PJN
ISSN 1680-5194

PAKISTAN JOURNAL OF NUTRITION

ANSInet
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorpjn@gmail.com

Pakistan Journal of Nutrition 11 (2): 145-149, 2012
ISSN 1680-5194

Total Trans Fat Content in Commercially Available Hydrogenated Vegetable Oils

Rabia Naz[1], Faqir Muhammad Anjum[1], Ghulam Rasool[1],
Muhammad Atif Nisar[2], Rizwana Batool[1] and Farhan Saeed[1]
[1]National Institute of Food Science and Technology, University of Agriculture, Faisalabad, Pakistan
[2]Department of Food Sciences, Bahauddin Zakariya University, Multan, Pakistan

Abstract: In the domain of food, many efforts were conducted in the past to study the diet and health linkages. However, the variety of food components and their effects on human metabolism demands thorough research scientist to bring systematic and coherent information for the end-user. Thus current research was performed to determine the total Trans fat content in selected brands of hydrogenated vegetable oils which are more popular among people of Pakistan. Five different brands for each of vegetable ghee and margarine were analyzed for assorted physicochemical characteristics and total trans fat content in hydrogenated vegetable oils available in Pakistan. Results showed that physicochemical characteristics varied significantly according to commercial brands. Specific gravity and refractive index revealed non significant variations. Among vegetable ghee samples, the highest value for melting point was found in V_3 (37.0°C) and lowest value was observed in the V_2 (35.6°C). On the other hand, for margarine it ranged from 37.1-49.7°C. Highest acid value and FFA contents were recorded in M_1 (0.25%, 0.5%) and V_5 (0.24%, 0.46%). Pakistani vanaspati has iodine value 69% while margarine has 64.7% Total trans fat content was significantly higher for all vegetable ghee, ranged from 5.36-33.03% and in margarine samples these varied from 1.56-23.99%. In the nutshell, quality and stability of V_2 and M_2 brand from vegetable ghee and margarine was found good and also trans fat content were low in these brands.

Key words: Hydrogenated oils, vegetable ghee, margarine, physicochemical properties, trans fat

INTRODUCTION

Hydrogenated vegetable oils are a key part of dietary fats of local population in Pakistan (Ratnayake and Gilani, 2004). The demand for vegetable oil in Pakistan has been increasing progressively and has seen rapid growth in this industry from two factory production units in 1947 to more than 40 factory production units in 1998 (GOP, 2005). Vegetable oils contribute as a good source of protein, vitamins, fat and essential fatty acids in the food and their quality in term of physicochemical properties and most importantly to recognize them as better food ingredient (Wardlaw, 1999; Arshad *et al*., 2008). By the standard specified; vegetable ghee should melt at the body temperature when taken orally. In the manufacture of vegetable ghee and margarine, hydrogenation is concerned. Hydrogenation involves saturation and isomerization of double bonds. This resulted in isomerization products are thick, consistent and long shelf life. At the same time small number of hydrogen atoms move around and converted into the trans configuration. Whereas, commercial hydrogenation is usually partial in order to get a strong malleable fat that is solid at room temperature, grease to get it melts during cooking and baking (Mozaffarian and Willett, 2007). Hydrogenated vegetable oils and prepare product after cooking and frying the sources of trans fats. Margarine and shortenings used in the production pastries and cookies, adding to main sources of trans fat in the diet owing to the high oil content of partially hydrogenated oil (Hunter, 2006). High amounts of trans fats in cereal-based foods are a worrisome matter for both quality control authorities and consumer health (Mahesar *et al*., 2010). Industrial-produced Trans Fatty Acid (TFA) have deleterious effects (Gebauer *et al*., 2011). Intake of Trans Fatty Acids (TFA) increases risk factors for Cardiovascular Disease (CVD) (Ascherio, 2006; Judd *et al*., 2002; Baer *et al*., 2004; Mensink *et al*., 2003). Specifically, TFA increase LDL-Cholesterol (LDL-C), decrease HDL-Cholesterol (HDL-C) and promote inflammation and endothelial dysfunction (Gebauer *et al*., 2007; Mozaffarian *et al*., 2009; Wallace and Mozaffarian, 2009). Trans fats are even more contributing to heart disease than saturated fats. It increases LDL ("bad" cholesterol) and lowers HDL ("good") cholesterol, whereas saturated fats raise both types of cholesterol levels in the blood. It can cause heart disease by other means, such as impaired functioning of the internal walls of blood vessels (De-Roos *et al*., 2001).

