Research Article

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HEALTH RISK ASSESSMENT OF NITRATE AND NITRITE VIA CONSUMPTION OF SELECTED CANNED FOOD SOURCE

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ABSTRACT

This study aimed at assessing the levels of nitrate and nitrite in some canned food source sold in Nigeria market and hence, reports its health risk implications. To achieve this, five batches of two brands of canned Fish (T and FS), Tomato paste (TO), Corned beef (M) and Baked beans (BB) were bought from different locations in Zaria market, Nigeria. The samples were then treated and analysed according to standard methods for nitrate and nitrite. The results showed the trend for nitrate concentration (µg/g), T > M > TO > FS > BB, for nitrite the trend was FS > TO > BB > T > M. The daily intake rate (µg per^{-1} day^{-1}) for nitrate in adults was M > TO > T > BB > FS and that of nitrite was TO > BB > FS > M > T. The study also considered the Health Risk Index in the abstract for nitrate in adults shows M > TO > BB > TO > FS, while Health Risk Index for nitrite in the same group shows TO > FS > BB > M > T. The HRI was conducted for children it shows that for nitrate M > TO > BB > T > FS and for nitrite the Health Risk Index was TO > FS > BB > M > T. The Target Hazard Quotient (THQ) showed that nitrite is slightly more hazardous than nitrate in adults. The results concluded that the nitrate and nitrite content of canned foods sold in Zaria were high but risk assessment showed it was not significantly high to cause serious health concern.

Keywords: Canned foods, nitrate, nitrite and risk

INTRODUCTION

In recent attempt to explain the reasons for some of the health problems persisting in our societies today; scientists all over the world are exploring the various foods and their compositions and subsequently relate it to health problem through toxicological interpretations. Canning is one of the best methods of preservation with little addition and preserving both flavor and taste[1]. There are various food products that are preserved by canning in our markets today such as tomatoes, fish, beans, meat, vegetables and lots more.

Vegetables are one of the major sources of foods and supplying a range of dietary requirements such as minerals, fiber, protein, vitamins and nitrate among others. Nitrate and nitrite are commonly found in various canned foods and the concentration is always varying. This is because the availability of nitrate and nitrite in vegetables are affected by many factors such as soil properties, water source, plant maturity, time of harvest and so on[2]. Nitrates and Nitrites are important in human toxicology simply because in the environment it can form nitrogenous compounds by microorganisms present in the soil, water, saliva and even in the gastro intestinal tract. Although Nitrate poses low toxicity, its conversion to Nitrite causes higher toxicity and thought to be responsible for several adverse health effects like methaemoglobinemia and blue eye syndrome in infants[3,4,5]. It has also been shown that nitrite administration causes oxidative stress in rats[6]. The excess nitrate and nitrite is removed from the body system through waste, hence does not allow accumulation in the body.

Nitrate itself is relatively non-toxic but its metabolites may produce a number of health effects. Until recently nitrate was perceived as a purely harmful dietary component which causes infantile methaemoglobinaemia, carcinogenesis and possibly even teratogenesis. Fan and Steinberg[5] (1996), reported nitrate and nitrite in drinking water and relate it to methaemoglobinemia occurrence and reproductive and developmental toxicity, while Gatseva *et al*[7]., (1984), studied the incidence of goiter among children in a village with nitrate contamination of drinking water.

Nitrate is formed from fertilizers and decaying organic matter. It is also available in the air, soil, water and food and is produced naturally within the human body. It is also used as a preservative and antimicrobial agent in foods such as cheese and cheese products, raw and processed meats, edible casings, processed fish, fish products, spirits and liqueurs. Nitrite and *N*-nitroso compounds are toxic and can lead to severe pathologies in humans. The best-known effect of nitrite is its ability to react with haemoglobin (oxyHb) to form methaemoglobin (metHb). This potentially fatal condition is known as methaemoglobinaemia, or blue baby syndrome[4]. Ward *et al*[8]. (2005) reported an intake of high level of Nitrite with drinking water has also been associated with cancer and adverse reproductive outcomes such as spontaneous abortion and premature births.

Nitrate and Nitrite intake requirement is affected by age and sex thereby requiring for a separate acceptable daily

intake value for various ages and sex groups. There is an increased interest in determination of effects of nitrate and nitrite levels in food and food products due to the fact that vegetables and canned foods are major foods in urban populations like Zaria.

