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RESEARCH ARTICLE

EFFECTS OF SUBSTITUTING FISH MEAL WITH GROUNDNUT CAKE AND INCORPORATING *ADANSONIADIGITATA* (BAOBAB) AND *MORINGAOLIFERA*LEAVES IN THE FEED OF TILAPIA (*OREOCHROMISNILOTICUS L.*) DURING THE REARING PHASE IN SENEGAL

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Abstract

The strong growth of aquaculture in Senegal has led to a significant use of fishmeal, which is becoming rarified and expensive. In order to make the feed accessible to small-scale producers, it became necessary to find a substitute for the fish meal mainly used in fish feeds, due to its high content of balanced proteins. Therefore, three feeds were formulated for rearing fish in comparison to an industrial feed. The study was conducted for 45 days and involved 4 g fry of the species Oreochromisniloticus. They were fed twice a day with iso-protein diets containing 40% PB/MS. Fishmeal was substituted by groundnut meal at doses of 0%, 25%, 50% respectively in the different feeds tested noted R1 R2 and R3. Other ingredients were added such as maize meal, *Moringaolifera*leaf and *Andansoniadigitata*(baobab) leaf. The growth performance of the animals on these three diets was measured and compared to fish fed with the control feed (imported industrial feed noted R4). The average final weights obtained were respectively for the diets R1, R2, R3 and R4 (5.32±0.63g, 6.84±1.20g, 8.81±2.10g, 7.41±1.47g). Fish fed the R1 diet had the lowest growth. Fish fed R3 had the best performance with a specific growth rate of 1.96 ± 0.35 and a feed conversion ratio (FCR) of 1.28 ± 0.53, compared to a specific growth rate (SGR) of 1.75 ± 0.44 and a feed conversion ratio of 1.53 ± 0.34 for fish fed the control diet R4. The latter is comparable to R2 which has a final average weight almost equivalent to R4.

Introduction:-

In Senegal, fish is a major part of the usual culinary preparations. It makes a major contribution to food security and can alone account for 70% of the nutritional intake of animal proteins (FAO, 2016). Together with certain plant products, fish constitutes a complete food. With an annual catch rate of 450,000 tonnes per year (FAO, 2016), Senegal is the second largest producer in the sub-region, behind Nigeria (530,000 tonnes/year). Thus, the volumes of fishery

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products exported over the period 2008-2018 are of the order of 170,000 tonnes on average per year and represent nearly 38% of the total annual average national production (Dème, 2020). C Fish consumption in Senegal is on average 20.7 kg/year/person**.**

Since 1961, the average annual increase in apparent global fish consumption has been higher than population growth and meat consumption **(FAO, 2016)**.

Faced with the shortage of fish to meet demand, the supply side resorts to farmed fish. Thus, aquaculture appears to be a stopgap measure to fill the gap in capture fisheries. It is probably the fastest growing food industry. Every year, almost 20 million tonnes of capture fish are used to feed other farmed fish (fish in/fish out principle), through fish meal. In view of the high purchase price, the growing demand for aquaculture and the increase in per capita consumption, it is becoming necessary to reduce the proportion of fishmeal in the feed of aquaculture farms.

Apart from the common carp (Cyprinuscarpio), no other fish species is currently as widely used in fish farming as the Tilapia (Oreochromisniloticus). Indeed, this species benefits from an omnivorous diet that broadens its food range. However, in intensive aquaculture, the food item represents a significant part of the production cost of the fish, i.e. more than 50% of the total cost.

The economic interest of this type of farming is therefore very dependent on the availability and cost of feed **(Azaza, 2005).** In order to reduce this cost and make feed accessible, aquaculture professionals are trying to develop different types of feed from local raw materials **(Fiogbe, et al, 2009).** Thus, protein sources of animal origin are mostly replaced by vegetable protein sources in order to maintain the growth and feed conversion performance of the fish.

Within this framework, experimental diets consisting mainly of locally available ingredients (groundnut cake, *Adansoniadigitata*(baobab) and *Moringaolifera*leaves, maize flour, etc.) were formulated and tested on tilapia fry during the rearing phase in comparison with an imported industrial feed.

Materials and Methods:-

Material

Technical facilities

The experiment was carried out at the “Centre d'Application des Techniques d'Elevage (CATE)” of the “EcoleNationaleSupérieured'Agriculture (ENSA)” in Thies, Senegal. Plastic tanks with a volume of 50 litres installed on tables were used as aquariums. There were twelve (12) tanks, divided into four batches. The tanks were cleaned and disinfected with soapy water and bleach. Above the tanks, aeration pumps were hung on the wall. Two submerged bubblers were connected to each pump to ensure oxygenation of the environment.

Biological materials

The monitoring was carried out on male monosex tilapia fry of the species *Oreochromisniloticus*. They are six weeks old. At start-up, there were about 200 fry weighing between 1.5 and 7 g. The fish were individually weighed and 120 fry were selected from them with an average weight of 4 g. They were then randomly divided into batches of 30 fish per diet, i.e. 10 fish per tank.

