

Farming Features of African Bonytongue Fish *Heterotis niloticus* in Cameroon, Central Africa

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Abstract

The characterization of African bonytongue *Heterotis niloticus* fish farming was conducted in the Bi-modal agro-ecological zone of Cameroon from January to May 2021. Thirty-two fish farmers were interviewed and SPSS 6.2 Version was used to analyse the data. The results showed that the majority of fish farmers (81%) are men above 51 years, all of whom are Christians with more than fifty percent of them married. About 43% of them have university level education, and more than 6% of them considered the farming of *Heterotis niloticus* as their main income-earning activity. The main objective of *Heterotis niloticus* farming is sales (50%) and the uses (56%) of waged labour. A majority of the farmers produced reared African bonytongue in a polyculture system and 65% of them raised *Heterotis niloticus* in derivation ponds.

Keywords

Aquaculture, Characterization, African Bonytongue, Cameroon, Central Africa

1. Introduction

Since 1960, aquaculture ponds were estimated to 300,000 in Africa but six years later, with some difficulties in fish farming, most of the fish farmers were abandoned and the new estimate was about 20,000 ponds [1]. Aquaculture is supplementing fish catches which alone, is not able to meet the demand for fish in Cameroon. In 2019, the World's Fish Production from fishery was 92.49 million

tonnes as compared to 85.34 million tonnes from Aquaculture. Fish contributes to 66% of aquaculture production. In Africa, fish production represents 3.64% of world fish production [2]. Despite, the rich potential of Africa fish production does not meet the demand of population because of an ever increasing demand from the growing population [3]. In 2018, aquaculture represented 6.5% of Cameroon's national fish production (287,461 tons) [4]. This production is large insufficient for the total population of Cameroon estimated at about 23,248,044 inhabitants, while the demand for fish is still very high (500,000 tons). To satisfy this demand, fish farming is recommended by the Government [5]. In Cameroon, fish farming started in 1948 to meet the demand of the population and its characterization played a very important role in fish production [6]. Tilapia (*Oreochromis niloticus*), catfish (*Clarias gariepinus*), Carp (*Cyprinus carpio*) are the most species produced in Cameroon. However, African bonytongue (*Heterotis niloticus*) is the only species of the Osteoglossidae family in Africa which has a high commercial and economic value in fisheries and aquaculture system Adite et al. [7]. *Heterotis niloticus* is reared in West, East and Central Africa [8], but in Cameroon, the farming of bonytongue fish is not yet properly documented.

The main objective of this study was to identify the *Heterotis niloticus* fish farming features in Cameroon. The specific objectives were to describe social profile of the bonytongue fish farmers, evaluate their fish farming techniques and inventory the main challenges encountered in *Heterotis niloticus* fish farming in Cameroon.

2. Material and Methods

2.1. Period and Area Study

The study was conducted from January to May 2021 in the bi-modal equatorial agro-ecological zone of Cameroon (Figure 1). This agro-ecological zone is situated between 2°30'N and 11°45'E and has a Guinea type of climate. Humidity is high and the average precipitation per year varies from 1500 to 2000 mm. This zone is characterized by four seasons. A long dry season from December to May followed by a rainy season from May to June, a short dry season from July to October and a heavy rainy season from October to November.

The average temperature in those regions is 25°C. The Nyong, Ntem, Dja, Lobo, Lobé and Lokounje are the main rivers in this zone. This zone was selected for their high potential in aquaculture of African bonytongue and the favourable resource and climatic conditions of this fish species.

2.2. Sampling Techniques

Thirty-two fish farmers selected purposively were interviewed. We were worked in partnership with the regional delegation of Livestock, Fisheries and Animal Industries of the South and the Centre regions to select the interviewees. Before the administration of questionnaire, fish farmers were briefed about the objective