They also caused partial deficiency of Omega-3 fatty acids thus increasing the risk of heart attack (Larque *et al*., 2000; Simpoulos, 2002). Similarly, trans fat also

Corresponding Author: Farhan Saeed, National Institute of Food Science and Technology, University of Agriculture, Faisalabad, Pakistan

seemed to be associated with lower levels of linoleic acid is converted as a result of linoleic acid into trans fatty acid. For the maintenance of functional properties of hydrogenated oils; trans fat should substituted by saturated fatty acids (Pedersen and Kirkhus, 2008; Kyu *et al*., 2011). The fats are used in the manufacturing of margarine and spreads are about 15 to 25% trans fat. Most currently available bakery shortenings usually about 15 to 30% trans fat (Stender *et al*., 2006). In light of the fact that these partially hydrogenated vegetable oils are major source of trans fat is often used in baking, frying and routine cooking; it is best to avoid high trans fat diet. Trans fat can be eliminated in vegetable oil by applying high pressure, by the oil mixture, using saturated fatty acids and time temperature modification during hydrogenation (Nielsen, 2006). The purpose of this study was to assess the total trans fat content and other physico-chemical properties of vegetable ghee and margarine mostly used in Pakistan.

MATERIALS AND METHODS

Physicochemical analysis: Vegetable ghee and margarine samples were procured from local market and contents were analyzed for different quality attributes i.e. melting point, refractive index, free fatty acids specific gravity, acid value, peroxide value, saponification value, iodine value by the procedure given in AACC (2000) Method No 58-40, 58-20A, 58-15b, 58-16, 58-50, 58-30A respectively.

Trans fat analysis: Total trans fat content was find out in terms of elaidic acid (trans isomer of oleic acid). Preparation of FAMES: The Fatty Acid Methyl Esters (FAME) samples were prepared before analysis by Gas Chromatograph (GC-FID) following Method No. (58-17) in AACC (2000). Exactly 200 mg of well melted hydrogenated oil sample was weighed in a stoppered glass vial. Approximately 2.0 mL of GC grade hexane was added followed by the addition of 2 N methanolic Potassium Hydroxide (KOH). Vials were sealed and shaked for 30 sec and centrifuged. The top layer was removed and diluted with hexane. The esters were extracted with GC grade hexane. The esters obtained were analyzed by Shimadzu Gas Chromatograph Model 14-A (Shimadzu Co., Japan), using a polar capillary column DB-Wax (30m x 0.32mm x 0.25 µm) and a flame ionization detector and nitrogen as carrier gas at a flow rate of 30 mL/min. The operating conditions were maintained as; injector and detector temperature 260°C and initial column oven temperature was 1400°C for 5 min. Elaidic acid was identified by retention time and comparing with the fatty acid standard.

Statistical analysis: The data obtained for each parameter was subjected to statistical analysis using statistical level of significance $p \leq 0.05$. Analysis of Variance (ANOVA) technique was applied to settle on the level of significance. Means were further compared using Duncan's Multiple Range test (DMRt) following the methods as described by Steel *et al.* (1997).

RESULTS AND DISCUSSION

It is evident from the results that among all the samples there is a significant difference in the physical and chemical behavior, but the results for the refractive index and specific gravity revealed non significant variations (Fig. 1). Among the samples vegetable ghee melting point was found higher in V_3 (37.0°C) and lowest observed in the V_2 (35.6°C). However, for margarine ranged from 37.1-49.7°C. Maximum contents of FFA and acid value were recorded in V_5 (0.24%, 0.46%) and M_1 (0.25%, 0.5%). Saponification, Peroxide and iodine values for vegetable ghee remain.

