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GUEST EDITORIAL

Fish and Chips: Considering convenience and affordability, but with what harm and cost to your health?

Michael Lokuruka

Michael N.I. Lokuruka, PhD, EBS
Associate Professor of Food Science
Karatina University, Department of Food Science and Nutrition
Box 1957-10101, Karatina, Kenya, and,
Commissioner, Public Service Commission of Kenya
Box 30095-00100, Nairobi
Email: mlokuruka@gmail.com

Introduction

I remember the 1970s-1990s as the decades of the "fish and chips" craze, especially for the youth of the time. The craze seemed at the time to have originated from the UK, though I feel the place of origin may not have influenced its embrace by the Kenyan youth. The tastiness of fish and chips as contributed by fat, its crispiness on chewing and the brown appearance of the surface may be part of the allure to consume it. I was, of course, also a participant in the fad, as it was fashionable and socially-acceptable for young people. Thus, food fads contribute to the internationalization of foods and cuisine. What I and others of that generation did not know was that we were setting ourselves up for life-long consumption of deep-fried chips and may be fish, occasionally. This is not to say that it is possible for one to change dietary habits along the journey of life, but "habits die hard", they say. Today, I sparingly eat chips, but cooked fish is one of my dietary favourites because I am a trained food/fish processing scientist and a nutrition enthusiast, who has learnt and tries hard to select foods based on familiarity, sensory appeal, scientific sense and nutritional benefit. The regular consumption of fish in order to obtain the polyunsaturated omega-3 fatty acids found in fish muscle, as part of healthy eating, besides its good amino acid profile, is premised on that. The consumption of fish and chips has nutritional benefits, but in today's dietary parlance, the two food items fall within the realm of "junk food".

Junk food in human nutrition

Junk food is pre-prepared food that generally has low nutritional value. Nutritional value refers to the extent to which a food supplies the nutrients that are expected in a balanced meal, the digestibility and therefore absorbability of the nutrients contained therein [1]. Junk foods are often convenience foods, which are eaten on the go and save the consumer meal preparation time and are affordable. Nutritionally, junk foods may be deficient in some of the major and or micro nutrients that balanced food should contain. The deficiency may be related to adverse processing conditions, the result of which may be the destruction of some nutrients and/or introduction of components that are nutritionally undesirable. The latter scenario is likely to be observed in the practice of deep-frying of foods, where thermo-labile vitamins such as vitamin C are destroyed substantially and polycyclic aromatic hydrocarbons are formed due to the high temperatures of cooking, often >160 ^{o}C for 2-4 minutes [2] or greater. Excessive deep-frying of chips may also destroy the thermolabile B-vitamins including thiamin (B1), pantothenic acid (B5), pyridoxine (B6), and folate (B9) [3]. Together with vitamin C and potassium, they tend to be the most vulnerable nutrients when subjected to leaching, heat, and, oxygen.

Junk foods are often high in lipids, carbohydrate and/or sugar, so they tend to be energy-dense. Modern healthy-eating advice discourages the consumption of excessive amounts of lipids, carbohydrates and sugar. However, destitute or low-income consumers, the illiterate or those without adequate and appropriate education, are unlikely to access information on healthy-eating and are therefore likely to suffer the consequences of the consumption of deep-fried chips. Common foods for the urban-poor include fries and soda or chips and other beverage like sweetened milked-tea or high sugar fizzy drinks. Young people in colleges who may be short of money to purchase balanced meals and

lack time to prepare a decent meal, may also fall into the trap of living on chips and soda or soda and white bread, soda and scones on the go, for a good part of their college life, with malnourishment or undernourishment being the result.