The aim of this work was to quantify the nitrate and nitrite that could possibly be deposited in the body via consumption of selected canned foods sold in Zaria. The work estimated the intake of nitrate and nitrite and measure the risk associated with such intake to adults and children and recommend for further work on national database on acceptable dietary intake in the country.

MATERIALS AND METHOD

Five brands of canned foods were purchased from Samaru market in Zaria-Kaduna state in September, 2010. These include two brands of canned Fish, Tomato paste, Corned beef and Bake beans and were coded T and FS, TO, M and BB respectively. Three samples were collected from each batch of a brand and the batch samples were homogenized together to form a representative sample for that brand. All samples were prepared in triplicates and reagents used were analytical grades. The samples were prepared by using a slightly modified method[9, 10] in which 10g each of the sample were homogenized by blending after adding 70ml of distilled water and 12ml of freshly prepared 2% NaOH solution. The slurry was transferred into 250ml volumetric flasks to check the pH using pH meter (Hanna pH 210, Microprocessor pH Meter) and the sample was heated in a water bath at 50^0C for 10min. A freshly prepared 10ml of $ZnSO_4$ solution was added to the mixture before cooling in an ice bath. Finally, the mixture was filtered through Whatmann filter paper number 41 into sample bottles. Nitrate and Nitrite contents were determined using spectrophotometer (HACH DR/2400) at the National Research Institute for Chemical Technology, Zaria.

Statistical Analysis

The results were presented in bar charts obtained from the average values of triplicate analysis of each sample. However, health risk assessment was conducted using daily intake rate as calculated by Okunola *et al* 2011[11], Health Risk Index as defined by Cui *et a1* 2004[12] for adults and children, while the Target Hazard Quotient as defined by Sajjad *et al* 2009[13] was also calculated.

RESULTS AND DISCUSSION

The mean nitrate and nitrite content (µg/g) of the canned foods sold in Zaria was presented in Figure 1 showing the presence of the nitrate above unity in all the samples. The lowest was BB (111.43) and the highest was M (204.10), while nitrite was highest in FS (131.30) and the lowest was M (82.20). Figure 2 presents the daily intake rate (µg per^{-1} day^{-1}) for average body weight of 65 Kg, the highest nitrate content was in M (0.682) and the lowest was FS (0.2997) and for the nitrite content the highest was TO (0.3237) and the lowest was T (0.1675). The daily intake rate (µg per^{-1} day^{-1}) for average body weight of 10 Kg was presented in Figure 3. The highest nitrate content was in sample M (4.0820) while the lowest was FS (1.9484) and that of nitrite was highest in sample TO (2.1042) and was lowest in M (1.0889).

The Health Risk Index (HRI) for an average body weight of 65 Kg was presented in Figure 4 showing the highest nitrate in M (0.3925) and the lowest was in FS (0.1873), while the nitrite for that body weight was highest in TO (3.2372) and lowest in T (1.6750). The same information was used and calculated for children of 10 Kg body weight and presented in Figure 5 the highest nitrate was in sample M (2.55) while the lowest was in FS (1.21). The HRI for nitrite was highest in FS (20.3515) and the lowest was T (10.8875). Finally, Target Hazard Quotients associated to the consumption of the products were calculated for 65 Kg body weight and presented in Figure 6.

The result revealed the predominance of Nitrate in all the samples except in fish and source sample. This is because fish normally contained higher nitrite than nitrate. Hence, the trend for nitrate in the samples were T > M > TO > FS > BB. This result does not agree with most of the results from the other literature compared with since much nitrite is expected in meat and fish than nitrate, however samples BB and TO have corresponded to the literature. All the results were greater than those reported by Okafor and Nwogbo[13] (2005), which ranged between 2.29-16.50 (mg/l) for nitrate and 5.50-12.03 (mg/l) for nitrite in eight brands of fruit juices marketed in Nigeria. The same author reported a range of 0.64-7.56 for nitrate and 0.12-4.42 for nitrite in twelve brands of sachet water.

The nitrite contents of samples BB and TO, were lower as expected since those samples were vegetables and sample FS had highest nitrite content as expected of fish and meat samples. The nitrite concentration followed a trend of FS > TO > BB > T > M. The result, however, was far different from what was expected for T and M samples. This is because the availability of nitrate and nitrite in vegetables are affected by many factors such as soil properties, water source, plant maturity, time of harvest and so on[2] used in preparing the sauce, age of the consumer[14] and body weight[3]. Hence, there is the need to identify the contributions of all factors in determination of daily intake rate for nitrate and nitrite which this study did not consider, but determined the daily intake rate as a function of the contribution of the samples only. All nitrate concentrations were greater than 100 µg/g, while all nitrite concentrations were greater than 50 µg/g.