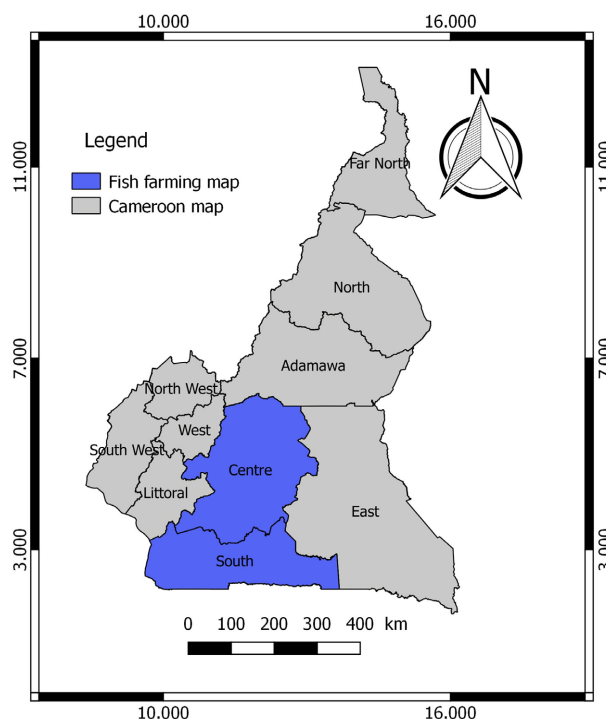


Figure 1. Study zones.

of the study and their consent was obtained. The inquiry centered on the socio-economic profile of the fish farmers, fish farming techniques of *Heterotis niloticus* and the difficulties of fish farming. For the socio-economic profile of fish farmers, data was collected on: age, gender, religion, level of education, marital status, ethnic groups, occupation and source of income while the fish farming techniques were the type of infrastructure and system, water supply and quality, water management, fish species, types of fish feed, constraints and perspectives Tiogué *et al.* [9].

2.3. Statistical Analysis

Data collected were coded and entered in a database system using Microsoft Excel software. These data were exported to the Statistical Package for the Social Science (SPSS) 6.2 Version. Descriptive statistics were used to determine the mean, sum and frequency for variables.

3. Results

3.1. Socio-Economic Characterization of the Fish Farmers

The farming of *Heterotis niloticus* is dominated by men (81.25%) with just a few women involved. Old persons constituted 46.90% of the respondents. The majority of the fish farmers (78.13%) were married, and all the fish farmers were Christians. Some of the farmers were educated, 43.75% of them had studied at the university level. Their main activities was livestock (40.63%) production (Table 1).

Table 1. Social characteristics of fish farmers of *Heterotis niloticus* according to the region.

Characteristics	Regions		
	Centre	South	Total (%)
Gender			
Male	43.75	37.50	81.25
Female	15.63	3.12	18.75
Age group			
[21 - 30[	0	6.25	6.25
[31 - 40[	25	6.25	31.25
[41 - 50[	12.50	3.12	15.62
[51 and +[	21.87	25.00	46.87
Marital status			
Single	9.37	12.50	21.87
Married	50	28.13	78.13
Religion			
Christianity	59.37	40.63	100
Education			
Primary level	12.50	6.25	18.75
Secondary level	18.75	18.75	37.50
Higher level	28.13	15.62	43.75
Main activity			
Agriculture	6.25	3.12	9.37
Animal husbandry	31.25	9.38	40.63
Fish farming	0	9.37	9.37
Civil service	18.75	15.63	34.38
Other business	3.12	3.12	6.24

In **Table 2**, 37.50% of the fish farmers have a professional experience of at least more than 10 years. The objectives of fish farming of *Heterotis niloticus* were for selling (50%) and self-consumption and selling (46.87%). The labour used for the fish production was mainly wage (56.25%).

3.2. Fish farming Techniques of *Heterotis niloticus* in Cameroon

Figure 2 illustrates the year of the creation of fish farming in Cameroun.

The fish farming of *Heterotis niloticus* started since 2000, but most of farming (31.25%) only began recently in Cameroon.

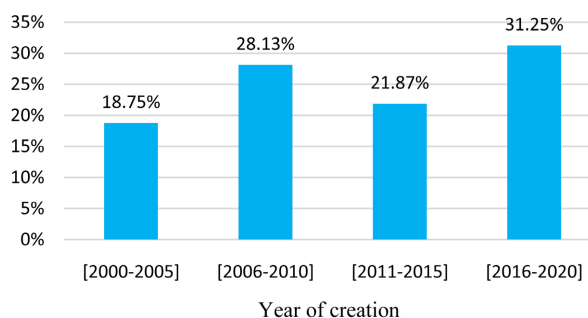


Figure 2. The *Heterotis niloticus* fish farming year of creation.

