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ANALYSIS OF FATTY ACID COMPOSITION IN CHICKEN FAST FOODS OF DHAKA CITY

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ABSTRACT

Fatty acid composition in chicken fast food was analyzed by attenuated total reflectance-Fourier transform infrared (ATR-FTIR) spectroscopy and gas chromatography-flame ionization detector (GC-FID). Saturated fatty acids (SFA), monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA) have been found in various amounts in the fast food samples. None of the fast food samples contain *trans* fatty acid. Chicken Winglet (A) and Chicken Hot Wings (B) have higher amount of saturated fatty acids (SFA) which are 28.73% and 25.92% respectively. The amount of saturated fatty acids (SFA) in Chicken Drumst (C), Chicken Botik (D), Fiery Grilled Chicken (E), Chicken Meatballs (F), and Chicken Nuggets (G) are in between 10.94-19.38%. The saturated fatty acids found in the fast food samples are palmitic acid, stearic acid, and myristic acid. Highest amount of linoleic acid (omega-6, 18.90%) was found in Chicken Meatballs (F). The ratio of omega-6 and omega-3 in sample D was 2.32:1 which is in the acceptable range. Although *trans* fatty acid was not found in the samples, presence of more than 10% saturated fatty acids in chicken fast food is still harmful for health as it may increase risk of cardiovascular disease (CVD).

Keywords: chicken fast food, *trans* fatty acids (TFAs), saturated fatty acids (SFA), monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA).

INTRODUCTION

Fatty acids can be saturated or unsaturated. Unsaturated fatty acids can be monounsaturated fatty acids (MUFA) or polyunsaturated fatty acids (PUFA). Saturated fatty acid intake is known to increase low density lipoprotein (LDL) cholesterol, and therefore has been associated with increased risk of cardiovascular disease (CVD) (Siri-Tarino *et al*. 2010). Moreover, it is believed that human beings evolved on a diet with a ratio of omega-6 to omega-3 essential fatty acids (EFA) of 1:1 (Simopoulos 2002, Simopoulos 2016 and Simopoulos 2008). Omega-6 to omega-3 fatty acid ratio of 5:1 or less is considered as less harmful for health (Rubio-Rodríguez *et al*. 2010). Now due to change in food habit and preference to fast food, people are having excessive amounts of omega-6 fatty acids and less amount of omega-3 in their food. This leads to increase omega-6 to omega-3 ratio to 20:1 or even more (Simopoulos 2016). A high amount of omega-6 polyunsaturated fatty acids (PUFA) in food and a high omega-6/omega-3 ratio promote cardiovascular disease, cancer and inflammatory diseases (Simopoulos 2002). Recent studies show that omega-6 to omega-3 fatty acid ratio play important role in obesity (Simopoulos 2016).

Fast food makers sometimes prefer to use hydrogenated vegetable oil because this oil is inexpensive and have increased shelf life, remain stable during deep frying, and can improve the food's texture. Though the natural vegetable oils generally contain mostly unsaturated fat which is good for health, they are more prone to oxidation leading to the formation of hydroperoxides, and thus they more easily become rancid (Dixit *et al*. 2012). Dorni *et al.*

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did a survey of fatty acid profile of edible oils and fats consumed in India (Dorni *et al.* 2018). They found vanaspati (also known as vegetable ghee) contains *trans* fatty acid 'elaidic acid' content, ranged from 1.04 to 12.09%. Vanaspati is produced from vegetable oils using partial hydrogenation at a certain temperature and pressure in the presence of nickel as catalyst. This process modifies the fatty acid composition into saturation and isomerization of few *cis* double bonds to their *trans* forms by changing the position of hydrogen atom (Dorni *et al.* 2018). *Trans* fatty acids (TFAs) cause adverse effects on health. TFAs increase the risk of coronary heart disease, cancer and diabetes (Costa *et al.* 2016). Consumption of TFA increases the risk of type 2 diabetes (Bhardwaj *et al*. 2016). High intakes of saturated and *trans* fatty acids contribute to increased cardiovascular disease by lowering the 'good HDL cholesterol' and raising the 'bad LDL cholesterol' (Benatar *et al.* 2014, Menaa *et al.* 2013, Dixit *et al*. 2012, Downs *et al*. 2013, and Zevenbergen *et al.* 2009). Among various *trans* fatty acids, elaidic acid (C18:1 trans-9), and vaccenic acid (C18:1 *trans*-11) are considered mostly responsible for coronary heart disease (CHD) (Mozaffarian *et al*. 2009, and Katan *(*2006).

