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Proximate and *trans* fatty acid composition of fast foods in Sohag, Egypt and the impact of rosemary essential oil on *trans* fat content

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Abstract

This study was conducted to investigate the nutritional composition and *trans* fatty acid (TFA) content of some fast foods consumed in Sohag city, Egypt. Furthermore, we studied the effect of using rosemary essential oil (REO) on the TFA content of frying oil. A total of 50 fast food samples were randomly collected from a different restaurant in Sohag city, Egypt. The examined samples were grilled beef burger, fried chicken broast, fried chicken strips, fried beef sausage and fried fish. The samples were examined for moisture, protein, fat, carbohydrate and cholesterol content. Additionally, gas chromatography was used to evaluate TFA content using standard technique. The greatest protein level was found in fried fish samples (22.82%), while the lowest was found in fried chicken strips (14.71%). Fat percentage ranged from 8.4% to 16.2%. Fast foods had a high-calorie value ranging from 215.22 to 329.45 Kcal/100g. Fried chicken broast had the highest cholesterol level which was 79.84 mg/100g. The results demonstrated that fast food had a total TFA concentration ranging from 2.6% to 18.5%. TFA content of the examined fast food exceeded the limits established by WHO as well as FDA regulations. This study showed the nutritional value of Egyptian fast food. However, high TFA content should receive special consideration. REO is an effective natural antioxidant that can be used without harming the sensory aspects of the product.

Keywords: Nutritional composition, Cholesterol, *Trans* fatty acids, Rosemary, Fast food, Egypt

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Competing interest: The authors have declared that no competing interest exists.

Introduction

There has been a considerable change from traditional diets to fast food as a result of population growth and the rapid advancement of technology. Fast food is a category of mass-produced food that is prepared and served very quickly. Fast food has several advantages because it is quickly cooked and served and provide affordable meals (Atanova and Yanenko, 2016). However, fast food consumers occasionally consumed more calories, extra sugar, and salt, as well as less fiber (Jaworowska *et al.*, 2013).

Trans fat is a type of unsaturated fat that occurs in trace levels in milk fat and meat (Kuhnt *et al.*, 2011). It was widely produced industrially from vegetable oil for use in margarine (Gormley and Juturu, 2010), snack food and frying fast food (De Meester *et al.*, 2010). TFA stays in circulation and cannot be broken down by human lipase, potentially causing atherosclerosis. (Brundiek *et al.*, 2012). Elaidic fatty acid is most commonly TFA found in margarine and ghee samples before and after the heat treatment (Afaneh et al., 2017).

The frying process causes oxidative deterioration and the formation of TFA in oils (Jain *et al.*, 2020). For preventing oxidation of the edible oil, synthetic antioxidants are frequently utilized as they are inexpensive and have a high antioxidant activity. Natural antioxidants are regarded as safer than synthetic antioxidants since they don't have the negative health impacts that synthetic antioxidants have (Sharma *et al.*, 2019). Rosemary extract is a safe, heat-resistant and broad-spectrum antioxidant that has recently become a focus of food antioxidant research. The main components of rosemary that act as antioxidants include terpenoids, phenols, and acids (Zheng *et al.*, 2019). As these components inhibited the formation of polar substances, polymers, and decomposition of polyunsaturated triacylglycerols in oil (Reblova *et al.*, 1999).

Knowledge of the nutritional composition and *trans* fat in fast food consumed in Egypt is still scarce. Therefore, the objectives of this study are determination the nutritive value, cholesterol and TFA content of the most famous fast items consumed in Sohag city, Egypt. Furthermore, we investigated the impact of utilizing rosemary essential oil on TFA content of oil during the frying of chicken nuggets.

Materials and methods

Collection and preparation of samples

Fifty samples of widely consumed fast food, including grilled beef burger, fried chicken broast, fried chicken strips, fried beef sausage and fried fish (10 samples each) were randomly collected from a different restaurant in Sohag city, Egypt from January 2020 to April 2022. About 50 gm of each sample was collected in clean polyethylene bags. The samples were carefully grounded into a blender (Moulinex, Paris, France) and stored at −20°C till analysis.