The major nutrients that must be supplied in a balanced meal are carbohydrate, proteins, fat, minerals, water, fibre and vitamins. Fish and chips are high in carbohydrate and lipids. Both foods are deep-fried, often in recycled lard or other saturated fat, partly due to the conscious effort to keep processing costs low, and therefore maximize profit to the vendor. In Kenya, recycled animal fat is often the fat of choice for deep-frying of fish and chips. However, in developed countries and also in the starred hotels in Kenya one observes the preference for vegetable oils such as corn oil, soybean oil, sunflower oil and palm oil, whenever hoteliers make fried fish fillet and chips for their guests. The health benefits of the use of either animal fat or liquid vegetable oils for deep-frying of fish fillet and chips are different; vegetable oils offer a higher content of monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA) as opposed to the higher saturated fatty acids (SFA) content in a meal when animal fat is used for frying the food. The deep-frying process in high-class hotels uses shorter frying times at probably the same high temperatures, thus keeping low the amount of heterocyclic and polycyclic aromatic hydrocarbon formed in the food, whose surface colour rarely becomes brown (due to low levels of Maillard reaction in products). The adverse health effects of such mildly fried foods are not as severe on the consumer. Deep-fried, high-fat foods are associated with obesity, cardiovascular artery disease and type 2 diabetes, which are mediated by comorbid hypertension and hypercholesterolemia [4].

Composition of deep-fried fish and chips

Fish and chips are good sources of fat, which is a good source of metabolizable energy. Fish fillet tends to be high in protein, while chips are a low protein food [Table 1a-1b]. Both are relatively good sources of the various minerals required for human physiological needs [Table 1c]. Their supply of the various vitamins is influenced by the time and temperature of cooking. Fish and chips by their nature vary in the level and nature of the fatty acids in the lipids. The nature of frying fat may also influence the fatty acid profile in the cooked food; however, the potato cultivar and the main feed of the fish are also important determinants of the fatty acid profile in the fish and chips meal. The Danish Food Institute gives the nutrient content presented in Tables 1a-1d for deep-fried chips and breaded fish fillet [5]. The amino acid profile of deep-fried chips is given in Table 1e, but that of deep-fried fish fillet was not included due to inconsistencies noted in the literature.

Chemical changes during deep-frying of fish and chips

The most important events include:

On water: the evaporation of moisture from the interior and the surface of the food results in the drying of the chips and fish. The loss of moisture raises the dry matter content of the foods.

On lipids: the lipids are broken down and/or polymerized by the excessive heat penetrating into the molecular structure of the foods. The lipids release free fatty acids which increase in the reaction space as a result of the high temperature oxidation, polymerization and hydrogenation reactions. The higher the temperature of frying and the longer the processing times, the greater the amount of degraded products formed. Some of the degraded products volatilize into flavour compounds that induce the sensory attractiveness of the food to consumers. Higher cooking temperatures greater than 160 ^{o}C can also lead to the formation of heterocyclic and polycyclic aromatic hydrocarbons (HAHs and PAHs). Many PAHs have toxic, mutagenic and/or carcinogenic properties [8, 9, 10]. The PAHs are highly lipid soluble and thus are readily absorbed from the gastrointestinal tract of mammals. They are rapidly distributed in a wide variety of tissues with a marked tendency for localization in body fat. Metabolism of PAHs occurs via the cytochrome P450-mediated mixed function oxidase system with oxidation or hydroxylation as the first step [11].

On proteins: the frying process results in the breakdown of the proteins into various types of low molecular mass nitrogenous compounds, most of which eventually end up as amino acids. One other result is the formation of a number of products by the reaction of reducing sugars and protein breakdown products, mainly the amino acids. These Maillard products contribute to the browning of the food. The higher the temperature of processing for longer periods of time, the browner the products, which can become caramelized and unsightly if the processing parameters are not appropriately controlled.

On vitamins: a moderate loss of a number of thermolabile B-vitamins and vitamin C occurs under conditions of high temperature-time of food processing.

On minerals: a moderate loss of most minerals and a considerable loss of potassium occurs under the high temperature-time conditions of deep-frying of fish fillet and chips in oil.

