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RESEARCH ARTICLE

CONTRIBUTION TO THE STUDY OF THE USE OF NATURAL BINDERS IN TILAPIA FEEDING (*OREOCHROMIS NILOTICUS*)

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ABSTRACT

The present study was conducted in the hatchery of the graduate school of fisheries and aquaculture located at the Department of Animal Biology, Faculty of Science and Technology of University Cheikh Anta Diop. It is a contribution to the development of aquaculture feeds using natural binders. A growth performance test was conducted using four isoproteic diets of 30 ± 0.50% differentiated from each other by a binding agent: A: 20 g of *Adansonia digitata* leaves meal, B: 20 g of *Corchorus tridens* leaves meal, C: 20 g of arabic gum meal and D : the control containing 20 g of Carboxy-Methyl-Cellulose were fed to a duplicate of *Oreochromis niloticus* fry for 45 days, with an initial weight of 5.74 ± 0.01g/fish in an isolated system consisting of 8 plastic tanks of 50 liters with a density of 13 fish per tank. The results showed that the best survival rates were obtained with the fish fed B and C diets and the lowest with those fed A and D diets. The specific growth rate (SGR) was higher in the fish fed diet B (1.90 ± 0.1) and lower in fish fed diets (A (1.47 ± 0.1), C (1.46 ± 0.1) and D (1.41 ± 0.1)). The best feed conversion rate (FCR) (2.43 ± 0.01) was obtained in the fish fed diets B. Diets A (3.21 ± 0.02), C (3.56 ± 0.01) and D (3.75 ± 0.01) gave the lowest FCR. The best protein effeciency ratio (PER) was observed with the fish fed diet B (1.34 ± 0.05). The lowest PER were noticed in the other diets. Encouraging results, although preliminary, were obtained at the end of the study. Therefore, these results suggest that the *Corchorus tridens* leaves meal is likely to replace the Carboxy-methyl-cellulose in feed formulations tilapia diets as binder.

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INTRODUCTION

Aquaculture is considered more and more as part of the means used to ensure food security and global economic development (FAO, 2002).However, we must recognize that the aquaculture sector has not yet reached a viable economic dimension in Africa, both in terms of volume or place of this activity in other production systems (Lazard and al., 1991). Siddhuraju and Becker (2003) revealed that the major constraint to the development of aquaculture in developing countries is the cost of feed. For them, the use of fishmeal as the main protein source in feed for aquaculture is the reason for the high cost of these feeds. According to Slembrouck *et al*., 1991 and Gourène *et al*., 2002, in terms of expenditure, feed represents about 50% of the cost of production of farmed fish. The various agricultural by-products, which are used by many fish farmers empirically, need to be formalized in order to reduce the cost of feed.

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The use of agricultural products in the diet of fish has already shown encouraging results in the savannah regions (North and Central) of Ivory cost (Campbell, 1978 and Lazard, 1984). However, the formulations constraints are unfavorable to the good feed compaction and do not y*et al*low the production of a granulated comprising all the required qualities. This results in many fine returns (constituents of certain hydraulic binders) (10 to 20%) and poor stability to water (more than 90% loss in 10 minutes) (Luquet Rumsley (1978). These authors also indicated that these binding agents outside their tied power usually have a secondary lubricant role. They also claim that recent work on this issue, implement artificial binders (Carboxy-Methyl-Cellulose (CMC)) and derivatives of algae (alginates, carrageenan) without nutritive value. A binder may be defined as a product, which serves to agglomerate by mass the solid particles in the form of powder or granulates. Binders coat the pigment powder and agglutinates to form a more or less liquid or slurry substance. They act as a dryer and hardener. They will allow the colored material dry and harden to form a solid and durable paint film. This solidification may be permanent (in the case of accrylic) or reversible (case of water colors and wax). Different substances have been used to increase the stability of the water of aquaculture feed. Some are already used by the food industry to increase durability (resistance to physical damage during handling and storage) feeds for aquaculture species. Some specialty chemicals, others are natural products that are raw or refined. Some binders have additional nutritional value. Among these binders there is: gelatin, agar, carrageenan, sodium alginate, carboxymethyl cellulose (CMC), konjac glucomannan, guar gum, xanthan gum etc. Several authors have worked on these binders. Generally these binders have effects on the growth of aquaculture species and feed digestibility.