The Daily Intake Rate (µg per^{-1} day^{-1}) of an adult of average body weight of 65 Kg was calculated for the sample and presented by Fig 2.0. The trend of DIR for nitrate in adults was found to be M > TO > T > BB > FS, while that of nitrite was TO > BB > FS > M > T. It shows that a lower percent of the total concentrations of both nitrate and nitrite of the samples actually go into the body. The concentration and intake are related as reported by

Sajjad *et.*al 2009[13]. The overall intake for this body weight for all the samples were less than 1 µg per^{-1} day^{-1}.

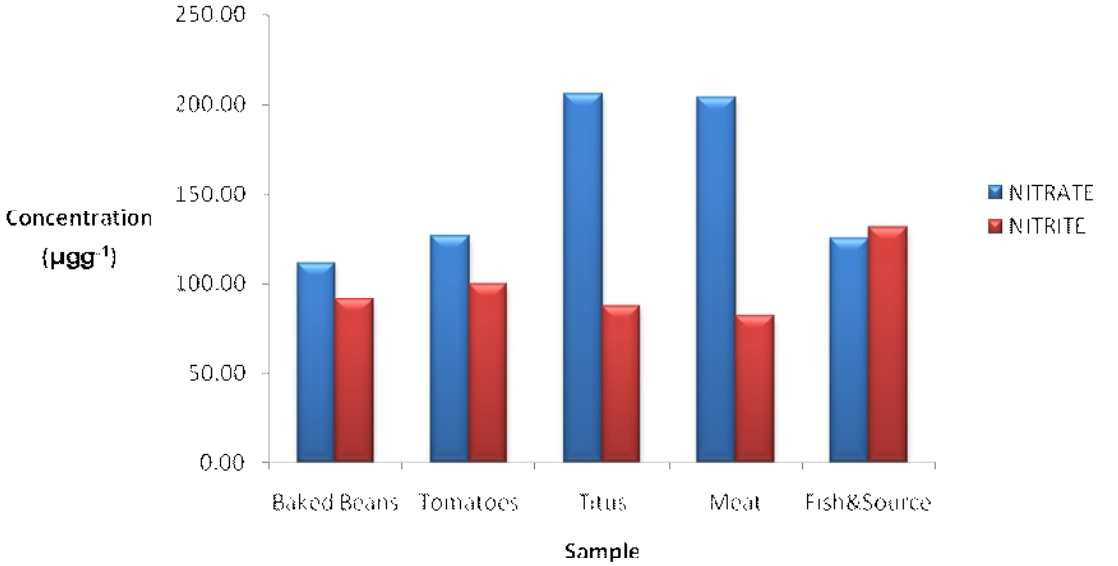

Figure 1: The Concentration in µgg^{-1} of Nitrate and Nitrite in the Samples

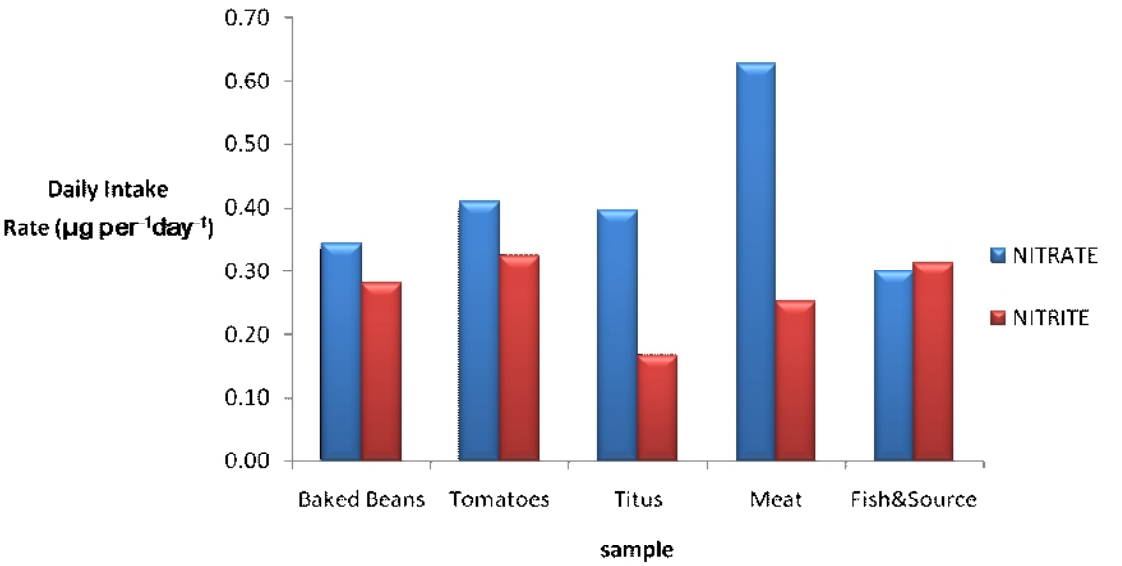

Figure 2: The Daily Intake Rate (µg per^{-1} day^{-1}) of Nitrate and Nitrite in the samples based on 65 Kg Average Body Weight for Adults

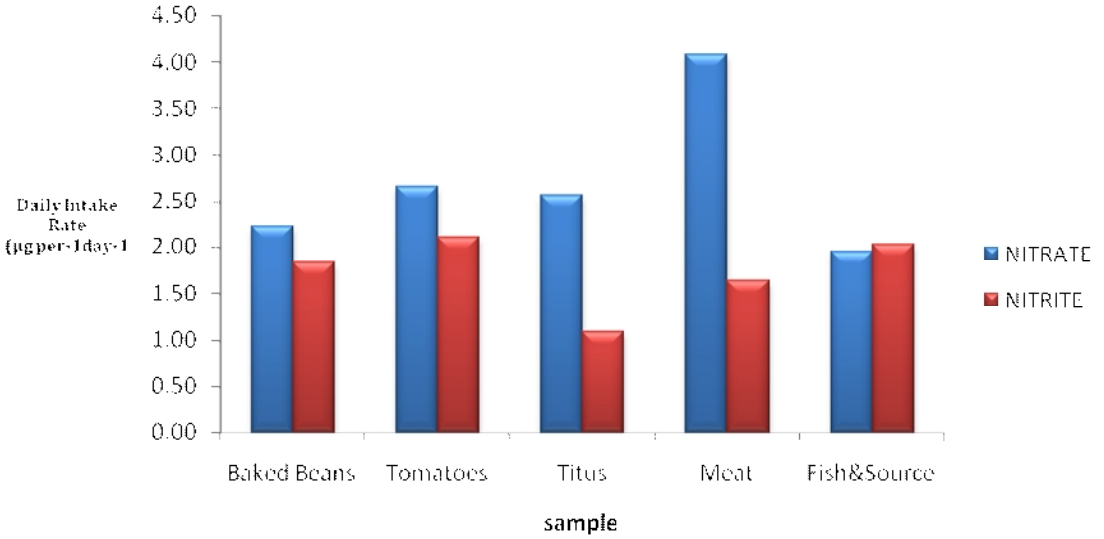

Figure 3: The Daily Intake Rate (µg per^{-1} day^{-1}) of Nitrate and Nitrite in the samples based on 10 Kg Average Body weight for Children

