = 90% SGF+10% flaxseed flour, T_3 = 85% SGF+15% flaxseed flour, T_4 = 80% SGF+20% flaxseed flour, T_5 = 75% SGF+25% flaxseed flour, T_6 = 70% SGF+30% flaxseed flour, T_7 = 65% SGF+35% flaxseed flour, T_8 = 60% SGF+40% flaxseed flour

***Cookies production*:** The flaxseed flour in concentration of 0, 5, 10, 15, 20, 25, 30, 35, and 40 percent was blended in wheat flour to prepare cookies dough. Dough was prepared using AACC (2000) method No. 10-50D with slight modifications. The supplementation levels of flax seed flour in wheat flour along with detailed ingredients of recipe is provided in Table No. 2. Electronic scale was used to weigh all ingredients with greater precision. Dough mixer was used to mix hydrogenated vegetable fat and sugar. Beaten egg was added periodically during mixing sugar and hydrogenated vegetable fat. To this mixture, composite blended flours and baking powder were sifted. Later on, beaten egg mixture and in the last vanilla flavor was added during mixing operation until a homogeneous mass was obtained. The homogenized mass was shifted on cooled steel table and rolled out using wooden rolling pin to have uniform thickness. A steel cookie cutter was used to cut even sized cookies with uniform thickness dimensions and immediately placed in steel trays. These trays were placed in electric oven that were preheated at 250±5 °C.

After10 minutes baking time, cookies trays were taken out and placed at room temperature to cool down for 30 minutes. Once it was cooled to room temperature, cookies were packed in sealed plastic bags and stored for 24 h before chemical or organoleptic analyses were conducted.

Table 2. Recipe used for cookies preparation

Ingredients	Weight
Supplemented Flour	100 g
Sugar	50 g
Hydrogenated vegetable fat	50 g
Baking powder	1.0 g
Salt	1.4 g
Beaten egg	1 normal
Vanilla flavor	3 drops

Physicochemical analysis**:** Various chemical analysis was performed to evaluate the quality of cookies. Moisture contents were determined using AOAC(2000) method No. 926.5, percent Nitrogen and crude protein were determined using method No. 950.36(AOAC, 2000) while a conversion factor of 5.7 was used to convert % nitrogen into %protein. Moreover, for crude fat determination AOAC (2000) method No. 935.38 was used, ash/mineral content was determined by method No. 930.22 (AOAC, 2000) and crude fiber was determined by AACC (2000) method No. 32-10 for baked treated and control samples. Furthermore, total carbohydrates as NFE were calculated by following AOAC (2000) method No. 975.14.

Organoleptic evaluation of cookies**:** Prepared cookies were subjected to organoleptic testing; this evaluation was performed by professional or semi-professional judges having a good knowledge of Food science, sensory evaluation and nature of bakery products. However, they were offered coded samples to avoid biasness during judgment process. A hedonic scale comprising of nine-point scale from 1 to 9 was used for studied quality parameters including:color, flavor, texture and overall acceptability (Meilgaard *et al*., 2006).

Statistical analysis**:** All the data were subjected to statistical analysis using analysis of variance technique (ANOVA) where significance was found through Duncan's Multiple Range at 5% level of significance. Statistix software (Version 8.1) and R-Studio were used to carry out all statistical analysis.

