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THE EFFECT "TRANS FATTY ACID LEVEL AND SOME QUALITIES OF SELECTED HYDROGENATED FOOD PRODUCTS IN THE MARKETS OF MEKELLE

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ABSTRACT

Mass production of foods and extremely large variety of food products make the quantification of their nutrient composition a difficult task. Regulations on mandatory product labeling vary from country to country, but rarely include details of fatty acid composition. Ethiopia imports several tons of food items composed of entirely fatty acids and considerable amount of fat. However, there is no regulatory basis for control of fatty acid composition. Therefore, the present study has been initiated to evaluate the hydrogenation process and determine the TFA level and some physicochemical characteristics of hydrogenated food products in the markets of Mekelle. Samples in triplicate from each of the selected commercial margarines (M1, M2, M3), vegetable ghee (G1, G2, G3) and shortenings (S1, S2, S3) were analyzed for their physicochemical characteristics and fatty acid composition. Physicochemical characteristics were determined following standard methods. The total composition of fatty acids of the isolated fat was determined by gas chromatography (GC). Characterization of the fatty acids was done using commercial standard reference material of fatty acid methyl esters (FAME).. The data obtained from the laboratory analysis were subjected to ANOVA using SPSS software. TFA level of 3% was used as a reference mean (control). All the TFA means were then compared and significance was set at 5% level. The results showed that all the samples contained a considerable amount of TFA ranging from 18.9 to 52.6%, and significant mean differences were observed at $p< 0.05$. The physicochemical characteristics and other fatty acid values were found to be within the recommended range. Investigation of the *hydrogenation process at AMEOC revealed that the high TFA is partly related to the hydrogenation method currently employed in the complex. The present study clearly indicated that the hydrogenated food products in Mekelle markets contain higher TFA levels compared to the same products studied in Europe and America. In this situation, continuous consumption of both local and imported hydrogenated food products may expose to greater risk of cardiovascular diseases. Reducing Trans fatty acids through process optimization and introduction of enzymatic inter esterification isunquestionablyessential.*

KEYWORDS: *Mass production, TFA level, AMEOC revealed.*

INTRODUCTION

The production of oils from oilseeds and oil-rich fruits such as the olive and palm almost certainly pre-dates biblical times, but oil modification processes are generally not more than one hundred years old (Hamm, 2005). The widespread use of the three oil modification processes namely; hydrogenation, interesterification and fractionation in the twentieth century extended the range of applications of the triglyceride oils almost beyond recognition. These processes principally serve the purpose of modifying the melting properties of oils and fats in order to improve their functional properties in specific applications, but the processes are also used to improve the stability of the oils and fats thus processed (Hamm, 2005; ISEO, 2006).

Hardening of fats is produced by the addition of hydrogen to double bonds in the chains of fatty acids in triacylglycerols (Hamm, 2005). This process has a vital role in the fats and oils industry because it achieves two main goals. In the first place, it permits the transformation of liquid oils into semisolid fats more indicated for specific applications, as in the cases of margarine and shortenings, and secondly, it results in materials with an improved stability (Pollock, 2004; ISEO, 2006).

In the field of edible oil processing, fractionation almost always refers to the mechanical separation of the liquid from the crystallized solid constituents of a given oil or fat. The split between liquid and solid fractions depends on the temperature at which crystallization is carried out (Hamm, 2005; ISEO, 2006).

Natural fats do not have perfect distribution of fatty acids among the glyceride molecules and the tendency for certain fatty acids to be more concentrated at particular positions varies according to the species, environment and location in the plant or animal (Hamm, 2005). The physical characteristics of s fat are greatly affected not only by the nature of constituent of fatty acids (i.e. chain length and level of unsaturation) but also by their distribution in the triacylglycerol molecules. In effect, the unique fatty acid distribution patterns of some natural fats limit their industrial applications

In Ethiopia, different factory which carries out hydrogenation process to produce margarine and vegetable ghee. It produces 6554 tons of margarine and vegetable ghee annually. However, such amount of production is insufficient as compared with existing homeland consumer needs. Thus, a considerable amount of hydrogenated products were imported. The Ministry of Health and Customs Authority registered four types of shortenings and six types of vegetable ghee and margarines in the market. According to the data obtained from Ethiopian Customs Authority, there was a rapid increase of the amount imported in each year. For instance, it was about 3421 tons in 2003/4 and increased to about 7591 tons in 2005/6. On the other side, basic data and assessment of quality control of imported fats seem to be until yet not established.

Several epidemiological and clinical studies were carried out to investigate the effect of *trans* fatty acids on human health specially on chronic illnesses. The possible public health relevance of dietary *trans* fats was emphasized by a study reporting that the level of *trans* fatty acid intake was directly associated with increased risk of cardiovascular disease (Hu, *et al*., 1997).

