IOSR Journal of Biotechnology and Biochemistry (IOSR-JBB)
ISSN: 2455-264X, Volume 4, Issue 4 (Jul. – Aug. 2018), PP 53-62
www.iosrjournals.org

Minerals, Vitamins And Anti-Nutritional Contents Of New Poultry Foods Based On Corn Flour Enriched With The Flours Of Seeds And Pulp Of Parkiabiglobosa, Snail And Fish.

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Abstract: *This study consisted initially in formulating 3 feeds (A1, A2 and A3) intended to feed poultry from local products available, at a lower cost and not appreciated for human consumption. Beside these 3 formulated feeds, there was an AT trade feed that was used as a control feed. Then these foods were analyzed. The results revealed that the formulated foods are true sources of minerals (macro-elements such as Calcium, Potassium, magnesium and phosphorus and micro-elements such as iron, manganese, Sodium, copper and Zinc) and vitamins (A, B1, B2 and C). Also contain anti-nutritional substances (Oxalates, tannins, and phytate). In our study, the Phytate/Ca and phytate/Fer ratios are respectively below 2.5 and above 0.4. The major foodstuffs that have been taken into account in the formulation of these foods are maize as a carbohydrate source, pulp and seed(Parkiabiglobosa)grains as a vegetable protein source and fishmeal (Sardinellamaderensis) and snail flours (AchatinaFulica) were used as a source of animal protein.*

Key words*: Parkiabiglobosa, Flour, seed, snail, corn.*

Date of Submission: 28-07-2018 Date of acceptance: 12-08-2018

I. Introduction

In developing countries such as Ivory Coast, poultry play an important role in the socio-economic life of the population. However, production suffers from high food costs that account for approximately 60 to 80% of production costs **(MRA, 2010)**. As a result, it is becoming urgent to look for new, inexpensive, unconventional sources of food even non-appreciated by human. In the context of new poultry feed resources, our work will consist in enriching corn flour with grain and *Parkiabiglobosa* pulp as vegetable protein source on the one hand; fishmeal (*Sardinellamaderensis*) and snail (*Achatinafulica)* important protein sources, available and inexpensive food in Côte d'Ivoire on the other hand **(Aboua, 1990;Gicogna, 1992; Aboua, 1995)**. In fact,*Parkiabiglobosa* is a plant whose nutritional interest lies in the high protein content of its seeds (35%) **(Bonkoungou, 1987)**.Nere seeds are generally fermented to produce a seasoning commonly known as "soumbala" in Bambara. Its pulp is rich in carbohydrates (60%) and also contains vitamin B2. The aim of this work is to study the composition of minerals, vitamins and ant-Nutritional substances of 3 available and lower cost formulated diets based on local products and that of a trade feed intended for poultry feed in Ivory Coast.

II. Results And Discussion

1-Results

1-1-Rates of mineral elements

1-1-1-Rates of macroelements (%)

Calcium levels in formulated (A1, A2 and A3) and (AT) Trade launch feeds were 1.97 ± 0.07, 0.95 ± 0.06; 1.46 ± 0.07 and 1.22 ± 0.01%.Those of the formulated growth foods (A1, A2 and A3) and of the AT trade are respectively 1.91 ± 0.08; 1.62 ± 0.05; 2.27 ± 0.06 and 0.80 ± 0.01%. Calcium levels in starter feeds are different ($P \leq 0.05$). The decreased order is as follows: Calcium level in start-up feeds A1-A3-AT-A2 (**Figure 1**); that of the growth feeds is as follows: A3-A1-A2-AT (Figure 2). Potassium levels in the formulated (A1, A2 and A3) launch and AT trade feeds feed are 0.89 ± 0.01, 0.93 ± 0.01; 1.00 ± 0.02 and 1.01 ± 0.03%. Those of the formulated (A1, A2 and A3) and AT trade growth feeds are respectively 0.98 ± 0.03; 0.88 ± 0.01; 1.10 ± 0.03 and 1.12 ± 0.01%. Potassium levels in launch feeds are statistically different ($P \leq 0.05$). The decreased

order is as follows: Potassium content in AT launch feeds = A3-A2-A1 (**Figure 1**); that of the growth feeds is as follows: AT = A3-A2-A1 (**Figure 2**). Magnesium level in formulated (A1, A2 and A3) and (AT) trade start-up feeds are respectively 0.25 ± 0.01; 0.24 ± 0.01; 0.20 ± 0.01 and 0.19 ± 0.01%.The formulated (A1, A2 and A3) and AT trade growth feeds are respectively 0.21 ± 0.03; 0.26 ± 0.01; 0.33 ± 0.03 and 0.34 ± 0.01%. Magnesium levels in launch feeds are statistically different ($P \leq 0.05$). The decreased order is as follows: Magnesium level in start-up feeds A1 = A2-A3 = AT (**Figure 1**); that of the growth feed is as follows: AT = A3-A2-A1 (**Figure 2**).

