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***RESEARCH ARTICLE***

# INCORPORATION OF LOCAL PLANT RAW MATERIALS IN THE FEEDING OF JUVENILE NILE TILAPIA (Oreochromis niloticus, LINNE, 1758) IN SENEGAL, WEST AFRICA

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## Abstract

A research for eight weekswas conducted to evaluate the effect of substituting fish meal with local agricultural products in the diet of Nile Tilapia (Oreochromis niloticus).Three treatment dietaries were prepared. The dietary composition of the tested diets is as follows: A1/plant based-diet (Groundnut cake, sesame cake, millet bran, maize meal and 0% fish meal); A2/fishmeal partial replacement diet (Groundnut cake, sesame cake, millet bran, maize meal, and 10% fish meal) and A3/fishmeal based-diet (Groundnut cake, sesame cake, millet bran, maize meal, and 25% fish meal). All the diets were isoprotein and isolipidic diets. The initial average weight of the fish was 3.45±0.5g. The fishes were fed twice a day in triplicate for eight weeks. After the experiment, the final average weights were 4.97±0.5g, 5.43±0.5g, and 5.86±0.5g for A1, A2, and A3, respectively. There were significant differences ($p < 0.05$) among the three diets. The Feed Conversion Ratio (FCR) of juveniles fed on the A3 diet (1.77) was significantly better (lower) compared to A1 and A2 (3.41 and 2.59, respectively). The FCR of the fish fed diets A1 and A2 were not significantly different. The Specific Growth Rate (SGR), Individual Daily Growth (IDG), and relative average weight gain of juveniles fed on A3 and A2 diets were not significantly different. However, they were significantly higher ($p < 0.05$) than those of the A1 diet. There were no significant differences ($p > 0.05$)among all the diets for average weight gain and survival rate. This study revealed the possibility of partial but not total substitution of fishmeal by plant materials in the diet of 3.45g Oreochromis niloticus fingerlings considering both growth and economic factors.



## Introduction:-

Globally, since 2016, aquaculture has been the primary source of fish available for human consumption. In 2018, this share was 52 percent, which is expected to continue to increase in the long term. Aquaculture has extended the supply of fish to regions and countries with little or no access to aquaculture, often at lower prices, leading to

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improved nutrition and food security (FAO, 2020). The evolution of aquaculture production in general and inland fish farming in particular towards increasingly intensive systems has made it possible to increase productivity and reduce product prices. This production increased from 3.5 megatons/ metric tons (Mt) in 1970 to more than 44 Mt in 2011, more than 70% of world aquaculture production (FAO, 2012).

Worldwide aquaculture production has been marked by spectacular growth in recent years with a total production of 82.1 millionof tons. For Africa, this production is 2.2 million tons.Senegal's aquaculture production is about 1000 per year. (FAO, 2020).

This considerable development in production has been accompanied by the massive use of fishmeal and fish oil for the feed industry of aquaculture, which further accentuates the problems of depletion of fishery resources.

Therefore, it has become necessary to find substitutes to limit the dependence of aquaculture on fishmeal (Medale and Khausik, 2009; Medale et al., 2013; Burel and Medale, 2014). The valorization of local agricultural by-products in fish feed could reduce competition between human and animal consumption of fish, but also production costs of aquaculture feeds (Medale and Khausik, 2009; Zhao et al., 2010).

For the sustainability of this sector, it is essential to diversify the raw materials used in the formulation or composition of aquaculture feeds while ensuring a balanced and digestible feed to limit the impact of farming on the environment. One of the significant issues in fish feed composition is resources with high protein levels and good lipid profiles. The cost of fishmeal, usually used as a protein source in feed formulas, strongly influences the development of fish farming (Gougbedji et al., 2020).

In the sub-region, many researchers have worked on substituting fishmeal with local ingredients, such as Tshinyama (2016), Chikou et al. (2019), Coulibaly et al. (2020), and Kouadio et al. (2020) in the Democratic Republic of Congo-DRC and Kimu et al. (2016) in Ivory Coast. These studiesshowed that combining locally available ingredients would provide good quality fish feed at a lower cost. In this context, the study on the formulation of fish feed based on local ingredients is undertaken.

In Senegal, Ndong and Fall (2007); Fall et al. (2012); Loum et al. (2013); Sagne et al. (2013); Ly et al. (2021)have conducted study on the use of one or two ingredients.

Therefore, this study aims to develop feed from locally available plant raw materials (Groundnut cake, sesame cake, millet bran, and corn flour) by partially or totally replacing fishmeal to reduce cost without affecting feed efficiency for juveniles (3.45g) tilapia, O. niloticus. In addition, evaluate the impacts of the experimental diets on the cost of the product to determine the most cost-effective diet for tilapia farming in Senegal.

## Materials And Methods:-

### Culture Conditions

The fishes used in this trial were obtained from the aquaculture station of the University Institute of Fisheries and Aquaculture of the University Cheikh Anta DIOP Dakar, Senegal. One hundred and eighty (180) Oreochromis niloticus fry, with an initial mean weight of 3.45 ± 0.5g, were used. The fishes were collected from the same batch of hatcheling to have homogeneity among the individuals. After collection, the fish were acclimatized to the experimental conditions for two weeks. To determine initial body composition, 20 randomly selected fish were killed, filleted, and stored at -18°C for subsequent proximal analysis (AOAC, 1990). At the beginning of the experiment, one hundred and eighty fish were randomly divided into three different groups with three replicates per group, and each replicate or tank contained 20 fish. A total of nine plastic tanks with a capacity of sixty (60) litereach were used in an open system. An air pump was used to oxygenate each tank. All tanks were cleaned daily in the morning and afternoon by siphoning off the remeaning diet and faeces.