The relationship between the composition, the food availability and aquatic species growth rate has a crucial importance for optimizing the conditions of breeding. To understand this relationship, the main physiological processes of the body (ingestion, assimilation, respiration, growth and reproduction) must be taken into account and assessed through integrated models such theories dynamic energy budget (DEB) (Van der Wed, 2006). Authors have shown that some binders have positive effects on fish growth. Indeed, Person The Ruyet *et al*. (1993) demonstrated that the alginate appears to be conducive to the cultivation of bass larvae (*Dicentrarchus labrax*). Several reports indicated a relationship between binders and nutrient digestibility. Different factors influence the efficiency of digestion. It seems that some binders have adverse effects on nutrient digestibility in fish because they accelerate the time to gastrointestinal transit (Storebakken, 1985). The inclusion of guar gum in tilapia feed has nutrient digestibility coefficients lower than those of CMC-containing diets, the starch of corn and wheat gluten (Fagbenro and Jauncey, 1995). Recently, the effect of two natural binders (Beans) on the digestibility of proteins and lipids to the food the Atlantic salmon (*Salmo salar*) showed no significant difference between treatment and food addition of guar gum for trout feed (Pratoomyot *et al*., 2011).

In addition to these binders mentioned above we used for our purposes such natural binders as: *Adansonia digitata* leaves meal, *Acacia senegal* gum meal and *Corchorus tridens* leaves meal. The baobab is extremely important for humans and animals that live in the dry areas of Africa. It provides shelter and provides food, fiber and medicines, as well as raw materials for many uses. Baobab leaves are an excellent source of protein and contain all the essential amino acids, and most non-essential amino acids. They also have a high content of minerals and vitamins A and C. They are used as fresh vegetables or are sun dried, ground and sieved to produce a green powder used to flavor sauces in many parts of Africa. In most African countries where there are *Adansonia digitata*, the leaves are used as a vegetable. They are collected and sold by many families. In the southern part of the continent, people are reaping the fruits and seeds to sell to local companies that manufacture oil from the seeds and pack fruit pulp. The Arabic gum from *Acacia senegal* is widely used. It is a descending sap solidified exudate produced naturally or as a result of an incision on the trunk at the foot of trees of the acaciasfamily Edible, it is harvested mainly in Africa Saharan Africa (Maghreb, Mali, Senegal, Chad, Egypt, Sudan, etc.). Arabic gum is a highly branched acid polysaccharide, which is in the form of potassium salts of mixtures of magnesium and calcium. The monomeric components of the free acid (arabic acid) are D-galactose, arabinose, L-rhamnose and D-glucuronic acid. It is recognized that arabic gum consists of at least two fractions of polysaccharides of different structures. The higher molecular weight fraction contains a proportion of modest but critical amino acids for its properties. There are arabic gum commercially as a powder or crystals unmilled more or less round pale yellow to brownish yellow. The gum is bland (tasteless) and odorless. It is soluble in water, insoluble in alcohol. The leaves of *C.olitorius L., C. aestuans L., C. tridens L., C. capsularis, C.depressus* are used in human food such as lettuce and spinach. Species of the genus also have emollient and mucilaginous properties (Baillon, 1886 Pursglove, 1968). The rods contain fibers that are used in the manufacture of ropes, packaging and fabrics in the manufacture of bags (Anonymous, 1991). *C. olitorius*L. is considered a medicinal taxon because of its seeds which are used in India as a purgative and its leaves are tonic and diuretic (Oliver-Bever, 1986). *C. aestuans* L. is also regarded as a medicinal taxon since its leaves and roots are used in West Africa against gonorrhea (infectious disease of genitals), while its fruits and seeds treat colic and pneumonia (AYENSU, 1978).

