

Exposure assessment of trans fatty acids in Ghanaian fried foods: a case study on plantain chips sold within the Accra Metropolitan Area

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Conference link: www.ANH-Academy.org/ANH2021 #ANH2021



INTRODUCTION

Consumed in many parts of the world, plantain chips are perceived to be a healthy alternative to potato chips or other greasy snacks due to their relatively high fibre and low sodium content. Typical of street foods, they provide an accessible and affordable source of nutrition for many people in low- and middle-income countries (LMICs), yet snack foods are significant sources of unhealthy fats including trans fatty acids (TFA) [1]. According to the USDA national nutrient database, the total fat per a serving of plantain chips (30g) is 8% representing about 27% of fat in 100g plantain chips [2]. In Ghana, food preparation practices including repeated usage of cooking oils [3] and frying foods at elevated temperatures [4] could induce formation of TFA in deep fried foods.

There is a growing public health concern about the consumption of foods containing TFA due to the established link with chronic disease morbidity and mortality [5]. WHO recommends that daily TFA intake be limited to less than 1% of total energy [6]. However, there is sparse scientific data on TFA levels in locally produced foods and intakes among Ghanaians. While much attention has been given to saturated fatty acids and their effect on non-communicable diseases (NCDs), equally critical is the levels of TFA in the Ghanaian diet and how much consumers are exposed to this type of fatty acids.

Our pilot study determined the amounts of TFA in a popularly consumed snack, plantain chips sold within the Accra Metropolitan Area (AMA) of Ghana and estimated intakes among regular consumers of this snack.

Research Questions

- Are there any TFA in plantain chips produced and consumed in the AMA? If yes, what types and levels of these fatty acids are present?
- How much TFAs are consumed in plantain chips?
- What is the nutritional status (BMI, BF%) of regular consumers of plantain chips?
- Is there any association between BMI, BF% and TFA intakes?

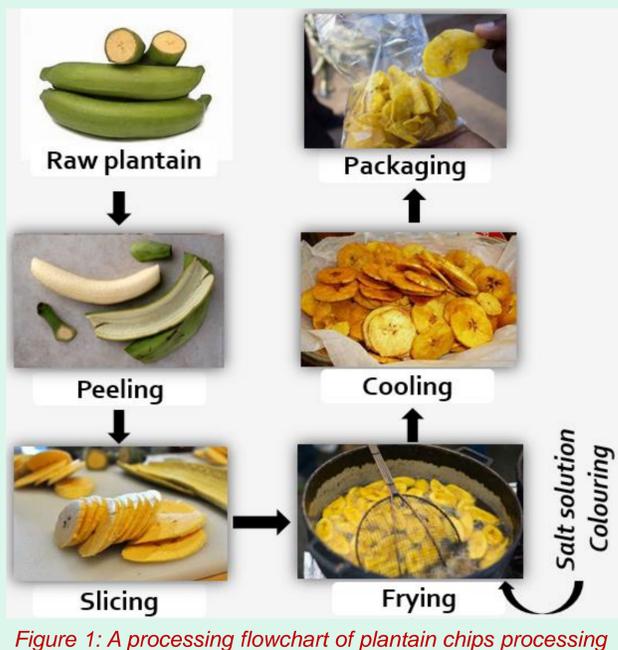


Figure 1: A processing flowchart of plantain chips processing

METHODS/APPROACH

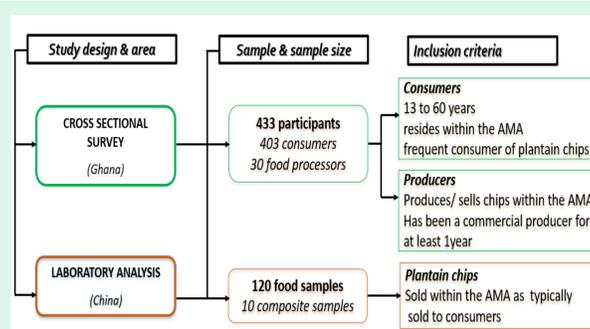


Figure 2: Flow chart displaying summary of study methodology

TFA was detected and quantified in 120 plantain chips samples randomly purchased from street vendors along the principal streets within the AMA. Fatty Acid Methyl Esters (FAME) was prepared according to ISO 12966-2:2017 and analyzed by Gas Chromatography Spectrometer with Flame Ionising Detector (FID) [7]. The total TFA was calculated as the sum of elaidic acid (t9-C18:1), linoelaidic acid (t9,t12-C18:2) and isomers of trans α -linolenic acid (t9,t12, t15-C18:3).

A cross-sectional survey comprising 389 respondents aged 13 to 60 years was carried out to solicit information on TFA intakes. Weight, height and body fat (BF%) of each participant were measured. The WHO body mass index (BMI) principal cut-off; BMI ≥ 30.0 kg/m² [8], and a frequently used BF% cut-off; $\geq 25\%$ in men and $\geq 35\%$ in women for defining obesity were applied [9]. TFA intake was estimated as a product of the mean TFA concentration and the quantity of chips consumed in a day. Values were expressed as the average intake of TFA (as % of energy) based on a 2000kcal diet using the WHO recommended limit of 1% of energy as reference. A multiple regression was performed to predict BMI and BF% from TFA intake and other variables.

