



Effect of Water Quality Parameters on Nutritive Value of Catfish, Khartoum State, Sudan

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Abstract

The aim of this study was to evaluate the effect of water quality parameters on nutritive value of Catfish (*Clarias gariepinus*) in Khartoum State, Sudan. A total of 60 samples of catfish (*Clarias gariepinus*) were collected from Nile river and earthen ponds fish farms around Khartoum State and the samples were subjected to chemical composition analysis (Dry matter (DM%), Crude protein (CP%), Ether Extract (EE%) and Crude fiber (CF%) moisture% Nitrogen Free Extract (N.F.E%) Ph as well as ash%). Also, a total of 36 samples of water were collected from the ponds where fish samples were taken, Water quality parameters (No₂, No₃, Cl₂, PH, TDS, EC. and Salinity were done where fish samples has been collected. The data was subjected to SPSS by using one-way analysis of variance (ANOVA). The findings of this study revealed that, Catfish (*C. Gariepinus*) from Nile environment has Higher in nutritive values that catfish from earthen pond environments and there was highly significant difference ($P \leq 0.01$) except the pH. However, when compare Nile River water and earthen pond water, we found that; the pH and electrical conductivity showed a highly significant difference ($P \leq 0.01$), and total dissolved solids and salinity showed no significant difference ($P > 0.05$). Accordingly, the study concluded that the fish from Nile River water has a high in nutritive values than earthen pond fish. Also, Nile river aquaculture environment is an immediate environment in relation to ponds environment. The study recommended that, aquaculture is so recent in Sudan and only few farmers are realized about water quality parameters, hence the facilities and equipment for physio chemical parameters measurements should be facilitated to aqua culturists and rearing fish.

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Introduction

Fish is an important food source. The ever-high human population is couple with an increasing demand on fish. As a result, fish culture has grown rapidly worldwide (Sofia 2005 and Aremu and Ekunode 2008) ^[27, 4]. Aquaculture is often looked at as a potential source to fill the gap in fish supply from fish catch (FAO., 2007; Thomas *et al*, 2012) ^[13, 29]. Fish of Africa is a key dietary ingredient in many coastal and land lock African countries providing much-needed high-quality protein. The World Fish Center cites a decline in the per capita supply of such protein in sub- Saharan Africa (SSA) which they attribute to a decline of fish from wild fisheries and rising population in the region (FAO., 2007; Thomas *et al*, 2012) ^[14, 29].

In Africa, fish is a significant source of animal protein accounting for up to 80% of daily animal protein intake (FAO., 2007) ^[15]. According to the World Fish Centre the supply of fish in Africa is in crisis.

In recent years worldwide attention has been paid to the problems of environmental contamination by metals (Malik *et al*, 2010) ^[21]. So, metals were of particular concern due to their toxicity and ability to bio-accumulate in aquatic ecosystems (Mohmmadi *et al*, 2011) ^[23], as well as persistency in the natural environment. Among the metals some are potentially toxic (As, Cd, pb,) Others probably essential (Ni, V, Co) and many essential (Cu, Zn, Fe,). These essential metals can also produce toxic effects

when the metal intake is excessively elevated (Alibabic' *et al*, 2007) ^[1] stated that out of all water dwellers, fish is one of the most susceptible to toxic substances present in water. Fish lie at the top of the aquatic food chain and may concentrate big amounts of some protein from water and food. In addition another protein, fish is the most indicative factor in freshwater systems, for the estimation of metal pollution water fish and risk potential of peoples. Thus determination of protein in some target of fish is extremely important from health point of view. Varied level from measurement in fish samples were reported by (Alne-na-el., 2003; Authman and Abbas., 2007; Authman., 2008 and 2011) ^[2, 5, 6, 7].

The tropical freshwater fish, catfish, is the culture environment for fish and other aquatic organisms. It is the physical support in which they carry out their life functions such as feeding, swimming, breeding, digestion and excretion (Bronmark and Hansson., 2005) ^[9]. Based on this, access to adequate, regular and constant supply of good quality water is vital in any aquaculture project. According to (Sikoki and Veen., 2004) ^[26], any water body is a potential medium for the production of aquatic organisms. Fishes are reared in different culture media that can retain water and these are earthen ponds, concrete, plastic, wooden, metal, glass and fiber glass tanks. The recent increase in intensive aquaculture production in Nigeria will require effective water quality management for its success (Ezenwa., 2006) ^[12].