### Diet Preparation

Pearson's Square Method was used for the feed formulation. Three isonitrogenous and isocaloric diets were formulated diets. A portionof the total dietary protein is derived from fish meal, and the remainingis from the different ratios of maize meal, millet meal, groundnut meal, and sesame meal (Table 1).

Theobjective of the present study was to compare three different diets in triplicate: Diet A1 (plant based-diet, without fishmeal); Diet A2 (fishmeal partially substituted at 60%, 10% dietary incorporation); Diet A3 (fishmeal based-diet, 25% dietary inclusion). The plant base diet constitutes the basic composition of the test diets : (groundnut cake, sesame cake, millet branand corn flour).

The diets are iso-protein (31%) and iso-lipidic (13%). The primary protein sources are groundnut and sesame meals with or without fishmeal. All the primary ingredients were ground in the hammer mill and passed through a No. 40 (425μm) mesh screen. The minerals and vitamins mixture were purchased from Aquavet Company, Thies, Senegal. Afterwell mixing the ingredients, 30% water was added and mixed to form dough or paste. The paste was passed through an extruder to produce spaghetti-like shape and dried at 37°C for two days. The dried feeds were packaged in plastic bags and stored in a freezer. The proximate analysis was performed on all the feeds.

**Table 1:-** Composition of the test diets (g/1000g) used for rearing juvenile Oreochromis niloticus.

| Ingredients | Protein level % | Lipid content % | Diet A1 | Diet A2 | Diet A3 |
|---|---|---|---|---|---|
| Fishmeal | **60** | **8.5** | **0** | **10** | **25** |
| Groundnut cake | 46 | 8.9 | 56 | 44 | 20 |
| Millet bran | 15.26 | 9.26 | 15 | 15 | 15 |
| Sesame cake | 44.9 | 11.3 | 10 | 10 | 10 |
| Corn flour | 9.3 | 3.7 | 6 | 8 | 17 |
| Fish oil | 0 | 100 | 5 | 5 | 5 |
| Sterculia gum | 15.5 | 2.28 | 2 | 2 | 2 |
| Yeast | 14 | 3.5 | 4 | 4 | 4 |
| Vitamin mixture [a] | 0 | 0 | 1 | 1 | 1 |
| Mineral mixture [b] | 0 | 0 | 1 | 1 | 1 |
| Crude protein (%) | | | **31** | **31** | **31** |
| Crude Lipid (%) | | | **13** | **13** | **12** |
| Cost is $, including the cost of production | | | **0.51** USD | **0.58** USD | 0.77 USD |

a : Vitamins -A 250000UI;Vitamin D3 250000UI;Vitamin E 5000mg;Vitamin B1 100mg;Vitamin B2 400mg; Niacin 1000mg; Pantothenate Ca 2000mg;Vitamin B6 300mg;Vitamin K3 1000g;Vitamin C 5000mg; Biotine15mg;Choline100 g ; BHT 1000 mg;

b :Minerals - Phosphorus 7%; Calcium 17%; Sodium 1.5%; Potassium 4.6%; Magnesium 7.5%; Manganese 738 mg; Zinc 3000 mg; Iron 4000 mg; Copper 750 mg; Iodine 5 mg; Cobalt 208 mg; Calcium and ground attapulgite qs 1000 g ; Fluoride 1.5% .

**1 dollar** = 596.5 Francs Communauté Financière Africaine (FCFA) on April 2022

**Growth Parameters**

The growth parameters were calculated according to the following equations by Ridha (2006) and Jiwyam (2011):
Weight gain (WG, g/ fish) = final mean body weight - initial mean body weight;
Specific growth rate (SGR, % /day) = ((ln Wt- ln Wi) /T) x 100, where,
Wt = fish weight at time t,
Wi =fish weight at time 0,
T = rearing period in days;
Feed conversion ratio (FCR) = total dry feed fed g/ fish / total wet weight gain g/ fish;
Survival rate (%) = 100 x (number of fish that survived/initial number of fish).

2.4 Water Quality Measurement

The temperature,oxygen and pH were measured in situ using a multi-parameter simultaneously. These parameters were measured twice per day (morning and afternoon).

2.5 Statistical Analysis

Data were analyzed using the statistical system (SAS-PC) (Joyner, 1985) and subjected to a One-way Analysis of Variance (ANOVA). P<0.05 indicates that the effects of treatment are significant; Tukey's test was used to compare significant differences between treatments. Results are presented as Mean (±) Standard Deviation.

## Results:-

### Physical water quality

The water parameters monitored during the study are shown in the Table2. The average temperature recorded in the experimental tanks varied between 23.25 and 23.55 °C, whereas the pH values varied between 7.63 and 7.75, oxygen varied between 3 and 4mg/l . The statistical analysis showed that the difference between the physical water quality (T, O and pH) in all the experimental tanks was not significant (P > 0.05).

