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RESEARCH ARTICLE

Effect of Soil Textural Property on Nutrient Profile of *Clarias gariepinus* (Burch, 1822) from Earthen Ponds

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ABSTRACT

The effect of soil textural property on nutrient profile of *Clarias gariepinus* from earthen ponds was investigated between March and August 2016. Three soil profile pits were dug side-by-side three existing earthen ponds in three different geomorphological locations of Imo State at Umuagwo, Ulakwo, and Uboma. Three homogenous soil horizons (0–20, 20–60, and 60–150 cm) were identified and evaluated for soil moisture, soil textural class, and nutrient composition by standard methods (USDA, 1971). 10 adults of *C. gariepinus* of 580 ± 6.5 g average weight randomly selected from the associated earthen ponds were chemically evaluated for carcass composition in accordance with AOAC (2005). Soil textural class of fish pond was sandy at Umuagwo (sand: 79.8 ± 6.4%, silt: 11.7 ± 0.8%, and clay: 10.0 ± 0.7%), sandy loam at Ulakwo (sand: 68.7 ± 7.0%, silt: 16.0 ± 1.5%, and clay: 15. 3 ± 1.3%), and clay loam at Uboma (sand: 32.8 ± 3.0%, silt: 21.5 ± 2.8%, and clay: 50.0 ± 4.8%). Crude protein of fish carcass from the clay pond (27.6 ± 2.0%) and crude fat (18.2 ± 0.8%) was significantly higher ($P < 0.05$) than in the sandy pond (14.2 ± 0.8% and 2.3 ± 1.2%) and the sandy loam (18.1 ± 1.0% and 11.1 ± 0.2%) ponds, respectively. Soil textural property was positively related to carcass quality of *C. gariepinus* in earthen ponds.

Key words: Soil textural property, Nutrient, carcass quality *Clarias gariepinus*

INTRODUCTION

The value of any food product, including fish, is a function of its nutritive properties, evaluated in terms of health-promoting factors such as crude protein content, lipid, vitamins, minerals, and other valuable substances present.[1] The awareness of the unique nature of fish nutrients in human diets and health management has tremendously increased in recent times, resulting in an unprecedented demand for fish in preference to other sources of animal protein. Fish are now a dietary delicacy and preferred menu in households and all important occasions as well as for patients on special diets.

It is speculated[2] that the quality of dietary nutrients in pond-raised fish may be related to the texture of the underlying soil in which the fish were cultured. Consequently, the study seeks to investigate the effect of soil textural property on carcass quality of *Clarias gariepinus* raised in earthen ponds in Imo state.

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MATERIALS AND METHODS

Selection of fish ponds and experimental design

Three existing earthen fish ponds were selected for the trial at Umuagwo in Ohaji-Egbema LGA, Ulakwo in Ngor-Okpala LGA, and Uboma in Ihitte-Uboma LGA of Imo state. Each pond measured approximately 30 m × 25 m × 1.5 m (750 m^2) and stocked with 6000 fingerlings of *C. gariepinus* of 35.0 ± 1.6 g mean body weight at the rate of 8 fingerlings/m^2. The fish were fed with commercial feed concentrates at 5% body weight divided into two feeding regimes of mornings (0600 h) and evenings (18,000 h) and 6 days in the week.

The trial was designed as a completely randomized experiment (CRD) with three replications. The mathematical model[3] is as follows:

CRD: xij = M + Ti + Eij

Where,
xij = Value of independent observation
M = Unknown population variable
Ti = Treatment effect
Eij = Error term.

Soil profile pit selection and description

In each of the pond locations at Umuagwo, Ulakwo, and Uboma, a soil profile pit was dug. Each pit measured 1 m × 1 m × 1.5 m deep. The depth was chosen in line with the maximum permissible depth of fish ponds as 1.5 m.[4] The color of the various soil horizons in the soil profile was qualitatively determined on exposure by Visual method and by the use of color chart.[5] Thereafter, soil samples were collected in triplicates from each of the homogenous horizons for separate analysis.

Proximate analysis of fish carcass

After 6 months of culture, 10 adult fish, with average weight of 280.0±6.5 g, were randomly selected from each of the earthen ponds at Umuagwo, Ulakwo, and Uboma and processed for carcass analysis at the Fisheries Wet Laboratory, Federal University of Technology Owerri. Samples were analyzed chemically in accordance with the methods of Official Analytical Chemists.[6] Nutrients evaluated include crude protein, crude fat, ash, fiber, moisture, nitrogen-free extract (NFE), and caloric value.