Table 1: Summary of data collection approach

Data type	Tools/ instrument	Variables	Outcome measure(s)
Food analysis	GC-FID	C-18 trans fatty acids	total fat, TFA levels
Socio-demographic	semi-structured questionnaire	age, gender, educational level, average monthly income	socio-economic status
Physical Activity	questionnaire	status, duration, frequency	physical activity score
Dietary	food frequency questionnaire	frequency of consumption, portion sizes	Quantity of chips consumed/day
Anthropometric	stadiometer, weighing scale, fat loss monitor	Height, weight, body fat	body mass index, percent body fat



Figure 3: Plantain chips sellers hawking on a principal street in the AMA. Photo Source: CNCNEWS. [\[http://en.cncnews.cn/news/v_show/62973_Making_plantain_chips_in_Ghana.shtml\]](http://en.cncnews.cn/news/v_show/62973_Making_plantain_chips_in_Ghana.shtml)

FINDINGS AND INTERPRETATION

1. Plantain chips sold within the AMA contain some amounts of TFA and have high fat content.
 - Average fat content of $27.5 \pm 1.2\text{g}$
 - Trans isomers of oleic, linoleic and α -linolenic acids were detected; a total mean of TFA of $2.1 \pm 0.4\text{g}/100\text{g}$ fat and $0.6 \pm 0.1\text{g}/100\text{g}$ food.
2. TFA consumed from plantain chips falls within the recommended population target of <1% of food energy.
 - Total fat intake of 12.02 ± 11.76 g/day, representing 5% energy
 - TFA intake of $0.26 \pm 0.25\text{g}/\text{day}$ representing 0.1% energy.
3. Male participants were older, taller, weighed slightly heavier, were more physically active and recorded lower BMI and percent body fat readings than females.
 - Mean age, BMI, BF% and physical activity score were 30 ± 13 years, $25.5 \pm 5.5\text{kg}/\text{m}^2$, $25.0 \pm 10.9\%$ and 3.4/10.0 points respectively.
4. Regression analysis showed that TFA is positively linked with BMI and BF% but not a significant predictor of these two variables.

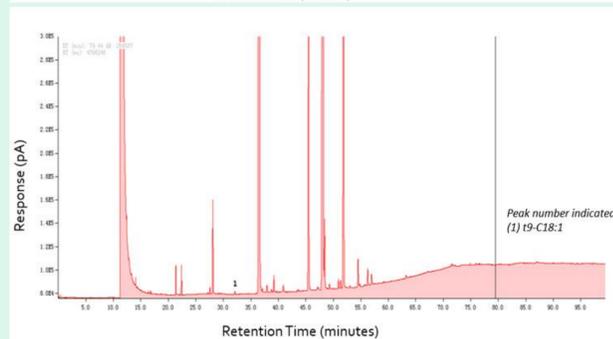
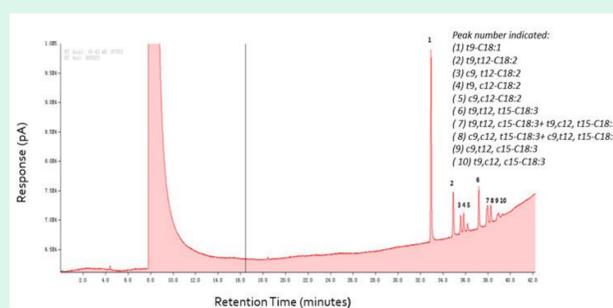


Figure 4: Chromatograms of the trans fatty acid standard mixture and that of a plantain chips sample

Table 2: Background Characteristics of Study participants (N = 389)

Characteristic	n (%) / Mean \pm SD ^a
Gender	Male 163 (41.9) Female 226 (58.1)
Age, years	Mean \pm SD 30.9 \pm 12.5 Minimum-maximum 13 – 60
Marital Status	Single/Never married 263 (67.6) Co-habiting/Married 102 (26.2) Divorced/Separated/Widowed 24 (6.2)
Educational Level	None/Primary 51 (13.1) Secondary/Vocational 154 (39.6) Tertiary 184 (47.3)
Work Status	Employed 223 (57.3) Unemployed/Student/Retired 166 (42.7)
Average Monthly Income ^b	< \$100 195 (50.1) \$100 - < \$300 94 (24.2) \geq \$300 29 (7.4)

^aSD, standard deviation. ^bData were missing for average monthly income (n=72).

CONCLUSIONS

TFA contained in plantain chips are consumed at safe levels. Nonetheless, attention needs to be given to the health risks that accompany excessive consumption of this snack. General recommendations are that snacks high in fats and containing TFA be eaten in moderation. This research likely being the first of its kind in Ghana, it is hoped that the results contribute to filling the knowledge gap and inform future research.

Acknowledgements

We acknowledge the funding support from the West China School of Public Health, Sichuan University.

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