**Table 2:-** Values of the physical water quality parameters of the experimental tanks.

| Diets | TANKS | T°C Min | T°C Average | T°C Max | pH Min | pH Average | pH Max |
|---|---|---|---|---|---|---|---|
| A1 | TANK1 | 20.2 | 23.45 | 26.7 | 7.01 | 7.7 | 8.4 |
| | TANK4 | 20 | 23.25 | 26.5 | 7.1 | 7.65 | 8.2 |
| | TANK7 | 20.3 | 23.55 | 26.8 | 7.1 | 7.7 | 8.3 |
| A2 | TANK2 | 20.1 | 23.4 | 26.7 | 7.1 | 7.75 | 8.4 |
| | TANK5 | 20 | 23.35 | 26.7 | 7.2 | 7.66 | 8.12 |
| | TANK8 | 20 | 23.3 | 26.6 | 7.1 | 7.65 | 8.2 |
| A3 | TANK3 | 20.1 | 23.35 | 26.7 | 7.1 | 7.65 | 8.2 |
| | TANK6 | 20.2 | 23.5 | 26.8 | 7.1 | 7.63 | 8.16 |
| | TANK9 | 20 | 23.35 | 26.7 | 7.1 | 7.65 | 8.2 |

### Zootechnical Parameters

#### Average Final Weight

Figure 1 shows the evolution of final weight gain over the entire study of O. niloticus fed the different diets A1, A2 and A3. The final average weights were 4.97±0.5g, 5.43±0.5g, and 5.86±0.5g for A1, A2, and A3, respectively. No significant differences (p >0.05) for A1, A2 and A3 speeds. After the first 30 days of rearing, the fish fed with Diets A1, A2, and A3 had almost similar growth, but two groups could be distinguished beyond this period. The higher growths were observed from Diets A3 and A2, while lower growth was observed from Diet A1 (Figure 1).

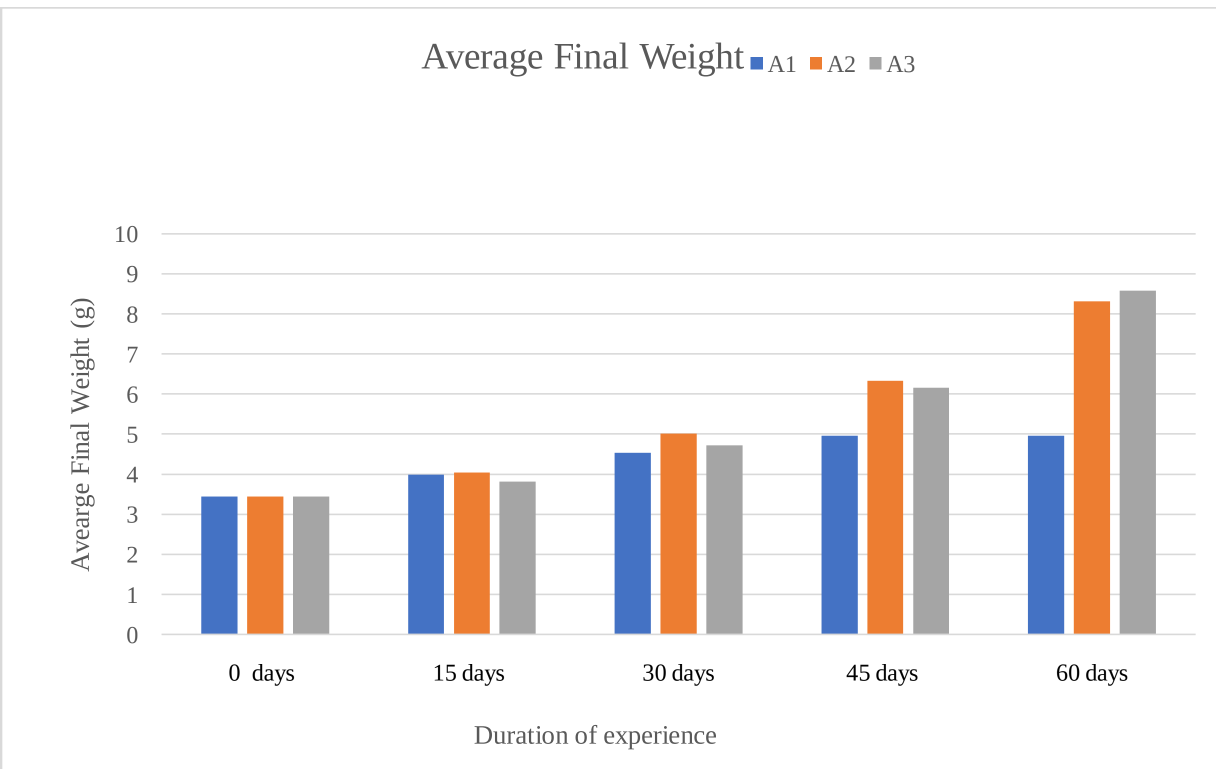


**Figure 1:-** Variation in the average final weight of Oreochromis niloticus in the tanks as a function of time and type of feed.

**Daily Individual Growth (DIG)**

The average daily individual gains (ADIG) (Figure 2) gave values of 0.036g/d for Diet A1; 0.047 for A2; 0.057 g/d for A3. These results showed that the fish fed with Diets A3 and A2 would present the best ADIG.