Livestock and feed manufacturing equipment

Different materials were used. These were plastic tanks for fish rearing, plastic tubes for siphoning, bubblers and pumpers for oxygenation, landing nets for handling (fishing), mills and accessories for grinding, paper handkerchiefs for wiping the fish during weighing sessions, containers, basins for storing and draining water, mortar for crumbling particles; basins for water storage and changing; aluminium trays for transferring and weighing fish; 1.5mm sieves for sieving.

Measuring and weighingequipment :

A PCE electronic scale with a maximum capacity of 210 g and an accuracy of 0.001 was used. It was used to weigh the fish and the amount of feed to be distributed daily. A pH meter and a thermostat were used to measure water pH, room temperature and water temperature respectively.

Methods:-

Experimental set-up

The study was conducted in plastic bins set up in a room with an average room temperature of 25.83°C. Three feeds (R1, R2 and R3) were developed from the raw materials maize meal, moringa leaf, baobab leaf (Table 1), incorporated in equal doses for the three diets, for feeding Tilapia in the fry rearing phase. Within these feeds, fishmeal was substituted proportionally for groundnut meal at the rate of (75% TD; 0%FP) for R1 (50 TD; 25%FD) R2 and (25%TD; 50%FD) R3. These three feeds were compared to a commercial feed R4 (imported feed), serving as a control and coming from the DAC of Séfa The 120 fish were weighed individually and randomly distributed in the 12 tanks filled to 30 litres volume. Each feed corresponds to a treatment, thus forming 4 treatments in triplicate, i.e. 10 fish per tank. Fry weighing on average 4 g were selected for the start-up phase. The fish were stored in the tanks one week before the start of the experiment to acclimatise them to the new conditions.

The fish were manually fed the experimental feed twice a day (9:00 a.m. and 1:00 p.m.), 7 days a week. meals per day (9:00 am and 1:00 pm) and 7 days a week. They were weighed early in the morning every fortnight to monitor their growth and numbers.

Table 1:- Composition in % of the three foods tested.

Ingredients	Feed R1	Feed R2	Feed R3
Maize	10	10	10
peanut cake	**75**	**50**	**25**
Moringaoliferaleaf	10	10	10
Fishmeal	**0**	**25**	**50**
Andansoniadigitata(baobab) leaf	1	1	1
Vitaminpremix	1	1	1
Mineralpremix	1	1	1
Vegetableoil	2	2	2
Total	100	100	100

Food manufacturing

Three foods were made manually. The process consisted of drying the leaves in the shade and grinding all the ingredients into mealy form. Thus the manufacturing process is successively as follows: drying, grinding, sieving, weighing, mixing, granulating, exposing, packaging and feeding.

Each ingredient was weighed according to the values given in Table 1 of the feed composition, before being mixed together. To make the mixture malleable, water was added at 40% of the DM. The mixture was put through a 2 mm mesh sieve which allowed the contents to pass as pasta. At the outlet, the filaments were spread out on cardboard in the shade. After drying for 2 to 3 days before distribution, the feed is broken up with the mortar into crumbs of about 1 to 1.5 mm in size.

Conduct of the trial

Subject fry were fed twice a day at a feeding rate of 10% of their body weight for the first two weeks. By the third week, fish weighing more than 5 g received 6% of their biomass (table 2). The crumb feed was stirred and the noise it made when it came into contact with the tray attracted the attention of the fish, which came to the surface of the water to eat. The feed is always placed in the same place to facilitate feeding. The feeding rate depends on the amount of food eaten, the biomass of the fish and the number of fish left in the tank after the last control fishing. The water is changed daily with a plastic tube by siphoning off particles (refuse, faeces) that are suspended or deposited on the bottom, and the tanks are cleaned during the control fisheries.

Table 2:- Feeding rate in % of body weight.

Stage of development	Fish size (g)	Feeding rate (in % of body weight)
Fees	0-1	30-10
Fry	1-5	10-6
Fingerlings	5-20	6-4
Juveniles	20-100	4-3
Magnification	100-250	3-2

Chemical analysis
Chemical analyses (proteins, lipids, ash, celluloses) were carried out in duplicate according to the standard methods of AOAC (1995). The analyses were performed on the ingredients, the four test feeds and the fish carcasses at the beginning and end of the experiment. The fish were all ground to a powder for comfortable and accurate analysis.

Proteins are determined by the Kjeldahl method (%N x 6.25), lipids by the hot petroleum ether extraction method (Soxhlet type). Crude cellulose is analysed by method n°978.10, ash by method n°942.05 and dry matter by method n°943.01.

Zootechnical growth parameters
The following parameters and indices were calculated to monitor the weight of the fish:
a) Average weight gain **(AWG)**: This is the weight gained over a given time by the fish during the entire experiment. This parameter is also called body mass gain (BMC);
b)Absolute average weight gain=final weight (g)-initial weight (g)
Relative average weight gain=final average weight-initial average weight Initial average weight∗100
c) Individual daily growth **(ID**G)**:** This index, also called daily weight gain, allows to assess the weight gained daily by the farmed fish.
CIJ (g/j/ind)= Average final weight- Average initial weight/ duration of experiment
d) Specific growth rate (**SGR**): This coefficient allows to evaluate the weight gained each day by the fish as a percentage of its live weight. This index is used in aquaculture to estimate the production after a certain period.