Some fast foods of Dhaka city have been investigated to know kinds of fatty acids present in it, the ratio of omega-6 to omega-3 in fast foods and to find the presence of any harmful *trans* fatty acids.

MATERIALS

For ATR-FTIR analysis, standard *trans* fatty acids such as palmitelaidic acid (C16:1, trans-9) and elaidic acid (C18:1, *trans*-9) were procured from Santa Cruz Biotechnology and *trans*-vaccenic acid (C18:1, *trans*-11) was purchased from Sigma-Aldrich. For GC-FID analysis, reference standard- Supelco 37 Component FAME Mix (CRM47885) was purchased from Sigma Aldrich.

Chicken Winglet (A), Chicken Hot Wings (B) and Fiery Grilled Chicken (E) were collected from Dhanmondi, Dhaka. Chicken Drumst (C) and Chicken Botik (D) were collected from Mohammadpur, Dhaka. Chicken Meatballs (F) and Chicken Nuggets (G) were collected from Mirpur, Dhaka.

Soxhlet extraction method was performed to extract fatty acids from the different samples. No cleanup procedure was performed as it may wash away fatty acids from the samples.

METHODS

Trans fatty acids (TFAs) were determined using attenuated total reflectance-Fourier transform infrared (ATR-FTIR) spectroscopy and gas chromatography-flame ionization detector (GC-FID).

ATR-FTIR of liquid samples was performed in an ATR sample cell with a zinc selenide (ZnSe) crystal from IRprestige-21 Shimadzu (Japan) Spectrometer. ZnSe crystal was mounted in the sample compartment of the spectrometer. All standards and samples were scanned over the range of 4000-650 cm^{-1} by 16 scans with a resolution of 4 cm^{-1}. The ATR crystal was carefully cleaned by wiping with soft tissue paper and propanol to remove any lipophilic or hydrophilic residues from the previous sample. A fresh background spectrum of air was taken before recording the spectra of each standard and sample.

GC-FID was performed in a Shimadzu, GC-2010 Plus (Tokyo, Japan) gas chromatograph fitted with a fused silica polar capillary column (75 m x 0.18 mm i.d x 0.14 μm film thickness) coated with poly(biscyanopropyl siloxane) and flame ionization detector. GC-FID analysis was performed under following conditions: Initial column temperature was maintained at 180ºC

and held for 45 min. Then the temperature was increased to a final temperature of 240ºC at a rate of 4ºC/min and hold for 15 min. Injector temperature: 250ºC, Injected volume: 1 µL, Injection mode: split, split ratio- 50:1. Detector temperature: 250ºC, column flow rate: 0.34 mL/min and carrier gas: nitrogen.

Extraction of fatty acids

Samples were grinded as fine as possible without any pretreatment. Fatty acids in various food samples were extracted by the Soxhlet extraction method (Daugherty *et al*. 1983). 10 g of grinded food sample was accurately weighed and was put into a cellulose-extraction thimble, which was covered with cotton wool. 150 mL chloroform/methanol solvent (2:1, v/v) was taken in a round bottom flask and used to extract fatty acids under reflux for 8 hours at 70ºC. Solvent was removed from the extract by using rotary evaporator and dried at 40-60ºC for 1 hour.

Fatty acids were converted into fatty acid methyl esters (FAMEs) for GC-FID analysis. FAMEs were prepared according to method AOAC 969.33. To prepare FAME, lipids/ fats were hydrolyzed with methanolic KOH solution and the hydrolyzed lipids/ fats were transesterified by using BF_3-methanol complex solution. Finally FAMEs were extracted with petroleum ether.