RESULTS AND DISCUSSION

Physicochemical analysis of roasted flaxseed flour cookies

Moisture and ash content**:** The results showed that control samples of cookies prepared without roasted flaxseed (T_0) exclusively from wheat flour contained moisture and ash at lowest level while comparing with treated samples (Table 3).The increasing level of flax flour in composite flour tends to increase the level of crude fat, crude fiber and crude protein content in prepared cookies. These parameters were highest in cookies in T_8 when 40% flaxseed flour was incorporated in 60% SGF. Increased level of crude fiber and crude protein due to incorporation of flax seed flour was responsible to hold elevated levels of moisture in prepared cookies as evident in Table 3. These components along with starch of wheat flour in the composite flour caused more binding of moisture thus increasing overall moisture content. Moisture and ash retention in flax flour supplemented samples in presence of protein and fiber showed the hygroscopic nature of these constituents in cookies and are in line with previous studies that demonstrated presence of proteins are often associated to hold water and impart viscous rheology to dough. These characteristics of protein and other constituents from flax seed highly resembles with hydrocolloids and can be advantageously used to improve the functional characteristics of the cookies and other baking products in which higher water binding is required. The excess moisture is technically desirable in these products to modify the gluten network by breaking down of strands of gluten. Thus, amend the overall rheology of the cookies dough system while its interaction with other chemical ingredients of composite flour. These chemical amendments in dough are responsible for changes in quality of final baked products (Wang *et al*. 2004). Treatment with highest level of flaxseed flour (T_8) in composite flour was responsible for highest ash content in cookies. Surely, these minerals richness was achieved due to elevated levels of flax in all treated samples. It has been reported by Carter (1993) that flaxseed is rich in mineral contents including phosphorus, potassium, magnesium, manganese, calcium, zinc, iron and copper. While consuming, these supplemented cookies, micronutrient deficiencies can be combated in underdeveloped countries.

Crude fat**:** Data indicated that at all treatment levels prepared cookies contained more crude fat as compared to control samples of cookies. An increasing trend of crude fat is evident while increasing the level of flax seed flour supplementation in composite flours (Table 3). This showed that flax seed flour is contributing crude fat in the cookies samples. This increased fat not only contributing towards chemical modification of cookies but also supporting to prepare energy dense product. Most of the flax seed fats comprise of omega 3 and omega 6 fatty acids having good amounts of ALA (α-linolenic acid) are responsible for good health and require essentially for most of the body processes. Thus, it is considered nutritionally important in controlling number of ailments. Part of the flax seed contributed fats acts as precursor for several flavoring substances that may generate during processing. Results indicated that treatments T_5, T_6, T_7 and T_8 are highly effective to produce energy dense products with elevated level of crude fat that may range between approximately 17 to 21 %. But at these level one have to compromise its chemical characteristics due to higher amounts of unsaturated fatty acids in these fats. Higher

Table 3. Physicochemical analysis of roasted flaxseed flour cookies

Treatments	Moisture (%)	Ash (%)	Crude Fat (%)	Crude Fiber (%)	Crude Protein (%)	Carbohydrate Content as NFE (%)
T_0	5.12 i	1.20 i	11.30 i	0.30 h	10.25 i	71.83 a
T_1	5.23 h	1.44 h	12.61 h	1.54 g	12.85 h	66.33 b
T_2	5.40 g	1.56 g	13.40 g	2.26 f	14.09 g	63.29 c
T_3	5.57 f	1.69 f	14.90 f	2.85 e	15.42 f	59.57 d
T_4	5.61 e	1.84 e	16.34 e	3.43 d	16.60 e	56.18 e
T_5	5.72 d	1.99 d	17.41 d	4.05 c	17.99 d	52.84 f
T_6	5.78 c	2.12 c	18.90 c	4.57 c	19.40 c	49.23 g
T_7	5.84 b	2.24 b	19.93 b	5.12 b	21.04 b	45.83 h
T_8	5.90 a	2.38 a	21.31 a	5.50 a	22.57 a	42.34 i

T_0 = 100% SGF, T_1 = 95% SGF+05% flaxseed flour, T_2 = 90% SGF+10% flaxseed flour, T_3 = 85% SGF+15% flaxseed flour, T_4 = 80% SGF+20% flaxseedflour, T_5 = 75% SGF+25% flaxseedflour, T_6 = 70% SGF+30% flaxseedflour, T_7 = 65% SGF+35% flaxseedflour, T_8 = 60% SGF+40% flaxseed flour

amounts of unsaturated fats may have deleterious effects during storage as these may come up with rancid flavor during long term storage, when stored in poor storage conditions. To prepare cookies with comparatively better chemical properties without compromising quality, treatments with lesser amounts of fat levels (T_1, T_2, T_3 and T_4) may be selected in composite flours (Rangrej*et al*., 2015).

