CONTRIBUTION OF SELECTED STREET FOODS TOWARDS DIETARY TRANS FATTY ACID INTAKE FOR ADULTS IN KAWEMPE DIVISION

NAKAYAGA CLAIRE

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A DISSERTATION SUBMITTED TO THE DIRECTORATE OF RESEARCH AND GRADUATE TRAINING IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF PUBLIC HEALTH OF KYAMBOGO UNIVERSITY

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DECLARATION

I, Nakayaga Claire, declare that the work in this dissertation, which I hereby submit for the degree of Master of Public Health of Kyambogo University, is entirely mine and has never been presented before, to any higher institution of learning, for a similar or other award.

Signature ……………………….   Date ……………………………….

APPROVAL

We certify that the dissertation entitled "Contribution of selected street foods towards dietary total fat and trans fatty acid intake in adults in Kawempe division" is the student's own work and is ready for submission in partial fulfillment of the requirements for the award of the degree of Master of Public Health of Kyambogo University.

1. Dr. Michael Bamuwamye

Lecturer,

Department of Food Science and Technology,

Kyambogo University.

Signature ………………………. Date ………………………….

2. Dr. Asio Santa Maria

Senior Lecturer,

Department of Biological Sciences,

Kyambogo University.

Signature ………………………. Date …………………………..

DEDICATION

Dedicated to my children: Deron Michael Njuba, Donnell Mathew Male and Malaika Taliah Namale.

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ABBREVIATIONS AND ACRONYMS

CLA	Conjugated linoleic acid
CHD	Coronary Heart Disease
CVD	Cardiovascular disease(s)
BFM	Body fat mass
BM1	Body mass index
FA	Fatty acid(s)
FAO	Food and Agriculture Organization of the United Nations
HCA	Heterocyclic amine(s)
HDL	High-density lipoproteins
iTFA	Industrial trans Fatty Acid(s)
IP-TFA	Industrially produced trans fatty acids
LDL	Low-density lipoproteins
MUFA	Monounsaturated fatty acids
NCD	Non-communicable Disease(s)
PAH	Polycyclic aromatic hydrocarbons
PUFA	Polyunsaturated fatty acid(s)
SF	Street food(s)
SFA	Saturated fatty acid(s)
T2DM	Type 2 diabetes mellitus
TFA	Trans fatty acid(s)
UFA	Unsaturated fatty acid(s)
WHO	World Health Organisation

ABSTRACT

Total fat and trans fatty acids (TFA) affect blood lipoprotein profiles, promote inflammation and endothelial dysfunction, and are risk factors of coronary heart disease, diabetes, and cancer. This study assessed the consumption rates, total fats and TFA of the street foods; fried chicken, pancakes, potato chips, chapattis and fish obtained from Makerere, Wandegeya and Bwaise in Kawempe Division with the view to establishing the contribution of street foods towards dietary TFA intake. Data on consumption rates of street foods were collected using validated and pretested questionnaires. A total of 30 samples of deep-fried street foods and used frying oil were analyzed for total fat and TFA. Total fat content was determined by extraction with n-hexane in a Soxhlet apparatus. Trans fatty acids were determined as fatty acid methyl esters (FAME) using gas chromatography coupled with flame ionization detection (GC-FID). More male participants (52.8%) consumed street foods than females (47.2%). Shallow-fried chapatti was the most consumed food followed by potato chips while deep-fried chapatti was the least consumed**.** The total fat content ranged from 6.8 to 18.3%. Street foods from Bwaise contained more total fat than those from Makerere and Wandegeya. Fried chicken contained more total fat, followed by potato chips, fried fish and pancakes. Twenty-four fatty acids (FA) were detected in the deep-fried foods while 23 FA were detected in used frying oils. Palmitic acid (16:0) and stearic acid (18:0), and oleic acid (18:1ω9) and linoleic acid (18:2ω6), were predominant saturated and unsaturated FA, respectively. All frying oils analyzed in this study tested positive for TFA (linoelaidic (C18:2ω6*t*) and elaidic (C18:1ω9*t*) acids). Linoelaidic acid was the dominant TFA. Individual food items showed no risk concern; however, the aggregate effect of TFA in the different foods was definite for women in Makerere. Public health education and awareness campaigns for both street food vendors and consumers are recommended to reduce dietary trans fatty acid exposure.

CHAPTER ONE: INTRODUCTION

1.1 Background

Fats and oils are essential to human health and play important roles in the processing, preparation, and sensory aspects of food (Nagpal *et al*., 2021). The major form of dietary fats and oils is triacylglycerols (TAG) or triglycerides (TG). Triacylglycerols are composed of three fatty acids (FA) esterified to a glycerol molecule. The nutritional and physical properties of the TAG are determined by the specific FA esterified to the glycerol moiety and the actual position occupied by a particular FA. Fatty acids are long-chain hydrocarbons that can be separated into saturated (SFA) and unsaturated (UFA), and usually contain 4 to 24 carbon atoms. Unsaturated fatty acids occur in either of two geometric isomeric forms, *cis* or *trans*. In the cis configuration, the hydrogens attached to the doubly bonded carbon atoms are in the same plane, while in the trans configuration, the hydrogens are in different planes. *Cis*-FA have been reported to contribute positively towards human growth and development (Thompson & Minihan, 2011). However, *trans* fatty acids (TFA) have negative effects on human health. Dietary fat intake exceeding 35% of daily calorie requirements is associated with increased calorie and SFA intake (Dhaka *et al*., 2011). Dietary SFA and TFA are strongly correlated with total and low-density lipoprotein (LDL) cholesterol levels in adults. Both total blood cholesterol and low-density lipoproteins (LDL) are markers of cardiovascular disease (CVD) (Morenga & Montez, 2017). the cis-9, trans-11-CLA and trans-10, cis-12-CLA confer numerous health benefits to the human body. At intake levels of 2-4 g/d, TFA derived from ruminants has been proven to have no detrimental outcomes on CVD biomarkers (Wang & Proctor, 2013). Dairy products are the principal source of CLA in human diets, with the cis-9, trans-11 isomer representing 75–90% of total CLA in dairy foods

Despite being minor dietary components, TFA-containing foods alter the balance between favorable *cis*-MUFA and *cis*-PUFA, and unfavorable SFA and TFA in the diet (Aro *et al*., 2006). An adult's risk of developing heart disease is 20% higher when they consume an average of 5 g of TFA each day (Kušar *et al*., 2020). The human diet contains four main sources of TFA: (1) naturally occurring TFA found in animal fats like butter fat and beef (Żbikowska, 2010); (2) TFA produced by partial hydrogenation of vegetable oils, such as in margarine, shortenings, and baked and fried foods (Li *et al*., 2019); (3) TFA generated by heat processing of foods; (4) TFA synthesized for use as dietary supplements (Downs *et al*., 2013; Pipoyan *et al*., 2021). Excessive consumption of process-generated TFA has been associated with the etiology of CVD, cancer, diabetes, inflammation, and endothelial dysfunction (Morenga & Montez, 2017). Because of the health risks associated with the consumption of TFA, the World Health Organization (WHO) recommends limiting TFA intake to less than 1% of daily total energy intake.

Street foods (SF) are foods and beverages prepared and or sold by vendors and hawkers in streets and other public places for immediate consumption or consumption at a later time without further processing (WHO, 1996). The SF sector plays an important role in providing accessible and low-cost meals that even poor members of the community can afford. Approximately 2.5 billion people worldwide consume street foods every day (FAO, 2007). In many African cities, the urban poor obtain 70% of their daily calories from street foods (Garvelink, 2014). However, there is a lack of a formal mechanism for regulating the SF sector, and this makes street foods a potential public health risk. Most SF meals in Uganda consist of staple foods (bananas, potatoes, cassava, maize, millet, and rice) served in various forms. The most popular deep-fried SF include meats (chicken, pork, goat and beef), fish, starchy foods (potato, cassava and banana chips), chapatti, doughnuts and pancakes in various forms. The SF are prepared in an open environment, and frying oils are reused several times to cut costs (Ima-Nirwana *et al*., 2007). Deep-frying food leads to the formation of chemical compounds such as TFA, which have many negative effects on human health. Consumption of SF may be a major route of dietary exposure to TFA for regular consumers.

1.2 Statement of the problem

The total fat and TFA content of SF is not well known, although Kampala's urban and peri-urban dwellers are thought to consume much of the SF. Excessive TFA in the diet are linked to a high risk of CVD, various cancers, stroke, and type 2 diabetes mellitus (T2DM) (WHO, 2020). A 2% absolute increase in energy intake from TFA has been associated with a 23% increase in CVD risk (Islam *et al*., 2019). For example, TFA have been linked to pregnancy-related hypertensive diseases, which are leading causes of illness and death among mothers and their offspring (Nakimuli *et al*., 2016). Nonetheless, data on consumption trends and the risks associated with TFA exposure in SF are limited.

1.3 Justification of the study

Food consumption patterns in urban societies have evolved as a result of cross-cultural interactions and the participation of women in the labor force (Sezgin & Şanlıer, 2016). Consumption of minimally processed and non-processed nutritious foods is on the decrease, while consumption of highly processed foods is on the increase (Albuquerque *et al*., 2020). According to Abrahale & Sousa (2018), urban communities rely largely on SF because they are convenient and cost-effective. Increased dietary intake of TFA in SF simultaneously raises blood levels of LDL cholesterol (bad cholesterol) and decreases HDL cholesterol (good cholesterol). This makes TFA an important risk factor for NCD.

Non-communicable diseases kill 41 million people each year, equivalent to 74% of all deaths globally (WHO, 2022). About 26.4% of the adult population in Uganda is affected by diabetes, while the incidence rate of breast cancer stands at 5.5% (Ndejjo *et al*., 2020). Studies carried out on SF around the world have largely focused on consumption and availability, microbial safety, and the contribution of SF to the attainment of basic nutrient requirements. The study is in line with Social Development Goal (SDG) 3, "to ensure healthy lives and promote well-being for all at all ages".

1.4 Objectives

1.4.1 General objective

To assess the consumption rates, the total fat and trans fatty acid contents of deep-fried street foods, and determine the contribution of the selected foods towards dietary total fat and trans fatty intake for consumers in Kawempe Division located in Kampala city.

1.4.2 Specific objectives

The specific objectives of the study were to determine:

1. The consumption rates of fried chicken, pancakes, potato chips, chapattis and fish obtained from Makerere, Wandegeya and Bwaise in Kawempe Division.
2. The amount of total fat and trans fatty acids in the selected foods.

3. The contribution of the selected street foods towards dietary intake of trans fatty acids for street food consumers in Kawempe division.

1.5 Research Questions

1. What is the consumption rate of fried chicken, pancakes, potato chips, chapattis, and fish from Makerere, Wandegeya and Bwaise in Kawempe Division?
2. How much total fat and TFA is contained in the selected deep-fat-fried SF?
3. What is the proportion of dietary energy contributed by TFA in the foods for street food consumers in Kawempe division?

1.6 Scope of the study

The contribution of SF towards dietary TFA intake among consumers in Makerere, Wandegeya and Bwaise parishes in Kawempe division was assessed. The study was both field and laboratory-based. The study focused on deep-fat-fried foods; potato chips, chicken, fish, pancakes and chapattis, obtained from Makerere, Wandegeya and Bwaise (Kawempe Division). The foods were analyzed for the total fat and FA composition. The TFA content was determined from the FA profile of the oil extracts of the different foods.

