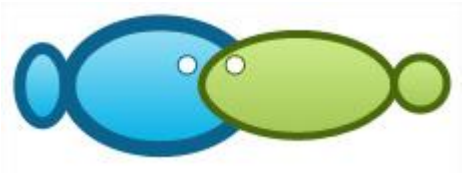

Chicken viscera meal valorization in feeding of African sneakhead fish fingerlings (*Parachanna obscura*) reared in captivity: zootechnical performances, feed utilization and composition

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Abstract. Five diets isonitrogenous and isocaloric were formulated to evaluate the effect of chicken viscera meal using on the zootechnical parameters and feed utilization of *Parachanna obscura* fingerlings. Fish meal in diet was replaced with chicken viscera meal at the inclusion level of 0% (D1), 25% (D2), 50% (D3), 75% (D4) and 100% (D5). The results showed significant variation of parameters ($P<0.05$) according to the treatments. The variation of biomass and SGR of fingerlings increased with the substitution rate of fish meal by chicken viscera meal up to 75% (D4) and decreased later on. The best PER and PPV values were obtained with D4. Therefore, chicken viscera meal can replace 75% of fish meal in *P. obscura* fingerlings diet.

Key Words: fish meal, protein ingredient, *P. obscura*, growth parameters, carcass composition.

Introduction. The worldwide population increase and demographic pressure observed in Africa during the latter decades, draw attention of many researchers to solve the food self-sufficiency problem (FAO 2018). Live food production from slaughterhouse or fisheries waste constitute an issue to palliate problem related to animal protein unavailability (Djissou et al 2015; Vodounnou et al 2016; Oke et al 2016; Sogbessan et al 2007). Thus, chicken viscera are trustable protein source to be valorized in animal production and aquaculture (Gümüs & Baki 2013; Tabinda et al 2013; Alofa et al 2015). Poultry viscera are wastes difficult manageable in slaughterhouses and local chicken markets. Obtaining fresh viscera for transformation into flour constitutes by the same way a mean for environment sanitation (Hedji et al 2014). Chicken viscera are very rich nutritional element and their protein rate is up to 70% (Hedji et al 2014). Many studies were carried out on the use of viscera for poultry feeding and aquaculture purpose. In aquaculture, studies focused on chicken viscera valorization were carried out on species such as tilapias and catfishes in order to reduce production cost (Tabinda & Butt 2012; Alofa et al 2015). There was no such a study on *Parachanna obscura*, an African (especially in Central and West Africa) species belonging to channidae family and in Asia with Channa (Kpogue et al 2012c; Vodounnou et al 2018). It's a carnivorous fish reproducing 9 months over the year (Isangedighi & Umoumoh 2011). Its meat is very appreciated by Benin population with a high economic value. Some studies were carried out to determine its nutritional needs in protein (45 and 55.5% for larvae; 42.5 and 53.5% for juveniles) (Kpogue et al 2012b; Kpogue et al 2013), lipid (7%) (Kpogue et al 2018b), carbohydrate (12%) (Kpogue et al 2018a), feeding rate ($5.01(\text{fish biomass})^{-0.23}$) (Kpogue et al 2012a) and feed distribution frequency (3 times/day) (Kpogue et al 2018b). Nowadays, aquaculture is spreading in Africa, especially in Benin through increase in fish production (Abou et al 2007; FAO 2018; Imorou Toko et al 2008). In

spite of this spread over, aquaculture is facing some difficulties related to the use of high quantity of fish meal in fish feed (Samocha et al 2004; Zhou et al 2010). By considering negative effects of climate changes and demographic pressure, we observe a worldwide decrease in fishery products (FAO 2018). This trend leads to the unavailability and expensiveness of fish meal in term of quality and quantity. The use of chicken viscera in aquaculture aims to find a new protein source in replacement of fish meal through its good nutritional elements profile closed to those of fish meal. It's for that purpose that the current study has been carried out. This study aims to evaluate the effect of chicken viscera meal on the zootechnical parameters, feed utilization and the carcass composition of *P. obscura*. This study will help in the domestication of *P. obscura*.

Material and Method

Chicken viscera collection, treatment, drying and grinding. Chicken viscera were collected in local market of "Ouando" situated in capital "Porto-Novo" areas of Benin. Chicken viscera collected were come from chicken slaughtered the same day. The chicken viscera used did not undergo any degradation. After collection, the droppings were emptied from the chicken viscera. Then the chicken viscera were washed and drained. After cooking by fire at about 100°C in interest for innocuousness, they were drained again. After cooking at 100°C with water, and after draining they were placed in oven for drying. The drying temperature was 60°C. Dried chicken viscera were grounded for obtaining chicken viscera meal (CVM).

