

## **A Study on the Concentration of Tartrazine in Plantain Chips Commonly Sold Within South-Eastern Nigeria**

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**Abstract:** *The concentration of tartrazine in a package of locally processed plantain chips (of about 2mm thickness and 150-200g) within the five South Eastern states of Nigeria was investigated. Twenty five plantain chips products from different manufacturers were purchased from IMO, ABIA, ANAMBRA, ENUGU, and EBONYI STATES. The plantain chips were subsequently subjected to spectrophotometric analysis to determine the concentration of tartrazine in them. The weights of several healthy individuals were collected using a standard weight balance. The individuals were subsequently grouped into different age groups and further categorized according to their sex in cases where wide differences were observed in their ages. The acceptable daily intake (ADI) of tartrazine as recommended by the FAO/WHO Experts was calculated for each age group and was used to match with the concentration obtained. The calculation was purely based on the average body weight of each group. The result showed that eight (32%) of the samples contained more than the ADI of tartrazine for all the groups used in this work and with average body weight range between 25kg and 105kg. The result further suggested that school age children and teenagers were most endangered to the abuse of the substance and therefore most likely to suffer from abuse of this substance.*

**Keywords:** *PLANTAIN CHIPS, CONCENTRATION, ADI, TARTRAZINE, ABUSE, EFFECT.*

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### **I. Introduction**

Knowledgeable dieticians consistently warn against “careless dieting” due to their health implications. The consumption of foods which are not completely natural must be limited as much as possible to stay healthy (Ogazi, 2010). Many natural food materials are characteristically associated with an attractive colour which, in part, may act as a guide to their quality and edibility. Unfortunately, this intrinsic colour is often destroyed totally or partially, during processing, particularly if heat is applied, so that the resulting food may have far from attractive colour. Although one of the main attributes of edible products is their flavor, the correct and anticipated colour also contributes significantly to their acceptance and appeal as flavour and colour perception are intimately linked. The use of colour creates appetizing appearance, enhance flavour appreciation, and correct objectionable colour change or natural variation and, serves as decorative purpose (FAO, 1997).

Tartrazine (E102) is a synthetic lemon azo dye used as a food colouring with chemical formula  $C_{16}H_9H_4Na_3O_9S_2$  and a molecular weight of  $534.3\text{g}\cdot\text{mol}^{-1}$ . Tartrazine falls within the group of additives that the FAO/WHO Experts Committee on food Additive classified as "LIST A (1)". This class of additive "is additive which have been fully evaluated and either given acceptable daily intake (ADI) or not limited toxicologically". Tartrazine consist essentially of 3-carboxy-5-hydroxy-1-sulfophenyl-4-p-sulfophenyl-lazopyrazole trisodium salt and is a commonly used all over the world, mainly for yellow colours of food but can also be used with brilliant blue and green (FAO, 1997). It is a water-soluble salt stable to heat and light. Many food products containing tartrazine in varying proportion (Frances, 2005). Food products containing tartrazine include, but not limited to, confectionaries (e.g. cake mixes), soft drinks (e.g. Mountain Dew), energy drinks (e.g. Lucozade) cereals (e.g. cornflakes), pastries (e.g. meat pie), noodles (e.g. Indomie), convenience foods (e.g. plantain chips), biscuits (e.g. wafers and creamed biscuits) (Atinmo, 1988). Tartrazine has an ADI of 0-7.5mg/kg body weight (Ogazi, 2007). If this limit is exceeded, it may result to fetal health effects such as DNA damage, lethal asthma attack and rashes, tumors, migraine, sleep disturbance, hyperactivities in children, heat waves, purple skin patches, itching, anxiety, general weakness and lots more (Ogazi, 2007). Investigation at the Federal Medical Centres in Nigeria speculates that the most predominant health effect of tartrazine now noticed in patients is the "gall bladder effect" (Atinmo, 1988).