CHAPTER TWO: LITERATURE REVIEW

2.1. Fatty Acids in human nutrition and health

The biological activities of FA influence cell and tissue metabolism, and the responsiveness to hormonal and other signals (Calder, 2015). Fatty acids in the free form or as part of complex lipids, play important roles in metabolism, major energy reserves for the body, essential components of all membranes, and act as gene regulators. The main sources of FA in the diet include vegetable oils, dairy products, animal products, cereals, and seafood (Rustan & Drevon, 2005). The nutritional and physiological properties of fats and oils depend on the type and nature of the FA they contain, the position of the FA in the TAG molecule, and where applicable, the position of the first double bond from the ω-carbon (CH_3) end of the FA chain. Fatty acids are generally categorized as SFA or UFA. Saturated FA such as palmitic (PA; 16:0) and stearic acid (18:0) contain exclusively single bonds in their structure. The UFA incorporate at least one double bond in the carbon chain and are subdivided into monounsaturated (MUFA) and polyunsaturated (PUFA) acids. Monounsaturated FA such as oleic acid (OA; 18:1ω9) and palmitoleic acid (16:1ω7) contain one carbon-carbon bond in the structure. On the other hand, the PUFA such as linoleic (LA; 18:2ω6) and alpha-linolenic (18:3ω3) acids contain more than one double bond in their structure. The most important of the PUFA are the omega (ω) 6 and ω3 FA. In the ω6 PUFA, the first double bond is located at carbon number 6 from the CH_3 end, while in the ω3 PUFA, the double bond is at carbon number 3. The parent compound for the ω6 series of FA is 18:2ω6 and the parent compound for the ω3 series is 18:3ω3. Eicosapentaenoic acid (EPA; 20:5ω3), docosapentaenoic acid (DPA; 22:5ω3) and docosahexaenoic acid (DHA; 22:6ω3) are other important members of the ω3 series of 3FA.

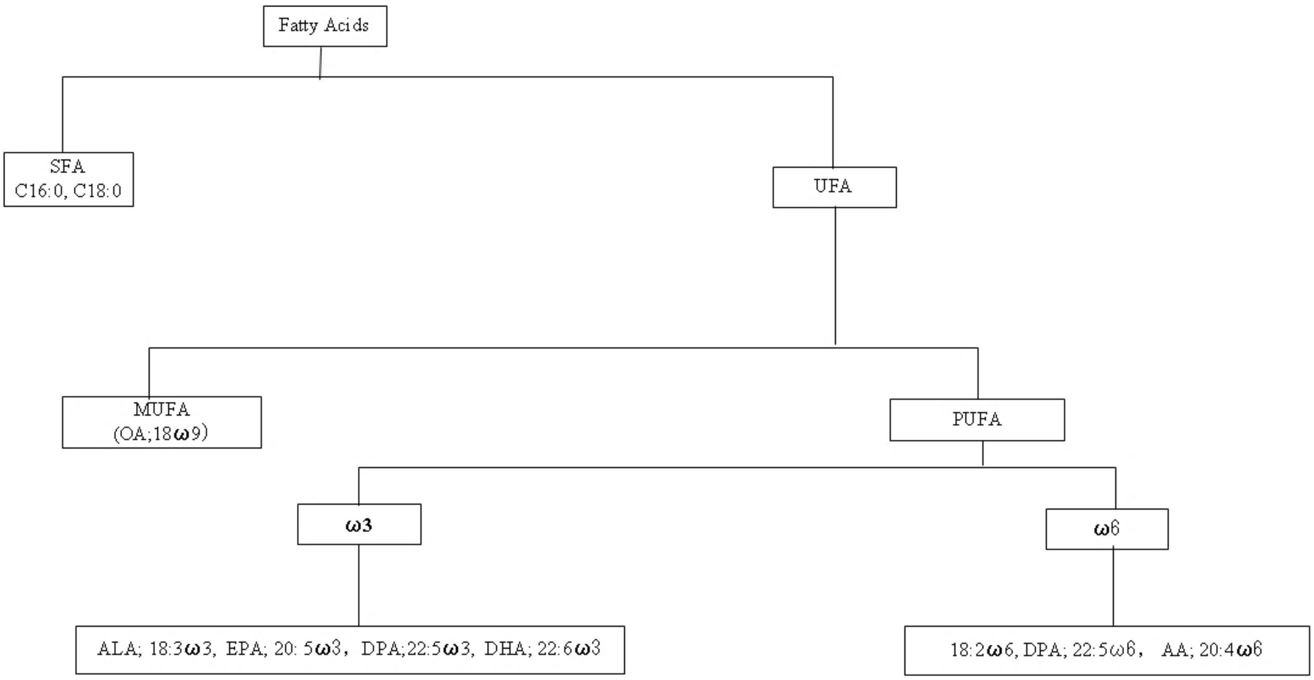

Figure 2.1: Classification of fatty acids based on the number and position of double bonds in the carbon chain.

2.1.1 Isomeric fatty acids

Isomeric FA are those in which the double bonds originally present have been modified in either conformation (*cis*-/*trans*-) or position by processing (Craig-Schmidt, 2001). Positional isomers C18:1ω9*c* and vaccenic acid (C18:1ω7) are the ones in which the location of the double bond is the only difference. On the other hand, C18:1ω9*c* and elaidic acid (18:1ω9*t*) are geometric isomers in which the hydrogens attached to the double-bond carbon atoms are in the same plane (cis configuration) or in different planes (trans configuration), respectively (Figure 2.2). Structurally, TFA are similar to SFA, hence similar body physiological effects (Zhu, Bo, & Liu, 2019).

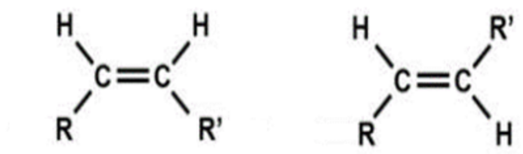

Figure 2.2: Geometric isomers; cis (left) and trans (right).

2.1.2 Health effects of natural trans fatty acids

Trans fatty acids that occur naturally in foods derived from ruminants have been reported to possess neutral effects on cardiovascular health (Guillocheau *et al*., 2020). Studies have documented the beneficial effects of natural TFA on obesity, inflammation and T2DM. For example, a protective effect of trans-palmitoleic (C16:1ω7*t*) acid towards the risk of T2DM has been highlighted (Guillocheau *et al*., 2020). Conjugated linoleic acid (CLA) that naturally occurs in dairy and beef has been shown to enhance immune responses and prevent cancer, atherogenesis and diabetes (Tricon *et al*., 2005). It has also been shown to reduce abdominal obesity, which is a risk factor for T2DM, CVD, and metabolic syndrome (Dilzer & Park, 2012). In addition, CLA were found to have a positive effect on body mass fat (Mozaffarian *et al*., 2004). Nonetheless, there may be some risk of coronary heart disease associated with the consumption of TFA from ruminant sources (Stender *et al*., 2008) .

2.1.3 Health effects of industrially generated trans fatty acids

Many populations, especially in developing countries, consume excess amounts of TFA. In these countries, many people consume lots of processed foods (Teegala *et al*., 2009). Industrially generated TFA have harmful effects on blood lipid profiles (WHO, 2003). They simultaneously raise total and LDL cholesterol, and lower the concentration of HDL cholesterol in the blood

(Oteng & Kersten, 2020). According to Mauger *et al*. (2003), TFA are atherogenic due to their tendency to diminish LDL particle size in a dose-dependent fashion. The result is an increased risk of atherosclerosis and high blood pressure development (Dhaka *et al.,* 2011). The consumption of TFA interferes with the body's ability to utilize essential fatty acids (18:2ω6 and 18:3ω3), which alters the composition of the phospholipid FA in the aorta hence elevating CVD risk (Pipoyan *et al*., 2021). Besides, TFA impair the immune system and sperm production in men by unexpectedly releasing insulin in response to a glucose load and by boosting the creation of free radicals (Dhaka *et al*., 2011). Trans fatty acids also contribute to low birth weight in preterm and full-term infants, shorter pregnancies, and the development of preeclampsia in pregnant women (Mouratidou *et al*., 2014). In their investigation on the link between breast cancer and TFA in European postmenopausal women, Kohlmeier *et al*. (1998) observed a positive association between the concentration of TFA in the adipose tissue and breast cancer. A higher intake of TFA he also been correlated with raised amounts of inflammatory markers such as tumor necrosis factor, interleukin-6 (IL-6), and C-reactive protein (CRP). According to Mozaffarian *et al*. (2004), the effect of TFA on these factors is greater in women with high body mass index (BMI) suggesting that pro-inflammatory effects may be mediated by effects on adipose tissue**.**

2.1.4 Processes that lead to the formation of trans fatty acids in food

Martin, Milinsk, Visentainer, Matsushita, & De-Souza (2007) reviewed the processes that lead to the formation of TFA in food. The major processes leading to TFA formation in food include the hydrogenation and refining of edible oils, biohydrogenation, meat irradiation, and frying of food. Hydrogenation is the chemical process involving the direct addition of hydrogen across points of unsaturation in FA in the presence of an inorganic catalyst such as nickel (Ni), palladium (Pd) and platinum (Pt). Liquid oils are converted to a semisolid or solid form for use in foods such as shortenings and margarine. Hydrogenation also improves the oxidative stability and shelf life of the product. Biohydrogenation occurs in ruminant animals with the help of bacteria that convert UFA to SFA (Lourenço *et al*., 2010). Hydrogenation may be classified as partial, total, selective, or nonselective based on the process conditions (Gray & Russell, 1979). The extent of saturation during hydrogenation primarily depends on the number of double bonds in the liquid oil, the temperature of the oil, hydrogen pressure, stirring rate, reaction duration, and inorganic catalyst type and concentration (Martin, Milinsk, Visentainer, Matsushita, & De-Souza, 2007). Notwithstanding the technological advantages, side reactions occur alongside hydrogenation and lead to the formation of many undesirable isomeric byproducts whose amounts depend on the process conditions. For many years, the hydrogenation industry believed that producing fats with a high TFA content was crucial for improving the physical, chemical, and organoleptic properties of fats (Martin *et al*., 2007).

Vegetable oils contain many substances that alter their flavor, color, and aroma, thereby limiting product shelf life and use (Martin *et al*., 2007). Therefore, oils are refined to remove these substances. Processes involved in vegetable refining include: degumming, neutralization, bleaching, and deodorization. Oils are heated during refining to temperatures between 60 and 100°C before deodorization. The temperature is then raised to between 180 and 270°C during the deodorization process to enhance the oils' organoleptic properties. Deodorization has been found to account for more than 90% of the TFA formed in oils during refining (Bhardwaj *et al*., 2011).

Frying of food is one of the oldest food processing methods since ancient times. It involves the simultaneous transfer of heat from the frying oil to the food and the subsequent drawing out of water from the food, which leads to the drying (Dana & Saguy, 2006). The empty spaces left behind by the lost water are filled with oil absorbed by the food. During frying, the oil undergoes physicochemical and organoleptic changes owing to hydrolysis, oxidation, pyrolysis, and isomerization and polymerization of FA (Martin *et al*., 2007). The process temperature, the number of frying cycles, and the duration over which the oil has been active have a direct impact on the amount of TFA formed. Trans fatty acid formation has been observed to start at 150◦C and become much more pronounced at 250˚C (Nayak *et al*., 2016a).

Food irradiation is the process of exposing food and its packaging to ionizing radiation, such as gamma rays, X-rays, or electron beams. Food irradiation technology (FIT) has attracted the attention of scientists and food processors because it is effective and has wide applications in the food industry. The FIT is non-thermal and extends product shelf-life, maintains natural flavor, and reduces pathogens (Asghar, Ayub, & Khalid, 2022). If correctly used, FIT enhances food quality and safety by prolonging product shelf life emanating from effective destruction of spoilage organisms and foodborne pathogens, the inhibition of sprouting and ripening, and the control of insects and pests. However, irradiation can alter the conformation of some chemical components in food materials. For example, when UFA are exposed to radiation, free radicals are generated and these react with oxygen to form carbonyl compounds, which lead to changes in the nutritional and organoleptic properties of foods (Lund *et al*., 2011). The free radicals produced can additionally destroy unsaturated bonds, which also favors TFA formation.