Table 2. Professional experience, objectives and labour of African bonytongue fish farming.

Modalities	Centre	South	Total (%)
Professional experience			
[0 - 5[	12.50	18.75	31.25
[5 - 10[	25	6.25	31.25
[10 and +[	21.88	15.62	37.50
Objectives of fish farming			
Own C	3.13	0	3.13
Sales	28.12	21.88	50
Own C-Sales	28.12	18.75	46.87
Labour			
Family	15.63	28.12	43.75
Wage	43.75	12.50	56.25

Own-C: Own Consumption.

The different ethnic groups that reared *Heterotis niloticus* were Bene, Bami-leke, Bali, Bassa, Beti, Ewondo, Bulu, Soo and Toupouri (**Figure 3**). Many fish farmers were Bene (38.47% for South region and 31.59% for the Centre).

Heterotis niloticus (**Figure 4**) was reared with tilapia (*Oreochromis niloticus*), common carp (*Cyprinus carpio*), catfish (*Clarias gariepinus*), Chanidae (*Parachanna obscura*) and *Hemichromis fasciatus*.

Polyculture is the farming of more than one fish species in a pond or tank at the same time. Polyculture (75%) is the most important system of *Heterotis niloticus* fish farming in Cameroon (**Figure 5**).

For the fish farming of *Heterotis niloticus*, the majority of fingerlings (87.50%) come from rivers. Fishermen catch the fingerlings and sell to the fish farmers (**Figure 6**). The price of the fingerling varies from 50 to FCFA 200 with FCFA 130 average price (**Figure 7**).

Figure 8 shows the age of sexual maturity of *Heterotis niloticus*. For fish farmers (71.87%), the age of sexual maturity of *Heterotis niloticus* is estimated at one year.

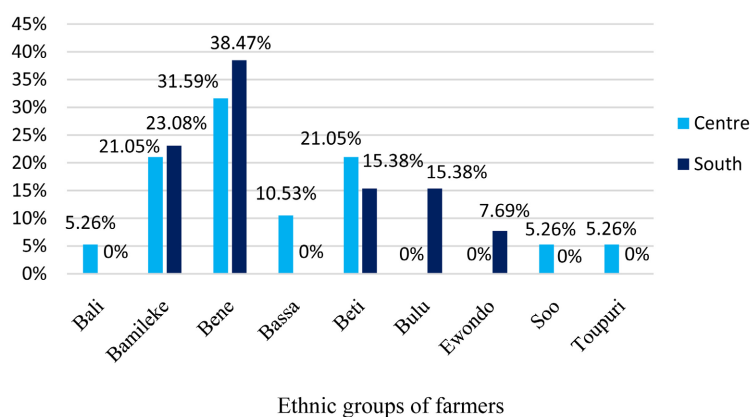


Figure 3. Ethnic groups of *Heterotis niloticus* fish farmers in Cameroon.



Figure 4. African bonytongue *Heterotis niloticus*.

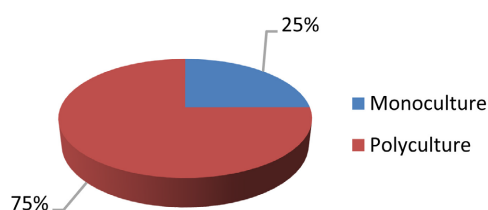


Figure 5. Fish farming system of *Heterotis niloticus*.

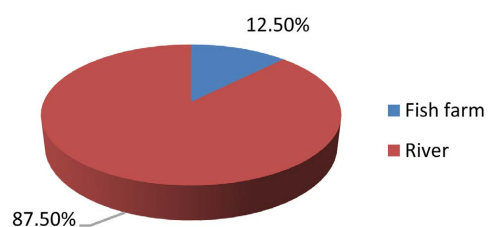


Figure 6. Source of fingerlings of *Heterotis niloticus* in Cameroon.

