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Public Perception on Health Risk Implications of Lead and Cadmium Ingestion through Consumption of Saratherodon Melanotheron in the Fosu Lagoon

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Abstract
Various research works have indicated that the Fosu Lagoon is polluted with lead and cadmium. The consumption of fish, particularly saratherodon melanotheron (blackchin tilapia) in the Fosu Lagoon in Cape Coast, Ghana, could therefore give rise to negative health implications. Yet people consume tilapia from the lagoon. The purpose of the study was therefore to ascertain public perception on the health implications of tilapia consumption due to the presence of lead and cadmium presence in the tilapia. A questionnaire and interview schedule was used to collect the data. Subjects were sampled using purposive sampling technique for a sample size of fifty-five from the Cape Coast Metropolis where the lagoon is located. Descriptive analytic tools such as frequencies, percentages and tables were employed utilising Statistical Package for the Social Sciences (SPSS) version 21software for the analysis. The study revealed that 60 percent of the respondents either strongly disagreed or disagreed that the lagoon and its content are polluted with lead and cadmium; though 65.5 percent had heard of the pollution of the lagoon and its content on one occasion or the other. It was also revealed that about 58 percent and 21.6 percent respectively strongly disagreed and disagreed that tilapia consumption has negative implications. The study further showed that about 80 percent of the respondents consume between 13.65-65.51g of tilapia per meal and an average of 175.8g per week (i.e. 4-5 days per week). The paper recommends that a strategic plan to educate the public on the consumption of tilapia from the lagoon and its health implications be drawn and implemented.
Keywords: contamination; environment; heavy metals; pollution; tilapia; water bodies

1.0 Introduction

Pollution may be defined as the release of physical, chemical, biological material and/or waveform in the environment at such magnitude that its harmful effect can affect the healthy or comfortable existence of living organisms or the quality or quantity of non-living matter now or the future (Baffour-Awuah, 2014$_a$; Tripathy & Panda, 2003). Pollution is caused by pollutants. As key elements, pollutants are waste materials produced as a result of production-consumption activities. The quest for development and the consequential modernization has therefore brought about various pollutants that are inimical to humans and the environment which include air, water and soil.

Technological advances have resulted in overproduction, over consumption and over pollution. Population growth and urbanization have also contributed to global environmental pollution affecting both developed and the developing world. The ability of the earth to counteract the pollution scourge has been overstretched resulting in visible consequences of pollution on the planet. Pollutants do not know boundaries. They have the potential of destroying biological species and their habitats and a host of them are biologically non-degradable, thus staying in the ecological environment with its toxic effects for several decades of years. Santos (1990) reports about 65000 chemicals. All these are potential pollutants to the environment, though are being produced and used by humans. These chemicals when released into the environment may cause severe harm to humans, lithosphere, hydrosphere and the atmosphere.

Atmospheric pollution affects air. With chemicals such as volatile organic compounds (VOCs), air borne particles, radioactive pollutants, carbon monoxide, sulphur dioxide, etc. released into the atmosphere, advective processes ensure that atmospheric pollution becomes of global consequences. Soil pollution and its pollutants such as hydrocarbons, solvents and heavy metals also provide their share of the planetary destruction. Water pollution caused by herbicides, insecticides, weedicides, food processing waste, volatile organic compound, chemical wastes, heavy metals among others are also of great concern since they cause untold damage to water bodies. These water resources include oceans, rivers, lakes and lagoons (Ehrlich, Ehrlich, & Holdren (1977).

Lagoon pollution directly affects the physical structure of the water body and the biological species of the resource. Whether the water is contaminated or polluted, humans may indirectly be affected through the food chain. The Fosu Lagoon located in Cape Coast (refer to figure 1) in the Central Region of Ghana is not spared of such environmental effects. The major biological beneficiary of the lagoon saratherodon melanotheron (blackchin tilapia) is therefore affected by pollution of the lagoon (Akwansah-Gilbert, 2007; Essumang, Dodoo & Kendie 2006; Hagan, 1996).