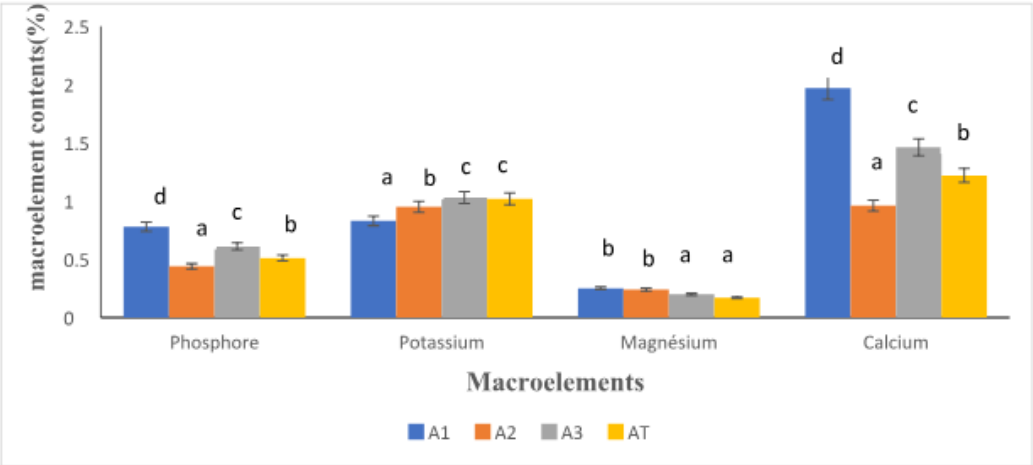

Figure 1: Macro-element content in formulated and trade start-up feeds the same letters assigned to averages mean that they are not different at the 5% threshold.

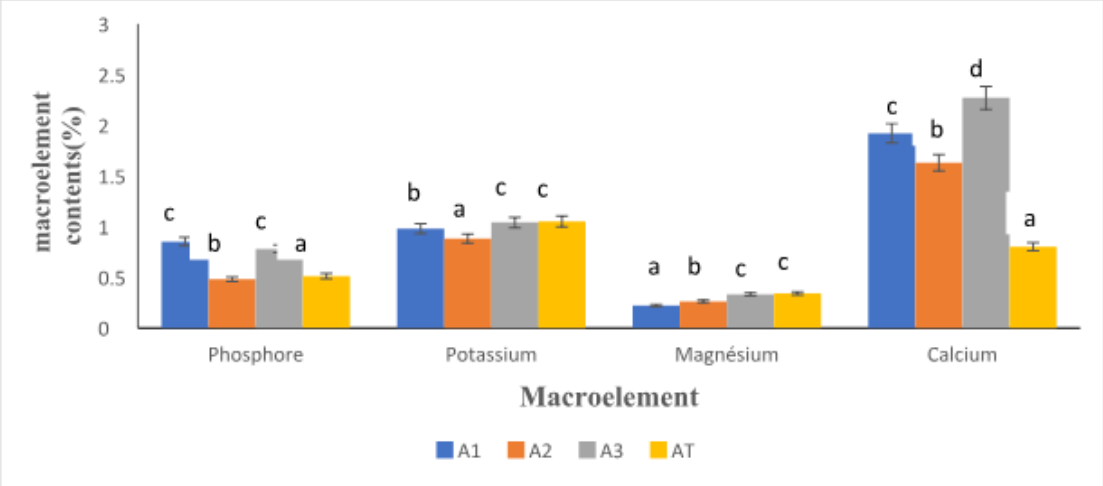

Figure 2: Macro-element content in formulated and trade growth feeds. The same letters assigned to averages mean that they are not different at the 5% threshold.

1-1-2-Rates of trace elements (mg/kg)

The iron content in formulated (A1, A2 and A3) and AT trade start-up feeds are 3.33 ± 0.04; 3.81 ± 0.01; 5.72 ± 0.03 and 4.32 ± 0.01 mg / kg. Those of the formulated (A1, A2 and A3) and AT trade growth feeds are respectively 3.31 ± 0.04; 3.36 ± 0.01; 4.43 ± 0.05 and 3.34 ± 0.01 mg / Kg. The decreased order of the iron levels in the launch feeds is as follows: A3 feed rate - AT feed rate. A2 feed rate - A1feed rate (**Figure 3**). That of the growth feed is as follows: rate of feed A3 - rate of feed A2 - rate of feed AT -rate of feed A1 (**Figure 4**).Manganese content in formulated (A1, A2 and A3) start-up feeds are 1.8 ± 0.02, 1.81 ± 0.01; 1.8 ± 0.01 and 1.77 ± 0.03 mg / Kg. There is no significant difference between them (**Figure 3**).The growth rates formulated (A1, A2 and A3) and AT trade are respectively 1.80 ± 0.01; 1.81 ± 0.01; of 1.82 ± 0.02 and 1.65 ± 0.11 mg / Kg.Those of the formulated growth foods (A1, A2 and A3) are statistically identical ($P \geq 0.05$). They are statistically higher ($P \leq 0.05$) than the commercial growth food (AT) (**Figure 4**).The rate of formulated (A1, A2 and A3) and AT trade growth feeds are respectively 1.80 ± 0.01; 1.81 ± 0.01; 1.82 ± 0.02 and 1.65 ± 0.11 mg / Kg.Those of the formulated (A1, A2 and A3) growth feeds are identic ($P \geq 0.05$). They are statistically higher

than the trade growth feed (AT) (**Figure 4**). Sodium levels in formulated (A1, A2 and A3) and (AT) trade start-up feeds are respectively 8.87 ± 0.12; 6.31 ± 0.21; 8.98 ± 0.01 and 8.77 ± 0.13 mg / Kg. Sodium levels in A1 and A3 start-up feeds are equal ($P \geq 0.05$). These are higher than formulated A2 and trade starter feeds ($P \leq 0.05$) (**Figure 3**). Sodium levels in formulated (A1, A2 and A3) and (AT) trade growth feeds are 15.5 ± 0.32; 9.61 ± 0.21; 17.81 ± 0.11 and 6.57 ± 0.13 mg / Kg. These are significantly different from each other ($P \leq 0.05$). The decreasing order of sodium level in the growth feeds is as follows: A3 rate, A1 rate, A1-AT trade rate. Sodium levels are high among all the mineral materials studied (**Figure 4**).

