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Review

Review on Health Concern: *Trans* Fatty Acids and Hydrogenation Process

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Abstract. *Trans* fats are the worst fat that human being consumed in a diet. It has been produced during the hydrogenation process of edible oil/fats. Basically it has an adverse effect on human health by raising bad cholesterol (LDL) and decreasing the %level of good cholesterol (HDL). This ultimately increases the chance of heart stroke due to high build-up of bad cholesterol in blood arteries. Now days, the growing interest related to the consumption of foods products comprising *trans* fatty acids (TFAs) has been increased due to their risky effects on health. The permissible consumption limit of *trans* fat in foods should be less than 1%. Therefore, it is necessary to focuses on the process that generate TFAs in different food products. Hydrogenation is main source for TFAs production, the part of industrial hydrogenation is mainly affected to raise the level of *trans* fat (10-50%) comparative to thermal process (1-3%).

Keywords: hydrogenation, *trans* fatty acids, edible oil, rancidity, shelf life

Introduction

In nature, oils and fats are existed in the form of triglycerides. The physical and chemical properties of edible oils and fats are directly influenced by the fatty acids (FA) composition of triglycerides (Le Dréau *et al*., 2009). Edible oils such as soybean, canola and sunflower oils are mixtures of mainly triacylglycerols. FA are monocarboxylic aliphatic acids that ultimately serve as lipid building blocks. Furthermore, they are classified as saturated fatty acid (SFA), monounsaturated fatty acid (MUFA) or polyunsaturated fatty acid (PUFA) depending on the existence or absence of double bonds. SFA make up a large portion of solid fat, whereas MUFA and PUFA make up a large portion of oils (Ratnayake and Galli, 2009). All unsaturated fatty acids (UFA) in plant oils are naturally present in the form of *cis* (Salimon *et al*., 2012). During the extraction, refining, deodourization as well as the heating and frying processes of oils at high temperatures, a small percentage of UFA isomers converted to their *trans* fatty acids (TFAs) counterparts, while the proportion of TFAs are significantly increases during industrial hydrogenation process of oils (Choe and Min, 2007).

The formation of TFAs during frying was influenced by many parameters such as frying conditions, frying materials and even the techniques used for the measurements of TFAs. Although it can be formed by used frying materials and released into the frying oil (Bansal *et al*., 2009; Liu *et al*., 2007; Chen *et al*., 2001). Oil undergoes deterioration during frying through hydrogenation process and as a result increases the amount of TFAs and decreases the level of UFAs (Guallar-Castillón *et al*., 2012; Fillion and Henry, 1998).

TFAs are the non-conjugated geometrical isomers of MUFA and PUFA. It contains at least one methylene

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group (-CH_2-), carbon - carbon double bonds in the *trans* configuration. It has been present in small amounts in the diet since humans began eating animal derived foods. In UFAs, when hydrogen added into the double bond the oil commenced to hard and this process is known as hydrogenation reported by Korver and Katan (2006). Although TFAs of unsaturated lipids are not a natural lipid isomer, it can be produced in different ways from *cis*-UFAs. Numerous bacteria, particularly parasitic bacteria in the rumen of cattle, can use a *cis-trans* isomerase to convert unsaturated lipids from *cis* to *trans* isomers (Heipieper *et al*., 2003).

The use of partially hydrogenated edible/vegetable oils in processed foods led to increased levels of TFAs in the diet. The most common source of TFAs production is partial hydrogenation process although TFAs can be produced in trace amounts during the deodorization and refining process of vegetable oils (Tasan and Demirci, 2003).

The basic process of hydrogenation of edible oil described (Normann, 1903). Three simultaneous reactions were involved in the chemistry of hydrogenation process i.e., saturation of double bonds, geometric of *cis-trans* and isomerization's of positional isomers (Mozaffarian *et al*., 2004). To extend the shelf life of vegetable/edible oils and provide the desired melting characteristics, hydrogenation of UFAs is performed. In the existence of a supported or Raney Ni catalyst, commercial hydrogenation processes are carried out in batches at temperature ranging from 150 to 225 °C and pressure ranging from 69 to 413 kPa. The level of TFAs is known to rise with higher temperatures and lower pressures (Van den Hark and Härröd, 2001).