Experiment monitoring. 750 fingerlings of *P. obscura* (mean weight 1.05±0.06 g) were used for the study. The study was carried out for 6 weeks on a farm stock located at Dangbo town in Ouémé areas in Bénin country. 15 rectangular concrete tanks were used and half covered by straw to provide shadow. Each experimental diet was tested in triplicate. Each concrete tank contained 100 L of water. The density was 50 fishes/tank. On the acclimation period of one week of *P. obscura* fingerlings were observed before the beginning of the experiment. During this period, a mixture of different experimental diets (20% of each of them) was used as feed. The biomass and the total length of each fish were measured before experiment start up. The fish were feed with $5.01(\text{fish biomass})^{-0.23}$ rate. The feeding frequency of reared fingerlings was three times daily (Kpogue et al 2018b). Growth control was carried every 7 days. All ponds were washed and the fishes were counted and weighted. At the experiment end, biomass, total number of the fishes, weight and individual length were measured in each pond. The physico-chemical parameters such as dissolved oxygen, pH and temperature, were monitored three times daily. These parameters were monitored with an oxygen meter, a pH meter and thermometer respectively.

Chemicals, zootechnical parameters and feed utilization. Standard methods for dry matter were used to analyze the ingredients and diet samples. The oven drying was performed at 105°C for 24 h, crude protein (CP) (N- Kjeldahl ×6.25) and ash (oven incineration at 550°C for 12 h) were used. Lipids were extracted according to Bligh & Dyer (1959). Analysis of the amino acids in the ingredients was carried out by high performance liquid chromatography (HPLC, Waters 474, Milford, MA, USA). These analyses were carried out according to the method described by Bosch (Alegria et al 1999). Whereas gossypol was determined according to the method described by Imorou Toko et al (2008), phytic acid in the ingredients was acid-extracted using 3% H_2SO_4 for 60 min at room temperature, centrifuged at 3,897 rpm for 15 min. Supernatant was mixed with $FeCl_3$ (0.1 N) and centrifuged again to obtain a precipitate at which we added de-ionized water and NaOH (1.5 N) to extract the phytate after incubation at 80°C during 30 min. After the feeding trial, fish were collected, counted, weighed and the different parameters were calculated as follows:

$$\text{Feed Efficiency (FE)} = (FB+DB-IB) / FD$$

Specific Growth Rate (SGR; %/d) = 100 × [Ln (Final Body Weight (g)) - Ln (Initial Body Weight (g))] / Duration (days) of the experiment

Consumption Index (CI) = 1/FE

Survival Rate (SR, %) = 100 x FN/IN

Protein Productive Value (PPV) = 100 x (Final Protein in fish – Initial Protein in Fish) / (Total Feed Intake per Fish x Dietary Protein)

Protein Efficiency Ratio (PER) = (FB - IB) / (FD x Dietary Protein)

Where:

IB: Initial Biomasses (g), FB: Final biomasses (g), DB: Dead fish biomass (g), FD: Feed distributed (g), IN: Initial number of individuals, FN = Final number of individuals.

Data processing. After data collection and encoding in Excel software, different zootechnical parameters, physico-chemical parameters and feed utilization parameters were calculated. Mean and range of each parameter were calculated and graphs were drawn. The data were analyzed using a one-way analysis of variance (ANOVA) with the facilities of STATVIEW version 5.01 software, after the verification of variance homogeneity, using Hartley's test. Significant differences among means were determined using Fisher's test p=0.05 significance level.

Results and Discussion

Essential amino-acids composition of main ingredients and diet formulation. After obtaining chicken viscera meal, the composition of essential amino-acids of chicken viscera and other main ingredients were determined (Table 1). On the basis of nutritional value of the ingredients, five experimental diets were formulated and the proximate composition of each of them was determined (Table 2). Ferrous sulfate was used to decrease a possible toxicity of free gossypol in the diet (Imorou Toko et al 2008). The diets were formulated to be isonitrogenous and isocaloric. Fish meal in diet was replaced with CVM at the inclusion level of 0% (D1), 25% (D2), 50% (D3), 75% (D4) and 100% (D5) (Table 1). The diet ingredients were grounded, weighted and mixed. Feed preparation was made by mixing the ingredients with boiling water and oil in paste. The paste was transformed into pellets of 2 mm diameter by food blender. After freeze drying at a temperature of 28 to 35°C in lyophilisator, the pellets were grounded again in small pieces and passed through 1.2 mm mesh sieves.