Water quality is made up of physical, chemical and biological factors which influence the use of water for fish culture purposes. These factors include dissolved oxygen, pH, hardness, turbidity, alkalinity, ammonia and temperature. Other parameters such as biological oxygen demand and chemical oxygen demand indicate the pollution level of a given water body (Ehiagbonare and Ogundiran., 2010).

Productivity depends on the physicochemical characteristics of the water body and water quality is one of the most critical factors besides good feed/feeding in fish production. For a successful aquaculture venture, the dynamics and management of water quality in culture media must be taken into consideration (Huct., 1986) ^[17].

Justification

The Importance of Catfish (*Clarias gariepinus*) rearing environment type as a source of protein and polyunsaturated fatty acids which decrease the risk of cardiovascular diseases for humans.

The objectives

- To evaluate Chemical composition of Catfish (*Clarias gariepinus*) that to be taken from their rearing environment (Nile river and Earthen ponds) in Khartoum State.
- To study the effect of water quality parameters of Nile river and Earthen ponds on nutritive value of Catfish reared that which was reared in, Khartoum State.

Materials and Methods

Area of study

In the present investigation, two sampling sites were selected in fish River Nile and fish farm in Khartoum State. For easy interpretation of results; samples were analyzed depending on general experimental strategy as follows:

- The similarities and differences in nutritive value of Catfish (*C. Gariepinus*) were done between River Nile fish and fish farms.
- Chemical Composition (crude protein CP%, crude fiber%, Ash%, moisture%, Dry matter DM%, Either Extract %, Nitrogen Free Extract NFE%, and Ph were

analysed and compared between River Nile fish and fish farms.

- Water quality parameters (NO₂, NO₃, Cl₂, PH, TDS, EC. And Salinity) were taken where fish samples has been collected.

Experimental Design

The study was carried out in to two areas identified as treatments at Khartoum State:

Treatment (1) River Nile fish (wild Catfish) was carried-out using (Elmaorada fish market) for fish sampling;

Treatment (2) Fish farms (cultured Catfish) was carried out using (Jebel Al-aulia farm) for fish sampling.

Fish Sampling

A total of 60 samples of Catfish (*C. Gariepinus*) ranged from 1.10kg weight and 46 cm length were collected from Nile River and fish farm (Jebel Aulia) around Khartoum State, 30 representative samples were randomly collected from each treatment.

River Nile fish samples were taken from fishing landing after captured fish landed to fishery directly.

Preparation of fish samples

Collected fish were divided in to two parts, each one was removed and washed with clean, potable water, after that, 20 grams of dorsal muscle were taken and transferred to sterilized plastic (60 ml size), then, sent to Sowba laboratory for approximate analysis (moisture, DM, ash, crude protein CP, EE, crude fiber, NFE, and ph).

Chemical composition of fish

The samples were minced for proximate analysis (Dry matter (DM%), Crude protein (CP%), Either Extract (EE%) and Crude fiber (CF%) moisture% Nitrogen Free Extract (N.F.E%) Ph as well as ash%) using standard AOAC (Horwitz, 2000) methods. The analysis was done in laboratory of Sowba in Khartoum.

Water Samples

A total of 36 samples of water were collected from Nile River and fish farm around Khartoum State (Jebel Aulia), 18 representative samples were randomly collected from each treatment. The samples were collected in sterilized water plastic (300 ml) and transferred immediately to the laboratory of department of fish production and technology, Faculty of Animal Production, University of Gezira Include;) nitrite (mg/l), nitrate (mg/l), chlorinate(mg/l), PH, Total dissolved solids (mg/l), Electrical conductivity (ppm) and Salinity%. Using portable field laboratory equipment.

Statistical Analysis

The data was analysed by using statistical package for Social Studies (SPSS version 14.0). One-way ANOVA was used for means separation between (treatments). A P-value of ≤ 0.05 was considered indicative of a statistically significant difference.

Results and Discussion

This study was conducted to evaluate of Catfish (*C. Gariepinus*) in wild environment (Nile River) compared with aquaculture environment, in Khartoum State, mainly The similarities and differences in chemical composition: (crude protein CP%, crude fiber%, Ash%, moisture%, Dry matter DM%, Either Extract %, Nitrogen Free Extract NFE%, and Ph). This work was also, intended to determine and compare physical and chemical parameters of water which include:

(NO_2 , NO_3 , Cl_2 , PH, TDS, EC. in the same environments which were fish has been taken.

The findings of the present study showed some fact on the manifesto of the popular cultured fish (chemical composition

among wild and farmed C. Gariepinus which serves as the principle basis in evaluating the nutritional and economical value of the fish as well as water quality parameters.