The hydrogenation process is a widely applied technique to change the properties of a vegetable oil in such a way that it can be processed by food producers. In the industrial catalytic hydrogenation process mostly, natural FAs are devastated and formed new artificial *trans* isomers are that behave consistently to SFAs (Triantafillou *et al*., 2003).

In order to increase oxidative stability, products shelf life as well as enhanced physical characteristics i.e., higher melting points and solid fat contents, partial hydrogenation of edible/vegetable oils used as a major industrial process. This process is most widely used for the modification of edible/vegetable oils and provides a good texture, taste and other characteristics of food (Chaves *et al*., 2018).

The food industries have historically used partial hydrogenation to raise the melting point of edible/vegetable oils to improve their oxidative, flavour stability and extended shelf life because the oil products can become rancid after exposure to air. The multiple unsaturated chains are known to be the most susceptible to reaction oxygen (Dijkstra, 2006). Beside the hydrogenation reaction a side reaction occurs in which these naturally occurring *cis*-isomers are *trans* formed into *trans*-isomers. Under the typical operating conditions that are currently applied, a relatively high amount of *trans*-isomers (upto 45%, depending on the final degree of saturation) may be formed (Beers, 2004).

In order to prolong the shelf life, the aim is to convert the polyunsaturated carbon chain into a monounsaturated fat. At the same time the aim is to prevent the hydrogenation towards a saturated in which all double bonds are hydrogenated, because the presence of these solid fats is also undesirable. The number of double bonds in the carbon chains also influences the melting properties of a fat containing product (Gerčar, 2002). By using the different factors of the hydrogenation process, the TFAs content of partially hydrogenated edible/vegetable oils can be determined. These factors are catalyst, temperature, hydrogen pressure, time, varieties, proportions of edible/vegetable oils and the chemical composition of mono and PUFAs (Ghafoorunissa, 2008).

Factor affecting on hydrogenation. The type, quality, temperature, hydrogen pressure, catalyst and stirring rate/mixing efficiency of the oil are all factors that influence the course of hydrogenation. The impact of these process parameters on activity and selectivity, particularly in relation to the formation of TFAs (Jang *et al*., 2005; Veldsink *et al*., 1997).

Temperature control. Both the hydrogenation and the isomerization reaction are strongly influenced by temperature.

The selectivity of hydrogenation of edible oil is directly affected by temperature the lowering temperature obviously results in a lower *trans*-isomer formation, while increase in the level of saturated factor affecting (FA). The typical hydrogenation temperature that is currently applied by oil producers is about 140-200 °C (Beers, 2007). This results in *trans* fatty acid levels of more than 14% for this liquid application. The lowering temperature to 40-60 °C, it is even possible to achieve a decrease *trans* fatty acid level of 6% by using nickel catalyst that is specially developed for these low hydrogenation temperatures. Unfortunately, a reversed proportional effect is observed on the balance between *trans*-isomer and saturate formations; when *trans* fatty acid levels decrease, saturate levels will increase. The levels of polyunsaturated fat which are known to affect the oxidative stability of the oil product are barely influenced by the temperature (Ghafoorunissa, 2008).

Lowering the hydrogenation temperature implies that the heat exchange capacity of the existing edible oil hydrogenation plants needs to be modified in order to maintain the lower hydrogenation temperatures. Currently they are only capable of working at temperatures above 140 °C. Finally, it should be noted that the *cis* double bonds in fatty acids are change over to the *trans*-isomer at temperatures above 200 °C. In this respect, the food processors should perform all other oil refining steps, such as the deodourization treatment, with care to avoid these high temperatures and loss of oil stability (Menaa *et al*., 2013).