Moisture content was determined using the oven dry method, ash by muffle furnace method, crude fiber by the reflux method, crude fat by the Soxhlet extraction technique, and crude protein by the micro Kjeldahl apparatus. The various parameters were estimated as follows:

$$\text{i. Carcass Moistures content (\%)} = \frac{Wb - Wc}{Wb - Wa} \quad 100$$

Where,
Wa = Weight of weighting bottle only
Wb = Weight of weighing bottle + sample before drying
Wc = Weight of weighing bottle + sample after drying.

$$\text{ii. Ash content (\%)} = \frac{Wc - Wa}{Wb - Wa} \quad 100$$

Where,
Wa = Weight of empty crucible
Wb = Weight of crucible + sample before ashing
Wc = Weight of crucible + sample after ashing.

$$\text{iii. Crude fibre (\%)} = \frac{W_2 - W_1}{\text{Weight of original sample}} \quad 100$$

Where,
W_1 = Weight of empty crucible
W_2 = Weight of crucible and its content after incineration.

$$\text{iv. Crude fat (\%)} = \frac{W_2 - W_1}{\text{Weight of original sample}} \quad 100$$

Where,
W_1 = Weight of empty beaker only
W_2 = Weight of beaker + ether extract.

v. Crude protein

The crude protein was obtained by multiplying the percentage of nitrogen content by a constant factor of 6.25, where the percentage of nitrogen is estimated, thus:

$$\%\,N = \frac{\dfrac{(T - B) \quad \text{Normality} \quad \text{Atomic mass}}{\text{vol}}}{\text{Weight of original sample}} \quad 100$$

Where,
T = Titer value of sample
N = Normality of HCl used
Atomic = Factor for atomic mass of nitrogen
Vol = Volume of digest

vi. NFE was determined by subtracting the sum of (% moisture + % C.P + other extract + % crude fiber + % ash) from 100.

NFE (%) = 100 – (% m + % C.P + % C.F + % ash + % E E)

vii. Caloric value (Energy)

The caloric value (Kcal) was obtained by multiplying the value of the C.P, EE, and NFE by 4, 9, and 4, respectively, as the sum of the product. i.e., Caloric value (Kcal/100g) = (C.P × 4) + (EE x 9) + (CHO or NFE × 4).

Statistical method

Data were analyzed with one-way analysis of various as described by Steel and Torrie.[7] Significant differences in mean values of parameters were separated using the Duncan's multiple range test.[8] This statistical analysis employed the computer Statistical Package for the Social Sciences (SPSS), version 19, Window 8.

RESULTS

Soil textural property

Tables 1-3 show the particle size distribution of the soil profiles developed at Umuagwo (recent alluvium), Ulakwo (coasted plain sands), and Uboma (sandstone and marine shale), respectively. The result shows that the soil at Umuagwo [Table 1] is dominantly sandy (sand: 79.8 ± 6.4%, silt: 11.7 ± 0.8%, and clay 10.0 ± 0.7%), Ulakwo [Table 2] was dominantly sandy loam (sand: 68.7 ± 7.0%, silt:16.0 ± 1.5%, and clay: 15.3 ± 1.3%), and clay loam at Uboma [Table 3] (sand: 32.8 ± 2.5%, silt: 21.5 ± 0.8%, and clay: 50.0 ± 4.5%). The third horizon was clay (sand traction: 22.0%, silt: 14%, and clay: 64%).

Table 1: Particle size distributing of soil profile developed at Umuagwo, Imo State (recent alluvium)

Soil depth (cm)	Soil particle size (%)			Soil texture
	Sand	Silt	Clay	
0–20	95.0	0.6	4.9	Sandy
20–60	94.4	0.4	5.2	Sandy
60–150	50.0	34.0	20.0	Sandy loam
X̄±SE	79.8±6.4	11.7±0.8	10.0 ± 0.7	Sand

SE: Standard error

Table 2: Particle size distribution of soil profile developed at Ulakwo, Imo state (coastal plain sands)

Soil depth (cm)	Soil particle size (%)			Soil texture
	Sand	Silt	Clay	
0–20	80.7	14.5	4.8	Sandy
20–60	65.0	15.5	19.5	Sandy loam
60–150	60.5	18.0	21.5	Sandy loam
X̄±SE	68.7 ± 7.0	16.0 ± 1.5	15.3 ± 1.3	Sandy loam

