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Determination of selected micronutrients (zinc, iodine and selenium) in three different egg varieties from Sokoto, Nigeria

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Abstract
The aim of this study was to determine the levels of selected micronutrients (zinc, iodine and selenium) in three different egg varieties from Sokoto, Nigeria. Egg samples were bought from Gwadabawa Market, Sokoto, Nigeria and prepared according to standard preparations. Iodine was determined by Titrimetric Method, while, selenium and zinc were determined using Atomic Apsorption Spectrophotometer, Model Shimadzu AA-6800. All reagents used are of analytical grade. Selenium levels detected in the egg whites were: 28.505±1.0, 48.8912±0.02, 5.07±0.5; for duck (D), exotic chicken (EC), and local chicken (LC) respectively, while levels in yolks are: 46.3952±1.0, 41.20685±0.1, and 45.70+0.7 for duck (D), exotic chicken (EC), and local chicken (LC) respectively. Iodine levels detected in egg whites were: 1.15±0.23, 1.15±0.23, and 1.1 ±0.14 for duck (D), exotic chicken (EC), and local chicken (LC) respectively, while levels of iodine determined in yolks were: 1.95±0.1, 1.1±0.14, and 2.1±0.14 for duck(D), exotic chicken (EC), and local chicken (LC) respectively. Levels of zinc in egg whites are: 0.01335±0.0009, 0.3907±0.0005, and 0.1522±0.009 for duck (D), exotic chicken (EC), and local chicken (LC) respectively. The determined concentrations of zinc in yolks were: 0.0611±0.3, 0.257±0.003, and 0.18145±0.01 for duck (D), exotic chicken (EC), and local chicken (LC) respectively. It can be concluded that duck, exotic chicken, and local chicken contain considerable amount of iodine, selenium, and Zinc. Selenium was the most concentrated among others.

Keywords: Selenium, Zinc, Iodine, chicken, micronutrients,

Introduction

Micronutrients are among the groups of nutrients needed by the human body. They consists of selected vitamins and minerals (Salwa, 2016) and made up the essential elements needed by life in small quantities; generally less than 100mg/day in contrary to macro-elements which are required in large quantities. Some of the elemental micronutrient includes iron, cobalt, chromium, copper, iodine, manganese, selenium and zinc (Friday *et al.*, 2011; Skalnaya and Skalny, 2018). Though humans require micronutrient in small amounts consuming the recommended amounts is important, because micronutrients deficiency can have a devastating effects on the body (Centers for Disease Control and Prevention, 2021).

The roles of micronutrients are many. Forinstance, iodine is required during pregnancy and infancy for the infants' health, and precognitive development. Iodine deficiency is the main cause of many health abnormalities in humans, more especially young ones. Therefore, is a public health problem that requires attention, monitoring and intervention? The estimated prevalence of iodine deficiency has been monitored worldwide. The result in 2003, showed that more than 1.9 billion individuals have inadequate iodine nutrition, out of which 285 are school–age children. The prevalence was 42.6 % in Africa among the general population (GP), 42.3 % among the school age children; 9.8 % in America among general population, 10.1 % among school age (SAP); 54.1 % among Eastern general population (GP) and 55.4% among SAP; 39.8% among Southern Asia, in SAP; 24.0 % in Western Pacific GP and 25.7 % in SAP (American Council on Science and Health, 2002; CDC, 2021).

Moreover, people who are deficient in iodine cannot make sufficient amount of thyroid hormone. This in turn causes permanent harm on fetus such as stunted growth, intellectual disability, and lead to poor sexual development. Less severe iodine deficiency can cause lower intelligence quotient (IQ) in infants and children, and reduces adult's ability to work and think properly. Goiter is another effect of iodine deficiency (Seuss-baum, 2005). However, too much iodine is also harmful to the body. It can result to some symptoms similar to those known for iodine deficiency such as goiter, thyroid inflammation, thyroid cancer, vomiting, nausea, weak pulse, comma, stomach pain, fever and burning of mouth or throat or stomach (Salau *et al*., 2010; Ifeyinwa and Azuka, 2013).

