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Research Paper

FORMULATION OF NEW POULTRY FOOD PRODUCTS BASED ON LOCAL PRODUCTS IN IVORY COAST: MINERALS POTENTIALITIES

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Abstract

The objective of this study is to develop new foods quail from available local produce cheaply and not valued as human food. At first, 3 foods (A1, A2 and A3) were developed based on corn flour, seed powder and néré pulp. In front of these 3 formulated foods, there was an AT food that was used as a control food. In a second step, the content of minerals was measured. The results revealed that the newly formulated foods are true sources of minerals in sufficient quantity and quality to produce a harmonious development of the quail.

Key words: Flour, nere, pulp, fish, snail, corn, food, poultry, quail.

INTRODUCTION

In Ivory Coast, despite extensive projects carried out by both private and state structures for livestock development, this sector remains a secondary activity **(Coulibaly, 2013)**. Thus, among the many technical questions that arise to accompany the development of the sector, that of food is particularly pregnant. Indeed, food represents the main share of the cost (60 to 80%) of production **(MRA, 2010).** The issue of supply of food inputs is all the more crucial nowadays as we are witnessing on the international market the rising cost of ordinary raw materials such as corn (carbohydrate food), soybean meal and groundnut powder. fish (protein raw materials). Soybean meal has better nutritional characteristics. However, low domestic soybean production and high costs of imported meal are the main factors limiting its use. In addition, the high prices of commonly used fish and meat powders force food manufacturers or poultry farmers to import these raw materials **(June *and al.,* 1991)**.

Given this situation, research and development of alternative food resources whose availability or cost are not limiting factors could be a solution to improve poultry productivity. Thus, this study will consist in enriching corn flour (*Zea mays*) with grain and nere pulp (*Parkia biglobosa*) as a source of vegetable protein on the one hand and with fish powders (*Sardinella maderensis*) and snail (*Achatina fulica*), important sources of protein and inexpensive commodity available in Ivory Coast (**Aboua 1990, Aboua 1995, Gicogna 1992**). The objective of this work is to study the mineral composition of 3 diets formulated with corn meal and enriched with nere powders (grains and pulp), fish and snail and a commercial food for quail feed in Ivory Coast.

MATERIALS 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) **(figure 1)**.

