THE TRANS FATTY ACID CONTENT IN THE PARTIALLY HYDROGENATED VEGETABLE OILS AVAILABLE IN THE MARKETS OF DHAKA CITY, BANGLADESH

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ABSTRACT

Background: Trans fatty acids (TFAs) found in partially hydrogenated vegetable oils (PHOs) are a significant health risk factor for cardiovascular diseases. Despite global initiatives to minimize TFAs, including the WHO's REPLACE action framework, data on their content in Bangladeshi food products remains limited. This study assessed the trans-fat content in PHOs available in the Dhaka City market, which will be beneficial in providing critical baseline data for public health interventions. **Methods:** The study involved market surveys of four wholesale and nine retail markets across Dhaka to identify PHO brands. A total of 20 PHO samples representing four major brands and their various batches were collected from both retail and wholesale markets. Samples were analyzed for fatty acid composition, including saturated, monounsaturated, polyunsaturated, and trans fatty acids, using gas chromatography with flame ionization detection (GC-FID) according to the AOAC Official Method 996.06. Additionally, the probable intake of TFA through PHO consumption and its contribution to the percentage of the daily allowable intake were estimated. **Results:** According to our findings, PHOs were mainly used by bakeries and restaurants. The mean trans-fat content of the samples was 10.20 ± 2.39 g per 100 g, with all samples exceeding the WHO recommended limit of 2%. TFA levels varied significantly across brands, ranging from 7.64±0.71 to 13.39 ± 2.85 g per 100 g. Saturated fatty acids (SFA) constituted 57.10 ± 3.55g per 100 g, while monounsaturated (MUFA) and polyunsaturated (PUFA) fatty acids were 38.87 ± 4.97 g and 4.03 ± 1.51 g, respectively. If consumed at a level similar to 50% of average oil intake (15.4 g/day), PHOs would contribute 67.5% of the WHO's recommended daily TFA limit (2.2gday) and 40% of the SFA limit (22.22g/day). **Conclusion:** The PHOs sold in Dhaka contain high levels of trans fats, posing serious public health risks. Urgent regulatory action, such as enforcing WHO-recommended TFA limits or banning PHOs, is needed to reduce and ultimately eliminate industrially produced TFAs from the Bangladeshi food supply chain.

KEYWORDS: Trans fatty acids, partially hydrogenated vegetable oils, industrially produced trans fatty acids, probable daily intake, Bangladesh, food safety, public health.

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Introduction

Naturally occurring trans-fat (rTFA) is found in products derived from ruminant animals, such as milk, butter, ghee, beef, and mutton. Industrially produced trans fats (iTFA) are formed during the hydrogenation of vegetable oil for the production of semi-solid fats with longer shelf-life, such as daldha (Vanaspati), sometimes used for the production of margarine, and to prepare bakery items and for high-temperature deep frying (WHO, 2023).

Consuming trans-fat-ridden partially hydrogenated oils (PHOs) increases the risk of coronary heart disease (Mozaffarian, D., & Clarke, 2009; Global Health Advocacy Incubator, 2025). Trans fatty acid consumption increases the total cholesterol to HDL cholesterol ratio, a strong indicator of cardiovascular disease risk, by lowering the level of high-density lipoprotein (HDL) cholesterol and increasing the level of low-density lipoprotein (LDL) (Stampfer, 1991). TFA has been found to have detrimental effects on serum lipids as it evidently increases the

triglycerides and lipoprotein levels in blood than other types of fats (Mensink, 2003; Ascherio, 1999). Trans fatty acid also increases the risk of type-2 diabetes and replacing trans fatty acids with non-hydrogenated polyunsaturated fatty acids significantly decreases the type-2 diabetes disease risk (Salmerón, 2001). A high level of serum trans-monounsaturated fatty acids, such as palmitoleic acid and elaidic acid, was found to be associated with an increased risk of breast cancer in women (Chajès, 2008). Higher intake of TFA also increases the plasma biomarkers of inflammation, which in turn can adversely affect the endothelial function (Lopez-Garcia, 2005). These circumstances indicate the need to control trans fatty acid intake through the intake of PHOs used in processed food preparations.