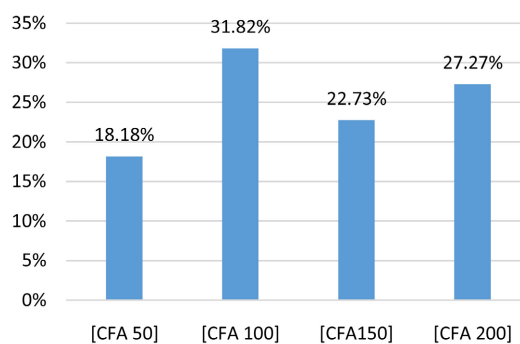


Figure 7. Purchase price of fingerlings of *Heterotis niloticus* in Cameroon.

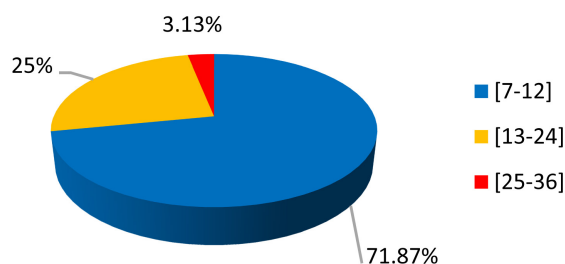


Figure 8. Age of sexual maturity of *Heterotis niloticus*.

3.3. Aquaculture Infrastructures of *Heterotis niloticus* in Cameroon

Heterotis niloticus was reared in concrete tank (Figure 9), dam pond (Figure 10) derivation pond (Figure 11) and in happa (Figure 12).

Most of farmers (65.63%) reared *Heterotis niloticus* in derivation ponds and the surface area varies from 200 to 6000 m² while the maximum surface area of concrete tanks is 200 m² (Table 3).

The majority system of fish farming was opened and water supply to feed them was a river at 84.40% (Figure 13).

Physical parameters of water for fish farming were taken into consideration (Figure 14). The majority of fish farmers (78.13%) did not prioritize the physical parameters of water during the rearing process. The minority of fish farmers consider the following parameters such as: temperature, pH, oxygen and transparency of water.

Figure 15 illustrates the nature of fish farming and the source of funding. Whatever the region chosen, the majority of fish farmers (78.13%) of *Heterotis niloticus* use personal sources of funding and only 21.87% of fish farmers received the subsidies from Government of Cameroon.

3.4. Feeding of *Heterotis niloticus* in Cameroon

The majority of fish farmers feed their fish (Figure 16) and the food are various type.

Figure 16 shows the different types of *Heterotis niloticus* food. They can be natural or artificial. Artificial food is made of pellets and locally produced food. A total of 33.33% of the fish farmers used local food (LF) to feed their fish and only 5.56% used pellet food (imported). The average cost of local food was FCFA 728.25 ± 113.86 per kg and from imported food this cost was FCFA 2010.27 ± 639.43 per kg of food.

The feeding frequency varies from once to twice per day (see Figure 17). More than half of the fish farmers feed *Heterotis niloticus* twice a day.

3.5. Diseases and Treatment

Figure 18 illustrates the frequency of fish disease. The majority of fish farmers didn't notice any diseases in their fish farming, only 6.30% of fish farmers discovered common diseases like ulcers for catfish.



Figure 9. Concrete tank.



Figure 10. Dam pond.



Figure 11. Derivation pond.



Figure 12. Happa system.

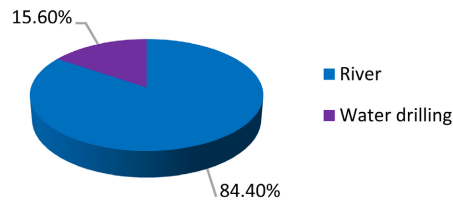


Figure 13. Water supply in fish farming of *Heterotis niloticus*.

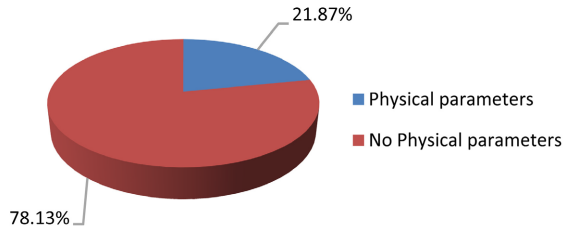


Figure 14. Physical parameters of water in aquaculture of African bonytongue fish.