TCS (%/j)=100∗ Ln (final average weight)-Ln (initial average weight)/ΔT
ΔT: duration of the experiment.
e) Feed conversion ratio (FCR): This is a feed conversion index that measures the efficiency of converting feed into fish flesh, and represents the ratio of the total amount of dry feed fed to the fish to the biomass gain. A conversion rate of 2.4 means that 2.4 kg of feed is required to produce 1 kg of live weight of fish.

TCA=Quantitéd′alimentingéré en MSBiomasseproduite
f) Survival rate (SR): The survival rate: 100% - mortality rate is calculated from the number of fish obtained at the end of the experiment and the total number of individuals at the beginning of the breeding.
Survival rate = (number of final individuals/number of initial individuals)∗100
g) Protein Efficiency Ratio (PER): This ratio is used to evaluate the efficiency of protein utilisation in the feed by the fish. It is the ratio of live weight gain to the amount of protein consumed.
CEP=Biomass produced (g)/ Protein ingested (g)
2.2.7. Data analysis
The results were compared by analysis of variance with a classification characteristic (ANOVA). Then the Student's Newman Keuls (SNK) test was used for the multiple comparison of means when the ANOVA revealed a significant difference at a fixed threshold of 5%. For the statistical analysis, each replicate is considered as an observation. Data were entered into Excel and analysed using R-Studio version 1.1.463.

Results and Discussion:-

Results:
The results concern bromatological analyses of feed and fish flesh, physico-chemical parameters, fry survival rates, growth performance, feed intake

Bromatological analysis
The chemical analysis of the tested ingredients gave the results shown in Table 3.

Table 3:- Results of bromatological analysis of feed inputs in % DM.

Ingredients	Protein	Fat	Ash	Cellulose	MSA
Moringaleaf	**25,48**	6,99	1,14	13,74	90,57
Baobab leaf	14,68	6,10	1,23	16,29	89,15
Corn flour	10,48	4,36	0,14	2,76	88,80
Peanut cake	**46,55**	**10,85**	0,77	12,42	93,94
Fish meal	54,42	8,28	3,86	5,53	95,50

The bromatological analysis of the four feeds gave the results shown in Table 4.

Table 4:- Chemical composition of foods.

Food	Protein	Fat	Organicmatter	Cellulose	DM (%)
Feed 1	**40,62**	10,72	98.94	**9,47**	93,26
Feed 2	**42,58**	10,04	98.19	**7,4**	93,67
Feed 3	**41,72**	9,5	97.48	**4,98**	94,36
Feed 4	**38,11**	2,45	99.38	**3,69**	92,94

Table 4 shows that the four feeds have relatively similar nitrogen values.

Physico-chemical parameters

Of the various parameters, only temperature and pH were monitored throughout the study. Thus, they were recorded every day before the water was changed and the feed was distributed. The temperature varied throughout the study between 24°C and 27.8°C, with an average of 25.50°C (Table 10). This variation was slight and successive from one tank to another. It always correlates with the ambient temperature of the room. The tanks placed at the back of the room recorded slightly lower temperature levels than those placed on the bench.

The pH of the water in the tanks varied between 7.26 and 8.35 throughout the experiment, with an average of 7.51.

Survival rate

The survival rate (Table 5) of the four batches was different in each triplicate. The first mortalities were noted the day after the first weighing of the fry.

Table 5:- Percentage change in survival rate (%) over the course of the experiment.

	J15	J30	J45	Average	Standard deviation
Lot 1	93,33	66,66	66,66	75,55	15,4
Batch 2	**100**	80	80	86,67	11,55
Batch 3	96,66	**96,66**	**96,66**	**96,66**	0
Batch 4	**95**	**95**	**95**	**95**	0

Thus, after 45 days, the survival rate in the different batches was 75.5%, 86.6%, 96.6% and 95% respectively for batches R1, R2, R3 and R4.

Statistically no significant difference ($P = 0.094$) between the survival rates of the batches was observed.

Growth performance

The assessment of growth performance is based on the evolution of average weights, body mass gain (BMC), specific growth rate (SGR), individual daily growth.

Table 6:- Evolution of the average individual weight (g) per feed.

	J0	J15	J30	J45	Standard deviation
Feed R1	3,96	4,67±0.011	5,23±0.01	5,32±0.006	± 0,63
Feed R2	3,98	5,25±0.014	5,86±0.015	6,84±0.008	± 1,20
Feed R3	4,01	5,63±0.012	7,48±0.017	8,81±0.018	± 2,10
Feed R4	4,06	5,66±0.011	6,76±0.013	7,41±0.011	± 1,47

Figure 1:- Shows the weight evolution of the fish according to the four feeds used.