Every average modern man/woman is busy, while the race for economic survival takes its toll on all people. As a result, people's eating habit is affected. Convenience foods seem to have a higher percentage of the kind of food most people find themselves eating almost every day (Atinmo, 1988). Plantain chips are one of such popular convenience foods. According to Onwuka (2003) the most important attribute affecting the appreciation of plantain chips is heavily altered by heat during frying. Manufacturers use water to blanch the freshly cut plantain pulp, and in order to improve the appearance (colour) of the final product tartrazine is added in the water (Eleazu, 2010). Unfortunately, the tartrazine is added without any scientific measurement by this

manufacturers suggesting that the ADI may be excessively abused at the detriment of the consumers. The objectives of this work therefore are:

1. To determine the concentration of tartrazine per package of some plantain chips sold within the five states in the South-East of Nigeria.
2. To compare the amount ingested per package of these chips with the FAO/WHO prescribed ADI for different age group and body weight.

## II. Materials And Methods

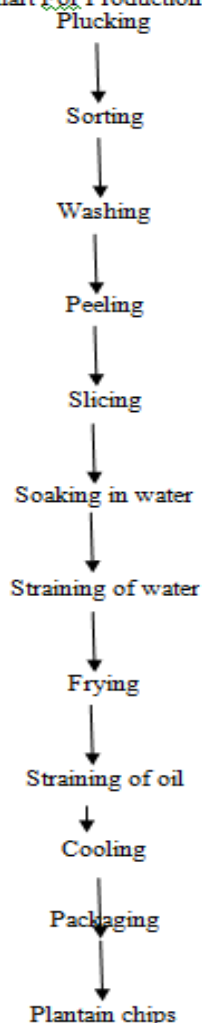
### Raw material procurement

Fresh unripe plantain fruits (*Musa Paradiaca*) used in preparing the plantain chips that was used as control for colour was purchased from “Eke Onunwa” market in Owerri Imo state. Samples of the other plantain chips were randomly purchased from different vendors in the five states in the south east of Nigeria.

### Production of Plantain Chips

The plantain chips were produced through the traditional as described by Ogazi, (2008) with a little modification. Fresh plantain fruits fingers were washed and peeled with a sharp knife. The peeled plantain fruits were sliced into thin slices using a manual slicer of about 2mm thickness. The resulting slices were soaked in water for 30 minutes. Water was strained from the thin slices with a stainless sieve. They were fried using the deep frying method. Oil was drained from the chips and kept to cool. The plantain chips were subsequently packaged. According to Godswill (2010), the packaging material (polythene) has a lot of effect on the shelf life of the chips. Part samples of the plantain chips produced and the ones purchased from different locations in South East were separately ground to flour with a manual grinding machine prior to analysis.

Figure 1: Flow Chart For Production Of Plantain Chips



Source: (Eleazu, 2010)

### III. Determination of Tartrazine Concentration

Method used was as described by Manisha et.al. (2012). A Shimazu 160A spectrometer was used for absorbance measurements. Ten packs (200g each) of plantain chips products from twenty five manufacturers were purchased from different stores within the five South East states. Tartrazine powder (from sigma chemical product) was made into aqueous solution by dissolving in water. Tartrazine stock solution had a concentration of 1000µg/ml<sup>-1</sup>. Standard solution of tartrazine for the fifth varied concentration (4.0-20.0µg/ml<sup>-1</sup>) were prepared with volumes 2, 4, 6, 8 and 10 ml of working solution and were each transferred into a 25ml volumetric flask and diluted to a volume of 25 ml with distilled water. Based on the dye contents, 5g of each sample was dissolved in distilled water and the solution was transferred into a 100 ml volumetric flask and diluted to a volume of 100ml with distilled water. The absorption spectra of the sample solutions were recorded between 350 and 750nm. First, the suitable derivative orders with appropriate wavelength, where all the samples could be analyzed in the presence of the other, were determined. Then by measuring the signal and appropriate calibration graph at the selected derivative order and wave length, the concentration was read. For quantifying the recovery in plantain samples, 10ml of sample solution was transferred into 25ml calibrated flasks, combined with deferent amounts of tartrazine and then diluted to a volume of 25 ml. The tartrazine contents were determined from the first and second derivative spectra by measuring the peak at their wave lengths, and total amount of colorant were calculated with the calibration graph. The recoveries were calculated by dividing the total dye amount found by the present amount (dye in sample/added).