SE: Standard error

Table 3: Particle size distribution of soil profile developed of Uboma, Imo State (sandstone and marine shales)

Soil depth (cm)	Soil particle size (%)			Soil texture
	Sand	Silt	Clay	
0–20	47.8	24.0	28.8	Clay loam
20–60	28.5	26.5	45.0	Clay loam
60–150	22.0	14.0	64.0	Clay
X̄±SE	32.8 ± 3.0	21.5 ± 2.8	50.0 ± 4.8	Clay loam

SE: Standard error

NUTRIENT COMPOSITIONS OF FISH CARCASS

Tables 4-7 summarize the proximate composition of *C. gariepinus* from the three different geomorphological soils of Imo state. Nutrient composition of fish carcass from the sandy soil of Umuagwo [Table 4] and the sandy loam at Ulakwo [Table 6] was essentially identical. Crude protein was 14.9 ± 2.0% and 14.8 ± 2.5% for Umuagwo and Ulakwo, respectively, while lipid content was 4.7 ± 0.5 and 4.4 ± 0.2%, respectively. The same trend was also observed in other nutrient factors evaluated (crude fiber, ash, moisture, nitrogen-free extract, and caloric value). Fish carcass from the clay loam pond at Uboma [Table 6], however, showed a marked improvement in two major quality criteria of C.P (23.1 ± 3.0%) and fat (6.36 ± 0.1%). This superiority in nutrient composition was also exhibited in terms of caloric value (90.3 ± 5.8 Kcal/100 g) as against 82.60 ± 5.5 and 81.3 ± 4.3 Kcal/100 g in fish from Umuagwo and Ulakwo ponds, respectively.

Comparison of the proximate composition of fish carcass from earthen ponds of different soil textural classes

Nutrient composition of fish raised in soils of different textural classes is compared. The result revealed a significant difference ($P < 0.05$) in crude protein content of fish between the sandy and the sandy loam ponds (14.7 ± 2.0% and 14.9 ± 2.1%), respectively, and the clay loam (23.1 ± 3.0%). The sandy pond (Umuagwo) and the sandy loam (Ulakwo) showed no discernible difference ($P > 0.05$) in crude protein content. This trend was also observed in terms of crude fat (4.4 ± 0.5 % and 4.7 ± 0.8% respectively for fish from

Table 4: Carcass composition of pond-raised *Clarias gariepinus* in sandy soil at Umuagwo (resent alluvium)

Sample	Nutrient composition (%)						Caloric value (Kcal/100 g)
	CP (n × 6.25)	Lipid	Fiber	Ash	Moisture	NFE	
1	15.0	4.5	0.62	0.60	86.5	6.50	82.5
2	15.0	5.8	0.55	0.86	84.8	5.50	80.3
3	14.8	4.0	0.50	0.75	80.0	6.00	85.0
Mean (X̄±SE)	14.7 ± 2.0	4.4 ± 0.02	0.56 ± 0.02	0.70 ± 0.03	83.7 ± 5.05	6.00 ± 0.15	82.60 ± 5.5

SE: Standard error, NFE: Nitrogen-free extract, CP: Crude protein

Table 5: Carcass composition of pond-raised *Clarias gariepinus* in sandy loam soil at Ulakwo (coastal plain sand)

Sample	Nutrient (%)						Caloric value (Kcal/100 g)
	CP	Lipid	Fiber	Ash	Moisture	NFE	
1	16.0	4.5	0.8	0.7	85.5	6.0	78.0
2	14.0	4.0	0.6	0.5	85.0	6.0	86.0
3	13.8	4.6	0.7	0.6	86.0	5.0	80.0
Mean (X̄±SE)	14.9 ± 2.5	4.7 ± 0.2	0.7 ± 0.01	0.7 ± 0.01	83.8 ± 3.0	5.86 ± 0.05	81.3 ± 4.5

NFE: Nitrogen-free extract, SE: Standard error, CP: Crude protein

Table 6: Carcass composition of pond-raised *Clarias gariepinus* in clay soil at Uboma (sandstone and marine shale)

Sample	Nutrient (%)						Caloric value (Kcal/100 g)
	CP	Lipid	Fiber	Ash	Moisture	NFE	
1	22.5	5.8	0.7	0.8	78.0	5.8	95.0
2	24.0	4.5	0.6	0.9	75.0	6.0	86.9
3	22.8	5.8	0.6	0.8	70.0	6.5	90.0
Mean (X̄±SE)	23.1 ± 3.0	5.36 ± 0.1	0.63 ± 0.01	0.83 ± 0.01	74.3 ± 5.0	6.1 ± 0.03	90.3 ± 5.8