In the human body, the effects of *trans* fats have been shown to be a more hazardous risk factor for heart disease than saturated fats. Studies have shown that dietary *trans* fats can increase levels of “bad” LDL (Low Density Lipoprotein) cholesterol and decrease levels of “good” HDL (High Density Lipoprotein) cholesterol. It can also increase triglyceride and lipoprotein levels which are risk factors for cardiovascular diseases (AHA, 2006).

In Ethiopia where several tons of food items composed of entirely fatty acids and having a considerable amount of fat were imported from abroad; there is no until yet regulatory basis for control of fatty acid composition and consumption of *trans* fatty acids is continuing with out knowing the level of the products. But these days, several consumers started questioning the use of vegetable fats.

Therefore, the present study has been initiated to determine the *trans* fatty acid level and some physicochemical characteristics of hydrogenated products in the markets of mekelle. Thus, this study will give insight on the technological advantages of the production of low level *trans* fatty acids and control of the imported and locally produced items. Furthermore, it creates public awareness and may provide a good input for policy makers and researchers to protect the community from taking unacceptable food items.

OBJECTIVES

General objective

The general objective of this research is to determine the *trans* fatty acid levels and some qualities of selected hydrogenated food products

Specific objectives

To identify *trans* fatty acid levels of hydrogenated food products which have great implication on human health

To determine some physicochemical properties of the products

EXPERIMENTAL

The experimental work was carried out in the laboratories of, Ethiopian agriculture Research Institute, the departments Chemistry of Mekelle University, for the different variables or components of hydrogenated food products .(trans fatty acid, total fatty acid, saturated fatty acid, mono saturated fatty acid, polyunsaturatedfatyacid ,moisture content free fatty acid, iodine value, peroxide value, refractive index , melting point, saponification value)

Sample preparation

Commercial margarines, vegetable ghee and shortenings were obtained from the supermarkets, shops, groceries, etc. in Mekelle. Three types (treatments) from each category were selected for the analysis. These treatments were coded due to ethical reasons as M1, M2, M3 for margarines; G1, G2, G3 for vegetable ghee, and S1, S2, S3 for shortenings. Within each treatment samples in triplicate were kept refrigerated till analysis has started.

Before analysis, each of the samples was homogenized, heated to a temperature of 10 ^{0}C above its melting point, and filtered according to the procedure indicated in ISO 661:2003(E Fatty acid methyl esters (FAME) were prepared by Methanolic Boron Triflouride (13-15%) following ISO 5509:2000(E) procedures (Annex 2) and analyzed as soon as possible.

Experimental design and data collection

Experimental design

Laboratory based experimental study was carried out using vegetable ghee, margarine and shortening samples under completely randomized design (CRD).

Analytical methods

Physicochemical analysis

Melting point was determined by ISO 6321: 1997 procedure (Annex-3) whereas IUPAC (1979) was used for density. Density was determined at a temperature of 60^0C and reported as g/ml using the following formula: Density at t (g_t) = $\frac{M1 - Mo}{Vt}$; Where, M_o mass of empty pyknometer,

M_1 is the total mass of pyknometer and sample, V_t is volume of pyknometer .Method indicated in IUPAC (1979) was used to determine moisture content and theresult is expressed as: Moisture content = $\frac{m - m1}{m} x100$, Where, *m* is the mass in g of test sample *m* and m_1 is the mass in g of the fat after heating.Titration methods by 0.5 m hydrochloric acid and 0.1 m thiosulphate solution were used for the determination of saponification and iodine value, respectively, as indicated in Egan, *et al.* (1981). Then saponification value is obtained as:Saponification value = $\frac{(b - a)}{m} x28.05$Where, *a* is amount in ml of hydrochloric acid used for the sample titration, *b* is the amount in ml of hydrochloric acid for balk titration and *m* weight of sample in g. Whereas iodine value is calculated using: Iodine value= $\frac{12.69C(V1 - V2)}{M}$ Where;

C is the numerical value of the exact concentration in moles per liter of the standard volumetric sodium thiosulphate, V_1 is the numerical value in the milliliters of standard volumetric sodium thiosulphate solution used for the blank, V_2 is the numerical value in the milliliters of standard volumetric sodium thiosulphate solution used for the determination of the test sample and M is the numerical value of the mass ingramsofthetestportion.