All these properties mean that some species *Corchorus* L. are grown. This is the case of *C.olitorius* L. (Akoroda, 1988; and Akoroda Akintobi, 1983; and Akoroda Olufajo, 1981). In addition the organization and shape of flower receptacle, sometimes short, sometimes column encountered in various species make such a transition group between Tiliae and Grewiae, two tribes of the family Tiliaceae (Baillon, 1886).For their various interests, these species have been the subject of several studies including those of Roberty (1954); Hutchinson *et al*. (1958); Berhaut (1967); Epenhuijsen (1974); Merlier and Montegut (1982); Norman (1992); Le Bourgeois and Merlier (1995); Mbaye (1999).It is clear from these studies that the characteristics of the fruit are the most discriminating. In fact the morphological and anatomical characteristics of the vegetative system and those of the flower exhibit very great similarities between species, making it difficult to identify. That is why we consider it is necessary to conduct researches in this direction using natural binders available locally in quantity and costless (*Adansonia digitata* leaves, sap of *Acacia senegal* commonly known as arabic gum and leaves of *Corchorus tridens*) in the formulation of the diet for *Oreochromis niloticus*. This work therefore aims to use natural binders in the manufacture of diets for *Oreochromis niloticus* to determine their effects on the growth performance.

MATERIALS AND METHODS

Raw Materials

The following list represents all the ingredients used in the manufacture of the different diets.

- Fishmeal is purchased NSAAP with a protein content of 56%.
- Sorghum meal is available everywhere in Senegal with a protein content of 10.9%.
- *Moringa oleifera* leaves meal is available on the local market.
- Sesame cake meal is available on the market.

- *Adansonia digitata leaves meal* is commercially available and is used as a binder with a protein content of 15.15%.
- Arabic gum meal on the market is used as a binder.
- *Corchorus tridens leaves meal* is commercially available and is used as a binder with a 16.76%protein content
- The Carboxy-methyl-cellulose bought from Aquavet Tivaone Thies is used as a binder.
- Fish oil is purchased from AFRIC NITROGEN
- Vegetable oil (peanut oil and soybean oil) is purchased at the local market level.
- Vitamins and minerals premix are purchased from Aquavet Tivaone Thies.

For each of the natural binders used in this study, we followed a particular method to have a milled product for the purposes of the experiment. *Adansonia digitata* leaves were already dried when purchased on the market. We then winnowed the ground using a sieve. The final product in the form of flour was packed in glass jars to keep them well. For the purposes of the experiment, a sample of 25 to 30 g was taken and analyzed in the laboratory Ecole Polytechnique (ESP) to determine protein levels.

The sap of *Acacia senegal* commonly called Arabic gum was also purchased on the market. Once at the laboratory, the product is screened and packed in jars for its preservation. Unlike *Adansonia digitata* leaves meal, Arabic gum has not been the subject of a biochemical analysis as being very low in protein levels according to the technicians of the Ecole Superieure Polytechnique (ESP) laboratory. The leaves of *Corchorus* tridens are first gathered at the Botanical Garden of the Cheikh Anta Diop University of Dakar under the supervision of Mr. CAMARA botanist technician. They are then spread under the shade until it is fully dried. Then the amount obtained is crushed, sieved before being packaged in glass jars until use in the experiment. Thereafter, a sample of 25 to 30 g is transmitted to the ESPlaboratory for analysis needs to determine the percentage of protein.

Diet preparation

Four Isoproteic diets (30 ± 0.50%) were formulated for a quantity of one kilogram (1 kg). They differ from each other by a binding agent (A: 20 g *Adansonia digitata leaves meal*, B: 20 g of *Corchorus tridens leaves meal*, C: 20 g of Arabic gum meal and the control binder D: 20 g of carboxy-methyl-cellulose). After, all ingredients were thoroughly mixed and an appropriate quantity of water provided (30% for 100 g of mixed ingredients), accordingly. Diets were supplemented with 5% of mixture of fish oil (FO) (Table 1).

