ORIGINAL ARTICLE

Thai jute seed oil: a potential polyunsaturated fatty acid source

Sirithon Siriamornpun[1], Duo Li[2], Lifeng Yang[3], Wanna Kanchanamayoon[4] and Maitree Suttajit[5]

Abstract

Siriamornpun, S., Li, D., Yang, L., Kanchanamayoon, W. and Suttajit, M.
Thai jute seed oil: a potential polyunsaturated fatty acid source
Songklanakarin J. Sci. Technol., 2006, 28(Suppl. 1) : 11-15

This study examined lipid and fatty acid compositions of different varieties of jute (Po-kra-jao, *Corchorus olitorius* L.) seed grown in Thailand. Four different jute seeds (Nonn-Soong, Keaw-Yai, Cuba and Khonkaen) harvested from northeastern Thailand were ground, their lipid was extracted with chloroform: methanol (2:1, v/v), and lipid composition was determined by Iatroscan (TLC/FID). Fatty acid composition was analyzed using GLC with standard methods. Triacylglycerol was a predominant lipid in jute seed oil, ranging from 70% to 74%, and other two minor components were phytosterol (12% to 28%) and diacylglycerol (0% to 9%). The ratio of saturates: monounsaturates: polyunsaturates, was approximately 2: 3: 4. Most predominant polyunsaturated fatty acid (PUFA) was linoleic acid (18:2n-6), accounting for 40-67% of total fatty acid. Nonn-Soong had the highest amount of PUFA (67.7%), followed by Khonkaen (44.53%), Keaw-Yai (41.14%), and Cuba (40.19%). Another PUFA found was α-linolenic acid (18:3n-3), accounting for about 1% of total fatty acid. The results indicated that jute seed oil was a potential edible PUFA source. The oils obtained from different kinds of jute seeds had significantly different lipid and fatty acid compositions.

Key words : jute seed, lipid, fatty acid, polyunsaturated fatty acid, *Corchorus olitorius* L.

[1]Ph.D.(Food Science and Technology), [3]B.Sc.(Food Technolgy), Department of Food Technology and Nutrition, Faculty of Technology, [4]Ph.D.(Analytical Chemistry), Assoc. Prof., [5]Ph.D.(Biochemistry), Prof., Faculty of Science, Mahasarakham University, Kantarawichai, Maha Sarakham, 44000 Thailand. [2]Ph.D.(Nutrition and Food Safety), Prof., Department of Food Science and Nutrition, Zhejiang University, Hangzhou, China.
Corresponding e-mail: sirithons@hotmail com
Received, 31 August 2004 Accepted, 14 November 2005

Polyunsaturated fatty acids (PUFA) can be divided into n-6 (ω-6)- and n-3 (ω-3)-fatty acids. About 80 to 90% of PUFA in the diet is provided by linoleic acid (18:2n-6) found in the vegetable oils such as sunflower oil, corn oil and soybean oil (Li *et al*., 2003). Linoleic acid is considered one of the two essential fatty acids for human health (Li *et al*., 2003). The other is α-linolenic acid (18:3n-3, ALA) found in some vegetable oils e.g. canola, soybean, linseed, perrila, and walnuts oils (Li *et al*., 2003). Two other n-3 PUFA, eicosapentaenoic (EPA, 20:5n-3) and docosahexaenoic acid (DHA, 22:6n-3), are commonly found in fish (Sinclair *et al*., 2002). Human body can synthesize a variety PUFA by desaturation and elongation reactions (Mimouni *et al*., 1991).

Jute is normally cultivated for its fiber. It can tolerate a wide variety of climatic conditions and so is grown in many countries, both during the dry and rainy seasons. It is also known that jute leaves contain several phenolic compounds (Azuma *et al*., 1999). However, since lipid and fatty acid composition of jute seed oil is not known, we conducted a study with four different varieties of jute (Po-kra-jao, *Corchorus olitorius* L.) seed grown in northeastern Thailand to elucidate this information.

Materials and Methods

Samples

Seed of four jute cultivars: Nonn Soong (JN), Keaw-Yai (JY), Cuba (JC) and Khon Kaen(JK) were used in the study. Dried seeds of each cultivar were ground with a mortar and pestle.