Globally, 17.3 of the population is at risk of zinc deficiency due to dietary inadequacy. Zinc promotes immune functions and help people to fight infectious diseases including diarrhea, pneumonia and malaria, and needed for healthy pregnancies. Enough zinc supplements reduce the incidence of premature birth, lowers deaths from all causes and increases growth and weight gains in infants and young children (CDC, 2021). The shortage of zinc causes slow growth in infants and children, delayed sexual development in adolescents and impotence in men. Other problems are hair loss, diarrhea, eye and skin sores, loss of appetite, weight loss, and delayed wound healing, and decreased ability to test food (Ogbu *et al*., 2017). Signs of too much zinc include; nausea, vomiting, loss of appetite, cramps, diarrhea, and headache. Some people with too much zinc exhibits low copper levels, low immunity, and low levels of high-density lipoprotein (HDL) cholesterol (the good cholesterol) (Dieter, 2008; CDC 2021).

Selenium is an important micronutrient necessary for many biochemical processes such as thyroid hormone metabolism, DNA synthesis, reproduction, and protection from infection (Yakubu *et al*., 2014). Its deficiency is linked with certain types of cancer, infertility in men or women, muscles weakness, fatigue, hair loss, weakened immunity (Karaye *et al*., 2015). Selenium is a part of the enzyme glutathione peroxidase, which metabolizes hydro-peroxide produce from polyunsaturated fatty acids. It is also part of the enzymes those deionate thyroid hormones. In general, selenium act as an antioxidant which works together with vitamin E (Zhnag and Zarbl, 2008; Ifeyinwa and Azuka, *et al*., 2013). Therefore, the aim of this study was to determine the levels of selected micronutrients (zinc, iodine and selenium) in three different egg varieties from Sokoto, Nigeria.

Materials and Methods

Sample Collections and Preparations

Sample collection*:* 1 egg of each species (duck, local chicken, exotic chicken) respectively was obtained from Gwadabawa market, Sokoto state, Nigeria.

Sample preparation: 2g of portion of egg (albumen & yolk) were obtained when the egg was broken.

Determination of iodine value

Method: Titrimetric Method

Principle: Fatty acid react with halogen (iodine) resulting in the addition of halogen at the C=C double bond site. In this reaction, iodine monochloride reacts with the unsaturated bond to produce a di-halogenated single bond, which one carbon has bond on atom of iodine.

Procedure: 2grams of each sample (duck, local chicken, and exotic chicken) were placed into a conical flask. 20mls of chloroform were also added to each sample respectively. 25mls of iodine solution were also added to each sample. The conical flask was stopped; the solution was well mixed and left in dark for 1 hour. 20mls of 10% KI solution was added followed by 100mls of distilled water using starch as indicator. The solution was titrated with standard 0.1 ml sodium thiosulphate ($Na_2S_2O_3$) solution, shaking continuously until the blue color disappeared

Calculation of Iodine Value (I):

$$I = \frac{12.69 \times (V1 - V2)}{2}$$

Determination of Selenium and Zinc

Method: Atomic Absorption Spectroscopy

Principle: Atomic Absorption Spectroscopy (AAS) is based upon the principle that free atoms in the ground state can absorb light of certain wavelength; because absorption of each element is specific, no other element used this wavelength.

Procedure: 2.0grams of each sample (duck, local chicken, and exotic chicken) WAS weighed and placed into a beaker (using weighing balance). 10.0mls of conc. Nitric acid were also added to each sample (duck, local chicken, and exotic chicken) respectively. 2.0mls of conc. Perchloric acid were also added to each sample respectively. It was then heated on a heating mantle until boiled. 100mls of distilled water was added and thoroughly shaken. It was filtered into a 100mls standard flask and filtered was made up to mark with distilled water. Aliquots of this were analyzed for selenium and zinc using Atomic Absorption Spectrophotometer, Model Shimadzu AA-6800. All reagents used are of analytical grade.