Table 1

Main ingredients essential amino-acids composition (% of EAA/EAA)

Composition (EAA %/EAA)	*CVM*	*CSM*	*SBM*	*MB*	*FM*
Threonine	9.37	4.76	8.12	4.42	8.57
Valine	7.59	5.29	5.98	4.42	10.27
Methionine	5.32	2.12	2.56	1.33	7.19
Isoleucine	6.33	26.46	5.56	2.88	9.08
Leucine	21.27	10.05	18.38	11.06	14.05
Phenylalanine	10.89	11.64	14.53	11.06	13.87
Histidine	6.08	7.41	6.84	9.73	6.49
Thryptophan	4.30	4.23	3.42	5.53	2.11
Lysine	13.42	5.29	12.82	9.73	15.65
Arginine	15.44	22.75	21.79	39.82	12.72
Total	100.00	100.00	100.00	100.00	100.00

CVM: Chicken viscera meal, CSM: Cotton seed meal, SBM: Soy bean meal, MB: Maize bran, FM: Fish meal.

Table 2

Formulation and proximate composition of experimental diet

Ingredients	(%)				
	D1	*D2*	*D3*	*D4*	*D5*
MB	12	13	14	18	19
FM	46	34.5	23	11.5	0
CVM	0	11.5	23	34.5	46
SBM	18	15	15	13	15
CSM	18	20	19	17	14
*CMV	2.5	2.5	2.5	2.5	2.5
IS	0.5	0.5	0.5	0.5	0.5
SO	2	2	2	2	2
CMC	1	1	1	1	1
Total	100	100	100	100	100
Proximate analyses					
Crude protein	45.01	45.15	45.5	45.84	46.69
Crude lipid	7.77	7.86	7.9	8.14	8.49
Carbohydrate	13.74	13.81	14.01	14.23	14.56
Ash	9.28	9.32	9.31	9.29	9.34
Antinutrients (g/100 g dry matter)					
Phitic acids	4.33	4.34	4.35	4.36	4.37
Gossypol	0.8	0.82	0.79	0.75	0.71

CVM: Chicken viscera meal, CSM: Cotton seed meal, SBM: Soy bean meal, MB: Maize bran, FM: Fish meal, IS: Iron sulfate, CMC: Carboxymethylcellulose, SO: Soya oil, CMV: Mineral vitamin complex.
*****contains (‰): Vitamin A 4,000,000 I. U.; Vitamin D 800,000 I.U.; Vitamin E 40,000 I.U.; Vitamin K_3 1,600 mg; Vitamin B_1 4,000 mg; Vitamin B_2 3,000 mg; Vitamin B_6 3,800 mg; Vitamin B_{12} 3 mg; Vitamin C 60,000 mg; Biotin 100 mg; Inositol 10,000 mg; Pantothenic acid 8,000 mg; Nicotinic acid 18,000 mg; Folic acid 800 mg; Cholin chloride 120,000 mg; Colbat carbonate 150 mg; Ferrous sulphate 8,000 mg; Potassium iodide 400 mg; Manganese oxide 6,000 mg; Cuivre 800 mg; Sodium selenite 40 mcg; Lysine 10,000 mg; Methionin 10,000 mg; Zinc sulphate 8,000 mg.

Water quality. The water physico-chemical parameters were recorded three times daily and the means were calculated each week. The evolution of these parameters was observed by week during experiment. pH during experiment ranged from 6.23±0.03 to 6.37±0.05 (Figure 1). Water temperature varied between 27.42±0.18 and 29.02±0.21°C (Figure 2). Dissolved oxygen in water varied between 6.28±0.11 and 6.96±0.13 mg L^{-1} (Figure 3).

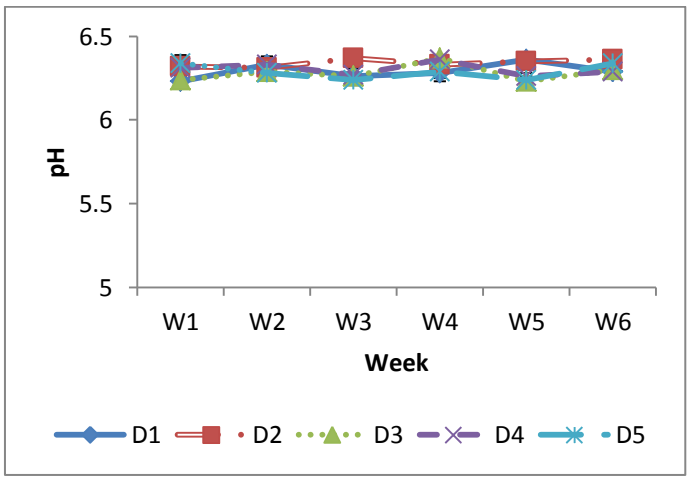

Figure 1. pH variation.