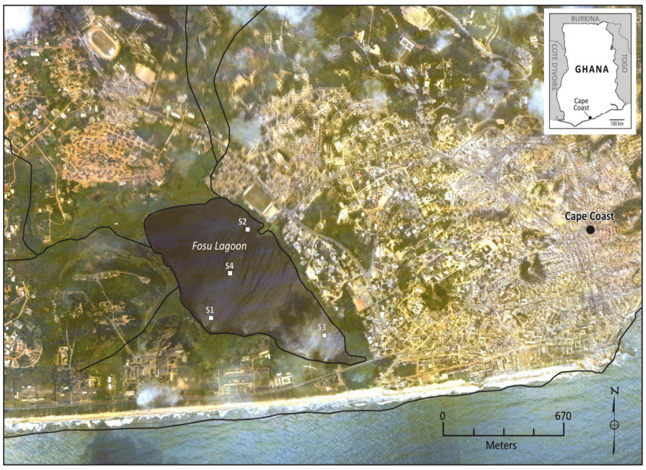

Figure 1: Map of Cape Coast metropolis showing the Fosu Lagoon (Source: Armah, Luginaah, Kuitunen & Mkandawire, 2012)

In spite of this, tilapia is still being caught by fishermen. Both fishermen and the general public rely on tilapia from the lagoon as dietary dependence. Majority of fishermen who feed on the tilapia are of the view that this could have no negative implications on their health (Baffour-Awuah, 2014_b). The purpose of this study was therefore to ascertain the extent to which the public patronise tilapia from the Fosu Lagoon. It also sought to find out those factors that contribute to the patronage of the specie. Finally the study sought to solicit the views of tilapia consumers on the health implications of the consumption of the tilapia; in addition to the perception of the public on pollution of the lagoon. Knowledge of these information and the recommendations, based on the findings, could help design educational programmes to minimize if not eliminate the effect of pollution on the lagoon environment, its effect on the lagoon itself and those that depend on it for dietary and economic purposes.

2.0 Literature review

This section dilates on literature about water pollution in general. It also looks at heavy metal pollution of the Fosu Lagoon. It further looks at the health implications of long-term lead and cadmium ingestion.

2.1 Water pollution

Globally, aquatic pollution has been caused through the release of physical, chemical and biological substances. Waveforms in the form of heat and nuclear radiations may also cause aquatic pollution (Baffour-Awuah, 2014_a; Tripathy and Panda, 2003). According to Tripathy and Panda (2003) this has affected about 60% of species in the biosphere. Lakes, rivers, oceans, aquifers, groundwater and lagoons have been affected. Water pollution may be natural or man-made. It is usually artificial when pollutants are directly or indirectly discharged into the biosphere through human activities. Living organisms in these biospheres are damaged in terms of species and populations as well as their natural biological habitats.

Water pollution may be the leading cause of global deaths and diseases. It could account for over 14000 deaths per day, (Pink, 2006; West, 2006). For example, it is estimated that water pollution accounts for over 580 deaths per day in India alone (CHNRI, 2010). In the United States, 45% of assessed stream miles, 47% of assessed lake acres and 32% estuarine square miles are considered polluted (United States Environmental protection Agency (EPA, 2007). China has its fair share of the pollution problem. Twenty-five percent of the length of seven major Chinese rivers was critically polluted to the extent of being injurious on skin contact (Watchman, 2007).

Aquatic pollution also affects organisms such as fishes. Whether pollution is point source or non-point source living biota in the water environment are negatively affected. When contaminants or pollutants enter an aquatic biosphere through a unitary identifiable source, such as ditch, pipe, or channel, it is referred to as point source. Municipal storm sewer systems and industrial storm water, from construction and industrial sites, are point source contaminants. Runoffs water may be classified as non-point source pollution. When runoffs from parking lots, roads and highways end in water bodies they are thus classified as non-point pollution.

Water bodies are polluted through point and non-point sources. In Ghana, rivers, streams and lagoons may be disturbed in this regard. It is on record that the Fosu lagoon in Cape Coast experience point and non-point pollution (Ahuahey, 2007; Essumang et al, 2006).

