Original Research Article

Health compromising components in french fries and fried chicken available in the markets of Dhaka city, Bangladesh

ABSTRACT

Background: Consumption of french fries and fried chicken contributes to overweight and obesity among the children and adolescents worldwide. This descriptive cross-sectional study was aimed to determine the health compromising components present in the top-selling brands of french fries & fried chicken available in the markets of Dhaka city, Bangladesh.

Methodology: Five top selling brands for both french fries and fried chicken were analyzed, to identify, sodium (*Na*) trans fatty acids (*TFAs)* and heavy metals like arsenic (*As*), lead (*Pb*), cadmium and chromium. *Na* was determined by flame photometry, *TFAs* by gas chromatography and heavy metals was detected by graphite furnace atomic absorption spectrophotometry.

Results: The median concentration of *Na, TFA, As* and *Pb* in french fries was 0.45 gm/100 gm, 0.11 gm/100 gm, 0.93 mg/kg and 0.03 mg/kg, respectively. Similarly, in fried chicken the median concentration of *Na, TFA, As* and *Pb* was 0.46 gm/100 gm, 0.13 gm/100 gm, 0.053 mg/kg and 0.06 mg/kg, respectively.

Conclusion: The study findings suggests that consuming french fries and fried chicken impose a health risk among the exposed population. Consumer awareness for appropriate food choices and strict monitoring by regulatory bodies are recommended to reduce the risk of non-communicable diseases.

Comment [u1]: French should start with a capital letter 'F'.

Comment [u2]: As observed and commented above.

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Comment [u4]: '**Were**' should replace '**was**'

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Keywords: *French fries; Fried Chicken; Sodium; Trans fatty acids; Heavy metals; Bangladesh*

1. INTRODUCTION

Fast food consumption has increased worldwide over the past few decades [1] leading to significant rise in obesity [2,3] and a poorer quality of diet [4]. Often these fast foods contains high level of sodium (*Na*), trans fatty acids (TFA) and heavy metals like arsenic (*As*), lead (*Pb*), cadmium (*Cd*) and chromium (*Cr*), which are potentially toxic, and known risk factors for hypertension, cardiovascular diseases, diabetes, depression, stroke, and multiple cancers [5–7]. Among the varieties of fast food available, french fries and fried chicken are the most popular items consumed by people worldwide [8]. The fast foods have become an important part of their dietary menu for children and adolescents, and has been determined as a risk factor for overweight and obesity among the adolescents in Bangladesh [9]. Even though the consumption of french fries and fried chicken is very common in Bangladesh, yet there is very little information on the harmful contents of such foods. Therefore, the objective of this study was to determine the health compromising components present in the top-selling brands of french fries & fried chicken available in the markets of Dhaka city, Bangladesh.

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2. MATERIAL AND METHODS

2.1 Sampling and sample collection

A descriptive cross-sectional study was conducted, where five top selling brands of french fries and fried chicken available in the markets of Dhaka, Bangladesh were sampled for the study. Two stage stratified sampling was done for selecting the brands of french fries and fried chicken from the retail outlets. Among the two city corporations of Dhaka, Dhaka South City Corporation was randomly selected by lottery for sample collection, from which a zone (Dhanmondi) for sample collection was chosen purposively. Then eight popular fast food shops were identified from the selected zone. Using a questionnaire, short interviews were conducted of the salespersons from those eight shops, to identify the volume of daily sales of french fries (packets and weight) and fried chicken (pieces and weight). For french fries, a

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ranking technique was implemented to identify the top selling five shops. The total number of packets (by weight) of french fries sold daily was considered and ranked as I to VIII following the order of the values. Then the top selling five shops were identified. For fried chicken, the total weight of the daily sold pieces of each shop was converted into grams then the highest to lowest values were ranked as I to VIII and the top selling five fried chicken shops were identified. For anonymity, the samples were coded using capital letters (A-E) to identify the brand names. French fry samples were coded as FF (A-E) and fried chickens as FC (A-E). This coding process was conducted and kept confidential by the researcher. The ethical permission for this study was received from the Institutional Review Board of Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh (Ref No. BSMMU/2017/7388).