***Crude fiber*:** Straight grade wheat flour (SGF) in its refined form is comparatively a poor source of crude fiber. Crude fiber content can be increased with incorporation of flax flour into the product. As evident in data (Table 3), crude fiber content of cookies increased as the level of flax seed flour increased. Control samples (T_0) have least amount of crude fiber while Flaxseed flour incorporation @40% in composite flour have maximum amount of crude fiber. Technologically, crude fiber is important in modification of chemical characteristics of cookies. The most affected parameters due to presence of crude fiber is moisture, higher levels of crude fiber retain more moisture. This study validates the previous studies of Hussain (2004) that observed substantial retention of moisture in composite flours prepared by combination of wheat and flaxseed flour. These characteristics are attributed to presence of crude fiber in flax seed flour that mainly comprises of pentosans, starch and lignans. Nutritionally, increased levels of crude fiber is desirable for diabetic and weightwatchers. Increased levels of crude fiber in food products are also beneficial in cardiovascular and obese patients.

***Crude protein and NFE*:** Roasted flax seed flour when substituted with SGF, this resulted in increased protein content of cookies. The increasing trend is evident in all treated samples; it seems to be positively correlated with level of flax seed flour in the recipe. This increase in crude protein at all treatments levels were attributed to roasted flaxseed flour that is naturally rich in proteins. Combining flax seed flour with wheat flour is a viable strategy to improve the protein quantity and quality in the final product with inclusion of essential amino acids in the product. Significantly highest crude protein content (22.57%) was observed when flax seed flour was added at 40 % level in composite flour. Cookies made by sole SGF without incorporating flax seed flour in control samples contain least amount of the protein. All the treatments for preparation of cookies significantly differed in protein contents. The level of protein has a greater influence on chemical characteristics; the most important is the moisture retention in the product. It is assumed that protein can hold the same amount of water as the mass of protein in the product. Some of the amino acids from these proteins also contribute towards color and flavor of the final product through Maillard reaction during thermal processing of the product. On nutritional grounds, presence of protein and essential amino acids are vital to combat protein deficiency malnutrition. Their presence sometimes, is highly effective in lowering bad cholesterol and triglycerides in human body. Protein data in this study validate the previous results of Gambus *et el*. (2003), that demonstrated that incorporation of linseed in specialized cookies may increase the level of protein, this is also validated by these researchers in case of muffins prepared by linseed. Carbohydrates contents calculated as NFE tends to decrease as the supplementation of roasted flax seed flour was increased in the treatments. A significant difference was observed at all supplementation levels. Significantly highest amount of NFE was observed in control samples of cookies while T_8 with 40 % flaxseed flour have the least carbohydrate content. Presence of carbohydrates has a marked effect on other chemical properties of cookies.

Dendrogram of treatments with respect to chemical analysis revealed three distinct regions (Figure 1). Treatments T_0, T_1 and T_2falls in same region having greater similarity; T_1 and T_2 have the highest level of similarities with respect to chemical parameters. Treatments T_3 and T_4 lie in 2nd region and are less similar as compared to T_2 and T_3. Treatments with higher levels of flax seed flour supplementations fall in third region that indicates two groups of similar treatments.

Treatment T_5 resembles more with T_6. Whereas, T_7has matching chemical properties as T_8.

