Pak. J. Sci. Ind. Res. 2007 **50**(6) 377-379

Short Communication

Cis and *Trans* Monoenoic Fatty Acids of Hydrogenated Mango Kernel Fats

Zeeshan Ali[a]*, Muhammad Saleem[a], Hamid Latif Siddiqui[b] and Shahid Mahmood[a]
[a]Applied Chemistry Research Center, PCSIR Labs. Complex, Ferozepure Road, Lahore-54600, Pakistan
[b]Institute of Chemistry, University of the Punjab, Lahore, Pakistan

(received September 20, 2007; revised December 13, 2007; accepted December 15, 2007)

Abstract: The fats produced as a result of hydrogenation of the oils of three varieties of mango kernel (*Mangifera indica),* were found to consist of *trans* fatty acids, $C_{16:1}$ (0.02-0.60 %), $C_{18:1}$ (2.69-4.48 %), $C_{20:1}$ (0.02-0.04 %), $C_{22:1}$ (traces-0.05 %), $C_{24:1}$ (traces-0.02 %) in addition to *cis* fatty acids.

Keywords: *Mangifera indica*, agro-waste, hydrogenation, mango kernel fats, fatty acids

Edible vegetable oils are hydrogenated by passing hydrogen through them in the presence of nickel catalyst under specific conditions (Raie *et al.,* 1990). The vegetable ghee thus produced is used as cooking fat and is extensively used for the preparation of foods like doughnuts, french fries, cookies, breads and cakes. The hydrogenated fat thus produced resists deterioration through oxidation (Swern, 1982). During the process of hydrogenation, *trans* acids are produced (Katan *et al.,* 1995), which are not recommended for edible purposes (Willett *et al.,* 1994; Booyens *et al.,* 1988). Oleic acid ($C_{18:1}$) is the major acid in vegetable ghee which is converted into $C_{18:1}$ *trans* oleic acid known as elaidic acid. Gurr (1983) reported that the hydrogenated fat providing the *trans* fatty acids can easily be metabolized and provide energy in the body at the cost of unsaturated fatty acids. One of the factors responsible for cardiovascular diseases, is reported to be *trans* fatty acids which raise the low density lipoprotein (LDL) cholesterol level and lower the high density lipoprotein (HDL) cholesterol, when consumed at a sufficient level. According to Gatto *et al.* (2002), Judd *et al.* (2002) and Katan (2000) the increase in LDL cholesterol is directly proportional to the amount of *trans* fatty acids consumed. Pakistan produces excellent varieties of mangoes in large quantities which are consumed locally and exported as well. Mango kernels are abundantly available as agro-waste material in Pakistan. The present study was made on the kernel oils of three varieties of mango i.e., Chaunsa, Sindhri and Desi.

The oil was extracted through treating the powdered dried mango kernel with chloroform\ methanol (2:1, v/v) solvent mixture (Kallio *et al.*, 2006). The oils were hydrogenated to produce fats of high melting point. The hydrogenated fats were converted into methyl esters of fatty acids, purified by thin layer chromatography (TLC) and later on separated into saturated fatty acids, *trans* fatty acids and monoenoic fatty acids by the use of $AgNO_3$ impregnated TLC (Raie and Rehman, 1992). The *cis* and *trans* fatty acids were identified by GC analysis.

The quantity of oils produced by Chaunsa, Sindhri and Desi kernels was 4.80 g, 5.44 g and 5.90 g, respectively. Methylation was performed as per standard methods; methanol/benzene/acetyl chloride were used for methylation.

The R_f values of *trans* fatty acids were less than saturated fatty acids but higher than monoenoic fatty acids. All the fatty acids were separated quantitatively as methyl esters. The infrared spectra of *trans* fatty acids at 966 cm^{-1} was distinct from the *cis* acids but the carbonyl absorption of *trans* and *cis* fatty acids as methyl esters is the same i.e. 1740 /cm. Amounts of saturated *trans* and mono-enoic methyl esters in the oils of the three varieties of mango are given in Table 1.