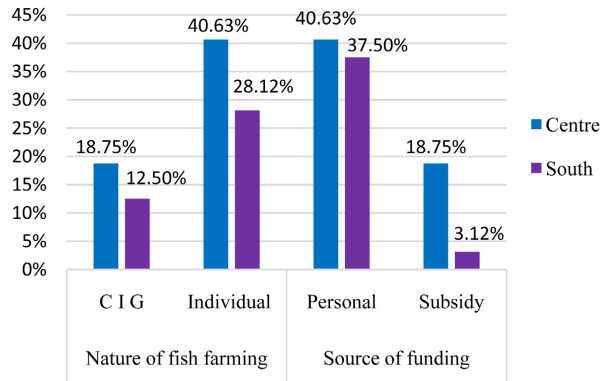


Figure 15. Nature of African bonytongue fish farming and Source of funding according to the regions.

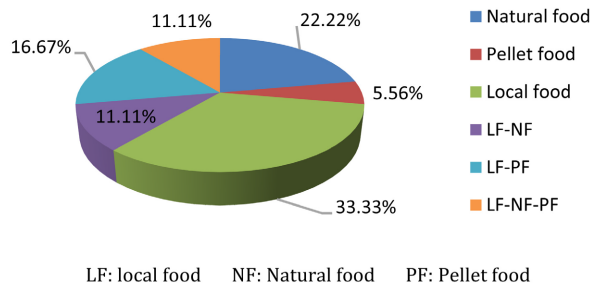


Figure 16. Different types of *Heterotis niloticus* food.

Table 3. Characteristics of pond and tank.

Characteristics	Fish farming infrastructures		
	Derivation pond	Dam pond	Concrete tank
Frequency (%)	65.63	25	9.37
Surface (m ²)	200 - 6000	10,000 - 25,000	100 - 200
System	Open	Open	Flow through

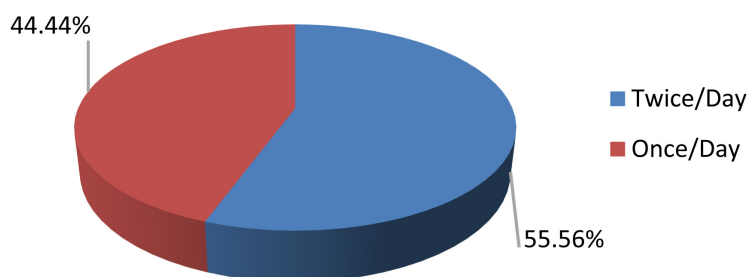


Figure 17. The *Heterotis niloticus* feeding frequency.

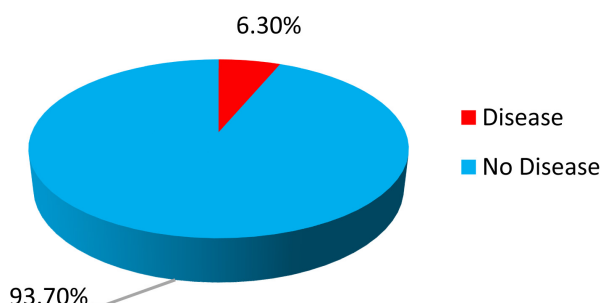


Figure 18. Frequency of fish diseases in aquaculture of African bonytongue.

In Cameroon, only 6.30% of fish farmers use antibiotics for the treatment and prevention of diseases (**Figure 19**).

3.6. Difficulties of *Heterotis niloticus* Fish Farming

The constraints faced by fish farmers of *Heterotis niloticus* were the lack of fingerlings, food, funding, technical support, and lack of materials, slump and theft (**Figure 20**). The most important difficulties were the lack of fingerlings (43.75%) followed by the lack of appropriate food (21.88%) and theft (12.50%).