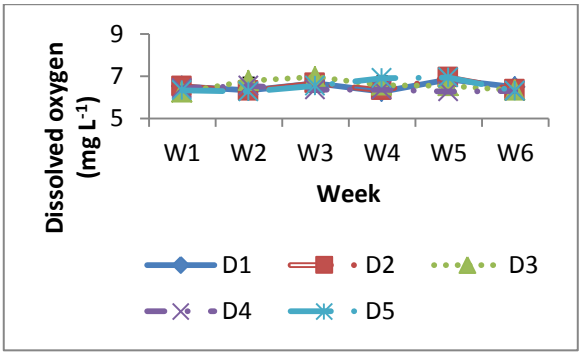

Figure 2. Dissolved oxygen variation.

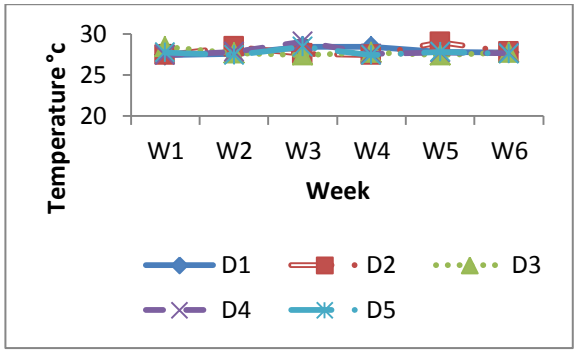

Figure 3. Temperature variation.

The recorded pH values ranged from 6.23±0.03 to 6.37±0.05 which is close to the optimum threshold, slightly acid that is accepted by *P. obscura* in natural environment (Bolaji et al 2011; Kpogue et al 2012c). The water temperature varied from 27.42±0.18 to 29.02±0.21°C. This temperature is in the limit supported by *P. obscura* in the wild (Bolaji et al 2011; Kpogue et al 2012c). Regarding dissolved oxygen rate, it ranged between 6.28±0.11 and 6.96±0.13 mg L^{-1}. This rate is acceptable by *P. obscura* that is a less dissolved oxygen requiring species. Indeed, *P. obscura* possesses accessories organs enabling aerial respiration and surviving in low oxygen media (Bolaji et al 2011; Odo et al 2012; Kpogue et al 2012c).

Growth parameters and feed utilization. Table 3 shows that final biomass varied significantly with the treatment ($P<0.05$). Diet D4 presented the highest final biomass. Final biomass observed with treatments D3 (113.33±1.53 g) and D4 (115.67±1.15 g) were not significantly different ($P>0.05$). The lowest final biomass was obtained with diet D1 (102.00±1.00 g). Also, any significant differences ($P>0.05$) was observed between this diet and D2 (105.00±1.00 g) and D5 (103.00±1.73 g). Specific growth rate obtained during the experiment varied significantly ($P<0.05$) with the treatments from 1.58±0.03 to 1.88±0.01/d (Table 3). While the highest SGR was obtained with diets D3 and D4; D1, D2 and D5 showed the lowest results of this parameter.

Table 3

Zootechnical parameters, feed utilization, survival rate, body composition of *Parachanna obscura* fingerlings reared with experimental diets

Parameters	*D1*	*D2*	*D3*	*D4*	*D5*
IB	52.60±0.36^a	52.67±0.74^a	52.40±1.22^a	52.53±0.25^a	52.50±1.32^a
FB	102.00±1.00^a	105.00±1.00^a	113.33±1.53^b	115.67±1.15^b	103.00±1.73^a
SGR	1.58±0.03^a	1.64±0.05^a	1.84±0.04^b	1.88±0.01^b	1.60±0.05^a
PER	0.89±0.02^a	0.98±0.01^a	1.28±0.05^b	1.62±0.06^c	0.88±0.04^a
PPV	4.11±0.10^a	6.19±0.12^a	9.67±0.72^b	12.08±0.66^c	5.44±1.06^a
SR	100.00±0.00^a	100.00±0.00^a	98.67±0.58^a	97.33±0.58^a	94.00±1.00^b

Each value is mean ± SE of triplicates. Means on the same row followed by different superscripts are significantly different ($P<0.05$).