Hydrogen pressure control. Increasing the hydrogen pressure leads to a higher coverage of hydrogen on the catalyst surface area, thus lowering the *trans* isomer formation. To achieve a *trans* fatty acid level of less than 10% for a solid fat, which at standard pressures would contain 30-40% of *trans* fatty acids, extremely high pressures of more than 60 bars of hydrogen need to be applied. This is practically not applicable in the existing edible oil plants because the upper pressure limit in these plants most often is about 5 bars and certainly not higher than 20-25 bars (Ghafoorunissa, 2008). Hence, this does not seem to be a solution for the edible oil industry that can be considered an affordable and practical one. Besides, a major consequence of applying such a high pressure is that the un-desired production of saturates is increased dramatically (>30% for the mentioned product).

Mixing efficiency. Another option to increase the hydrogen *trans* port from the oil to the catalyst surface area in order to suppress the *trans*-isomer formation to improve the mixing efficiency of the reactor system. If the mixing is not efficient enough, *trans* port of hydrogen through the oil to the catalyst might not be fast enough. This would lead to hydrogen starvation and as a result to a higher *trans*-isomer formation than desired. The current edible oil hydrogenation plants are often designed is such a way that these *trans* port limitations will occur. Increasing the stirrer speed or performing the hydrogenation in a reactor with a higher efficiency might improve the selectivity in this respect (Ghafoorunissa, 2008).

Low *trans* hydrogenation catalysts. It was already reported that nickel powder catalysts could catalyzed the hydrogenation of liquid oils (Normann, 1903). Nowadays, nickel is still used in the hydrogenation process of edible/vegetable oils, although the catalysts have been improved enormously with time. The performance of nickel which used as a catalyst for the hydrogenation of soybean oil towards a solid fat is presented in Fig. 2. Under typical conditions of 175-200 °C and 0.5-2 bar hydrogen pressure (black circles), a *trans*-isomer formation of 30% or more is found, while saturate formation is about 7-20% (Amin *et al*., 2020; Szukalska, 2003).

Sources of *trans* fatty acid. There are two mainly sources of TFAs formed in edible/vegetable oils. First is an industrial source such as catalytic hydrogenation and another is technological/domestic source such as thermal treatments (Menaa *et al*., 2013) as shown in Fig. 1.

Industrial sources. Partially hydrogenating fats and oils is still one of the best significant method to change their physical characteristics as well as their thermal and oxidative stability. This method is extensively used for the production of margarines, butter, spreads and bakery products among other things (Fernández *et al*., 2007).

During hydrogenation process of edible/vegetable oils, UFAs are converted in to saturated fats (Dhaka *et al*., 2011). The unsaturated fats which arise naturally are less tightly packed because they are usually present in the form *cis* configuration. Normally, at room

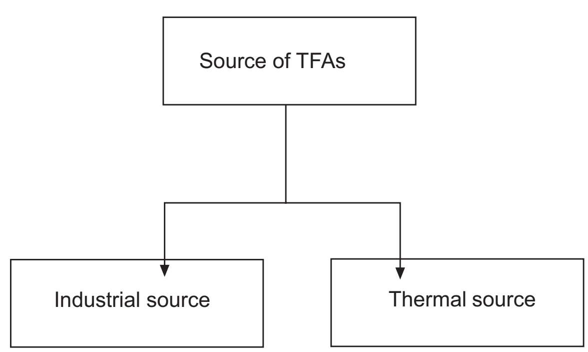

Fig. 1. Sources of TFAs.

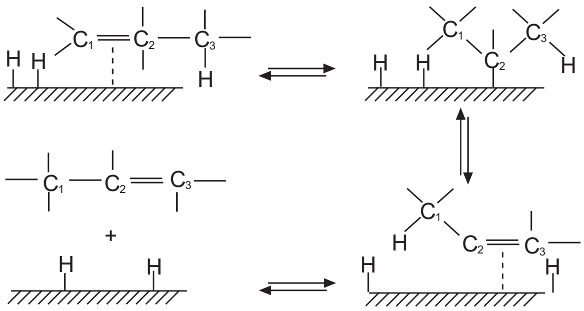

Fig. 2. Formation mechanism of geometric and positional isomers during hydrogenation process by (Min and Ahn, 2005).

