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Dietary Exposure Assessment of Trans-Fatty Acids through Consumption of Ice-Cream in Yerevan, Armenia

D.A. Pipoyan, M.R. Beglaryan, S.A. Stepanyan, G.K. Gharibyan

Informational Analytical Center for Risk Assessment of Food Chain of the Center for Ecological Noosphere Studies of NAS RA

david.pipoyan@cens.am, meline.beglaryan@cens.am, stella.stepanyan@cens.am, gharibyan-gohar@mail.ru

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ABSTRACT

This study aims to assess the dietary exposure of trans-fatty (TFA) acids through the consumption of ice-cream in Yerevan. To this end, 24-hour dietary recall method is used to investigate the ice-cream consumption. TFA contents in ice-cream samples are determined using gas chromatography-mass spectrometry. On the average, people consume 0.018 g/day TFA through ice-cream for the whole year, while 0.111 g/day in summer. TFA intake through ice-cream consumption accounts for 0.007 % and 0.041 % of the total energy intake for a year and for summer season, respectively. Comparing with the WHO's threshold (less than 1 % of total energy), the daily intake of TFAs via ice-cream consumption during summer warrants some concerns.

Introduction

Trans-fatty acids (TFA) are unsaturated fatty acids with at least one double bond in the trans-configuration (Mozaffarian, et al., 2006; Pérez-Farinós, 2015). This configuration can come naturally from ruminant-based meat and dairy products, or artificially through partial hydrogenation of vegetable oils in the food industry and manufacturing processes (Mozaffarian, et al., 2006, Riobó, 2013). Several studies report that higher intakes of TFA increase the risk for heart disease, diabetes of type 2, infertility, obesity, Alzheimer's disease, allergy and certain cancers. Thus, it is recommended to reduce TFA in the diet (Delgado, et al., 2019, Takeuchi, 2017, Wang, et al., 2016, WHO, 2019).

World Health Organization (WHO) introduced the "Action Package to Eliminate Industrially Produced Trans-Fatty Acids" which recommends that the average intake of trans-fats should be less than 1 % of total energy (WHO, 2018). The first country regulating industrially produced TFA was Denmark, which in 2004 put into place a limit of 2 grams of TFA per 100 grams oils and fats in all foods (Stender, 2006). Meanwhile, in Canada, the average trans-fat intakes have been reduced to 1.42 % of overall energy (Ratnayake, 2009). In 2019, the EU also put into force regulations to limit industrially produced TFA to 2 grams per 100 grams of total fat in all foods (EC, 2019). Armenia is a member of the Eurasian Economic Union (EAEU) and in 2018 Technical Regulation that limits TFA to 2 %

in fats and oils came into force in member countries (CU TR 024/2011, 2013). However, studies shall be carried out to show if TFA needs to be regulated in other food products as well, that use fat and oil as their raw materials. From this perspective, TFA in ice-cream is a matter of concern since it is widely consumed among the local population, especially in the summer season. Previously no studies were conducted to evaluate the risks of TFA in ice-cream in Armenia. Hence, the present study aims to assess the dietary exposure of trans-fatty acids through the consumption of ice-cream.

Materials and methods

Sampling

Ice-cream was randomly sampled from the supermarkets of Yerevan. Then, 24-hour dietary recall survey was conducted that showed which are the most commonly consumed ice-cream products among the Yerevan population. Information regarding the most commonly consumed ice-creams among the sampled ones is presented in table 1.

Table 1. The most commonly consumed ice-cream products in Yerevan*

Ice-cream sample numbers	Producer/Brand name
I1	Ice-cream in a waffle cup "Grand Candy", Vanilla
I2	Ice-cream Vanilla "Tamara", cone
I3	Ice-cream "Ashtarak Kat", bourbon briquette
I4	Ice-cream Vanilla "Tamara", briquette
I5	Ice-cream Vanilla "Elite Shant" briquette
I6	Ice-cream "Ashtarak Kat" bourbon cone

*Composed by the authors.

Analysis of TFAs

Standard STB ISO 15304-2007 was used for the determination of trans-fatty acids in the selected food items (g/100 g of product) using gas chromatography-mass spectrometry (GC MS, Perkin Elmer) method (Pachytskaya, et al., 2015). This method is specially designed to evaluate the level of trans-isomers as formed during (high temperature) refining, or during hydrogenation of vegetable oils or fats. The analytical tests were performed by an independent accredited laboratory of "Standard Dialog" LLC. The determination of TFA content in samples was performed with three replications.

Data collection and statistical analysis

So, it has been already mentioned that 24-hour dietary recall method was used to investigate dietary consumption patterns of ice-cream among the Yerevan population. 1272 respondents aged from 18 to 65 took part in the survey. Data were analyzed by SPSS software (SPSS Ins., version 22.0). According to the survey results, only 90 respondents consumed ice-cream in the past 24 hours of the survey day. On the average, the daily intake of ice-cream throughout a year was 16.6 g, meanwhile, in the summer season it was 99.7 g. This number is the average for those who consumed ice-cream during the last 24 hours; therefore, it excludes those who haven't consumed it in the past 24 hours since the survey date.

Daily Intake of TFA

Daily intake (DI) of TFA (g/day) is calculated through the following equation:

$$DI = C \cdot IR, \quad (1)$$

where C is the mean content of TFA in all the studied ice-cream products (g in 100 g), IR is the daily consumption of ice-cream (g/day). In this study, DI was calculated in two ways - for all year round and for the summer season only. Correspondingly, daily consumption of 16.6 g is used to calculate the DI for a year, while 99.7 g is used to calculate it for the summer season.