Deep-fried fish and chips in human health

Chips are typically high in fat and calories, which can raise the risk of weight gain and obesity. A 2011 study in "The New England Journal of Medicine" found that the daily consumption of 100 g of potato chips (one can eat as much as 3 times this amount at a serving) led to an average weight gain of about 3 kg over four years [12]. This estimate did not consider the level of activity and the type of other foods which can contribute to weight gain. However, the link between potato chips and weight gain was stronger than the link between weight gain and other dietary components, including processed meats, sugar-sweetened beverages and unprocessed red meats. Being overweight or obese, raises the risk of diabetes, heart disease and some forms of cancers-cancer of the breast (in women past menopause), colon and rectum, endometrium (lining of the uterus), oesophagus, kidney, and, pancreas. Chips and fish are also low in dietary fibre (1.0-4.0 g/100 g of food). Also, if you regularly include chips as part of your diet, you may not be consuming as many nutrients as you should. Chips are typically low in vitamins and minerals, and they also tend to displace components in the diet that are higher in healthy nutrients. The sodium content in chips may negatively impact one's cardiovascular

health. A high intake of sodium can cause an increase in blood pressure, which can lead to stroke, heart failure, coronary heart disease and kidney disease. Potato chips generally have between 120 and 180 milligrams of sodium per 28 g, while tortilla chips can have 105 to 160 milligrams of sodium per 28 g. A bag of chips typically contains more than 30 g, so many people consume more sodium than they realize when eating chips. According to the 2010 Dietary Guidelines for Americans, most people are advised to limit their salt consumption to 2,300 milligrams per day or less, while individuals who are over 50 years old, African-Americans, and, anyone with high blood pressure condition, kidney disease or diabetes, should not consume more than 1,500 milligrams per day [13]. In Kenya, the habit of adding salt to nearly all foods is surely a bad practice, especially for those who are hypertensive, a condition that a lot of people are often unaware of, making it take the name, “the silent killer”.

Most chips are deep-fried, a process that creates trans fats, which are nutritionally undesirable type of fatty acids. In addition, when the oils used for frying chips are saturated fats, they contribute to high serum cholesterol levels. A 2007 study published in the journal "Circulation" found that high levels of trans fats in the bloodstream were associated with high levels of low-density lipoprotein (LDL) cholesterol and an increased risk of coronary heart disease [14]. High levels of trans fat in the diet are correlated to high levels of LDL (“bad” cholesterol) in the blood.

Conclusion

Overall, long-time, high temperature deep-frying in recycled fat, may not be a good method of cooking food, if the aim is to maintain the nutritional quality of food. The high lipid content of oil-fried food gives it a high energy value. Deep-frying also improves the flavour and the visual characteristics of food due to the formation of lipid breakdown and browning reaction products; however, these chemical and physical attributes may not be worth the adverse effects on health and the associated long-term costs of curative care. It is, therefore, advised that people should avoid the frequent consumption of fish and chips as major items of diet, especially chips that are fried in animal fats, and, those that make a crackling sound on chewing and appear dark or deep brown on the surface. However, when they are fried in vegetable oils for short periods of time, they may contribute to the overall nutrient content of a diverse diet.

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Table 1a: Macro-Nutrient content of deep-fried chips and breaded fish fillet

Nutrient	Content in chips (unit)	Content in fish fillet (unit)	Comment
Energy	1299 (KJ) or 311 Kcal	1201 (KJ) or 287 (Kcal)	Both components are good energy sources
Protein, total	3.8 g/100 g	13.4 g/100 g	Chips is a poorer source, but fish is an excellent source of high biological value protein
Carbohydrate, by difference	42.2 g/100g	22.9 g/100 g	Chips is a better source
Carbohydrate, available	39.0	21.9 g/100 g	Chips would be a better source
Dietary fibre	3.2	1.0 g/100 g	Both foods are poor sources, though chips is a better source than fish fillet, despite the breading of the fillet
Fat, total	14.8 g/100 g	16.1 g/100 g	Both foods are good sources
Ash	2.2 g/100 g	1.9%	Both foods have moderate mineral contents generally
Dry matter	62.9	54.2%	The degree of drying influences the final dry matter content
Water	37.1	45.8 %	Apparently the fries would be soggy, while the fish fillet was not dried sufficiently