1 kilocalorie (Kcal): The quantity of heat required to change the temperature of 1 l of water by 10°C. SE: Standard error, NFE: Nitrogen-free extract, CP: Crude protein

Table 7: Comparison of the proximate composition of *Clarias gariepinus* raised in earthen ponds with soils of different textural properties

Soil/pond location	Nutrient parameter of fish (X±SE)						Caloric value (Kcal/100 g)
	CP	Fat	Ash	Moisture	Fiber	NFE	
Umuagwo sandy	14.7 ± 2.0[a]	4.4 ± 0.5[a]	0.7 ± 0.03[a]	74.6 ± 5.0[a]	0.6 ± 0.02[a]	4.0 ± 0.6[a]	82.6 ± 5.5[a]
Ulakwo sandy loam	14.9 ± 2.1[a]	4.7 ± 0.8[a]	0.6 ± 0.01[b]	82.2 ± 3.0[b]	0.7 ± 0.01[a]	5.8 ± 0.5[a]	81.3 ± 4.5[a]
Uboma (clay loam-clay)	23.1 ± 3.0[b]	6.4 ± 0.5[b]	0.8 ± 0.20[a]	84.3 ± 5.0[b]	0.6 ± 0.2[a]	6.1 ± 0.3[a]	90.5 ± 6.1[b]

[a,b,c]Mean values in the same column with different superscripts are significantly different at $F_a = 0.05$. SE: Standard error, NFE: Nitrogen-free extract, CP: Crude protein

Umuagwo and Ulakwo fish ponds) as against 6.4 ± 0.5% in fish from the clay loam ponds at Uboma, as well as for caloric value (82.6 + 5.5 and 81.3 + 4.5 Kcal/100 g) in fish from sandy and sandy loam ponds, respectively, also differed significantly ($P < 0.05$) from 90.3 ± 5.0 Kcal/100 g in fish from the clay loam ponds at Uboma.

DISCUSSION

The result shows that soils rich in clay impacted more positively on the nutrient quality of *C. gariepinus* them the other soils. This is probably because clay soils have good reserves of total nitrogen and available phosphorus compared to sandy and sandy loam soils[9] which is attributed to the differences in their parent materials. According to Ohiri and Ano,[10] sandy soils have multinutritional problems due to the quartz sand as parent material while clay loam soils with sandstones and marine shales as parent materials are usually high in available phosphorus, total nitrogen, and potassium. Novikov (1983) explains that aquatic plants and animals need nitrogen compound in the form of nitrate ions (NO_3) and ammonium ion (NH_4^+) to form protein and other important molecules such as deoxyribonucleic acid (DNA) and vitamins in the body tissue. Mineral compound of phosphorus (P) extracted from the underlying soil occurs in water (fish pond) as orthophosphate ($P0^{3-}_4$) ions and utilized by aquatic plants (algae and fungi) and considered as a limiting factor for primary production and fish yield in ponds.[11] These polyphosphates and nitrogenous compounds derived from soil phosphorus and total nitrogen undergo series of continuous conversions in aquatic ecosystem to form nucleotides (nucleic acids) which are present in living cells of fish as DNA and ribonucleic acid.[6,12-15]

Nitrogen found in soil, through the process of nitrification (nitrogen fixation) is converted to mineral (organic) compounds of nitrogen by aquatic plants (blue-green algae and some fungi). They occur in water as ions of ammonia (NH_4^+) and nitrate (NH_3^-). Green plants take up the inorganic forms of nitrogen (NH_3 and NO_3) for assimilation and reduce them to ammonia and finally to aspartic and glutamic acids as precursors in protein formation in fish.[16] The foregoing seems to explain the positive relationship which exists between soils of high inorganic nutrient (total nitrogen, available phosphorus, and exchangeable bases) and nutrient status of fish carcass from the difference earthen ponds. Another pertinent observation is that as the fat content of the fish increased, the moisture content declined. This is in agreement with the observations of Novikov (1983) that the greater the quantity of fat in fish flesh, the smaller the quantity of water and vice versa. Similarly, it was observed that the higher the lipid (fat) content of the fish the higher the caloric value of the fish. Novikov (1983) is of the view that fish fat which is rich in phosphorus, particularly adenosine triphosphate, has high-energy equivalents than other nutrient parameters in fish, adding that in the course of assimilation, 1g of protein releases 4.1 calories of heat, carbohydrate 4.1, and fat as much as 9.3 calories per gram.[17-18]

CONCLUSION

It would seem that clay soil, apart from its advantage of retaining water in earthen ponds and saving cost from concrete pond establishment, also improves nutrient status of cultured *C. gariepinus* in earthen ponds more than in other kinds of soil.