2.1.5 Potential food sources of trans fatty acids

About 20% of dietary TFA comes from foods of animal origin, whereas vegetable oils and processed foods account for the remaining 80% (Dhaka *et al*., 2011). The main food sources of industrial fats include baked goods (pies, cakes, cookies, and crackers), packaged snacks, chapattis, deep-fried starchy foods (cassava, potato and banana chips), and deep-fried meats (beef, goats' meat, chicken and pork), fried fish, and margarine (Paliwal & Wan, 2024).

2.1.6 Total fat and trans fatty acid intake around the world

Cameroon and Nigeria in Africa, alongside Belgium and Greece in Europe, had fat intakes much greater than 40%E. The United States (US) and many Asian and European countries had fat intakes ranging from 20% to 35%E. The USA, Taiwan, New Zealand, Austria, Denmark, France, Germany, Hungary and Spain had fat intakes >35% E. These values are higher than the WHO/FAO guideline of 20% to 30% E (Kornsteiner, 2009). Mexico, China, India, Japan, South Korea and Portugal were the only countries whose total fat intake was within the WHO/FAO recommendation. Overall, African countries had the highest observed total fat intake (Kornsteiner, 2009). Only Tanzania had an average per capita fat intake of < 15%E. There is hardly any data documented on the intake of fat among the population in Uganda.

Recent estimates on TFA intake indicated that the intake of TFA ranged from 0.3% to 4.2% E across the globe (Wanders, Zock, & Brouwer, 2017). Seventy-six percent of countries with data had trans-fat intake higher than the WHO recommendation of 1% E. The American Heart Association (AHA) also advises that a healthy lifestyle to combat heart disease should limit TFA intake to less than 1% (*ca*. 2 g) on a 2000-calorie diet. However, intakes of TFA from animal sources were higher than those from industrial sources. Trans fat and total fat intake for both men and women of all ages ranged from 2.6% to 2.8% and 7.1% to 7.9% E, respectively (Wanders, Zock, & Brouwer, 2017).

2.1.7 Regulation of industrial trans fatty acids in food

In 2009, the WHO Scientific Review on TFA recommended a tremendous reduction or elimination of TFA from the food supply because of the association with increased risk of CVD (Franco-Arellano, Arcand, Kim, Schermel, & L'Abbé, 2020). As a result, many countries have now taken varying measures to reduce the amounts of TFA in foods. These measures include labeling as a voluntary or mandatory measure, and/or limiting the addition of industrial TFA (iTFA) in foods. Canada and the US have enacted nationwide TFA bans on partially hydrogenated oil (Bloks, 2019). The European Union (EU) imposed a 2% limit on iTFA in all foods effective 2021. Chile, Denmark, Ecuador, Iceland, Norway, Singapore and South Africa set mandatory limits of 2% for iTFA in all foods. The mandatory limit for TFA in fats, oils and emulsions has been set at 5% in India. Colombia, Iran, Saudi Arabia, Bahrain and Argentina limit iTFA to 2% in vegetable oils and margarine but limit iTFA in all other foods to 2%. India, China, Philippines, Bahrain and Iran additionally require labeling of TFA on packaged goods. Only South Africa has best practice mandatory limits on iTFA in foods, fats and oils in Africa (WHO, 2019). Other African countries have no known policies or regulations on iTFA in food. In general, most low-middle-income countries (LMIC) have no known or have not enforced policies they have on iTFA (Li, 2019).

2.2 General aspects of street foods

The street food business constitutes the informal sector's largest employer in many cities in developing countries (Karakire *et al*., 2015). Street food business is a major economic activity in urban and peri-urban centers in Uganda. Street foods comprise meats, grains, legumes, fruits, vegetables, tubers, and beverages prepared in various ways (Namugumya *et al*., 2012). Traditional foods may be roasted, fried, baked, steamed, or boiled as the main dishes for lunch and dinner (Guy *et al*., 2021). Street foods are consumed by a vast majority of people (Khairuzzaman *et al*., 2014). This is because they are convenient and less expensive when compared with foods prepared in restaurants and hotels (Sultana, 2021). Street foods also provide revenue and are a means of living for low-income communities in many developing countries.

2.2.1 Contribution of street foods towards human nutrition

Street foods enhance the energy intake of city dwellers in many countries. They also contribute towards the intake of essential nutrients, especially for the middle- and low-income segments of the population (FAO 1993). Street foods provide a variety of nutrients that are crucial for meeting human health needs (Imathiu, 2017). They are an affordable source of protein and energy (FAO 2010). Like in many other African countries, consumers of SF in Uganda obtain substantial amounts of energy from those foods. According to Sseguya *et al*. (2020), the high energy value of SF may be due to the high content of fat associated with deep-fried foods. However, Gelormini *et al*. (2020) noted that there was a likelihood that SF had poor nutritional quality because of the high amount of fat and probably TFA.

2.2.2 Safety of street foods

The SF business is largely unregulated and outside government protection. Therefore, the consumption of SF is considered a public health risk by health bodies around the world (Ceyhun Sezgin & Şanlıer, 2016). The quality of food ingredients, the preparation methods employed, the environment within which the food is prepared, as well as the adequacy of storage facilities, impact on the safety of the foods (Proietti *et al*., 2014). The health risks associated with SF are due to environmental, chemical and biological hazards (Lund *et al*., 2011). Disease outbreaks linked to the consumption of SF remain a threat in many parts of the world (FAO 2010). Microbial contamination of SF is a health hazard whose risk is dependent on the kind of food and the methods of preparation and preservation. Bereda *et al*. (2016) reported that food vendors handled SF inappropriately, held it at an incorrect temperature, and prepared and sold the food in filthy environments.

Unapproved chemicals such as food color, flavor compounds and preservatives may be used (Rane, 2011). Environmental pollutants like pesticide residues and heavy metals have also been detected in many SF. In addition, SF preparations that employ high-temperature cooking techniques (open-air roasting and frying) have been proven to cause the formation TFA in the frying oils (Lund *et al*., 2011). Frying oils are reused and reheated several times, which increases the risk of forming toxic compounds in the oil (Ima-Nirwana *et al*., 2007). The compounds formed are consumed along with the food and increase one's chance of developing NCD.

CHAPTER THREE: MATERIALS AND METHODS

3.1 Description of the study area

Kawempe division is the largest among five divisions that make up Kampala Capital City Authority (KCCA) and is located in the northern part of the city (Baker, 2011). Other divisions include Kampala Central, Makindye, Nakawa & Lubaga. Kawempe division lies at latitude 31°35' and 32°33' E and longitudes 0°20' and 0°24' N. The division covers an area of 32.45 square kilometers, 25% of which comprises peri-urban settlements (Lund *et al*., 2011). It has an estimated population of 338,665 persons of whom 48% are male and 52% female (UBOS, 2014). Nearly 28% of the population is below 18 years. Kawempe division predominantly covers low swampy areas, which in a way, exacerbates water and sanitation challenges, especially during the rainy seasons. For administrative purposes, the division is divided into 19 parishes largely considered slum settlements that are associated with poor quality of life due to high poverty levels (KCCA, 2014). The parishes include Bwaise I, Kanyanya, Kazo-ward, Kyebando, Makerere III, Mulago I, Bwaise II, Kawempe I, Kikaya, Makerere I, Mpererwe, Mulago III, Bwaise III, Kawempe II, Komambogo, Makerere II, Mulago I, Makerere University, and Wandegeya. This study centered on Bwaise 1, Makerere1 and Wandegeya (Figure 3.1).

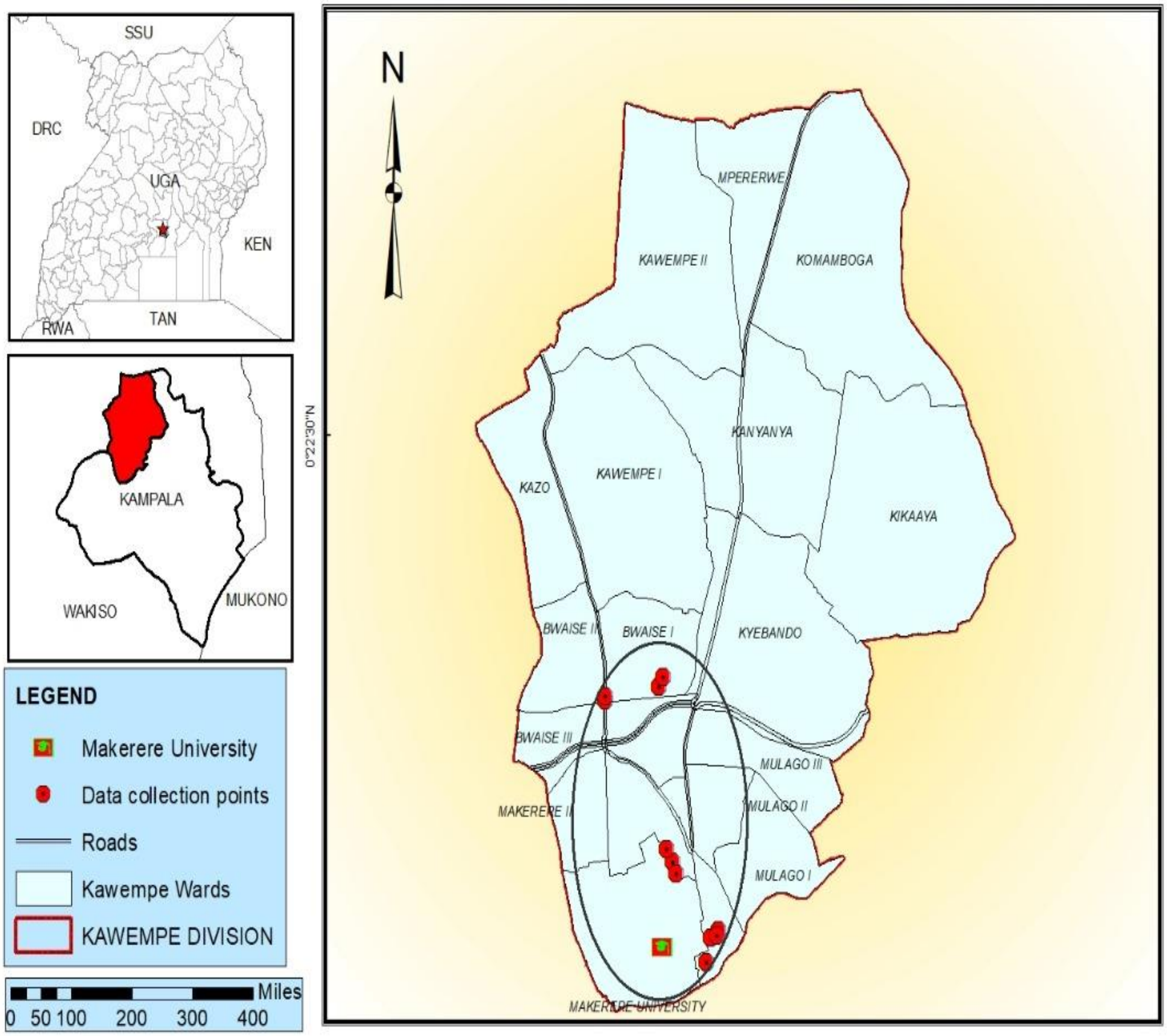

Figure 3.1: Map showing the location of Kawempe division and the sampling points

Kawempe division has a higher mortality and morbidity burden than the other divisions in the city (Beyer *et al*., 2022). Seventy-five percent of hotspots for risky behavior, such as substance abuse, have been reported to be rampant. Kawempe also hosts a high student population. These demographics put the division at the center of the SF business.

3.2 Study design

The study used a descriptive cross-sectional survey and experimental design. Data on the rate of consumption of street food were collected using validated and pretested questionnaires (Appendices 1 and 2). Samples of deep-fried street foods and used oil were also collected. Total fat content and fatty acid profile of street foods and used frying oil fractions obtained from street food vendors in the parishes of Bwaise 1, Makerere1 and Wandegeya were determined.