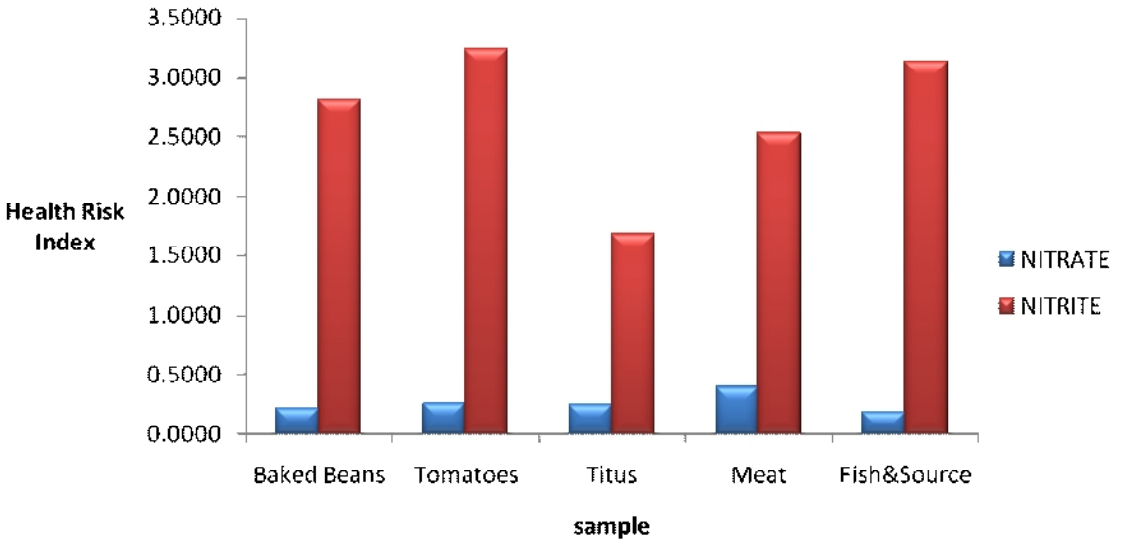

Figure 4: Health Risk Index of Nitrate and Nitrite based on 65Kg Average Body Weight for Adults

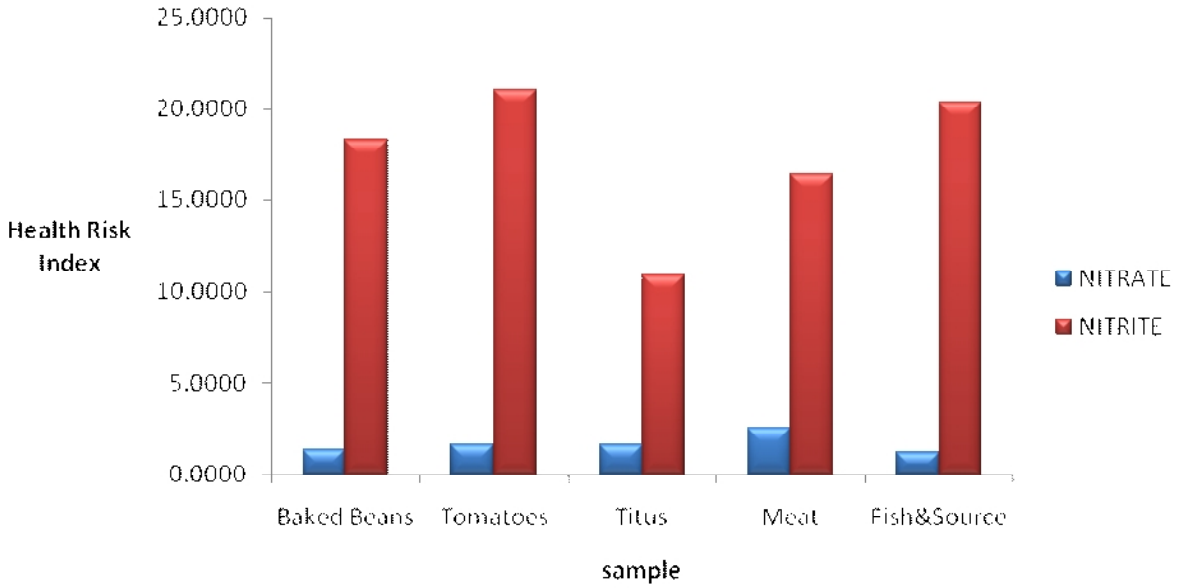

Figure 5: Health Risk Index of Nitrate and Nitrite based on 10 Kg Average Body Weight for children