Copper content in formulated (A1, A2 and A3) and AT trade launch feeds are 0.47 ± 0.02; 0.61 ± 0.12; 0.68 ± 0.03 and 0.70 ± 0.03 mg / Kg. Those in formulated A2, A3 and trade start-up feeds are equal ($P \geq 0.05$). They are statistically higher than in A1 start-up feeds ($P \leq 0.05$) (**Figure 3**). Copper content in formulated A1, A2, A3 and AT trade growth feeds are respectively 1.00 ± 0.12; 1.10 ± 0.12; 1.11 ± 0.03 and 0.96 ± 0.05 mg / Kg. They are statistically identical to each other ($P \geq 0.05$) (Figure 4).Zinc levels in A1, A2, A3 and trade start-up feeds are 2.7 ± 0.02; 2.21 ± 0.12; 2.22 ± 0.03 and 1.80 ± 0.03 mg / Kg. Those in A2 and A3 launch feeds are statistically identical ($P \geq 0.05$). They are respectively lower ($P \leq 0.05$) then higher than those in A1 and trade feed (**Figure 3**). Zinc levels in A1, A2, A3 and trade growth feeds are respectively 1.63 ± 0.02; 1.21 ± 0.02; of 1.00 ± 0.03 and 1.81 ± 0.03 mg / kg. The decreasing order of Zinc rates in growth feeds is as follows: Zinc rate in trade feed - zinc rate in A1 - zinc rate in A2 - zinc rate in A3 (**Figure 4**).

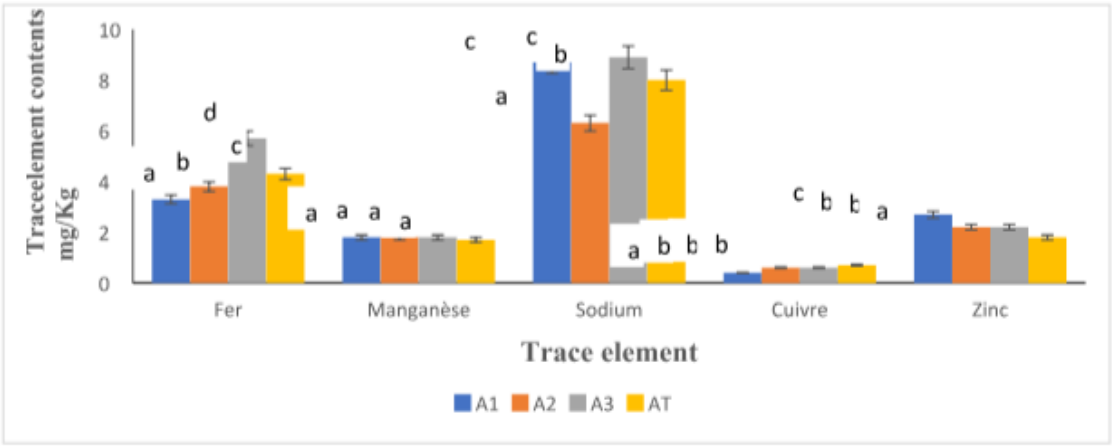

Figure 3: Trace element contents in formulated and trade launch foods. The same letters assigned to averages mean that they are not different at the 5% threshold.

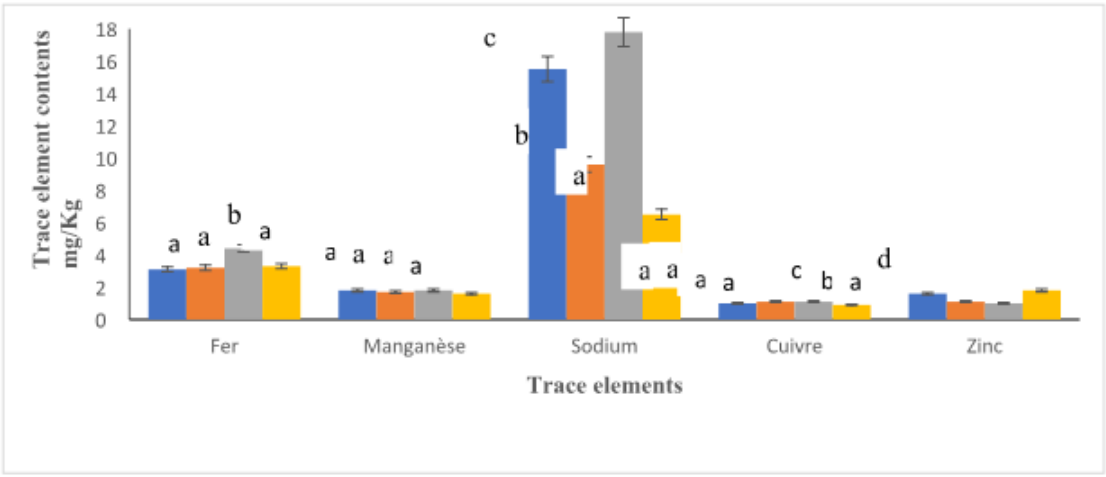

Figure 4: Trace element contents in formulated and trade growth feeds. The same letters assigned to averages mean that they are not different at the 5% threshold.