3.3 Study population

The study population comprised consumers of street foods in Kawempe division in the parishes of Bwaise 1, Makerere1 and Wandegeya. Fifty-nine participants in this study were interviewed in Bwaise 1, 59 participants Makerere1 and 60 participants in Wandegeya.

3.4 Eligibility criteria

Only deep-fat-fried SF and frying oils used in SF preparation were analyzed for their fat content and FA composition. Similarly, only SF vendors and consumers who had the will to participate in the study were recruited.

3.5 Determination of sample size

3.5.1 Laboratory samples

A total of thirty samples of deep-fat-fried SF and fractions of used frying oil were obtained by simple random sampling. Samples were randomly picked from 3 parishes; Bwaise I, Wandegeya and Makerere I. Ten samples were picked from each of the three parishes. Purposive sampling was used to select the location of the street vendor from whom samples of the food and used oil were obtained. Purposive sampling involves using one’s expertise to select a sample that is most useful for the research purpose.

3.5.2 Field respondents

A total of 178 respondents were interviewed. Kish’s formula for cross-sectional studies $n = \frac{z^2 p(1-p)}{e^2}$ was used to calculate the sample size (Kish, 1965). In that formula, z is the standard normal variate at 5% confidence interval. According to Steyn *et al*. (2013) 12% of the world’s population consumes SF regularly, meaning that P=0.12. By substitution in the formula, 178 respondents were obtained. Street food consumers who participated in the survey were selected using a simple random sampling technique. In simple random sampling, each member of the population has an equal chance of being selected.

3.6 Determination of the amount of total fat and trans fatty acids in street foods

3.6.1 Total fat

Total fat was determined following the protocol of the Association of Official Analytical Chemists (AOAC) Official Method 996.06 (AOAC, 2002). Fat was extracted in a Soxhlet apparatus using n-hexane (boiling range 62-68°C) as the extraction solvent (Hewavitharana *et al*., 2020). The sample was dried, ground into fine powder to increase the surface area for extraction, and the powder was extracted in a porous thimble with the solvent. The extraction process lasted eight hours. The extract was dried by evaporating off the solvent on a rotary evaporator. The mass of the lipid extracted was gravimetrically determined as a percentage of the original weight of the food (Hewavitharana *et al*., 2020).

3.6.2 Trans fatty acids

Trans fatty acids were worked out as a proportion of the total FA composition (Preview, 2017). The fatty acids were converted into fatty acid methyl esters (FAME) following the procedure outlined in Standard ISO 12966-2:2017 by the International Organization for Standardization (ISO 2017). Analysis was done using a gas chromatograph (Varian 3800) and a flame ionization detector (FID). Relative retention times of sample FAME peaks were compared to FAME peaks of pure standards. The GLC-607 standards FAME mix purchased from NuChek Prep Inc (US) was used.

3.7 Determination of health risks in the population due to TFA exposure in street foods

Total fat and TFA intakes were determined as the estimated daily intake (EDI); a product of the mean TFA concentration and the ingestion rate (IR) (the quantity of SF consumed) using Eq 2.

$$EDI = C \times IR \tag{2}$$

where EDI is the estimated daily intake of trans fatty acid, C is the mean content of TFA in street food (g/100 g), and IR is the ingestion rate (g/day).

The contribution of TFA towards daily energy intake was computed as energy percent (E %) of the total energy intake using Equation 3 (Pipoyan, Beglaryan, Stepanyan, & Merendino, 2022).

$$E\% = \left(\frac{EDI \times 9}{DE}\right) \times 100 \tag{3}$$

where E% is the proportion of dietary energy intake from TFA, and EDI is the TFA intake (g/day). The WHO a dietary energy intake (DE) of 2,000 and 2,400 kcal per day, for adult women and men, respectively (WHO, 2010). The factor 9 kcal/g is the energy transfer index for TFA.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 Social demographic characteristics of the respondents

A total of 178 participants, of whom 53% were male and 47% were female, were interviewed. Thirty-two percent were between 18 and 24 years. Twenty percent were in the 30 to 34-year age bracket, while 18% were in the 25 to 29-year age bracket. The proportion of participants who were divorced, widowed, and separated was 18%, 3% and 0.6% respectively. Fifty-seven (32%) participants belonged to the Born-again faith, while 27% were Anglican, 22% were Catholic, and 18% were Muslim. Only 1% of the participants were Seventh Day Adventists (SDA). As far as education is concerned, 79% of the participants had completed some level of formal education, and the remaining 21% were still in school. Among those out of school, 19% had attained Primary level of education, 24.5% had completed Ordinary Level of secondary education, 15.7% had attained Advanced Level secondary education, 16% had a college or university degree, and 10.2% had attained a diploma. In terms of occupation, the majority (51%) were in private employment (boda-boda riders, shop owners, street food vendors), 20% were students, 16% were wage earners (shop attendants, hairdressers, SF vendors), and 6% were salary earners. Only 6.2% of the participants were unemployed (Table 4.1).

Table 4.1: Socio-demographic characteristics of the participants who consumed deep fried street food in Kawempe Division

Variable	**Number of participants (n)**	**Percent (%)**
Gender		
Male	94	52.8
Female	84	47.2
Age (years)		
18-24	57	32.0
25-29	32	18.0
30-34	36	20.2
35-39	15	8.4
40-44	15	8.4
45-49	10	5.6
50+	13	7.3
Occupation		
Civil servant	11	6.2
Privately employed	90	50.6
Student	35	19.7
Wage earner	28	15.7
Unemployed	11	6.2
Other	3	1.7
Marital status		
Single	77	43.3
Cohabiting	32	18.0
Married	48	27.0
Widowed	5	2.8
Divorced	15	8.4
Separated	1	0.6
Religion		
Catholic	39	21.9
Anglican	48	27.0
Islam	32	18.0
Born-again	57	32.0
SDA	2	1.1
The highest level of education attained		
PLE	28	19.1
Secondary (Ordinary level)	36	24.5
Secondary (Advanced level)	23	15.7
Certificate (Tertiary institution)	21	14.3
Diploma	15	10.2
Degree	24	16.3

These findings are similar to those of Hill *et al*. (2016) who reported that more males than females consume street foods. The authors also reported that most SF consumers were single, followed by the married and those cohabiting in that order. Street food consumer age groups were also closely similar to those of Hill *et al*. (2016).

4.1.1 Consumption rates of the street foods

The majority (95.5%) of participants reported consuming street foods at one point in time (Figure 4.1). About 40.1% consumed SF from their homes. Another 34.2% consumed the foods at their workplaces, 20% at the selling point and only 5.8% consumed SF at school (Figure 4.2).

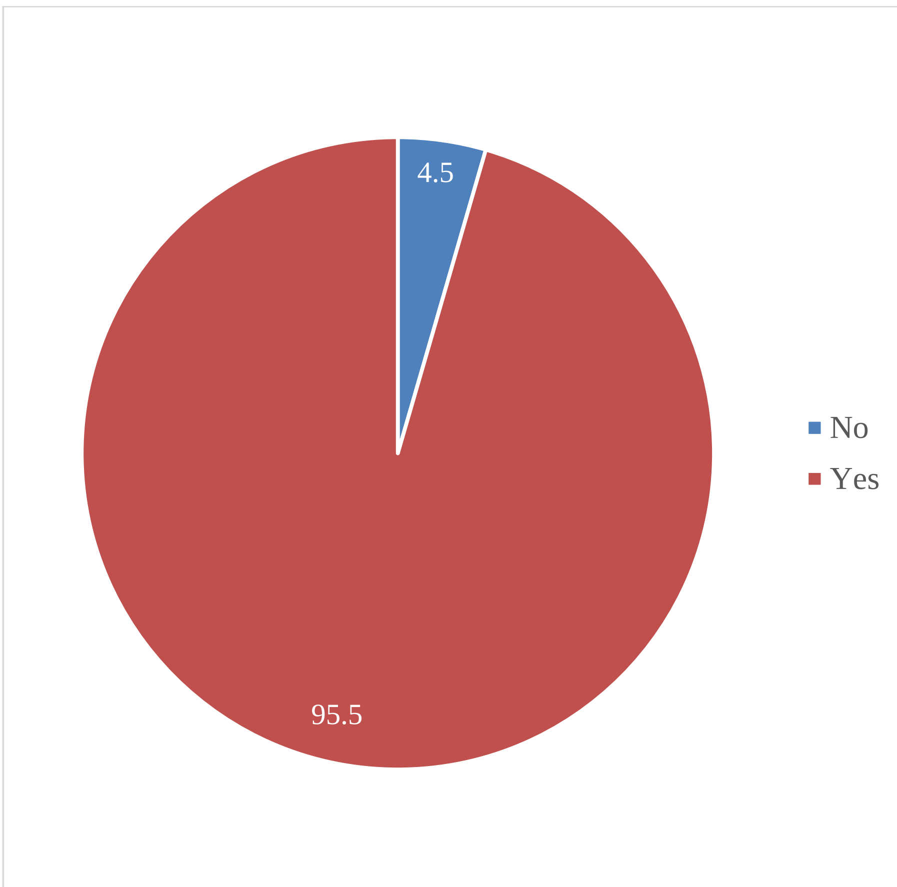

Figure 2.1: Consumption of deep-fried street foods

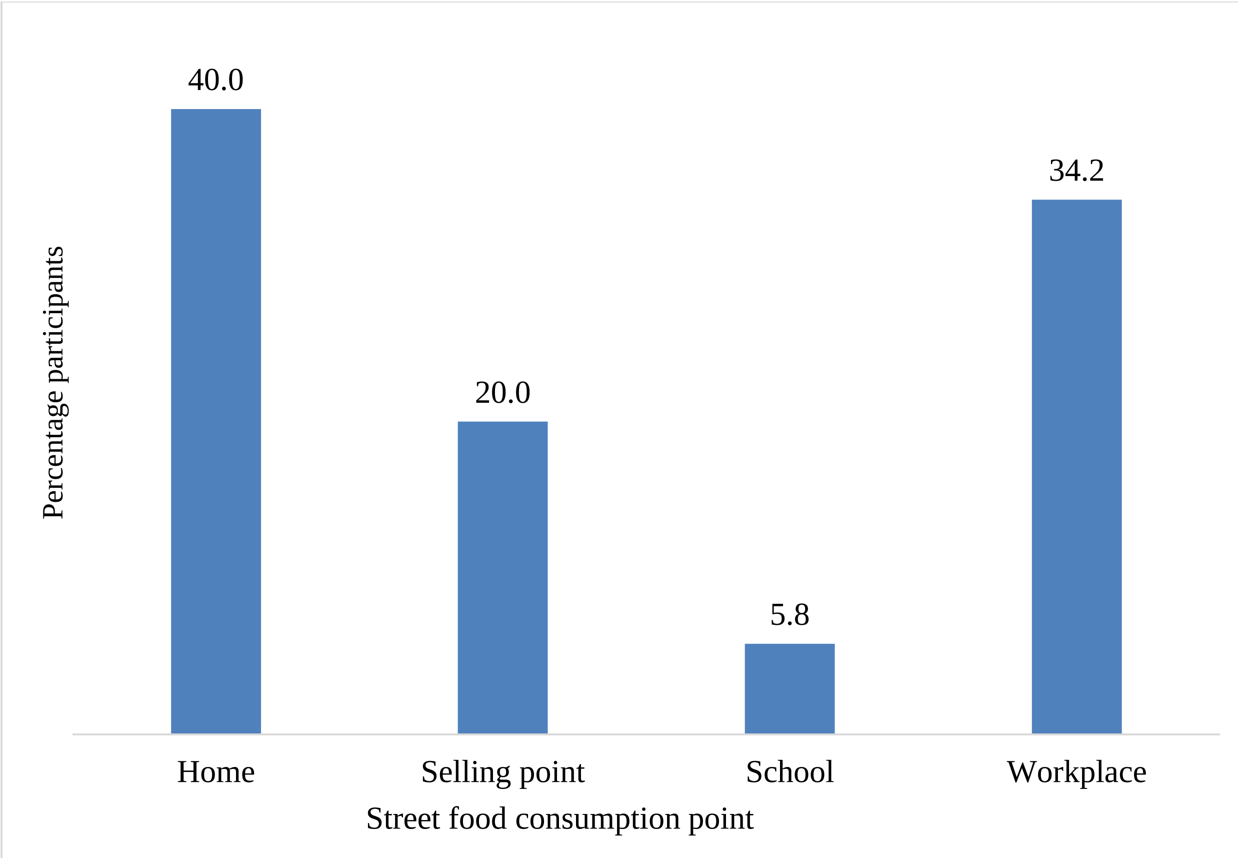

Figure 3.2: Places where consumption of deep-fried street foods was done.