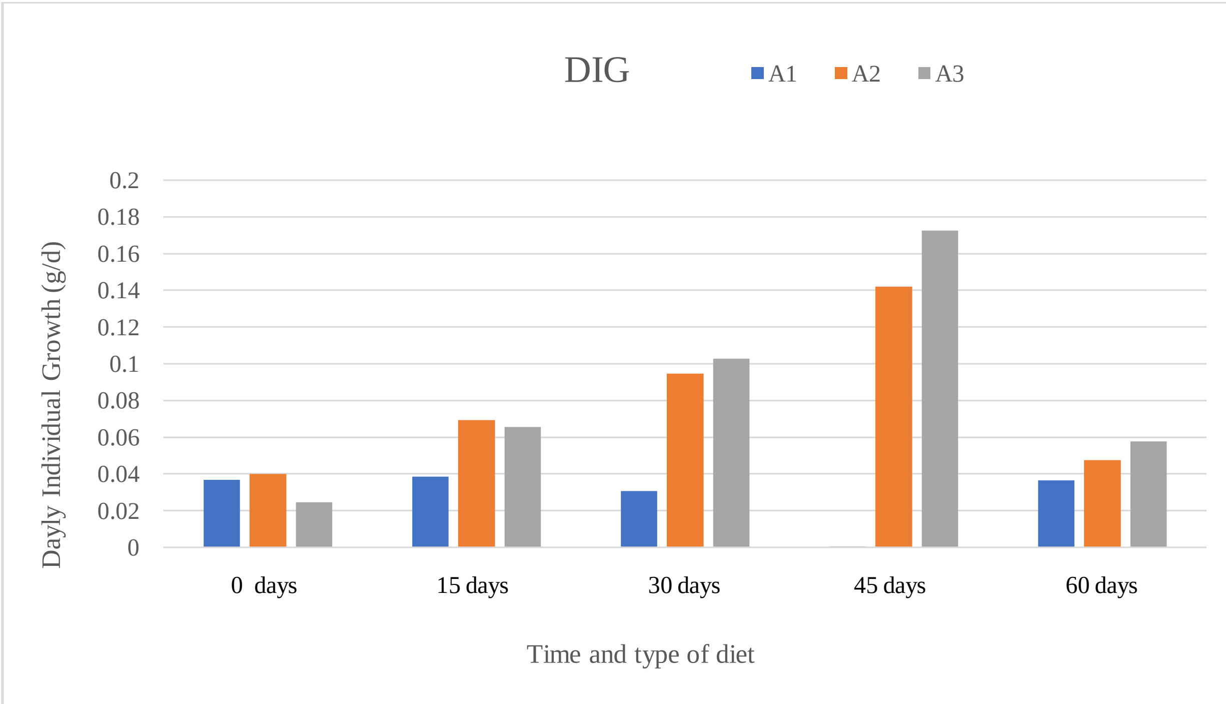


**Figure 2:-** Variation in Daily Individual Growth (DIG) between the different diets.

**Specific Growth Rate (SGR)**

The values obtained for the specific growth rate were 0.86, 1.3, and 1.26 %/d for Diets A1, A2, and A3, respectively. Diets A3 and A2 had better specific growth rates and were significantly different from Diet A1 (Figure 3).

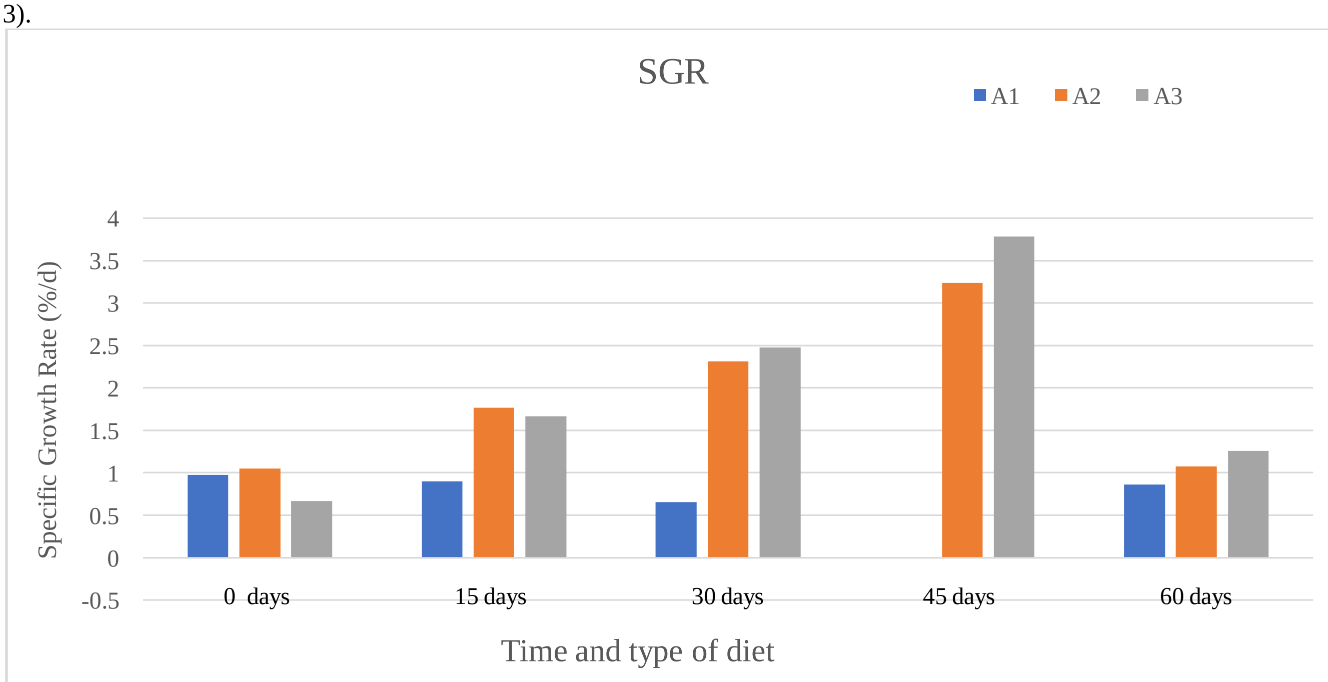


**Figure 3:-** Variation of the Specific Growth Rate (SGR) of the fish fed the three diets.

**Average Weight Gain (AWG)**

The average weight gain is shown in Figure 4. No significant difference (p >0.05)among fish fed the different diets was observed. Value-wise, the highest weight gain was obtained in the fish fed Diet A3(2.41 g/ fish) followed by those given A2 (1.76 g/ fish) while the lowest was observed in the fish fed Diet A1(1.52 g/ fish).