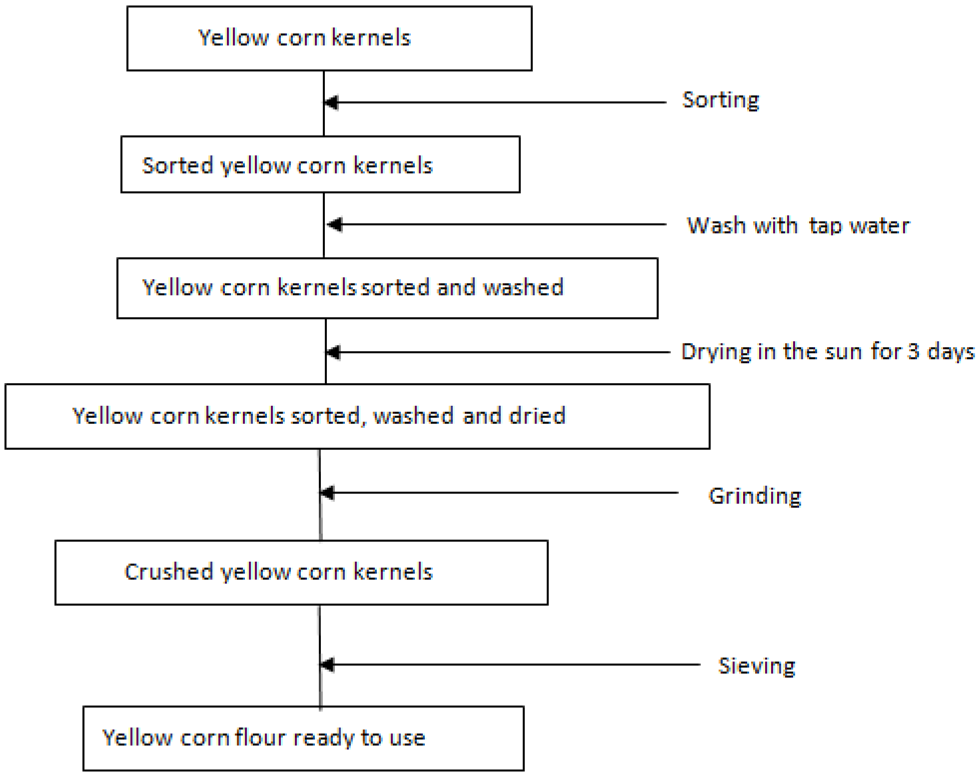

Figure 1: Process flow diagram of corn flour (*Zea mays*)

1.2- Seed powders and nere pulp (*Parkia biglobosa*)

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. After getting the nere 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 **(Figure 2)**.