Dough was passed through an extruder to produce spaghetti and dried at 37°C for two days. So, the concerned dried diet was packaged into plastic bag and stored frozen until its usage. The experimental diets and samples of the dorsal muscle were analyzed for proximate composition based on AOAC (1984) methods. Crude protein was determined with a Kjeltec system 1002 (Tecator). Crude lipid was determined by chloroform-methanol (2:1, v/v) extraction method (Folch *et al.,* 1957). Crude fiber was determined by the Fibertec system M 1020 hot extractor (FOSS Tecator). Ash and moisture were determined with conventional methods using muffle furnace at 505°C and an oven at 105°C.

Table 1. Diets composition

Ingredients	Diets			
	A	B	C	D
Fishmeal	150	150	150	150
Moringa leaves meal	460	460	460	460
Sesame cake meal	200	200	200	200
Sorghum meal	100	100	100	100
Fish oil	50	50	50	50
Vit mix[a]	10	10	10	10
Min mix[b]	10	10	10	10
Adansonia digitata leaves meal	20	…….	…….	…….
Corchorus tridens leaves meal	…….	20	…….	…….
Arabic gum meal	…….	…….	20	…….
CMC	…….	…….	…….	20
Total	1000	1000	1000	1000

a= vit A 250000 UI; vit D3 250000UI; vit E 5000mg ; vit B1 100mg ; vit B2 400mg ; vit B3(pp) 1000mg ; vit B5 pantode Ca2000mg ; vit B6 300mg ; vit K3 1000g ; vit C 5000mg ; H biotin 15mg ; choline 100g ; anti- oxydant (BHT), crushed and calcinedattapulgiteqs 1000mg;

b= phosphorus 7% ; calcium 17% ; sodium 1,5% ; potassium 4,6% ; magnesium 7,5% ; manganese 738mg ; zinc 3000mg ; iron 4000mg ; copper 750mg ; iodine 5mg ; cobalt 208mg ; calcined and ground attapulgiteqs 1000g; fluorine 1.5% (approximately).

Table 2. Biochemical Composition of Diets

Composition	Diets			
	A	B	C	D
Dry matter (%)	90.59	90.59	90.59	92.39
Ash (%)	3.98	3.98	3.98	4.08
Gross energy (MJ/Kg)	3.79	3.79	3.79	3.79
Digestible energy (MJ/Kg)	2.81	2.81	2.81	2.81
Crude protein (%)	30.53	30.56	30.22	30.22
Digestible protein (%)	0.60	0.60	0.60	0.60
Crude Lipid (%)	11.31	11.31	11.31	11.31
Crude Fiber (%)	5.88	5.88	5.88	5.88

Culture conditions

This experimental study was conducted in an isolated system. The latter consists of eight (8) plastic tanks of 50 liters each. Three fiberglass tanks load of 500 liters each, were used for storage of water. The tanks are fitted with aerators to oxygenate the breeding environment. This isolated system has advantages. Indeed, if any contamination is noted in one of the tanks, others can be saved without difficulty handling did not pose major problems, either. The fish used for the purposes of the experiment are a mixture of male and female of Nile tilapia (*Oreochromis niloticus*), aged four weeks from the Richard Toll hatchery. Upon arrival, they were acclimated to the laboratory conditions for four weeks in plastic tank. During this period, the fish were fed with commercial feed imported from China obtained at the FAO TCP / SEN 3307.After acclimation, individual size of between 5 and 6.6 g were selected for the purposes of the experiment. Thus, four diets were manufactured and tested on the fish for six weeks. A total of 104 fish were divided into 8 tanks with a density of 13 fish each. The initial mean weight was 5.74 ± 0.01g. The tanks were cleaned daily in the morning and afternoon before serving the food. In each tank, the water was completely renewed in the morning with the one stored in the chlorine-free fillers reserver by the oxygenation phenomenon. Fish in each tank were fed 10% of their biomass in an amount twice daily (8:00 h and 17:00 h). This rate was reduced to 6% and 4% after each weighing. The biomass of each tank was weighed at the beginning and every two weeks, the feed rate is adjusted for the new biomass obtained.