Final biomass and SGR of fingerlings increased with the substitution rate of fish meal by chicken viscera meal up to 75% (D4) and decreased later on. The growth parameters (biomass and the SGR) progression showed that treatment D3 and D4 with respectively 50% and 75% substitution rate of fish meal by chicken viscera meal provided the highest results. These results are similar to those of Vodounnou et al (2016) during substitution of fish meal by earth worm meal. According to those authors, the best SGR was recorded with treatment that received 50% substitution of fish meal by earth worm meal. The SGR obtained in the present study (1.58±0.03-1.88±0.01/d) are close to the findings of Aliyu-Paiko et al (2010) for *Channa striata* (1.55–2.56%/d), Zehra & Khan (2011) for *Channa punctata* (1.21–1.82%/d), Kpoguè et al (2013) (1.08–2.55%/d) and Vodounnou et al (2016) (1.55–2.11) for *P. obscura* fingerlings.

Feed conversion rate presented significant differences (P<0.05) according to the treatments (Figure 4). *P. obscura* fingerlings fed with experimental diets D4 presented the best FCR (1.50±0.02). It should be noted that any significant differences (P>0.05) were observed between the D3 and D4 treatment. Otherwise, any significant differences (P>0.05) were observed between the D1, D2 and D5 treatments (Figure 4).

The FCR presents significant differences in relation to treatments (P<0.05). Treatments D3 and D4 showed the best FCR. These results confirmed the findings of Vodounnou et al (2016b) who obtained the best FCR in treatment that received 50% substitution of fish meal by earth worm meal.

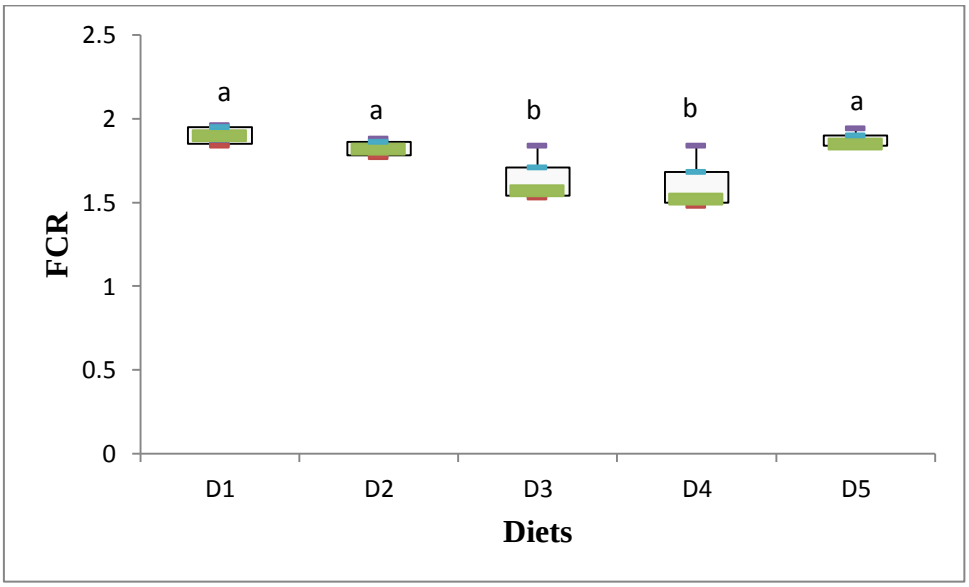

Figure 4. Feed conversion rate during experiment.

Inclusion of chicken viscera meal above 75% induced the reduction of growth performances and feed utilization parameters and leaded to growth parameters and feed utilization depression. Similar results were reported for *Carassius gibelio* (Yang et al 2006; Hu et al 2008), *Clarias gariepinus* (Oké et al 2016), *Clarias batrachus* (Giri et al 2010), *P. obscura* (Vodounnou et al 2016), *Ctenopharyngodon idella* (Tabinda et al 2013) fed on diets containing graded poultry viscera meal. According to Chor et al (2013), Sun et al (2014), Alofa et al (2016), Oké et al (2016) this depression of growth and feed utilization parameters at high inclusion level may be due to the presence of undigested grain and their by-products from the poultry diet, and the imbalanced amino acid content of the diet without fishmeal. This observation could be explained by the deficiency in methionine and lysine in the chicken viscera meal (Ronyai et al 2002; Fagbenro 2004; Hu et al 2008).