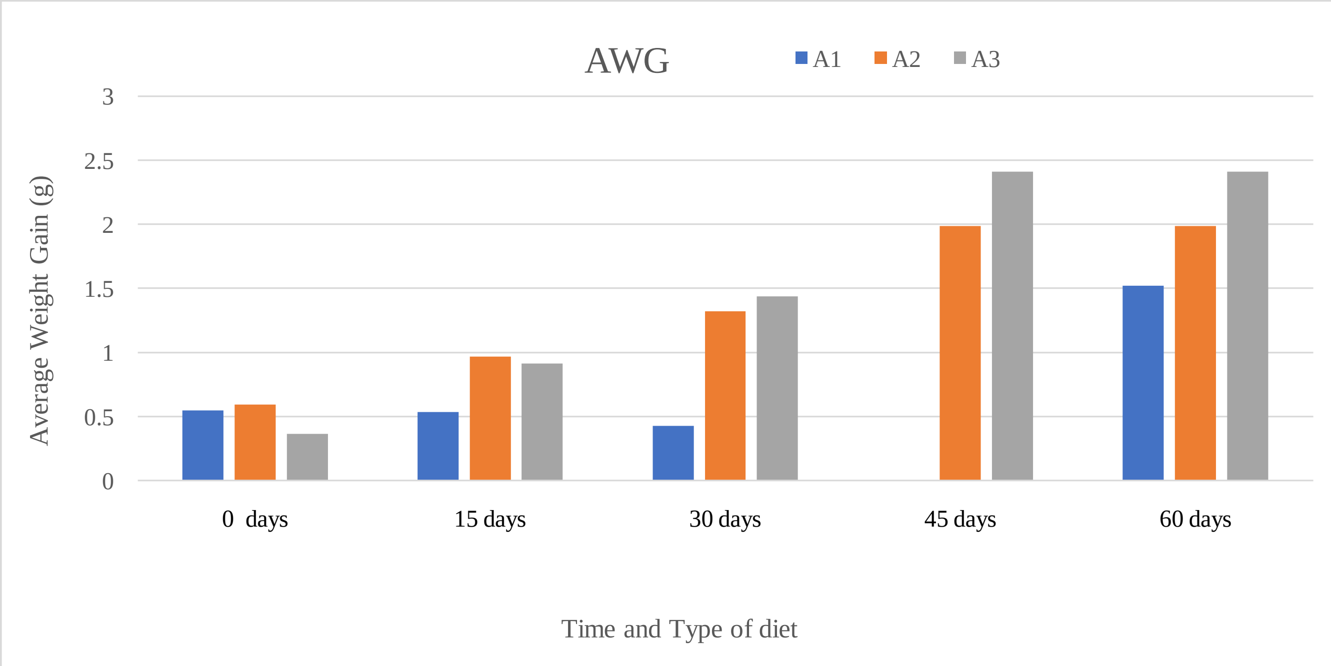


**Figure 4:-** Variation of the Average Weight Gain (AWG) of the fish fed the three diets.

**Feed Conversion Ratio (FCR)**

The FCR (Figure 5) showed that the best conversion of the fish over the entire experimental period was obtained with Diet A3 (1.77 %) followed by Diet A2(2.59%). The highest FCR was obtained with fish-fed Diet A1(3.41%).