Water quality measurement

The physico-chemical parameters (temperature, dissolved oxygen and pH) were measured twice a week using a multifunctional device YSI Model 58 meters oxygen (Yellow Springs Instruments, Yellow Springs, OH, USA) and a pH meter.

Growth parameters, survival and feed efficiency

Absolute mean weight gain (AMWG) (g) = final mean weight - initial mean weight

Relative mean weight gain (RMWG) (%) = 100x[(final mean weight - initial mean weight) /initial mean weight]
Specific growth rate SGR (%)= 100 x [(ln final mean weight - ln initial mean weight) / period of experiment / day)]
Survival rate (%) = (total Number of final-initial fish) x 100
Feed conversion rate (FCR) = feed intake (g)/wet weight gain (g),
Protein efficiency ratio (PER)= weight gain (g)/ protein intake (g),

Statistical analysis

The data obtained were calculated with Microsoft Excel. Analysis of these data was performed with the Statistical Analysis System (SAS-PC) (Joyner 1985) subjected to analysis of variance (ANOVA). Duncan's test was used to compare significant differences between treatments. The significance level of 5% was used.

RESULTS

Water quality control

Dissolved oxygen (O2), temperature (° T) and the potential hydrogen (pH) are the three parameters measured during the present study (Table 3). Temperatures range between 27.4 ± 0.2 and 28.2 ± 0.1illustrated in Table 3 show that there is no significant difference between the measured values. The dissolved oxygen level varies between 6.6 ± 01 and 7.1 ± 02. They do not reflect significant differences. The average pH values (7.2 ± 0.8 and 7.4 ± 0.7) shown in the Table 3 show no significant difference.

Growth performance

Table 4 presents the growth performance parameters (the absolute average weight gain, the relative average weight gain, the specific growth rate, the individual daily growth) and the survival rates during the experiment. The absolute mean weight gain obtained ranged from 6.75 ± 0.4 to 4.51 ± 0.1 g. The fish fed the diet B containing *Corchorus tridens* leaves meal as a natural binder showed the highest mean weight gain (6.75 ± 0.4 g), compared to those subject to the diets A (*Adansonia digitata* leaves meal), C (arabic gum meal) and D (carboxy methyl cellulose, control). These results show a significant difference between the test diet B and D 4.51 ± 0.1, which is not significantly different from diets A and C that are 4.68 ± 0.2 and 4.63 ± 0.1 respectively (Table 4). Regarding the relative mean weight gain, the results varied between 117.68 ± 10.09% for diet B to 78.54 ± 2.15% for the diet D. There is significant difference between the test diet B and D (control) but also between testing diets A with value 82.96 ± 3.12% and C with value 82.02 ± 3.20%. Nevertheless, it is not a marked difference between the control diet D Diet, A and C (Table 4). The best specific growth rate result was presented by the fish fed diet B (1.90 ± 0.1) that is containing the *Corchorus tridens* leaves meal as natural binder compared to A, C and D with their respective values 1.47 ± 0.1, 1.46 ± 0.1 and 1.41 ± 0.1. The SGR of fish fed A, C and D diets showed no significant difference (Table 4).