temperature *cis* fatty acids are in the form of liquids or oils. TFAs' comprises of double bonds that form a more fairly rigid configuration that takes up far fewer space than the *cis* double bond, ultimately subsequent in a melting point near room temperature between saturated and *cis* unsaturated FAs (Khanal and Dhiman, 2004). This process also prevents rancidity and improve the texture, stability and shelf life of food because TFAs have high melting point than the *cis* isomers (Wassell and Young, 2007). Elaidic acid is the most common TFA form during hydrogenation process of edible/vegetable oils (Mossoba *et al*., 2009; Mensink, 2005).

The TFAs content of industrially hydrogenated fats varies significantly, accounting for upto 60% of the FA contents, while the TFAs content of beef and dairy products is much lower, accounting for only 2-5% of the FAs contents (Weggemans *et al*., 2004).

Bakery products, processed meats, fat spreads, snacks and fried fast foods all are common sources of TFAs (Allen *et al*., 2015).

The mechanism of geometric and positional isomers formation during hydrogenation process proposed by Allen and Kiess in 1955 which based on the semi-hydrogenation or dehydrogenation sequence as shown in Fig.1. According to Allen and Kiess, at any end of double bond, a hydrogen atom can be entered, formed a free radical site and possibly bound to the catalyst during hydrogenation process. The site of free radical is quite unstable and if the catalyst is partly covered through hydrogen then hydrogen atom can be eliminated from the adjacent carbon. By this process, double bond can be regenerate and formed a positional isomer. As a result, the formation of a free radical site permits for free rotation and form a *cis* or *trans* double bond (Martin *et al*., 2007; Min and Ahn, 2005).

Thermal sources. Frying is a process of immersing food in heated oil. At high temperature (150 °C 200 °C), this process contacts oil with air and food. It is one of the best useable and familiar methods of cooking foods. During deep frying of food, the instantaneous heat and mass transfer of oil with food and air results in a food product with great sensory properties, including deep-fried food flavour with golden brown colour and amazing crispy texture which is very popular with consumers. Conversely, this process will cause UFAs to undergo deterioration by thermal oxidation and linked to increase the amount of TFAs in edible/vegetable oils which is caused by frying or heating of food. Formation of TFAs during frying has been studied in a variety of hydrogenated vegetable oils (Aladedunye and Przybylski, 2009).

During frying, the formation of TFAs has been shown to be influenced by the temperature and duration of the process. The isomerization of unsaturated triglycerides from *cis* to *trans* was induced by heating and TFAs amounts increased gradually depending on the heating period and the degree of *trans* in edible/vegetable oil (Tsuzuki *et al*., 2008).

Deep-fat frying has also been recognized as a source of TFAs production as shown in Table 1. In virgin olive oil, elaidic acid production was found to be very low, while sunflower oil contains a high amount of oleic acid content (Romero *et al*., 2000). The production of elaidic acid was induced by both heating and frying processes which was not present in the fresh samples

Table 1. Sources of TFAs in industrial and thermal sources

Sources of TFA	Processes	TFA (%)	Food products
Industrial source	Partial hydrogenation of vegetable oils	10-50	Vanaspati/margerine and food items prepared in these (e.g. sweets/savory items; jalebi/ladoo/kachori/namakpara, bakery products; patties/cakes)
Thermal treatment	Frying	1-3	Samosa/Bhatura/Pakora/French Fries

of oil. Heating and frying resulted in a higher concentration of 18:1 TFAs (Bansal *et al*., 2009). Frying time has a significant impact on quality parameters i.e., texture, colour, viscosity, free fatty acids (FFA) and dielectric characteristics of frying oil. The level of hydrogenation, quality and stability of frying oil can be altered by mixing hydrogenated and non-hydrogenated oils (Li *et al*., 2008).

TFAs present in foods. Foods that contain partially hydrogenated edible/vegetable oils, such as butter, shortening and margarines are the most common dietary sources of TFAs (Micha and Mozaffarian, 2009). Margarine is butter like substance made from a combination of edible/vegetable fats and oils. Generally, it contains suitable amount of hard vegetable fats obtained from coconut, palm kernel, interesterified and hydrogenated edible oils (Triantafillou *et al*., 2003).