Survival rate and body composition. The different treatments impacted significantly (P<0.05) the survival rate. There was no mortality in treatments D1 and D2 (SR 100.00±0.00%). But progressive mortalities were noticed from D3 to D5. However, there was no significant differences (P>0.05) among treatments D1, D2, D3 and D4. The lowest survival rate was observed in treatment D5 (SR 94.00±1.00%) that received 100% substitution of fish meal by chicken viscera meal. The low survival rate in D5 (SR 94.00±1.00%) could be due to the quality of the feed. It's also important to notice that *P. obscura* is naturally resistant and able to survive in extremely difficult conditions. Mean value recorded in survival rate during the current study was 98.00±2.36%. Similar results were obtained during nutrition studies upon the same species by Vodounnou et al (2018, 2019).

The body composition of carcass showed that the experimental diets impacted the nutritional value of carcass. Protein efficiency ratio showed significant differences (P<0.05) between treatments. The lowest PER was observed with D5 (0.88±0.04). No

significant differences (P>0.05) were observed between this treatment and D1 and D2 diets. PER values obtained with D1, D2, D5 are significantly different (P<0.05) from D3 and D4 results. The highest PER was observed in D4 (1.62±0.06) which showed also a significant difference (P<0.05) with D3 (1.28±0.05). Productive protein value showed also significant differences (P<0.05) between treatments. It showed same tendency with PER in relation with significant differences with exception that the lowest PPV was observed in D1. The lowest PPV was observed in diet D1 (4.11±0.10). The highest PPV was obtained with diet D4 (12.08±0.66). This difference could be explained by protein digestibility and its utilization by fishes in relation to the substitution rate of fish meal by chicken viscera meal in feed. Many studies substituting fish meal to other animal or vegetal genuine protein sources led to modification of the bromatological composition of the carcass. It concerns substitution of fish meal by chicken viscera meal (Rawles et al 2006; Thompson et al 2007), fish meal by earth worm meal (Sogbessan et al 2007; Hasanuzzaman et al 2010; Olele 2011; Vodounnou et al 2016). There is also the substitution of fish meal by vegetal genuine protein (Abou et al 2007; Hlophe & Moyo 2014; Pucher et al 2014).

Conclusions. This study proved that the chicken viscera meal is an interesting ingredient useable in *P. obscura* diet. It has good nutritional value and can be used to substitute the fish meal up to 75%. Total substitution of fish meal by chicken viscera meal in *P. obscura* diet can affect negatively growth, feed utilization, body composition and survival rate of *P. obscura* fingerlings.

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References

Abou Y., Fiogbe E. D., Micha J. C., 2007 Effects of stocking density on growth, yield and profitability of farming Nile tilapia, *Oreochromis niloticus* L., fed Azolla diet, in earthen ponds. Aquaculture Research 38:595-604.

Alegria A., Barbera R., Farré R., Lagarda M. J., Lopez J. C., 1999 Amino acid contents of infant formulas. Journal of Food Composition and Analysis 12:137–146.

Aliyu–Paiko M., Hashim R., Shu–Chien A. C., 2010 Influence of dietary lipid/protein ratio on survival, growth, body indices and digestive lipase activity in Snakehead (*Channa striatus*, Bloch 1793) fry reared in re–circulating water system. Aquaculture Nutrition 16:466–474.

Alofa C. S., Oke V., Abou Y., 2015 Effect of replacement of fish meal with broiler chicken viscera on growth, feed utilization and production of African catfish *Clarias gariepinus* (Burchell, 1822). International Journal of Fisheries and Aquatic Studies 4(6):182-186.

Bligh E. G., Dyer W. J., 1959 A rapid method for lipid extraction and purification. Canadian Journal of Biochemistry and Physiology 37:911–917.

Bolaji B. B., Mfon T. U., Utibe D. I., 2011 Preliminary study on the aspects of the biology of snakehead fish *Parachanna obscura* (Gunther) in a Nigerian wetland. African Journal of Food Agriculture Nutrition and Development 11:4708-4717.

Chor W. K., Lim L. S., Shapawi R., 2013 Evaluation of feather meal as a dietary protein source for African Catfish fry, *Clarias gariepinus*. Journal of Fisheries and Aquaculture Sciences 8:697-705.

Djissou A. S. M, Tossavi E. C., Vodounnou D. S. J. V., Toguyeni A., Fiogbe E. D., 2015 Valorization of agro-alimentary waste for a production of maggots like source of proteins in the animal feeds. International Journal of Agronomy and Agricultural Research 7:42-46.