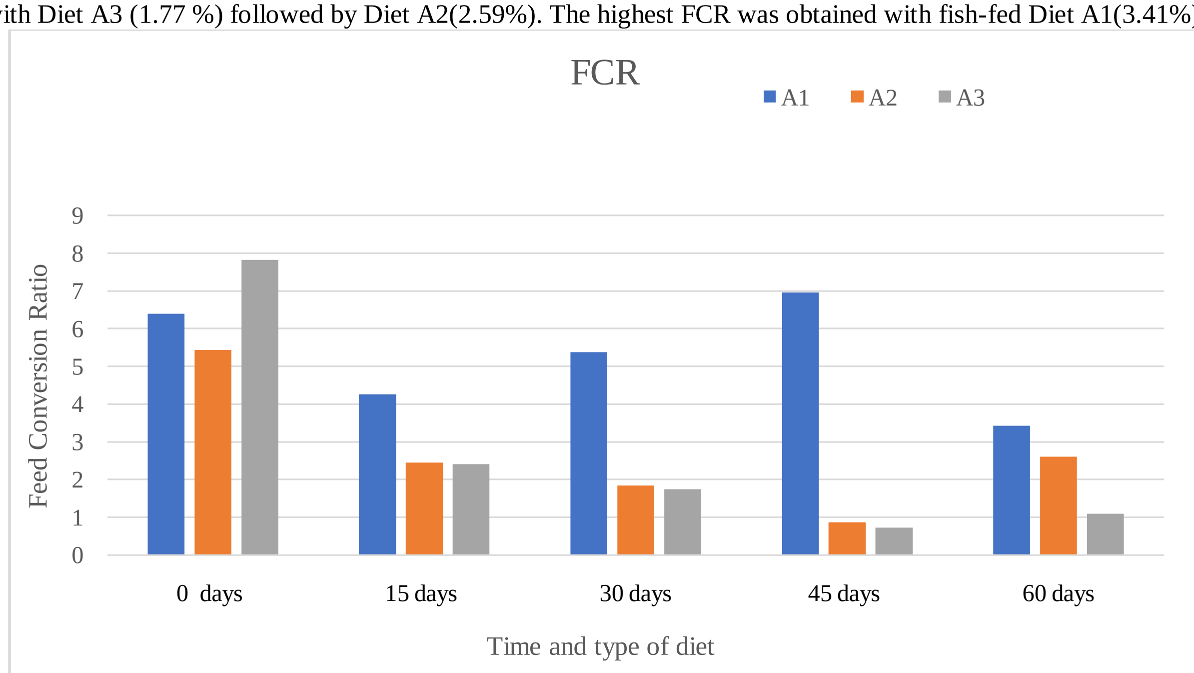


**Figure 5:-** Variation of the Feed Conversion Ratio (FCR) of the three diets.

**Survival Rate (SR)**
According to the Analysis of Variance (ANOVA) and Tukey's test, no significant differences ($P>0.05$)for the survival of the fish fed diets among Diets A1 (81.66), A2 (85.00), and A3 (96.66%) . The mortalities recorded during the experiment showed that the experimental conditions were acceptable. The deaths were caused by the fish jumping out of the tanks rather than poor water quality or feed.

The zootechnical parameters of the cultured fish are presented in Table 3. For all the growth parameters studied, namely the specific growth rate (SGR), daily individual growth (DIG), and relative average weight gain (RAWG), there were significant differences between the fish fed with Diet A3 and A2 and those fed with A1. The results of the feed conversion ratio (FCR) of juveniles fed with Diet A3 (fishmeal based-diet/25% dietary fish meal incorporation) were superior (ANOVA; $p < 0.05$) to those of juveniles receiving Diets A2 and A1 (10 and 0% fishmeal incorporation, respectively). For average weight gain (AWG) and survival rate (SR), no significant differences among fish fed the diets was observed.

**Table 3:-** Zootechnical parameters in Oreochromis niloticus subjected to three dietary treatments for 60 days.

| PARAMETERS | A1 | A2 | A3 |
|---|---|---|---|
| IAWIntial Average Weights | 3.45±0 | 3.45±0 | 3.45±0 |
| FAWFinal Average Weights | $4.95\pm0.16^{a}$ | $4.76\pm0.08^{a}$ | $4.88\pm0.30^{a}$ |
| AWG (g) Average Weight Gain | $1.52\pm0.34^{a}$ | $1.76\pm0.76^{a}$ | $2.41\pm 0.20^{a}$ |
| FCR Feed Conversion Ratio | $3.41\pm0.16^{a}$ | $2.59\pm0.60^{a}$ | $1.77\pm0.51^{b}$ |
| SGR (%/d) Specific Growth Rate | $0.86\pm0.16^{b}$ | $1.30\pm0.22^{a}$ | $1.26\pm0.08^{a}$ |
| RAWG AW (%)relative average weight gain | $44.9\pm10.07^{b}$ | $57.59\pm10.87^{a}$ | $69.96\pm5.81^{a}$ |
| DIG (g/d) Daily Individual Growth | $0.036\pm0.008^{b}$ | $0.047\pm0.008^{a}$ | $0.057\pm0.004^{a}$ |
| SR Survival Rate (%) | $85.00\pm5.77^{a}$ | $85\pm13.22^{a}$ | $96.66\pm2.88^{a}$ |

For each parameter, the values which are not assigned the same letter are significantly different ($p < 0.05$, and those with at least one same letter in common, are not significantly different ($P>0.05$)

**Fish Body Composition Analysis**
The analysis of the body composition of the initial and final fish is represented by the graph (Figure 6). The protein levels for the initial fish (15.8) and Diets A1 (16.8), A2 (15.9), and A3 (16.0) are relatively constant throughout the experiment. The Ash content of the initial (4.8) and final samples of Diets A1 (4.5), A2 (4.0), and A3 (4.7) was also similar. The fat percentage shifted slightly upward for the fish fed with A1 (6.6) and A2 (6.5) diets but not the A3 (4.4) diet when compared to the value of the initial fish (4.2). The difference in the dietary composition did not influence the body composition of the fish in this study.