Fat is the main ingredient in cookies that gives a good quality and texture (O'Brien *et al*., 2003). It has a variety of functions in the production of biscuits that interacts with other ingredients to develop the product's texture, mouth feel and overall lubricity sensation which affecting the rheological characteristic of baked biscuits (Jacob and Leelavathi, 2007). The presence of lipid fraction in biscuits indicated that it has a good source of SFAs and TFAs (Kandhro *et al*., 2008). According to (Dionisi *et al*., 2002) in milk, the level of TFAs varies substantially and depends on season and diet of animals. Beef tallow contains 4.5%, while lamb and mutton contain 8.8 and 10.6% of TFAs (Dionisi *et al*., 2002). Fast foods and fried snacks items are examples of foods that contain large quantities of TFAs. Frequent frying degrades the quality of both i.e., fried food items and edible oil (Guallar-Castillón *et al*., 2012). Deep-fried foods such as french fries are normally part of fast foods like burgers, sandwiches, snacks and others meals. In fried dishes TFA were found 2.7 to 6.6% (Anwar *et al*., 2006). It is reported by many researcher's that biscuits contain 9.4 to 34.9%, cakes 16.3% and corn chips around 2.5% of TFAs (Mahesar *et al*., 2010; Kandhro *et al*., 2008).

However, several foods such as hamburger, pizza, chick tenders, french fries and apple pie contains 2.79-5.70, 3.65-5.69, 0.71-11.69, 0.51-12.51 and 0.74-4.73% of TFAs level (Tyburczy *et al*., 2012). It was also found that the TFAs levels in many food products such as doughnuts, cake, brownies, sandwich, cookies, dessert toppings, margarine, sugar wafer cookies, popcorn, chocolate covered cookies, pasta, noodles with sauce soybean oil, rapeseed oil, rice bran oil, crisps, snacks, ice cream, soups and hamburger as shown in Table 2 (Kušar *et al*., 2021; Hein *et al*., 2018; Cui *et al*., 2017; Dias *et al*., 2015; Arcand *et al*., 2014). From the literature it has been found that biscuits and ice creams contain a very high level of TFAs 40-46%. French fries and chicken nuggets purchased from different outlets of McDonald's and KFC in several countries reported different amounts of TFAs as represented in Fig. 3. It was also described that low levels of TFAs was present in McDonald's (Denmark) and KFC (Germany) outlets, while high levels of TFAs was found in McDonald's (New York city, US) and KFC (Hungary) outlets in both French fries and chicken nuggets (Stender *et al*., 2009).

Health effect of *trans* FAs. TFAs in food are becoming a more serious problem for humans. The United States and many European countries are paying close attention