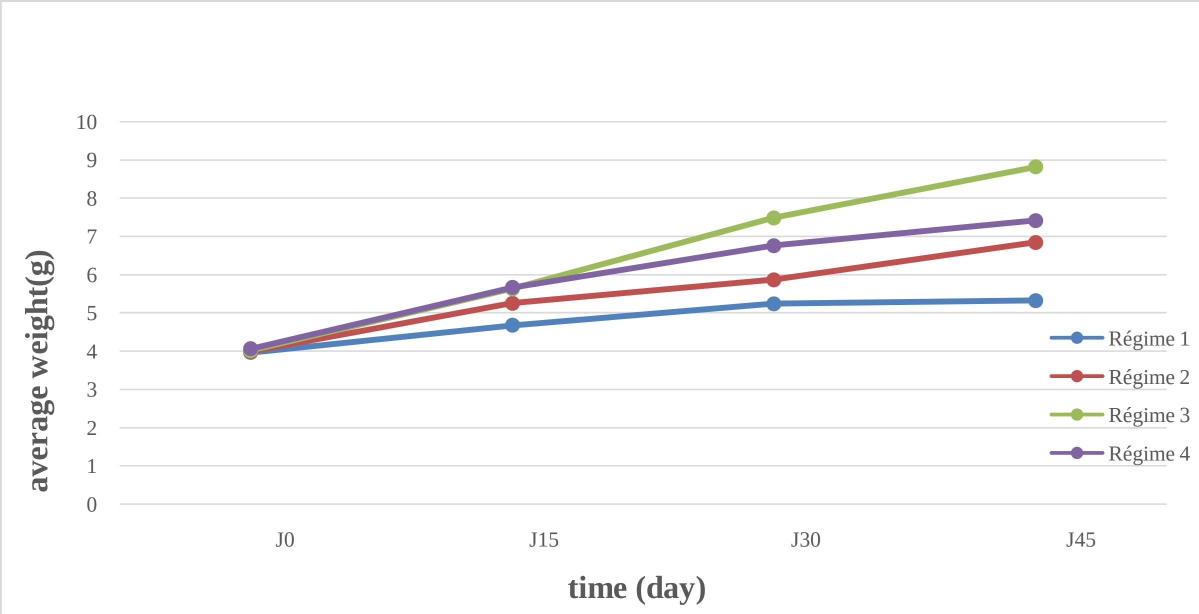

Figure 1:- Weight growth of fish by diet.

From the first week, the growth of the fry differs between the feeds. Feeds R3 and R4 grow simultaneously until the fifteenth day before a growth gap appears between them. Compared to feed R3, fish on feeds R2 and R4 grow moderately. The weight development of the fish is slowed down individually (per feed). For example, in 45 days, the fish in feed R1 only grew by 1.32g and the maximum individual weight obtained at the end of the experiment was 12g.

However, no significant difference was observed in the weight variation (P = 0.121). In other words, the evolution of the fish between the four treatments was clearly more visible at the third week of the experiment. Indeed, the weight of the fish in feed R1 had a very slight weight change compared to the initial weight and remains the lowest among the different feeds exploited. Thus, of all the feeds taken together, R3 showed the best growth performance with the highest final average weight of 8.81g.

For each variable, values with the same subscript letter on the same line are not significantly different (P > 0.05).

With a body weight gain of 3.30±1.60g in 45 days, giving an individual daily growth of (0.10±0.01g/d) and a specific growth rate of (1.96±0.35% bw/d), fish fed with the R3 feed show the best growth performance.

Table 7:- Value of coefficients estimating growth performance parameters.

Paramètres		R_1	R_2	R_3	R_4
GMC (g)		1,11±0,35^{a}	2,00±0,80^{a}	3,30±1,60^{a}	2,55±0,88^{a}
CIJ (g/j)		0,04±0,01^{c}	0,07±0,01^{bc}	0,10±0.01^{a}	0,09±0,02^{ab}
TCS (%/j)		0,96±0,24^{b}	1,45±0,35^{ab}	1,96±0,35^{a}	1,75±0,44^{ab}

GMC: Body Mass Gain
CIJ: Individual Daily Growth
TCS: Specific growth rate

This feed R3 is followed by R4, with an average weight gain of 2.55±0.88g, with an ICJ of (0.09±0.02g/d) and a specific growth rate of (1.75±0.44%/d). The R2 feed with a TCS of (1.45±0.35%/d) was not significantly different from the R4 feed according to the statistical analyses. On the other hand, fish fed R1 had the lowest performance with a body weight gain of 1.11±0.35g, a specific growth rate (SGR) of (0.96±0.24%/d) and an ICJ of 0.04 (g/d). With almost the same protein content, the SGR and SGC of R1 were significantly different from the other three feeds.

With regard to the body mass gain (BMC) of the feeds no significant difference was observed. However, there was a significant difference for TCS (P = 0.039) and a highly significant difference for ICJ between the feeds (P = 0.002)

Food ingestion

The growth performance of the three feeds tested was related to the amount of fishmeal incorporated in the feed. It can be seen that the more fishmeal is present, the better the feed processing in the fry is. A fishmeal content of 50% better meets the requirements for fry weight growth and feed conversion in initial fry with an average weight of 4 g.