The individual TFA intake as the percentage of total energy is calculated using the following equation (Liu, et al., 2015):

$$E\% = \frac{DI \cdot 9}{DE} \times 100, \quad (2)$$

where $E\%$ is the individual TFA intake as the percentage of total energy. DI is the individual TFA intake per day (g/day). The energy transfer index of TFA is 9 kcal/g. DE is the individual total dietary energy intake (kcal). Based on the ILCS-2016, the average Armenian consumes approximately 2420 kcal/capita/day (NSSRA/WB, 2016).

Results and discussions

Content of TFAs in Ice-Cream

The detected TFA contents are shown in table 2 as a percentage of the ice-cream. Since, according to the Customs Union Technical Regulation, fat content in ice-cream products cannot be above 12 % (CU TR 033/2013, 2013), 12 % was used as the TFA content in percentages in order to calculate TFA content in 100 grams of ice-cream.

Table 2. The contents of TFA in ice-cream*

Ice-cream sample numbers	Content of fat in ice-cream (%)	TFA content detected in ice-cream (%)	TFA content in ice-cream (g in 100g)
I1	12	1.2	0.144
I2		0.527	0.063
I3		1.4	0.168
I4		1.34	0.161
I5		0.08	0.009
I6		1.01	0.121
Average content of TFA in ice-cream products (g in 100 g)			0.111

*Composed by the authors.

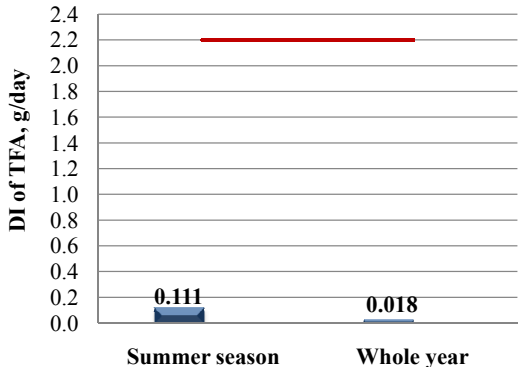

Figure 1. Daily intake of TFA via ice-cream consumption during the summer season and the whole year *(composed by the authors).*

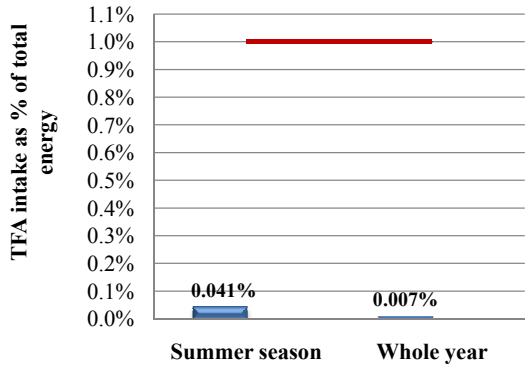

Figure 2. TFA intake through ice-cream consumption as the percentage of total energy *(composed by the authors)*.

The study results indicate that the TFA content in ice-cream samples range from 0.009 to 0.168 grams. Unfortunately, there is no regulation regarding TFA content in ice-cream in Armenia. Nevertheless, Armenia follows Customs Union Technical Regulation on Fat and Oil Products, according to which, starting from 2018, TFA content in margarine and milk fat replacers cannot be above 2 % (CU TR 024/2011, 2013).

To make a comparison with the study results of other countries, it can be highlighted that TFA content in Japanese ice-creams was on average 0.24 g, and was about two times higher than the average in the current study results (0.11 g). Similarly, according to the study carried out in Spain in 2015, the average TFA content in ice-cream was 0.271 g, that is, about two times higher than the presented results (Pérez-Farinós, et al., 2015). Moreover, a study carried out in Argentina indicated that TFA content in ice-cream ranged from 0.9 to 3.8 g (Kakisu, et al., 2018). Meanwhile, the content of TFA ranged from 1.1 to 1.9 g in Australian ice-creams (HY Wu, et al., 2017), which is again significantly higher than the current study results.

DI of TFA in Ice-Cream

In order to carry out a dietary exposure assessment, daily intake was calculated and compared with WHO's recommended level of less than 2.2 g/day for total TFA intake, which is equal to less than 1% of total energy intake (WHO, 2018). The results of this research indicate, that throughout the whole year the average TFA intake among the Yerevan population is estimated 0.018 g/day (Figure 1) and does not exceed the WHO limit of 2.2 g/day. Moreover, the obtained results reveal that on the average, during the summer season the Yerevan population has

approximately 0.111 g/day TFA intake through ice-cream consumption which is almost 6 times higher than the yearly average and does not exceed the WHO limit of 2.2 g/day. However, this number does not include people who reported that they did not consume ice-cream during the previous 24h according to the survey.

As the results indicate, TFA intake through ice-cream consumption accounts for 0.041 % and 0.007 % of the total energy intake for the summer season and for the whole year, respectively (Figure 2). The TFA intake obtained for the whole year didn't show a major health concern regarding the threshold (less than 1 % of total energy) recommended by WHO. Moreover, the TFA intake as a percentage of energy estimated for the summer season does not exceed the WHO's recommended threshold (WHO, 2018). This can be due to the relatively high level of ice-cream consumption in summer. Since there are other foods in Armenian's diet that can contain TFAs, the fact that ice-cream consumption alone exceeds the limit warrants some concerns.

Conclusion

The results of this study highlight the importance of investigations related to the daily intake of TFA through ice-cream consumption. This study indicates that the consumption of one product already contributes to the TFAs daily intake among the Yerevan adult population, however, does not exceed the WHO's recommended limit of less than 1 % of total energy. Moreover, the main outcomes of this study provided scientific evidence for the establishment of legislative requirements for the content of TFAs in ice-cream products. Besides, continuous monitoring on TFA contents should be performed that will also consider other food products of the population's diet. Meantime, efforts for reducing trans-fat intake must be implemented.

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