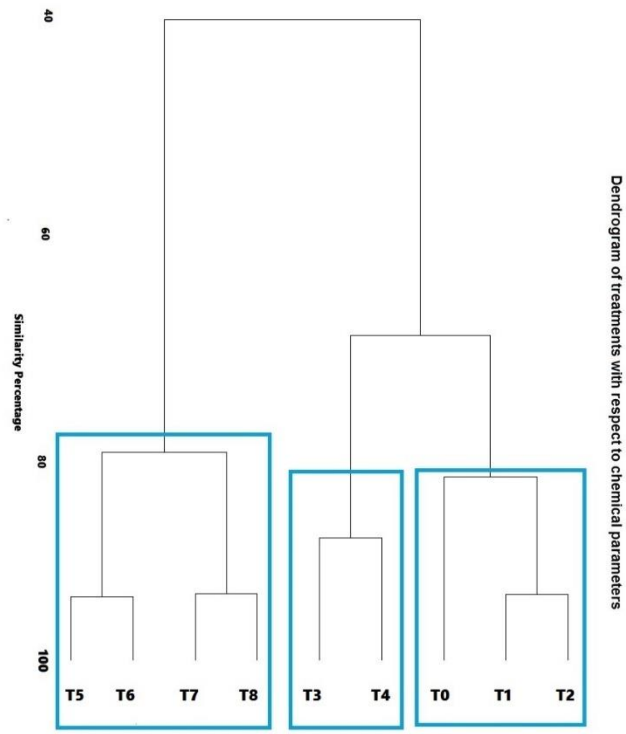

Figure 1. Dendrogram of treatment with respect to chemical parameters

T_0 = 100% SGF, T_1 = 95% SGF+05% flaxseed flour, T_2 = 90% SGF+10% flaxseed flour, T_3 = 85% SGF+15% flaxseed, T_4 = 80% SGF+20% flaxseed flour, T_5 = 75% SGF+25% flaxseed flour, T_6 = 70% SGF+30% flaxseed flour, T_7 = 65% SGF+35% flaxseed flour, T_8 = 60% SGF+40% flaxseed flour

***Organoleptic evaluation of roasted flaxseed flour cookies color*:** Color is an important organoleptic parameter defining the visual perception as observed by the sight sensation. Consumer acceptability lies on how a product visually looks like and serves as rapid acceptance or rejection of product. The data on visual color for cookies as observed by semi trained panel of judges is presented in Table 4. Among treated samples, treatment with low levels of flax seed flour ranked higher as compared to the product with higher levels of flax flour. The highest score for color was received in T_1 treatment having flax seed flour at level of only 5%. This was non-significantly differing with control samples that were prepared exclusively from SGF. Treatments coded as T_6, T_7 and T_8having comparatively higher amounts of flax seed flour were not liked for color and receive an average score of less than 6. Increasing the level of flax flour in composite flour causes a darker color in prepared cookies that was not liked by the consumer. Another reason is that elevated levels of flax flour cookies also contain more proteins that undergo Maillard reaction during thermal processing to impart darker shades of color in final cookies.

***Texture*:** External and internal surface as perceived by sense of touch refers to texture of the product. Various chemical constituents of the product may affect its texture, the most important are protein and moisture. As incorporation of flax seed flour modify the protein and moisture content of the cookies, its texture is also altered with increasing levels of these chemical constituents. Data indicated a substantial difference between texture of control cookies samples and treated samples. Among treated samples, T_1 received highest average score (7.92) for texture (Table 4), subsequent treatments with higher levels of flaxseed flour were ranked progressive decline in texture scores. During processing and storage texture of baking product may decline due to interaction between chemical constituents (Wang *et al.*, 2004). Treatments prepared with flax seed at level of 30 % or above received average score of less than 6 and are disliked for texture by the sensory panel members.

Table 4. Organoleptic analysis of roasted flaxseed flour cookies

Treatments	Color	Texture	Flavor	Overall Acceptability
T_0	7.90 a	6.32 e	6.70 d	6.93 c
T_1	8.00 a	7.92 a	8.00 a	8.00 a
T_2	7.56 b	7.56 b	7.90 b	7.90 a
T_3	7.09 c	7.01 c	7.00 c	7.10 b
T_4	7.01 c	6.91 d	6.95 c	6.95c
T_5	6.14 d	6.12 f	6.20 e	6.10 d
T_6	5.88 d	5.83 g	5.77f	5.88 e
T_7	5.20 e	5.30 h	5.19 g	5.29 f
T_8	5.00 e	5.03 i	5.01 h	5.01 g

T_0 = 100% SGF, T_1 = 95% SGF+05% flaxseed flour, T_2 = 90% SGF+10% flaxseed flour, T_3 = 85% SGF+15% flaxseed, T_4 = 80% SGF+20% flaxseed flour, T_5 = 75% SGF+25% flaxseed flour, T_6 = 70% SGF+30% flaxseed flour, T_7 = 65% SGF+35% flaxseed flour, T_8 = 60% SGF+40% flaxseed flour

***Flavor*:** Flavor refers to combine sensation of taste and smell, taste buds and olfactory lobe are involved to have this type of sensation. It's an important parameter to have consumer perception about the product. A marked statistical difference was observed between control sample and treated samples. Among treated samples low level of flax flour supplementation in composite flour showed promising results but higher level of flax incorporation was not too much effective. Incorporation of 5% flax seed flour in SGF for the preparation of cookies was liked by panel of judges as it received an average flavor score of 8. Least liked cookies samples (T_8) contained flaxseed at 40 % level (Table 4) but these scores are still in acceptable range.