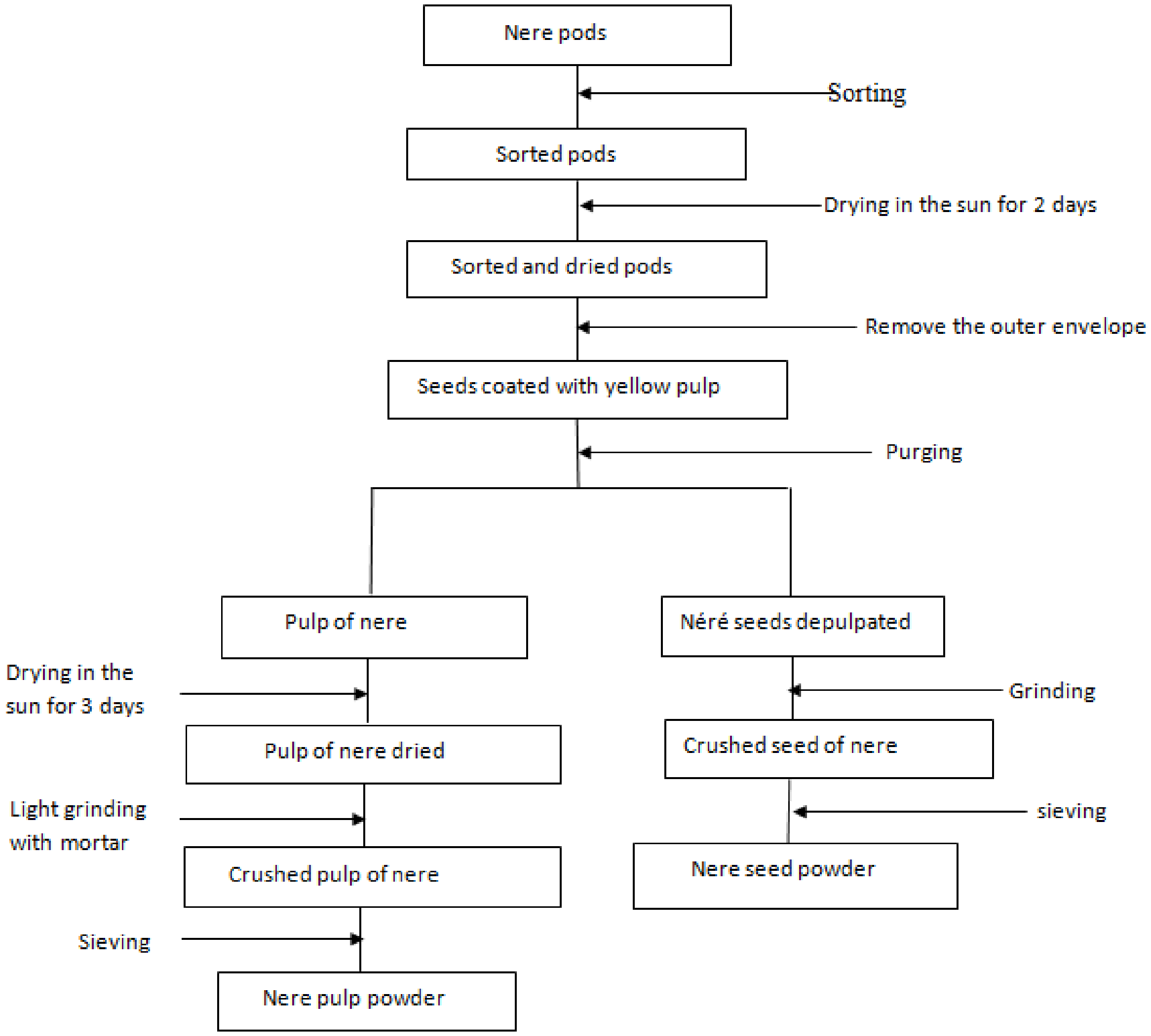

Figure 2 : Process flow diagram of pulp powder and nere seeds (*Parkia biglobosa*)

1.3-Snail Flour (*Achatina fulica*)

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 **(Figure 3)**.

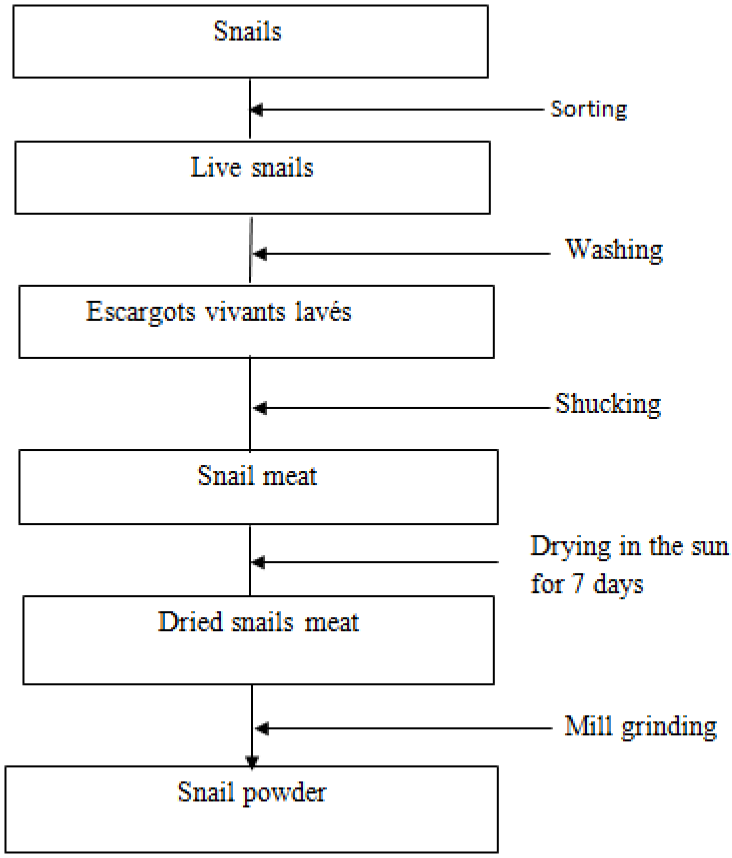

Figure 3 : Process flow diagram of snail powder (*Achatina fulica*)

1.4-Fish Flour (*Sardinella maderensis*)

After their purchase at the Adjamé 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 **(Figure 4)**.

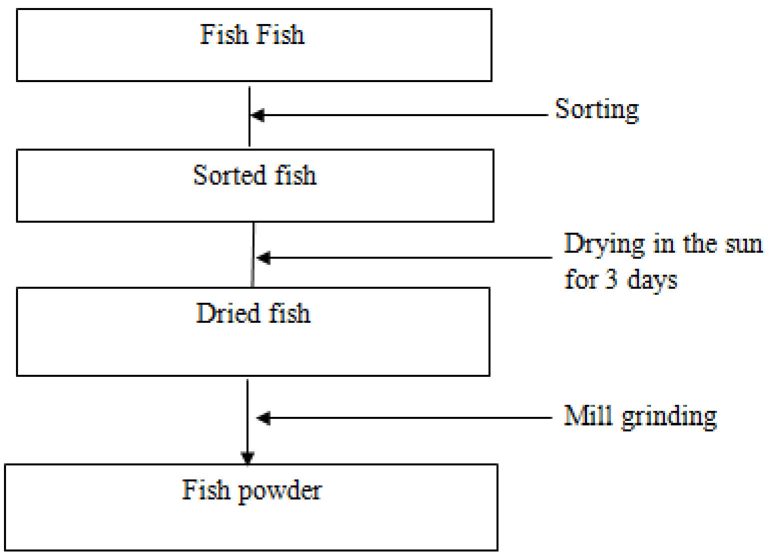

Figure 4 : Process flow diagram of fish powder (*Sardinella maderensis*)