Lipid analysis

Approximately 2 g of crushed seed was used to extract lipids with 20 mL of chloroform-methanol (2:1, v/v) containing 10 mg/L of butylated hydroxytoluene (BHT) and 0.2 mg/mL of tricosanoic acid (C23:0, Sigma, USA) as internal standard and stored at room temperature for 24 h.

The extracted lipid was then identified with MK-6s Iatroscan TLC/FID (Laboratories Inc., Japan) after partition. The fatty acid methyl esters (FAMEs) of the total lipid extract were prepared by saponification using 3 mL of H_2SO_4 in methanol (0.9 mol/L) and 1 mL of toluene. The FAMEs were separated by capillary gas chromatography using a 60 m x 0.25 mm (I.D.) fused silica bonded phase column (BPX70, SGE, Melbourne, Australia) (Li *et al*.,1998). The column oven was programmed from 125ºC for 3 min to 220ºC at 8ºC/min with helium as carrier gas at a flow rate of 43 cm/s. Fatty acids were identified by comparing with standard mixtures of fatty acid methyl esters. The results were obtained using response factors derived from the chromatograph of known standards (Nu-Chek-Prep, Elysian, MN, USA).

Results and Discussion

Total lipid content in jute seed JN (16.75g/100g) and JY (17.97g/100g) was significantly lower than in JK (23.10g/100g) and JC (21.53g/100g) (Table 1). The lipid composition of jute seed oil varied significantly among the samples (Table 2). Triacylglycerol was a predominant lipid in jute seed oil and phytosterol (PTS) was a minor component. Diacylglycerol (DAG) and free fatty

Table 1. Lipid content of different jute seeds.

Seeds	Lipid content (g/100g seed)
Jute Nonn Soong	16.75±0.30 [b]
Jute Keaw Yai	17.97±0.33 [b]
Jute Cuba	21.53±0.99 [a]
Jute Khonkaen	23.10±1.05 [a]

Note: Data presented as mean ± standard deviation. Numbers on the same row with differing superscripts are significantly different at $P \leq 0.05$

Table 2. Lipid composition of jute seed oils analyzed with TLC/FID (% of total lipids)

Seeds	TAG	DAG	FFA	PTS
Jute Nonn Soong	71.51±1.34 [b]	nd	nd	28.49±1.34 [a]
Jute Keaw Yai	70.86±1.40 [b]	7.36±0.60 [b]	3.84±0.30 [a]	17.93±0.58 [c]
Jute Cuba	72.89±2.04 [ab]	2.88±1.06 [c]	2.47±0.54 [b]	21.75±1.51 [b]
Jute Khonkaen	74.12±1.37 [a]	9.49±1.55 [a]	3.62±0.12 [a]	12.77±0.67 [d]

TAG = Triacylglycerol, DAG = Diacylglycerol, FFA = Free fatty acids
PTS = Phytosterol,
ns = no-significant difference, nd = not detected

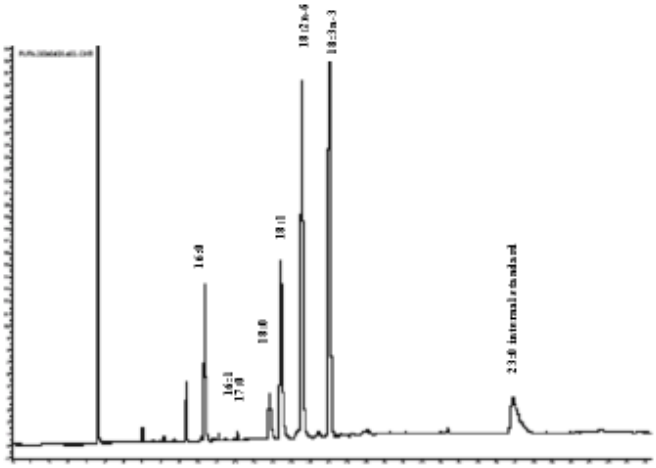

Figure 1. Chromatogram of fatty acid composition of jute seed oil analyzed with GC.