Nutritional analysis

Samples were examined for proximate composition using the following procedures:

- Determination of moisture, fat and ash contents (AOAC 2006).
- Determination of crude protein by biuret method (Torten and Whitaker 1964).

- Estimation of total carbohydrate content (AOAC 2003).
- Calculation of energy value (Merrill and Watt 1973).

Cholesterol determination

It was determined as described by (Zlatkis et al., 1953).

***Trans* fat acid analysis (Ichihara and Fukubayashi, 2010)**

Trans fat percentage was assessed in 15 fast food samples (fried chicken broast, fried chicken strips and fried beef sausage, 5 samples each) by using gas chromatography model 7890B from Agilent Technologies that had a flame ionization detector, separation was achieved using a Zebron ZB-FAME column (60 m x 0.25 mm internal diameter x 0.25 μm film thickness). Analyses were performed utilizing hydrogen as the transporter gas at a flow rate of 1.8 ml/min at a split-1:50 mode, injection volume of 1 µl and the subsequent temperature program: 100 °C for 3 min; rising at 2.5 °C /min to 240 °C and maintained for 10 min. The injector and detector were maintained at 250 °C and 285 °C, respectively.

Experimental study

Four types of oil were used in the experimental part:

The First type was margarine, which included antioxidant tert-Butylhydroquinone (TBHQ), beta carotene, and palm oil and its derivatives. The second type was a mixture of sunflower oil and soya bean oil without antioxidant. The third type was a mixture of refined sunflower oil, refined oline oil and refined soya bean oil with TBHQ antioxidant. The fourth type was a mixture of refined sunflower oil, refined oline oil and refined soya bean oil with TBHQ antioxidant.

Rosemary essential oil

It was prepared as described by Tohma andTuran (2015).

Experimental design

Two groups were conduced as following:

1-Control group

Homemade chicken nuggets were prepared as described by (Faiz et al., 2020). An electrical domestic deep-fat fryer (Tefal electrical deep fryer) equipped with its own thermometer. Furthermore, an external thermometer was also used to monitor the temperature. The frying pot was filled with 1 L of fresh oil, and then oil was heated for 5 min until reach 180 ˚C. Then added a batch of 250 g of frozen chicken nuggets fried at 180 C for 2.5 min then drained in the frying basket for 1 min. Repeat this process for ten frying cycles with no restitution to oil but new nuggets were refilled with each cycle. Finally, after the tenth frying cycles an aliquot of 10 mL of the frying oil was collected for further chemical analysis (**Albuquerque et al**., 2016).

2- Rosemary essential oil group

In this group, 0.08% rosemary essential oil (Chammem et al., 2015), was added to one liter of oil (first, second, third and fourth types) then make shaking by magnetic stirrer for 15 minutes then make ten frying cycles for homemade chicken nuggets as mentioned earlier. Subsequently, TFA was measured in oils after ten frying cycles.

Sensory evaluation of fried nuggets

Nuggets fried by using oil mixed with rosemary essential oil was sensory evaluated. Nuggets after one and ten frying cycles were put in dishes and on a scale of 1 to 5, Ten panelists were asked to evaluate each sample's general acceptability. Briefly, 5/5 (excellent), 4/5

(very good), 3/5 (good), 2/5 (accept), 1/5 (poor) (Ambrosiadis et al., 2004).

Results

Nutritional analysis of fast food

The obtained data in Figure 1, revealed the proximate composition of fast food samples. Moisture content in fast food samples varied between 34.76 ± 5.68 % (fried fish) and 55.12 ± 5.12% (fried chicken strips) with significant difference ($p < 0.05$). The average content of fast food samples varied between 14.71% ± 5.20% (fried chicken strips) and 22.82%±8.72 (fried fish). Fried fish samples had the greatest fat content (16.2±4.6%), while the grilled beef burger was the lowest fat content (8.4 ±4.7%).