2- Feed formulation

Three (3) types of feed have been formulated:

-A1: food whose major animal protein source is only the powder of fish *Sardinella maderensis* (100%);

-A2: food whose major animal protein source is only the Snail *Achatina fulica* powder (100%);

-A3: food whose major animal protein source is the snail composite powder (*Achatina fulica*) / fish (*Sardinella maderensis*) (50/50, w / w).

For each of these feed formulations, the main carbohydrate component is exclusively yellow corn meal (*Zea mays*). Then, the same amount of nere powder (grains and pulp) as well as the other usual inputs were added to these feeds as detailed in Table (1) below.

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

Quantity (Kg) out of 100 Kg of feeds	Breeding periods					
Ingrédients	Stard-up			Growth		
	A1	**A2**	**A3**	**A1**	**A2**	**A3**
Corn flour	56	56	56	58	58	58
Néré pulp flour	3	3	3	3	3	3
Néré seed flour	20,8	20,8	20,8	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
Méthionine	0.15	0.15	0.15	0.1	0,1	0,1

In addition to these three newly foods, a fourth food was purchased commercially and served as a control food: Food **AT**

3-Determination of Mineral Nutrient Contents

3.1 -Organic content 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.

The method of **Taussky & Shorr (1953)** using the vanado-molybdic reagent was used to determine the phosphorus content of foods. Indeed, a feed mass of 1 g was mineralized in a mineralizer (Nabertherm 30-3000 ° C) at 550 ° C for 12 h. The obtained mineralizer was dissolved in 0.1 mL of concentrated nitric acid. The resulting solution was stirred slightly for 2 min at room temperature (28 ° C). Then, three (3) ml of vanado-molybdic reagent was added to this reaction medium. The intensity of its coloration was determined at 495 nm against a control containing all the products except phosphorus. The absorbance of the test was converted to the amount of phosphorus by means of those reaction media containing potassium dihydrogenphosphate (2-4 mg / ml) prepared under the same conditions as the test.

4- Statistical analysis

Statistical analyses of the data were performed using the software Statisticala 7.1 (Statsolft Inc, 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 was defined at the 5% threshold.

III-Results And Discussion

1-Results

1-1-Contents of macronutrients

The calcium contents of the newly formulated A1, A2, A3 and AT trade starter foods are respectively 1.97 ± 0.07; 0.95 ± 0.06; of 1.46 ± 0.07 and 1.22 ± 0.01%. Those of the newly formulated A1, A2 and A3 and AT trade foods are respectively 1.91 ± 0.08; 1.62 ± 0.05; 2.27 ± 0.06 and 0.80 ± 0.01%. The calcium contents of the starter foods are statistically different ($P \leq 0.05$) from each other. The decreasing order of these contents is as follows: calcium content of the starter feed A1 > calcium content of the starter feed A3 > calcium content of the starter feed AT > calcium content of the feed starter feed A2 **(Figure 5)**. That of the growth foods is as follows: calcium content of the growth food A3 > calcium content of the growth food A1 > calcium content of the food of growth A2 > calcium content of the food of AT growth **(Figure 6).**

The phosphorus contents of the newly formulated A1, A2, A3 and AT trade starter foods are respectively 0.79 ± 0.04; 0.44 ± 0.01; of 0.60 ± 0.02 and 0.50 ± 0.02%. Those of newly formulated growth foods A1, A2 and A3 and AT trade are respectively 0.84 ± 0.03; 0.48 ± 0.01; 0.81 ± 0.03 and 0.51 ± 0.01%. The phosphorus contents of the starter feeds are statistically different ($P \leq 0.05$) from each other. The decreasing order of these contents is as follows: phosphorus content of the starter feed A1 > phosphorus content of the starter feed A3 > phosphorus content of the starter feed A > phosphorus content of the feed starter feed A2 **(Figure 5)**. That of the decay foods is as follows: Phosphorus content of the growth feed A1 Phosphorus content of the growth feed A3 > Phosphorus content of the AT growth feed > Phosphorus content of the growth feed A2 **(Figure 6)**.