acid (FFA) were found in JY, JC and JK but not in JN. A wide range of DAG concentration in jute seed oil was observed, from a non-detectable level in JN to as high as 9.49% in JK. This supports earlier contention that the largest constituent of edible oil is TAG, but the oil may also contain up to 10 % DAG, the level depending on the origin of the oil (Watanabe and Matsuo, 2002; Abdel-Nabey *et al*., 1992; D'alonzo *et al*., 1982). DAG content found in rapeseed oil was 0.8%, 1.0% in soybean oil, 2.1% in safflower oil, 5.5% in olive oil, 5.8% in palm oil and up to 9.5% in cottonseed oil. The highest amount of DAG in jute was similar to that in cottonseed oil (Abdel-Nabey *et al*., 1992). However, variation in the amount and composition of lipid may be due to inherent differences among varieties and/or environment under which the seed developed.

Fatty acid composition of the jute seed oil was determined with GC (Figure 1). The ratio of saturates: monounsaturates: polyunsaturates, was found to be approximately 2: 3: 4, indicating that the proportion of PUFA found in jute seed oil was higher than saturated and monounsatuarted fatty acids. The predominant SFA found was 16:0 (range: 18.3 to 22.4) and other two minor fatty acids were 18:0 (range: 3.3 to 3.9) and 17:0 (range: 0.1 to 0.2). Only 16:0 was significantly different among the jute varieties. Fatty acids 18:1 (range: 10.2 to 36.0) and 16:1 (range: 0.2 to 0.4) were the main MUFA found in jute seed oil. Most predominant PUFA was linoleic acid (18:2, n-6) (40-65% of total fatty acid). JN had the highest PUFA followed by JK, JY, and JC (Table 3). Another PUFA was 18:3, n-3, ranging from 0.4 to 1.5% of total fatty acid. The fatty acid composition of jute

Table 3. Fatty acid composition of jute seed oils.

Seeds	SFA				MUFA			PUFA		
	16:0	17:0 ^{ns}	18:0 ^{ns}	Total	16:1 ^{ns}	18:1	Total	18:2 n-6	18:3 n-3	Total
Jute Nonn Soong	18.30±1.10^{b}	0.10±0.02	3.37±0.10	21.77±1.2^{3c}	0.25±0.05	10.25±0.14^{d}	10.49±0.19^{d}	66.23±1.04^{a}	1.51±0.25^{a}	67.74±1.28^{a}
Jute Keaw Yai	18.70±1.07^{b}	0.26±0.17	3.46±0.45	22.43±1.69^{b}	0.44±0.15	35.99±0.46^{a}	36.43±0.61^{a}	40.74±1.83^{b}	0.40±0.03^{b}	41.14±1.86^{bc}
Jute Cuba	22.42±0.61^{a}	0.17±0.10	3.98±0.12	26.57±0.84^{a}	0.44±0.28	32.80±0.17^{b}	33.24±0.45^{b}	39.72±0.77^{b}	0.47±0.04^{b}	40.19±0.81^{c}
Jute Khonkaen	20.31±1.88^{ab}	0.25±0.05	3.68±0.59	24.24±2.52^{ab}	0.41±0.22	30.82±0.82^{c}	31.23±1.05^{c}	49.94±3.03^{b}	0.58±0.09^{b}	44.53±3.13^{b}

Data presented as mean ± standard deviation. SFA = saturated fatty acids, MUFA = monounsaturated fatty acids and PUFA = polyunsaturated fatty acids. Numbers on the same row with differing superscripts are significantly different at $P \leq 0.05$.

seed oil was similar to soybean, cottonseed or rapeseed oil with respect to the high amount of 18:2, n-6 and low amount of 18:3, n-3 (Gunstone, 2003).