The results showed that the physico-chemical properties vary according to the trade marks. Present findings are confirmed by the previous investigation of various scientific research. According to Eddy and Ekop (2007) palm oil has specific gravity and melting point; 0.8940 and 39.74°C, respectively. Although vegetable oils have saponification, acid and iodine value: 187-196 mgKOH/g, 0.4-1.2% and 82-119.4%, respectively (Otunola *et al*., 2009). Pakistani vanaspati has iodine value 69% (Kheiri and Bangi, 1985). Similarly, margarine has melting point 41.3°C and iodine value 64.7% (List, 2004). The same results were also reported by Moustafa and Stauffer (1997).

A large significant change in total content of trans fat was observed with in different vegetable ghee and various brands of margarine. The content of trans fat which are reported to increase blood cholesterol ranged from 5.36-33.03% and 1.56-22.99% in vegetable ghee and margarine, respectively. The maximum value of trans fats in vegetable ghee was observed in V_3 (33.03%) and lowest in V_2 (5.36%) as shown in (Table 1). While it is clear from (Table 2) that in the samples of margarine M1 (1.56%) has lowest trans fat content and M_3 (23.99%) has maximum percentage.

Table 1: Physicochemical analysis of vegetable ghee

Samples	Melting point (°C)	Refractive index	Specific gravity	Free fatty acid (%)	Peroxide value (meq/kg)	Acid value (%)	Saponification value (mg KOH/g)	Iodine vale (%)
V_1	36.1±0.35^{bc}	1.4699±0.006	0.9239±0.015	0.15±0.02^{d}	1.97±0.21^{b}	0.29±0.04^{d}	185.59±0.55^{c}	67.13±0.52^{b}
V_2	35.6±0.42^{c}	1.4654±0.004	0.9224±0.012	0.12±0.02^{e}	0.93±0.06^{c}	0.23±0.03^{e}	190.84±0.63^{a}	65.27±0.51^{c}
V_3	37.0±0.25^{a}	1.4668±0.004	0.9296±0.010	0.20±0.03^{b}	3.76±0.21^{a}	0.40±0.06^{b}	186.40±0.75^{c}	63.88±0.43^{d}
V_4	36.4±0.38^{b}	1.4687±0.009	0.9167±0.020	0.17±0.03^{c}	1.77±0.31^{b}	0.34±0.05^{c}	188.05±0.44^{b}	67.36±0.50^{b}
V_5	36.2±0.20^{b}	1.4669±0.006	0.9135±0.015	0.24±0.04^{a}	1.03±0.06^{c}	0.46±0.07^{a}	184.40±0.60^{d}	69.60±0.55^{a}