Abbe type refractometer was used at a temperature of 60^0C for refractive index determination. Refractive index (n) at t (n_t) = n_{t1} + (t_1- t) F if t_1>t and (n_t) = n_{t1}+ (t-t_1) F if t_1<t; Where, t_1 is the reading temperature, t is the prescribed temperature, F is equal to 0.00035 at t =20^0C, F is equal to 0.00036 at t = 40^0Cand t =60^0C (annex-5). Titration with 0.002m sodium thiosulphate using starch indicator was employed to determine peroxide value (Annex-7). Free fatty acid was also determined by titration (IUPAC, 1979; Egan *et al*., 1981). The result

is expressed as:

Acid value = $\frac{Titration(ml)}{M}x5.61$; Where, *m* is mass of the sample used in g and Acid value = 2xFFA .

Fatty acid composition

The total composition of fatty acids of the isolated fat was determined by gas chromatography (GC) using a GC1000 Dani (Italy, 2002) chromatograph equipped with auto sampler and Flame Ionization Detector (FID) following ISO 15304:2003(E). EC^{Tm}-5 column (50 m, 0.32-mm i.d., 0.20-mm film thickness) was used and the column temperature was programmed as 50 ^{0}C (2 minutes), 4^{0}C/min to 250^{0}C and then kept at this temperature for 15 minutes. Nitrogen was used as a carrier gas with a flow rate of 1ml/min. The injector and detector temperatures were 210^{0}C and 260^{0}C, respectively with split mode injector. With the above conditions, the total run time was about 67 minutes. The peaks were identified in comparison with commercial reference material of FAME components and the results were reported in terms of FAME percentages of peak areas by giving emphasis to *trans* fatty acids and major fatty acid compositions as indicated in ISO 15304:2003(E).

Data analysis

The data obtained from the experiment were subjected to analysis using statistical software, SPSS (Statistical Package for Social Sciences) version 13.0. A 3% mean *trans* fatty acid level was used as a reference (control). Accordingly, ANOVA, mean comparison and significance were set at 5% level.

RESULTS AND DISCUSSION

Physicochemical characteristics and fatty acid composition of all commercial margarines (M1, M2, M3), vegetable ghee (G1, G2, G3), shortenings (S1, S2, S3), and process evaluation were carried out. The obtained results are tabulated and discussed hereunder:

Physicochemical analysis

Physicochemical characteristics determined for all commercial margarines, vegetable ghee and shortenings are indicated in Tables 1, 2 and 3.

Table 1. Some physicochemical characteristics of commercial margarines (M1, M2, M3). (Mean + SD)

Parameters	M1	M2	M3	Recommended
Density, 60^0C (g/ml)	0.912+0.004	0.912+0.002	0.918+0.007	0.821-0.941
Melting point (^{0}C)	43.3+0.1	42.4+0.2	42.8+0.1	33- 44
Moisture content (%)	16.27+0.04	17.01+0.03	16.39+0.05	<17
Refractive index, 60^0C	1.465+0.003	1.466+0.002	1.465+0.001	1.46- 1.47
Free Fatty acid(%as oleic acid)	0.156+0.009	0.114+0.005	0.198+0.003	<0.3
Peroxide value(mEq/kg)	10.26+0.05	8.81+0.01	19.98+0.05	<10
Saponification value(mgKOH/g)	190.13+0.11	190.07+0.1	192.09+0.2	185-200
Iodine value(g I/100g)	55.63+0.01	52.41+0.02	51.59+0.01	45-60

Commercial margarines are found to have mean values from 0.910 to 0.919g/ml of density; from 42.4 to 43.3 ^{0}C of melting point and 16.27 to 17.01% of moisture content on dry basis. Peroxide value ranges from 8.81 to 19.98 mEq/kg with MO3 having the highest value while free fatty acid calculated as oleic acid for all margarine samples is 0.114 to 0.198% (Table 1). The results for all the physicochemical parameters are in the normal range required for margarines except the peroxide value of MO3 (19.98 mEq/kg) which is higher than the required level. For fresh and normal margarines, the peroxide value should not exceed 10 mEq/kg. Egan, et al (1981) indicated that rancidity becomes noticeable if the peroxide value exceeds 20 mEq/kg.

In commercial vegetable ghee, density varies from 0.892 to 0.899 g/ml while melting point is between 40.0^{0}C and 41.3^{0}C. Free fatty acid and peroxide value range from 0.168 to 0.220% oleic acid and 11.87 to 18.95 mEq/kg respectively. Commercial shortenings are found to have the highest melting point (44.1 to 44.9^{0}C) and the lowest free fatty acid relative to margarines and vegetable ghee analyzed. All other parameters analyzed in this study were indicated in Tables 2 and 3.