***Overall acceptability*:** Overall acceptability refers to all possible organoleptic parameters that determine the likeness

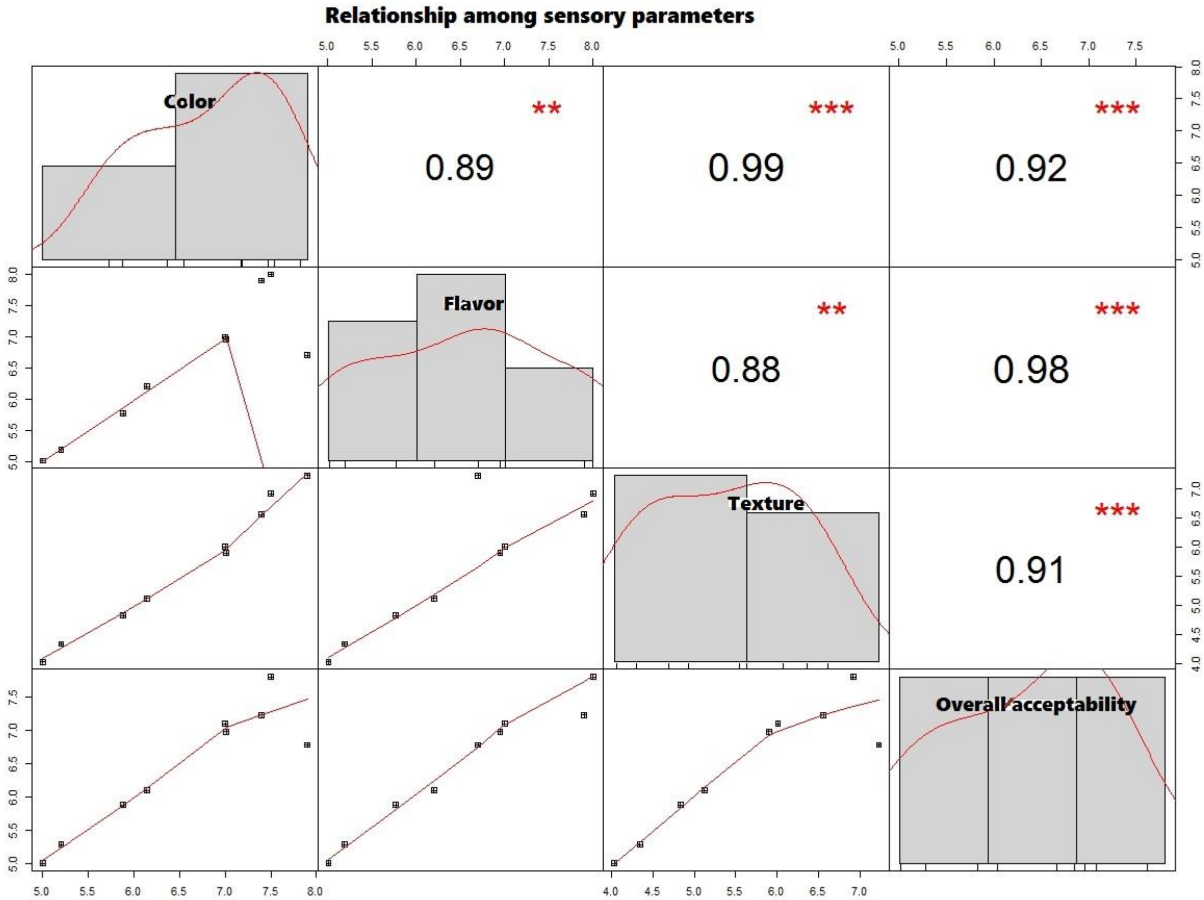

Figure 2. Relationship among sensory parameters

or dislikes of a product as perceived by the consumer and include texture, color, aroma in specific and other factor in general (Rangrej *et al*., 2015). In this study, highest score for overall acceptability was reported for T_1. Among the treated samples, T_1, T_2, and T_3got score of more than 7 and is better ranked as compared to control samples. Higher level of supplementation in T_6, T_7, and T_8 have lower acceptability as compared to control samples (Table 4).