The potassium contents of the newly formulated A1, A2 and A3 starter feeds and AT trade feeds are respectively 0.89 ± 0.01; 0.93 ± 0.01; of 1.00 ± 0.02 and 1.01 ± 0.03%. Those of newly formulated growth foods A1, A2 and A3 and AT trade are respectively 0.98 ± 0.03; 0.88 ± 0.01; of 1.10 ± 0.03 and 1.12 ± 0.01%. The potassium contents of starter foods are statistically different ($P \leq 0.05$) from each other. The decreasing order of these contents is as follows: potassium content of the starter feed AT = potassium content of the starter feed A3 > potassium content of the starter feed A2 > potassium content of the feed starting food A1 **(Figure 5)**. That of the growth feeds is: potassium content of the growth feed AT = potassium content of the growth feed A3 potassium content of the growth feed A1 > potassium content of the growth feed A2 **(Figure 6)**.

The magnesium contents of the newly formulated starter foods A1, A2 and A3 and AT trade are respectively 0.25 ± 0.01; 0.24 ± 0.01; of 0.20 ± 0.01 and 0.19 ± 0.01%. Those of the newly formulated growth foods A1, A2 and A3 and AT trade are respectively 0.21 ± 0.03; 0.26 ± 0.01; 0.33 ± 0.03 and 0.34 ± 0.01%. The decreasing order of these contents is as follows: magnesium content of the starter food A1 = magnesium content of the starter feed A2 > magnesium content of the starter food A3 = magnesium content of the starter food AT start feed **(Figure 5)**. That of the growth foods is as follows: magnesium content of the growth food AT = magnesium content of the growth food A3 > magnesium content of the food growth A2 > magnesium content of the food of growth A1 **(Figure 6)**.

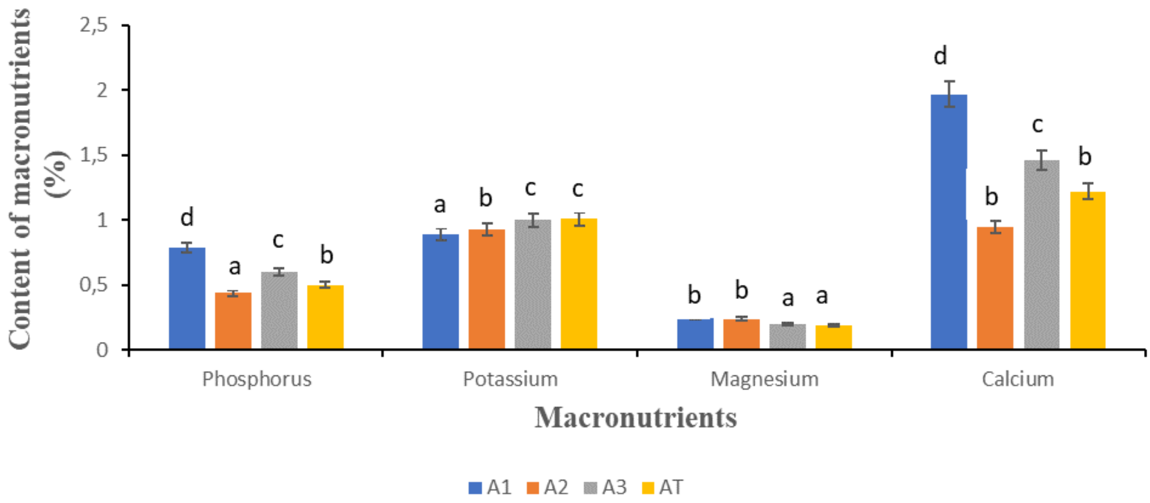

Figure 5: Contents of macronutrients newly formulated starter food and trade
The same letters assigned to averages mean that they are not different at the 5% threshold.