Feed efficiency

The results presented in Table 5 highlight the effectiveness of the tested diets. Regarding the FCR, the most effective diet is the one with the lowest rate. In our experience, the diet B containing the natural binder *Corchorus tridens leaves meal* is the feed most effective because having the lowest FCR which is equal to 2.43 ± 0.01. Diets A = 3.21 ± 0.02, C=3.56 ± 0.01 and D = 3.75 ± 0.01 have higher FCR. These three diets have no significant difference. On the contrary, they present significant difference from the diet B. In addition, the Figure 11 shows that the more fish adaptto the diet, the more they use it. This is what also explains a feed conversion ratio greater than the 5th to 15th day of the experiment and an FCR equal to 1 after 45 days of this experimental phase (Table 5). For the protein efficiency ratio (PER), the best results were obtained with diets B (1.36 ± 0.05) and A (1.03 ± 0.09) which are not significantly different. The diets C and D present the lowest PER values of 0.93 ± 0.03 and 0.88 ± 0.04 respectively. The results showed that there is no significant difference between C and D diets. However there is a significant difference between the first two (A, B) and the last two (C, D).

Survival rate

The survival rate during the experiment varied between 53.85% and 92.31%. The highest value (92.31%) was obtained from fish fed with the diets containing B and C followed by those fed the control diet containing CMC as binder. Finally, the lowest survival rate 53.85% was obtained in the fish fed with diet A containing the *Adansonia digitata* leaves meal as a natural binder.

Dorsal muscle composition

Table 6 shows the protein content, fat and dry matter from the dorsal muscle of the fish before and after experiment. The results of the carcass composition of the fish presented in Table 6 show that they are significant differences between the tested diets. The protein content of the dorsal muscle of the fish fed

Table 3. Mean value of the physico-chemical parameters

Diets	Temperature (°C)	Dissolved oxygen (mg/l)	pH
A	27.8 ± 0.3	6.9 ± 0.3	7.4 ± 0.5
B	28.2 ± 0.1	6.6± 0.2	7.3 ± 0.4
C	27.4 ± 0.2	7.1± 02	7.4 ± 0.7
D	27.7 ± 0.1	6.6 ± 01	7.2 ± 0.8

Table 4. The growth parameters and survival during the experiment

Diets	Initial mean weight (g)	Final mean weight (g)	Absolute mean weight gain (g)	Relative mean weight gain (%)	SGR	Survival (%)
A	5.75 ± 0.11[a]	10.43 ± 1.12[b]	4.68 ± 0.2 [b]	82.96 ± 3.12 [b]	1.47 ± 0.1 [b]	53.85
B	5.74 ± 0.12 [a]	12.49 ± 1.15[a]	6.75 ± 0.4 [a]	117.68 ±10.09 [a]	1.90 ± 0.1 [a]	92.31
C	5.75 ± 0.09[a]	10.38 ± 1.14[b]	4.63 ± 0.1 [b]	82.02 ± 3.20 [b]	1.46 ± 0.1 [b]	92.31
D	5.74 ± 0.14[a]	10.25 ± 1.10[b]	4.51 ± 0.1 [b]	78.54 ± 2.15 [b]	1.41 ± 0.1 [b]	84.62

a, b, c The different letters indicate a significant difference (P <0.05) between diets.

Table 5. feed efficiency parameters (FCR, PER)

Diets	FCR	PER
A	3.21 ± 0.02 [a]	1.01 ± 0.09 [a]
B	2.43 ± 0.01 [b]	1.34 ± 0.05 [a]
C	3.56 ± 0.01 [a]	0.93 ± 0.03[b]
D	3.75 ± 0.01 [a]	0.88 ± 0.04 [b]

Table 6 : Proximate analysis of dorsal muscle of tilapia *Oreochromis niloticus*

Composition	Diets				
	Initial fish	A	B	C	D
Protein (%)	87.25	80.51	89.03	86.14	85.58
Dry matter (%)	92.58	93.24	93.34	93.01	93.32
Lipid (%)	8.00	3.88	6.31	6.73	7.17

[a, b, c] The different letters indicate a significant difference (P <0.05) between diets.

with diet B (89.03) was higher than that of the initial fish (87.25). Fish fed diet B also had higher protein content of the carcass compared to diets A (80.51), C (86.14) and D (85.58). Fish fed diet A (80.51) presented the lowest carcass protein content. However, the carcass protein content of fish fed diets A, C and D show lower values compared to that of the initial fish. No significant difference of dry matter content of the dorsal muscle was observed between the fish fed the test diets (A = 93.24, B = 93.34, C = 93.01 and D = 93.32) compared to the initial fish (92.58). Significant differences were observed on the lipid content of the dorsal muscle of the fish fed different diets. The lowest value was observed in the fish subject to the diet A compared to fish fed the control diet. No significant differences were noted between the lipid content of the dorsal muscle of the fish fed with diets B, C and D and that of the initial fish.