The intake and utilisation efficiency of the test feeds is assessed by calculating the feed conversion ratio (FCR). The feed conversion rate of feed R1 is high during the first 15 days of the experiment and decreases constantly until the end of the study. This decrease is also noted for the other feeds. Compared to the other feeds, feed R3 has the lowest TCA values, with a mean level of (1.28±0.53). It is noted that from day 30 onwards, the ACT of diet R3 decreased compared to the control diet R4.

According to the analyses of variance, there is a significant difference between the foods in terms of their ACT (P = 0.036).

Table 8:- Food conversion rate.

Food conversion rates (FCR) of the 4 foods during the experiment				
	Feed 1	Feed 2	Feed 3	Feed 4
J15	3,99±0,93	2,39±0,39	1,80±0,20	1,89±0,19
J30	3,04±0,74	2,18±0,50	1,27±0,21	1,50±0,22
J45	2,08±0,44	1,41±0,18	0,95±0,20	1,21±0,18
Average value	3,28±1,04a	1,99±0,51ab	1,28±0,53b	1,53±0,34b

Values with different subscript letters on the same line are significantly different (P>0.05).

The results show that fish fed R2 and R3 seem to value the protein better than those fed R4. . For statistical analysis, the ANOVA shows a significant difference between the feeds (P = 0.027).

Table 9:-Proteinefficiency ratio (PEF).

	Feed R1	Feed R2	Feed R3	Feed R4
CEP	0,37±0,11a	0,85±0,09b	1,4±0,17b	0,7±0,20b

The protein content of the fish flesh of the tested feeds is higher than that of the original fish. However, the imported feed had the highest protein content. However, there is no significant difference (P = 0.1215) between the feeds.

Table 10:-Bromatological composition of fry flesh at the beginning and end of the experiment.

Composition in (%) DM	Food				
	Initial state	R1	R2	R3	R4
OilyMatter	3,24	12,77	4,41	7,64	15,01
Protein	72	75,68	75,67	74,9	77,01
MO	99,16	99,32	99,65	99,49	99,11

Similarly, the lipid content of the fish fed with the different feeds is higher compared to the lipid content of the initial fish. For this molecule, there is a difference between the values of the diets. The lipid level of fish fed with the diet containing 75% peanut meal is higher than the levels of fish fed with fish meal.

Also with regard to the biochemical analysis of the carcasses, the level of each compound is slightly different in each batch of animals. It evolves according to the ratio between the protein content of animal and vegetable origin. This is the reason for the variation in content between batches of fish.

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Discussion:-

Survival rate

The minimum survival rate obtained at the end of the experiment was 75.5%. These results show a high mortality considering that the margin of tolerance of the mortality rate is estimated at 10%. The survival rates for batches 1, 2, 3 and 4 are 75.5%, 86.6%, 96.6% and 95% respectively. These results are not in agreement with those of **(Iga-Iga, 2008)** who obtained more than 97% survival rate with feeds based on local by-products in Gabon.

The mortalities recorded are most often due to thermal shocks that occurred during water renewal.

In addition, the study took place between January and March. It therefore coincided with the coolest period of the year with an average ambient (room) temperature of 25.83°C. This could inhibit their palatability and growth. The optimum temperature for growth of O. niloticusandClariasgariepinuswas between 26-30°C (**SARR et al., 2011)**. But at 27°C, 5g fish of this species grew 7 times faster than at 21°C **(FAO, 2009)**.

When the water in the tanks was changed, the temperature of the environment increased and the oxygen consumption became higher, the smaller the fish. If there was a lack of oxygen, they would drown in the water and die suddenly from asphyxiation.

In the same context, **Bical and Lassserre (1978)** showed that following a thermal shock of 5°C, between 15 and 25°C, sea bass fry show rapid adjustments in their respiratory activity.

The pH range obtained (7.26 to 8.35) during the study is in perfect cohesion with the work of **Cissé et al. (2007)**[1]which showed that O. niloticuscan live in waters with a pH between 5 and 11.

In addition, the first recorded mortalities the day after the first weighing were probably due to stress from handling and water changes, especially as no injuries were recorded. Furthermore, there was no lack of feeding as all feed was palatable.

Growth performance

The TCS **(%. D-1)** are respectively for the feeds R1 , R2 , R3 and R4 :(0,96±0,24 ; 1,45±0,35 ; 1,96±0,35 ; 1.75±0,44). They range from 0.96±0.24 to 1.96±0.35%/d and are better compared to those of IgaIga (2008) with a TCS (1.04±0.07 to 1.56±0.08%/d). However, the results are not consistent with those of **Jauncey and Ross (1982)** whose specific growth rate is higher than 3%/d.

Individuals fed with feed R1 showed the poorest growth performance resulting in an average weight increase from 4 to 5.32g in 45 days, i.e. a final weight gain of 1.32g. These results showed a growth deficiency compared to fry fed R3 and are in agreement with **Azaza and Kraïem (2005)** who argued that for a fish such as Tilapia, a diet containing only plant proteins does not result in good growth performance during pre-growth.