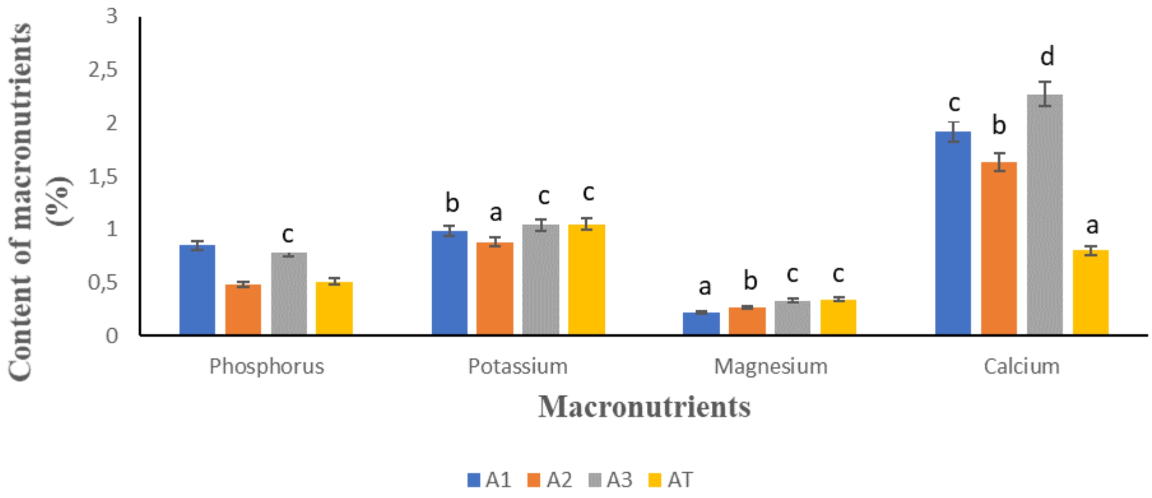

Figure 6 : Contents of macronutrients newly formulated growing food and trade The same letters assigned to averages mean that they are not different at the 5% threshold.

1-2-Contents of trace elements

The iron contents of the newly formulated A1, A2, A3 and AT commercial starter foods are respectively 3.33 ± 0.04; 3.81 ± 0.01; of 5.72 ± 0.03 and 4.32 ± 0.01 mg / kg. Those of newly formulated growth foods A1, A2 and A3 and AT trade are respectively 3.31 ± 0.04; 3.36 ± 0.01; 4.43 ± 0.05 and 3.34 ± 0.01 mg / Kg. The decreasing order of these contents is as follows: Iron content of the starter feed A3 > iron content of the starter feed AT > iron content of the starter feed A1 **(Figure 7)**. The food of growth is as follows: iron content of the food of growth A3 - iron content of the food of growth A2 = iron content of the food of growth AT = iron content of the food of growth A1 **(Figure 8)**.

The manganese contents of the newly formulated starter foods A1, A2 and A3 and AT trade are respectively 1.8 ± 0.02; 1.81 ± 0.01; 1.8 ± 0.01 and 1.77 ± 0.03 mg / Kg. There is no significant difference ($P \geq 0.05$) between them **(Figure 7)**. The manganese contents of the newly formulated A1, A2, A3 and AT trade feeds are 1.80 ± 0.01, respectively; 1.81 ± 0.01; of 1.82 ± 0.02 and 1.65 ± 0.11 mg / Kg. Those newly formulated growth foods A1, A2 and A3 are statistically identical ($P \geq 0.05$) to each other. However, they are statistically higher ($P \leq 0.05$) than that of the AT commercial growth food **(Figure 8)**.

