



International Journal of  
**Agricultural  
Research**

ISSN 1816-4897



Academic  
Journals Inc.

[www.academicjournals.com](http://www.academicjournals.com)

## Effect of Flaxseed (*Linum usitatissimum*) on the Baking Properties of Cakes and Cookies\*

Shoukat Bashir, Tariq Masud and Asia Latif  
Department of Food Technology, University of Arid Agriculture Rawalpindi,  
Rawalpindi, Pakistan

**Abstract:** Wheat flour was replaced with linseed flour at five different levels i.e., 5, 10, 15, 20 and 25%, respectively. Pure wheat flour sample was less in protein, fat and ash contents, but high in moisture contents as compared to all other samples containing linseed flour. Cookies and cakes were separately prepared using all types of flours in standard methods. Cookies and cakes prepared by each treatment were analyzed for moisture, ash, fat and protein contents. The percentage values of moisture, ash, fat and protein of both cookies and cakes increased as the amount of linseed in composite flour was increased. Physical properties of cookies such as average thickness, average width and spread factor were determined. The average thickness and width of cookies increased as the amount of linseed in composite flour was increased but astonishingly spread factor was decreased. Cakes were observed for their overall loaf volume and it was observed that overall volume of cakes decreased as the amount of linseed was increased in the treatment. Finally cookies and cakes were analyzed for different sensory attributes like colour, texture, taste, flavour and overall acceptability. Based on these findings it is concluded that small to moderate inclusion levels of linseed, especially in the range of 10 to 20%, result in favorable baked products. Products prepared with flaxseed not only taste great but also provide enormous health benefits therefore it is highly recommended that this potential important seed must be used extensively in baking industry to provide value added products to consumer.

**Key words:** Flaxseed, cookies, cakes, baking properties

### Introduction

Linseed or flaxseed is a blue flowering crop mainly grown in Canada for its oil-rich seeds. The seeds of linseed plant are tiny, smooth, flat and range in colour from light to reddish brown. They serve variety of purposes, including medicinal, baking and other food uses. Linseed contains almost all types of amino acids. One of the most important components of linseed is its oil. Approximate percentage of oil in some varieties is up to 40.3%. Out of total minerals there is 0.89% K, 0.60% P, 0.33% Mg, 0.21% Ca and 0.04% Na. Linseed also contains both soluble and insoluble fiber and mucilage.

In Pakistan total area under linseed cultivation were 4729, 6153 and 5946 hectares during the years of 2000-01, 2001-02 and 2002-03, respectively. Total production during years of 2000-01, 2001-02 and 2002-03 was 2710, 3021 and 2966 tones. According to province wise collected data total area under cultivation of linseed in Punjab were 1897, 1800 and 1675 hectares during the years 2000-01, 2001-02 and 2002-03, respectively. Total production during 2000-01, 2001-02 and 2002-03 was 1550, 1417 and 1335 tones, respectively (Ministry of Food, Agriculture and Livestock, Economic wing, Govt. of Pakistan, 2004).

According to recent survey two main varieties of linseed are being grown in Pakistan. One of these varieties is LS Chandni released by ORI, AARI, Faisalabad in 1990 and the other is ILSI 90 released by ARI Tandojam in 1990 (Anonymous, 2003a).

---

**Corresponding Author:** Asia Latif, Department of Food Technology, University of Arid Agriculture Rawalpindi  
Rawalpindi, Pakistan

Flaxseed Flour (FF) is a desirable ingredient for functional foods because it contains two beneficial components; dietary lignans are associated with reduced colon and breast cancer and omega-3 fatty acids are implicated in reducing cardiovascular disease and cancer indices. Major constituents of flaxseed, such as protein and fiber, alter the physicochemical behavior of muffin batter and baked products, increasing the complexity of functional food development (Anonymous, 2006a).

Ground flaxseed is the easiest and most common way to purchase flax, look for “milled flax” or flaxseed flour. Ground flaxseed can be used in baking and be used in cooked and uncooked foods. Ground flaxseed is particularly beneficial because the grinding process releases the nutrients in flax more effectively than chewing the whole seeds. Ground flaxseed is shelf stable for up to four months and should be kept refrigerated in an airtight container. Add to cereal (hot and cold), salads, yogurt, rice, pasta, etc. (Anonymous, 2006b).