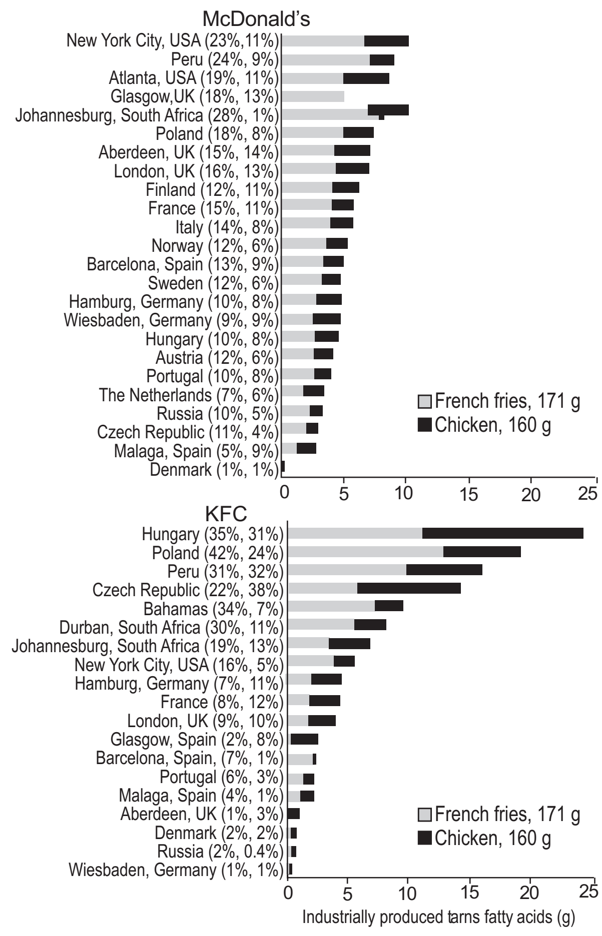

Fig. 3. TFAs levels of famous fast-food outlets in several countries (Stender *et al*., 2009).

Table 2. Presence of *trans* FAsin food products

Food product	Range (%)	References
Beef tallow	4.5	(Dionisi *et al*., 2002)
Mutton	10.6	
Lamb up	8.8	
Butters	3.0-5.0	(Anwar *et al*., 2006)
Doughnut cakes	5.3-17.1	
Meat-containing foods (chicken thighs)	1.9-21.3	
Potato chips	0.4-22.2	
Fried fish	2.7-6.6	
Biscuits	9.4-34.9	(Kandhro *et al*., 2008)
Cakes	16.3	(Mahesar *et al*., 2010)
Corn chips	2.5	
Hamburger	2.79-5.70	(Tyburczy *et al*., 2012)
Pizza	3.65-5.69	
Chick tenders	0.71-11.69	
French fries	0.51-12.51	
Apple pie	0.74-4.73	
Doughnuts, cake	0.7-14.5	(Arcand *et al*., 2014)
Brownies and other squares	0.4-3.1	
Sandwich cookies	0.2-8.3	
Dessert toppings	0.8-2.0	
Margarine	0.3-16.3	
Sugar wafer cookies	0.1-12.9	
Popcorn	0.2-17.4	
Chocolate-covered cookies	0.3-8.7	
Pasta and noodles with sauce, canned and dry	0.2-2.1	
Biscuits/scones	0.3-5.6	
Cookies	0.3-8.6	
Rice	0.0-1.2	
Chocolate wafer	0.04	(Dias *et al*., 2015)
Strawberry wafer	0.04	
Chocolate sandwich with cream filling	0.08	
Strawberry sandwich with cream filling	0.15	
Chocolate sandwich with cream filling	0.80	
Strawberry sandwich with cream filling	0.86	
Malted milk	0.03	
Chocolate	0.71	
Coconut	0.14	
Maisena	0.05	
Peanut oil	0.17	(Cui *et al*., 2017)
Soybean oil	0.91	
Rapeseed oil	1.47	
Corn oil	1.00	
Rice bran oil	2.13	
Sesame oil	0.39	
Linseed oil	0.12	
Peony seed oil	0.31	
Milk	0.12	(Hein *et al*., 2018)
Biscuits	46	(Kušar *et al*., 2021)
Cakes	21	
Chocolate and sweets	19	
Crisps and snacks	29	
Ice cream	40	
Margarine	5	
Soups	24	
Hamburger	25	

to this issue because TFAs consumption is linked to an increased risk of cardiovascular disease, diabetes and inflammation (Kandhro *et al*., 2008).

Health authorities worldwide have shown that *trans*-isomer have negative effects for human health (Anwar *et al*., 2006).

According to recent studies, increased total TFAs intaker anging from 2.8 to 10 g/day was linked to a 22% increase in the risk of coronary heart disease (CHD) as well as a comparable increase in the risk of fatal CHD (Mahesar *et al*., 2010).

Increases in plasmatic LDL (low-density lipoprotein or "bad cholesterol") and decreases in plasmatic HDL (high-density lipoprotein or "good cholesterol") levels are also mediated by TFAs (Mozaffarian *et al*., 2009; WHO, 2003; Dionisi *et al*., 2002).