Table 2. Some physicochemical characteristics of commercial vegetable ghee (G1, G2, G3) (Mean + SD)

Parameters	G1	G2	G3	Recommended
Density, 60^0C (g/ml)	0.892+0.006	0.894+0.05	0.899+0.007	0.881-0.901
Melting point (^{0}C)	40.0+0.2	40.3+0.1	41.1+0.2	37-43
Refractive index, 60^0C	1.467+0.002	1.469+0.002	1.466+0.003	1,46-1.47
Free fatty acid (%as oleic acid)	0.172+0.02	0.168+0.01	0.220+0.01	< 0.3
Peroxide value (mEq/kg)	11.87+0.04	12.21+0.02	18.95+0.04	<10
Saponification value (mgKOH/g)	193.85+0.17	194.89+0.13	192.41+0.23	185-200
Iodine value (g I/100g)	43.71+0.01	44.22+0.01	45.48+0.01	40-53

Peroxide value for GO3 is higher than the required level which indicates the poor quality of the sample. FAO/WHO joint committee standard for such products indicates that peroxide value should not exceed 10 mEq/kg; the free fatty acid should also be less than 0.3% and the slip melting point between 37 to 43^{0}C for vegetable ghee and 41 to 51^{0}C for shortenings. As indicated in Tables 2 and 3, other physicochemical characteristics of commercial vegetable ghee and shortenings are in recommended normal range for such products.

Table 3. Some physicochemical characteristics of commercial shortenings (SO1, SO2, SO3)

Parameters	S1	S2	S3	Recommended
Density, 60^{0}C (g/ml)	0.877+0.007	0.881+0.002	0.882+0.008	0.851-0.899
Melting point (^{0}C)	44.7+0.1	44.9+0.1	44.1+0.2	41-51
Refractive index, 60^{0}C	1.469+0.002	1.469+0.002	1.468+0.001	1.46-1.47
Free fatty acid (%as oleic acid)	0.089+0.01	0.099+0.004	0.064+0.002	<0.3
Peroxide value (mEq/kg)	8.99+0.02	9.91+0.02	9.14+0.02	<10
Saponification value (mgKOH/g)	191.01+0.04	192.24+0.1	192.07+0.2	185-200
Iodine value (g I/100g)	46.98+0.02	46.33+0.01	47.16+0.01	42-55

(Mean + SD)

Fatty acid composition

The fatty acid compositions were given in Tables 9, 10, and 11 whereas selected gas chromatograms of fatty acid methyl esters obtained from the gas chromatographic analysis are indicated in figures 6, 7 and 8. Other chromatograms are indicated in annex 12.

Palmitic acid (C16:0), the major component in all the samples ranged from 17.3 to 41.1 % in margarines, 21.3 to 49.9 % in vegetable ghee and 44.7 to 47.8 % in shortenings (Tables 4, 5, and 6). A study conducted in India on commercial Vanaspathi (popular hydrogenated product in India) indicated that the palmitic acid content was 36.4 to 53.0 % (Jeyarani and Reddy, 2005). Cetin, *et al.* (2003) found a range of 11.3 to 31.8 % in Turkish margarines whereas a recent study by Karabulut and Turan (2006) showed 23.8 to 38.4% in shortenings and 7.3 to 34.3% in margarines marketed in Turkey. Marekove, *et al.* (2002) reported 8.5 to 34.7 % for imported margarines; 12.7 to 19.6 for domestic margarines; and 6.3 to 45.9 % for frying fat in Bulgaria. The content of palmitic acid varies widely indicating the use of different oils with variable amounts of palmitic acid for the production of such products.