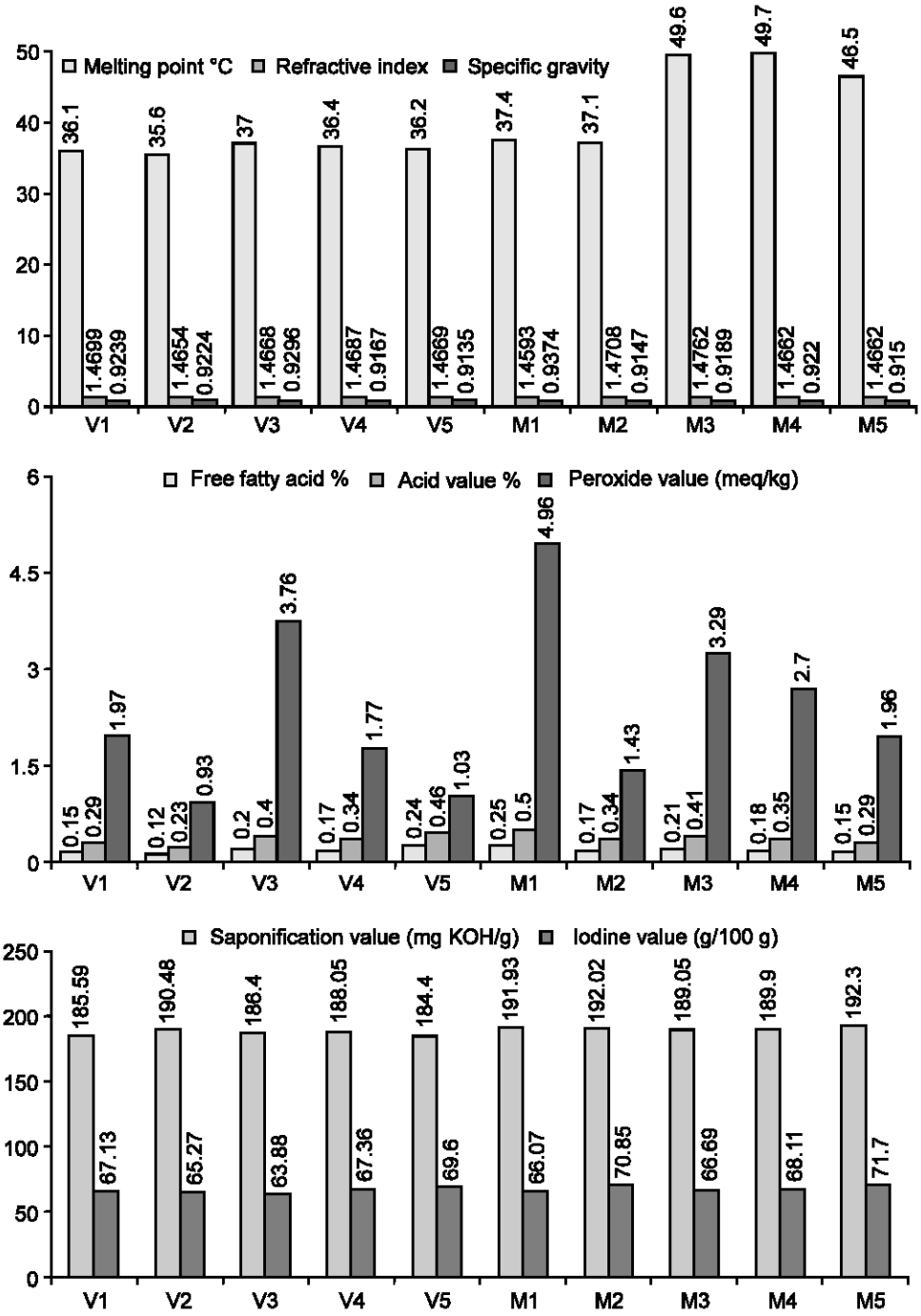

Fig. 1: Physicochemical properties of hydrogenated vegetables oils

Table 2: Physicochemical analysis of margarine

Samples	Melting point (°C)	Refractive index	Specific gravity	Free fatty acid (%)	Peroxide value (meq/kg)	Acid value (%)	Saponification value (mg KOH/g)	Iodine vale (%)
M_1	37.4±0.31^{c}	1.4593±0.02	0.9374±0.01	0.25±0.04^{a}	4.96±0.21^{a}	0.50±0.07^{a}	191.93±0.66^{a}	66.07±0.39^{c}
M_2	37.1±0.25^{c}	1.4708±0.01	0.9147±0.02	0.17±0.03^{c}	1.43±0.32^{e}	0.34±0.05^{c}	192.02±0.62^{a}	70.85±0.50^{a}
M_3	49.6±0.45^{a}	1.4762±0.01	0.9189±0.02	0.21±0.03^{b}	3.26±0.21^{b}	0.41±0.06^{b}	189.05±0.50^{b}	66.69±0.44^{c}
M_4	49.7±0.15^{a}	1.4662±0.02	0.9220±0.01	0.18±0.03^{c}	2.70±0.26^{c}	0.35±0.04^{c}	189.90±0.45^{b}	68.11±0.56^{b}
M_5	46.5±0.30^{b}	1.4662±0.01	0.9150±0.02	0.15±0.02^{d}	1.96±0.21^{c}	0.29±0.04^{d}	192.30±0.55^{a}	71.70±0.56^{a}

Table 3: Trans fat contents in vegetable ghee

Samples	TFA (%)
V_1	18.57±0.93[d]
V_2	5.36±0.27[e]
V_3	33.03±1.67[a]
V_4	28.85±1.45[b]
V_5	22.11±1.11[c]