There is no safe limit of trans fat intake, and the World Health Organization's (WHO) goal is to achieve the elimination of industrially produced trans fats (Nishida, 2009; and WHO, 2021). Intake of high iTFAs can be linked to 540,000 deaths each year. High TFA also increases the risk of death from any cause by 34% and death linked to coronary heart disease by 28% (Global Health Advocacy Incubator, 2025).

Elimination of industrially-produced TFA from the global food supply has been identified as one of the priority targets of the WHO's strategic plan, the draft 13th General Program of Work which guides the WHO's work in 2019 –– 2023. Moreover, as part of the United Nation's Sustainable Development Goals, the global community has committed to reducing premature death from non-communicable diseases by one-third by 2030; global elimination of industrially-produced trans fats can help achieve this goal (WHO, 2018). The WHO has created the REPLACE Action Package to provide governments with a strategy to achieve the prompt, complete, and sustained elimination of industrially-produced trans-fat from their national food supplies. (WHO, 2021).

On November 29, 2021 Bangladesh took an important step to improve public health by setting a strict new trans fat limit that aligns with WHO best practice. Bangladesh trans fat limits stipulate that TFA content in fats, oils and food may not exceed 2% of total fat which took effect on December 31, 2022.

Little is known about TFA content in Bangladeshi ready-to-eat foods. In India, partially hydrogenated vegetable oils (PHVOs) are consumed principally through Vanaspati, a vegetable ghee used as cooking oil to prepare fried snacks, baked goods and street vendor foods (L'Abbe, 2009). A high level of TFA was reported to be present in the commonly consumed street foods and snacks in India (Gupta, 2016); and breakfast meals and snack foods in Pakistan (Shah, 2016). It is reported that biscuits sold in Dhaka, Bangladesh, contained a high level of TFA (Mala, 2015); likely due to the use of PHO as bakery shortening. However, the TFA content in the PHOs available in the market in Bangladesh is unknown. So, the objective of the current study is to collect information about the market chain (from manufacturer to retailer) of PHO and the collection of samples available in the wholesale market, retailers, and manufacturers and analyze these for fatty acid profiles including trans-fat. The purpose of the analysis is to quantify the levels of TFA in partially hydrogenated oil (PHO) samples collected before the enforcement of the TFA Act, with the aim of establishing a baseline for post-regulation comparisons and supporting evidence-based policy evaluation.

Methods

Identification of PHO brands available in the market

PHO brands available from wholesale and retail markets in Dhaka were identified through visiting 4 wholesale markets (Karwan Bazar, Moulovi Bazar, Krishi Market, Mohakhali market) and 9 retail markets (Newmarket, Kaptan Bazar, Lalbag Bazar, Polashi Bazar, Borobagh market (Mirpur 2), Muktijoddha Market (Mirpur 1), Shantinagar Bazar, Khilgaon city Corporation market, Malibag Bazar) across Dhaka City from 13 to 30 May 2019. These markets are the major source of PHOs in Dhaka city. The wholesale markets were selected based on popularity and the retail markets were randomly selected from different parts of the city. Owners of the shops were interviewed to identify PHO brands, their average weekly sales, price, and the main consumers of PHO.

Sample collection

After identifying four major brands, samples were collected from wholesale and retail markets (20 samples). From wholesale/retail markets, samples were collected from different batches (at least six for each brand), with the exception of one brand for which only two batches were available in the market. All samples were collected within less than one month to minimize seasonal variation. All samples were shipped in insulated containers to protect them from extreme temperature fluctuation and the total shipping duration was <2 hours. Samples were transferred to the Institute of Nutrition and Food Science (INFS) laboratory and immediately refrigerated upon arrival until additional sample processing followed collection.