The four jute cultivars were significantly different in the four types of lipids (Table 2). The absence of DAG and FFA in JN may be due to the impact of genetics or environment. Effects of vegetable oil on blood cholesterol have been recently elucidated (Howell *et al*., 1998; Sarkkinen *et al*., 1998). Lipid in diacylglycerol (DAG) form was found to have a significant beneficial effect by lowering the serum triacylglycerol level (Yasunaga *et al*., 2001; Taguchi *et al*., 2000). The mechanism of the hypotriacylglycerolemia of dietary DAG has been proposed to be due to the reduction of re-esterification (by glycerol and free fatty acid) and chylomicron assembly in the small intestine, or to the reduction of subsequent secretion of chylomicron into the circulation (Taguchi *et al*., 2000).

Fatty acid composition in the jute oil samples was found to be significantly different. Total SFA was significantly higher in JK than in JY and JN (Table 3). JY contained the highest amount of MUFA, especially oleic acid (18:1), while JN contained significantly higher amount of PUFA than the other three cultivars.

Conclusion

Lipid content and composition, and fatty acid composition of jute seed oil varied greatly among different varieties. Results in this study indicate that jute seed could be a potential source of poly-unsaturated fatty acids. High level (~ 9.5%) of diacylglycerol (DAG) in some jute varieties will encourage its use as edible oil as this compound is known to have positive health effects.

References

Abdel-Nabey, A.A., Shehata, A.A.Y., Ragab, M.H. and Rossell, J.B. 1992. Glycerides of cottonseed oils from Egyptian and other varieties. Riv. Ital. Sostanze Grassr., 69: 443-447.

Azuma, K., Nakayama, M. and Koshioka, M. 1999. Phenolic antioxidants from the leaves of *Corchorus olitorius* L. J. Agric Food Chem., 47:

3963-3966.

Díalonnzo, R.P., Kozarek, W.J. and Wade, R.L. 1982. Glyceride composition of processed fats and oils as determined by gas chromatography. J. Am. Oil Chem., 59: 392-395.

Gunstone, F.D. 2003. Lipids for functional foods and nutraceuticals. The Oily Press, UK.

Howell, T.J., MacDougall, D.E. and Jones, P.J.H. 1998. Phytosterols partially explain differences in cholesterol metabolism caused by corn or olive oil feeding. J. Lipid Res., 39: 892-900.

Li, D., Ng, A., Mann, N. and Sinclair, A.J. 1998. Meat fat can make a significant contribution to dietary arachidonic acid. Lipids, 33: 437-440.

Li, D., Bode, O., Drummond, H. and Sinclair, A.J. 2003. Omega-3 (n-3) fatty acids. In Lipids for Functional Foods and Nutraceutricals, pp 225-262. Gunstone, F.D. (ed). The Oily Press, UK.

Mimouni, V., Christiansen, E.N., Blond, J.P., Ulmann, L., Poisson, J.P. and Bezard, J. 1991. Elongation and desaturation of arachidonic and eicosapentaenoic acid in rat liver. Effect of clofibrate feeding. Biochem. Biophys. Acta., 1086: 349-353.

Sarkkinen, E.S., Uusitupa, M.I.J,, Gylling, H. and Miettinen, T.A. 1998. Fat-modified diets influence serum concentrations of cholesterol precursors and plant sterols in hypercholesterolemic subjects. Metabolism, 47: 744-750.

Sinclair, A.J., Attar-Bashi, N.M. and Li, D. 2002. What is the role of alpha-linolenic acid for mammals? Lipids, 37: 1113-1123.

Taguchi, H., Watanabe, H., Onizawa, K., Nagao, T., Gotoh, N., Yasukawa, T., Tsushima, R., Shimasaki, H. and Itakura, H. 2000. Double-blind controlled study on the effects of dietary diacylglycerol on postprandial serum and chylomicron triacylglycerol responses in healthy humans. J. Am. Coll. Nutr., 19: 789-796.

Watanabe, H. and Matsuo, N. 2002. Diacylglycerols. **In** Lipids for Functional Foods and Nutraceuticals, pp. 113-148. Gunstones, F. (ed), The Oily Press, UK.

Yasunaga, K., Watanabe, H., Matsuyama, T., Nakaya, N., Katsuragi, Y., Tokimitsu, I. and Yasukawa, T. 2001. Long-term effect of dietary diacylglycerol on serum lipid and body-fat metabolism in humans. 92nd AOCS Annual Meeting Abstract, S54-S55.