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2.2 Determination of Na

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Na content was determined by flame photometry using a JENWAY PEP7 Flame Photometer, Made in U.K. Flame photometry was carried out according to AOAC method 990.23z [10]. This method has the advantage of following the direct determination of the *Na* ion. As reagent, standard *Na* solution was used, where 2.542g of sodium chloride crystals was dissolved in water and diluted the solution to a volume of 1000 ml. This solution contained 1000 ppm of *Na*. Measurement of *Na* was done by comparing the emission with the standards made from distilled water containing 0.5, 10 and 20 ppm of *Na*.

Comment [u20]: Correct as: **Flame photometer (Model No. PEP7 Jenway, UK)**

2.3 Determination of TFAs

TFAs were analyzed with Shimadzu GC-14B (Japan) series gas chromatograph equipped with flame ionization detector and fused silica capillary column (FAMEWAX, Crossbond® polyethylene glycol, 15 m×0.25 mm×0.25 μm film thickness, Restek; Pennsylvania, USA). In the laboratory the food samples were cut into small pieces of about 1 cm^2, from which 400 gm of the samples were placed in a conical flask, and 500 ml of petroleum ether (Merck, Mumbai, India) was added into the flask, shaken well for proper mixing, and then it was kept overnight for oil extraction. The solvent with the oil was then filtered through a filter paper, evaporated in the water bath, and the extracted oils were kept in sample bottle for analysis. In this method, a few drops of extracted fat were dissolved in petroleum ether in a test tube and methylated by using sodium methoxide (Merck, Germany) in presence of flame. The solution was then diluted with distilled water and allowed to settle for few minutes, until a clear portion was visible in the

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Comment [u24]: Please be specific, '**3 mins**' or '**5 mins**' upper part of the tube. The upper layer of fatty acid methyl ester was then collected and used for gas chromatograph analysis.

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2.4 Determination of heavy metals

Heavy metals were determined by using graphite furnace atomic absorption spectrophotometry (GF-AAS). Collected food samples were taken in a similar amount using an electric balance and cut into small pieces with a sharp stainless steel knife for further analysis. Samples were then weighed in equal amounts and stored for acid digestion. Then 5 gm of each sample was taken and placed in a hot plate on the Barnstead fume hood. Concentrated 2.0 ml of nitric acid was added to the sample and heated until the sample turned into black color. The sample was then placed in the furnace for at least eight hours. After that, the sample was placed in the fume hood and 5 ml of hydrochloric acid was added to complete the acid digestion. The digested sample was then water boiled and filtered to remove the debris. Then the sample's final volume was made up to 100 ml in a volumetric flask and stored in the fridge until analyzed by the GF-AAS.

Comment [u26]: '**Spectrophotometer**' or '**Spectrophotometry**'.

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2.5 Statistical analysis

All the statistical analyses were performed using Microsoft Excel (version 2013). Levels of *Na* and TFAs are reported as gm/100 gm and heavy metals are reported as mg/kg. The average value was achieved by calculating the median. Estimation of the heavy metal intake was determined by considering the weight of the servings which was 100 gm for french fries, 100 gm for the leg piece and 125 gm for the breast piece of fried chicken. The estimated concentration of heavy metals was then compared to the maximum allowable daily exposure level (MADL) of heavy metals, and how much it contributed to the MADL. Data is presented in table and in text, following descriptive analysis.

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Comment [u31]: Use capital letter '**T**' to present Table. This is because Table in this context is a noun.

3. RESULTS

Among the samples of french fries analyzed, the median concentration of *Na* was 0.45 gm/100gm, and was found highest in FF A (0.54 gm/100gm) (Table 1). The median of the *Cd* content was 1.31×10^{-3} mg/kg, which was highest in FF C (5.78×10-3 mg/kg). For total *As* in french fries the median was 0.93 mg/kg and was found to be highest in FF D (1.35 mg/kg). In the analyzed samples of fried chicken (Table 2), the median *Na* content was 0.46 gm/100gm and the highest concentration was found in FC C (0.60

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gm/100gm). The median concentration of *Cd* and total *As* was 2.17×10^{-4} mg/kg and 0.053 mg/kg, respectively. High level of *Cd* was determined in FC D (6.06×10^{-3} mg/kg), where total *As* was found high in FC C (0.144 mg/kg).