Relationship among sensory parameters**:** Relationship among sensory parameters indicated a high level of relationship among all parameters (Figure 2). Unimodal distribution of sensory scores for all parameters as evident from the figure showed high reliability of sensory evaluation by the trained judges. Highest correlation exists between color and texture but this correlation does not imply causation. Similarly, a strong correlation (r=0.98) exists between flavor and overall acceptability of cookies prepared through supplementation of roasted flax seed flour.

Conclusion**:** This study indicated that chemical parameters of cookies can be partly improved by addition of flaxseed flour into straight grade flour to develop composite flours. This strategy not only improves the technological feature of the cookies but also nutrition status of the cookies in terms of proteins and crude fats. Dendrogram indicated a high level of similarity among T_0, T_1 and T_2. Similarly, another region of similarity appeared as T_5, T_6,T_7 and T_8. Organoleptic analysis also revealed the promising behavior when flax seed flour was incorporated at levels between 5 to 15%. Above these levels, although the product is acceptable but lesser acceptability was recorded. Based on chemical, organoleptic data and dendrogram trend 5-10 % level of flax seed flour has better performance for cookies making and is recommended to effectively utilize this crop to develop value added food product.

REFERENCES

AACC. 2000. Approved Methods of American Association of Cereal Chemists. The Am. Assoc. Cereal Chem., St. Paul, Minnesota, USA.

Agarwal, S. 1990. Prospects for small scale biscuit industry in the nineties. Indian Food Ind. 9: 19-21.

AOAC. 2000. Official Methods of Analysis (17th ed.): Assoc. of Analytical Chemists, Virginia 22201, Arlington. USA.

Bartkiene, E., I. Jakobsone, I. Pugajeva, V. Bartkevics, D. Zadeike and G. Juodeikiene. 2016. Reducing of acrylamide formation in wheat biscuits supplemented with flaxseed and lupine. LWT-Food Sci. Tech. 65: 275-282.

Carter, J. F. 1993. Potential of flaxseed and flaxseed oil in baked goods and other products in human nutrition. Cereal Food World 38:753-759.

Conforti, F.D. and S.F. Davis. 2006. The effect of soya flour and flaxseed as a partial replacement for bread flour in yeast bread. Int. J. Food Sci. Tech. 41: 95-101.

Gambus, H., A. Mikulec and A. Matusz. 2003. The Canadian muffins and hermit cookies with linseed. Zywnosc. 10: 82-93.

Gandhi, A., N. Kotwaliwale, J. Kawalkar, D. Srivastav, V. Parihar and P.R. Nadh. 2001. Effect of incorporation of defatted soyflour on the quality of sweet biscuits. J. Food Sci. Tech. 38: 502-503.

Hayat, I., A. Ahmad, A. Ahmed, S. Khalil and M. Gulfraz. 2014. Exploring the potential of red kidney beans (*Phaseolus vulgaris* L.) to develop protein based product for food applications. The JAPS 24:860-868.

Hussain, S. 2004. Biochemical and technological properties of flaxseed supplemented wheat flour.Ph.D Thesis, University of Agriculture, Faisalabad, Pakistan.

Hussain, S., F.M. Anjum, M.S. Butt, M.I. Khan and A. Asghar. 2006. Physical and sensoric attributes of flaxseed flour supplemented cookies. Turkish J. Bio. 30: 87-92.

Kajla, P., A. Sharma and D.R. Sood. 2015. Flaxseed - a potential functional food source. J. Food Sci. Tech. 52: 1857-1871.

Meilgaard, M.C., B.T Carrand and G.V. Civille. 2006. Sensory Evaluation Techniques: CRC Press.USA.

Rangrej, V., V. Shah, J. Patel and P. Ganorkar. 2015. Effect of shortening replacement with flaxseed oil on physical, sensory, fatty acid and storage characteristics of cookies. J. Food Sci. Tech.52 : 3694-3700.

Wang, X., S.G. Choi and W.L. Kerr. 2004. Water dynamics in white bread and starch gels as affected by water and gluten content. Leb.Technol. 37: 377-384.

Yang, H., Z. Mao and H. Tan. 2004. Determination and removal methods of cyanogenic glycoside in flaxseed. Canadian Soc. Agri. Eng. Proc. Abstract 46066.

[Received 11 July 2018; Accepted 9 Aug- 2019; Published (online) 16 Nov 2019]