Sample preparation and shipment to the laboratory

Samples were prepared and stored in PET jars and labelled with a code for individual aliquots. All samples were shipped in insulated containers with ice packs to maintain low temperatures. After that, they were shipped through a courier service in a special courier pouch in less than 2 days. Twenty samples were shipped to FARE Lab, Gurgaon (near Delhi), India. As all samples were in solid form (daldha), there was no issue of mixing and no separation of solid and liquid components. Each sample was labelled, with unique code numbers, and handled by designated personnel throughout the sample processing and analysis process.

The remaining samples were stored at the lab of the Institute of Nutrition and Food Science (INFS), Dhaka University as an archive so that analysis could be repeated if needed.

Analysis method of samples

The fatty acid profile was analyzed using a gas chromatograph with flame ionization detector (FID), autosampler (model Agilent 7890B) using column Supelco 2560 (100m X 0.25mm X 0.20µm) Sigma

following AOAC Official Method 996.06. The injection temperature was 250^0 Centigrade at an injection gas (nitrogen) flow of 1ml/minute. Blank and standard (FAME Mix GLC 674, manufacture: Nu-Chek PREP; and Linoleic Acid Methyl Ester Isomer mix, manufacturer: Sigma Aldrich (Catalog No. CRM 4791) was run at the start of the chromatogram and after every 10 samples.

Estimated intake of TFA and SFA from PHO

Since there is no national data on PHO intake in Bangladesh, we estimated potential intake levels by aligning PHO

consumption with average edible oil intake, as PHO and edible oil can be often used interchangeably. According to HIES 2022, the average daily per capita consumption of edible oil in Bangladesh is 30.8 grams. Based on this, we assumed hypothetical PHO intake scenarios at 25%, 50%, and 100% of the average edible oil consumption—equivalent to 7.7 g, 15.4 g, and 30.8 g per day, respectively. We then estimated the corresponding levels of TFA intake that would result from each of these assumed consumption levels. We then calculated the percentage of the daily allowable intake covered by the estimated TFA and SFA intake from each assumed level of PHO consumption. The allowable intake values used were 22.22 g/day for saturated fatty acids (SFA) and 2.2 g/day for TFA. For each intake scenario—7.7 g, 15.4 g, and 30.8 g of PHO per day—we estimated the corresponding % daily allowable intake of TFA and SFA that would be consumed.

Results

Table 1 summarizes both wholesale and retail market visit information. On average, each wholesaler reported selling around 100-200 cartons of PHO per week, with each carton containing 16 kg. However, retailers only sold around 1-2 cartons per week. All PHO wholesalers also sold edible oils, with PHO accounting for less than 10% of their total sales volume. The average price of PHO ranged from BDT 90 to 110, compared to BDT 62–65 for palm oil and BDT 82–90 for soybean oil (unbranded) in December 2021; the present price of the PHO ranged between 180 to 220 BDT and the price of loose palm and soybean oil were between BDT 169-170 during April 2025. PHO was primarily sold to restaurants, bakeries and confectionery businesses for the preparation of cakes, biscuits, pastries, and similar products.

Table 1. Wholesale and Retail Market Visits for PHO in the Dhaka City

Type of market	Number of markets visited	Vendors interviewed	Average sale per week (carton)[1]	Average Price (BDT)	Main customers
Wholesale	4	11	100-200	190	Bakery
Retail	9	46	1-2	210	Bakery and Restaurants

1One carton contains 16 KG of PHO

The physical and chemical characteristics of the PHOs are shown in Table 2. The overall physical and chemical properties of partially hydrogenated vegetable oils. The average melting point was 42.73 °C. The peroxide value was 2.75 meq/kg, while the iodine value was 41.04. The acid value was 0.50, and the saponification value was 194.85.