#### Statistics Analysis

Each analytical determination was carried out in replicates. The mean and the standard error of the mean (SEM) of the triplicate analysis were calculated. Data were subjected to analysis of variance (ANOVA) to determine significant differences between the means, while the means were separated using Fisher's least significant difference (LSD)

### IV. Results And Discussion

Table 1: Tartrazine Concentration of Plantain Chips and Absorbance Levels

| Parameters |                                 |                     |
|------------|---------------------------------|---------------------|
| Samples    | Concentration (c) (mg/g sample) | Absorbance (L/mol)  |
| MZN        | 0.0915 <sup>d</sup>             | 0.087 <sup>a</sup>  |
| MYW        | 0.0985 <sup>d</sup>             | 0.094 <sup>a</sup>  |
| MXA        | 0.1050 <sup>d</sup>             | 0.0143 <sup>a</sup> |
| MXM        | 0.2020 <sup>c</sup>             | 0.0192 <sup>a</sup> |
| MUI        | 0.2435 <sup>c</sup>             | 0.0231 <sup>a</sup> |
| MTK        | 0.2955 <sup>c</sup>             | 0.0281 <sup>a</sup> |
| MSZ        | 0.3440 <sup>bc</sup>            | 0.0327 <sup>a</sup> |
| MRE        | 0.3870 <sup>b</sup>             | 0.0368 <sup>a</sup> |
| MQL        | 0.4455 <sup>b</sup>             | 0.0423 <sup>a</sup> |
| MPI        | 0.4780 <sup>b</sup>             | 0.0454 <sup>a</sup> |
| BET        | 0.1390 <sup>d</sup>             | 0.0132 <sup>a</sup> |
| DES        | 0.1730 <sup>d</sup>             | 0.0164 <sup>a</sup> |
| DOR        | 0.1745 <sup>cd</sup>            | 0.0166 <sup>a</sup> |
| EGO        | 0.2520 <sup>c</sup>             | 0.0238 <sup>a</sup> |
| ELE        | 0.2860 <sup>c</sup>             | 0.0272 <sup>a</sup> |
| DEC        | 0.4000 <sup>b</sup>             | 0.0380 <sup>a</sup> |
| BES        | 0.4120 <sup>b</sup>             | 0.0391 <sup>a</sup> |
| IKW        | 0.6055 <sup>a</sup>             | 0.0575 <sup>a</sup> |
| NWA        | 0.6800 <sup>a</sup>             | 0.0646 <sup>a</sup> |
| LIZ        | 0.3710 <sup>b</sup>             | 0.0352 <sup>a</sup> |
| CHI        | 0.1975 <sup>c</sup>             | 0.0188 <sup>a</sup> |
| ELE        | 0.1145 <sup>d</sup>             | 0.0109 <sup>a</sup> |
| MKG        | 0.2490 <sup>c</sup>             | 0.0237 <sup>a</sup> |
| AMN        | 0.4635 <sup>b</sup>             | 0.0440 <sup>a</sup> |
| AKR        | 0.43 15 <sup>b</sup>            | 0.0410 <sup>a</sup> |
| CTR        | 0.0000 <sup>c</sup>             | 0.0000 <sup>a</sup> |

- Mean values having the same superscript along columns are not significant different (P>0.05).

**Table 2: Products Within the FAO/WHO ADI For Different Groups**

|                                   | Average weight (kg) | ADI (mg/day) | Products within ADI                                    |
|-----------------------------------|---------------------|--------------|--|
| <b>School age (5-12yrs)</b>       | 25                  | 187.5        | MZN  |
| <b>Teenagers(13-19yrs)</b>        | 47                  | 352.5        | BET MXA ELE MYW MZN                                    |
| <b>Young adults(20-45yrs)</b>     |                     |              |  |
| Male                              | 62                  | 465          | MZN MYW, MXA, MXM, CHI BET DES DOR                     |
| Female                            | 70                  | 525          | CHI MKG EGO MZN MYW MXA MXM BET DES DOR                |
| <b>Full adults(above – 45yrs)</b> |                     |              |  |
| Male                              | 85                  | 637.5        | MKG EGO MZN MYW MXA MXM BET DES DOR IKW MTK<br>ELE     |
| Female                            | 105                 | 787.5        | MRE LIZ MKG EGO MZN MYW MXA MXM BET DES DOR MTR<br>ELE |