The sodium contents of the newly formulated A1, A2, A3 and AT trade starter foods are respectively 8.87 ± 0.12; 6.31 ± 0.21; of 8.98 ± 0.01 and 8.77 ± 0.13 mg / Kg. Those of starter foods A1 and A3 are statistically ($P \geq 0.05$) identical to each other. They are statistically higher ($P \leq 0.05$) than A2 starter and AT trade foods **(Figure 7)**. sodium contents of the newly formulated growth foods A1, A2 and A3 and AT commerce are respectively 15.5 ± 0.32; 9.61 ± 0.21; of 17.81 ± 0.11 and 6.57 ± 0.13 mg / Kg. They are significantly ($P \leq 0.05$) different from each other. The decreasing order of these contents is as follows: sodium content of the growth food A3 > sodium content of the growth food A1 > sodium content of the A1 growth food > sodium content of the food AT trade growth food. Sodium levels are the highest of all the minerals studied **(Figure 8)**.

The copper contents of the newly formulated A1, A2, A3 and AT commercial starter foods are respectively 0.47 ± 0.02; 0.61 ± 0.12; of 0.68 ± 0.03 and 0.70 ± 0.03 mg / Kg. Those of the A2, A3 and AT trade starter foods are statistically identical ($P \geq 0.05$) to each other. They are statistically higher ($P \leq 0.05$) than that of the starter feed A1 **(Figure 7)**. The copper contents of the newly formulated A1, A2 and A3 and AT trade feeds are 1.00 ± 0.12, respectively; 1.10 ± 0.12; of 1.11 ± 0.03 and 0.96 ± 0.05 mg / Kg. They are statistically ($P \geq 0.05$) identical to each other **(Figure 8)**.

The zinc contents of the newly formulated A1, A2, A3 and AT trade starter foods are respectively 2.7 ± 0.02, 2.21 ± 0.12; 2.22 ± 0.03 and 1.80 ± 0.03 mg / Kg. Those newly formulated starter foods A2 and A3 are statistically ($P \geq 0.05$) identical to each other. They are statistically ($P \leq 0.05$) lower and higher respectively than those of A1 foods and AT trade **(Figure 7)**. The zinc contents of the newly formulated A1, A2 and A3 and AT trade feeds are 1.63 ± 0.02, respectively; 1.21 ± 0.02; of 1.00 ± 0.03 and 1.81 ± 0.03 mg / kg. The descending order of these grades is as follows: Zinc content of the AT trade growth feed > Zinc content of the A1 growth feed > Zinc content of the A2 growth feed > Zinc content of growth food A3 **(Figure 8)**.

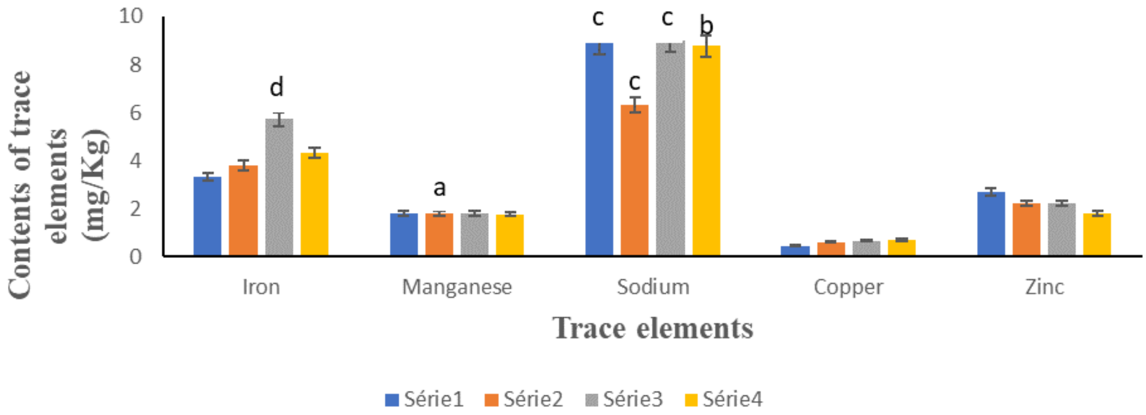

Figure 7 : Contents of trace elements newly formulated starter food and trade
The same letters assigned to averages mean that they are not different at the 5% threshold.