Wheat is a staple food in Pakistan and is consumed in many forms such as bread, biscuits, cookies, cakes, buns etc. Wheat is deficient in certain very important amino acids such as lysine and threonine. It also lacks in certain essential fatty acids, minerals and vitamins. So there is severe need to supplement wheat with other indigenous crops to improve nutritional status of average human diet in Pakistan. As linseed is an important crop of Barani areas and also has pronounced nutritional and physico-chemical impact on cereal products so therefore there is a need to use this nutritionally important crop in different products. Keeping in view all above facts, regarding linseed, this study was designed to achieve the following objectives:

- To determine the effect of linseed flour supplementation with wheat flour on the important chemical properties of composite flour.
- To determine the effect of linseed flour supplementation on the baking properties of cookies and cakes.

## **Materials and Methods**

### *Procurement of Raw Materials*

Raw materials included wheat flour, linseed; sugar, shortening (butter), eggs, baking- powder, salt etc. were purchased from the local market.

### *Preparation of Treatments*

Wheat flour was replaced by linseed flour at five different levels for preparation of cookies and cakes each.

Treatments	Wheat flour (g)	Linseed flour (g)
T <sub>0</sub>	100	0.0
T <sub>1</sub>	95	5
T <sub>2</sub>	90	10
T <sub>3</sub>	85	15
T <sub>4</sub>	80	20
T <sub>5</sub>	75	25

### *Preparation of Cookies*

Cookies were prepared by the AACC (1983) method No. 10-52.

### *Preparation of Cakes*

Linseed cakes were prepared by the method as described by Sultan (1982).

### *Chemical Analysis of Flour Samples, Cookies and Cakes*

Wheat flour and Linseed flour samples were analyzed for moisture, fat, ash and protein contents as described by American Association of Cereal Chemists (AACC, 1983). After preparation cookies and cakes were also analyzed chemically.

#### *Physical Analysis of Cookies and Cakes*

Cookies were analyzed for thickness, width and spreads factors according to standard methods as given by AACC (1983). Cakes were observed for their overall loaf volume.

#### *Sensory Evaluation of Cookies and Cakes*

A panel of six judges evaluated cookies and cakes. Parameters were colour, taste, flavour, texture and overall acceptability as described by Larmond (1977).

#### *Statistical Analysis*

All the data obtained was analysed statistically by completely randomized design, as described by Steel and Torrie (1980).

### **Results and Discussion**

#### *Chemical Composition of Wheat, Linseed and Composite Flours*

The chemical composition of wheat and linseed composite four samples is presented in the Table 1. Linseed flour was higher in protein, fat and ash contents as compared to wheat flour whereas wheat flour was higher in moisture contents as compared to linseed flour. The percentage of protein in linseed flour was showed to be many times greater as compared to that of wheat flour. These results were in accordance with those described by Flax Council of Canada (2004) and Broihier (1999).

The results for chemical composition of wheat flour proved to be in close proximity to those found by Anonymous (1997) and Yang (2003) i.e., the protein, ash and moisture contents in special soft wheat cake flour should be 7.8-8.6, 0.36- 0.39 and 13.0-13.7%, respectively .

#### *Chemical Analysis of Cookies and Cakes*

##### *Moisture*

Table 2 comprising the results associated with moisture contents of cookies and cakes showed that the percent moisture in cookies and cakes increased slowly with the increasing level of linseed in composite flour. The probable reason for the increase in moisture contents with the increasing level of linseed substitution might be the increase in fiber contents due to linseed. The results are in accordance with the findings of Daniel (2004) i.e., the dietary fiber of flaxseed hull is about evenly split between an insoluble fiber fraction and a highly soluble, periodic mucilaginous fiber fraction which gives the flaxseed hull a high-water absorption, moisture-binding capacity as well as lubricity.

##### *Ash*

The ash percentage data of different treatments for cookies and cakes is presented in the Table 2. The results evidently indicated that the percent ash increased with the increasing level of linseed flour in the composite flour. These results were in agreement with the findings of Cole *et al.* (2002) i.e., linseed substitution in cinnamon bread increased fiber and ash contents without negatively affecting the appearance, texture, flavour and overall acceptability of the product.