3.7. Perspectives of *Heterotis niloticus* Fish Farming in Cameroon

The perspectives of the majority of fish farmers (56.25%) will be the improvement of the farming of *Heterotis niloticus*, to acquire feed mixers and pellet machines to produce fish food and transform fish (smoking, sausage...) for value addition. A few farmers (6.25%) plan to transform their fish farms to tourist sites (**Figure 21**).

4. Discussion

In Cameroon, most of fish farmers of *Heterotis niloticus* are men but the number of women is not negligible. The majority of fish farmers are more than 51 years old and 40% of them have university level education. This result was similar to Kenfack *et al.* [6] in East region of Cameroon who found that 80% of fish farmers were men while in South region of Cameroon all fish farmers are men [10] and 50 years old but the level of education of fish farmers in the East region of Cameroon was primary level. The results of Tiogué *et al.* [9] were higher than

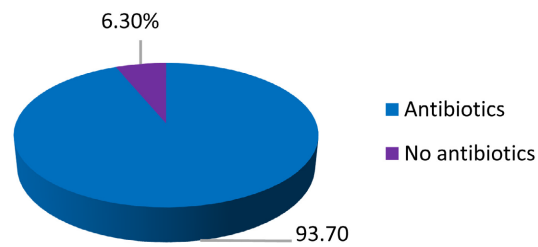


Figure 19. Antibiotic usage in fish farming.

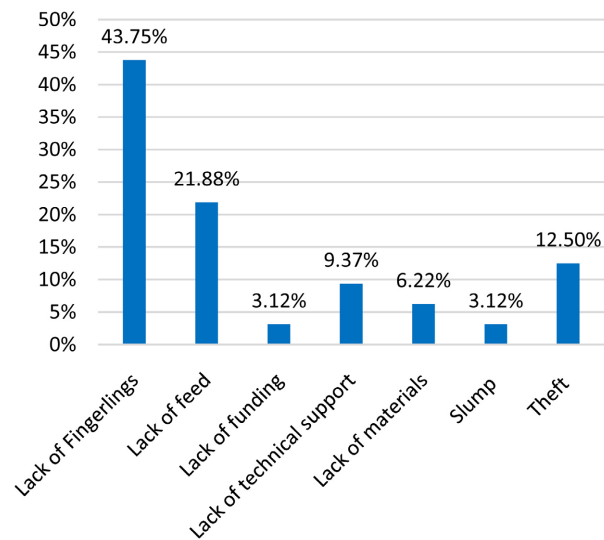


Figure 20. Constraints of *Heterotis niloticus* fish farming.

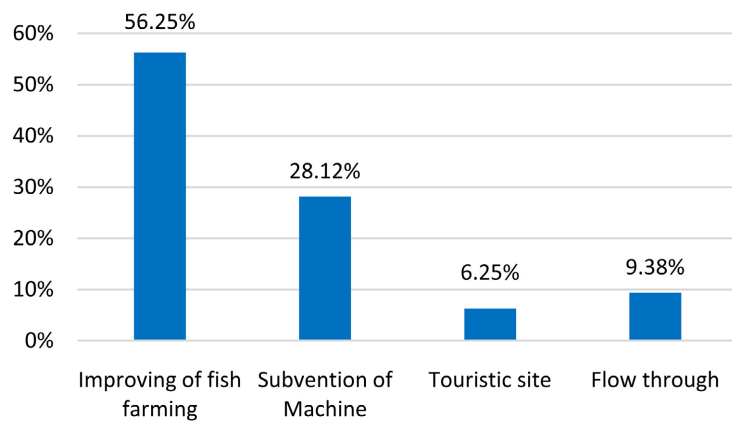


Figure 21. Perspectives of *Heterotis niloticus* fish farming.

the results of this study because 95% of fish farmers were men in the Mbam and Inoubou Division (Centre region, Cameroon) and 50% of fish farmers are aged 50 to 60. However, in DRC, 75% to 77.20% of fish farmers were men and the majority of fish farmers are 26 - 55 years old [11], Kifufu *et al.* [12]. Our result was not considerable as the results of N'dri *et al.* [13] and Tiogué *et al.* [9] who found respectively that in Congo 88.90% of fish farmers were married as 90% of fish farmers were married in Mbam and Inoubou Division (Centre-Cameroon).