1-2-Vitamin levels

1-2-1- Vitamin B1 levels

Vitamin B1 levels in A1, A2 and A3 launch feeds are respectively 105.67 ± 2.01; 91 ± 0.36; 63 ± 0.44 and 0 mg / Kg. Start-up feed A1 has the highest vitamin B1 level ($P \leq 0.05$). Vitamin B1 levels in A1, A2, A3

and trade feeds are as follows 56 ± 0.67; 369 ± 0.78; 17 ± 0.08 and 0 mg / Kg. The A2 growth feed has the highest rate among growth feeds ($P \leq 0.05$).It is followed by the start-up feed A1. Start-up and growth Trade feeds do not contain vitamin B1 (**Figure 5**).

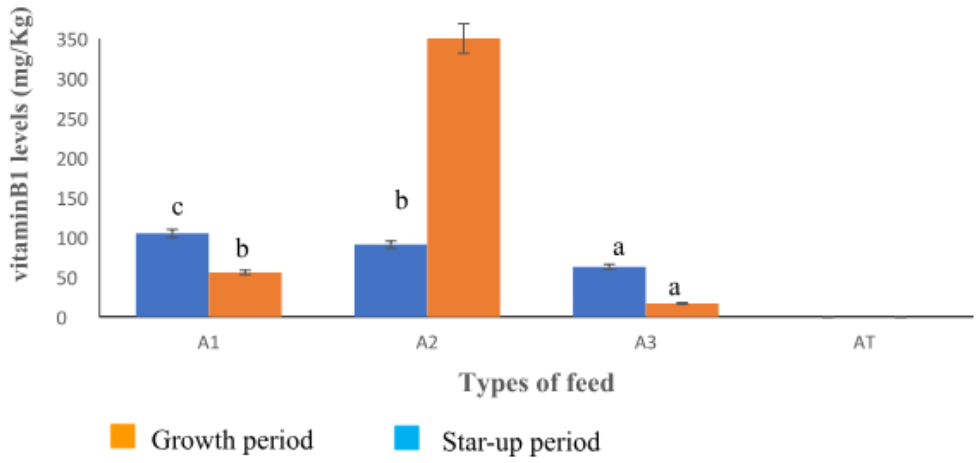

Figure 5: Vitamin B1 levels in formulated and trade start-up and growth feeds. The same letters assigned to averages mean that they are not different at the 5% threshold.

1-2-2-Vitamin B2 levels

Trade start-up and growth feeds do not contain vitamin B2. Vitamin B2 levels in A1, A2 and A3 start-up feeds are respectively 3393 ± 1.60; 3391 ± 2.56 and 3480 ± 1.40 mg / Kg. Vitamin B2 levels in A3 start-up feed is the highest ($P \leq 0.05$). Vitamin B2 levels in A1, A2, A3 and trade feeds are the followings: 3466 ± 3.10; 3468 ± 3.50; 4115 ± 2.33 and 0 mg / Kg.

The decreasing order of vitamin B2 levels in growth feeds is as follows: rate in A3- rate in A2 = rate in A1-rate in trade (**Figure 6**).

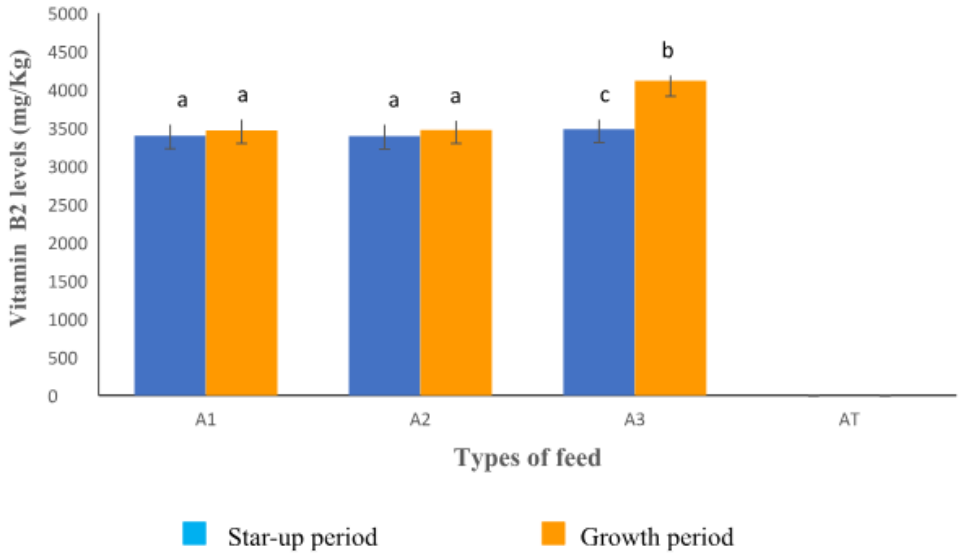

Figure 6: Vitamin B2 levels in formulated and trade start-up and growth feeds. The same letters assigned to averages mean that they are not different at the 5% threshold.