Source: [5]: Found at: https://frida.fooddata.dk/ShowFood.php?foodid+1209

Table 1b: Vitamin content of deep-fried chips and breaded fish fillet

Nutrient	Content in chips (unit)	Content in fish fillet (unit)
Vitamin A, retinol	0.000	---
B-carotene	0.0000	---
Vitamin D	0.000	---
Vitamin E, tocopherol	0.1 mg/100 g	---
B2, Riboflavin	0.058 mg/ 100 g	0.112 mg/100 g
Niacin	1.20 mg/100 g	0.10 mg/100 g
Vitamin B6	0.180 mg/100 g	---
Pantothenic acid	0.2000 mg/100 g	----
Biotin	0.000	---
Folate, free	3.000 mg/100 g	----
B12	0.000	----
Vitamin c	23.3 mg/100 g	----
L-ascorbic acid	14.3 mg/100 g	----
L-dehydroascorbic acid	9.000 mg/100 g	----

Source: [5]: Found at: https://frida.fooddata.dk/ShoeFood.php?foodid+1209

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Table 1c: Mineral content of deep-fried chips and breaded fish fillet

Mineral	Content in chips (units)	Content in breaded fish fillet(units)	Commentary
Chloride	584 mg/100 g	817 mg/100 g	A fair source, but one requires another source or salt addition; RDA 1800-2300 mg/day based on age, sex and condition of person
Sodium, Na	377 mg/100 g	519 mg/100 g	Poor sources, RDA is 2500 mg/day
Potassium, K	587 mg/100 g	205 mg/100 g	Poor sources; RDA is 4700 mg/day
Calcium, Ca	13.2 mg/100 g	38.5 mg/100 g	Very poor sources; RDA is 1000-1200 mg/day. Other high calcium foods would be required.
Magnesium, Mg	32.7 mg/100 g	22.2 mg/100 g	Poor sources, where the foods are major daily dietary items-RDA is 280 and 350 mg/day for females and males, respectively
Phosphorus, P	120.000 mg/100 g	130 mg/100 g	Poor sources; RDA is 1000 mg/day
Iron, Fe	10.788 mg/100 g	0.557 mg/100 g	Poor sources; RDA is 8 and 18 mg/day for males and females, respectively
Copper, Cu	0.171 mg/100 g	0.660 mg/100 g	Poor sources; RDA is 2 mg/day
Zinc, Zn	0.506 mg/100 g	0.642 mg/100 g	Poor sources;-RDA is 9 and 11 mg/day for females and males, respectively
Iodine, I	0.000	-----	One would need a source of the mineral; RDA is 150 µg/day

Manganese, Mn	0.185 mg/100 g	0.279 mg/100 g	Poor sources-RDA is 10 mg/day
Selenium, Se	2.300 µg/100 g	----	Poor sources; RDA is 300 µg/day
Nickel, Ni	41.000 µg/100 g	----	Poor sources-RDA is 700 mg/day
Cadmium, Cd	7.100 µg/100 g	----	US EPA has determined it is a human carcinogen and levels in water should not exceed 0.005 µg/100 mL, so the level in the chips here may be of concern
Lead, Pb	4.000 µg/100 g	----	Classified as a group 2 potential human carcinogen, The CDC of the US gives 10µg/100 mL as the blood level of concern. The level in the chips here may be of concern if 300 g was eaten, though that may not necessarily translate to the same level in blood serum.

Source: [5, 6]: Found at: https://frida.fooddata.dk/ShowFood.php?foodid=1209l
RDA-Recommended daily allowance; CDC-Centres for Disease Control and Prevention of the US; US EPA-US Environmental Protection Agency
N.B: For toxic metals such as lead and cadmium, . the acceptable daily intake (ADI) or tolerable intake or level (TI or TL) is what used in nutritional studies and not RDA. The ADI or TL is based on body weight and age, sometimes on gender and condition of a mother

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Table 1d: Lipid content of deep-fried chips and breaded fish fillet