Table 2. Overall physical and chemical properties of the partially hydrogenated vegetable oils

Samples (number of samples analyzed)	Melting point, 0°C	Peroxide value, meq/kg	Iodine value	Acid value	Saponification value
Brand 1 (6)	43.87+2.81	3.54+3.09	39.96+2.62	0.46+0.19	194.82+2.34
Brand 2 (6)	44.37+1.15	1.89+1.48	38.85+2.33	0.27+0.10	196.60+2.43
Brand 3 (6)	40.85+3.04	5.21+2.62	42.28+2.55	0.30+0.28	195.19+1.78
Brand 4 (2)	41.85+2.33	0.37+0.25	43.09+0.12	0.96+0.05	192.78+8.78
Overall (20)	42.73+1.66	2.75+2.09	41.04+1.97	0.50+0.32	194.85+1.58

Table 3 presents the fatty acid composition (per 100g) of four different brands of edible oil or fat products, explicitly focusing on saturated fatty acids (SFA), monounsaturated fatty acids (MUFA), polyunsaturated fatty acids (PUFA), and trans fatty acids (TFA). Among the four brands, Brand 2 has the highest SFA content (60.84 g/100g). Brand 4 shows the highest MUFA level (45.51g /100g) and also contains the highest TFA content (13.39 g/100g). In contrast, Brand 2 has the lowest TFA content (7.64 g/100g). Elaidic acid was mainly present as TFA in the samples. PUFA levels are relatively low across all brands, ranging from 1.80 g in Brand 4 to 5.05g in Brand 2. All the samples had TFA levels exceeding 2% (data not shown).

Table 3. Fatty acid composition (g/100g) of the partially hydrogenated vegetable oils by brand

Sample (number of samples analyzed)	**SFA[1]**	**MUFA[2]**	**PUFA[3]**	**TFA[4]**	**Palmitic acid**	**Stearic acid**	**Elaidic Acid**
Brand 1 (6)	58.87±2.25	36.26±1.32	4.88±1.02	9.51±1.49	45.06±1.86	10.50±2.54	9.13±1.82
Brand 2 (6)	60.84±1.90	34.12±1.62	5.05±1.01	7.64±0.71	46.80±1.73	10.55±0.82	7.52±0.72
Brand 3 (6)	55.98±2.34	39.61±3.14	4.42±1.78	10.28±2.44	44.67±1.81	7.64±2.63	9.32±2.65
Brand 4 (2)	52.70±0.52	45.51±1.25	1.80±0.74	13.39±2.85	37.60±0.46	11.74±1.14	13.25±2.78
Overall (20)	57.10±3.55	38.87±4.97	4.03±1.51	10.20±2.39	43.53±4.06	10.10±1.74	9.80±2.43

(Values are reported as Mean± SD) 1SFA-Saturated fatty acid; 2MUFA-mono unsaturated fatty acid, 3PUFA-poly unsaturated fatty acid, and 4TFA-trans fatty acid

Table 4 highlights the estimated potential health risks associated with hypothetical PHO consumption in Bangladesh by estimating SFA and TFA intake under assumed intake scenarios of 25%, 50%, and 100% of the average edible oil consumption level (30.8g/day). Notably, TFA intake exceeds the allowable intake (2.2g/day) at the 100% scenario, reaching 2.89g or 131.6% of the permissible intake. Even at the 25% scenario, TFA contributes nearly 33% of the permissible intake, indicating that small amounts of PHO could significantly raise trans-fat intake. In contrast, SFA intake remains within recommended limits at all levels, though it reaches 80% of the allowable intake at whole PHO intake.

Table 4. Estimated intake of saturated and trans fats based on the assumption that 25%, 50%, and 100% of the usual intake[1] of fats and oils are partially hydrogenated oils (PHO)

Wholesale	Intake (g) – 25%	Percent of maximum allowable intake – 25%	Intake (g) – 50%	Percent of maximum allowable intake – 50%	Intake (g) – 100%	Percent of maximum allowable intake – 100%
SFA[2]	4.45±0.19	20.04±0.86	8.91±0.38	40.08±1.73	17.81±0.77	80.15±3.45
TFA[3]	0.72±0.24	32.89±10.91	1.45±0.48	65.79±21.82	2.89±0.96	131.58±43.64

[1]*Since no national data on PHO intake is available for Bangladesh, Values are based on assumption that PHO intake is equivalent to 25%, 50%, and 100% of the average edible oil consumption of fats and oils in Bangladesh, i.e., 7.7g, 15.4g, and 30.8g/day respectively. (HIES, 2022)*