1-2-3-Vitamin A levels

Vitamin A levels in A1, A2, A3 and trade start-up feeds are respectively 1453 ± 2.31; 1450 ± 3.71, 1459 ± 5.61 and 299 ± 0.71 mg / kg. Those in A1, A2 and A3 start-up feeds are equal ($P \geq 0.05$).They are higher ($P \leq 0.05$) than the trade start-up feed.The vitamin A levels in A1, A2, A3 and trade feeds are 1439 ± 1.11; 1440

± 0.23, 1447 ± 3.61 and 290 ± 0.41 mg / Kg. Those in A1 and A2 growth feeds are statistically equal ($P \geq 0.05$). They are respectively lower then higher than those in A3 and trade feeds ($P \leq 0.05$) (**Figure 7**)

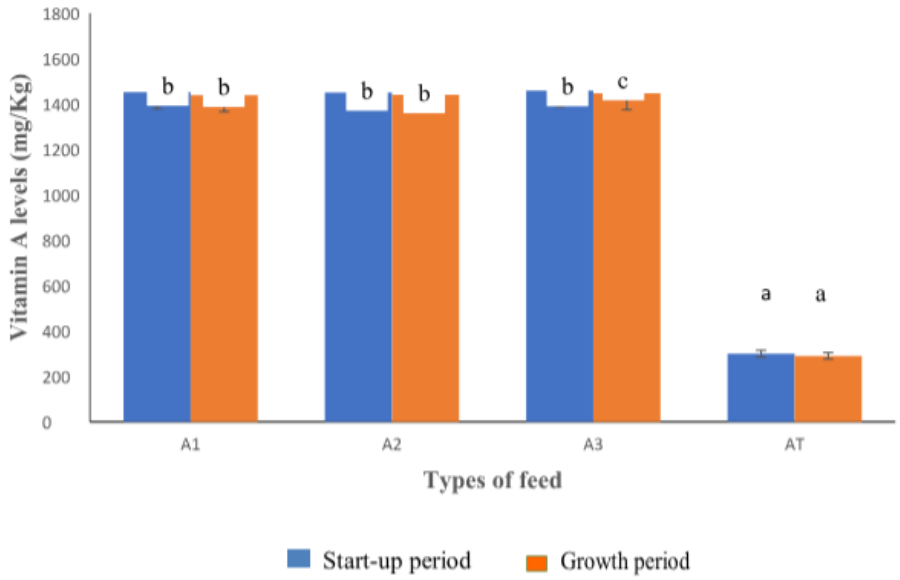

Figure 7: Vitamin A levels in formulated and trade start-up and growth feeds. The same letters assigned to averages mean that they are not different at the 5% threshold.

1-2-4-Vitamin C levels

Vitamin C levels in A1, A2, A3 and trade launch feeds are respectively 873 ± 3.09; 877 ± 4.05, 883 ± 2.05 and 443 ± 0.05 mg / Kg. Those in A1 and A2 start-up feeds show the same rates ($P \geq 0.05$). They are respectively lower and then higher than those in A3 trade feed ($P \leq 0.05$). Vitamin C levels in A1, A2, A3 and trade feeds are 877 ± 0.7; 877 ± 0.5, 883 ± 0.05 and 443 ± 0.05 mg / Kg. A1 and A2 Growth feeds are the same ($P \leq 0.05$). These rates are different from those in A and trade growth feeds. A3 Growth feed has a vitamin C level higher than that in trade feed ($P \leq 0.05$) (**Figure 8**).

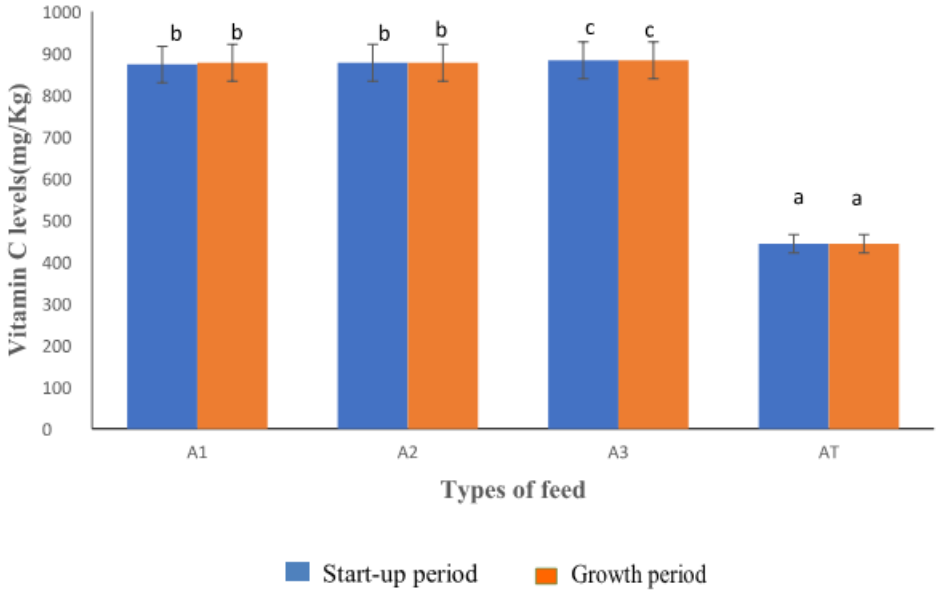

Figure 8: Vitamin C levels in formulated and trade start-up and growth feeds. The same letters assigned to averages mean that they are not different at the 5% threshold.

1-3-Anti-nutritional factors Rates

1-3-1-Tannin content

The tannin levels in A1, A2, A3 and trade start-up feeds are respectively 18.22 ± 0.49; 26.37 ± 2.86; 26.05 ± 0.32 and 35.80 ± 0.98 (mg / 100g). Those in A2 and A3 launch feeds are identical ($P \geq 0.05$). They are statistically lower then higher respectively than those in trade growth feeds and formulated A1 feeds. The tannin levels in A1, A2, A3 and trade feds are respectively 43.41 ± 2.80; 29.26 ± 1.79; 29.69 ± 2.6 and 32.90 ± 1.94 mg / 100g.Those in A2, A3 and trade growth feeds are the same ($P \geq 0.05$). However, they are lower than that in A1 growth feed ($P \leq 0.05$) (**Figure 9**).