Table 1: Chemical composition of wheat and linseed flour samples

Raw materials	Percent			
	Moisture	Ash	Fat	Protein
Wheat flour	13.02	0.38	01.84	08.04
Linseed flour	07.59	4.29	40.93	24.50

Table 2: Effect of treatments on the selected parameters of cakes (DMR test)

Percent level of replacement of wheat flour with linseed flour	Parameters							
	Moisture (%)		Ash (%)		Protein (%)		Fat (%)	
	Cakes	Cookies	Cakes	Cookies	Cakes	Cookies	Cakes	Cookies
Control	24.73f	2.82f	1.25e	0.52f	5.92f	5.73f	19.85f	31.77f
5%	24.98e	3.01e	1.37d	0.58e	6.04e	5.95e	20.36e	32.72e
10%	25.14d	3.43d	1.42c	0.64d	6.17d	6.17d	21.17d	33.65d
15%	25.68c	3.90c	1.44c	0.71c	6.28c	6.33c	22.77c	34.44c
20%	25.98b	4.32b	1.52b	0.76b	6.34b	6.62b	23.22b	35.34b
25%	26.53a	4.86a	1.63a	0.82a	6.53a	6.82a	24.46a	36.36a

### *Protein*

The protein percentage of different treatments for cookies and cakes is given in the Table 2. It was observed that the percent protein increased with the increasing level of linseed in composite flour. The results could easily be accounted for by the fact that linseed is far higher in protein contents than wheat flour as shown by Table 1. These findings correlate with the findings of Jeremy (2004) i.e., the addition of linseed increases protein for the same 100 calorie slice of bread previously prepared with wheat only.

### *Fat*

The data recorded for fat percentage of cookies and cakes is given in the Table 2, according to which the fat percentage increased with the increase of linseed in the composite flour. One of the prominent features of linseed is its high fat contents and due to this reason it is categorized under oilseed crops. The results of significant increase in fat contents of cookies with increasing level of linseed substitution is in accordance with the findings of Jeremy (2004) i.e., substitution of flaxseed increases unsaturated fats for the same 100 calorie slice of wheat bread. Cole *et al.* (2002) also observed an increase in fat contents in cinnamon bread when he substituted linseed for wheat flour.

### *Sensory Evaluation*

#### *Colour*

The average quality score of colour of different treatments for cookies and cakes is shown in the Table 3, according to which the score decreased with increasing percentage of linseed flour in the composite flour. The probable reason for these results could be the light brown colour of linseed which became reddish brown on such high baking temperatures i.e., 205°C.

#### *Texture*

The mean values for average quality score for texture (feeling of smoothness in mouth as the food is consumed) of different treatments of cookies and cakes are given in the Table 3. It was observed that the average quality score for texture of cookies and cakes varied widely for different treatments which might be due to differing individual preferences and specific textural properties at specific ratios of linseed and wheat flour. These wide ranging results were also obvious from different findings of different researchers such as according to Anonymous (2003b) i.e., flaxseed considerably influences the volume and texture of breads, muffins, cookies, bagels and other baked goods.

#### *Taste*

The data recorded for average quality score for taste of different treatments for cookies and cakes is given in the Table 3. The tables showed that like other attributes for sensory evaluation, taste of the cookies and cakes was considerably influenced due to linseed substitution and in medium levels received higher values. It might be due to the fact that wheat flour in alone has quite familiar and

Table 3: Effect of treatments on the selected parameters of cakes (DMR test)

Percent level of replacement of wheat flour with linseed flour	Sensory evaluation									
	Colour		Texture		Taste		Flavour		Overall acceptability	
	Cakes	Cookies	Cakes	Cookies	Cakes	Cookies	Cakes	Cookies	Cakes	Cookies
Control	8.17a	8.33a	7.17b	7.50a	8.00a	8.17a	6.67b	6.50b	7.83a	7.83a
5%	7.17b	7.33b	6.17c	6.67b	6.67b	7.50a	6.50b	6.83b	6.83b	7.33a
10%	5.67c	6.33c	7.17b	6.50b	6.33b	6.17b	7.00ab	6.83b	6.83b	6.50b
15%	6.17c	6.17c	8.33a	7.50a	8.17a	7.50a	7.83a	7.83a	7.67a	7.33a
20%	4.33d	4.50d	5.33d	5.50c	5.33c	5.00c	5.33c	5.00c	5.17c	5.17c
25%	3.67d	3.33f	3.50e	3.83d	3.67d	4.00d	4.17d	3.83d	4.00d	4.00d

unique light taste as compared to linseed which upon substitution of linseed flour results in almost different taste which could easily be distinguished and in medium quantities might account for best taste of bakery product. These results could easily be interrelated with the findings of Stitt (1988) i.e., flaxseed fits right into people's taste and preferences and could easily be used in baked goods, cereals etc. Furthermore Anonymous (2002a) and Anonymous (2002b) also referred to linseed as food having good taste, pleasant nutty flavor and nutritive value.