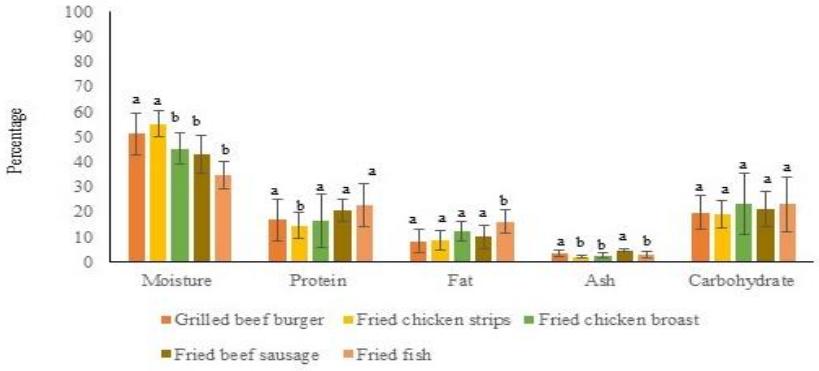

Figure 1: Nutritional profile of various classes of fast foods. Data are means ± standard devations. Various letters indicated a statistically significant difference between the means at $p < 0.05$.

The average ash content value was between 2.1 ± 0.5 % to 4.7 ± 0.5%. It was observed that the percentage of carbohydrates did not significantly differ among the samples that were analyzed.

The Cholesterol content of grilled beef burger, fried chicken strips, fried chicken broast, fried beef sausage and fried fish were 75.25 ± 22.73, 65.19 ± 27.78, 79.84 ± 8.69,55.73 ± 26.66and 72.43 ± 19.91 mg/100g, respectively (Table 1). Fired fish samples had the highest energy content (329.45+33.55 Kcal/100g), significantly different from other samples (Table 1).

Table 1. Energy and cholesterol content of examined fast foods

Fast food	Energy (Kcal/100g)	Cholesterol (mg /100 g)
Grilled beef burger	**222.83±45.67^{b}**	**75.25+22.73^{a}**
Fried chicken strips	**215.22±27.90^{b}**	**65.19+27.78^{a}**
Fried chicken broast	**273.12±32.43^{b}**	**79.84+8.69^{a}**
Fried beef sausage	**258.25±40.15^{b}**	**55.73+26.66^{b}**
Fried fish	**329.45±33.55^{a}**	**72.43+19.91^{a}**

Data are mean ± SD. various letters in the same column indicated a statistically significant difference between the means at $p < 0.05$.

Fired fish samples had the highest energy content (329.45+33.55 Kcal/100g), significantly different from other samples (Table 1). The percentage of energy derived from protein, carbohydrate and fat from the examined fast foods in the current study was illustrated in Table 2.

Table 2. Percentage of food energy (kcal) from protein, carbohydrate and fat in grilled beef burger, fried chicken strips, fried chicken broast, fried beef sausage and fried fish.

Fast food	Percentage (%) food energy (kcal)			Energy (Kcal/100g food)
	Protein	Fat	Carbohydrate	
Grilled beef burger	**30**	**34**	**36**	**222.83**
Fried chicken strips	**27**	**37**	**36**	**215.22**
Fried chicken broast	**25**	**41**	**34**	**273.12**
Fried beef sausage	**32**	**35**	**33**	**258.25**
Fried fish	**28**	**44**	**28**	**329.45**

Trans fatty acid analysis

All the examined fast food samples contain TFA which varied from 2.6 ± 1.3% to 18.5% ± 12.4 %. Fried beef sausage had the highest TFA value, followed by fried chicken strips, while fried chicken broast had the lowest value. Elaidic acid was the main TFA that was ranged from 2.2 + 1.1% (fried chicken broast) to 16.6 + 12.4% (fried beef sausage). Linolelaidic acid was detected in the examined samples but lower concentration than elaidic fatty acid (Table 3).

