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Fatty acid profile of selected flaxseed, *Linum usitatissimum* L varieties

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ABSTRACT

A laboratory experiment was carried out to analyze the fat content and fatty acid profile of flaxseed varieties viz Padmini and J-23 along with commercial sample. Results revealed that fat content in selected flaxseed varieties ranged from 33.4 to 35.3 g per 100 g and fatty acids such as palmitic, stearic, oleic, linolenic and linoleic acids ranged from 6.97 to 7.69, 6.79 to 9.96, 29.76 to 32.43, 38.65 to 43.65 and 11.47 to 12.90 per cent respectively. However significant differences in fat content and fatty acid profile among all the three flaxseed varieties were observed.

Keywords: Flaxseed; varieties; fatty acid profile; fat content

INTRODUCTION

Flax (*Linum usitatissimum* L) is a minor oil seed crop with multipurpose uses belonging to the family Linnaceae. It is a Rabi oilseed crop in India and occupies the second position next to rapeseed-mustard in the view point of area as well as production (Chauhan et al 2009). Flax is grown on about 4-5 lakh ha of land with an average productivity of 395 kg/ha in India (Dubey et al 2009). The important flaxseed growing states of the country are Madhya Pradesh, Uttar Pradesh, Chhattisgarh, Bihar, Rajasthan, Orissa and Karnataka. Each part of the crop has specific economic importance. Its seeds are rich in oil that is about 36 to 40 per cent and has long been used in human and animal diets and in industry as a source of oil. Because of its dying properties flaxseed oil is used in paints, varnishes and polymer industries (Gill 1967). Flaxseed has been used as a precious nutritional food grain and traditional medicine in human diets for thousands of years and more recently it has been used as a source of nutraceuticals and identified as a functional food whose benefits on health are generally attributed to high concentration of linolenic acid (omega-3) and lignin as well as significant quantities of dietary fiber (28%) including

soluble and insoluble fibers, protein (21%), dietary fiber and fat (41%) with unique fatty acid profile. Flaxseed oil is the richest plant source of linoleic (omega-6) and linolenic (omega-3) polyunsaturated fatty acids (PUFA) which are essential for humans since they cannot be synthesized in the organism and must be ingested through food. Present study was undertaken to analyze fatty acid profile of selected flaxseed varieties.

MATERIAL and METHODS

Flaxseed varieties such as Padmini and J-23 along with commercial sample were selected for study. Padmini and J-23 were procured from All India Coordinated Research Project on Sunflower, Bangalore and commercial sample from the local market in Bangalore. Fat content was determined by using the Soxhlet extraction unit according to the Anon (1980). Flaxseeds of both varieties along with commercial sample were ground and made moisture free. Moisture free samples were taken (5 gram each) and were extracted with petroleum ether in a Soxhlet apparatus for 14-26 h. The solvent was removed by evaporation and the residue of fat was weighed and results documented.

$$\text{Fat (g/100g)} = \frac{\text{Weight of ether extract (g)}}{\text{Weight of sample used (g)}} \times 100$$

Fatty acid profile was analyzed in oil where five gram flaxseeds of each variety along with commercial sample were taken, powdered and extracted with petroleum ether in a Soxhlet apparatus for four hours. The extract was concentrated under reduced pressure. The GC analysis was performed for analysis of components of fixed oil. Fatty acid profile was assessed through gas chromatography – mass spectroscopy (GC-MS). The standard and the sample fatty acids were converted to methyl esters (Vogel 1975). The fatty acid methyl esters were determined by GC–MS using Trace GC Model 2000 series. The gas chromatography was equipped with DB-5 (5%-phenyl) methylpolysiloxane 25ì capillary column, 50 m x 0.25 mm ie 1.5 m thickness. The n-3/n-6 ratio was calculated after obtaining of result of n-3/n-6 content in flaxseeds from GC-MS. All tests were conducted in triplicates. Complete randomized design (CRD) analysis of variance was applied and the data obtained for each analysis subjected for statistical analysis to determine the level of significance. Significant difference was defined as $p \leq 0.05$. Data are reported as standard error means along with CD values. The values of correlation coefficient (r) were

calculated to find out relationship between fat content fatty acid profile, saturated and unsaturated fatty acids.

RESULTS and DISCUSSION

In the present study fat content ranged from 33.4 to 35.3 g per 100 g (Table 1). Significantly highest fat content was found in Padmini (35.3 g/100) followed by commercial sample (35.1 g/100 g) and least fat content was reported in J-23 (33.4 g/ 100 g) variety. Such varietal difference was also studied by Coskuner and Karababa (2007) who reported that flaxseed has 30 to 45 per cent of fat. Dubey et al (2009) reported the similar result for fat content in four flaxseed varieties that ranged between 33-34 per cent. El-Beltagi et al (2011) and Hasler et al (2000) findings in five different cultivars of flaxseed showed the fat content of 36 to 39 per cent. The difference in the fat content among the selected varieties might be attributed to change in genetic and environmental factors where it was reported that genetic and environmental factors determine the protein and oil content of soyabeans (Wolf et al 1982).