Table 1: Profile of Nutritive value of Catfish according to the Rearing Environment type

Nutritive value of Catfish %	Rearing Environment Type		S. E	Overall	Sig.
	Nile	Farm			
Moisture	73.62	69.62	0.93	71.6 $\pm$ 0.66	**
Dry Matter	26.4	30.4	0.94	28.4 $\pm$ 0.7	**
Crude Protein	31.7	29.7	0.15	30.7 $\pm$ 0.10	**
Crude Fiber	1.09	1.26	0.34	1.17 $\pm$ 0.24	**
Ether Extract	7	6.6	0.61	6.8 $\pm$ 0.43	**
Ash	1.15	1.23	0.27	1.19 $\pm$ 0.09	*
Nitrogen Free Extract	32.66	30.60	1.008	31.63 $\pm$ 0.71	**
pH	5.07	4.07	0.12	4.91 $\pm$ 0.84	Ns

**= significant at ($P \leq 0.01$).

NS= not significant at ($P > 0.05$)

S.E. = Standard Error of Means.

Sig. = Significant Level.

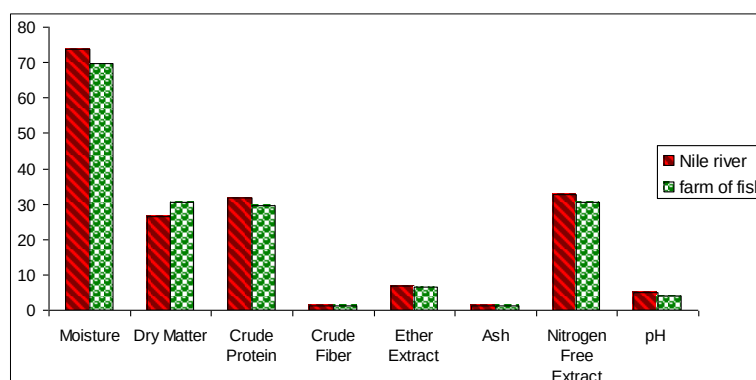


Fig 1: Profile of nutritive value of catfish according to the rearing environment type

Chemical Composition

The fluctuations in chemical composition parameters in the present study are shown in tables (1).

Moisture Content (MC)

Table (1), showed that, the moisture content (MC) of *O. niloticus* from Nile river site and ponds-cultured farms was 73.62%, and 69.62%, respectively. The MC percentage of fish from River Nile was a highly significant different ($P \leq 0.01$) from the MC% of fish from fish farm. These differences probably might be due to the differences in ages, although all sampled fish were equal in weight and size but their ages may differ, and the aged fish have more bones than less aged fish, and as bone tissues increase ash content increase accordingly. These results were agreed with (Zeinab M. and *et al*, 2024) [32], who studied Quality Properties of African Catfish (*Clarias gariepinus*) Meat as Affected by its Color and figured-out that, the moisture content was ranged from 73.88 to 74.14 in black and gray catfish. Also, the findings in agreement with (Mmandu and Clement 2020) [22] who were investigated Fatty Acid Composition of Fillets of African Catfish, *Clarias gariepinus* Fed with Various Oil-Based Diets, and they were pointed-out that; the moisture % were ranged from 70.74 to 75.88%.

Dry Matter (DM)

Table (1), showed that, the DM percentage level of Catfish (*C. Gariepinus*) collected from Nile river site and –cultured was 24.60% and 30.40%, respectively. The DM percentage of fish from River Nile was a highly significant different ($P \leq 0.01$) from the DM% of fish from fish farm. These

differences probably might be due to the differences in ages, although all sampled fish were equal in weight and size but their ages may differ, and the aged fish have more bones than less aged fish, and as bone tissues increase ash content increase accordingly. These results were agreed with (Zeinab M. and *et al*, 2024) [32], who studied Quality Properties of African Catfish (*Clarias gariepinus*) Meat as Affected by its Color and figured-out that, the dry matter % were ranged from 25.86 to 26.12 % in black and gray catfish, respectively. Also, the findings in agreement with (Mmandu and Clement 2020) [22] who were investigated Fatty Acid Composition of Fillets of African Catfish, *Clarias gariepinus* Fed with Various Oil-Based Diets, and they were pointed-out that; the dry matter % were ranged from 24.12 to 29.26 %.