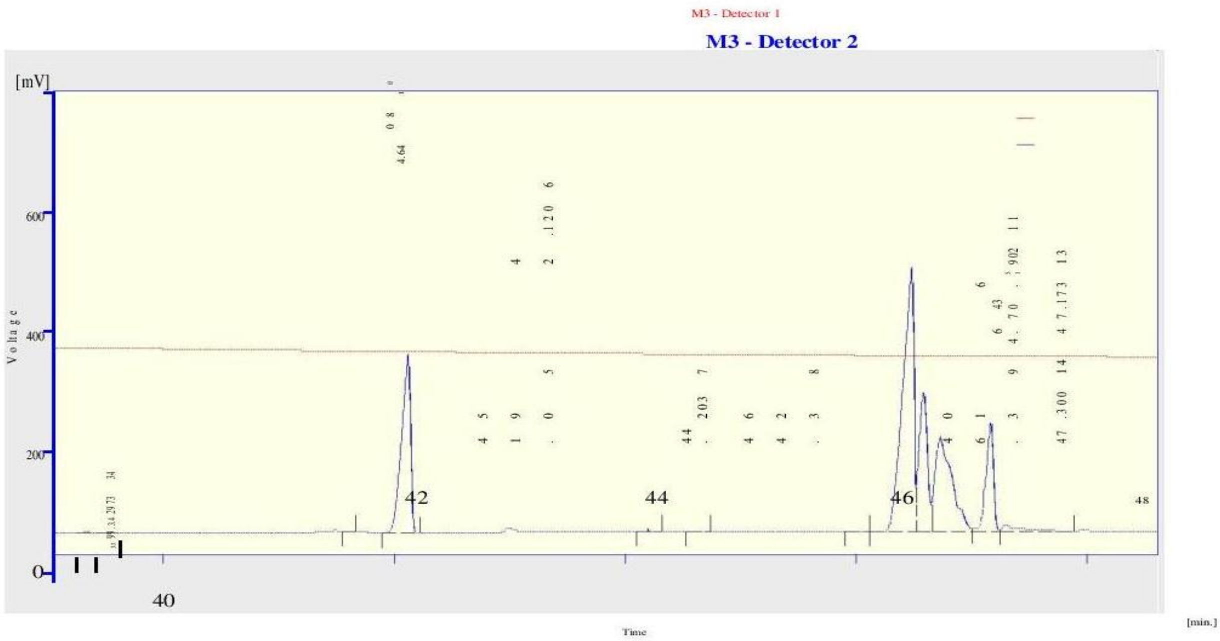

Fig.6. Gas Chromatogram of fatty acid methyl esters of commercial margarine (M3)

Table 4. Fatty acid composition (percentage of fatty acid methyl esters) of commercial margarine (M1, M2, M3)(Mean + SD)

Fatty Acid	M1	M2	M3
Myristic acid (C14:0)	0.9 ± 0.1	1.5 ± 0.2	Trace
Palmitic acid (C16:0)	41.2 ±0.1	37.5±0.1	17.3 ±0.1
Stearic acid (C18:0)	Trace	18.4±0.1	33.1 ±0.1
Oleic acid (C18: 1n9c)	14.8 ± 0.1	4.2 ±0.1	12.7±0.1
Elaidic acid (C18: 1n9t) [1]	36.4 ± 0.1	29.4 ±0.1	17.7 ±0.1
Linoelaidic acid (C18: 2n6t) [2]	4.9± 0.1	5.7 ±0.2	9.2 ±0.1
All others	1.8 ± 0.1	3.3 ±0.1	10.0 ± 0.1
All TFA*	41.3 ± 0.2[a]	35.1 ±0.2[b]	26.9 ±0.1[c]
Total	100.00	100.00	100.00

* TFA = *trans* fatty acid (the sum of [1] and [2]), Control TFA mean =3%[d]

*All TFA means including the control significantly differ from each other at $p < 0.05$

The most significant and major component obtained in this study is Elaidic acid (C18:1n9t) which ranges from 17.7 to 36.3% in margarines, 12.6 to 39.8% in vegetable ghee and 38.2 to 48.2% in shortenings (Tables 9, 10, and 11). A study carried out by Aro, *et al*. (1998) in different European countries showed *trans* fatty acid levels to be 2.4 to 50.2 % for frying and cooking fats and 0.3 to 28.1% for margarines. Marekove, *et al*. (2002) reported that the percentage varies from 0.3 to 27.0% for imported margarines, 0.2 to 11.2 % for domestic margarines and 0.2 to 47.5% for frying and cooking fats. The results indicate that the *trans* fatty acid levels of some products were reduced significantly while others still contain a very large amount.