The discovery of a link between a high TFAs intake and the risk of preeclampsia was another unexpected finding (Zaloga *et al*., 2006).

The food industry has been compelled to review the simple recipe of many food products in order to reduce TFAs levels as a result of global regulatory action. Consequently, consumer awareness of dietary TFAs has been increased as a result of this regulatory action (Bendsen *et al*., 2011).

The effects and molecular mechanism of TFAs on cellular function and metabolic activity as shown in Fig. 4. Cell functions can be modulated by FAs as they can alter the fluidity of cell membrane and response of the receptors attached to it, not only this, it can participate in gene transcription by modulating the response of nuclear receptors. It can modulate the metabolic and inflammatory response of endoplasmic reticulum. In hepatocytes, TFAs can alter the secretion, composition of lipids, size of apo B100, accumulation and secretion of free cholesterol and cholesterol esters. It can decrease the plasma levels of HDL, increase the level of LDL

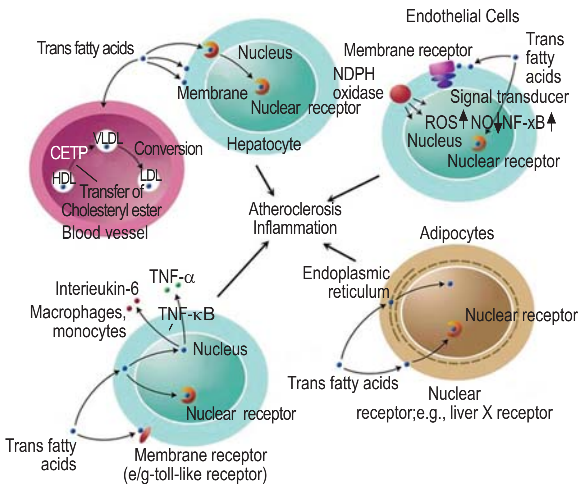

Fig. 4. Effects of trans-fatty acids (Takada *et al.*, 2019).

and very low density lipoproteins (VLDL) by enhancing the plasma activity of cholesteryl ester transfer protein. It can modulate the monocyte and macrophage functions which leads to increase in the production of tissue necrosis factor (TNF) and alpha interleukin-6. It can also impair the functioning of nitric acid dependent endothelium. It can affect the fatty acid metabolism of adipocytes causing reduction in the uptake of triglycerides, esterification of cholesterol and increase the production of free FAs. In animal studies, consumption of TFAs in adipocytes can change the gene expression (Takada *et al*., 2019).

Trends of analytical method for determination of *Trans* fatty acid. Many organizations, including Japan Oil Chemists' Society and American Oil Chemists' Society, Association of Official Agricultural Chemist (AOAC) International have already given their approval to the methods used to measure TFAs level in foods (Bhattacharya *et al*., 2006; Mozaffarian *et al*., 2006). For this several techniques with different methods developed to determine the level of TFAs percentage in the foods.

Gas chromatography with a flame ionization detector (GC-FID) is the traditional separation technique for FAs analysis. Before injection into the GC-FID equipment the extraction of lipid fraction, saponification reaction and derivatization of the total FAs content converted into fatty acid methyl esters (FAME) these all are the part of FAs methodology. However, this method is time consuming, having high technical skills and interpretative ability of obtained results (Kandhro *et al*., 2008; Jacob and Leelavathi, 2007). In edible/vegetable oils and fats, GC and infrared spectroscopy (IR) are the official methods used for the determination of TFAs on foods (Brouwer *et al*., 2010; Eckel *et al*., 2007; Yli-Jama *et al*., 2002). American Oil Chemists' Society developed a new method of GC to determine 21 different FAs in which 15 *cis* fatty acids and others are *trans* FAs (Endo *et al*., 2018), while, Fourier *trans* form (FT) infrared (IR) spectroscopy is a simple and rapid technique for determination of TFAs with isolated *trans*-double bonds, applied directly on the oil sample without any pre-treatment as comparison to GC-MS methods that requires sample derivatisation of FAs to FAMEs (Karami *et al*., 2020). Quick methods i.e., near-infrared, middle-infrared and Raman spectroscopy, on the other hand, have been widely used to analyse TFAs in food matrix (Mossoba *et al*., 2012; Guy *et al*., 2011; Bailey-Hall *et al*., 2008).