Table 3. trans- fat content (%) in some fast food

Fast food	Elaidic acid	Linoelaidic	Total TFA
Fried Chicken broast	2.2 ± 1.1^{a}	0.4 ± 0.4^{a}	2.6 ± 1.3^{a}
Fried Sausage	16.6 ± 12.4^{b}	1.9 ± 1.8^{a}	18.5 ± 12.4^{b}
Fried Chicken strips	4.7 ± 3.0^{a}	0.6 ± 0.3^{a}	5.4 ± 3.2^{a}

Various letters in the same column indicated a statistically significant difference between the means at $p < 0.05$.

Effect of rosemary essential oil addition on the percentage of *trans*-fats

Data presented in the current work illustrated the percentage of TFA in all examined types of oil both before (raw) and after heat treatment. TFA acid was found in the first oil type which was (0.081%), but not in other oils. TFA rose in all four types of oils after ten frying cycles at 180°C. In the first type of oil (Table 4), TFA percent increased from 0.081% to 1.09 % (Table 5), in the second type from 0% to 0.82 % (Table 6 and Figure 2), in the third type from 0 to 0.56 % and in forth type from 0% to 0.21% (Table 7). Interestingly, adding REO to all types of oil reduced TFA content after ten frying cycle. In first oil type TFA was reduced from 1.09% to 0.18%, from 0.56% to 0.02 in the third type. TFA wasn't detected in the second and fourth type of oil after ten frying cycle with REO added.

Table 4. Effect of rosemary essential oil addition on the percentage of *trans*-fats in first type of oil

Condition of oil	Control			Rosemary essential oil		
	TFA	Elaidic	linolelaidic	TFA	Elaidic	linolelaidic
Raw	0. 081	0.081	0	0. 081	0.081	0
After 10 frying cycle	1.09	1.09	0	0.18	0.16	0.02

Table 5. Effect of rosemary essential oil addition on the second type of oil's trans-fat content

Condition of oil	Control			Rosemary essential oil		
	TFA	Elaidic	linolelaidic	TFA	Elaidic	linolelaidic
Raw	0	0	0	0	0	0
After 10 frying cycle	0.82	0.82	0	0	0	0

Table 6. Effect of rosemary essential oil addition on third type of oil's trans-fat content

Condition of oil	Control			Rosemary essential oil		
	TFA	Elaidic	linolelaidic	TFAs	Elaidic	linolelaidic
Raw	0	0	0	0	0	0
After 10 frying cycle	0.56	0.56	0	0.02	0.02	0

Table 7. Effect of rosemary essential oil addition on fourth type of oil's trans-fat content

Condition of oil	Control			Rosemary essential oil		
	TFA	Elaidic	linolelaidic	TFAs	Elaidic	linolelaidic
Raw	0	0	0	0	0	0
After10 frying cycle	0.21	0.21	0	0	0	0

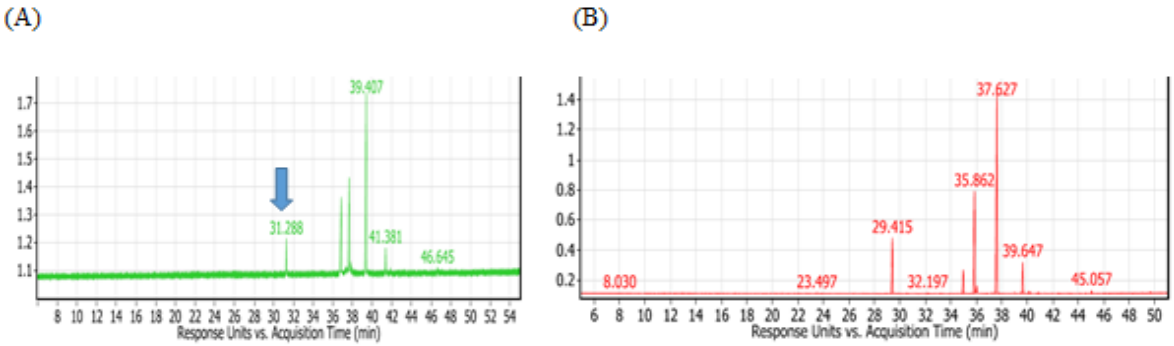

Figure 2: GC chromatogram of *trans* fatty content of the second type of oil. (A): elaidic *trans* fatty acid was detected after ten frying cycle at retention time 31.288 minutes, as indicated by the arrow. (B): elaidic fatty acid couldn't be detected after addition of rosemary essential oil to the second type of oil.