Crude Protein (CP)

Table (1), showed that, the Crude protein (CP) percentage of Catfish (*C. Gariepinus*) collected from Nile river site and cultured was 31.7% and 29.7%, respectively. The CP contents of fish from River Nile was a highly significant different ($P \leq 0.01$) from the CP contents of fish from fish farm. There was a highly significant difference ($P \leq 0.01$) in CP content between *C. Gariepinus* from River Nile and fish farms. So, the higher CP content was found in *C. Gariepinus* from River Nile and the lower CP content was found in *C. Gariepinus* from farms. these differences probably might be due to the differences in feeding because, wild fish is normally eat selectively from the natural feed (planktons and water plants) which are high in protein because most feed is zoo planktons which is animal protein and even plant planktons and water plants which are plant protein

nevertheless their protein higher than other diet ingredients like dura and cakes, while cultured fish is always depends mainly/or partially upon manufactured feed (supplementary diets) and this differ according to ingredients (input) used to formulate the feed. However, the findings were disagreed with Fawole *et al* (2007) ^[16] he was figured out that, the CP% of *C. Gariepinus* tissues was 38.40% because this study used part of fish consist bone and muscle and as we known bones contain less protein when compared with muscle. also, these findings were less than These results were agreed with (Zeinab M. and *et al*, 2024) ^[32], who studied Quality Properties of African Catfish (*Clarias gariepinus*) Meat as Affected by its Color and figured-out that, the CP % were ranged from 74 to 76 % in black and gray catfish, respectively.

Crude fiber contents

Table (1), showed that, the crude fibre percentage of Catfish (*C. Gariepinus*) collected from Nile river site and –cultured was 1.09% and 1.26%, respectively. There was a highly significant difference ($P \leq 0.01$) in crude fibre content between *C. Gariepinus* from River Nile and fish farms. Fish farm samples were recorded a higher crude fibre content and River Nile were recorded the lower crude fibre content. However, these differences might be interpreted as difference in feeding sites, because fish farms which were recorded higher percentages their feed was manufactured by specialized feed plant and the feed ingredients may had high fibre. Although wild fish was fed on natural feed, nevertheless recorded lower fibre contents.

Ether Extract

Table (1), showed that, the Ether Extract percentage of Catfish (*C. Gariepinus*) collected from Nile river site and –cultured was 7% and 6.6%, respectively. There was a highly significant difference ($P \leq 0.01$) in ether extract content between *C. Gariepinus* from River Nile and fish farms. River Nile samples were recorded a higher ether extract content and fish farm fish were recorded the lower ether extract content. These results were disagreed with (Zeinab M. and *et al*, 2024)

^[32], who studied Quality Properties of African Catfish (*Clarias gariepinus*) Meat as Affected by its Color and figured-out that, the fat % were ranged from 21,17 to 19,81 % in black and gray catfish, respectively. Also, the findings in agreement with (Mmandu and Clement 2020) ^[22] who were investigated Fatty Acid Composition of Fillets of African Catfish, *Clarias gariepinus* Fed with Various Oil-Based Diets, and they were pointed-out that; the fat% were ranged from 3 to 6 %.

Ash Content

Table (1), showed that, the ash percentage of Catfish (*C. Gariepinus*) collected from Nile river site and –cultured was 1.15% and 1.23%, respectively. There was a highly significant difference ($P \leq 0.01$) in ash content between *C. Gariepinus* from River Nile and fish farms. Fish farm samples were recorded a higher ash content and River Nile fish were recorded the lower ash content. The findings were lower Adam and Keji (2011) they were pointed out that, the ash% of wild and cultured fish was 2.80% and 2.98 respectively. Also, the findings in disagreement with (Mmandu and Clement 2020) ^[22] who were investigated Fatty Acid Composition of Fillets of African Catfish, *Clarias gariepinus* Fed with Various Oil-Based Diets, and they were pointed-out that; the ash% were ranged from 3.13 to 4,24 %.

Nitrogen Free Extract (NFE)

Table (1), showed that, the NFE percentage of Catfish (*C. Gariepinus*) collected from Nile river site and –cultured was 32.66% and 30.60%, respectively. There was a highly significant difference ($P \leq 0.01$) in NFE content between *C. Gariepinus* from River Nile and fish farms. River Nile samples were recorded a higher NFE content and fish from farms were recorded the lower NFE content.

pH values

Table (1) showed that, pH value of Catfish (*C. Gariepinus*) collected from Nile river site and –cultured fish was 5.07 and 4.07%, respectively. There was no significant difference ($P > 0.05$) in pH value between *C. Gariepinus* collected from Nile river site and cultured fish.