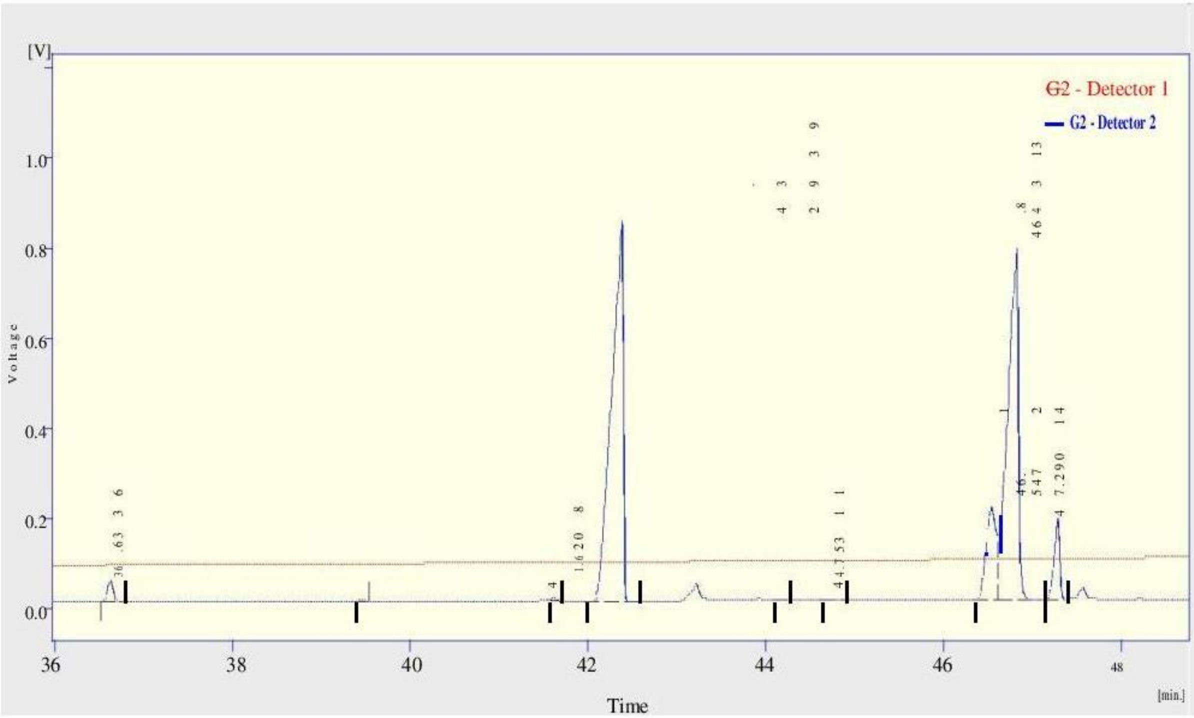

Fig.7. Gas Chromatogram of fatty acid methyl esters of commercial vegetable ghee (G2)

Cetin, *et al*. (2003) found a *trans* fatty acid content of 0.2 to 27.4 % in Turkish margarine but other study done in Turkey by Karabulut and Turan (2006) indicated the content to range from 2.0 to 16.5% in shortenings and 0.2 to 39.4 % in margarines. In Indian Vanaspathi the content varied from 5.9 to 30.0 % (Jeyarani and Reddy, 2005) whereas in Argentina the average TFA in margarines was found to be 27.5% (Tavella, *et al*., 2000). A study done in Czech Republic by Brat and Pokorny (1999) showed that the amount varied from 0.1 to 34.5 % in margarines and 0.2 to 38.1% in cooking fats.

Table 5. Fatty acid composition (percentage of fatty acid methyl esters) of commercial vegetable ghee (G1, G2, G3) (Mean + SD)

Fatty Acid	G1	G2	G3
Myristic acid (C14:0)	1.3 ± 0.1	1.1 ±0.1	0.9 ±0.1
Palmitic acid (C16:0)	49.9 ± 0.1	43.8±0.1	21.3 ±0.1
Stearic acid (C18:0)	7.6 ± 0.1	9.4 ±0.2	31.4 ±0.1
Oleic acid (C18: 1n9c)	Trace	Trace	15.9±0.1
Elaidic acid (C18: 1n9t) [1]	34.9 ± 0.2	39.8 ±0.1	12.5 ±0.1
Linoelaidic acid (C18: 2n6t) [2]	4.6 ± 0.1	4.4±0.1	6.4 ±0.1
All others	1.7 ± 0.2	1.5 ±0.1	11.6±0.1
All TFA*	39.5 ± 0.2 [a]	44.2 ±0.1 [b]	18.9 ±0.2 [c]
Total	100.00	100.00	100.00

* TFA = *trans* fatty acid (the sum of [1] and [2]), Control TFA mean =3% [d]

* All TFA means including the control significantly differ from each other at p≤ 0.05

Linoelaidic acid (C18:2n6t) content was found to range from 4.9 to 9.1% in margarines, 4.1 to 4.6% in shortenings and 4.4 to 6.4% in vegetable ghee which makes the total *trans* fatty acid content in all samples to significantly ranges range from 18.9 to 52.6% ($p < 0.05$). It has been observed that gram-for-gram the *trans* fatty acids (TFA) contained in commercially hydrogenated fats are associated with a considerably (2.5-fold to >10-fold) higher risk increment for heart diseases (Ascherio, *et al*., 1999; Stender & Dyerberg, 2003). Recognizing these effects, FAO/WHO (2003) has recommended an upper intake limit of 1% kcal of the diet for TFA in terms of energy. When compared with other studies, the total *trans* fatty acid content was higher in all the samples in this study. Because, none of the samples were found to contain less than 2 %, which was first used by Denmark as maximum value and now used as regulatory bases in most European countries (Stender and Dyerberg, 2003). In America, the level is below 2 % where a food product is labeled as *trans* free if it contains below 0.5 grams per 100gram of fat (AHA, 2006, FDA, 2006). Similarly joint FAO/ WHO (2006) indicates hydrogenated products should not be used in infant formula and the *trans* fatty acid content should be kept below 3% to prevent health risks. According to FAO/ WHO, to promote cardiovascular health, diets should provide very low intake (i.e., 1%) of *trans* fatty acids (hydrogenated fats) in terms of energy. This recommendation is extremely important in many developing countries where low-cost hydrogenated fat is frequently consumed (Nishida, *et al*., 2004).