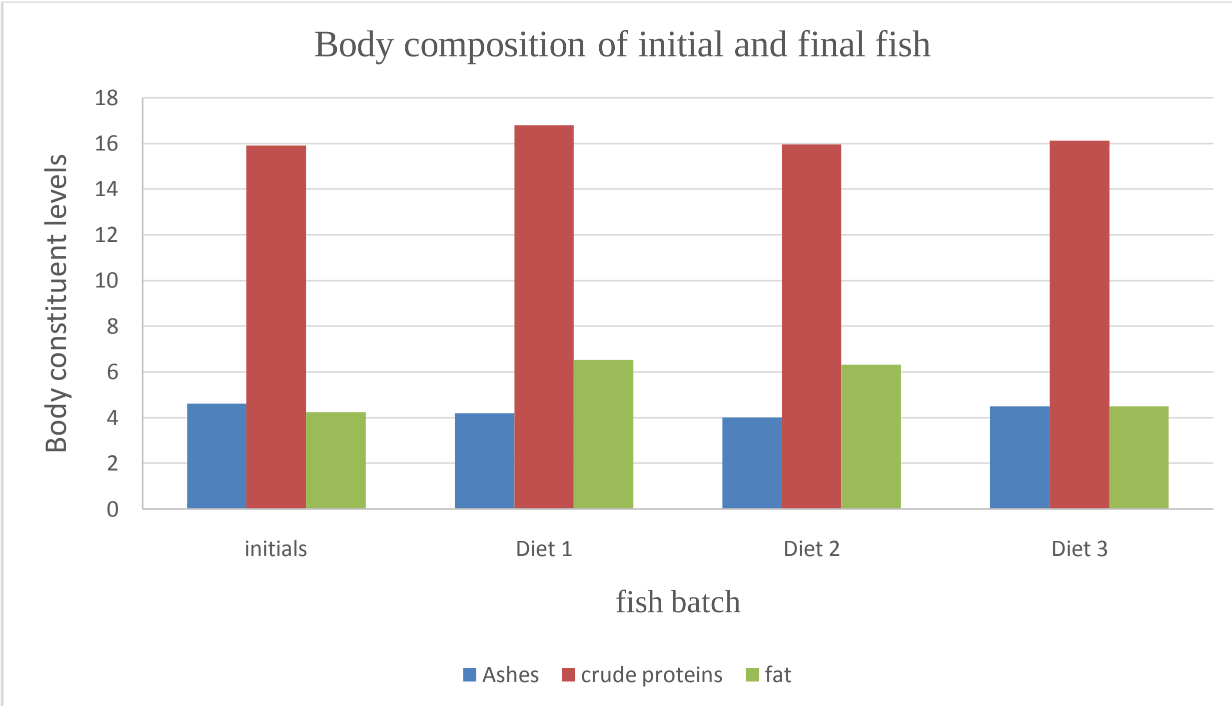


**Figure 6:-** Variation of body composition of juvenile tilapia (Oreochromis niloticus).

**Economic Approach**

**Cost Estimation of 1Kg of Feed**

The production cost of kg of feed was determined from the raw materials available in the local market and the percentage of incorporation of different ingredients in the formulation. The approach is summarized in Table 4. Diets A1, A2, and A3 cost, 0.51; 0.58 and 0.77 US $ per kg , respectively. The price difference between Diets A2 and A3 is 19 US $.

**Table 4:-** Estimation of the cost (USD) of one kg of produced feed.

| Ingredient prices (USD)* | Price of one kg of diet A1 | Price of one kg of diet A2 | Price of one kg of diet A3 |
|---|---|---|---|
| Fishmeal = 0.87 | (0 x 0.87)/100 | (10 x 0.87)/100 | (25 x0.87)/100 |
| Fish oil = 0.71 | (5 x 0.71)/100 | (5 x 0.71)/100 | (5 x 0.71)/100 |
| Groundnut meal = 0.35 | (56 x 0.35)/100 | (44 x 0.35)/100 | (20 x 0.35)/100 |
| Corn flour = 0.43 | (6 x 0.43)/100 | (8 x 0.43)/100 | (17 x 0.43)/100 |
| Millet flour = 0.26 | (15 x 0.26)/100 | (15 x 0.26)/100 | (15 x 0.26)/100 |
| Sesame cake = 0.26 | (10 x 0.26)/100 | (10 x 0.26)/100 | (10 x 0.26)/100 |
| Vitamins = 3.46 | (1 x 3.46)/100 | (1 x 3.46)/100 | (1 x 3.46)/100 |
| Minerals 4.33 | (1 x 4.33)/100 | (1 x 4.33)/100 | (1 x 4.33)/100 |
| Yeast 0.87 | (4 x 0.87)/100 | (4 x 0.87)/100 | (4 x 0.87)/100 |
| Baobab leaves (Lalo) = 0.52 | (2 x 0.52)/100 | (2 x 0.52)/100 | (2 x 0.52)/100 |
| Transport. electricity and Workforce : 0.087 USD/kg | **0.087** | **0.087** | **0.087** |
| Total | **0.51** USD | **0.58** USD | **0.77** USD |

**Cost Estimation of 1 Kg of Fish**

The feed cost of production per kg of fish was estimated by multiplying the price per kg of feed by the consumption index, defined as the ratio of feed consumed to weight gain (Table 5). Producing 1 Kg of fish with an A3 diet costs less than those of A2 and A1 diets, while in terms of fish growth performance, there were no significant differences between A2 and A3 diets. The feeds currently imported into Senegal gave approximately the same results as the test feeds regarding zootechnical performance but cost twice as much as A2 and A3 diets.

**Table 5:-** Estimated feed cost for producing one kilogram of fish.

| Diets | Price for one kg of feed (USD) | FCR | Cost for producing one kg of fish (USD) |
|---|---|---|---|
| Diets A1 | 0.51 | 3.41 | 1.72 |
| Diets A2 | 0.58 | 2.59 | 1.51 |
| Diets A3 | 0.77 | 1.77 | 1.37 |

## Discussion:-

### Physical Water Quality

The highest water temperature recorded was 26.8 $^{o}$C. The value decreased to 20$^{o}$C in the last month of the experiment as it coincided with the cold period, and there was no water heater to increase the water temperature. The optimum temperature for optimum growth for Oreochromis niloticus is between 25 and 30$^{o}$C (FAO, 2012). On the other hand, the pH values (7.01 to 8.4) during this experiment remained within the recommendations, which are between 5 and 9, according to (FAO, 2012). The oxygen level is almost constant during the whole experiment. Air aerators are permanently installed in the rearing tanks.