Sensory evaluation

Data present in Table 8 indicated sensory evaluation of nuggets after ten frying cycle from the previous experiments. Sensory analysis revealed that until the tenth frying cycle, the fried nuggets in oil with rosemary essential oil had the best crispiness and taste. When compared to the oil without REO. We could notice that nuggets made with REO was more acceptable due to their excellent integrity and beautiful golden yellow colours, due to the larger inhibitory effect on lipid oxidation (Figure 3 and 4).

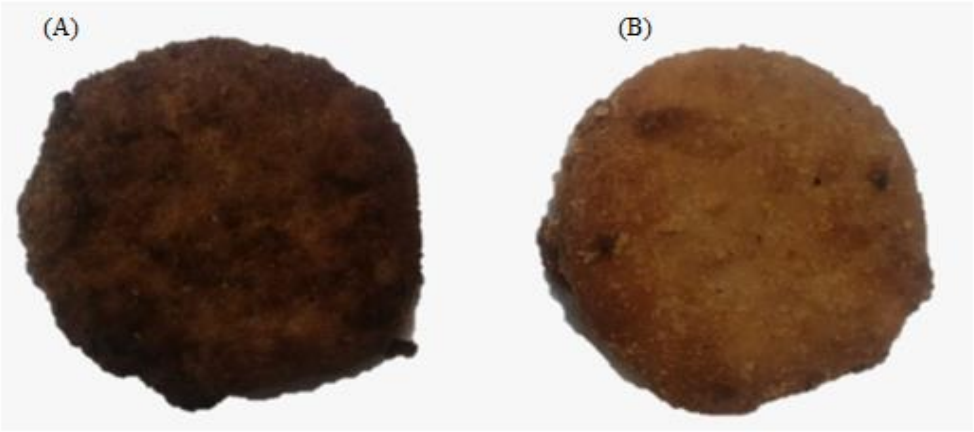

Figure 3: Appearance of fried home made chicken nuggets after ten frying cycle . (A): oil only. (B): oil with rosemary essential oil.

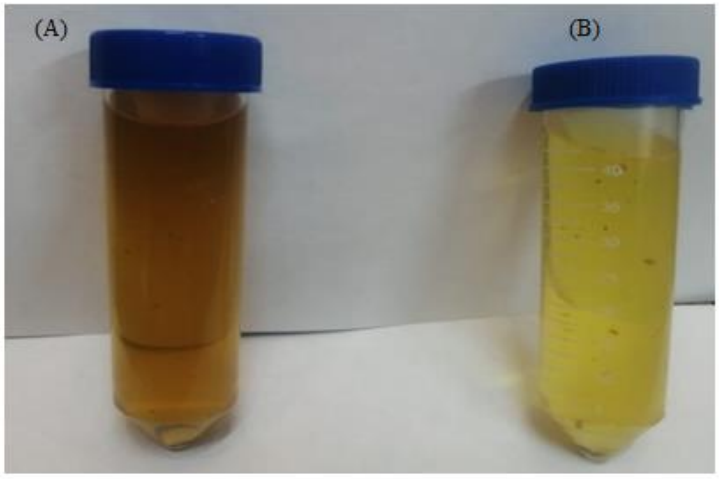

Figure 4: Appearance of oil after ten frying cycle. (A): oil only. (B): oil with rosemary essential oil.

Discussion

In the current study, the nutritional value, cholesterol content, and TFA content of fast food samples from various restaurants were assessed.