RESULTS AND DISCUSSION

Fatty acids have been extracted from fast foods using Soxhlet extraction method in chloroform/methanol solvent according to standard method (Daugherty *et al*. 1983). None of the samples were cleaned as it may wash away fatty acids from the samples. Attenuated total reflectance-Fourier transform infrared (ATR-FTIR) spectroscopy and gas chromatography-flame ionization detector (GC-FID) have been used to determine *trans* fatty acids in the fast foods in Dhaka city.

ATR-FTIR results

In this study, elaidic acid (C18:1 *trans*-9), vaccenic acid (C18:1 *trans*-11) and palmitelaidic acid (C16: 1 *trans*-9) have been used as standard in ATR-FTIR analysis because elaidic acid (C18:1 *trans*-9) and vaccenic acid (C18:1 *trans*-11) are considered as risk factor for coronary heart disease (CHD). The ATR-FTIR of sample A (Chicken Winglet) is shown in Fig. 1. ATR-FTIR spectrum of three standard *trans* fatty acids and all fast food samples (A-G) are shown

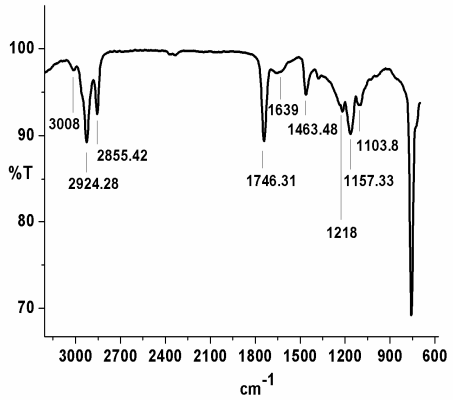

Fig. 1. ATR-FTIR of fatty acid from fast food sample A (Chicken Winglet).

in Fig. 2. Both Figs. 1 and 2 clearly show the presence of typical functional groups in fatty acids of the fast food samples. In Fig. 1, C-H stretching vibration of *cis*- double bond appears at 3008 cm^{-1}. The band at 2924 cm^{-1} is due to asymmetric stretching of aliphatic methylene group, -C-H (CH_2) present in fatty acid of sample. The symmetric stretching of–C-H (CH_2) is at 2855 cm^{-1}. The band at 1746 $cm^{-1}$is due to –C=O stretching which arises from ester carbonyl group of triglyceride of fatty acid. The

C=C stretching vibration of *cis*-olefin appears at 1639 cm^{-1} as a very weak band. The –C-H bending of the CH_2 and CH_3 of aliphatic groups appear at 1463 cm^{-1}. The bands at 1218 cm^{-1}, 1157 cm^{-1} and 1103 cm^{-1} are due to stretching vibration –C-O ester group (Vlachos *et al*. 2006).

An expanded ATR-FTIR spectrum of three standard *trans* fatty acids and fast food samples (A-G) are shown in Fig. 3 to show *trans* peak more clearly. *Trans* peak at 964 cm^{-1} is clearly found in all the three standard *trans* fatty acids namely elaidic acid, vaccenic acid, palmitelaidic acid (Fig. 2 and Fig. 3). However, none of the fast food samples (A-G) has any peak in the characteristic *trans* peak region from 976 to 956 cm^{-1}. According to literature, *trans* peak is found in the region from 976 - 956 cm^{-1} with a maximum at 966 cm^{-1} which is due the CH out-of-plane deformation absorption (Sherazi *et al*. 2009 and Juaneda *et al*. 2007).

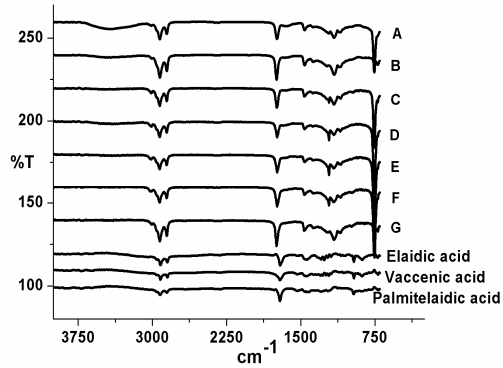

Fig. 2. ATR-FTIR of three standard *trans* fatty acids and fast food samples (A-G) from 700-4000 cm^{-1}.