More participants consumed SF from home because of the desire to share it with their family members, especially during supper. Most working mothers lack time to prepare meals for their families, and so they find SF more convenient. Unlike female consumers who carry packed food to places of work and school for lunch, most male consumers depend on SF. Sujatha *et al*. (1997) reported similar findings. However, it seems that most unmarried people consume SF from the selling point to save time and probably to avoid the extra burden of washing utensils at home.

The most consumed street food was the shallow-fried chapatti, followed by potato chips, pancakes, deep-fried chicken, deep-fried fish, and deep-fried chapatti in that order. Thirty-six percent of the participants reported having consumed shallow-fried chapatti 2 to 4 times a week, 27% once a week, while only 14% of participants consumed shallow-fried chapatti once a day (Figure 4.3).

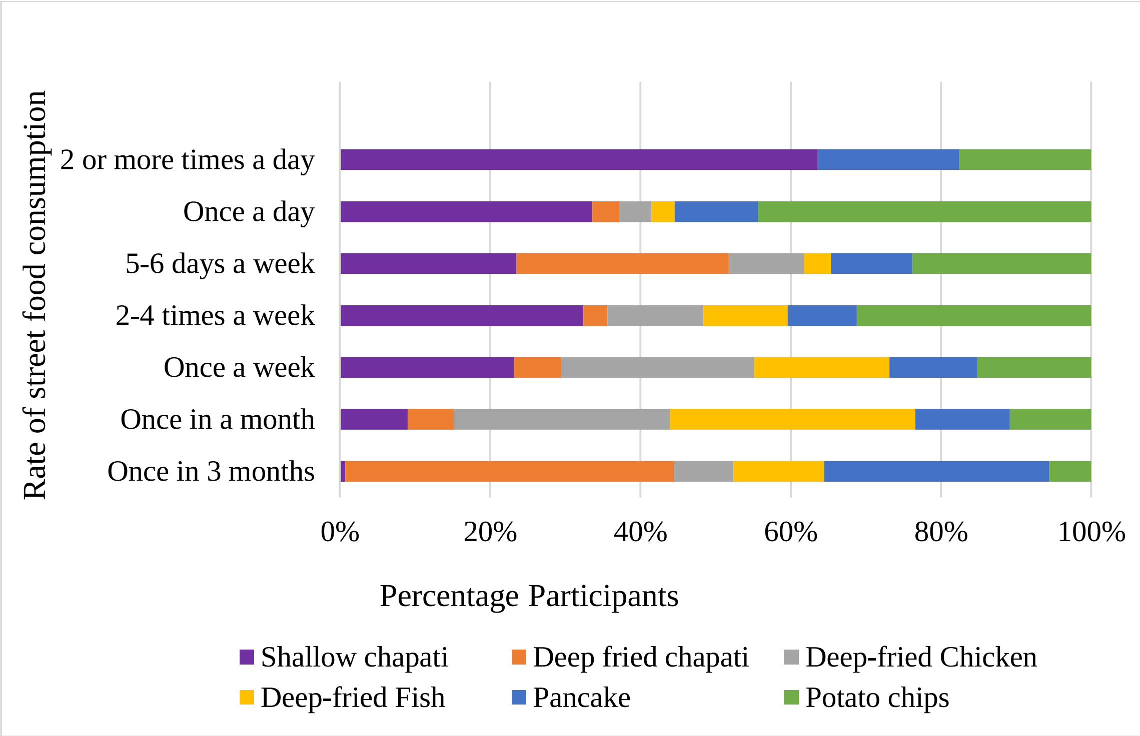

Figure 4.4: Frequency of consuming deep-fried street food

Regarding potato chips, 35% of the participants reported consuming them 2 to 4 times per week, 18% once a day, 17% once a week, and 15% once a month. Deep-fried chicken was consumed correspondingly by 35% and 29% of the participants once a month and once a week. Forty-five percent of the participants consumed deep-fried fish once a month, 21% once a week, and another 21% once in 3 months. Slightly over half (51%) of the participants consumed pancakes once in 3 months. The majority (75%) of participants consumed deep-fried chapatti only once in 3 months, implying that deep-fried chapatti was the least popular among SF consumers.

Many (47%) participants reported consuming two chapattis every time they did, while 42% ate only one chapatti. Nine percent of the participants consumed three or more chapattis. The proportion of participants who consumed one piece of deep-fried chicken each time was 67% while the proportion that consumed two pieces was 28%. Only 5% of the participants consumed more than two pieces. Similarly, 62% of the participants reported consuming one piece of fish, while 32% consumed 2 pieces. For pancakes, 61% of the participants consumed 2 pieces while 31% consumed 1 piece each time. Eighty-five percent of the participants who consumed deep-fried potato chips consumed 1 serving every time. About 12% consumed two servings of potato chips, while only 3% consumed more than two servings (Figure 4.4).

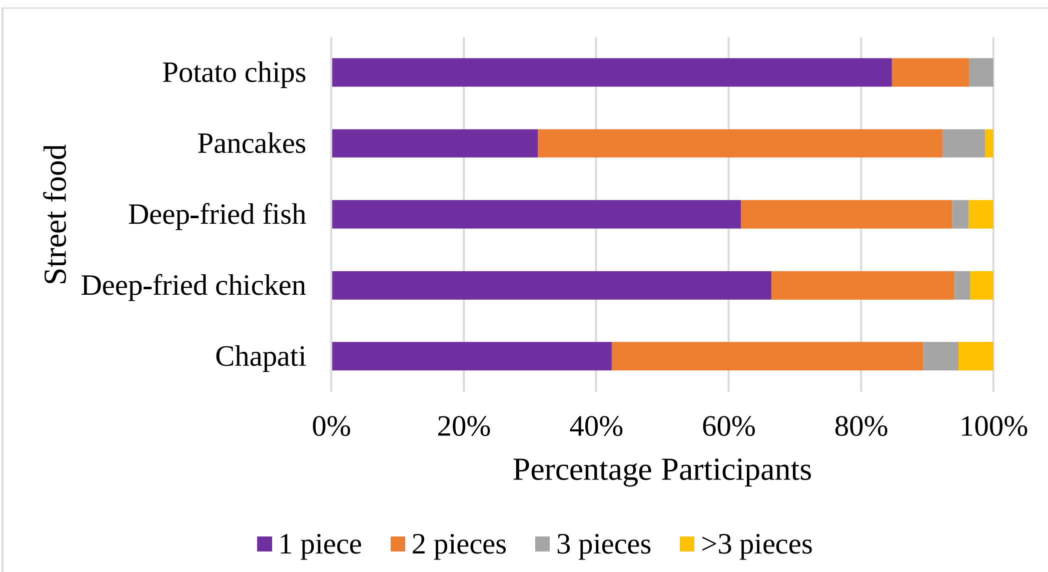

Figure 4.5: Quantity of street food consumed every consumption time

The majority (72%) of the participants who consumed chapatti did so at breakfast. The proportion of participants who consumed chapatti at lunch and dinner was evenly divided at 12.5%. Only 3%

participants consumed chapatti in between meals. Similarly, pancakes were consumed by 93% of the participants at breakfast. The remaining 7% consumed pancakes at lunch, dinner, or in between meals. Deep-fried chicken was consumed by 63% of the participants at dinner, while another 32% consumed the chicken at lunchtime. Fish was also largely consumed at dinner, by 55% of the participants, while 40% did so at lunchtime. Just like for deep-fried chicken and fish, potato chips were mainly (i.e., 59% participants) consumed at dinner. Another 33% consumed potato chips at lunch. It appears that most people who consumed chicken and fish did so alongside potato chips.

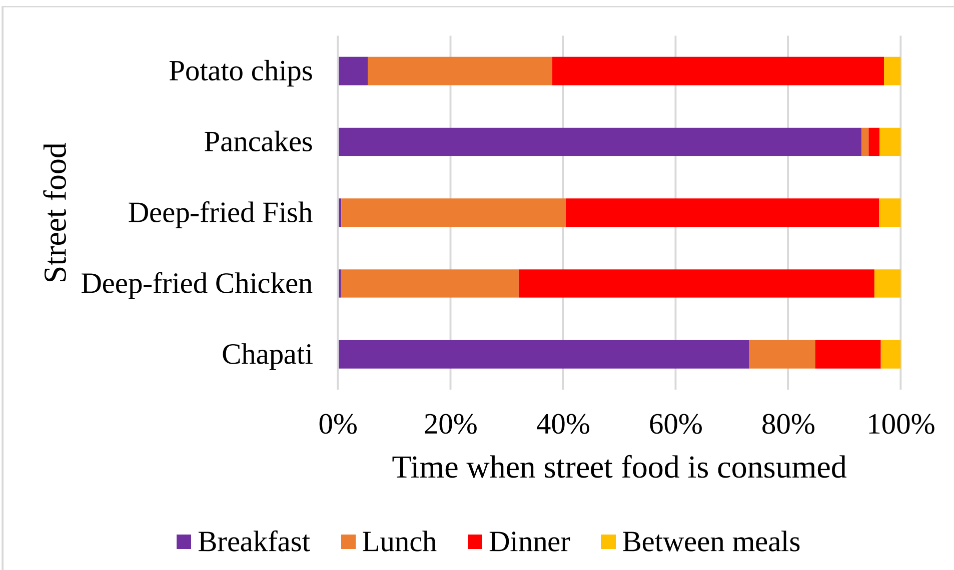

Figure 4.6: Time of consumption of deep-fried street foods

4.1.2 Reasons for consumption of deep-fried street food

Many (23.4%) participants reported that they consumed deep-fat fried foods because they were readily available and saved their time in terms of preparation. The participants who consumed the foods because they were cheap and affordable, and those who consumed them because they were delicious and had good taste, were evenly divided at 15%. Some (11%) participants consumed deep-fried foods because they were tasty, cheap and accessible. Another 11.5% indicated the desire for the foods, diet diversification, because of hunger, and that the foods were better than other foods in some cases (Table 4.2). Similar reasons were found by Mohammed & Shehasen (2020a) in their study on street food consumption and associated health risks.

Table 4.2: Reasons for consumption of deep-fried street food

Reason	Percentage
Readily available/save time	23.4
Convenient and easy to access	17.0
Cheap and affordable	15.2
Tasty and delicious	14.6
Tasty, accessible and cheap	11.1
Desire for the street food	8.2
Change diet	4.1
Hunger	2.9
Better than other foods	2.3
Other	1.2

4.1.3 Knowledge of the health effects associated with deep-fried foods

Sixty-two percent of the participants had heard about the harmful effects associated with the consumption of deep-fried foods, but the remaining 38% had not. Among those who had some knowledge, 39% received the information through the radio, 34% through television, and 11% through social media. The majority (87%) of participants were eager to know more about the potential risks that may be associated with consuming deep-fried SF, while the rest (13%) did not (Table 4.3).