Other fatty acids obtained in this study are also comparable with studies discussed above. For example, myristic acid (C14:0) as expected and reported in other studies was found to be lower in all the samples.

Table 6. Fatty acid composition (percentage of fatty acid methyl esters) of commercial shortenings (S1, S2, S3) (Mean + SD)

Fatty Acid	S1	S2	S3
Myristic acid (C14:0)	1.1 ± 0.1	1.2 ±0.1	1.4 +0.1
Palmitic acid (C16:0)	45.1± 0.1	44.6 ±0.1	47.8 ±0.1
Stearic acid (C18:0)	9.3 ± 0.1	0.1±0.1	0.1 ±0.1
Oleic acid (C18:1n9c)	Trace	Trace	Trace
Elaidic acid (C18:1n9t) [1]	38.2 ± 0.1	48.3 ±0.1	45.5±0.1
Linoelaidic acid (C18:2n6t) [2]	4.7 ± 0.1	4.3 ±0.2	4.1 ±0.1
All others	1.6 ± 0.1	1.5 ±0.2	1.1 ±0.1
All TFA*	42.9 ± 0.2 [a]	52.6 ±0.2 [b]	49.6 ±0.2 [c]
Total	100.00	100.00	100.00

* TFA = *trans* fatty acid (the sum of [1] and [2]), Control TFA mean =3%[d]

*All TFA means including the control significantly differ from each other at $p \leq 0.05$

Legislation introduced in Denmark in 2004 mandated that all oils and fats used in locally made or imported foods must contain less than 2% industrially produced *trans* fatty acids. This virtually eliminated *trans* fatty acids and had no effect on quality, cost, or availability of foods (Stender and Dyerberg, 2003). In January 2006, the US Food and Drug Administration mandated that all food manufacturers provide the content of *trans* fatty acids on nutrition labels for all manufactured foods (FDA, 2006).

The UK Food Standard Agency is currently pressing for revision of the European directive that governs the content and format of nutrition labels on foods marketed in the United Kingdom and other European countries so that these fats are labeled. The *trans* fatty acid content of commonly used and randomly selected foods consumed in the UK up to 2002 varied substantially between one type and another. Some margarine may now have lower concentrations of *trans* fatty acids, but consumers need to know which ones to choose. Mandatory addition of the content *trans* fatty acids to nutrition labels would enable consumers to make healthy food choices that could lower LDL concentrations and reduce the risk of coronary heart diseases and other vascular events (Weggemans, *et al.*, 2004).