#### *Flavor*

The average quality score for flavor of different treatments of cookies and cakes is shown in the Table 3. It was observed that as compared to the scores for other attributes, the scores for flavor did not vary widely at lower levels of substitution. However at moderate levels of substitution flavour of cookies was found very appreciable and received higher scores even more than control treatment. These results support the findings of Stitt (1988) i.e., the flavor of linseed is highly appreciable. Furthermore Anonymous (2003b) also observed that linseed has a pleasant nutty flavor that complements many flavor combinations. As the amount of linseed in a product increases, the flavor intensifies, enabling linseed to serve as the primary flavoring agent in many applications. The variation in results especially among different treatments having linseed substitution could be interrelated with the findings of Aarestad *et al.* (2002), according to which although ground linseed has a unique flavor, its acceptability is influenced by individual preferences.

#### *Overall Acceptability*

The results recorded for overall acceptability of different treatments of cookies and cakes, given in the Table 3, revealed that quality score varied widely for different treatments and the reason behind which could be individual preference and also a change in general trend and acceptability criterion in comparison with wheat flour products. However linseed substitution at moderate levels have resulted in acceptable product and received best scores which were comparable with control treatment. These results are in agreement with the findings of Aarestad *et al.* (2002) i.e., ground linseed into a cookie creates an acceptable product; however it's acceptability is influenced by individual preferences. The results could also be interrelated with the findings of Cole *et al.* (2002) i.e., in ground for linseed is an acceptable substitution in cinnamon bread without negatively affecting the appearance, texture, flavor and overall acceptability of the product.

#### *Physical Analysis*

##### *Thickness*

The data recorded for average thickness of different treatments of cookies is given in the Table 4, according to which the average thickness of the cookies increased with the increase in level of linseed substitution.

Table 4: Effect of treatments on the average thickness of cookies (DMR test)

Treatments	Percent level of replacement of wheat flour by linseed flour					
	Control	5	10	15	20	25
Means (thickness)	5.33e	6.50d	7.00c	7.60b	7.82b	8.82a
Means (width)	35.17f	35.77e	36.50d	38.50c	39.01b	40.23a
Means (spread factor)	63.60a	55.13b	52.36c	50.70c	50.08cd	48.27d

#### *Width*

The Table 4 revealed that average width of cookies increased with increasing level of linseed in the composite flour. These trends were almost similar to those of average thickness.

#### *Spread Factor*

Table 4 revealed that the spread factor for different treatments gradually decreased with increasing level of linseed substitution. This reduction in spread factor might be due to increase in protein percentage with increasing level of linseed substitution and because protein has more binding power and thus it might have reduced spread of cookies. It is the reason due to which soft wheat varieties are recommended with low protein contents to prepare cookies and cakes (Miller and Hoseney, 1997; Kadharmestan *et al.*, 1998).

#### *Overall Loaf Volume of Cakes*

The overall volume of cakes clearly appeared to have been decreased as the amount of linseed flour increased in composite flour. The appearing volume of cakes of control treatment was excellent as compared to all other treatments.