The mean value of the moisture content of grilled beef burger was near to value reported by Musaiger et al. (2008) and lower than the moisture percentage reported by Baggio and Bragagnolo (2006) and Juárez et al. (2010). Mean of moisture content of fried chicken broast was similar to the findings obtained by Kamal (2016) and Sadek et al. (2018). However, it was lower than moisture content reported by (Pawar et al., 2013). The difference in moisture content is primarily due to the methods used in preparation, high cooking temperatures or the deep-frying process cause fried food to lose more moisture (Musaiger et al., 2008).

The average value of moisture content of fried fish was higher than moisture content (22.5%) demonstrated by Devi and Sarojnalini (2012) in fried fish. However, it was lower than result obtained by Magawata and Ahmed (2014). The difference in moisture content in fried fish value is related to frying duration and temperature (Chang et al., 2021).

Fried fish had the greatest protein level, while fried chicken strips had the lowest. Average of protein content of grilled beef burger was comparable to results obtained by Ragab et al. (2019) and lower than results reported by Juárez et al. (2010). Protein mean value in fried fish was nearly like percentage obtained by Magawata and Ahmed (2014). The lower protein composition may be due to substitution with non-meat components as meat proteins are more expensive than non-meat components (Quasem et al., 2009).

All the examined fast foods in the current study had various fat content. Mean value of fat percentage in grilled beef burger was nearly to result obtained by Serrano et al. (2007). Lower values were reported by Baggio and Bragagnolo (2006), Dunford et al., (2010) and Sadek et al. (2018). Mean values of fat in fried chicken broast

similar to percentage stated by Kamal (2016). Average of fat in fried sausage was nearly similar to results demonstrated by Musaiger et al. (2007) and Kamal (2016). Fat percentage mean value in fried fish was similar to Ansorena et al. (2010) and lower than result obtained by Tadesse et al. (2020).

Regarding the energy value of the examined fast food samples. The energy value fluctuated from 215.22 to 329.45 Kcal/100g. The allowed daily intake for energy for an adult male should be 2900 Kcal and 2200 Kcal for and adult female. The current work showed that a 100 g intake of grilled beef burger would provide 7.6 % versus 10.12% of the daily required energy for an adult male compared adult female. The fried chicken strips would provide 7.4% versus 9.7% of the daily required energy for an adult male compared adult female. In the same context, 9.4% versus 12.4% of the daily required energy would be provided by the intake of the 100g of fried chicken broast. Furthermore, fried beef burger would provide 8.9% versus 11.7% of the daily required energy for an adult male compared adult female. Fried fish would provide 11.3% versus 14.9% of the daily required energy for an adult male compared adult female.

According to the world Health Origination (WHO, 2003), a balanced diet should contain 55–75% from the total energy derived from carbohydrate, 15–30% from fats and 10-15% from proteins. The energy generated from fat in the examined grilled beef burger, fried chicken broast and fried beef sausage surpassed 30% of the total energy. Hence, theses fast foods are might not be suitable acceptable for individuals who have limit on the amount of energy they can obtain from fat.

On one hand, the result of this study indicates that all the fast foods samples contain varying concentrations of cholesterol. Cholesterol mean value in grilled beef burger was higher than value reported by Baggio and Bragagnolo (2006). Mean value of cholesterol in fried chicken broast was similar to value showed by Afolabi et al. (2013). Cholesterol in fried fish was nearly similar to average demonstrated by Pirronen et al. (2002) which was 49–92 mg/100 g. All the cholesterol content of the examined fast food within the limit established by Dietary Guidelines for Americans (2010) that stated the daily permitted limit for cholesterol in the diet is 300 mg, which equivalent to the daily dietary cholesterol need.

On the other hand, the results in this study demonstrated that the highest percentage of TFA was found in fried beef sausage, while the lowest percentage was found in fried chicken broast. The principal TFA was elaidic acid. These results nearly similar to results that reported in African American diets which was 0% to 19.13 % (Huang et al., 2006). Zula and Desta (2021) confirmed that a higher temperature can speed up the oxidation reaction rates, resulting in more trans-fat being created in the frying oil and penetrating the food. Furthermore, TFA formation in fried foods is caused by using margarine and the repeated use of frying oil for multiple cooking cycles (Chen et al., 2014). TFA average in fried chicken nearly similar

to percent obtained by Kamal (2016), higher than results obtained by Jenkins et al. (2012) and Zaki et al. (2021). Average of TFA in fried beef sausage was lower than percentage stated in Iranian research which was 25.3 % and higher than percentage reported by Sadek et al. (2018) which was 11.3% in Egyptian hot dog.