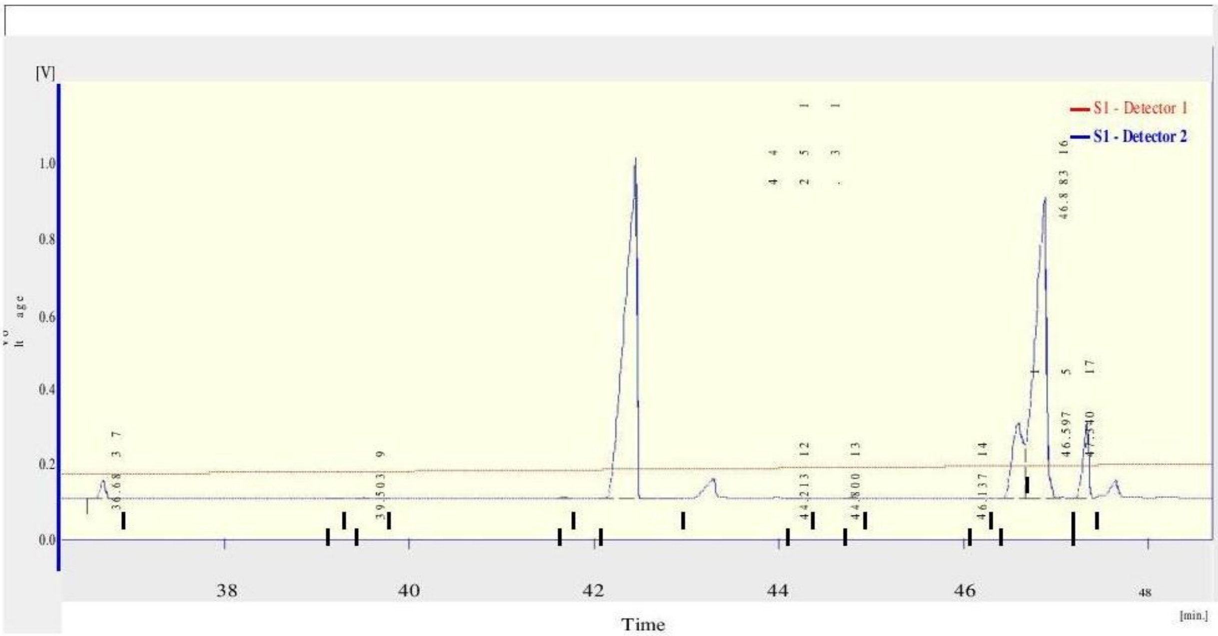

Fig.8. Gas Chromatogram of fatty acid methyl esters of commercial shortening (S1)

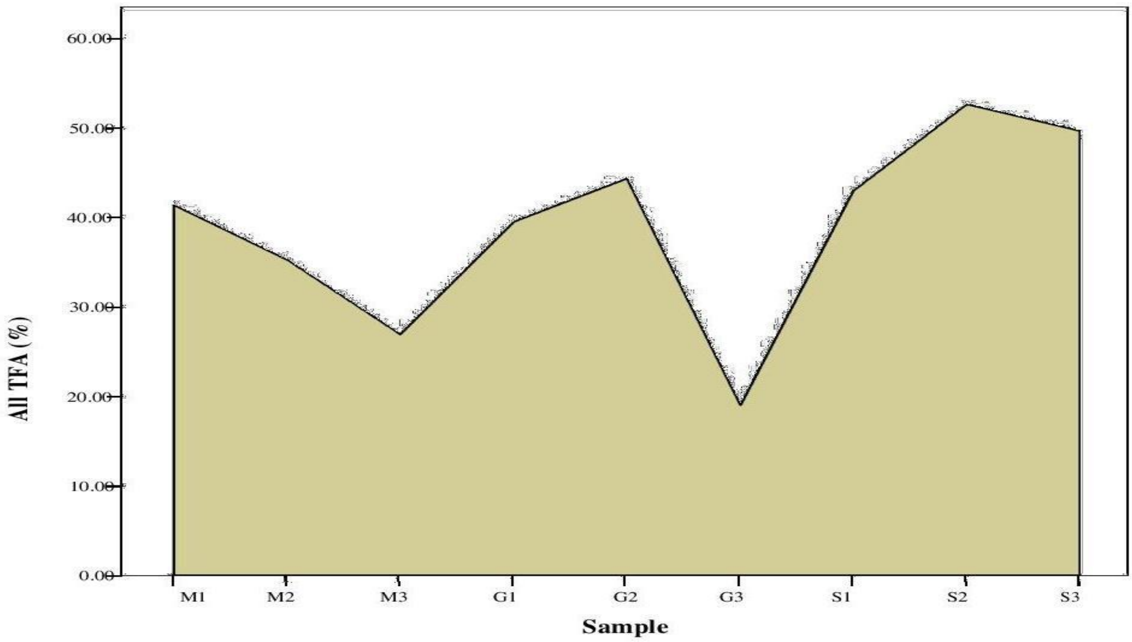

Fig.9. Mean values of all *trans* fatty acid content for the analyzed samples

CONCLUSION AND RECOMMENDATIONS

This study clearly indicates that hydrogenated food products in the markets of mekelle are high in *trans* fatty acid levels. As none of the samples analyzed was found to contain low contents of *trans* fatty acids, there is a risk of developing cardiovascular diseases. In similar studies carried out by various researchers in different countries, there are products in the market that are safe for consumers. It requires great effort and motivation as well as legal background for the control of some of these products. Production of margarine using enzymatic inter esterification reveals that it is possible to develop products with the desired quality. As indicated in the current study, many countries are trying to regulate *trans* fatty acids based on the research outcomes of epidemiological and metabolic studies. In our case, the present study is the first of its kind and encompasses both the *trans* fatty acid level and process opportunities to get the desired quality of the products.

In view of the problems associated with hydrogenated food products, the following recommendations are forwarded Concerned bodies especially Quality and Standard Authority and Ministry of Health should start the control work by establishing appropriate laboratories and legal framework.

Public awareness should be created with regard to consumption of such hydrogenated products by the Ministry of Health

FURTHER STUDIES ARE RECOMMENDED ON

- Detailed feasibility study for enzymatic interesterificatiion
- Daily intake of fats by placing emphasis on *tran*s fatty acid levels and the prevalenceofcardiovasculardiseases

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