## V. Discussion

### Concentration of Tartrazine In The Plantain Chips

Table 1 above showed the result obtained for the concentration of tartrazine in 25 plantain chips purchased from the local manufacturers and the control (CTR) which contains no tartrazine. All the samples were apparently different. The result showed that the concentration of tartrazine in samples NWA and IKW were significantly higher than that all other samples tested. Such piece of information suggested that the required amount of dye (Tartrazine) may have been excessively abused. It is possible that the manufacturers have the intention to make the colour of their own product more attractive than others at the expense of consumers; especially children. This may be seen as a deliberate act to maximize profit or an act of ignorance.

The table also shows that the concentration of tartrazine in samples MP1, MQL, AMN, AKR, BES, DEC, MRE and LIZ were significantly lesser than the concentration of tartrazine in NWA and IKW but significantly higher than the concentration of all other samples. These samples were the most frequent statistically equivalent members in the group. This suggests that this range is the most prevalent level of tartrazine within the products in the market. It also indicated that if this range of tartrazine concentration is above the ADI for a majority of its target consumers, then it might have posed serious health damage with possible severe hazard in the offing.

The table 1 shows that the quantity of tartrazine in MUI, MTK, EGO, ELE, CHI, and MKG were significantly lower than samples NWA, IKW, MPI, MQL, AMN, AKR, BES, DEC, MRE, and LIZ. The information also showed that samples MUI, MTK, EGO, ELE, CHI, and MKG were significantly higher than samples MZN, MYW, MXA, BET,DES, ELE but only apparently higher than sample DOR and apparently lower (statistically equal to) than samples MSZ.

Also, samples MZN, MYW, MXA, BET, DES and ELE contained tartrazine that were significantly lower than the quantity of tartrazine present in all the other samples, except the control which contained no tartrazine. Although, this is not a criterion for endorsing these sets of chips, it will not be out of place to say that they may be the healthiest set of the plantain chips that were collected; all things being equal. It will also be inappropriate to use these chips as a benchmark for tartrazine addition in chips just because they contain the least quantity of tartrazine content.

### Products within ADI

Table 2 showed the arrangement of the different age groups and the products that are within their ADI as recommended by the FAG/WHO Experts (FAO/WHO, 1997). From the table above, the age groups were merely done by grouping the individuals concerned into a range of age and then their sex; especially where the weight of the group is known to vary consistently according to their gender. Considering the nutritional benefits attached to plantain as claimed by Ketiku (2008), children may be encouraged to eat a lot of this plantain chips. The school age children were those children within 5-12 years old. Their average weight as determined in this study was within 25 kilogram. Since the maximum quantity of tartrazine that can be consumed by an individual per day is 7.5mg/ body weight (kg) it implies that those whose average age falls within this group should not consume foods that will contain more than 187.5mg of tartrazine (i.e.  $7.5 \times 25$ ) be it plantain chips, or any other food or their combination. The result obtained here was very surprising. The table 2 above showed that only sample MZN can be recommended for people within this age group. This goes to show that parents who are in the habit of buying plantain chips for their children/wards either for launch either during school period or before dinner after school, probably to placate them when returning from work, may have long fed them with excessive tartrazine which could have a short term side effect of nettle rashes, anxiety, itching, heat waves, purple skin patches, sleep disturbance, and hyperactivity. The long term effect of this abuse include, but not limited to lethal asthma attack, DNA damage, tumor, general weakness, and gall bladder effect. This could be a very serious problem considering the number of people who consume this plantain chips on daily basis. Ogazi,

(2004) affirmed that plantain chips are the most popular chips in Nigeria. In line with the above statement, it will be possible that a good number of school children who have suffered or still suffer hyperactivity may have acquired this from plantain chips. The effect of this hyperactivity is manifest in them as their academic carrier which started brilliantly begins to sink or have sunk into mediocrity. This is therefore a major challenge, and a cankerworm that could eat average performance of the Nigerian child. Unfortunately, the teachers who have tried to improve on these children's mental ability might have worked fruitlessly by making several efforts in the wrong direction.