Results and Discussion

Table 1: Determination of micronutrient (selenium) in commonly consumed eggs (Duck, exotic chicken, local chicken

MINERAL ELEMENT (Mg/l)		SELENIUM
TYPE OF EGG	**WHITE**	**YOLK**
DUCK	28.5050±1.0[a]	46.3952±1.0[a]
EXOTIC CHICKEN	48.8912±0.02[a]	41.20685±0.1 [a]
LOCAL CHICKEN	5.0700±0.5 [b]	45.70000±0.7 [a]

Values are mean ± standard deviation of 3 replicas, value which differ significantly $p < 0.05$.
Values within the same column with no common superscript differ significantly $p < 0.005$

Table 2: The result of determination of micronutrient (iodine) in commonly consumed eggs (Duck, exotic chicken, local chicken)

MINERAL ELEMENT (Mg/l)		IODINE
TYPE OF EGG	**WHITE**	**YOLK**
DUCK	1.15±0.23[a]	1.95±0.1 [b]
EXOTIC CHICKEN	1.15±0.23 [a]	2.1±0.14 [a]
LOCAL CHICKEN	1.1±0.14 [a]	2.1±0.14 [a]

Values are mean ± standard deviation of 3 replicas, value with differ significantly $p < 0.05$ are statistically insignificant.
Values within the same column with no common superscript differ significantly $p < 0.05$

Table 3: The result of determination of micronutrient (Zinc) in commonly consumed eggs (Duck, exotic chicken, local chicken)

MINERAL ELEMENT (Mg/l)		ZINC
TYPE OF EGG	**WHITE**	**YOLK**
DUCK	0.01335±0.009 [b]	0.06110±0.3 [b]
EXOTIC CHICKEN	0.39070±0.0005 [a]	0.2579±0.003 [a]
LOCAL CHICKEN	0.39070±0.0005 [a]	0.18145±0.01 [a]

Values are mean ± standard deviation of 3 replicas, value with differ significantly $p < 0.05$ are statistically insignificant
Values within the same column with no common superscript differ significantly $p < 0.05$

The tables 1-3 had shown the results of determination of Zinc, selenium, and iodine micronutrients in varieties of eggs from Sokoto, Nigeria. Determination of iodine, in the entire egg types duck (D) exotic chicken (EC) and local chicken (LC) had revealed that yolk contained higher level of iodine compared to the yolk. This is in agreement with many reports. Several past reports have revealed that egg yolk contains much more nutrients than white; for instance, reports by Friday *et al.*, (2011); Bertechini and Mazzuco, (2013); (Rehault-Godbert *et al.*, 2019). This might be because the concentration of the egg nutrient is dependent on the size of the yolk to egg as opined by (Ogbu *et al.*, 2017); therefore, the more the yolk, the more the nutrient content of the egg. Moreover, the yolk is an older component form before the white. Yolk is formed from the hepatic (liver) component (noteworthy, liver is essential in biochemical metabolism, such as synthesis of amino acid, protein, albumin, drug metabolism, storage of minerals etc.) and egg white is produce after ovulation released of the mature yolk. Thus, the yolk might be essential to provide nutrient to the developing egg (Rehault-Godbert *et al.*, 2019) showing that yolk contain most of the selenium in an egg.