DISCUSSION

Water quality parameters

The mean values of the water quality parameters (temperature, dissolved oxygen (DO) and the pH) during the entire experimental period are shown in Table 6. The results revealed that the temperature of the water ranged from 27.4 to 28.2 ° C; the dissolved oxygen varied between 6 to 7.1 mg / L and the pH fluctuated between 7.2 and 7.4. This is in agreement with the findings of Hakim *et al*, 2007. These results show acceptable proportions necessary for normal growth and development of physiological activities of Nile tilapia.

Growth performance

The use of natural binders in the formulation of the tested diets positively affects the growth performance of *Oreochromis niloticus*. The diet B showed the best absolute mean weight gain of 6.75 ± 0.4 g. This result is in accordance with the work of Pearce *et al*. (2002). They argued that the use of natural binders in the formulation of feed for aquaculture species has positive effects on the growth of aquatic organisms.

Regarding the relative mean weight gain, the best results were obtained with the diet B containing *Corchorus tridens leaves meal*, which is 117.68 ± 10.09% compared to the diet D (78.54 ± 2.15) containing CMC as binder. These results are in line with those of Adan *et al*. (2011). In their study on Nile tilapia growth performance (*Oreochromis niloticus*), the relative mean weight gain ranged from 113.43 to 120.11%. In the present study, fish fed the diet B showed greater SGR 1.90 ± 0.1% / day than those of the fish fed diets A, C and that of the control D (mean SGR is 1.40 ± 0.1% / day). These results are similar to those reported by Bahnasawy (2009); IGA IGA (2008). They obtained SGR ranging from 1.47 ± 0.08 to 1.66 ± 0.03. On the contrary, it appears that the SGR values obtained in this study are lower than those reported by Fanda (2012). He found SGR ≥ 3% / day. In addition Jauncey (1982); Hung *et al.*

(2010) found values of SGR ranging from 2.74 to 3.17% / day that are greater than that of tested diets in the present study.

Feed efficiency

During the study, the different experimented diets tested on *Oreochromis niloticus* give positive growth. In fish nutrition, the most effective diet is the one that presentsthe lowest FCR. The results of the present study showed that the best FCR was obtained with the fish fed diet B with a FCR of 2.43 ± 0.01. This resultagreed with that reported by Noureddine 2011. On the contrary, this value is less than that observed (1.49) by Mosen *et al*. (2010). According to Mélard (1986), fry *Oreochromis niloticus* growth performance are dependent on thermal conditions and availability of oxygen dissolved in the rearing environment rather than distributed diets. The protein efficiency ratio (PER) obtained upon completion of our experiments is much higher than those obtained by Fagbenro (1994), Huang (2004) and Benabdella (2011). On the contrary, those of Mohsen *et al*. (2010) were higher (1.19 and 1.58). In view of the values obtained, the voluntary ingestion presents no significant differences in the consumption of diets. Apparently, none of the tested diets present repellency (lack of appetite). The fish growth difference can be explained either by the variation of the ingested voluntarily or by the difference in feed utilization efficiency. As the level of consumption, the difference between the diets is less apparent, the weak growth performance of fish fed with diets A, C and D would result from the poor digestibility of nutrients from the food. This is in line with the study of Storebakken *et al*., 1987, showing that fish feed containing highly effective binders have negative effects on the digestibility of macronutrients probably due to physical effects such as changes in the viscoelastic properties. Several studies show that the binders incorporated into diets for aquaculture species can positively or negatively affect the growth performance. Person The Ruyet *et al*. (1993) demonstrated that the alginate appears to be conducive to the cultivation of bass larvae (*Dicentrarchus labrax*). Lee *et al*. (1996) had previously reported that larvae of *Lates calcifer* could digest both the alginate and gelatin bound in diets. As against the CMC sodium included in the post-larval feeding (*Cynoglossus semilaevis*) did not result in positive growth according to Liu *et al*. (2008).