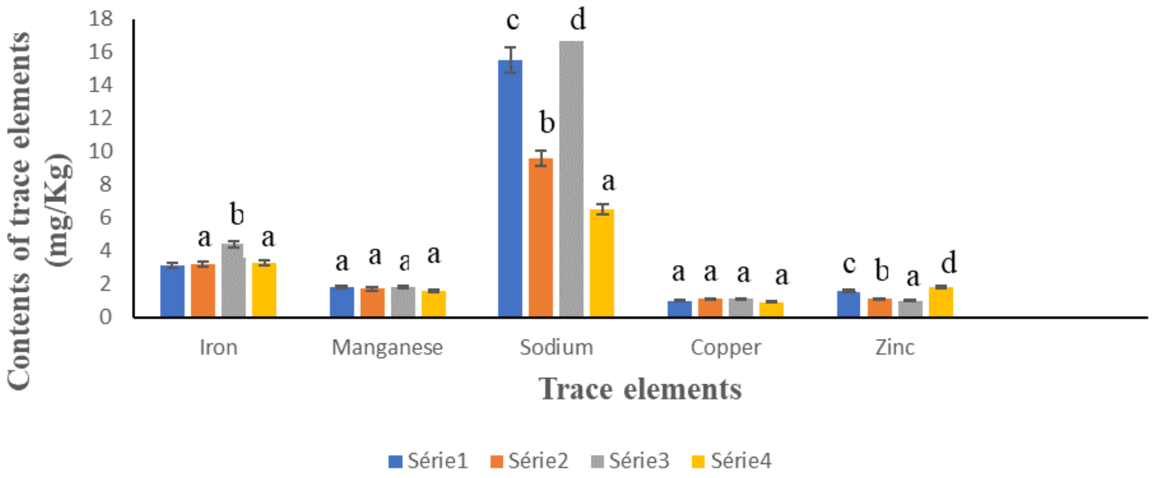

Figure 8 : Contents of trace elements newly formulated growing food and trade
The same letters assigned to averages mean that they are not different at the 5% threshold.

2-Discussion

The newly formulated and commercial starter and growth foods contain a variety of mineral elements. Certainly, the mineral elements present in formulated foods are found in commercial foods but most of these minerals are more concentrated in formally new foods (iron, zinc, phosphorus, calcium ...). This is an advantage for newly formulated products as these minerals are of paramount importance because of their role in the body. Indeed, iron is used for the production of red blood cells and is used to produce hemoglobin, which provides oxygen to the cells... **(Umar *and al.,* 2007)** Calcium is best known for its role in bone building, nevertheless, it is only one of its properties. One can for example emphasize its action on the heart rate or on the control of the weight. Zinc, on the other hand, plays a role in the constitution of the genetic material of DNA and RNA, and is involved in cell growth. The most abundant mineral element is unfortunately sodium. Sodium in the body plays an important role in the hydration state of the body. 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 to increasing the risk of cardiovascular disease, kidney disease and osteoporosis **(Onyiriuka *and al.,* 1997, Umar *and al.,* 2007)**. This abundance in the foods studied can be explained by its incorporation into the production of food. Potassium whose presence in newly formulated and commercial foods should play an important role in the acid-base balance of our body by maintaining a good pH level in our body, the synthesis of macronutrients such as carbohydrates and carbohydrates. protein, the regulation of blood pressure, its intervention in the phenomenon of muscle contraction, essential for the proper functioning of the heart muscle and the entire body muscle, is unfortunately not abundant, so that reports Na / K are greater than 1. Indeed, **FAO / WHO (1991)** recommended for food a Na / K ratio of less than 1. Ca / P ratios obtained with newly formulated foods (A1, A2 and A3) are greater than 1, which shows that they are richer in calcium than in phosphorus. This situation is obtained thanks to shredded shells that have been incorporated into formulated foods. Certainly, a source of calcium has also been incorporated into the commercial food. Ca / P ratios greater than 1 are in accordance with the recommendations of **Jacotot & Leparco (1992) and Kemi *and al.* (2010)**.

IV-Conclusion

At the end of this study, it is worth remembering that the mineral balance highlighted in newly formulated foods is a real asset for these feeds destined for poultry feed. The foods studied are rich in minerals capable of meeting the needs of poultry for maintenance, production, growth and reproduction. However, the A3 formulated food appears to be the one that could produce the same impact as the control feed on the quality of the poultry products.

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