Table 2: Profile of Water Quality Parameters of Water according to Rearing Environment type

physicochemical Parameters of water	Rearing Environment Type		S. E	Overall	Sig.
	Nile	Farm			
nitrite (mg/L)	000	000	000	000	
nitrate (mg/L)	000	000	000	000	
chlorinate(mg/L)	000	000	000	000	
Ph (mg/l)	7.60	8.06	0.46	7.8±0.33	**
Total dissolved solids (mg/L)	166.7	166.8	1.2	166.8±0.84	Ns
Electrical conductivity (ppm)	143.44	140.06	0.93	141.7±0.66	**
Salinity%	18.2	18.1	0.84	18.13±0.6	Ns

**= significant at ($P \leq 0.01$).

NS= not significant at ($P > 0.05$)

S.E. = Standard Error of Means.

Sig. = Significant Level

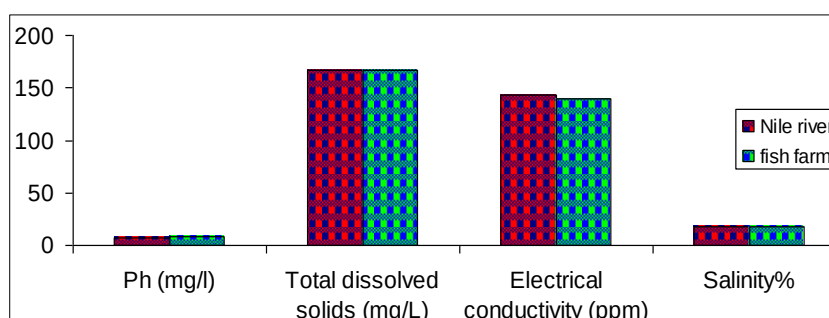


Fig 1: profile of water quality parameter of water according to rearing environment type

Water quality parameters

The physic-chemical parameters analyzed during study period at different chosen sites of Nile river, and fish rearing sites are presented into table (4.7) as follows:

Ammonia (Nitrite and nitrate)

The major source of ammonia in a water of a heavily stocked culture pond or in the effluent of a raceway is from excretion of fish, mostly via their gills. Ammonia is produced by animals as a byproduct of protein metabolism (Boyd 1990) ^[8].

Table (4.2), showed that, nitrite and nitrate mg/L were 00.00 mg/L.

The chlorinate mg/L

Chloride is a by-product of chlorine dissociation in water, but it is also widely associated with numerous other compounds that are highly water soluble. Chloride occurs in a range of concentrations in water and is often used as an indicator to characterize aquatic environments as saline or fresh. Fish, too, are classified as freshwater or marine as determined by their physiological adaptation to salinity. Chloride is important to fish in osmoregulation and other physiological processes and is regarded as nontoxic within the tolerance range of each species (Rick, 2012) ^[25].

Table (2), showed that, the chlorinate mg/L was 00.00 mg/L.

pH

Water pH affects metabolism and physiological processes of fish and also exerts considerable influence on toxicity of ammonia. Table (2), showed that, pH of water from Nile river site and farms (earthen ponds) was 7.60 and 8.06, respectively. There was a highly significant difference ($P \leq 0.01$) in pH from Nile river water and earthen ponds. The higher pH was found in earthen ponds water and the lower pH was found in Nile river water.

The measured water pH in ponds farms and river Nile in this study is considered normal for Nile tilapia life in the Khartoum state. The pH observed in this study agrees the report of (Lloyd, 1992) ^[20] he was pointed out that, the recommended level of pH for tilapia aquaculture 6.8 – 9.5 °C. The values represent quality for the optimal growth of the freshwater species rather than absolute limits for specific species (Environmental Policy and Planning, 2013) ^[11].

Total Dissolved Solids (TDS)

Total dissolved solids (TDS) are the term used to describe the inorganic salts and small amounts of organic matter present in solution in water. The principal constituents are usually calcium, magnesium, sodium, and potassium cations and carbonate, hydrogen carbonate, chloride, sulfate, and nitrate anions. Total Dissolved Solids (TDS) is a measure of all constituents dissolved in water. The inorganic anions dissolved in water include carbonates, chlorides, sulfates and nitrates. The inorganic cations include sodium, potassium, calcium and magnesium. Thus, sulfate is a constituent of TDS and may form salts with sodium, potassium, magnesium and other cations (WHO, 2003) ^[31].