[2] *The World Health Organization (WHO) advises that saturated fat intake should not exceed 10% of total energy intake. For a 2,000-calorie diet, this translates to about 22 grams per day. (WHO, 2020)*

[3]*The World Health Organization (WHO) recommends that trans-fat intake should be less than 1% of total energy intake, which is approximately 2.2 grams per day for a 2,000-calorie diet (WHO, 2020)*

Discussion

The aim of the study was to determine the TFA content in 20 PHO samples collected from the top five brands available in the market. These samples represent majority of the PHO brands in Bangladesh. Analysis of all 20 samples revealed that each contained more than 2% TFA. The average TFA content in the analyzed samples was approximately 10%, with elaidic acid being the predominant form.

In our study, the levels of saturated fatty acids (SFA), monounsaturated fatty acids (MUFA), and polyunsaturated fatty acids (PUFA) were approximately 57%, 39%, and 4%, respectively. Similar to our findings, an earlier Indian study by Dorni (2018) reported that in vanaspati samples, SFA ranged from 28.7% to 46.1%, MUFA from 4.2% to 37.6%, PUFA from 1.0% to 40.7%, and total unsaturated fatty acids (TUFA) from 5.2% to 49.0%. Likewise, a study evaluating the fatty acid profile of partially hydrogenated cooking oils in Pakistan found mean values of 44.98% for SFA, 47.51% for MUFA, and 7.49% for PUFA in vanaspati ghee (Kandhro, 2010). Previous literature reported that in branded vanaspati samples, the SFA, MUFA, and PUFA contents ranged from 49.34 to 64.13 g, 35.86 to 49.80 g, and 0.71 to 4.87 g per 100 grams of sample, respectively (Mehta, 2018).

The average TFA content in our samples was around 10%. Similar to our findings, a recent Indian study analyzing seven vanaspati samples reported that all of them contained TFA levels exceeding the permitted limits, ranging from 9.4% to 23.7%, with elaidic acid identified as the major TFA formed during industrial hydrogenation (Dorni et. al., 2018). Another study found that among branded vanaspati samples, the TFA content ranged from 5.14 to 26.83g/100 grams (Mehta, 2018). In Pakistan, a study on vanaspati ghee samples reported a TFA level of 8.08% (Kandhro, 2010).

According to WHO guidelines, TFA consumption should not exceed 1% of total energy intake, translating to less than 2.2 g/day in a standard 2,000-calorie diet (WHO, 2021). Based on our analysis, if PHOs were to account for approximately 50% of total oil intake, equivalent to about 15.4 grams per day, it would result in an estimated TFA intake of 1.45 grams per day, representing around 66% of the allowable intake for TFA. This level of intake poses significant public health concerns. However, as the actual consumption of PHO in Bangladesh has not been systematically documented, this estimate only indicates the potential exposure scenario. Notably, since PHO is not typically consumed directly at the household level, as described by the interviewees of our study, individuals who frequently consume bakery and restaurant foods may be indirectly and unknowingly exposed to PHO, thereby increasing their risk of TFA-related health harms.

With the rapid pace of urbanization, the consumption of processed foods is increasing, driven by their convenience and easy availability in the market (Popkin, 2012). A 2015 study reported that people in high-income countries obtain nearly two-thirds of their dietary energy from industrially produced, ready-to-eat foods (PAHO, 2015), and this trend is also growing in low- and middle-income countries (Baker & Friel, 2016). In Bangladesh, similar trends have been observed in several studies. A national survey identified several packaged foods that are widely consumed throughout the year (Choudhury et al., 2021). Another study also highlighted particularly high levels of processed and unhealthy foods and beverages intake among Bangladeshi adolescents (Shamim et al., 2023); and elderly (Shamim et al., 2024).