Variegated spectrum of chemicals and pathogens, temperature changes and discoloration could also lead to water pollution. The concentration of these substances determines whether a substance is a contaminant or a pollutant. In the latter the carrying-capacity of the biosphere may be exceeded. Plant matter such as leaves and grasses can also pollute the aquatic biosphere. They may cause turbidity or act as canopy to light and disrupt plant growth. Gills of fish species may also be clogged in this regard (EPA, 2005).

The toxicity of chemical pollutants is of concern. They alter water chemistry in terms of temperature, electrical conductivity, and acidity among others. This may destroy the water quality and consequently polluting fish quality and quantity. A host of diseases could thus be caused by pathogens through the food chain when these biotic entities are consumed by humans. Chemical pollutants can therefore cause non-communicable and non-infectious diseases through the food chain (Hogan, C.M, 2010). Unfortunately, chemical pollution has been found to occur in the Fosu Lagoon (Essumang et al, 2006). These chemicals include heavy metals such as lead and cadmium.

2.2 Heavy metal pollution of the Fosu lagoon

Globally millions of tons of pollutants including heavy metals are produced annually. These substances are dumped into the environment without the thought of causing danger to the environment. The devastating effects of these toxic effluents, water pollutants and piles of solid and hazardous waste on the environment has become of great concern to both advanced and developing nations (Cunningham & Saigo, 1997).

Heavy metals as integral part of solid and hazardous waste are non-degradable and non-destructive chemicals that are lethal to biotic entities. They may find their way into humans through plants via animals during the food chain processes. Heavy metals are toxic to plants, animals and humans. In humans they may case several non-communicable and non-infectious diseases. When they enter the body their effects could be immediate or long term depending on the type of metal and the quantity absorbed (Hart, 2008; Akwansah-Gilbert, 2007; Cunningham & Saigo, 1997)

The toxicity of heavy metals to plants, animals and humans depends on the internal bio-chemical relations that occur within their bodies and body cells. Within living organisms some heavy metal in small quantities, though, have the potential of alleviating deficiency disorders and therefore useful to humans. However others, though average in quantity may exhibit negative consequences when ingested. Their ability to context for sites of metabolites renders them capable of knocking down healthy cells (Anukwah, 2007). Toxic heavy metals including Cadmium (Cd), lead (Pb), Antimony (Sb), Mercury (Hg), Arsenic (As), Titanium (Ti) and Uranium (U), among others can cause several medical conditions to humans (Bellinger, 2008; Anukwah, 2007; Kido, Nogawa, Honda, Tsuritani, Ishizaki & Yamada, 1990)

When close to water bodies, heavy metals are made assessable to zoological species through plants via their roots, leaves, fruits and seeds. Their accumulation in these organs makes them exposable to zoological organisms such as fishes. Thus through the consumption of aquatic animals, heavy metals are transmitted to humans (Baffour-Awuah, 2015; Anukwah, 2007; Hangi, 1996). It is through this process by which accumulation of small quantities of these metals through fundamental ingestion by humans could result in lethal environmental diseases (Hangi, 1996).

The presence of heavy metals in the Fosu lagoon, both trace and non-trace, have been documented by many researchers. Mercury and copper have been found in the lagoon as early as 1986 (Hagan, 1986). Copper concentrations of between 90ppm and 102ppm in lagoon water were reported. Tay (1989) also documented mercury concentrations in lagoon algae between 0.04ppm and 1.12 ppm. According to Adjei (1991) copper presence in the lagoon stands at 48.5ppm and 106.85ppm; lead concentrations ranging from 0.04ppm to 1.12ppm.

Between the period of 1993 and 2013, several studies in relation to the Fosu lagoon showed the presence of heavy metals in lagoon water, sediments and fish muscle (Baffour-Awuah, 2014_b). For instance, the findings of Akwansah-Gilbert (2007) showed 0.78 – 33mg/kg concentration of cadmium in lagoon water. Not only was cadmium detected. Nickel, zinc, manganese and iron concentrations were also measured at 0.31-0.14mg/kg, 0.24-2.6mg/kg and 0.36mg/kg respectively, concluding that the average cadmium concentration in the lagoon was above the 0.7mg/kg limit of the cadmium interim marine/estuarine sediment guidelines for the protection of aquatic lives, though values of the other metals were not beyond thresholds.