Table 4.3: Awareness of adverse effects of consuming deep-fried street food

Awareness	Frequency	Percent
Had some knowledge of the effects associated with SF	110	61.8
Did not have any knowledge of the effects of SF	68	38.2
Source of information		
Radio	42	39.3
Television	36	33.6
Social media	12	11.2
Youth groups	9	8.4
Local leaders	4	3.7
NGO	2	1.9
Private companies	2	1.9
Desired to know more about the effects associated with consumption of SF	154	86.8
Did not desire to know the adverse effects associated with consuming SF	23	13.2

4.2 Total fat content of deep-fried street foods

The fat content ranged from 9.3% to 17% for chapatti. Chapatti obtained from Makerere recorded the lowest value while that from Bwaise recorded the highest. The fat content of potato chips ranged from 7.9% to 18.8%. The lowest content was recorded from potato chips from Makerere while the highest content was in potato chips obtained from Bwaise. Fat content in fried chicken ranged from 11% to 26% with the lowest content observed in chicken obtained from Makerere and the highest content in chicken obtained from Wandegeya. Regarding deep-fat fried fish, the fat content was lowest (9.6%) in fish obtained from Makerere and highest (16.7%) in fish obtained from Bwaise. Similarly, the total fat content in pancakes was lowest (6.2%) in Makerere and highest (12.5%) in Bwaise. In general, street foods obtained from Makerere ware less oily than those from Wandegeya and Bwaise (Table 4.4).

Table 4.4: Total fat (%) in deep-fried street foods after frying

Food type	**Range**	**Mean ± SD**
Fried chicken	11-26	16.83±6.41
Fried fish	9.6-16.7	13.04±2.66
Chapatti	9.3-17	13.78±2.68
Potato chips	7.9-18.8	14.9±5.16
Pancakes	6.2-12.5	8.20±2.26

The total fat content of fried chicken was comparable to 10.5% to 23.58% previously reported by Soonpan *et al*. (2011). Potato chips contained less fat than that reported by Pérez-Farinós *et al*. (2016). There is hardly any study that reported on the total fat content of pancakes and chapatti probably because these foods are localized to Uganda.

4.2 Fatty acid composition of oil extracted from the deep-fried street foods

A total of 24 FA were detected in the oil fractions extracted from the deep-fried street foods. They included: butyric acid (C4:0), caproic acid (C6:0), caprylic acid (C8:0), capric acid (C10:0), undecanoic acid (C11:0), tridecanoic acid (C13:0), myristic acid (C14:0), pentadecylic acid (C15:0), palmitic acid (C16:0), margaric acid (C17:0), stearic acid (C18:0), arachidic acid (C20:0), tricosanoic acid (C23:0), lignoceric acid (24:0), myristoleic acid (C14:1ω5), palmitoleic acid (C16:1ω7), elaidic acid (C18:1ω9*t*), oleic acid (C18:1ω9*c*), eicosenoic acid (C20:1ω9), erucic acid (C22:1ω9), linoleic acid (C18:2ω6*c*), linoelaidic acid (C18:2ω6t), gamma linolenic acid (GLA; C18:3ω6*c*), alpha linolenic acid (ALA; C18:3ω3*c*) and arachidonic acid (C20:4ω6*c*).

Unsaturated FA predominated over SFA. Oleic acid and 18:2ω6 were the predominant UFA analyzed in all the street foods. Fried chicken had the highest amount of 18:1ω9 (42.77 %) while fried fish had the lowest content (34.48%). The content of C18:2ω6 was very variable in the foods. Linoleic acid was highest (10.69%) in fish obtained and lowest (10.10%) in the chapatti. The most common sources of dietary PUFA are vegetable and seed oils such as sunflower, soybean, corn, and safflower oils, which contain substantial amounts of 18:2ω6 (Mercola & D'Adamo, 2023). High dietary intakes of 18:2ω6 increase the occurrence of inflammation, and chronic diseases such as CVD and cancer (Jay Whelan, 2013). The oil extracted from the chapatti, chicken, and fish also contained moderate amounts of C16:1ω7*c*, i.e., 3.68, 1.65 and 3.02% respectively. Palmitoleic acid is an omega-7 (ω-7) MUFA with beneficial effects such as the promotion of cardiac growth, proliferation of pancreatic β-cells, regulation of lipogenesis, and the desaturation of FA in adipocytes. The predominant SFA were 16:0 and 18:0. Like 18:1ω9 and 18:2ω6, 16:0 and 18:0 were present in oil fractions extracted from all the street food samples. Palmitic acid was highest (42.56%) and lowest (38.91%) correspondingly in oils extracted from chapatti and pancakes. Stearic acid was highest (4.89%) in chapatti and lowest (3.53%) in fried chicken. Overall, the four FA; 18:1ω9, C18:2ω6, 16:0, and 18:0 accounted for 89.64 to 99.24 % of the total FA composition. Fatty acids with 4 to 13 carbon atoms were mostly below the method limit of detection of 0.05% while the other FA were present in rather small quantities (Table 4.5).

Table 4.5: Fatty Acid composition of oil extracted from deep-fried street foods

FA	Fried fish	Pancakes	Chapati	Potato chips	Fried Chicken
C4:0	$<0.05^{b}$	0.28 ± 0.49^{a}	$<0.05^{b}$	$<0.05^{b}$	0.05 ± 0.09^{a}
C6:0	0.20 ± 0.26^{a}	0.38 ± 0.66^{a}	$<0.05^{b}$	$<0.05^{b}$	$<0.05^{b}$
C8:0	0.43 ± 0.43^{a}	0.66 ± 1.14^{a}	0.76 ± 0.67^{a}	0.13 ± 0.23^{a}	0.37 ± 0.32^{a}
C10:0	0.13 ± 0.23^{a}	<0.05b	<0.05b	$<0.05^{b}$	$<0.05^{b}$
C11:0	$<0.05^{b}$	0.40 ± 0.69^{a}	$<0.05^{b}$	$<0.05^{b}$	$<0.05^{b}$
C13:0	$<0.05^{b}$	0.67 ± 0.60^{a}	$<0.05^{b}$	$<0.05^{b}$	$<0.05^{b}$
C14:0	2.22 ± 0.64^{a}	0.83 ± 0.71^{b}	1.05 ± 0.24^{b}	0.97 ± 0.11^{b}	0.09 ± 0.16^{ab}
C15:0	0.2 ± 0.17^{a}	0.02 ± 0.04^{b}	0.03 ± 0.05^{b}	$<0.05^{ab}$	0.03 ± 0.06^{b}
C16:0	41.99 ± 4.05^{a}	40.09 ± 3.54^{a}	42.56 ± 4.34^{a}	38.91 ± 0.03^{a}	39.99 ± 4.05^{a}
C17:0	0.39 ± 0.01^{a}	0.26 ± 0.19^{a}	0.12 ± 0.12^{ab}	0.12 ± 0.02^{ab}	0.05 ± 0.08^{b}
C18:0	4.04 ± 1.11^{a}	4.72 ± 0.03^{a}	3.55 ± 1.28^{a}	4.89 ± 0.21^{a}	3.53 ± 3.06^{a}
C20:0	0.03 ± 0.06^{a}	$<0.05^{b}$	$<0.05^{b}$	0.03 ± 0.05^{a}	$<0.05^{b}$
C23:0	0.24 ± 0.25^{a}	$<0.05^{b}$	$<0.05^{b}$	$<0.05^{b}$	$<0.05^{b}$
C24:0	0.50 ± 0.24^{a}	0.03 ± 0.06^{b}	0.03 ± 0.05^{b}	0.12 ± 0.11^{ab}	0.08 ± 0.14^{b}
C16:1ω7c	3.02 ± 2.62^{a}	0.26 ± 0.07^{b}	3.08 ± 3.78^{a}	0.57 ± 0.57^{b}	1.65 ± 2.31^{ab}
C18:1ω9t	0.09 ± 0.08^{a}	0.21 ± 0.23^{b}	0.18 ± 0.32^{b}	0.06 ± 0.11^{a}	0.10 ± 0.13^{b}
C18:1ω9c	34.48 ± 4.29^{b}	38.94 ± 3.15^{b}	37.60 ± 2.92^{b}	41.96 ± 0.49^{a}	42.77 ± 1.99^{a}
C20:1ω9c	0.09 ± 0.15^{a}	0.54 ± 0.42^{b}	0.20 ± 0.31^{ab}	0.17 ± 0.01^{ab}	0.08 ± 0.14^{a}
C22:1ω9c	0.15 ± 0.18^{a}	$<0.05^{b}$	0.04 ± 0.07^{ab}	$<0.05^{b}$	$<0.05^{b}$
C18:2ω6t	0.18 ± 0.10^{b}	0.28 ± 0.35^{a}	0.30 ± 0.33^{a}	0.38 ± 0.26^{a}	0.07 ± 0.08^{ab}
C18:2ω6c	10.69 ± 1.27^{a}	10.66 ± 0.83^{a}	10.10 ± 1.03^{a}	10.57 ± 0.32^{a}	10.66 ± 0.38^{a}
C18:3ω3c	0.69 ± 0.13^{a}	0.30 ± 0.12^{ab}	0.21 ± 0.01^{ab}	0.42 ± 0.19^{b}	0.14 ± 0.04^{c}
C18:3ω6c	0.14 ± 0.25^{a}	0.43 ± 0.01^{b}	0.21 ± 0.22^{a}	0.42 ± 0.06^{b}	0.18 ± 0.21^{a}
C20:4ω6c	0.05 ± 0.08^{a}	0.03 ± 0.04^{a}	$<0.05^{b}$	0.26 ± 0.34^{ab}	0.16 ± 0.27^{ab}

Values reported as mean ± standard deviation. Values along the row bearing different superscript letters are significantly different ($p<0.05$).

4.2.1 Fatty acid composition of frying oils used to deep-fried street foods

A total of 21 FA were detected in the oils used to deep-fry the street foods (Table 4.6).

Table 4.6: Fatty acid composition of frying oil used in the preparation of street foods

Fatty acids	Chapatti	Potato chips	Chicken	Fish	Pancakes
C8:0	0. 30±0.34[a]	0.48±0.11[a]	0.18±0.06[a]	0.41±0.31[a]	0.54±0.47[a]
C10:0	0.14±0.25[a]	<0.05[a]	<0.05[a]	<0.05[a]	<0.05[a]
C14:0	1.07±0.17[a]	0.94±0.22[a]	0.60±0.55[a]	1.56±0.60[a]	1.11±0.06[a]
C15:0	<0.05[a]	0.03±0.05[a]	<0.05[a]	0.05±0.09[a]	0.03±0.05[a]
C16:0	41.47±7.01[a]	36.72±5.35[a]	37.88±1.72[a]	37.35±4.19[a]	40.29±5.15[a]
C17:0	0.07±0.06[a]	0.09±0.08[a]	0.08±0.07[a]	0.39±0.34[a]	0.07±0.06[a]
C18:0	4.16±0.91[a]	4.52±1.39[a]	4.50±1.12[a]	4.52±1.12[a]	4.08±0.88[a]
C 20:0	0.05±0.09[a]	0.07±0.07[a]	0.05±0.09[a]	0.07±0.08[a]	0.133±0.14[a]
C21:0	<0.05[a]	0.03±0.05[a]	<0.05[a]	<0.05[a]	<0.05[a]
C22:0	<0.05[a]	0.05±0.09[a]	<0.05[a]	0.04±0.07[a]	<0.05[a]
C23:0	<0.05[a]	<0.05[a]	<0.05[a]	<0.05[a]	0.12±0.21[a]
C14:1ω5	<0.05[a]	0.02±0.03[a]	0.03±0.05[a]	0.13±0.22[a]	<0.05[a]
C16:1ω7	0.43±0.44[a]	1.81±1.37[a]	1.69±2.00[a]	2.67±1.91[a]	0.58±0.68[a]
C18:1ω9t	0.31±0.22a	0.61±0.91[a]	0.14±0.14[a]	0.12±0.11[a]	0.05±0.04[a]
C18:1ω9c	40.48±3.75[a]	38.78±2.87[a]	40.02±1.49[a]	37.60±4.41[a]	40.30±2.23[a]
C20:1ω9c	0.12±0.10[a]	0.16±0.14[a]	0.12±0.11[a]	0.16±0.15[a]	0.11±0.09[a]
C18:2ω6t	0.29±0.10[a]	0.14±0.08[a]	0.20±0.14[a]	0.22±0.06[a]	0.23±0.09[a]
C18:2ω6c	10.80±2.51[a]	11.74±0.45[a]	12.64±1.18[a]	11.92±0.76[a]	10.69±1.37[a]
C18:3ω6c	0.29±0.27[a]	0.67±0.50[a]	0.39±0.17[a]	0.55±0.50[a]	0.42±0.30[a]
C18:3ω3c	0.42±0.04[a]	0.46±0.22[a]	0.27±0.24[a]	0.54±0.22[a]	0.633±0.42[a]
C20:4ω6c	0.27±0.27[a]	0.29±0.25[a]	0.41±0.41[a]	0.15±0.13[a]	0.17±0.15[a]

Values reported as mean ± standard deviation. Values along the raw bearing different superscript letters are significantly different (p<0.05).