Table 1: Health compromising components in french fries (n= 5)

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	Na (gm/100gm)	**TFAs** (gm/100gm)	***As*** (mg/kg)	***Pb*** (mg/kg)	***Cd*** (mg/kg)	***Cr*** (mg/kg)
FF A	0.54	ND	0.76	0.02	1.63×10^{-4}	0.012
FF B	0.35	0.08	0.24	0.09	1.24×10^{-5}	0.014
FF C	0.51	*ND	0.93	0.01	5.78×10^{-3}	0.011
FF D	0.33	0.11	1.35	0.04	1.26×10^{-5}	0.012
FF E	0.45	0.17	0.96	ND	1.31×10^{-5}	0.010
Median	0.45	0.11	0.93	0.03	1.31×10^{-3}	0.012

ND= Not detected

Table 2: *I* (n= 5)

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	Na (gm/100gm)	**TFAs** (gm/100gm)	***As*** (mg/kg)	***Pb*** (mg/kg)	***Cd*** (mg/kg)	***Cr*** (mg/kg)
FC A	0.57	0.02	0.054	0.09	2.17×10^{-4}	0.011
FC B	0.37	0.57	0.050	0.06	5.63×10^{-3}	0.012
FC C	0.60	ND	0.144	0.05	1.81×10^{-5}	0.013
FC D	0.42	0.01	0.00001	0.06	6.06×10^{-3}	0.012

FC E	0.46	0.23	0.053	0.05	1.63×10^{-4}	0.012
Median	0.46	0.13	0.053	0.06	2.17×10^{-4}	0.012

ND= Not detected

If we were to consider the intake of 100 gm of french fries and fried chicken for an adult, since the MADL for *As* is 0.22 mg [11], 100 gm of french fries will contribute to 42.57% of his daily allowable limit of *As* (Table 3). Similarly, the intake of one piece of fried chicken (100 gm, leg piece) will fulfil 2.41% and 2.89% for breast piece (125 gm) of the daily allowable limit of *As.* For *Pb*, the MADL is 0.25 mg/day [12], therefore eating 100 gm of french fries will contribute to 1.20%, one piece of fried chicken will fulfil 2.40% (for leg piece) and 2.88% (breast piece) of the daily allowable limit of *Pb.*

Table 3: Consumption of heavy metals from french fries and fried chicken

Heavy metals	**French Fries**		**Fried chicken**				**Reference MADL (mg/day)**
			Leg piece		***Breast piece***		
	Conc./100 gm	% MADL reached	Conc./100 gm	% MADL reached	Conc./125 gm	% MADL reached	
As	0.093	42.27	0.0053	2.41	0.00636	2.89	0.22
Pb	0.003	1.20	0.006	2.40	0.0072	2.88	0.25
Cd	1.31×10^{-4}	<1.00	2.17×10^{-5}	<1.00	2.604×10^{-5}	<1.00	0.175[a]
Cr	0.0012	1.00	0.0012	1.00	0.00144	1.20	0.12[b]

[a] – EFSA sets lower tolerable intake level for cadmium in food

[b] – Rahman, M.L., 2014. Acceptable level of chromium in food

4. DISCUSSION

4.1 Content of Na in french fries and fried chicken

This study determined the median *Na* content in french fries and fried chicken was 0.45 gm/100gm and 0.46 gm/100gm, respectively. Few studies previously had determined the mean content of *Na* in french fries, where it was 0.28 gm/100gm in New Zealand [13], 0.21±0.014 gm/100gm in USA [14] and 0.59 gm/100gm in Argentina [15]. Similarly, the mean *Na* content in fried chicken revealed in other studies includes 0.68 gm/100gm, 0.75 gm/100 gm and 0.45.0±65.3 mg/100gm [13,14,16]. The variation in the findings of the mean content of *Na,* might be due to the salt applied as a surface seasoning before or after frying. Another possible contributor to *Na* in the fried chicken, maybe because of the chicken preparation procedure, where many chicken manufacturers soak or inject chicken meat with salt water (brine), to keep it juicy [17]. The World Health Organization (WHO) recommends, for an adult, the recommended consumption of *Na* be limited to 2gm/day [18]. Therefore, based on our current findings, for an adult, consuming 100 gm of french fries or fried chicken will fulfil almost one quarter of the daily recommended limit of *Na*.