Nutrient	**Content in chips (units)**	**Content in deep-fried breaded fish fillet (units)**	**Comments**
Sum, SFA	3.49 g/100 g fat	2.67 g/100 g fat	-------
Sum, MUFA	7.6	6.90 g/100 g fat	-------
Sum, PUFA	2.75	4.21 g/100 g fat	Fish has a higher amount than chips
FA, total	13.5	13.8 g/100 g fat	-------
Sum, n-3 FA	0.498	1.00 g/100 g fat	The fish fillet contains about twice the amount in chips
Sum, n-6 FA	2.25	3.21 g/100 fat	A little higher in the deep-fried fish fillet
TFA, total	0.052	0.018 g/100 g fat	Chips develop a greater amount than fish fried at any time-temperature combination
Cholesterol	0.000	------	The chips were probably fried in vegetable oil
Saturated fatty acids in chips and deep-fried fish fillet			
Nutrient	**Composition in chips (units)**	**Composition in fish fillet (units)**	**Comments**
C4, C6, C8, C10, C15, C17, C24	0.000	0.000	Not detected in both foods
C14:0	0.065 g/100 g fat	0.075 g/100 g fat	
C12:0 (lauric acid)	0.012 g/100 g fat	0.000	Not detected in fried and breaded fish fillet
C16:0 (palmitic acid)	2.87 g/100 g fat	2.11 g/100 g fat	------
C18:0 (Linoleic acid)	0.485 g/100 g fat	0.425 g/100 g fat	------
C20:0	0.045 g/100 g fat	0.058 g/100 g fat	------
C22:0	0.016 g/100 g fat	0.000	Not detected in the fried fish fillet

Source: [5]

Legend: FA-fatty acids; SFA-saturated fatty acids; MUFA-monounsaturated fatty acids PUFA-polyunsaturated fatty acids; TFA-trans fatty acids

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Table 1d: Continued-Polyunsaturated fatty acids content of deep-fried chips and breaded fish fillet

Nutrient	Content in deep-fried chips (units)	Content in breaded deep-fried fish fillet (units)	Comments
C18: 2, n-6	2.21 g/100 g fat	3.21 g/100 g fat	----
C18: 2 conjugated, undifferentiated	----	0.000	----
C18: trans undifferentiated	0.017 g/100 g fat	-------	---
C18: 3, n-3	0.498 g/100 g fat	0.793 g /100 g fat	----
C18: 3, n-6	0.048 g/100 g fat	0.000	Not detected in the fried fish fillet
C20: 4, n-3, C20: 2, n-6, C20: 4, n-6 were not detected in both food products (0.000)			
C20: 5, n-3 (EPA)	0.000	0.126 g/100 g fat	Not detected in the fried chips
C20: 6, n-3 (EHA), and other fatty acids in chips and C22: 5 n-3 (DPA) were not detected in the fried fish, respectively			
C22: 6 n-3 (DHA)	------	0.083 g/100 g fat	-----
Other fatty acids	------	0.032 g/100 g fat	Fatty acids of higher molecular mass

Source: [5]

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Table 1e: Amino acids in deep-fried chips

Amino acid	Content in deep-fried chips (unit)	Essential or non-essential amino acid (RDA)
Isoleucine (Ile)	136.0 mg/100 g	Non-essential
Leucine (Leu)	201.0 mg/100 g	Essential, RDA 20 mg/Kg body weight
Lysine (Lys)	213.0 mg/100 g	Essential, RDA 30 mg/kg body weight
Methionine (Met)	50.0 mg/100 g	Essential, RDA (Met 10.4+4.1 cysteine) = 15 mg/kg body weight.
Cystine (Cys)	30.0 mg/100 g	Non-essential
Phenylalanine (Phe)	148.0 mg/100 g	Essential, RDA (Phe+Tyrosine)=25 mg/kg body weight
Alanine (Ala)	130.0 mg/100 g	Non-essential
Glutamic acid (Glu)	491 mg/100 g	Non-essential
Aspartic acid (Asp)	781 mg/100 g	Non-essential
Glycine (Gly)	107.0 mg/100 g	Non-essential
Proline (Pro)	130.0 mg/100 g	Non-essential
Serine (Ser)	130.0 mg/100 g	Non-essential
Tyrosine (Tyr)	71.0 mg/100 g	Non-essential
Threonine (Thr)	124.0 mg/100 g	Essential, RDA 15 mg/kg body weight
Valine (Val)	219.0 mg/100 g	Essential, RDA 25 mg/kg body weight
Tryptophan (Trp)	56.0 mg/100 g	Essential, RDA 4 mg/kg body weight
Arginine (Arg)	154.0 mg/100 g	Non-essential
Histidine (His)	65.0 mg/100 g	Regarded as essential for infants but not for adults, RDA 10 mg/kg body weight of infant

Source: [5, 7]

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