Indeed, fry fed with R1 are fed with the highest cellulose content 9.47% DM compared to 3.69% DM for R4 (imported), 4.98% DM for R3 and 7.4% DM for R2.

The R feed1 is rich in cellulose unlike other feeds**.** While fibre in reasonable amounts in the feed according to (NRC, 2011) should have a cellulose content below 8% DM. However, they improve the growth of fish, as they can constitute a ballast in the food bolus by regulating the speed of intestinal transit **(Otchoumou et al, 2011).**

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Conversely, insoluble fibres can reduce the digestibility of lipids and proteins in the feed, by trapping them in a network that hinders the access of digestive enzymes to their substrate **(Burel and Médale, 2009).**

The use of plant ingredients increases the risk of introducing mycotoxins (**Spring and Burel, 2014) into** fish feed. In other words, only aflatoxin-free or less than 1.25 mg/kg aflatoxin meals can be used; above this threshold, they are questionable and incorporation rates should be reduced. These cakes can be used widely up to 50% for fish **(Chow, 1984).** This is perfectly consistent with the levels of oilcake used in the R2 and R3 diets. As in other animal species, aflatoxin has carcinogenic effects in fish **(Burel and Médèle, 2014).** Studies show that plants rarely contain a single anti-nutritional factor (ANF) and interactions between different substances are suspected **(Krogdahlet al., 2010).**

Thus, the interaction of FANs and sensitivity between fish species is a major constraint to the use of plants in aquaculture feeds **(Médale et al, 2013).**

In addition, in combination with maize meal as an energy source, feed efficiency is always low in fish. This is due to either the nutritional contributions of the two feeds not complementing each other or the two feeds alone not being sufficient to meet all the nutritional requirements of the animal. In addition, the starch contained in the seeds (cereals and protein crops) is in its native state, poorly digested, which results in a decrease in digestible energy intake **(Médale and Kaushik, 2009).**

In the batch of fish fed the R1 diet, feed intake is conditioned. The subjects did not react when the food was dispensed unless they saw it when it was poured into the water. Therefore, they did not smell the food because of the lack of an attractant and/or stimulant, unlike in other foods where fishmeal is present. A small amount of fishmeal was enough to change the food to the smell of fishmeal. These results are supported by **(Burel and Médale, 2014),** who argue that the incorporation of 5-10% of marine products in the diet is often sufficient to make the feed attractive and restore the appetite of the fish.

Thus, feed R2 with 25% fishmeal performed better than feed R1. In 45 days, an average final weight of 6.84g was obtained. These results are almost similar to the data obtained with the imported feed R4 with an average final weight of 7.4g. It is likely that with small improvements, R2 could cover the animal's nutritional requirements at a lower cost.

This feed R2 is therefore more palatable than R1 due to the substitution of 250g of peanut meal by fish meal. This quantity was sufficient to change the subjects' appreciation of the food. For some species **(Médale and Kaushik, 2009)**, the presence of a small amount of fishmeal could be sufficient to maintain an optimal voluntary intake. However, replacing 2/3 of the fishmeal with peanut meal (50%TD) resulted in only 60% of the growth performance in O. niloticus**(Sitasit and Sitasit, 1977). (Alukunde, 1982)** also showed that substitution of 11% of fishmeal by groundnut meal in a 45% protein feed did not affect growth in O. niloticusfry.

Among the various feeds tested, the higher the fishmeal content, the better the weight gain. This is why R3 has the highest and most important weight gain per day of all the feeds.

Peanut meal, with a protein content of about 48-50%, does not by itself provide normal weight gain in fingerlings on the R feed1. It would be interesting to consider the protein source of the feed, whether it is meal or fishmeal or whether it is of plant or animal origin. Indeed, the incorporation of animal proteins strongly increases the digestibility of the feed and thus the growth performance **(Yougbaré et al,2018; Azaza, 2005).**

It should be noted that in tilapia (Oreochromisniloticus), the ratio of animal to plant proteins has an important role on growth performance, which increases with the share of animal proteins **(Sitasit and Sitasit 1977; Azaza, 2005).**

This explains why, with the same ingredients in diets of approximately the same protein level (iso-protein), the performance of the fry differs from one diet to another and is best in the R3 feed with the highest animal protein content. Indeed, according to **Stickney (1986),** in O. niloticus, the replacement of animal protein by plant protein up to 25% seems acceptable **(Azaza, 2005; Bamba et al,. 2007).**

The poor growth could also be related to the amino acid deficiency of plant products. Many of them do not contain enough lysine and methionine, in this case peanut meal. Therefore, in the formulation, these two amino acids were supplemented in equal doses for the three feeds, although the requirements per feed were different. According to **Anselme (1987),** groundnut cake from Senegal, which contains up to 0.4ppm aflatoxin, can be used to cover protein requirements when the ration is supplemented with essential amino acids such as lysine, methionine and tryptophan. On the other hand, when dietary amino acid intake is not precisely adapted to the animal's needs, nitrogen catabolism increases, protein retention is reduced and nitrogen excretion is **increased (Médale and Kaushik, 2009)**.