High percentage of saturated fatty acids was found in seed oils of the three varieties of mangoes (Table 2). The fatty acids analysis of three varieties of mango kernel oils without hydrogenation shows composition of saturated fatty acids to be 52.79-60.51 %, monoenoic fatty acids 31.78-39.77 %, dienoic fatty acids 3.18-6.21 % and trienoic fatty acids 3.24-4.72 % (Ali *et al.,* 2007).

After the process of hydrogenation, dienoic and trienoic acids disappears altogether which is comprehensible due to conversion of trienoic acids to dienoic and dienoic to monoenoic, *trans* and saturated fatty acids (Swern, 1982) (Table 2).

*Author for correspondence; E-mail: shani363@yahoo.com

Table 1. *Cis* and *trans* fatty acids methyl esters in mango kernel fats

Fractions of methyl esters	R_f values	Chaunsa		Sindhri		Desi	
		Wt (mg)	Percent	Wt (mg)	Percent	Wt (mg)	Percent
Saturated	0.58	88.0	73.33	90.0	75.0	87.0	72.50
Trans	0.48	5.5	4.58	4.0	3.33	5.0	4.17
Monoenoic	0.36	26.5	22.09	26.0	21.67	28.0	23.33

Linolenic acid in the soybean oil, earlier in low percentage (7.70 %), disappears after hydrogenation; however, high percentage of linoleic acid, 46.90 % was reduced to 14.90 % and 16.70%, by using 23.0 % imported and 21.0 % locally prepared nickel catalyst, respectively (Raie *et al.*, 1990), but does not disappear. The melting point of fat, before and after hydrogenation was 34.0-35.8 °C and 37.0 °C, respectively. The previous workers reported the melting point of fats to be 32.0-35.8 °C (Uzoho *et al.*, 1997; Van Pee *et al.*, 1981), which is comparable with our findings. However, the temperature after hydrogenation is raised to 37 °C, which is the normal body temperature and recommendable for edible fats as these can be easily digested. The process of hydrogenation for vegetable oils is checked for partial saturation of unsaturated fatty acids and is sold under the name of vegetable ghee; it is utilized for the production of margarine, shortening and peanut butter etc., and is commercially used for the preparation of bakery and food products. The hydrogenation process saves the oil from flavour reversion and rancidity (Swern, 1982). The partial hydrogenation of mango seed oil would raise the melting point

Table 2. Fatty acid composition of three varieities of mango kernel fats before and after hydrogenation

Fatty acids	Fatty acid (%) before hydrogenation			Fatty acid (%) after hydrogenation		
	Chaunsa	Sindhri	Desi	Chaunsa	Sindhri	Desi
$C_{12:0}$	0.17	0.15	0.13	0.16	0.18	0.14
$C_{14:0}$	0.20	0.50	0.28	0.21	0.54	0.31
$C_{16:0}$	9.10	10.10	8.91	9.05	12.94	8.95
$C_{16:1}$	0.07	2.70	0.05	–	–	–
$C_{16:1}{}^{trans}$	–	–	–	0.03	0.60	0.02
$C_{18:0}$	42.03	44.31	49.20	62.00	60.28	60.57
$C_{18:1}$	39.05	30.27	31.10	22.09	21.67	23.33
$C_{18:1}{}^{trans}$	–	–	–	4.48	2.69	4.05
$C_{18:2}$	4.20	6.21	3.18	traces	traces	traces
$C_{18:3}$	3.24	4.72	4.53	–	–	–
$C_{20:0}$	0.53	0.45	0.83	0.84	0.56	1.12
$C_{20:1}$	0.32	0.12	0.31	–	–	–
$C_{20:1}{}^{trans}$	–	–	–	0.02	0.04	0.03
$C_{22:0}$	0.64	0.24	0.27	0.89	0.28	0.41
$C_{22:1}$	0.28	0.03	0.19	–	–	–
$C_{22:1}{}^{trans}$	–	–	–	0.04	traces	0.05
$C_{24:0}$	0.12	0.18	0.89	0.18	0.22	1.00
$C_{24:1}$	0.05	0.02	0.13	–	–	–
$C_{24:1}{}^{trans}$	–	–	–	0.01	traces	0.02
Saturated	52.79	55.93	60.51	73..33	75.00	72.50
Trans	–	–	–	4.58	3.33	4.17
Unsaturaed	47.21	44.07	39.49	–	–	–
Monoenoic	–	–	–	22.09	21.67	23.33