In ATR-FTIR (Fig. 2), C-H stretching vibration of *cis*-double bond appears at 3008 cm^{-1}. The assymetric stretching of CH (-CH_2) is at 2924 cm^{-1}, symmetric stretching of CH (-CH_2) is at 2855 cm^{-1}. The ester group (-C=O) is observed at 1746 cm^{-1}, bending of –CH (-CH_2-, CH_3) is at 1463 cm^{-1} and stretching of –C-O is at 1157 cm^{-1} of fatty acids present in the sample. The band at 1639 cm^{-1} is due to C=C stretching vibration of *cis*-olefin.

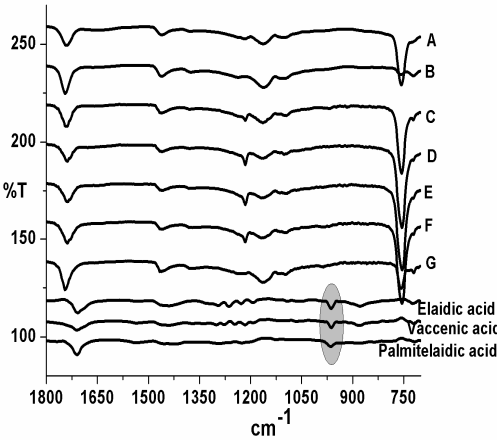

Fig. 3. ATR-FTIR (expanded) of three standard *trans* fatty acids and fast food samples (A-G) to show *trans* fatty acids from 976 to 956 cm^{-1} more clearly.

GC-FID results

ATR-FTIR provides information of *trans* fat containing more than 5% (Sherazi *et al*. 2009). However, GC can give measurement at lower level of *trans* fat.

The results obtained from ATR-IR were further verified by the GC-FID. It is known that very long (around 100 m) and highly polar capillary columns can provide better resolution of *trans* fatty acid isomers (Sherazi *et al.* 2009). For this reason, a polar capillary column (75 m long) coated with poly(*bis*cyanopropyl siloxane) is used in GC analysis to maximize the resolution of *trans* fatty acid isomers. For GC-FID analysis, methyl esters of standards and samples were performed. Figs. 4 and 5 show the GC-FID chromatogram of standard fatty acids and sample D (Chicken Botik), respectively. *Trans* fatty acids were not found in any of the samples in GC-FID analysis (Fig. 5 and Table 1).

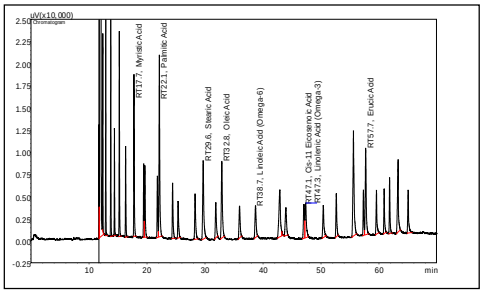

Fig. 4. GC-FID chromatogram of standard fatty acids

This result is consistent with the ATR-FTIR analysis. Table 1 shows the fatty acids and their contents that are present in each of the fast food samples by GC-FID analysis. Saturated fatty acids (SFA), monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA) have been found in the fast food samples. Chicken Winglet (sample A) and Chicken Hot Wings (sample B) have higher amount of saturated fatty acids (SFA) which are 28.73% and 25.92% respectively. The amount of saturated fatty acids (SFA) in Chicken Drumst, Chicken Botik, Fiery Grilled Chicken, Chicken Meatballs, and Chicken Nuggets are in between 10.94-19.38%. Saturated fatty acids found in the fast food samples are palmitic acid, stearic acid, and myristic acid. All fast food samples contain oleic acid and linoleic acid (omega-6) in various

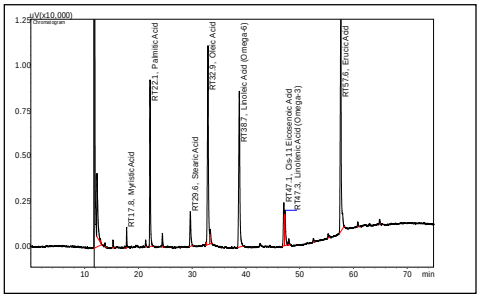

Fig. 5. GC-FID chromatogram of sample D (Chicken Botik).

amounts ranging from 12.47% to 28.53% and 8.30% to 18.90% respectively. Except sample D (Chicken Botik) none of the sample contains linolenic acid (omega-3) fatty acid. In sample D, 8.30% linoleic acid (omega-6) and 3.57% linolenic acid (omega-3) are present. This shows omega-6 to omega-3 ratio in sample D is 2.32:1 which is in the acceptable range.