Survival rate

The present study showed that the survival rate obtained ranged from92% to 53.85%. There were no significant differences (P> 0.05) regarding the survival rate of tilapia fed with tests diets B, C and D. The lower survival rate was observed in fish fed the control diet A (53.85%). Which would confirm the good quality of foods tested. Similarly, Yacouba *et al*. (2008) reported survival rate ranging from 92.48% to 75.49%. Contrary, IGA IGA (2008) revealed that the survival rate was 96% in its work developing feed for tilapia *Oreochromis niloticus* using local inputs.

Carcass composition

Chemical analysis (protein, lipid and dry matter content) at the end of a feeding trial is frequently used to determine the influence of feed on fish composition. According to Hepher (1990), endogenous factors (size, sex, and stage of life cycle) and exogenous factors (diet composition, feeding frequency, and temperature) affect the body composition of fish. It should be noted that within exogenous factors, the composition of the feed is the only factor, which could have influenced the different chemical composition of the fish, as other endogenous factors were maintained uniform during the study. The results in Table 6 showed that the initial fish protein content is higher than those of fish fed diets A, C and D, but lower than the diet B. This may be due to the protein content *Corchorus tridents* (16.76%) in the diet. *Corchorus* leaves are rich in essential amino acids and only the methionine is present in small quantities (Fafunso and Basir, 1975). There is no significant difference dry matter content in the statistical point of view. Nevertheless the results experienced schemes are slightly higher than those of the original fish. The fat content of body composition of initial fish are higher than those of fish fed the different tested diets. These results are not in line with those reported by Rivas-Vega *et al*. (2012). They showed in their research that the composition of the fat body content of the initial fish is lower than that of fish subject to testing diets. This could mean that the fish subject to the tested diets have spent a lot of energy during the experimental phase to meet the conditions of their living environments where the presence of low percentage lipid in the flesh. Moreover, this low rate of fat body content of fish fed with the diets (A, B, C and D) can be caused by poor digestion of fats in the diets tested. Lipids, generally well digested, allow fish to have fatty deposits. These play a major role in energy supply, especially important role in fish that the majority of these problems digesting complex carbohydrates (Guillaume *et al*., 1999).

Conclusion and Perspectives

The main objective of this study was to identify which of the formulated diets using natural binders compared to the diet containing CMC (control), give best performance standpoint and profitability. This attempt aims to solve the problem posed by the lack of quality fish feed means accessible to fish farmers and contribute to the growth of this activity in Senegal. Subsequent to this investigation, encouraging results, although preliminary, were obtained. Given growth performance, feed efficiency we can, in the present state of the results, consider diet B containing *Corchorus tridens* leaves as the most interesting in terms of quality, performance and profitability. The best feed is the one that covers the nutritional needs of the fish. We concluded that *Corchorus tridens leaves meal* could replace Carboxy-methyl-cellulose in feed formulations for tilapia. The other two natural binders namely *Adansonia digitata* leaves meal and Arabic gum meal have not been satisfactory. They couldn't replace CMC in tilapia diet.

The work was carried out indoors therefore it needs to be tested in an outdoor (natural ponds) production environment and could probably help to improve results. Knowing the potential of tilapia to take advantage of different food sources in the wild, organizations and benthic plankton ingested by fish, could thus settle, to some extent, the problem of deficient nutrients. It would also be interesting to conduct further studies to test different *Corchorus* to determine which of them is the best binder. Other studies such as determining the optimal inclusion best *Corchorus* leaves as binder, and the effect of this natural binder on feed digestibility and water stability will complement this work.

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