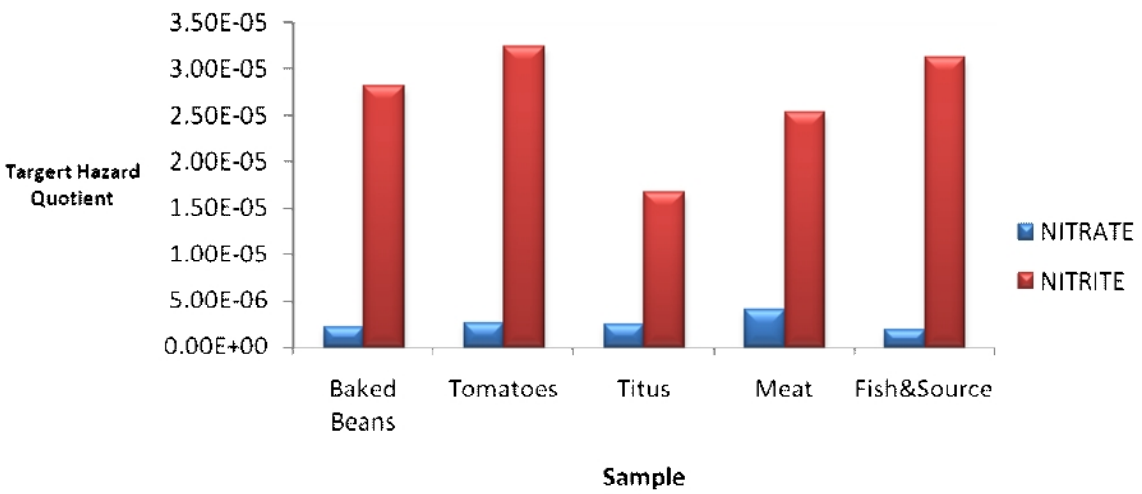

Figure 6: Target Hazard Quotient of Nitrate and Nitrite in the samples

Figure 3 presents the nitrate daily intake rate (µg per^{-1} day^{-1}) for children which was M > TO > T > BB > FS while that of nitrite was found to be TO > FS > BB > M > T with the maximum about 4.08ug/g and minimum of 1.94µg/g which were 2.10µg/g and 1.08µg/g for maximum and minimum values respectively for children of 10 Kg body weight. This showed a higher intake rate at this body weight compared to adults of body weight 65 Kg with maximum and minimum values of nitrate intake of 0.60µg/g and 0.20µg/g respectively, while that of maximum and minimum values of nitrite intake were 0.32µg/g and 0.10µg/g. This high intake could be attributed to low body immunity and premature body systems in children. These and other factors make children prone to health risk resulting in various manifestations. Health risk assessment is therefore, important in preparing precautionary measures by governments and agencies.

The health risk index for 65 Kg body weight was presented in the Figure 4. The HRI as a function of reference oral dose for nitrate and nitrite shows that the body system is more tolerable to nitrate than nitrite. The trend for nitrate HRI in adults was M > TO > BB > T > FS and the nitrite follows TO > FS > BB > M > T. If the information above is to measure the risk, it could be deduced that nitrite is almost ten times greater in terms of nitrate. The effect of nitrite in the body weight of 65 Kg was between 1.50 for minimum value and 3.30 for maximum value as against nitrate values which were all less than 0.5. Certain canned foods were consumed in uncooked and cooked states. For these foods, cooking

cause a drop in their nitrate and nitrite contents, these reductions reach approximately 60% in certain food[9].

Figure 5 represents the HRI for children of average body weight of 10 Kg. The trend for nitrate was found to be M > TO > BB > T > FS and the nitrite follows the trend TO > FS > BB > M >T. This chart showed that nitrite was even greater in children due to reasons stated earlier. The most interesting point to note in this chart is the fact that; the highest HRI value for adults was 3.2 (Fig. 4), while the lowest HRI value for children was above 10.0 and the highest value was about 20.0. This has clearly defined the extent of risk of children to nitrite that could result into so many diseases as stated earlier. It also showed that nitrate in both body weights were very low, hence, it poses little or no risk to both groups.

Another important risk assessment index is the Target Hazard Quotient (THQ) as defined by Okunola *et al*[11]. (2011). The chart (Figure 6) presented the THQ for an average body weight of 65 Kg. Since the THQ is dependent on the life expectancy, it cannot be calculated for children. However, it shows from the study that, nitrate causes no hazard while nitrite showed a little hazard but could not be pronounced. However, the basis of this study was only considering the consumption of the content and not considering other determinant factors such as temperature, maturity and storage time. The THQ is therefore considered very low. This could be attributed to well developed digestive, excretory and immune systems by adults.

CONCLUSION

The nitrate and nitrite intake via canned foods consumption were estimated. The study indicated relatively high nitrite content when compared to nitrate. This could be true considering the samples studied. The Daily intakes of these compounds were high but health risk assessment showed higher risk for nitrite than nitrate. The study suggested that the study of nitrate and nitrite in canned foods should also be accompanied with vitamin C and beta carotene content which appears to be protective factors for cancer.

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Abbreviations
T & FS = Two different brands of fish
TO = Tomato paste
M = Corned beef
BB = Baked beans
HIR = Health Risk Index
THQ = Target Hazard Quotient

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