REFERENCES

1. Novikov VM. Hand Book of Fishery Technology. Vol. 1. Moscow: Pishechevaya Promychlennost Publishers; 1983. p. 491.
2. Njoku DC. The Ecology of Nigerian Fishes, an Introductory Course. Owerri, Imo State Nigeria: Contacom Communications Ltd.; 2004. p. 53.
3. Njoku DC, Onuh MO, Ohazurike NC. Research Methods and Field Experimentation in Agriculture and Biological Sciences. Owerri, Nigeria: Alphabet Nigeria Publishers Ltd.; 1998. p. 111.
4. Njoku DC. Fish Biology and Taxonomy. Owerri, Nigeria: Brighton Graphic Publishers; 2014. p. 250.
5. FAO. Guidelines for Soil Profile Description. Soil Survey and Fertility Branch Land and Water Dev. Division Food and Agriculture Organization (FAO). Rome. Italy: FAO; 1977. p. 560.
6. AOAC. Official Methods of Analysis of the Association of Official Analytical Chemists. 18th ed. Maryland, USA: AOAC; 2005. p. 1550.
7. Steel GD, Torrie JM. Principles and Procedures of Statistics. New York, USA: McGraw Hill; 1996. p. 250.
8. Duncan DB. Multiple range and multiple F test. Biometrics 1955;11:1-42.
9. Singer MJ, Mum DN. Soils, an Introduction. 3rd ed. New Jersey, USA: Prentice Hall Inc.; 1996. p. 480.
10. Ohiri AC, Ano AO. Soil and fertility management for sustainable crop production in South Eastern Agricultural zone of Nigeria. In: Iwueke CO, editor. Technology Generation Under the Unified Extension Service: Progress, Problem and Prospects. Proceedings of the 7th Annual Farming System Workshop, NRCRI Umudike 7th-11th December 1992; 1992. p. 22-33.
11. Devere B. Ecology of Fish and Wildlife. New York, United States of America: Delmer Thomson Learning Inc.; 1966. p. 420.
12. USDA. Soil Survey Laboratory Methods and Procedure for Collecting Soil Samples. Soil Conservation Service, US Department of Agriculture (Soil Survey Investigations Report No 1) Washington D.C, USA: USDA; 1971. p. 63.
13. Asadu CL, Chibuike GU, Dixon AG. Micronutrients availability in a cleared forest land after seven years of continuous cultivation and eight years of natural fallow in an Alfisol in Eastern Nigeria. In: Ojeniyi SO, editor. Nigerian Agricultural Transformation Agenda, Soil as a key to National development. Proceedings of the 38th Annual Conference of Soil Science Society of Nigeria, University of Uyo, Nigeria, March 10-14, 2014. p. 317-24.
14. Barnabas IM, Nwaka GI. Characterization of upland soils of Jiwa in the Federal Capital Territory, Abuja, In: Ojeniyi SO, editor. Nigerian Agricultural Transformation Agenda, Soil as a Key to National Development. Proceedings of the 38th Annual Conference of Soil Science Soc. Nigeria. University of Uyo, Nigeria, March 10-14, 2015; 2014. p. 106-13.
15. Cheng KL, Bray RH. Determination of calcium and magnesium in soil and plant materials. Soil Sci 1951;72:449-58.
16. Jackson ML. Soil Chemical Analysis, Advanced Course. Madison, USA: Prentice Hall Inc.; 1956. p. 991.
17. Udoh UM, Lekwa G. Characterization and classification of selected soils in Etim Ekpo LGA, AkwaIbom state, Nigeria. In: Ojeniyi SO, editor. Nigerian Agricultural Transformation Agenda. Proceeding of the 38th Annual Conference of Soil Science Society of Nigeria. University of Uyo, Nigeria, March 10-14, 2014; 2014. p. 216-24.
18. Waterman JJ. Composition and Quality of Fish. Edinburgh, UK: Torry Research Station; 2000. p. 250.