A study by Armah, Luginaah, Kuitunen & Mkandawire (2012) on the "Ecological health status of the Fosu Lagoon, Southern Ghana II: Environmental and human health risk assessment" found Arsenic and manganese concentrations in the lagoon. The study concluded that this poses carcinogenic risk as a result of arsenic and manganese ingestion through sediments, plants and fish to humans and that there is considerable contamination of these metals in lagoon sediment confirming the findings of Akwansah-Gilbert (2007) and Avi (1998).

Working on the paper "Assessment of heavy metals pollution of sediments from Fosu Lagoon in Ghana" Bentum, Anang, Boadu, Koranteng-Addo & Owusu-Antwi (2010), measured the concentrations of copper, lead, zinc and iron in sediments of the lagoon. Summer average values obtained were in the range of 26.4$\pm$ 51.0, 28.1$\pm$101.0, 20.9$\pm$ 41.9 and 1.15 x 10^3 $\pm$2.02mg/kg respectively, with an increasing order of iron, lead, copper and zinc (Fe, Pb, Cu and Zu). Lead gave high to extremely high enrichment level while the concentrations of copper and zinc were found to be significant. Iron enrichment was however minimal.

Akoto, Eshun, Darko & Adjei (2014) on the other hand did an extensive work on several heavy metals present in fish muscles of sarotherodon melanotheron from the Fosu lagoon on the title 'Concentrations and health risk assessment of heavy metals in fish from the Fosu Lagoon'. The results of the study showed that concentrations of heavy metals such as Cu (0.10-0.35mg/kg); Zn (18.25-23.15mg/kg); Ni (0.032-0.550mg/kg); Fe (5.50-18.18mg/kg); and Mn (20.95-32.30)mg/kg have mean concentrations below the EU and FAO maximum tolerance levels (EU, 2006; FAO, 1983). However all fish samples in the lagoon contained lead of concentrations ranging between 4.32 and 10.85mg/kg with mean value 6.28$\pm$ 2.28mg/kg, exceeding the EU maximum tolerable limit (MTL) of 0.3mg/kg in fish meat (EU 2006). Concentrations of cadmium (Cd) were also between 0.17 and 0.32mg/kg with a mean of 0.28$\pm$0.47mg/kg; exceeded the limit (0.02mg/kg) set by the EU. The study also revealed that about 87% of fish samples in the study contained cadmium. Thus according to the study both lead and cadmium concentrations in lagoon fish muscle could pose potential health risk to tilapia consumers. A study conducted by Baffour-Awuah (2014_c) also shows that the presence of lead and cadmium in tilapia in the lagoon could have negative physical medical implications on lagoon fishermen.

2.3 Health implications of long-term lead and cadmium ingestion

When ingested into the body, lead accumulates in bones in the form of lead phosphate in cells, tissues and organs, though it does not yield any physiological benefits. It rather acts as a catalyst in enzymatic reactions instead of zinc and iron by displacing them in their supposed roles in the body (ATSOR, 2011; Kosnett, 2006). Less than 5.5 percent of lead ingested in the body is able to leave the body in the long term through perspiration, defecation and other related body processes. The rest that remains could lead to male and female infertility.

Lead presence may also affect the cognitive abilities of children. Lead presence may have negative implications on peripheral and central nervous system and weakness of the exterior muscle of the wrist (wrist drop) that occur after several weeks of exposure. Bluish line formation along the gum of lead ingested persons (Burton line) may be observed for long-term consumers of lead-ingested fish (Kumar, Abass & Aster, 2013, Bellinger, 2008; Patrick, 2006; Williams, Berger & Elston, 2005; Landrigan, Schachter, Lipton, Fahs & Schwartz, 2002). One way by which lead enters the body is through the food chain where the metal is transmitted via plants, animals such as fish and finally into humans.