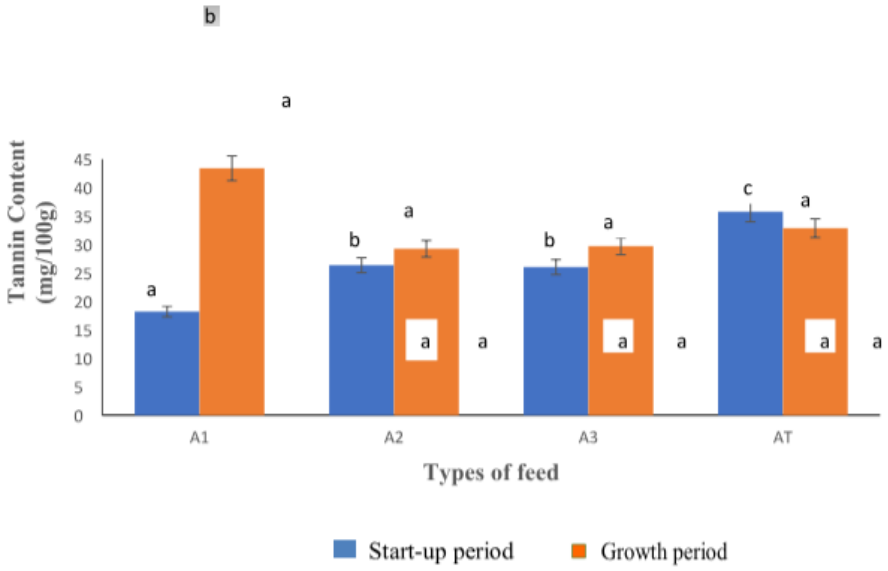

Figure 9: Tannin levels in formulated and trade start-up and growth feeds.
The same letters assigned to averages mean that they are not different at the 5% threshold.

1-3-2-Phytate levels

The phytate levels in A1, A2, A3 and trade launch feeds are 55.43 ± 2.41; 56.89 ± 1.10; 57.70 ± 1.79 and 58.63 ± 3.43 mg / 100g. There is no significant difference between them ($P \geq 0.05$) . This result is also obtained with A1, A2, A3 and trade feeds. Their respective phytate levels are 59.68 ± 1.34; 59.15 ± 5.25; 59.60 ± 1.40 and 59.39 ± 0.67 g / 100g (**Figure10**).

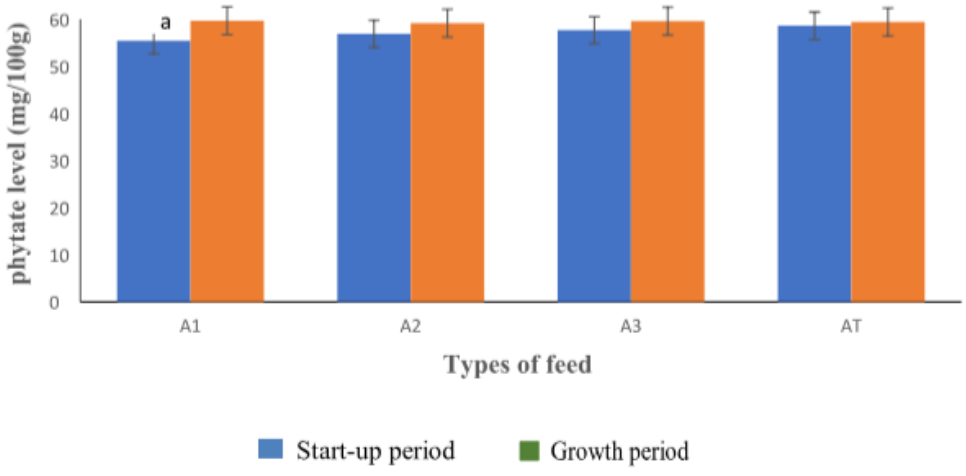

Figure 10: Phytate levels in formulated and trade start-up and growth foods.
The same letters assigned to averages mean that they are not different at the 5% threshold.