### Growth Performance Parameters

### The survival

The survival rates (85.00, 85.13 and 96.66%) observed during the 60 days of the experiment showed that the experimental conditions were within the accepted standard. The results of the present study are in line with those of Fiogbe et al.(2009)(86.67 to 97.78%); Bamba et al.(2014) (89 to 93%); Djekota et al.(2020) (89 ± 0.83 to 89.39 ± 0.30%). On the contrary, the survival rate values of this study are relatively less than those of Robert-IGA (2008) (97%) and Sarr et al. (2015) (99%).

### Feed Conversion Ratio

The statistical analysis revealed that fish fed with Diets A3 and A2 obtained significantly better FCR values than those fed on A1 ($P < 0.05$). FCR values ranged between 3.41 (A1) and 1.72 (A3).The highest FCR of fish-fed diet A1 is due to lower feed consumption. These results are slightly higher than those of Sagne et al. (2013) (1.77; 2.67; 1.45, 1.98; and 1. 37), Sarr et al. (2015) (1.64 and 1.79), and Almeida et al. (2020) (0.9; 0.72 and 1.85). Among the three diets, fish that received Diet A3 containing 25% fishmeal had the best conversion ratio. The nutritional needs of fish correspond approximately to the body composition of the species in question. In other words, fishmeal has macro and micronutrient profile that meets the nutritional needs of fish. Vegetable raw materials have lower nutritional qualities compared to fishmeal proteins. These products contain anti-nutritional elements (phytic acid, anti-trypsin factors, saponins, gossypol, tannins, alkaloids, fungal toxins, and aflatoxins) (Guillaume et al., 1999), affecting their digestibility. Heat treatments such as extrusion would increase the digestibility of these vegetable ingredients.

According to Medal et al. (2013), the principle of substitution is based on the fact that fishmeal is not an essential raw material; it is the ingredient that provides the required nutrients. However, its complex composition makes it difficult to replace. Rich in highly digestible proteins and balanced in essential and non-essential amino acids, it also contains lipids (5 to 12%) that are not eliminated during its manufacture and minerals from the skeleton and scales.

### Daily Individual Growth (DIG):

The daily individual growth is much more appreciable with the A3 diet, followed by the A2 diet. This growth is lower with the A1 diet. Indeed, replacing animal proteins with vegetable proteins up to 25% seems acceptable for O. niloticus. **Ly and Ba** (2015) also showed that the substitution of 11% of fishmeal with groundnut meal in a 45% protein diet did not affect the growth of O. niloticus. With a diet less rich in protein (30%), replacing 2/3 of the fish meal with groundnut cake only allowed to obtain 60% of the growth performance in O. niloticus (Bamba et al., 2015).

**Specific Growth Rate (SGR):**
The SGR ranged from 0.86%/d (A1) to 1.30%/d (A2). These results are similar to those reported by Dibala et al. (2018) and Loum et al. (2013). On the other hand, they are lower than the results of Jauncey et al. (1982), with an SGR of 3%/d. The low growth rate may be related to the absence of fish meal in Diet A1 and probably the lack of amino acids. Not including fishmeal in Diet A1 could lead to a decrease in palatability which can consequently cause low feed intake. Indeed, authors have shown that total replacement of fishmeal by plant products leads to a decrease in growth rate and feed efficiency in high trophic level species, even if all necessary nutrients are present in the diet (Gómez-Requeni et al., 2004; Vilhelmsson et al., 2004; Panserat et al., 2008; Dupont-Nivet et al., 2009; Alami-Durante et al., 2010; Le Boucher et al., 2012, 2013a).

**Body composition of fish:**
In fish, in general, several authors reported that the body composition of nutrients is strongly dependent on the size of the individual, its physiological state, and the nutritional conditions of the environment (Adelman, 1978; Wilson et al., 1988; Robinson et al., 1988; Robinson al., 2003). In this study, the analysis of the body composition of the initial fish and those fed with the experimental diets showed no significant difference ($p>0.05$). The result of the demonstrates present study that there is no significant difference in body composition of the fish-fed diets A1 (protein level 16.82% and fat level 4.2%), diet A2 (protein level 15.98% and fat level 4.1%), and diet A3 (protein level 16.13% and fat level 4.51%).These results align withthose observed by Olvera-Novoa et al. (2002); Soltan et al. (2008) in Nile tilapia.

**Economic analysis of costs of feeds:**
The production cost of kilogram of feed slightly differed among the three diets. Although the cheapest diet was Diet A1 (0.51), followed by Diet A2 (0.58) and then A3 (0.77), the cost of producing a kilogram of fish was lowest with Diet A3 (1.37), followed by Diet A2 (1.51) and then Diet A1 (1.72). The cost of producing our food is below that found by Diatta et al.(2022), which is between \$0.71 and \$1.08.Even though Diets A2 and A3 had approximately the same zootechnical performance, economically, the A3 diet costs less to produce one kilogram of fish than the A2 diet due to lower FCR obtained with Diet A3.

## Conclusion:-
The main objective was to investigate whether partial or total replacement of fishmeal with plant ingredients will affect negatively the growth and economic performance of Nile tilapia. The study shows that partially substituting fishmeal with local plant raw materials is an excellent method of tilapia farming in Senegal, considering the growth performance. It will be an opportunity to reduce the pressure exerted on fishery resources (increased fishmeal use) and reduce feed costs.

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