In addition, the cause of growth retardation in fish fed mainly with plant products (R1 and R2) may be due to the absence of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). Both of these essential fatty acids must be provided in the feed. The decrease in growth resulting from the total replacement of fishmeal by plant products in trout (**De Francesco et al., 2004))**, is accompanied by a decrease in muscle lipid levels; the flesh is then firmer with a less pronounced fishy odour**(Médale et al, 2013).**

In order to correct the lipid level in the flesh, it is necessary to use vegetable products rich in polyunsaturated fatty acids, particularly linoleic acid, such as soya, rapeseed and linseed oil. But these products are difficult to find in our regions, which is another problem. Indeed, the total substitution of fish oil by vegetable oils (rapeseed, linseed) or a mixture of vegetable oils (rapeseed 55%/palm 30%/linseed 15%) does not lead to changes in voluntary intake, growth performance and feed efficiency **(Médale and Kaushik, 2009).**

In sum, the combination of research knowledge has pushed the limits of fishmeal substitution in all species provided different plant products are used in a mixture **(Collins et al., 2013).**

On the other hand, according to **Medaleet al. (2013),** the total replacement of fishmeal by plant products causes a decrease in growth rate and feed efficiency in high trophic level species, although the necessary nutrients are present in the feed.

Apart from added vitamin and mineral premixes, no other substances were added to these feeds and it was possible to obtain an R3 feed that exceeds the performance of the imported R4 feed containing plant protein concentrates (60-90% DM protein).

But what is advantageous in this attempt is that replacing fishmeal with plant sources of protein substantially reduces the levels of organic pollutants such as dioxins and PCB-DL in food **(Médale and Kaushik, 2009)**

The study, while denying the possibility of total substitution of fishmeal, identifies the limits of its use and establishes an acceptable margin of use of up to 50% with the R feed3. It has also been shown in research that it is not possible to raise fish on plant protein without altering growth and influencing survival **(Ndiaye, 2014).** The results are consistent in showing no or very slow weight gain in fully vegetarian fish.

Conclusion:-

The general objective of this study was to propose a fish feed based on local plant products, in order to reduce the high use of animal protein in fish feed. For this purpose, it was necessary to make a comparison with an imported feed to measure the nutritional quality of our home-made diets. The feed not containing fishmeal shows the lowest performance and shows the limitations of using plant products alone in a fish feed formula. These results are due to several factors that prompt numerous studies to understand the deleterious effects of plant products on fish growth, digestion and metabolism.

However, research on fish nutrition continues to evolve on the composition of feeds aiming at higher levels of plant protein sources. Thus, plant products represent the majority share in new attempts to formulate fish feeds. Many avenues are being explored to produce more and more fish feed from plant products. It will be a matter of selecting within a single species subjects that will genetically accept the new plant feed or of using proteins from insect larvae and microalgae that produce n-3 PUFAs, particularly DHA.

With a moderate addition of 5-10% fishmeal to R2, plant products will remain in the majority in the diet and the growth of these fish would be comparable to or better than that of the fish in R4 . However, some progress has been noted, with a 50% incorporation of fishmeal, acceptable results could be obtained with the R3 diet.

Other studies show that these substitutions can be pushed to higher rates.

Despite many efforts to substitute animal proteins with plant proteins, the data are not yet in line with the requirements of fish. There are constraints to the full use of plant products such as Biological limitations that prevent full use of plant products, appetite determinants of fish. These are in addition to the mode of action of anti-nutritional factors, the interactions between nutrients and their consequences on the muscle development of fish.