Fagbenro O. A., 2004 Soybean meal replacement by roquette (*Eruca sativa* Miller) seed meal as protein feedstuff in diets for African Catfish, *Clarias gariepinus* (Burchell 1822), fingerlings. Aquaculture Resource 35:917-923.

Giri S. S., Sahoo S. K., Mohanty S. N., 2010 Replacement of bycatch fishmeal with dried chicken viscera meal in extruded feeds: effect on growth, nutrient utilization and carcass composition of catfish *Clarias batrachus* (Linn.) fingerlings. Aquaculture International 18(4):539-544.
Gümüs E., Baki A., 2013 Effect of poultry by-product meal on growth performance and fatty acid composition of carp (*Cyprinus carpio*) fry. Turkish Journal of Fisheries and Aquatic Sciences 13:827-834.
Hasanuzzaman A. F. M., Hossian S. Z., Das M., 2010 Nutritional potentiality of earthworm (*Perionyx excavatus*) for substituting fish meal used in local feed company in Bangladesh. Mesopotamian Journal of Marine Science 25(2):134-139.
Hèdji C. C., Houinato M., Yehouenou B., Fiogbé E. D., 2014 Effect of packaging on the microbiological quality of chicken and fish viscera flour. International Journal of Current Microbiology and Applied Sciences 3(10):233-242.
Hlophe S. N., Moyo N. A. G., 2014 Replacing fish meal with Kikuyu grass and Moringa leaves: Effects on growth, protein digestibility, histological and haematological parameters in *Clarias gariepinus*. Turkish Journal of Fisheries and Aquatic Sciences 14:795-806.
Hu M., Wang Y., Wang Q., Zhao M., Xiong B., Qian X., Zhao Y., Luo Z., 2008 Replacement of fish meal by rendered animal protein ingredients with lysine and methionine supplementation to practical diets for gibel carp, *Carassus auratus* gibelio. Aquaculture 275:260-265.
Imorou Toko I., Fiogbe E. D., Kestemont P., 2008 Growth, feed efficiency and body mineral composition of juvenile catfish (*Heterobranchus longifilis*, Valenciennes 1840) in relation to various dietary levels of soybean or cottonseed meals. Aquaculture Nutrition 14:193-203.
Isangedighi I. A., Umoumoh O. E., 2011 Some aspects of the reproductive biology of African snakehead - *Parachanna obscura* in itu-cross river system. Nigerian Journal of Agriculture, Food and Environment 7(4):19-30.
Kpogue D. N. S., Ayanou G. A., Imorou Toko I., Mensah G. A., Fiogbe E. D., 2013 Influence of dietary protein levels on growth, feed utilization and carcass composition of snakehead, *Parachanna obscura* (Günther, 1861) fingerlings. Academic Journals 5(5):71-77.
Kpogue D. N. S., d'Almeida F. M. A., Odjo I., Fiogbe D. E., 2018a Utilisation des glucides chez les alevins de *Parachanna obscura* élevés en milieu contrôlé. International Journal of Biology and Chemistry Sciences 12(1):286-293.
Kpogue D. N. S., Gangbazo H. K., Vodounnou J. V., Mensah G. A., Fiogbe E. D., 2018b Optimal feeding frequency for African sneakhead fish (*Parachanna obscura*, Gunther, 1861) fingerlings reared in captivity. International Journal of Aquaculture 8(22):161-167.
Kpogue D. N. S., Fiogbe E. D., 2012a, Feeding rate requirements for *Parachanna obscura* fry reared under controlled environmental conditions. Journal of Applied Biosciences 55:3962-3972.
Kpogue D. N. S., Gangbazo H., Fiogbe E., 2012b, A preliminary study on the dietary protein requirement of *Parachanna obscura* (Günther, 1861) larvae. Turkish Journal of Fisheries and Aquatic Sciences 13:111-117.
Kpogue D. N. S., Mensah G. A., Fiogbe E. D., 2012c A review of biology, ecology and prospect for aquaculture of *Parachanna obscura*. Review of Fish Biology and Fisheries 23:41-50.
Odo G. E., Onoja S. U., Onyishi G. C., 2012 The biology of *Parachanna obscura* (Osteichthyes: Channidae) in Anambra river, Nigeria. International Journal of Fisheries and Aquaculture 4:154-169.
Oké V., Abou Y., Adité A., Kabré J. A. T., 2016 Growth performance, feed utilization and body composition of *Clarias gariepinus* (Burchell 1822) fed marine fish viscera-based-diet in earthen ponds. Fisheries and Aquaculture Journal 7:183 doi:10.4172/2150-3508.1000183.
Olele N. F., 2011 Growth response of Heteroclarias fingerlings fed on earthworm meal in hatchery tanks. Journal of Life Sciences 3(2):131-136.