Cadmium may also enter humans through the food chain (Bernard & Lauwery, 1997). In the short term, cadmium ingestion may cause persistent vomiting, salivation, chocking attacks, and abdominal pains, loss of consciousness and spasm of the anal sphincter (Bernard & Lauwerys, 1986). A large proportion of cadmium is permanently stored in the body after ingestion causing painful bones and wrist drop (DeCort, 2000; Lenntech, 2008). Cadmium presence can have direct effect on vitamin and calcium metabolism. This may result in softening of bones causing bending and painful bone structure (Kido, Nogawa, Honda, Tsuritani, Isahiziaki & Yamada 1990).

3.0 Research methodology

The aim of the study was to ascertain the perception of patrons of saratherodon melanotheron (blackchin tilapia) on the implications of their health as a result of lead and cadmium ingestion through consumption of the fish. Perception on lagoon pollution was also ascertained. The Cape Coast metropolis was targeted using the purposive sampling technique to select the sample. Fifty-five tilapia patrons were involved in the study. Both qualitative and quantitative methods were employed in the study. Both questionnaire and interview schedule was used. Open and closed ended questions were posed to solicit the required information. The descriptive method of analysis using frequencies, percentages, and tables were employed in analysing the data. The Statistical Package for the Social Sciences (SPSS) version 21software program was used. Health conditions included in the study were infertility, cancer, wrist drop, painful bones, Burton line and cognitive deficient children. For those who could not read the questions an interview schedule was rather employed. A pilot study conducted was specifically aimed at identifying individuals who consume tilapia caught from the lagoon. The sample was taken from those who throng to the lagoon to buy tilapia for domestic consumption.

4.0 Results and discussion

This section deals with the demographics of respondents such as gender, age, educational attainment, suburb of residence and number of children. It also presents the results of the data analysis as well as the discussion.

4.1 Demographic data

About 47 percent male and 52.7 percent female were involved in the study; with age ranging between 21 and 78. Participants had stayed in the metropolis between 4 and 68 years. Twenty one percent of the respondents had stayed in the metropolis between 21 and 30 years; 22.6 percent for 31-40 years; 32.0 percent for 41-50 years; 7.4 percent for 51-60 years; and 17 percent for more than 60 years. Majority of the respondents comprising 34.4 percent had stayed in the metropolis between 25 and 40 years.

In terms of highest educational attainment, 29.1 percent had no formal education; 50.9 percent had basic education; 14.5 percent had Senior Secondary School/Senior High School/Commercial/Vocational/Technical education; and 5.5 percent with tertiary education. Places of abode of respondents, Pedu, Abora, Anaafo, Kotokuraba, Bakaano, Nkontrodo, Ntotoo, and Siwdo were made up of 5.5; 5.4; 5.5, 3.6; 3.6; 5.5, 1.8 and 69.1 percent respectively. About 80 percent of the respondents were indigenes of the metropolis. The number of children of the respondents ranged between 3 and 10 with the mode being 6, comprising 25.5 percent of the participants.

4.2 Lagoon pollution

Participants were asked about the degree of pollution of the lagoon. Majority of the respondents (49.1 percent) disagreed that the Fosu lagoon is polluted with heavy metal while 10.9 percent strongly disagreed. Conversely, 29.1 percent agreed while 10.9 strongly disagreed. For those who agreed or strongly agreed various reasons were given. This includes runoff and drains that flows directly from the Siwdo workshops and garages into the lagoon. About 63.0 percent of the respondents supported this reasoning. Thirty -two percent attributed the pollution of the lagoon with waste materials metals to the drains that exude from the Ola Metropolitan Hospital into the lagoon. The remaining 5.5 percent directed the cause to drains that find their way into the lagoon from suburbs such as Ola, Bakaano and other parts of Cape Coast.