2-Discussion

Formulated and trade start-up and growth feeds contain a variety of mineral elements. The mineral elements in formulated feeds are found in commercial foods. This is an advantage for formulated products. The most abundant mineral element is unfortunately sodium. Sodium in the body plays an important role in its hydration state. It also helps maintain acid-base balance and is essential in the transmission of nerve impulses as well as muscle contraction but can increase blood pressure in subjects. In addition, it increases the risk of cardiovascular disease, kidney disease and osteoporosis **(Onyiriuka*et al.,* 1997, Umar *et al.,* 2007)**. This abundance in the studied feeds can be explained by its incorporation into feed production. Potassium whose presence in formulated and trade feeds should play an important role in the acid-base balance in our body by maintaining a good level of pH in it, the synthesis of macronutrients such as carbohydrates and proteins , to the regulation of the arterial pressure, to its intervention in the muscular contraction phenomenon, essential for the good functioning of the cardiac muscle and the whole muscular body, is unfortunately not abundant, which makes that the relations Na / K are greater than 1. In fact, **FAO/OMS (1991)** recommended for food, Na/K ratio less than 1.Ca/P ratio obtained with the formulated (A1, A2 and A3) feeds are greater than 1, which shows that these are richer in calcium than in phosphorus. This situation is obtained through shredded shells that have been incorporated into formulated feeds. Certainly, a calcium source has also been incorporated into the trade food. Ca/P ratios greater than 1 are in accordance with **Jacotot and Leparco(1992)** and**Kemi*et al.* (2010)**recommandations.In addition to the many nutrients mentioned above, formulated foods (A1, A2 and A3) are also a source of vitamins (A, B1, B2 and C). The major presence of vitamins A and B2 in formulated foods may be justified by the incorporation of nere pulp into these foods **(Bonkoungou, 1987).** Vitamin B2 deficiency in poultry feed causes stunting, decreased consumption index **(Summers, 1984)** and reduced resistance to infection **(Panigrahi, 1986)**. Vitamin A plays a vital role in the health of birds, fecundity and egg development, and resistance to infectious and parasitic diseases **(Jordan and Pattison, 1998)**. Birds receiving a vitamin C deficient diet undergo abnormal bone growth that is less resistant **(Doan and Giang, 1998)**.Known for their chelating action on certain minerals. Phytate and oxalates chelate bivalent cations such as Calcium, magnesium, Zinc, copper, and iron, reducing their bioavailability **(Sandberg, 2002)**. The anti-nutritive substances found in foods are the phytate and oxalate known for their chelating action on certain minerals. They chelate bivalent cations such as Calcium, magnesium, Zinc and iron, reducing their bioavailability **(Sandberg, 2002)**. In our study, oxalates/Ca ratios are between 0.063 and 0.13 for starter foods and between 0.063 and 0.15 for growth foods. These reports below the critical level of 2.5 **(Umar *et al.,* 2007)** to allow the bioavailability of calcium contained in food **(Hassan *et al.,* 2007)**.The presence of phytate in such a large quantity in food, including control foods, could be the fact that phosphorus in raw materials of plant origin would be stored as a molecule of phytic acid, making very little Available for poultry**(Jan *et al.,* 2007)**. Indeed, the presence of phytic acid in raw materials of plant origin would make Zinc and copper very unavailable for poultry. However, the use of microbial phytase would improve significance of the use of Zinc and copper by hydrolysis of phytate**(Narcy*et al.,* 2009)**.

CONCLUSION

In this study, the minerals, vitamins, and anti-nutritional factors of formulated (A1, A2, and A3) and commercial (AT) foods were evaluated. It emerges from our study that all foods have a wealth of minerals and vitamins capable of meeting the maintenance, production, growth and reproduction needs of poultry despite the presence of some ant-nutritional factors. However, the food formulated A3 proves to be the one that would be able to produce repercussions identical to that of the control food on the quality of the products derived from poultry.

I-MATERIAL AND METHODS

1-Samples preparation

1-1-Corn flour (*Zea mays*)

Once in the lab, the corn kernels were sorted and washed with tap water**.** Then, they were dried under the sun for three days to reduce the water content. After drying, the dry product obtained was grinded at the Huler grinder (SN200) taking into account the meshes for the launch and growth phases of the subjects. For the start-up and growth phases the diameters of mesh used were respectively (3mm) and (4mm).

1-2-Flour of nere pulp (*Parkiabiglobosa*)

When removing the external cover, the yellow pulp adhered to the néré seeds was removed and dried under the sun for 3 days. After drying, the product is slightly ground with wooden mortar and pestle. Using a sieve of 200 µm in diameter, the yellow flour of nere pulp is collected.

1-3-Flour of néré grains (*Parkiabiglobosa*)

After getting the *Parkiabiglobosa* pulp flour, the seeds were also milled in a grinder because of the hardness of the hull, the starting and growth meshes being taken into account.

1-4-Snail Flour (*Achatinafulica*)

As soon as they arrived at the lab, the snails were sorted, washed with tap water and then removed from their shells. Their shells cleared, their flesh was well washed with distilled water and then dried under the sun for 7 days. After 7 days, the dried flesh was carried to the mill for processing into flour.

1-5-Fish meal (*Sardinellamaderensis*)

After their purchase at the Adjame market, the fish were received at the lab. They were sorted and dried under the sun for 3 days before being carried to the mill for processing into flour.

2-Feed formulation

Three (3) types of feed have been formulated:
-Feed A1: Animal protein flour made up fish (*Sardinellamaderensis*) (100%) (Table VI);
-Feed A2: The animal protein flour made up snail (*Achatinafulica*) (100%) (Table VI);
-Feed A3: The animal protein flour made up mixed snail (*Achatinafulica)* / fish meals (*Sardinellamaderensis*) (50/50, P / P) (**Table I**).

For each of these feed formulations, the main carbohydrate component is exclusively yellow corn meal (*Zea mays*). Then, the same amount of *Parkiabiglobosa* powder (grains and pulp) as well as the other usual inputs were added to these feeds as detailed in Tables I below.

Table 1: Percentage Composition of Formulated Feeds A1, A2 and A3

Quantity (Kg) out of 100 Kg of feeds	Breeding periods					
	Stard-up			Growth		
	A1	A2	A3	A1	A2	A3
Corn flour	56	56	56	58	58	58
Nere pulp flour	3	3	3	3	3	3
Nere seed flour	20.08	20.08	20.08	19	19	19
Fish meal	15	00	7.5	14.5	00	7.5
Nail meal	00	15	7.5	00	14.5	7.5
Shell	2	2	2	2.2	2.2	2.2
Red oil	2	2	2	2	2	2
Vitamin complex	0.5	0.5	0.5	0.7	0.7	0.7
Salt	0.3	0.3	0.3	0.3	0.3	0.3
Lysine	0.25	0.25	0.25	0.2	0.2	0.2
Methionine	0.15	0.15	0.15	0.1	0.1	0.1
TOTAL (Kg)	100	100	100	100	100	100