Most of fish farmers considered the fish farming of *Heterotis niloticus* as their main livelihood activity and this result was similar to that obtained in the East region of Cameroon, where fish farmers do not consider fish farming as a priority Kenfack *et al.* [6] similarly to fish farming in Mbam and Inoubou where 7.5% of fish farmers considered this activity as their main activity Tiogu   *et al.* [9]. One third of *Heterotis niloticus* fish farmers have 10 years of experience while fish farmers in the Eastern Cameroon have 15 years of experience in fish farming Kenfack *et al.* [6] and in Mbam and Inoubou 50% of fish farmers have an experience of 10 to 20 years Tiogu   *et al.* [9]. The majority of fish farmers were married, and all fish farmers are Christians. The results of this study were similar to Tiogu   *et al.* [9] who found that 90% of fish farmers were married, but the majority were Christians (77.50%). Half of the labour is a wage, and this result is different from fish farmers of Eastern Cameroon where their labour use is family Kenfack *et al.* [6] and this result was higher than the result of Tiogu   *et al.* [9] who found that this workforce was related to salary (45%). This result may be due to their occupation as far as their main activity is considered. Most of the fish farmers of *Heterotis niloticus* have been receiving training in aquaculture at school, this frequency is higher than the value that Kenfack *et al.* [6] found (11.60%) in the East region of Cameroon and lower than the value (22.5%) obtained in Mbam and Inoubou by Tiogu   *et al.* [9]. The farming of *Heterotis niloticus* for most farmers began recently as in the Adamawa region where Dikwa [14] found that 32.60% of fish farmers started recently. Moreover, in Mbam and Inoubou 50% of the farming started from 2000 to 2010 Tiogu   *et al.* [9]. In Cameroon, the majority of fish farmers of *Heterotis niloticus* are Bene ethnic group while in Mbam and Inoubou, the Bafia ethnic group was considerable (42.50%).

The majority of fish farmers who reared *Heterotis niloticus* in polyculture like in the Mbam and Inoubou Division where 70% practice fish farming of African bonytongue with *Clarias gariepinus*, *Oreochromis niloticus*, *Cyprinus carpio*, *Parachanna obscura*. In the Adamawa region, 63.04% of fish farmers reared their fish in monoculture system [14] while in Madagascar, 76% fish farmers mixed African bonytongue with other species of freshwater fish (*Oreochromis niloticus*, *Cyprinus carpio*, Gourami) [15]. Polyculture is beneficial for *Heterotis niloticus* it has a microphagous diet Odo *et al.* [16]. In this line, Kiloso [17] and Adite *et al.* [18] found that African bonytongue was an omnivore feeding mainly on aquatic insects, micro-crustacean, seed and detritus according to the availability of resources in his habitat [19], Adite *et al.* [20].

The source of fingerlings supply provided from rivers, this is a main problem of fish farming in Cameroon and reproduction in captivity of African bonytongue takes time. In fact, sexual maturity is long (1 to 2 years) as founded in Cote d'Ivoire by Kouakou *et al.* [21], in Benin by Adite [22] and in DRC by Kiloso [17] and purchase of fingerlings becomes more expensive because of its scarcity.

The majority of African bonytongue were reared in derivation ponds [12] because *Heterotis niloticus* like enough space to live and to breed naturally [15].

This situation was the same as the study of Kifufu *et al.* [12] who found that in Bagata (DRC), 82.80% of fish farmers used derivation ponds to rear fish. Requiring enough space for its breeding, *Heterotis niloticus* needs enough water hence the source of water supply is the river. Physical parameters are important to fish farming, but a few number of fish farmers take physical parameters. This is a problem because growth performance of *Heterotis niloticus* will be affected by the variation of temperature which leads to stress fish and mortality follows [23] but decreasing of temperature (less than 25°C) will stop spermatogenesis and oogenesis of African bonytongue while the variation of pH from 6 to 7.2 leads to increase plankton production in the fresh water [24]. Moreover, decreasing of physical parameters would influence growth performance of *Heterotis niloticus* while when those parameters are optimal, African bonytongue could have a weight varies from 3.42 to 4.49 Kg (Djouatsa *et al.* [25]). This result was in contradiction with the result found in Congo where fish farmers didn't have equipment to measure water quality N'dri *et al.* [13]. To have subsidies, fish farmers should be grouped in Associations, Common Initiative Groups (CIG) or Cooperatives. In this study, the majority of fish farmers were not in association. This result was similar to those of Lazard *et al.* [26], Tiogu   *et al.* [9] [13] who had respectively found that in Western-Cameroon 68%, in Mbam and Inoubou 85.00% and in the Adamawa 67.39% of fish farming were individuals. But, N'dri *et al.* [13] and Kenfack *et al.* [6] found respectively that in Congo and in the East of Cameroon fish project was totally individual.