## **References**

- AACC, 1983. Approved Methods of American Association of Cereal Chemists. American Association of Cereal Chemists Inc., St. Paul. Minnesota. USA 8th. Edn., 1: 1525.
- Aarestad, A., M.M. Katie and L.A. Raabe, 2002. Flaxseed Acceptability as a Substitute in Chocolate Chunk Cookies. Concordia College <http://www4.cord.edu/fns/portfolios/laraabe/Abstract.doc>. Updated on 2002, Nov 18. Accessed 2003 Dec 23.
- Anonymous, 1997. Special Soft White Wheat Cake Flour. <http://www.starofthewest.com/Flourspec.htm#special>. Updated on 2004, Jan 12. Accessed 2004 Aug 5.
- Anonymous, 2002a. What Is Flax?. <http://www.flaxcouncil.ca/flaxnut2.htm>. Updated on 2002, Oct 15. Accessed 2003 Dec 22.
- Anonymous, 2002b. Flaxseed As A Food. <http://www.flaxcouncil.ca/flaxnut3.htm> Updated on 2002, Jan 4. Accessed 2003 Dec 22.
- Anonymous, 2003a. Registered and released crop varieties. [http://www.nationalpak.com/registered\\_varieties.htm](http://www.nationalpak.com/registered_varieties.htm) Updated on 2004, Jun 18. Accessed 2004 Jul 14.
- Anonymous, 2003b. For Commercial Bakers. <http://www.flaxcouncil.ca/flaxpd6.htm> Updated on 2003, May 5. Accessed 2003 Dec 22.
- Anonymous, 2006a. Properties of Flax seed. [http://ift.confex.com/ift/2001/techprogram/paper\\_8150.htm](http://ift.confex.com/ift/2001/techprogram/paper_8150.htm). Updated on 6 Mar 2006. Accessed 2006 March 20.
- Anonymous, 2006b. Flax Seed. <http://www.targetwoman.com/articles/flax-seed.html>. Updated on 14 Mar 2006. Accessed 2006 March 20.
- Broihier, K., 1999. Just the flax. [http://www.egginnovations.com/articles/just\\_the\\_flax.pdf](http://www.egginnovations.com/articles/just_the_flax.pdf). Updated on 2004 Jan 06. Accessed 2004 Aug 2.
- Cole, K., B. Busby and A. Ruten. 2002. Flax Acceptability in Cinnamon Raisin Bread <http://www4.cord.edu/fns/portfolios/kkcole/flax.htm> Updated on 2002, April 18. Accessed 2003 Dec 22.

- Daniel, B., 2004. Low-carb revolution fuels innovation with flaxseed. <http://www.ffnimg.com/ASP/home.asp> Updated on 2004 Jul 07. Accessed 2004 Aug 04.
- Flax Council of Canada, 2004. Flax nutrition. <http://www.flaxcouncil.ca/pdf/smarch.pdf>. Updated on 2004 Feb 02. Accessed 2004 Aug 11.
- Jeremy, L. 2004. The Worshipful Company of Bakers. <http://www.naturalphysiques.com/tools.php?catid=13> Updated on 2004, Feb 016. Accessed 2004 Aug 4.
- Kadharmestan, C., K.B. Byung and A. Zuzanna, 1998. Whey protein concentrate with heat or heat hydrostatic pressure in wheat based products. *Cereal Chem.*, 75: 762-766.
- Larmond, E., 1977. Laboratory Methods of Sensory Evaluation of Food. Research Branch, Canada, Dept. of Agric. Publ., pp: 44.
- Miller, R.A. and R.C. Hosney, 1997. Factors in hard flours responsible for reduced cookies spread. *Cereal Chem.*, 74: 330-336.
- Ministry of Food, Agriculture and Livestock, Economic wing, Govt. of Pakistan, 2004. Crops area and production (by districts). [http://www.pakistan.gov.pk/fooddivision/publications/dwap200203/table27\\_linseed.pdf+linseed+production+pakistan+2003](http://www.pakistan.gov.pk/fooddivision/publications/dwap200203/table27_linseed.pdf+linseed+production+pakistan+2003) and hl = en and ie = UTF-8 Updated on 2004, June 20. Accessed 2004 July 5.
- Steel, R.G.D. and J.H. Torrie, 1980. Principles and Procedures of Statistics. Mac-Graw. Hill Book CO., New York, pp: 633.
- Stitt, P.A., 1988. Flax as a source of alpha-linolenic acid. *Nato Asi Series: Series A: Life Sci.*, 389-390.
- Sultan, W.J., 1982. Practical Baking. The Avi Publishing Co., Inc. Westport, Connecticut, pp: 342.
- Wanasundara, P.K. and F. Shahidi, 1998. Process-induced compositional changes of flaxseed. Memorial University of New foundland, St. John's, Canada, *Adv. Exp. Med. Biol.*, 434: 307-25.
- Yang, J., 2003. The Components of FlaxSeed Oil. <http://www.bodybuildingforyou.com/Health-supplements/flax-seed-oil.htm> Updated on 2003, Aug 1. Accessed 2003 Dec 22.