III. Determination of Mineral Nutrient Contents

3-1-Mineral contents other than phosphorus

These mineral elements were determined by atomic absorption spectrophotometry according to the **AOAC (1990)** digestion method using strong acids. A sample of ash (0.5 g) was dissolved in 31 ml of a mixture of perchloric acid (11.80 mol / L), nitric acid (14.44 mol / L) and Sulfuric acid (18.01 mol / L). The well stirred mixture under the hood was heated on a hot plate until thick white smoke appeared. After this heat treatment, the environment reaction was cooled on the bench for 10 min and then diluted in 50 mL of distilled water. It was boiled again for 30 minutes using the same heating plate (HOT PLATE securit 5804) then cooled again under the same conditions. Then the mixture was filtered through WHATMAN filter paper No. 42. In this way, the filtrate obtained was added to the flask mark with distilled water. The level of mineral material was determined by VARIAN AA.20 brand flame atomic spectrophotometer in comparison with the standard solutions.

3-2-Phosphorus dosage by spectrophotometer.

One gramme of flour was mineralized using a mineralizer and the obtained result was treated with the vanado-molybdic reagent according to **Taussky and Shorr (1953)** method. The phosphorus content (P) was determined compared with a standard solution (0.136 g of potassium dihydrogenphosphate dissolved in a dilute solution containing nitric acid 0.1 ml and distilled water 50 ml .

IV. Determination of Vitamins contents

4-1-Vitamin C content

Vitamin C content in food was determined according to **Pongrac*zand al* (1971)** method. Ten gramme of food were solubilized in 40 mL of a mixture of metaphosphoric acid-acetic acid solutions (2%, p / v).The homogenized suspension stirred by hand for 2 min was centrifuged about 20 min at 3000 rpm in a centrifuge (SIGMA laborzentrifugen 3-16P).The supernatant volume obtained was reduced to 50 ml with distilled water. Vitamin C contained in ten mL of this solution was measured with 2,6-dichlorophenolindophenol (0.5 g / L) until pink turn. Vitamin C content in food was determined from the following equation:

$$Vitamine\ \ C\ (\%) = \frac{(0,5 \times V \times 10^{-3}) \times 5 \times 100}{m_e}$$

V: Taken volume of the dichlorophenol-indophenol (2,6 DCPIP) (mL); me: Sampled food mass (g).

4-2-Other Vitamins

Vitamins A, B1, B2 were determined according to the method described by (**Rougereau, 1984**). Five (5) grams of semolina flour were placed in a 100-mL volumetric flask and then 50 mL of distilled water was added thereto. The pH of the mixture was adjusted to 4.5 and then the solution was delipidated with a solution of sulfuric ether and petroleum ether. The new mixture obtained was filtered and neutralized to obtain a pH of 6.9. The resulting solution was lyophilized and the lyophilizate was reduced to a minimum volume of 30 mL. The dosage of the vitamins was carried out after the calibration of the standards of each vitamin. An HPLC system (SHIMADZU SPD 20A) equipped with a UV detector (PAD) and C18 ODS column (250 x 4.6 from Cluzeau, France) was used in isocratic mode for analysis. The mobile phase consisted of acetonitrile (55 mL), tetrahydrofuran (37 mL) and water (8 mL) with a flow rate of 1.5 mL per min. Ten (10) µL of each sample was injected and the compounds were detected at a wavelength of 325 nm.

V. Anti-nutritionals factors contents

5-1-Phytate Contents

The phytate dosage in food was carried out according to the **Latta and Eskin (1980)** method. One gramme of food was homogenized in 20 mL of hydrochloric acid (0.65 N) with magnetic stirring at room temperature (28 ° C) for 12 hours. The mixture was centrifuged at 12000 rpm for 40 min. 0.5 ml of the aliquot portions from the supernatant were removed and put into test tubes. These aliquot portions were diluted in 3 mL of Wade reagent. These new mixtures were left to rest for 15 minutes at room temperature (28 ° C) and the staining intensity was read on a spectrophotometer (visibility MS-V5100) at 490 nm against the control containing no phytate. The amount of phytates was determined through calibration line established from a stock solution of sodium phytate (10 µg / mL).

5-2-Tannin contents

Tannin content in food was determined according to **Bainbridge *and al* (1996)** method. One mL of methanolic extract was introduced in a test tube containing 5 mL of vanillin reagent. The test tube was left to rest for 30 minutes in the dark, and the optical density (OD) was read at 500 nm against a blank that did not contain tannins. Tannin amounts in the feed were determined through a standard range established from a stock solution of tannic acid (2 mg / mL) under the same conditions as the test.

6-Statistical analysis

All the measurements were done in triplicate. Statistical analyses of the data were made using the software Statisticala 7.1 StatsoftInc, Tulsa-USA headquartes) and XLSTAT-Pro 7.5.2 (Addinsoft SARL, Paris-France). The comparisons between the dependent variables were determined using two-factor Anova and the Duncan test. Statistical significance has been defined at the 5% threshold. The averages and écartypes of all analysis results were treated with this software and compared with each other.

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IOSR Journal of Biotechnology and Biochemistry (IOSR-JBB) is UGC approved Journal with Sl. No. 4033, Journal no. 44202.

N'gbo Martin Luther King "Minerals, Vitamins And Anti-Nutritional Contents Of New Poultry Foods Based On Corn Flour Enriched With The Flours Of Seeds And Pulp Of Parkiabiglobosa, Snail And Fish." IOSR Journal of Biotechnology and Biochemistry (IOSR-JBB) 4.4 (2018): 53-62.