Pucher J., Mayrhofer R., El-Matbouli M., Focken U., 2014 Effects of modified pond management on limnological parameters in small scale aquaculture ponds in mountainous Northern Vietnam. Aquaculture Research 47(1):57-70.
Rawles S. D., Riche M., Gaylord T. G., Webb J., Freeman D. W., Davis M., 2006 Evaluation of poultry by-product meal in commercial diets for hybrid striped bass (*Morone chrysops* male X *M. saxatilis* female) in recirculated tank production. Aquaculture 259:377-389.
Rónyai A., Csengeri I., Váradi L., 2002 Partial substitution of animal protein with full-fat soybean meal and amino acid supplementation in the diet of Siberian sturgeon (*Acipenser baerii*). Journal of Applied Ichthyology 18:682-684.
Samocha T. M., Davis D. A., Saoud I. P., DeBault K., 2004 Substitution of fish meal by co-extruded soybean poultry by-product meal in practical diets for the Pacific white shrimp, *Litopenaeus vannamei*. Aquaculture 231:197-203.
Sogbessan O. A., Ugwumba A. A. A., Madu C. T., Eze S. S., Isa J., 2007 Culture and utilization of earthworm as animal protein supplement in diet of *Heterobranchus longifilis* fingerlings. Journal of Fisheries and Aquatic Sciences 2:375-386.
Sun C. X., Xu W. N., Li X. F., Zhang D. D., Jiang G. Z., Liu W. B., 2014 Effect of fish meal replacement with animal protein blend on growth performance, nutrient digestibility and body composition of juvenile Chinese soft-shelled turtle *Pelodiscus sinensis*. Aquaculture Nutrition 22(2):315-325.
Tabinda A. B., Butt A., 2012 Replacement of fish meal with poultry by product meal (chicken intestine) as a protein source in grass carp fry diet. Pakistan Journal of Zoology 44(5):1373-1381.
Tabinda A. B., Ghazala R., Yasar A., Ashraf M., 2013 Utilization of chicken intestine as an alternative protein source in the diet for fingerlings of *Cirrhinus mrigala*. The Journal of Animal and Plant Sciences 23(6):1603-1608.
Thompson K. R., Metts L. S., Muzinic L. A., Dascupta S., Webster C. D., Brady Y. J., 2007 Use of turkey meal as a replacement for menhaden fish meal in practical diets for sunshine bass grown in cages. North American Journal of Aquaculture 69:351-359.
Vodounnou J. V., Kpogue D. N. S., Zounon J., Sintondji W., Fiogbe E. D., 2018 Nutrient requirement of African sneakhead fish (*Parachanna obscura*, Gunther 1861): a review. International Journal of Aquaculture 8(21):156-160.
Vodounnou J. V., kpogue D. N. S., Azon T. C., Godome T., Fiogbe E. D., 2019 Zootechnical parameters and feed utilization in African snakehead fish (*Parachanna obscura*) fed on earthworm based diet. Asian Journal of Applied Sciences 12(1):1-6.
Vodounnou D. S. J. V., Kpogue D. N. S., Tossavi C. E., Mennsah G. A., Fiogbe E. D., 2016 Culture of earthworm (*Eisenia fetida*), production, nutritive value and utilization of its meal in diet for *Parachanna obscura* fingerlings reared in captivity. International Journal of Fisheries and Aquatic Studies 4:1-5.
Yang Y., Xie S., Cui Y., Zhu X., Lei W., Yang Y., 2006 Partial and total replacement of fishmeal with poultry by-product meal in diets for gibel carp, *Carassius auratus* gibelio Bloch. Aquaculture Research 37:40-48.
Zehra S., Khan M. A., 2011 Dietary protein requirement for fingerling *Channa punctatus* (Bloch), based on growth, feed conversion, protein retention and biochemical composition. Aquaculture International 20:383–395.
Zhou P., Zhang W., Davis D. A., Lim C., 2010 Growth response and feed utilization of juvenile hybrid catfish fed diets containing distiller's dried grains with solubles to replace a combination of soybean meal and corn meal. North American Journal of Aquaculture 72:298-303.
*** FAO, 2018 World Review of Fisheries and Aquaculture. FAO, Rome, 237 p., (www.fao.org/publications/).

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