People within the age range of 13-19 years were referred to as teenagers. Since the maximum quantity of tartrazine that can be consumed by an individual per day is 7.5mg/body weight (kg) it implies that those whose average age falls within this group should not consume foods that will contain more than 352.5mg of tartrazine (i.e.  $7.5 \times 47$ ) be it plantain chips or any other food or their combination. The fact that teenagers mostly take a meal to school for launch and those of them who go to school with money will prefer biscuit to plantain chips makes them less prone to this abuse, especially from plantain chips. The table 2 above showed that only samples MZN, BET, IKW, MXA, ELE, and MYW contain tartrazine within the FAO/WHO Experts recommendation for this group. The implication of this is that only about 20% of the samples in the table were within the FAO/WHO Experts recommendations. Therefore, the teenagers are not to be exempted as those who are prone to this health problem even though they are less prone to such danger considering that they are not in the good number of those who are likely -to consume the products. Another danger is that the teenagers are likely to consume more of the products with a brighter colour (higher concentration) due to juvenile behavior for attractive foods (Nduhuizu, 2005). If this is the case then it will not be out of fact to state that even though the teenagers may not be a regular consumer of the plantain chips product may, or popular consumer at that, they may be the highest consumer of products tartrazine outside the FAO/who recommended ADI. The consequence of this piece of information is that some of these teenagers may have suffered or will suffer potentially lethal asthmatic attack due to the consumption of excessive tartrazine from plantain chips and/or from other foods. Other major effects that could have emanated from this abuse of the substance include DNA damage, migraine, sleep disturbance and gall bladder effect. None of the above mentioned health effect is cheaper than the cost of the best plantain chips in the market.

The young adults were grouped into male and female. Those in this group have age range between 20 to 45 years. However, the average age of the male and female is 62 and 70 years respectively. This difference in their age necessitated their differentiation. Since the maximum quantity of tartrazine that can be consumed by an individual per day is 7.5mg/ body weight (kg) it implies that those whose average age falls within this group should not consume foods that will contain more than 465mg and 525mg of tartrazine respectively (i.e.  $7.5 \times 465$  and  $7.5 \times 525$ mg respectively) be it plantain chips or any other food or their combination. This implies that a female individual within this group can consume any of the samples that are safe for a male of same age but the male cannot consume all the samples that are safe for the female category. This can be seen in the result obtained from the work in table 2 which showed that the female category of this group can consume samples CHI, MKG, EGO. MZN, MYW, MXA, MXM, BET. DES, and DOR whereas their male counterpart can consume only MZN, MYW, MXA, MXM, BET, DES, and DOR. This implies that while the female within this age group can consume 40% of the total food in this sample, the male can only consume 32% of them given the ratio of the number of plantain chips out of the 25 samples collected that met the FAO/WIIO standard of tartrazine for women to men is 3.2 Unfortunately, due to the economy of the country a good number of those within this range are always on the road and are the most likely consumer of these plantain products. Manisha *et al.*, (2012) stated that Tartrazine has been traced to impotency in men. Depending on the degree of fact in this statement, the problem that could be encountered by this group may be fatal. Impotency is a predominant challenge encountered by some young couples in Nigeria and world over. Although Manisha *et al.*, (2012) did not attribute impotency to mere abuse of tartrazine, it is however necessary to avoid this abuse since it can result to such undesirable health challenge. This group of people will most likely suffer sleep disturbance, general weakness and migraine when the recommended quantity of tartrazine is abused. The above mentioned effects will most likely result in poor health which will subsequently affect their productivity in all ramifications. The gall bladder effect could even worsen the chances of these individuals activity in life, especially as they age. Considering the fact that these group of people are the most active in their family; either been the bread winners in their homes or playing active role with regards to that, it therefore implies that the effect of this substance abuse on them can be indirectly suffered by other age groups both above or below their age.