In Cameroon, feeds were necessary for fish farming, more than half of the fish farmers feed African bonytongue. Our result was higher than N'dri *et al.* [13] who found in Congo that only 41.70% of fish farmers feed their fish. Most of the fish farmers used imported feed, this result was lower than the result of Tiogu   *et al.* [9] where 15% of fish farmers used imported feed while no fish farmers in Congo used imported feed. This result was lower than Tiogu   *et al.* [9] because there is a lack of specific feed of African bonytongue in Cameroon. In 2010, Monentcham and collaborators [27] [28] studied the requirement in the diet of the African bonytongue but the formula of feeding was not known by fish farmers and they used these ingredients for local production of African bonytongue food: fish meal, fish oil, soybean meal, cottonseed meal, corn flour, wheat products, palm oil, premix, vitamins and mineral. For imported food, fish farmers used Coopens, Nutra HP and Skretting while the natural foods of fish are zooplankton and phytoplankton which are produced by fertilization of ponds.

For *Heterotis niloticus* no diseases were declared by fish farmers. But with poly-culture, *clarias gariepinus* have ulcers and treatment was done by the use of antibiotics that caused resistance in fish. Despite the high demand of African bonytongue, its fish farming encounter some difficulties Wikondi *et al.* [29]. The factors that limit fish productivity were environment, sexual maturity, absence of sexual dimorphism and the high cost of feeding. For environment, fish needs an appropriate climate for rearing because if these conditions are not good, fish

would stress and stress conditions lead to influence growth performance [30]. The sexual maturity of African bonytongue was estimated from 1 to 2 years, this was very long compared to Nile Tilapia which had early sexual maturity [8] [31]. African bonytongue fish did not have visible sexual dimorphism, then artificial reproduction was difficult [32]. In 2009, Monentcham found a feeding formula of *Heterotis niloticus* diet but it was not popularize in the farming. The high cost of imported fish was a limit for fish farming [32].

The major constraints of *Heterotis niloticus* fish farming were the lack of fingerlings, lack of feed and theft but in 1991, Lazard *et al.* [26] found that in the Western part of Cameroon the major constraints were the lack of land, fingerlings, feed and lack of financial means while in Mbam and Inoubou the constraints were the ignorance of the projects (67.50%), the scarcity of subsidies (85.00%) because of lack of Associations/CIG/Cooperatives of fish farmers Tiogué *et al.* [9]. In Eastern Cameroon, the major constraints were the lack of financial means Kenfack *et al.* [6]. For the African bonytongue fish farmers from Madagascar, the most constraints are the management of reproduction and the fingerlings [14].

For aquaculture of *Heterotis niloticus*, natural reproduction of this species took time, meanwhile the lack of fingerlings is a major constraint. To improve fish farming of *Heterotis niloticus*, the majority of fish farmers wish to have financial means to extend their site and formulate their feeding.

5. Conclusion

The Socio-economic characterization of *Heterotis niloticus* fish farmers allowed us to know that the majority of fish farmers are men, most of them are married and almost all fish farmers are educated. For the majority of fish farmers, the fish farming of *Heterotis niloticus* is considered as a secondary activity. The majority of fish farmers used derivation pond to rear fish and the surface varies from 200 to 6000 m². The source funding is mainly from own savings. The lack of fingerlings and adequate feeds is the major constraint in the study zone Cameroon. These characteristics of fish farmers must be taken into account in order to improve bonytongue fish farming in Cameroon.

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Conflicts of Interest

The authors did not declare any conflict of interest.

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