Though an average 65.4 percent of the participants had heard that the lagoon was polluted, 40.7 percent of this figure did not believe that it was polluted. They were of the view that they had been consuming tilapia for a long time, since they were children but had no diseases relating to that. Some were also of the view that they would have been dead by now if the lagoon were polluted with heavy metals. A small percentage thought that fishermen who fish from the lagoon do not complain of metals in the lagoon. Some were of the opinion that the fish in the lagoon do not show signs of unhealthiness. Whether an unhealthy fish could be identified as such, is an issue to be contended with. This could thus be attributed to low level of educational attainment, illiteracy and ignorance (Baffour-Awuah, 2014_c).

4.3 Lagoon pollution awareness

Between 61.9 percent and 68 percent of the participants had at one time or the other heard of lagoon/tilapia pollution through radio communication; 24 percent through friends; and 8 percent through family members. For the first time of hearing, 60.9 percent had rather heard of it through the radio, 26.1 percent through friends and 13.0 percent through family members. On the other hand 70.6 percent and 14.7 percent each had heard of it the last time through radio as well as friends and family members respectively. Sadly, the last time respondents heard of the pollution of the lagoon/tilapia was over six months ago (10.9 percent), over a year ago (49.1 percent) and over two years ago (40 percent). Unfortunately, 84.6 percent of those who were in the known of the pollution of the lagoon/tilapia had neither done anything about it to reduce it nor curtail the problem. The remaining have been either trying to embark on good sanitation practices; persuading friends, relations, peers or students to do same.

Those who strongly disagreed that eating tilapia from the lagoon could result in environmental diseases were more than twice those who disagreed. Also those who either agreed or strongly agreed were approximately equal to those who were undecided. The ratio of those who generally agreed were uncertain, disagreed and strongly disagreed is 1:2:5.5

In comparison with the findings of Baffour-Awuah (2014_c), 86.7 percent of lagoon fishermen are of the view that the Fosu lagoon is not polluted with heavy metals. This proportion is about twice the figure obtained in this study. The opinion of Baffour-Awuah (2014_c) that the perception of the fishermen could be influenced by economic and financial gains therefore appears to be supported by this finding. None of the respondents in this study was a fisherman.

The study, attributing the major causes of the lagoon pollution to runoff and drainage from the Siwdo workshops and garages and suburbs in the metropolis, also supports the findings of Baffour-Awuah (2014_c). The fishermen also share the same view, though 73.3 percent attributed pollution of the lagoon to the workshops and garages. Since they work directly in the lagoon and are always confronted with the activities that go on in the workshops and garages, the effect could be seen and felt at the same time and more by the fishermen. Physical pollutants from the workshops and garages could be encountered by the fishermen more often that the general pubic. This source of pollution according to this study also corroborates the findings of Baffour-Awuah (2014_c), Akwansah-Gilbert (2007), Mensah (1997), Kendie (1997), Abekah (1993) and Biney (1982).

Findings of Baffour-Awuah (2014_c) indicated that over 90 percent of Fosu lagoon fishermen consume an average of 43.52g of tilapia per meal and over 289g per week is not comparable to that consumed by the general public. For example, about 80 percent of the public consume an average of 39.08g/meal and 175.86g per week of 4 or 5 days; unlike the fishermen who consume tilapia everyday. The consumption rate of the fishermen is therefore higher than that of the public, justifying the reasoning of the fishermen that they cant catch fish and consume something else (Baffour-Awuah, 2014_a). It may be relatively cheaper to patronise what they produce themselves than from somewhere else. According to the respondents of the current study, the reasons for patronizing tilapia from the lagoon include a particular taste to the palate, relatively cheaper than fish from the sea and assessible in terms of proximity.

Ninety percent of Fosu lagoon fishermen had low perception on cancer infection in relation to tilapia consumption. Seventy three percent, 70 percent, 66.7 percent, 76.7 percent also had low perception in terms of painful bones, Burton line condition, wrist drop and cognitive deficiency among children respectively (Baffour-Awuah 2014_a). Thus comparably consumers of tilapia from the Fosu lagoon also have low perception on health risk pertaining to the tilapia they consume. Like the fishermen, cost is one of the reasons for patronising the fish. According to Darkwa and Smardon (2010) cultural experience, lack of knowledge and cognition could be some of the reasons for these perceptions. Widespread visual absence of these ailments could also contribute to these perceptions. High fertility among respondents could also aid this perception (Baffour-Awuah, 2014_a); the modal fertility rate being about 6.