While C4:0, C6:0 and C13:0 were detected in the oil fractions extracted from the street foods, the three FA were not detected in the frying oils used to prepare the foods. Fatty acids with 21 to 23 carbon atoms were mostly below the method limit of detection of 0.05. Like in the oil extracted from the SF, the predominant FA determined were C18:1ω9 and C18:2ω6 as major UFA and 16:0 and 18:0 as major SFA. The highest content of UFA (55.57%) was observed in oil used to fry chicken and the lowest was observed in oil used to fry chapatti (52.81%) The highest content of oleic acid (40.48 %) was observed in oil used to fry chapatti , while the lowest content (37.6%) was observed in oil used to fry fish. Frying oil used to fry chapatti had the highest content of SFA (46.96%) while oil used to fry potato chips had the lowest amount of SFA content (42.93%).

4.2.2 Effect of deep frying on the fatty acid composition of oil

The vegetable oils predominantly used for roadside frying by vendors in Kawempe Division are best-fry and fortune Butto. These oils are cheap and therefore more affordable by the vendors. Palmitic acid ranged from 37.33 to 37.64% in the virgin oil. The content of 16:0 increased in oil used to fry chapatti obtained from Makerere, Wandegeya and Bwaise. It also increased in oil used to fry potato chips obtained from Makerere and Bwaise. It increased in oil used to fry chicken obtained from Makerere, Wandegeya and Bwaise. It also increased in oil used to fry fish obtained from Makerere, Wandegeya and Bwaise. The 16:0 content increased in oil used to fry pancakes obtained from Makerere, Wandegeya and Bwaise. Stearic acid ranged from 4.5 to 4.67% in virgin oil. The amount of 18:0 increased in oil used to fry chapatti from Wandegeya. It increased in oil used to fry potato chips obtained from Makerere and Wandegeya. The 18:0 increased in frying oil used to fry fish obtained from Makerere and Wandegeya and those used to fry pancakes obtained from Wandegeya.

Table 4.7: Comparison of fried street food, used frying oil and virgin oil commonly used in frying deep fried street food

Fatty Acid	Virgin oil	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5
C4:0	<0.05	<0.05	<0.05	0.00-0.15	<0.05	0.00-0.84	<0.05	<0.05	<0.05	<0.05	<0.05
C6:0	<0.05	<0.05	<0.05	<0.05	0.00-0.49	0.00-1.15	<0.05	<0.05	<0.05	<0.05	<0.05
C8:0	<0.05	<0.05-1.24	0.00-0.40	0.0-0.6	0.00-0.85	0.00-1.97	0.22-0.67	0.38-0.6	0.12-0.24	0.22-0.77	0.00-0.85
C10:0	<0.05	<0.05	<0.05	<0.05	0.00-0.39	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
C11:0	<0.05	<0.05	<0.05	<0.05	<0.05	0.00-1.2	<0.05	<0.05	<0.05	<0.05	<0.05
C13:0	<0.05	<0.05	<0.05	<0.05	<0.05	0.85-1.15	<0.05	<0.05	<0.05	<0.05	<0.05
C14:0	0.88-0.91	0.78-1.23	0.89-1.10	0.00-0.28	1.57-2.85	1.04-1.15	0.87-1.2	0.72-1.16	0.72-1.10	0.9-2.05	1.04-1.43
C15:0	<0.05	0.00-0.08	<0.05	0.00-0.1	0.28-0.31	0.00-0.07	<0.05	0.00-0.08	<0.05	0.00-0.15	0.00-0.08
C16:0	37.33-37.64	38.73-41.68	38.89-38.94	36.03-44.13	38.13-46.27	37.44-44.11	36.92-49.54	30.84-41.30	36.85-39.87	33.76-41.95	36.16-46.06
C17:0	0.00-0.09	0.12-0.23	0.09-0.13	0.00-0.14	0.38-0.40	0.15-0.48	0.0-0.12	0.00-0.14	0.00-0.14	0.14-0.77	0.0-0.11
C18:0	4.5-4.67	2.42-3.29	4.74-5.13	5.16-5.44	2.99-5.20	4.69-4.75	3.16-4.95	2.96-5.63	3.23-5.35	3.235-5.33	3.07-4.68
C20:0	<0.05	<0.05	<0.05	<0.05	0.225-0.50	<0.05	0.00-0.145	0.07-0.13	0.00-0.145	0.07-0.15	0.12-0.28
C21:0	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.00-0.09	<0.05	<0.05	<0.05
C22:0	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.00-0.15	<0.05	0.00-0.125	<0.05
C23:0	<0.05	0.00-0.09	0.15-0.21	0.00-0.25	0.24-0.69	0.00-0.095	<0.05	<0.05	<0.05	<0.05	<0.05
C24:0	<0.05	0.00-0.66	<0.05	<0.05	0.00-0.125	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
C14:1ω5	<0.05	<0.05	<0.05	<0.05	0.06-0.14	0.00-0.125	<0.05	<0.05	0.00-0.09	0.00-0.38	<0.05
C16:1ω7	0.17-0.18	<0.05	<0.05	<0.05	0.14-0.18	<0.05	0.12-0.94	0.23-2.69	0.17-3.96	0.5-4.05	0.19-1.37
C18:1ω9*t*	<0.05	0.05-0.55	0.16-0.17	0.00-0.25	<0.05-0.26	0.145-1.00	0.11-0.54	<0.05-1.65	<0.05-0.28	<0.05-0.19	<0.05-0.08
C18:1ω9c	44.81-45.1	34.94-40.72	41.42-42.38	40.49-44.19	30.4-38.96	35.79-42.08	36.36-43.69	36.4 -41.97	38.43-41.38	34.82-42.7	37.75-41.87
C20:1ω9	0.00-0.71	0.05-0.55	<0.05	<0.05	0.11-0.35	<0.05	0.18-0.19	0.19-0.28	0.18-0.19	0.2-0.29	0.15-0.17
C22:1ω9	<0.05	0.00-0.13	<0.05	<0.05	0.11-0.35	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
C18:2ω6*t*	0.14-0.14	0.24-0.65	0.22-0.68	0.00-0.16	0.08-0.28	0.16-0.67	0.17-0.36	0.07-0.23	0.09-0.36	0.15-0.25	0.18-0.33
C18:2ω6c	10.81-10.85	8.94-18.47	10.42-14.35	10.83-10.92	7.75-12.13	11.27-12.1	6.16-13.16	11.37-18.61	11.3-13.47	10.56-12.12	9.36-14.65
C18:3ω3c	0.42-0.5	0.18-0.44	0.36-0.45	0.13-0.4	0.00-0.43	0.42-0.44	0.05-0.58	0.34-1.25	0.25-0.58	0.09-1.09	0.21-0.76
C18:3ω6*c*	<0.05	<0.05	0.15-0.64	0.00-0.47	0.00-0.14	0.00-0.08	0.4-0.46	0.26-0.43	0.35-0.47	0.4-0.88	0.39-1.12
C20:3ω3*c*	0.19-0.2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
C20:4ω6c	<0.05	<0.05	0.15-0.64	<0.05-0.47	<0.05-0.14	0.05-0.08	0.27-0.54	<0.05-0.44	0.4-0.82	0.19-0.25	0.24-0.28

ND-Not Detected. "A" oil extracts: A1-Chapati; A2-potato chips; A3-chicken; A4-fish; A5-pancakes; "B" frying oils: B1-chapatti; B2-potato chips; B3-chicken; B4-fish; B5-pancakes.

4.2.3 Trans fatty acids

Two TFA; 18:1ω9*t* and 18:2ω6*t* were detected in both the oil extracted from the SF and the frying oils used to deep-fat-fry the foods (Table 4.9).

Table 4.8: Elaidic acid and linoelaidic acid content of oil extracted from the different street foods and frying oils compared with that of the virgin oil

Oil type	C18:1ω9*t*	C18:2ω6*t*	C18:1ω9*t* + C18:2ω6*t*
Virgin oil	<0.05	0.14-0.14	0-0.14
A1	0.05-0.55	0.24-0.65	0-0.24
A2	0.16-0.17	0.22-0.68	0.25-0.68
A3	<0.05-0.25	0.00-0.16	0-0.4
A4	<0.05-0.26	0.08-0.28	0.08-0.41
A5	0.145-1.00	0.16-0.67	0.16-1.12
B1	0.11-0.54	0.17-0.36	0.11-0.28
B2	<0.05-1.65	0.07-0.23	0.12-1.72
B3	<0.05-0.28	0.09-0.36	0.09-0.64
B4	<0.05-0.19	0.15-0.25	0.15-0.44
B5	<0.05-0.08	0.18-0.33	0.18-0.41

"A" oil extracts: A1-Chapati; A2-potato chips; A3-chicken; A4-fish; A5-pancakes; "B" frying oils: B1-chapatti; B2-potato chips; B3-chicken; B4-fish; B5-pancakes; C18:1ω9*t*-elaidic acid; C18:2ω6*t*-linolelaidic acid

The amounts of 18:2ω6*t* were higher than those of 18:1ω9*t*. In general, potato chips obtained from Wandegeya had the highest TFA content followed by potato chips from Makerere and chicken from Wandegeya. Linoelaidic acid was detected in chapatti obtained from Wandegeya and Bwaise, all potato chips samples, chicken from Wandegeya and Bwaise, all fish samples, and pancakes from Makerere and Wandegeya. Elaidic acid was found in chapatti obtained from Bwaise, potato chips from Makerere, fried chicken from Wandegeya, fried fish from Wandegeya and Bwaise, and pancakes obtained from Makerere and Bwaise. All frying oils analyzed in the study tested positive for TFA. Oil used to fry potato chips in Wandegeya had the highest content of TFA and that used to fry chapatti in Wandegeya had the lowest. Virgin oil did not contain 18:1ω9*t* but contained traces of 18:2ω6*t*. The TFA content of street foods and frying oils was less than the 2% limit set for TFA in most foods by many countries around the world.

4.3 Exposure to trans fatty acids consumed in street foods

Exposure to TFA in street foods was determined by computing the amount of energy consumed as TFA based on a calorie intake of 2400 and 2000 kcal for men and women, respectively. All the street foods that were sampled had a TFA content of less than 1%E. Women in Makerere had the highest intake (1.14%E) as TFA if they consumed all the foods in a day, followed by Bwaise with an energy intake of 0.97% while Wandegeya women consumed the least at 0.91%E. Similarly, men in Makerere had an estimated 0.94%E intake as TFA followed by Bwaise (0.82%E) and Wandegeya (0.54%E) in that order (Table 4.9).