Fatty acid profile of selected flaxseed varieties (Padmini and J-23) along with commercial sample in oil extracted from flaxseed grains showed presence of different fatty acids (Table 2). Saturated fatty acids such as palmitic and stearic acids in selected flaxseed varieties ranged from 6.97 to 7.69 and 6.79 to 9.96 per cent

Table 1. Fat content (g/100 g) in selected flaxseed varieties

Variety	Fat (g)
Padmini	35.3
J-23	33.4
Commercial sample	35.1
'F' value	*
SEm±	0.54
$CD_{0.05}$	1.89

Values are means of three replications

respectively. However current findings of saturated fatty as stearic and palmitic contents in flaxseeds are nearer to the findings of Bhatty (1995) and Choo et al (2007) that is of 9 to 12 per cent saturated fatty acids. Significantly highest palmitic acid content was recorded in commercial sample (7.69%) followed by Padmini variety (7.35%). However J-23 variety recorded least amount (6.97%) of palmitic acid. Stearic acid was significantly higher in Padmini (9.96%) followed by commercial (9.78%) and least was in J-23 (6.79%). Unsaturated fatty acids such as oleic, linolenic and linoleic acids in selected flaxseed ranged from 29.76 to 32.43, 38.65 to 43.65 and 11.47 to 12.90 per cent respectively. Oomah (2001) reported the same result for oleic acid ie flaxseed has 31.56 per cent oleic acid. Similar results for linolenic acid were reported by Flachowsky et al (1997) in flaxseed varieties (C18:3n"3, 36–50%). But Pellizzon (2007) reported higher values

for unsaturated fatty acids as 53 per cent of á-linolenic acids and 17 per cent linoleic acids (LAs) but lower value for oleic acid as 19 per cent. Padmini variety had significantly highest oleic acid content (32.43%) followed by commercial (31.34%) sample and least content of oleic acid was observed in J-23 variety (29.76%). J-23 had the highest linolenic (omega-3) acid (43.65%) followed by commercial sample (38.87%) and Padmini had the least linolenic acid content (38.65%).

Significantly highest linoleic acid (omega-6) content was recorded in J-23 (12.90%) followed by commercial sample (12.31%). Padmini had the least linoleic acid (11.47%) content among the three selected varieties. The ratio of n-3/n-6 ranged from 3:15 to 3:38. J-23 had the highest ratio of omega-3 and omega-6 (3.38:1) fatty acids followed by Padmini (3.36:1). In commercial sample least (3.15:1) ratio of n-3/n-6 was observed (Table 2). Nearer values for n-3/n-6 ratio (4:1) were documented by Hiltunen and Holm (2000).

Significant difference in fatty acid profile of both the analyzed varieties and commercial sample was observed. The data on correlation studies among fat and fatty acid profile of selected flaxseed varieties are presented in Table 3. Highly significant positive correlation between fat and stearic acid (r= 0.999) and inverse correlation between fat and linolenic acid (-0.998) followed by linolenic acid (r= -0.864) with fat were observed at 5 per cent level. Oleic and palmitic acids also showed significant positive correlation with fat (r= 0.949 and 0.832 respectively) at 1 per cent significance level and results are presented in Table 3. Stearic (unsaturated) acid showed highly significant negative correlation with linolenic (saturated) acid (r= -1.000) at 1 per cent level and results are depicted in Table 4. Significant difference was not observed among remaining saturated and unsaturated fatty acids.

Polyunsaturated fatty acids (PUFA) from flaxseed oil are essential for human especially to lower the risk of diseases related to cholesterol oxidation. As components of cell membranes n-3/n-6 fatty acids increase membrane fluidity and play an important role for the function of cell membranes and the nervous system (Davis and Kris-Etherton 2003). It can be concluded that flaxseed is the richest source of oil with á-linolenic acid which has biological value and also it has good amount of n-3/n-6 ratio. There was correlation between fat content and fatty acid profile. á-linolenic acid is an essential fatty acid which has beneficial role in health. So flaxseed can be included in the foodstuffs to obtain the health benefits.

Table 2. Fatty acid profile of selected flaxseed varieties

Flaxseed variety	Saturated fatty acids		Unsaturated fatty acids			n-3/n-6 ratio
	Palmitic acid (%)	Stearic acid (%)	Oleic acid (%)	Linolenic acid (%)	Linoleic acid (%)	
Padmini	7.35	9.96	32.43	38.65	11.47	3.36:1
J-23	6.97	6.79	29.76	43.65	12.90	3.38:1
Commercial sample	7.69	9.78	31.34	38.87	12.31	3.15:1
'F' value	*	*	*	*	*	-
SEm±	0.17	0.13	0.36	0.55	0.14	-
$CD_{0.05}$	0.60	0.46	1.24	1.90	0.51	-

Values are means of three replications

Table 3. Correlation coefficient (r) between fat and fatty acids

Characteristic	x_1	x_2	x_3	x_4	x_5	x_6
Fat	1					
Palmitic acid	0.832	1				
Stearic acid	0.999*	0.857	1			
Oleic acid	0.949	0.614	0.933	1		
Linolenic acid	-0.998*	-0.863	-1.000**	-0.929	1	
Linoleic acid	-0.864	-0.440	-0.840	-0.979	0.834	1

*Significant at 5 per cent

**Significant at 1 per cent

Table 4. Correlation coefficient (r) between saturated and unsaturated fatty acids

Characteristic	x_1	x_2	x_3	x_4	x_5
Palmitic acid	1				
Stearic acid	0.857	1			
Oleic acid	0.614	0.933	1		
Linolenic acid	-0.863	-1.000**	-0.929	1	
Linoleic acid	-0.440	-0.840	-0.979	0.834	1

**Significant at 1 per cent

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