Level of selenium (Se) in all the eggs also showed that yolk contains more selenium than the white, except in Exotic chicken, which showed higher level of selenium in white component. Zn levels were also higher in yolk than in white, with the exception of Exotic chicken, which showed higher Zn in white than yolk. Altogether, the element with higher concentration was selenium, then iodine and lastly the zinc. The highest level of selenium compared to levels of iodine and zinc, might be due to the specificity of selenium. It was reported by Seuss-Baum (2005) that selenium deficiency in poultry is rare, and slight increase in selenium in feeds of poultry could elevate the selenium level in eggs or even lead to toxicity in poultry. (Yakubu *et al*., 2014) also reported that addition of selenium in poultry food, spur an increase in selenium content embedded in egg yolk and white. Similarly, Zhang and Zarbl *et al.,* (2008) revealed a proportional relationship of increase in selenium in egg yolk and white to the increase in selenium feed over time. Therefore, the levels of selenium are essential to benefits the egg, and increase antioxidant activity by enhancing the activities of glutathione peroxidase, and catalase activities (Yaroshenko *et al*., 2003). Additionally, selenium supplementation in poultry is common; it might be the reason for elevated selenium levels (Abulude *et al*., 2006; Muhammad *et al*., 2021).

Certainly, it is essential to determine the level of Iodine, Selenium, and Zinc in diverse eggs, that are commonly consumed by people and being the elements essential to the functioning of human body. Furthermore, the higher or lower levels of these elements in the body are meted with different specific disorders (Fakayode and Olu-wolabi, 2003). Iodine is essential trace element of great important to human, failure to have optimal iodine is characterized with disorders such as goiter, hyper/hypothyroidism, mental problems, poor academic performance and relations (Shaikh *et al*., 2016). Level of iodine determined in all the three eggs was higher than the one found in vegetables and fruits (lime, plantain, paw, banana, grape, pineapple, bitter leaf, *Ugwu*, etc.) in Nigeria by (Salau *et al*, *2010*). The levels of iodine estimated in this study are the second most elevated after selenium. This elevated level of iodine might be due to iodine in the feed consumed by the poultry. This might also be useful to suggest that people who require iodine should use egg to meet their demands. Because in some places iodine rich food is used to raise the urine iodine levels in human as reported by (Seuss -Baum, 2005; Taunicek *et al.,* 2006). (Rehault-Godbert *et al*., 2019) also reported bioavailability of iodine in eggs supplemented with iodine.

Zinc present in eggs might be due to zinc feed among other factors. (Zaheer, *et al*, 2015) reported that supplementation of zinc in feed is essential and effective in enhancing zinc content in eggs and improving antioxidant capacity in laying hens. Zinc as cofactor such as superoxide dismutase it also helps in stabilization of membrane structure, protection of protein sulfur hydryl groups, upward regulation of metallothioneins (an antioxidant) (Dieter, 2008; Rayman, 2012).

Selenium is another important element required in human nutrition as it mediates many functions in the body. For example, Se improves glutathione peroxidase and CD4 in HIV positive patients, reproduction function, cardiovascular health, and endocrine functions among others (Zhou and Wang, 2011). The level of selenium presented on table 1 was high compared to I, and Zn. The level (e.g. 48.8912±0.021) was extremely higher than that reported by Adeniyi and Agoreyo (2018). In Nigeria, the enriched level of selenium in the examined eggs is usual, similar to the report of Combs (2001). Zhou and Wang (2011), Muhammad *et al* (2019), had showed that Se diet is essential in enriching the selenium in egg yolk and improve laying performance and other diverse functions. The levels of iodine (range; 1.1±0.14 to 2.1±0.14) is similar to iodine levels determined by (Muhammad *et al*., 2021) in commonly consumed foods (including eggs) in Zaria, Nigeria. The iodine is essential in eggs to performed many functions such as, improvement in weight, decreased the proportion of damage eggs (Jeroch *et al*., 2002).

Zinc is another essential element, a component of a large number (>300) of enzymes participating in diverse array of metabolic reactions; one of the causes of zinc deficiency is the low zinc intake (Ahmed *et al*, 2019). It has been shown that the lowest levels of Zn compared to I, Se. this determination is lower than the results of Ahmed *et al*, (2019) from Nasarawa state. Also lower than the zinc levels determined in eggs in Ibadan by (Fakayode and Olu-wolabi, 2003).

Conclusion:

From the result of this study, it can be concluded that, duck, exotic chicken, and local chicken contains significant concentration of iodine, selenium, and Zinc, but selenium was the most concentrated among others.

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