The last group involves people within the age bracket of 45 years and above. Those within this group are classified as full adults in this work. Their average weight as determined in this study is 85 and 105 years for male and female respectively. This difference in their age, as mentioned earlier, necessitated their differentiation. Since the maximum quantity of tartrazine that can be consumed by an individual per day is 7.5mg/ body weight (kg) it implies that those whose average age falls within this group should not consume foods that will contain more than 637.5mg and 787.5mg of tartrazine respectively (i.e.  $7.5 \times 637.5$  and  $7.5 \times$

787.5mg respectively) be it plantain chips or any other food or their combination. As already indicated in the table 2 above, the male individuals can safely consume samples NWA, CHI, MKG, EGO, MZN, MYW, MXA, MXM, BET, DES, DOR, MTK, and ELE while their female counterpart can consume MRE, and LIZ in addition to those listed under the male category. This implies that the female within this category are least prone to the existing challenge of tartrazine consumed from plantain chips. The female could comfortably enjoy 60% of the samples obtained for this work while their male counterparts have only about 48% of the samples falling within the recommended limit; a ratio of 5:4 for the women to men. This age group are the most prone to gall bladder effect. At the bottom of the table for this age group, going from the youngest to the eldest, it is expected that the ability for the body to fight disease will decline (Ndubuizu, 2005), thereby giving room for accelerated health defect and possibly rapid deterioration in the health of those within this group. It will only be unfair to add another problem to their delicate health by eating plantain chips to the extent of ingesting more than the recommended quantity of tartrazine. Tumor and anxiety is another major challenge that those within this group could suffer. If people within age become broken down by these ailments, they not only suffer but also become difficult to manage at home. Although those within this age may not be popular consumers of plantain chips, this work did not see them as people who cannot eat plantain chips.

From the result obtained in this work, samples AKR, AMN, NWA, IKW, BES, DEC, MPL and MQL are outside the limit recommended by FAO/WHO for people between the ages of 5 through 105 kilogram body weight. This implies that more than 32% of the plantain chips products in the market may contain tartrazine in its excess. If this is true, then it portends a great danger for the public who could be a victim already and are still in the habit of eating the same plantain chips. It is also necessary to state that the youths, especially the obese, may be the victims of the silent killer since the brighter colour would ordinary attract them more than the aged.

## VI. Conclusion

The level of tartrazine in 25 popular plantain chips products sold within the five South East state of Nigeria was successfully investigated. The level of tartrazine in these plantain chips products vis-a-vis the FAO/WHO acceptable daily intake (ADI) was properly compared using different age grades and average body weight. The study showed that 32% of the 25 products contained more than the FAO/WHO ADI for people within the age of 5 and 105 years. Only one (4%) of the products that were sampled contained tartrazine within the ADI for school age children (body weight within 25kg). It was also observed that only four (16%) of the products were within the ADI for teenagers (body weight within 47kg). The result showed that only six (32%) of the sampled products met the ADI for young male adults (body weight within 62kg) while ten (40%) of the products met the ADI of their female counterpart (body weight within 70kg). About twelve (48%) of the samples were within the ADI for full male adults (body weight within 85kg) while thirteen (52%) of the samples met the ADI for full adult women. From the foregoing, it can be concluded that almost everyone eating more than one pack of these popular plantain chips sold within the South East states of Nigeria will ingest more than the ADI of tartrazine as approved by the FAO/WHO with school age children and teenagers have been the most delicate victims.

The information in this work can be used to recommend that a serious sensitization exercise be carried out by government and non-governmental agencies to educate the public on the use of tartrazine and its possible health effects. It is strongly recommended that head of units in hospitals and private medical doctors educate their patients on the ingestion of tartrazine especially those suffering related ailments.

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*A Study on the Concentration of Tartrazine in Plantain Chips Commonly Sold Within South-Eastern*

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