Findings of the study is comparable with 70 percent perception of respondents (the public) who would be unhappy should tilapia consumption be banned attributing reasons to unemployment, street children and disobedience of children towards parents as a result of parents' inability to take care of them. About 23 percent of the fishermen in the study were indifferent (Baffour-Awuah, 2015) in this regard.

4.4 Tilapia consumption

Majority of the respondents (53.4 percent) enjoy tilapia in their meals, 4 or 5 times in a week (table 1). Three percent each for once, twice and thrice per week; 8.3 percent also consume the fish once in two weeks; and 13.4 percent, once in a month. Over 80 percents consume over 7 fingers of fish per meal (table 2).

Table 1: Frequency of tilapia consumption per week

Period	Frequency	Percent
Once a week	5	8.3
Twice a week	5	8.3
Thrice a week	5	8.3
Four times a week	14	28.4
Five times a week	13	25.0
Once in two weeks	5	8.3
Once in a month	8	13.4
Total	55	100.0

(Source: field data, 2014)

Table 2: Tilapia fingerlings consumed per week

Period (Years)	Frequency	Percent
< - 4	2	3.6
5 – 6	7	12.7
> - 7	46	83.6
Total	55	100.0

(Source: field data, 2014)

From the findings of the study, about 80 percent of the respondents consume between 13.65-65.51g per meal and an average of 39.08g per meal amounting to an average of 175.8g per week (i.e. 4-5days per week). This consumption rate is lower than that of Fosu Lagoon fishermen with 90 percent consuming 290g per week (Baffour-Awuah, 2014_c); and Barnet Bay fishermen with 80 percent average of 280g per week (Burger, Sanchez & Gochfield, 1998). Reasons given to consumption of the fish include taste, accessibility and relative inexpensiveness. Though this quantity is lower to relatively affect the health of consumers in the long term, the severity of risk to human health should be of concern. This is because participants have been consuming tilapia from the lagoon for a long time. For example, 83.6 percent of respondents have enjoyed tilapia from the lagoon for over 20 years; 5.5 percent for between 10 and 19 years and 9.1 percent for less than 10 years. Meanwhile as much as 79.4 percent claim of not being aware that eating tilapia from the lagoon poses health risk. They claim to be healthy and strong and that tilapia in the lagoon is good for consumption.

4.5 Health risk of specific diseases

Table 3 shows the distribution in terms of respondents' perception on health risks of tilapia consumption. Seventy-nine percent did not agree that eating tilapia from the lagoon could cause cancer. Similarity, majority (67.3 percent) disagreed that consuming tilapia from the lagoon could cause painful bones; and that eating consumption could be a cause.

Table 3: Perception on health implications

Diseases	SA	A	U	D	SD
Cancer	0	23.6	5.5	40.0	30.9
Painful bones	0	27.3	5.5	25.5	41.8
Burton line	0	5.5	23.6	43.6	27.3
Infertility	5.5	12.5	7.3	32.7	41.8
Cognitive deficiency	1.8	9.1	5.5	36.4	47.3
Wrist drop	0	18.2	9.1	43.6	29.1
Total	7.3	96.2	109	221.8	594.4

(Source: field data, 2014)

In the same vein, 72.7 percent disagreed that tilapia consumption could give rise to wrist drop effect. With respect to giving rise to cognitive deficient children, 81.7 percent disagreed to tilapia consumption as a cause. About 74.5 percent also disagreed that tilapia consumption can cause infertility in both men and women (table), with 18.0 percent agreeing while 70.9 percent disagreed that consuming tilapia from the lagoon could give rise to Burton line effect. Thus generally there is low risk perception among the public in terms of risk perception emanating from consumption of tilapia from the lagoon.