The fluctuations in the recorded mean TDS levels in the Nile river and rearing sites are presented in Table (2), showed that, TDS (mg/L) of water from Nile river and earthen ponds 166,7 mg/ and 166,8 mg/L, respectively. There was no significant difference ($P > 0.05$) in TDS between Nile river and earthen ponds.

However, these differences probably might be due to the difference in bottom ground of water sites, this might be interpreted that Nile river water contain more TDS than

earthen ponds water. The results of this study were less than (Omer and *et al*, 2023) ^[24] whom were studied Influence of some Water Quality Parameters on Nutritive Value of Nile Tilapia (*Oreochromis Niloticus*) Reared on Different Culture Systems (Earthen & Concrete) in Gezira State, Sudan and figured-out that, the TDS of earthen ponds was 417 mg/L. However, the outputs of this research fall in the optimal limits. The acceptable range of TDS for aquaculture is 20 – 450 mg/L (Environmental Policy and Planning, 2013) ^[11].

Electrical conductivity (EC)

The variations in the observed mean electrical conductivity EC, in all water source sites were shown in tables (2). The value of EC of Nile river and earthen ponds, were 143.44 $\mu\text{S/cm}$ and 140,06 $\mu\text{S/cm}$, respectively. There was a highly significant difference ($P \leq 0.01$) in electrical conductivity between water sources. The maximum electrical conductivity was noticed in Nile river whereas minimum electrical conductivity was observed in earthen ponds. The overall average electrical conductivity was 141.7 $\mu\text{S/cm}$. However, these differences might be due to many factors and other water quality parameters such as salts and temperatures. Boyd (1990) ^[8] stated that, specific conductance for fresh water often range from <25 to $>500 \mu\text{S/cm}$, hence values obtained in this study fall within acceptable limits. The electric conductivity influences a lot of processes, such as the different state of metals and stability of colloids (Jonsson, 2005) ^[18]. The total concentrations of dissolved metals and the electrical conductivity are in a close connection. The more salts (cations and anions) that are dissolved in the water, the higher are the value of the electric conductivity. The majority of metals, which remain in the water after a sand filter, are dissolved ions. High purity water that in the ideal case contains only H_2O without salts or minerals has a very low electrical conductivity. The water temperature affects the electric conductivity so that its value increases from 2 up to 3 % per 1 degree Celsius (Lenntech, 2006) ^[19].

Salinity (%)

The variations in the observed mean salinity, in all water source sites were shown in tables (2). The value of salinity % of Nile river and earthen ponds, were 18.1 and 18,2 %, respectively. There was no significant difference ($P > 0.01$) in salinity % between water sources. However, these differences might be due to many factors and other water quality parameters such as TDS and temperatures. Boyd (1990) ^[8] stated High purity water that in the ideal case contains only H_2O without salts or minerals has a very low electrical conductivity (Lenntech, 2006) ^[19].

Conclusion

This study was conducted to evaluate nutritive value of Catfish (*C. Gariepinus*) in wild environment (Nile River) compared with aquaculture environment, in Khartoum State, Sudan mainly The similarities and differences in chemical composition: (crude protein CP%, crude fiber%, Ash%, moisture%, Dry matter DM%, Ether Extract %, Nitrogen Free Extract NFE%, and Ph). This work was also, intended to determine and compare physical and chemical parameters of water which include: (NO_2 , NO_3 , Cl_2 , PH, TDS, EC. in the same environments which were fish has been taken.

The findings of this study revealed that, Catfish (*C. Gariepinus*) from Nile environment has Higher in nutritive values that catfish from earthen pond environments and there was highly significant difference ($P \leq 0.01$) except the pH. However, when compare Nile River water and earthen pond water, we found that; the pH and electrical conductivity

showed a highly significant difference ($P \leq 0.01$), and total dissolved solids and salinity showed no significant difference ($P > 0.05$). Accordingly, the study concluded that the fish from Nile River water has a high in nutritive values than earthen pond fish. Noted that, Nile river aquaculture environment is an immediate environment in relation to ponds environment.

Recommendations

- More researches should be done to determine water quality parameters (physico-chemical parameters) so as to standardize specific limits for Catfish *Clarias gariepinus* rearing in order to maximize the productivity in farms.
- Measurements of water quality parameters and general measurements of farmed fish should be taken regularly in order to decide whether to change ponds water or not.
- Aquaculture is so recent in Sudan and only few farmers are realized about water quality parameters, hence the facilities and equipment for physico-chemical parameters measurements should be facilitated to aquaculturists and rearing fish.

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