Table 4.9: Contribution of TFA towards energy intake (E%) for both men and women from the street foods

Food type	Makerere		Wandegeya		Bwaise	
	Men	Women	Men	Women	Men	Women
Chapatti	0	0	0.09	0.11	0.11	0.13
Potato chips	0.09	0.12	0.1	0.12	0.16	0.19
Fried chicken	0.44	0.53	0.06	0.08	0.42	0.5
Fried fish	0.15	0.18	0.26	0.30	0.06	0.07
Pancakes	0.26	0.31	0.28	0.30	0.07	0.08
Total	0.94	1.14	0.79	0.91	0.82	0.97

The WHO advises that a healthy diet should contain < 1%E (*ca.* 2 g/day) in a 2,000-calorie diet as TFA (Ogwok *et al*., 2017). This means that consumption of a single street food in this study may not lead to significant TFA exposure. However, the cumulative effect of TFA in all the foods in a particular locality showed a definite risk for women consumers in Makerere and a potential risk for women in Bwaise. Consumers of chapati in Makerere had a 0%E as TFA intake because the elaidic and linoelaidic acid content were less than 0.05%. These findings imply that consumption of SF can contribute to the dietary intake of TFA. Trans fatty acids are a risk factor for high blood pressure, CVD, T2DM, and cancer (Teegala *et al*., 2009). While individual food items may not warrant concern, consumers of street foods ought to be cautious because there could be many other sources of TFA in the diet.

CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

From the results of the study, it can be concluded that many people in Kawempe division consume deep-fried street foods. The most consumed street food is the shallow-fried chapatti, followed by potato chips, pancakes, deep-fried chicken, deep-fried fish, and deep-fried chapatti in that order. The total fat content was highest in fried chicken and lowest in pancakes. Unsaturated fatty acids predominated over the saturated. The principal fatty acids in oil extracts from the foods, and the frying oils included oleic acid, linoleic acid, palmitic acid and stearic acid. All street foods contained the trans fatty acid linoelaidic acid. The total trans fatty acid content was below the maximum limit hence the foods were safe for consumption. Individual food items did not show risk concern, however, the aggregate effect of TFA in the different foods showed potential risk.

5.2 Recommendations

Street food consumers should exercise caution because there are many other sources of TFA in the diet. Street food vendors should reduce the usage of overly recycled oil to fry food and reused oil should be strained to remove food particles before reheating and reuse. Public health education and awareness campaigns are recommended for both street food vendors and consumers to reduce the risk of exposure to trans fatty acids in the diet. Further studies are recommended in respect of scaling up this work to cover all deep-fat fried street foods in Uganda.

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APPENDICES

Appendix 1: Survey questionnaire for determining the rate of consumption of deep-fried street foods in Kawempe Division

Dear Sir/Madam

My name is Nakayaga Claire, a student at Kyambogo University pursuing a Master's Degree in Public Health. I am conducting a study entitled "Contribution of selected street foods towards dietary total fat and trans fatty acid intake in adults in Makerere, Wandegeya and Bwaise" The study aims to establish the health risks posed to consumers due to total fat and trans fatty acid exposure in deep-fried street foods. We shall collect information on the consumption of deep-fried street foods among consumers in Kawempe Division. The information provided will be treated with confidentiality and shall be used for academic purposes only. Thank you.

Date………………………………………

1. Respondent's biodata

a. Contact: Tel.……………………….. (Optional)

b. Gender: male….. female…….. c. Weight ………………..kg

d. Age of the respondent

18 - 24 years	25-29 years	30-34 years	35-39 years	40-44 years	45-49 years

e. Occupation of the respondent

Civil servant	Privately employed	Student	Wage earner	Unemployed	Other specify

f. Marital Status of the respondent

Single	Cohabiting	Married	Widowed	Divorced	Never married

g. Religion of the respondent

Catholic	Anglican	Islam	Born again Christian	Adventist	Orthodox	Other specify

h. Are you currently in school or out of school?

In school …………………… Out of School ……………………….

I. If in school, what at level of education are you?

Primary	Secondary	Tertiary institution	Vocational training	University

J. If out of school, what is the highest qualification attained?

PLE	Secondary (O- level)	Secondary (A-level)	Certificate	Diploma	Degree

2. Do you consume deep-fried street food?

No………………………. Yes …………………..

3. If your answer in 2 is yes, please indicate how many times you consume each of the following Street foods.

Street food	Once in 3 months	Once in a month	Once a week	2 to 4 times a week	5 to 6 times a week	Once a day	2 or more times a day
Chapati (shallow fry)							
Chapati (deep fry)							
Chicken							

Fish							
Pancakes							
Potato chips							

4. Each time you consume, how much of the food do you consume?

Chapati

One (1)	Two (2)	Three (3)	More than three (3)

Chicken

One (1) piece	Two (2) pieces	Three (3) pieces	More than three (3)

Fish

One (1) piece	Two (2) pieces	Three (3) pieces	More than three pieces

Pancakes

Two (2)	Four (4)	Six (6)	More than six (6)

Potato chips

One (1) serving	Two (2) servings	Three (3) servings	More than three (3)

5**.** What are the reasons for the consumption of deep-fried street food**?**

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

6. Where do you consume the street foods from?

Home	Selling point	School	Workplace	Other (explain)

7. When do you consume;

Chapati

Breakfast	Lunch	Dinner	In between meals

Chicken

Breakfast	Lunch	Dinner	In between meals

Fish

Breakfast	Lunch	Dinner	In between meals

Pancakes

Breakfast	Lunch	Dinner	In between meals

Potato chips

Breakfast	Lunch	Dinner	In between meals

8. How much money do you spend on street foods in a single day?

Chapati	Chicken	Fish	Pancakes	Potato chips

9. Have you received any form of awareness of the effects of consuming street foods

Yes…………………………. No…………………………………

10. If your answer to question 9 was yes, who provided the information?

Radio	Local leadership	Youth groups	NGO	Private company	TV	Other (specify)

INTERVIEWER: This is the end of the interview. Thank you for your participation!

Appendix II: Ebibuuzo by'okunoonyereza okuzuula engeli abantu gye balyaamu emmere e siikiddwa mu butto mu divizoni y'Kawempe

Omwagalwa mwami/ mukyala

Nze Nakayaga Claire, omuyizi mu Ssetendekero ely'e Kyambogo, nga nsoma diguli ey' okubiri mu bulamu bwa'abantu. Nkola okunoonyereza okutuumiddwa "okunonyereza a'kabi akava ku masavu agasukiridde agali mu mmere ensike y'okunguudo e Makerere, Bwaise ne Wandegeya mu divizoni y'e kawempe

Okunooneyereza kuno kugenderera okutegeera obulabe obuli mukulya emmere ensiike enyoo etunddibwa ku nguuddo. Tujja kukunganya obubaka ku nddya y'emmere esiikidwa ennyo mubutto mu division y'ekawempe. Obubaka obutuwereddwa tujja bukuuma nga bwa kyama era tujja bukozesa mu by'ensoma byokka. Weebale

.

Enaku zomwezi………………………………
1. Ebikwata ku bulamu bw'abuuzibwa

a. Okutuukirira: simu…………………. (kya kusalawo)

b. Obutonde: Mwami…. Mukyala….
c. Obuzito…………………mukilo
d.Emyaka gy'oyo abuuzibwa………………………

18 - 24 myaka	25-29 myaka	30-34 myaka	35-39 myaka	40-44 myaka	45-49 myaka

e. Omulimu gwa oyo abuzibwa

mukozi wa gavunment	Omuntu eye kozesa	muyizi	Enyingizza	Ayingiza Omusaala	Takola	N’ebilala

f. Embeera y’obufumbo

simufumbo	Abera namusajja	mufumbo	Namwanddu/ ssemwanddu	Yayawukana n’omwaami/mukyala	Tafumbirwangako

g. Eddini y ‘addamu ebibuuzo

Mukatuliki	mupolotestanti	Musilamu	Mulokole	mu adventi	Orthodox	n’ebilala

h. Oli musomero ennaku zinno?

Oli musomero …………………… Toli musomero……………………….

i. Okuddamu bwe kuba nti yee, oli ku ddala ki ely’obuyigirize

pulayimale	sekondule	Etendekero elya wagulu	Etendekero ly’e by’emikono	Yunivasite

j. Okuddamu bwekuba nti nedda, ddala ki ely’obuyigirize elisinga obunene?

PLE	Sekondule (0-ddala	Sekondule (A-ddala)	satifikeeti	Dipulooma	Diguli

2. Olya emmere ensiike mu buuto etundibwa ku ‘nguudo?

Nedda……………………   yee ……………………

3. Okuddamu kwo bwe kuba nti yee mu biri, nsaba otugambe emirundi emeka gy’olya buli emu ku mmere ensiike mubutto ettundibwa ku nguudo

.

Emmere ensiike etundibwa kunguudo	lumu mu myezzi esatu	lumu mu mwezi	lumu mu wiki	Emirundi ebiri kw’enna mu wiki	emirundi etanno ku mukaaga mu wiki	lumu mu lunaku	Emirundi ebiri n’okusinga wo mu lunaku.
chapatti ensike mu katono							
chapatti ensiike enyoo							
Enkoko							
Ekyenyanjja							
kabalagala							
Obumonde obusiike							

4. Buli lw’olya mmere ebeela yenkana ki?

Chapati

Emmu (1)	Biri (2)	satu(3)	ezisuuka mu satu (3)?

Enkoko

kifi kimu (1)	Ebifi bibiri(2)	Ebifi bisatu	Ebifi ebisuka mu bisatu

Kyenyanjja

Kimu (1)	Bi biri (2)	Bisatu(3)	Bisukka mu bisatu

Kabalagala

Biri (2)	Nyaa (4)	Mukaaga (6)	Suka kumukaaga (6)

Obumonde obusiike

Ekijulo (1)	Ebijulo biiri (2)	Ebijulo bisatu (3)	Ebijjulo ebisuukas mu bisatu

Appendix III: Introductory Letters

KYAMBOGO UNIVERSITY
P. O. BOX 1 KYAMBOGO
Tel: 041 - 4286792 Fax: 256-41-220464
Website: www.kyu.ac.ug Email: drgt@kyu.ac.ug
Directorate of Research and Graduate Training
Office of the Director

Date: 25/01/2023

TO WHOM IT MAY CONCERN

RE: NAKAYAGA CLAIRE

Dear Sir/Madam,

This is to introduce to you the above-named student Reg: No **21/U/GMSPH/14429/PE** pursuing Master of Public Health, Department of Biological Sciences, Kyambogo University.

She intends to carry out research on **"Risk Assessment of Total Fats and Trans Fatty Acids Consumed in Street Foods in Kawempe Division"** in partial fulfillment of the requirements of the award of Master of Public Health of Kyambogo University.

The purpose of this letter therefore is to request you to grant her permission to carry out his study in your institution.

Any assistance rendered to her will be highly appreciated.

Yours sincerely

Prof. Bosco Bua
DIRECTOR

KYAMBOGO UNIVERSITY
25 JAN 2023
DIRECTOR
DIRECTORATE OF RESEARCH AND GRADUATE TRAINING

KAMPALA CAPITAL CITY AUTHORITY
KAWEMPE DIVISION
KCCA
21 FEB 2024
CHAIRPERSON L.C I
MAKERERE II ZONE B VILLAGE

Chman Kalanda Wilson
Authorised to carry out study research in our area.
Chman
0704165574

KYAMBOGO UNIVERSITY

P. O. BOX 1 KYAMBOGO
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KAMPALA CAPITAL CITY AUTHORITY
KAWEMPE DIVISION
KCCA 21 FEB 2024 ★
CHAIRPERSON L.C I
MAKERERE I MUKWENDA VILLAGE

Received by
Chman Kawuma, Jum

KYAMBOGO UNIVERSITY
P. O. BOX 1 KYAMBOGO
Tel: 041 - 4286792 Fax: 256-41-220464
Website:www.kyu.ac.ug Email: drgt@kyu.ac.ug
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KAMPALA CAPITAL CITY AUTH.
KAWEMPE DIVISION
21 FEB 2024
CHAIRPERSON L.C I
WANDEGEYA BUSIA VILLAGE
KCCA