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4.2 Content of TFAs in french fries and fried chicken

The TFA content determined by the current study in french fries ranged from non-detectable to 0.17 gm/100gm and the median was 0.11 gm/100gm. The TFA content in takeaway french fries sampled in Australia from six leading fast food outlets ranged from 0.2 to 1.5 gm/100gm [19] and in Denmark only 3 out of 43 samples of french fries had TFA below 1.0 gm/100gm [20]. These reported content of TFA were quite high compared to the current study finding. Correspondingly, the TFA determined in fried chicken in this present study ranged between non-detectable to 0.57 gm/100gm, median was 0.13 gm/100gm. Other studies stated the TFA content in fried chicken from fast food joint was 0.08 – 0.14 gm/100gm [21], 0.159±0.024 mg/100 gm [22] and 0.16-1.96 gm/100gm [23]. The likely cause for the differences in TFA content might be due to the type of oil/fat used for frying the food [24], different brands of fats and oils used [21], differences in cooking methods since deep frying and cooking at high temperatures commonly lead to the increase in TFA [25]. It is also worth mentioning that samples from one brand of fast food denoted as C (FF C and FC C), did not have detectable levels of TFAs, since gas chromatography can easily quantify TFA as low as 0.5µg/mg of fat [26]. This result may be because that particular shop did not reuse oil several times in frying. Even though this study determined low levels of TFA, it should be that the serving size of these fast food are usually more than 100 gm, and is commonly with other food items such as breads, fizzy drinks and desserts. Thus, high levels of TFA can be ingested when these meals are consumed.

4.3 Content of heavy metals in french fries and fried chicken

In this present study, the median total *As* content of french fries and friend chicken was 0.93 mg/kg and 0.053 mg/kg, respectively. Thus, by consuming 100 gm of french fries contributes to almost half of the daily allowable limit of *As.* Even though, there was very little literature found on the arsenic levels in french fries and fried chicken, but plenty were available regarding the alarming levels of arsenic in potatoes and chicken [27–31]. *As* usually enters the food chain, when *As* contaminated water is used for irrigating crops or in feed additives for poultry [32], consequently entering into commercial food products prepared from *As* contaminated raw materials.

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This study identified low levels of *Pb* in the analyzed samples of fast foods. On the contrary, Haque et al., 2019 reported that among different fast foods, chicken burgers had the highest concentrations (1.14 mg/kg) of *Pb*, as the poultry farms used poultry feeds high in *Pb* (1.40-6.59 mg/kg) which was consequently passed down the food chain [33]. As our environment also contributes to the daily exposure to *Pb*, frequent consumption of fast foods will possibly add up to exceeding the maximum allowable limit of daily exposure to *Pb*. Therefore, fast food intake poses a high risk for *Pb* toxicity especially among the children, because of a high intake of *Pb* per unit body weight [12].

There are some limitations that needs to be considered before concluding the present study. Only branded outlets in Dhaka city, were chosen for sample collection. Thus, the findings may not be generalizable for all the french fries and fried chicken sold in the markets of Bangladesh. Also, in this study we only determined total *As* and not inorganic *As*, which is a human carcinogen.

5. CONCLUSIONS

The present study findings suggest that consuming french fries and fried chicken maybe a potential contributor to high *Na*, TFA and *As* intake among the exposed population. The presence of the afore-mentioned health-compromising components in these common fast foods may lead to detrimental health

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consequences. Awareness among the consumers for making appropriate food choices and strict monitoring by the regulatory authorities of Bangladesh, could be an important means in the reduction of the negative impact of fast foods like; french fries and fried chicken on health.

9. ETHICAL CONSIDERATIONS

This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving research study participants were approved by the Institutional Review Board of Bangabandhu Sheikh Mujib Medical University (Ref No. BSMMU/ 2019/9016). Written informed consent was obtained from all the respondents during the field survey.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

10. REFERENCES

Comment [u40]: 1. Make sure that you follow strictly the guidelines for referencing of this Journal.
2. Reference no 22 should be written using small letters and not as presented using capital letters for presenting the topic of the study.

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