FTIR spectroscopy is an appropriate and official method approved by the American Oil Chemists' Society (AOCS) and the Association of Official Agricultural Chemists (AOAC) used for quantitative analysis of TFAs contents present in oils and fats.

It's important to note that this method is only used to measures the total concentration of TFAs in edible/vegetable oils (Stefanov *et al*., 2011). Attenuated total reflection Fourier transformed (ATR-FTIR) spectroscopy is a rapid and fast method to analyse TFAs content (<1%) in edible/vegetable oils and fats (Priego-Capote *et al*., 2004). However, GC and FTIR spectroscopy isa common technique used for the determination of the TFAs in the edible oils and fats (Cho *et al*., 2011; Priego-Capote *et al*., 2007; Liu *et al*., 2007). The quantitative determination of isolated TFAs using FTIR spectroscopy is based on the measurement of *trans* peak area in the specific region (991-945/cm), which represents (CH) out-of-plane deformation absorption. For *trans* fats containing more than 5%, ATR-FTIR spectroscopy offers fast and repeatable measurements. For the measurement of lower level of *trans* fat, GC method of detection is preferred (Xu *et al*., 2015).

In recent years, capillary column coated with ionic liquid (stationary phase) was used. This is novel method which was used frequently now a days (da Costa Filho, 2014; Mossoba *et al*., 2011). Compared to conventional method in which cyanopropyl columns were used for separation of FAs. This column contains higher polarity and more selective interaction with the double bonds of FAs.

According to (Delmonte *et al*., 2007), a 100 m SLB-IL111 column can isolate most geometrical and positional isomers of MUFAs. After that, a fast and efficient methodology has been developed for quantitative analysis of the majority of *cis-trans* long chain FAs using indirect ultraviolent (UV) detection by capillary zone electrophoresis (CZE). In this method sample can be easily analysed and there is no need of derivatization or extraction procedures (Delmonte *et al*., 2012). Capillary electrophoresis (CE) is a separation technique mainly based on differentiated migration of neutral compounds, solvated ions or ionizable species when a capillary column filled with a convenient background electrolyte (BGE) that is subjected to an electric field. In the scientific community, this technique has been pursued as an appealing alternative separation technique for FAs (Delmonte *et al*., 2011). The short time analysis, no need of derivatization and separation of the analytes at lower temperatures are the major advantages of this technique over GC, these factors significantly increase analytical throughput (De Oliveira *et al*., 2014; de Castro Barra *et al*., 2013). CZE-UV was used as an alternative method for determining TFAs in processed foods. It has a quick analysis time with consist of low-cost composition (Porto *et al*., 2015; Barra *et al*., 2014; De Castro *et al*., 2010).

Conclusion

The process of hydrogenation is principally used to decreases the level of unsaturated fatty acids and raising the level of SFAs. However, the increased uptake of SFAs has serious effects on human health due to absorption of bad cholesterol in blood plasma and chances of CHD sometime therefore partial hydrogenation is carried out to reduce the level of SFAs. Beside this process inevitable TFAs has been formed that has same negative affect on human health. Present and hectic lifestyle increases the intake of fast-food consumption and odd eating habits. This caused the high ingestion of TFAs through junk diet and rate of coronary disease and other health problems produced rapidly. The quantity of TFAs in different food items according to the Food and Drug Administration (FDA) must be labelled as zero percentage TFA if these products have 0.5 g TFA/serving. However, the WHO also limit the ingestion of TFA from food to less than 1% owing to fatal health concern like CHD, hypertension, obesity and etc. At present several food companies did not mention their ingredients properly and it is considered to be non-mandatory. Conversely, the law does state that labelling of entire pre-package foods must be done and ingredients present should mention on the package.

Conflict of Interest. The authors declare that they have no conflict of interest.

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