of the product but the modification by hydrogenation of mango kernel fat would not lead to product simulating the cocoa butter in thermal properties (Chaudhuri *et al.,* 1983).

References

Ali, Z., Siddiqui, H. L., Hamid, S. 2007. Mango components and kernel oils. *Sci. Int. Lahore* **19:** 51-54.

Booyens, J., Louwrens, C. C., Katzeff, I. E. 1988. The role of unnatural dietary *trans* and *cis* unsaturated fatty acids in the epidemiology of coronary artery disease. *Med. Hypotheses* **25:** 175-182.

Chaudhuri, P. G., Chakraborty, M. M., Bhattacharyya, D. K. 1983. Effect of hydrogenation on the thermal properties of sal (*Shorea robusta*), mango kernel (*Mangifera indica*) and Mowrah (*Madhuca latifolia*) fats. *Fette Seifen Anstrichmittel* **85:** 259-262.

Gatto, L. M., Lyons, M. A., Brown, A. J., Samman, S. 2002. *Trans* fatty acids affect the lipoprotein metabolism in rats. *J. Nutr.* **132:** 1242-1248.

Gurr, M. I. 1983. *Trans* fatty acids. *Int. Dairy Fed. Bull.* **166:** 5-18.

Judd, J. T., Baer, D. J., Clevidence, B.A., Kris-Etherton, P., Muesing, R. A., Iwane, M. 2002. Dietary *cis* and *trans* monounsaturated and saturated FA, plasma lipids and lipoproteins in men. *Lipids* **37:** 123-131.

Kallio, H., Korkiasaari, K., Sjovall, O., Suomela, J. P., Linderborg, K. 2006. The regiospecific position of 18:1 *cis* and *trans* monoenoic fatty acids in milk fat triacylglycerols. *J. Am. Oil Chem. Soc.* **83:** 407-413.

Katan, M. B., 2000. *Trans* fatty acids and plasma lipoproteins. *Nutr. Rev.* **58:** 188-191.

Katan, M. B., Zock, P. L., Mensink, R. P. 1995. *Trans* fatty acids and their effects on lipoproteins in humans. *Annu. Rev. Nutr.* **15:** 473-493.

Raie, M.Y., Rehman, S. 1992. Characterization of *cis-trans* monoenoic acids in vanaspati ghee. *Proc. Pak. Acad. Sci.* **29:** 69.

Raie, M. Y., Ahmad, M., Ashraf, M., Khan, S. A. 1990. Evaluation of regenerated nickel catalyst. Part IV. *Pak. J. Sci. Ind. Res.* **33:** 122-124.

Swern, D. 1982. *Bailey's Industrial Oil and Fat Products,* vol. **2**, 4th edition, John Wiley & Sons Inc., New York, USA.

Uzoho, C.A., Ejezie, C. N., Ofoefule, S. I. 1997. Physicochemical properties of *Mangifera indica* seed fat used as suppository base. *Nig. J. Nat. Prod. Med.* **1:** 32-34.

Van Pee, W. M., Boni, L. A., Foma, M. N., Hendrix, A. 1981. Fatty acid composition and characteristics of the kernel fat of different mango (*Mangifera indica*) varieties. *J. Sci. Food Agric.* **32:** 485-488.

Willett, W. C., Ascherio, A. 1994. Stampfer, M. J. *Trans* fatty acids: Are the effects only marginal? *Am. J. Public Health* **84:** 722-724.