Reasons to low perceptions about health risks caused by polluted tilapia from the lagoon were basically homogeneous across the several diseases that could result from consumption of the fish; that consumers are healthy having consumed the fish from the lagoon for a long period. Interestingly when asked if certain that it could give rise to long term diseases such as mentioned above, 80 percent consented. They explained that they would not consume tilapia from the lagoon if such act would lead to death. According to the heath belief theory an individual is likely to react to a health-related action when the person has the feeling that a negative health risk does exist. Agreeably, this finding is therefore in line with the health belief theory (Rosenstock, 1974).

Ironically, majority of the respondents (65.5 percent) would be either very unhappy or unhappy if tilapia consumption in the lagoon is banned. They were of the view that this will deprive people from their jobs particularly fishermen and fishmongers who throng to the lagoon to transact business. Those who send prepared food (vendors) to the lagoon side will also loose their job. Thus the source of income of this section of the populace will be curtailed. About 35 percent were indifferent as to whether tilapia fishing is banned or not. These people may be those who do not have relations involved in the tilapia business. The communal and humane characteristics of African culture make it obligatory to take care of relations who are unable to do so. Thus when people lose their jobs their responsibility automatically resides on their family relations.

5.0 Conclusion and recommendations

The study looked at the rate of consumption of tilapia from the Fosu lagoon among the public. It also ascertained the factors that contribute to tilapia consumption in spite of pollution of the lagoon and its content. It also solicited the opinion of consumers in terms of health risk from tilapia consumption.

The findings of the study revealed that majority of the respondents 60 percent either strongly disagreed or disagreed that the lagoon and its content are polluted with heavy metals such as lead and cadmium. Majority (62.5 percent) also attributed pollution of the lagoon to activities at the Siwdo lagoon and garages; the remaining to activities in the municipalities through runoffs and rains into the lagoon. About 65 percent had heard of the pollution of the lagoon and its content on one occasion or the other.

From the findings of the study, about 80 percent of the respondents consume between 13.65-65.51g per meal and an average of 39.08g per meal amounting to an average of 175.8g per week (i.e. 4-5days per week). Reasons given to consumption of the fish include taste, accessibility and relative inexpensiveness.

Generally, respondents have low risk perception on health implications of tilapia consumption. The ratio of perception was 1:5.5 for high and low respectively. The ratio of indecision to disagreement in terms of perception was 2:5.5. About 71 percent, 67.3 percent, 70.9, 74.5, 81.7 and 72.7 perceived that eating tilapia could not result in cancer, painful bones, Burton line, infertility, cognitive deficiency and wrist drop respectively. Though majority 65.5 percent would be either very unhappy or unhappy should tilapia consumption be banned, 80 percent were ready to stop eating tilapia from the lagoon if they knew it could give rise to environmental diseases.

The study therefore recommends that serious education on the health implications of tilapia consumption from the lagoon be intensified. It appears authorities have not been propagating the message of lagoon/tilapia pollutants to public of late. About 90 percent of the respondents have not heard of such publicity since the last one or two years. Only 10.9 percent had heard of such educational message since the last six months. Since most of them (68 percent) have heard of such information through the radio, it is recommended that educators should concentrate on radio as the medium of educational communications (Baffour-Awuah, 2015). The pubic must also be informed on measures that individuals and households could take to alleviate pollution of the lagoon. There should be a strategic plan to effect educational programs to deal with the pollution issue of the lagoon. In the opinion of Baffour- Awuah (2014$_a$), using local language could be one of the surest ways of effectively communicating the strategy to the public in this regard.

Stakeholders such as the Metropolitan Assembly, Non-Governmental Organisations such as Greenstar Foundation, Cape Coast Polytechnic, the University of Cape Coast, Environmental Protection Agency (EPA) (Ghana), academicians, and the Oguaa Traditional Council should get involved in saving the lagoon. The study finally recommends that future studies on health implications of tilapia consumption should dwell on the presence of lead and cadmium in bone, hair and blood of consumers (Baffour-Awuah, 2015).

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