Table 4: Trans fat contents in margarine

Samples	TFA (%)
M_1	19.04±0.95[c]
M_2	1.56±0.08[e]
M_3	23.99±1.20[a]
M_4	22.16±1.11[b]
M_5	6.73±0.34[d]

Total trans fat %age was similar to the previous results. Bhangera and Anwar (2004) reported that trans fat %age in margarine are in the range of 1.6-23.1% and vanaspati showed significantly higher amounts of trans fat (from 14.2-34.3%). Jeyarani and Reddy (2005) found that trans fat in margarine has total upto 32.0%. Results for vegetable ghee and margarine were comparable to those of marketed in Pakistan (Anwer *et al*., 2006; Kandhro *et al*., 2008) These result were different from the findings of Ovensen *et al*. (1996) that Denmark margarine trans fat %age in all samples was 3.0%.

Conclusion: As a principal and essential frying component, edible hydrogenated vegetable oils were characterized with special reference to their fatty acid profile. The total trans fat content was evaluated in different oils by GC-FID. All sample contained trans fat and some had very higher amounts of trans fat, which is potentially high amounts of trans fats are a worrisome matter for both quality control authorities and consumer health. Therefore, individual firms, consumers and standard control authorities should all play a role to overseeing this alarming issue.

REFERENCES

AACC, 2000. Approved Methods of the American Association of Cereal Chemists, (10th Edn.). American Association of Cereal Chemists, Inc. St. Paul, MN, USA.

Arshad, M.U., S. Zakir, F.M. Anjum, T. Zahoor and H. Nawaz, 2008. Nutritive value of cookies containing wheat germ oil. Pak. J. Life Soc. Sci., 6: 127-134.

Anwer, T., M.I. Bhanger, F. Anwer, M. Khan, R. Shahaid and S. Iqbal, 2006. A comparative characterization of different non-conventional oilseeds found in Pakistan. J. Chem. Soc. Pak., 28: 144-148.

Ascherio, A., 2006. Trans fatty acids and blood lipids. Atheroscler. Suppl., 1: 25-27.

Baer, D.J., J.T. Judd, B.A. Clevidence and R.P. Tracy, 2004. Dietary fatty acids affect plasma markers of inflammation in healthy men fed controlled diets: A randomized crossover study. Am. J. Clin. Nutr., 79: 969-973.

Bhangera, M.I. and F. Anwar, 2004. Fatty acid composition and contents of trans unsaturated fat in hydrogenated vegetable oils and blended fats from Pakistan. JAOCS., 81: 129-134.

De-Roos, N.M., M.L. Bots and M.B. Katan, 2001. Replacement of dietary saturated fatty acids by trans fatty acids lowers serum HDL cholesterol and impairs endothelial function in healthy men and women. Arterioscler. Thromb. Vasc. Biol., 21: 233-237.

Eddy, N.O. and A.S. Ekop, 2007. Effect of additives on some physical parameters of palm oil. J. Chem., 4: 350-353.

GOP (Government of Pakistan), 2005. Agricultural Statistics of Pakistan, 2003-2004. Ministry of Food, Agriculture and Livestock, Government of Pakistan, Islamabad.

Gebauer, S.K., F. Destaillats, Z. Mouloungui, L. Candy, J.B. Bezelgues, F. Dionisi and D.J. Baer, 2011. Effect of trans fatty acid isomers from ruminant sources on risk factors of cardiovascular disease: Study design and rationale. Contem. Clin. Trials., 32: 569-576.

Gebauer, S.K., T.L. Psota and P.M. Kris-Etherton, 2007. The diversity of health effects of individual trans fatty acid isomers. Lipids., 42: 787-799.

Hunter, E., 2006. Dietary trans fatty acids review of recent human studies and food industry responses. J. Lipid., 41: 967-992.

Jeyarani, T. and S.Y. Reddy, 2005. Physicochemical evaluation of vanaspati marketed in India. J. Food Lipid., 12: 232-242.

Judd, J.T., D.J. Baer, B.A. Clevidence, P. Kris-Etherton, R.A. Muesing and M. Iwane, 2002. Dietary cis and trans monounsaturated and saturated FA and plasma lipids and lipoproteins in men. Lipids, 37: 123-31.