According to existing literature, the consumption of processed food contributes to an increased intake of TFA and saturated fats (Forouzanfar, 2015; Monteiro et al., 2011). Earlier Bangladeshi studies have also documented the presence of TFA in processed food products (Shaheen et al., 2024). These TFAs in processed foods can originate from two major sources: the PHO, as highlighted by our findings, and the edible oils used in food preparation, which earlier studies have also shown to contain high levels of TFA (Sarwar et al., 2024). Therefore, both PHO and edible oils contribute to the TFA burden in processed foods. As the consumption of processed foods continues to rise, so does the risk of exposure to elevated TFA levels. Therefore, to effectively reduce TFA intake at the population level, it is essential to control and lower the TFA content in both PHO and edible oils—since these are the main contributors of TFA in processed food products.

Our study found high levels of TFA in PHO samples, raising significant public health concerns regarding their unregulated use. Trans fats are well known for their harmful effects on cardiovascular health, underscoring the importance of informed food choices and highlighting the risks associated with PHO consumption (Stampfer, 1991). These findings can serve as a foundation for public health initiatives aimed at raising awareness among consumers, policymakers, and food manufacturers about the health implications of TFA intake. The WHO recommends two types of measures to protect public health from TFA: (1) limiting TFA to 2g / 100g total fat in all fats, oils, and foods, or (2) banning the production and use of PHO (Countdown to 2023: WHO report on global trans-fat elimination 2022). The WHO recommends either of these measures or a hybrid of the two, depending on which option best fits a country's regulatory system and food supply chain.

Although Bangladesh has introduced legislation to limit TFA content, effective enforcement remains crucial. Several countries have successfully strengthened their TFA control measures by reformulating existing regulations, such as removing the melting point cap on oils to better prevent TFA formation (Downs et al., 2013). Similar legal reforms, if necessary, should be considered in Bangladesh to ensure the effective implementation and enforcement of TFA regulations. In a previous study nationwide sampling of edible oils revealed elevated levels of trans fatty acids (TFA) (Sarwar, 2024), and heavy metals—especially mercury (Shaheen, 2024)—highlighting lapses in food regulation enforcement and emphasizing the urgent need to strengthen quality monitoring to ensure the availability of safe edible oils and fats, including PHOs, for the Bangladeshi population. Considering the widespread use of PHO in the food service sector, particularly in bakeries and restaurants, institutional regulation and rigorous monitoring of TFA levels are essential to reduce associated health risks. Future research and collaborative efforts among public health authorities, the food industry, and consumers are necessary to build upon these findings, promote a healthier food environment, and ultimately reduce the burden of TFA-related health outcomes in the population.

The study has several strengths and limitations. One of its key strengths is the inclusion of four major PHO brands and four key wholesale markets, which are significant contributors to the PHO market in Bangladesh. This selection enhances the likelihood that the findings closely reflect the actual market scenario. However, a limitation is that all PHO samples were collected solely from Dhaka city, which limits the national representativeness of the composite samples. Batch-related variations within the brand were not considered in this analysis as only two samples of Brand 4 were available due to its limited market presence. Further studies should aim to include samples from a wider geographic range to improve generalizability and provide a more comprehensive understanding of the national PHO market.

Conclusion

The analyzed samples in this study indicate that PHOs available in Bangladesh contain approximately 10% TFA, which is significantly higher than the WHO's recommended threshold. Although PHO is not directly consumed at the household level, it is widely used in restaurant foods, bakery products, and other processed foods, leading to indirect exposure among the population. With the rising consumption of restaurant, bakery, and packaged foods, the risk of TFA intake from PHO and other sources is increasing. Therefore, it is crucial to reduce the TFA content in PHO through the effective enforcement of Bangladesh's existing TFA regulations.

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Conflict of Interest

The authors declare that they have no conflicts of interest.

Ethics Statement

Ethical approval was obtained from the Institutional Review Board of the Institute of Health Economics (IHE-IRB), University of Dhaka, which is approved by the U.S. Department of Health and Human Services Federal Wide Assurance (Ref. No. IHE/IRB/DU/44/2021/Final, Date: 30 December 2021)

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