As recommended by WHO (2003) that TFA providing not more than 1% of total energy. The TFA content of fried chicken broast, fried sausage and fried chicken strips contribute to 8.5%, 58.3% and 22.5% of the total energy, respectively. Hence, the examined fast food in current work was exceeded the limit established by WHO. In addition to, the examined fast foods samples in current work is deemed excessive according to FDA regulations, which specified any food with less than 0.5 g TFA is permitted to claim "0 *trans*-fat" on product label.

Certain changes can occur during frying of oils, resulted in undeniable compounds. The use of rosemary as a natural oil and its effect on the quality of fried oil and home-made chicken nuggets were examined in the current study.

The analysis of raw oils showed that, the first type of oil had TFA, while the second, third and fourth were free from TFA. After heating at 180˚c for ten frying cycles TFA were increased in all three types of oils. In the same context, Jain et al. (2020) reported that mean TFA increased from 0.26 g/100g (160°C, 32nd cycle) to 5.89 g/100g (230°C, 32nd cycle) as a result of rising of temperature. In the current work, margarine showed the highest percentage of TFA, that can be attributed to margarine is mainly produced through the hydrogenation process, which involves combing hydrogen with vegetable oil to create partially hydrogenated oil, a semisolid product that results in the formation of TFA (Satchithanandam et al., 2004). The second and third type of oil didn't show any TFA before frying. However, after frying TFA is created as the frying process induces oxidative degradation and production of TFA in fats/oils (Jain et al., 2020).

Rosemary extracts are acceptable to use as an antioxidant in food, according to the European Food Safety Authority (Aguilar et al., 2008). In The current study adding REO to different types of oil reduces TFA percentage in all the four types of oil. Rosemary extract was showed to be beneficial as a frying oil addition. They not only avoided oxidation, but also trans isomerization and avoid the production of polar molecules in the early phases of heat treatment (Filip et al., 2011).

Sensory analysis revealed that until the tenth frying cycle, the fried nuggets prepared in oil with rosemary essential oil had the best crispiness and taste. We could notice that nuggets made with REO were more acceptable due to their excellent integrity and beautiful golden yellow colours, due to the larger inhibitory effect of rosemary on lipid oxidation. li et al. (2021) indicate that REO showed superior effectiveness in stabilizing the oil color by reducing the generation of copper ions at the conclusion of frying cycles as compared to the control oil. Furthermore, Zheng and Wang (2001) illustrate that Rosemary extract's

phenolic components are responsible for the development of a pleasant taste in the fried product. Lalas and Dourtoglou (2003) reported that the oil containing the rosemary extract showed more antioxidant activity as well as decreased rancidity and discoloration. Also confirm that nuggets more tolerable than nuggets cooked in oil without extract until the last frying.

Conclusion

The current study provided important data on the proximate composition, cholesterol content and TFA percentage in Egyptian fast food from different restaurant in Sohag city, Egypt. Egyptian fast food is a great source for many nutrients. Special attention should be given to high TFA content and calories especially it was generated from fat. TFA percentage reduced during frying by adding rosemary essential oil to oil during frying. Rosemary essential oil had no adverse impact on the sensory acceptability of the chicken nuggets. On the other hand, chicken nuggets fried in oil containing rosemary essential oil had the greatest scores in terms of overall acceptability. Rosemary essential oil is promising natural antioxidants can be used to reduce the harmful impact of synthetic ones, so we advise oil′s factories to add rosemary oil as anatural antioxidant and advise house wife to use it in home to decrease oxidation of oil. Further studies are required to study the antioxidative mechanism of rosemary essential oil in various frying oils and its interactions with other nutrients in oils as well as food.

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