Kandhro, A., S.T.H. Sherazi, S.A. Mahesar, M.I. Bhanger, M.Y. Talpur and Abdul-Rauf, 2008. GC-MS quantification of fatty acid profile including trans FA in the locally manufactured margarines of Pakistan. Food Chem., 109: 207-211.

Kheiri, M.S.A. and B.B. Bangi, 1985. Palm oil products in cooking fats. JAOCS., 62: 410-416.

Kyu, C., K. Sungkyun, K.K. Harpreet, X.L. Qing and J. Soojin, 2011. Quantification of trans fatty acid content in French fries of local food service retailers using attenuated total reflection - Fourier transform infrared spectroscopy. Food Chem., 125: 1121-1125.

Larque, E., F. Perezllamas, V. Puerta, M.V. Giron, M.D. Suzarez, S. Zamora and A. Gil, 2000. Dietary trans fatty acids effect decosahexaenoic acid concentration in plasma and liver but not brain of pregnant and fatal rats. Pediatr. Res., 47: 278-283.

List, G.R., 2004. Decreasing trans and saturated fatty acid content in food oils. J. Food Technol., 58: 23-31.

Mahesar, S.A., A.A. Kandhro, L. Cerretani, A. Bendini, S.T.H. Sherazi and M.I. Bhanger, 2010. Determination of total trans fat content in Pakistani cereal-based foods by SB-HATR FT-IR spectroscopy coupled with partial least square regression. Food Chem., 123: 1289-1293.

Mensink, R.P., P.L. Zock, A.D. Keste and M.B. Katan, 2003. Effects of dietary fatty acids and carbohydrates on the ratio of serum total to HDL cholesterol and on serum lipids and apolipoproteins: A meta-analysis of 60 controlled trials. Am. J. Clin. Nutr., 77: 1146-1155.

Moustafa, A. and C. Stauffer, 1997. Use of shortenings in bakery foods. In: Bakery Fats (edited by A. Moustafa and C. Stauffer). St Louis, MO: American Soybean Asssociation, pp: 29.

Mozaffarian, D., A. Aro and W.C. Willett, 2009. Health effects of trans-fatty acids: Experimental and observational evidence. Eur. J. Clin. Nutr., 63 (Suppl 2): S5-S21.

Mozaffarian, D. and W.C. Willett, 2007. Trans fatty acids and cardiovascular risk: A unique cardio metabolic imprint? Curr. Atheroscler. Rep., 9: 486-493.

Nielsen, K., 2006. Is the quality and cost of food affected if industrially produced Trans fatty acids are removed. Atheroscler. Suppl., 7: 61-62.

Otunola, G.A., G.B. Adebayo and O.G. Olufemi, 2009. Evaluation of some physicochemical parameters of selected brands of vegetable oils sold in Ilorin metropolis. Int. J. Phys. Sci., 4: 327-329.

Ovensen, L., T. Leth and K. Hanson, 1996. Fatty acid composition of Danish margarine and shortening, with special emphasis on trans fatty acid. J. Lipids., 31: 971-445.

Pedersen, J.I. and B. Kirkhus, 2008. Fatty acid composition of post trans margarines and their health implications. Lipid. Technol., 20: 132-135.

Ratnayake, W.M.N. and G.S. Gilani, 2004. Nutritional and health effects of dietary fats. Pak. J. Nutr., 3: 205-212.

Simpoulos, A.P., 2002. The importance of the ratio of omega 6/omega 3 essential fatty acid. Biomed. Pharmacother., 56: 365-379.

Stender, S., J. Dyerberg and A. Astrup, 2006. Consumer protection through a legislative ban on industrially produced trans fatty acids in foods in Denmark. Scand. J. Food. Nutr., 50: 155-160.

Steel, R.G.D., J.H. Torrie and D. Dicke, 1997. Principles and Procedures of Statistics. McGraw-Hill.

Wallace, S.K. and D. Mozaffarian, 2009. Trans-fatty acids and nonlipid risk factors. Curr. Atheroscler. Rep., 11: 423-433.

Wardlaw, G.M., 1999. Perspectives in nutrition, (4th Edn.). McGraw-Hill Company, United States of America, pp: 114-118.