Bibliography:-

1. Anselme, B., 1987. « L'aliment composé pour volaille .au Sénégal: Situation, contribution à son amélioration pour unemeilleurevalorisation des ressourcesnutritionnelles locales » . Thèse :Méd. vét., Toulouse; 103.
2. Azaza M.S. etKraïem M.M., 2005. - Effet de la températuresur la croissance chez le Tilapia du Nil Oreochromisniloticus (L., 1758). Bulletin de l'Institut National des Sciences et Technologies de la Mer., N° spécial (9): 159- 162. Acte des 7èmes JournéesTunisiennes des Sciences de la Mer
3. Bical. C ,Lasserre. P 1978. « Influence de la températuresur la consommationd'oxygène du bar juvenile, dioentl'al'ahufjzabl'a:!: l». publ. sei. tech. cnexo, no 7: 653 72.
4. Collins, M., et RetoKnutti, Jean-Louis Dufresne et Julie Arbiaser., 2013, « Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge; New York, pp. 1029-1136.
5. Chow, K.W. 1984. « Elevage du poisson-chat africainClariaslazera (Cuv& Val., 1840) En RepubliqueCentrafricaineiv - alimentation ». 1984
6. Burel Christine etMédale Françoise. 2014. « Quid de l'utilisation des protéinesd'originevégétale en aquaculture ? » EDP Sciences 21 (4).
7. De Francesco, M.; Parisi, G.; Médale, F.; Lupi, P.; Kaushik, S.J.; Poli, B.M., 2004. Effect of long-term feeding with a plant protein mixture based diet on growth and body/fillet quality traits of large rainbow trout (Oncorhynchusmykiss). Aquaculture, 236 (1-4): 413-429
8. El hadj Bara DEME, IdrissaDiédhiouet Pierre Failler.2020. Dynamique des exportations de produitshalieutiques du Sénégalet les impacts surl'approvisionnement du marché local. Dynamiquesenvironnementales, 46
9. Médale.F, Kaushik. S. 2009. « Evolution des recherches en nutrition piscicole à l'INRA : substitution des produitsd'origine marine dansl'alimentation des poissonsd'élevage ». INRA Prod. Anim 21 (1): 87 94.
10. Médale F, Leboucher. R, M. Dupont-Nivet, E. Quillet , J. Aubin, S. Panserat. 2013. « Des aliments à base de végétaux pour les poissonsd'élevage ». INRA Productions Animales, Paris: INRA, 2013, 26 (4), pp.303-316. hal-01019139
11. FAO. 2016. La situation mondiale des pêcheset de l'aquaculture 2016.
12. Contribuer à la sécurité alimentaireet à la nutrition de tous . Rome. 224 pages.
13. FAO. 2009. Oreochromisniloticus. In Cultured aquatic species fact sheets. Text by Rakocy, J. E. Edited and compiled by Valerio Crespi and Michael New. CD-ROM (multilingual).
14. Fiogbe, E. D., B. Akitikpa, et J.-M. M. Accodji. 2009. « Essais de Mise au point de formulesalimentaires à base d'azolla (AzollaMicrophyllaKaulf) et de sous-produitslocaux pour la pisciculturerurale du tilapia OreochromisNiloticus L. » International Journal of Biological and Chemical Sciences 3 (2).
15. Médale Françoise, etKaushikSadasivam. 2009. « Les sources protéiquesdans les aliments pour les poissonsd'élevage ». CahAgric 18 (2 3): 103 11.
16. Iga-Iga Robert. 2008. « Contribution à la mise au point d'aliments pour tilapia Oreochromisniloticus à base d'intrantslocaux : cas du Gabon ».
17. Jauncey K., Ross B., 1982. - A guide to Tilapia feed and feeding. Institute of Aquaculture, university of Stirling, Scotland. 111pJauncey K. and B ROSS. (1982). A guide to tilapia feeds and feeding. Institute of Aquaculture'', University of Stirling, Scotland, 111p.
18. Krogdahl, Ashild, Michael Penn, Jim Thorsen, StåleRefstie, Anne Marie Bakke. 2010. « Importantantinutrients in plant feedstuffs for aquaculture: An update on recent findings regarding responses in salmonids ». Aquaculture Research 41 (février): 333 44.
19. MalickNdiaye. 2014. « Etude comparative de deux régimes alimentaires à base de sous-produitsagroindustriels chez les alevins de Tilapias Oreochromisniloticus du fleuveSénégal »
20. NRC (National Research Council), 2011. Nutrition Requirements of Fish, Washington D.C., USA, National Academy Press, 373p.

21. Sarr, SerigneModou, AmsataThiam, El Hadji Faye, MamadouSene, etMalickNdiaye. 2015. « Production d'alevins de Tilapia (Oreochromisniloticus) avec 3 aliments à base de sous-produits agro-industriels au Nord du Sénégal ». International Journal of Biological and Chemical Sciences 9 (5): 2598-2606 2606.
22. Stickney, R. (1986) Tilapia Tolerance to Saline Waters: A Review. Progressive Fish Culturist, 48, 161-167. http://dx.doi.org/10.1577/1548-8640(1986)48<161:TTOSW>2.0.CO;2
23. PrasertSitasit; ViratdaSitasit[1977].; International Council for the Exploration of the Sea, Charlottenlund (Denmark). [Corporate Author] .
24. Otchoumouk.a.i,alla y. l.ikaushik s..1. 2011. « utilisation des farinesvégétalesdansl'alimentation des poissonsd'élevage en milieu tropical ». f. tech. & doc. vulg, 7 11.
25. Y. Bamba. 2007. « Apportsrelatifs en nourrituresnaturelleetartificielledansl'alimentation du tilapia oreochromisniloticus en captivité ». Fr. Pêchepiscic, 55 68.
26. Y. Bamba, A. Ouattara1et G. Gourene. 2007. « Production d'alevins de tilapia (Oreochromisniloticusl., 1758) nourris avec des sous-produitsagricoles, sans adjonction de farine de poisson ». AgronomieAfricaine 19 (2): 211 21.
27. YacoubaBamba, AlassaneOuattara, Kouassi S. DA Costa, GermainGourène. 2008. « Production de Oreochromisniloticus avec des aliments à base de sous-produitsagricoles ». ciences& Nature 5 (1): 89 99.
28. Yougbaré, Marie Chantal, KiessounKonaté, NessanDésiréCoulibaly, etMamoudou h Dicko. 2018. « production du tilapia du nil (Oreochromisniloticuslinneaus, 1758) avec des aliments à base de protéinesvégétales », no 10.