Although fast food samples did not have any *trans* fatty acid, saturated fatty acids (SFA) content in each food is more than 10%. The presence of higher amount of saturated fatty acids in the foods is still harmful as it can increase risk of cardiovascular disease (CVD). The World Health Organization (WHO) recommends for adults and children that saturated fatty acid intake should not be greater than 10% of total energy intake.

CONCLUSION

Saturated fatty acids (SFA), monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA) have been found in the fast food samples. None of the fast food samples that have been analyzed contain any *trans* fatty acids. The results of ATR-FTIR spectroscopy were found in good agreement with the results of GC-FID. All fast food samples contained omega-6 (linoleic acid) fatty acids in various amounts ranging from 8.30% to 18.90%. The ratio of omega-6 and omega-3 in Chicken Botik (D) was 2.32:1. This ratio is in the acceptable range. Except sample D, none of the fast food sample contains linolenic acid (omega-3). Chicken Winglet (A) and Chicken Hot Wings (B) have higher amount of saturated fatty acids which are 28.73% and 25.92%, respectively. Intake of saturated fat is known to increase low density lipoprotein (LDL) cholesterol, and therefore has been associated with increased risk of cardiovascular disease (CVD).

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Table 1: GC-FID analysis of fast food samples

Sample ID	Type	Name of Acid	Unit	Amount (%)
A	SFA	Palmitic Acid	%	20.64
		Stearic Acid	%	6.07
		Myristic Acid	%	2.02
	MUFA	Oleic Acid	%	12.47
	PUFA	Linoleic Acid (Omega-6)	%	13.49
			Total=	**54.69**
B	SFA	Palmitic Acid	%	24.33
		Stearic Acid	%	1.59
	MUFA	Oleic Acid	%	28.53
		Palmitoleic Acid	%	1.19
	PUFA	Linoleic Acid (Omega-6)	%	8.53
			Total=	**64.17**
C	SFA	Palmitic Acid	%	10.93
		Stearic Acid	%	1.78
	MUFA	Oleic Acid	%	19.89
		Palmitoleic Acid	%	trace
	PUFA	Linoleic Acid (Omega-6)	%	17.20
			Total=	**49.80**
D	SFA	Palmitic Acid	%	8.92
		Stearic Acid	%	1.04
		Myristic Acid	%	trace
	MUFA	Oleic Acid	%	17.85
		Erucic Acid	%	32.67
		cis-11 Eicosenoic Acid	%	4.46
	PUFA	Linoleic Acid (Omega-6)	%	8.30
		Linolenic Acid (Omega-3)	%	3.57
			Total=	**76.81**
E	SFA	Palmitic Acid	%	8.75
		Stearic Acid	%	3.56
	MUFA	Oleic Acid	%	13.63
		Palmitoleic Acid	%	1.75
		cis-11 Eicosenoic Acid	%	trace
	PUFA	Linoleic Acid (Omega-6)	%	9.43
			Total=	**37.12**
F	SFA	Palmitic Acid	%	16.64
		Stearic Acid	%	1.40
		Myristic Acid	%	1.34
	MUFA	Oleic Acid	%	18.29
		Palmitoleic Acid	%	1.03
		cis-11 Eicosenoic Acid	%	1.41
	PUFA	Linoleic Acid (Omega-6)	%	18.90
			Total=	**59.01**
G	SFA	Palmitic Acid	%	13.33
		Stearic Acid	%	1.5
	MUFA	Oleic Acid	%	21.66
		Palmitoleic Acid	%	3.00
		cis-11 Eicosenoic Acid	%	1.41
	PUFA	Linoleic Acid (Omega-6)	%	16.66
			Total=	**57.56**

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