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Comparative Effects of Three Lipid Sources (Refined Palm Oil, Soybean Oil, and Peanut Oil) in Food on Survival, Growth Performance, and Nutritional Quality of *Clarias gariepinus* Fry

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ABSTRACT

The study was conducted from April to June 2024 at the Application and Research Farm and the Ichthyology and Applied Hydrobiology Laboratory of the Faculty of Agronomy and Agricultural Sciences, University of Dschang. The main objective was to promote the use of local vegetable oils in the diet of *Clarias gariepinus*. For this purpose, 180 fry weighing 7.3 ± 0.45 g were divided into three treatments group, each repeated three times, corresponding to rations containing 4% refined palm oil, soybean oil and peanut oil. The results showed that, other growth parameters were significantly influenced by the type of the oil used, except for specific growth rate, total length, length gain, and condition factor (K) ($P< 0.05$). The highest weight gain (22.98 ± 0.26 g), average daily gain (0.365 ± 0.003 g) and live weight (30.40 ± 0.20 g) were significantly recorded with the ration containing soybean oil ($P< 0.05$). The chemical composition of the flesh did not vary significantly ($P> 0.05$) between the rations. However, the highest ash (15.01 ± 0.56 %), crude protein (51.70 ±1.64%), and dry matter (95.03 ± 0.54%) contents were obtained in fish fed with the ration containing soybean oil. In conclusion, soybean oil ration is the one that generally produced the best performance.

INTRODUCTION

The population's supply of fishery resources from the natural environment is limited due to pollution, climate change, the destruction and degradation of habitat by anthropogenic actions **(Domwa, 2012)** and especially the overexploitation of natural stocks. This is why aquaculture is increasingly regarded as a viable solution to address this challenge. In fact, according to the **FAO (2020)**, aquaculture is the fastest growing animal production sector in the world, with an average annual rate of about 10.3% since 2010 and produced 89% of the global total in volume terms in the last 20 years. However, the development of the aquaculture sector faces numerous constraints including the increasing costs of fish-derived ingredients, such as fish meal and fish oils **(Tacon & Metian, 2008)**. In addition to the high costs of these ingredients, we also noted their unavailability and the difficulties of access to fish farmers in rural areas. In order to preserve natural resources, while allowing sustainable development of aquaculture, it is therefore imperative to reduce the use of fish flour and fish oil in fish feed through the exploitation of sources of vegetable proteins and oils, available in greater quantities and with more regularity **(FAO, 2016)**. In developing countries in general and in Cameroon in particular, the aquaculture industry is faced with the growing need to find alternative and sustainable sources of nutrients for farmed fish. This is why for decades the substitution of ingredients from fishing (fish flour and oil) by alternative plant or animal sources in fish farming **(Mube *et al*., 2025; Tsoupou *et al*., 2025)** has been, and is currently, an important research issue for a strategy of environmentally and economically sustainable food.

Fish oils are the main source of lipid in aquaculture feeds to promote growth and development of farmed species by providing essential polyunsaturated fatty acids, especially high unsaturated fatty acids **(Tintle *et al*., 2023)**. However, in recent years, the increasing demand with limited supply of fish oil necessitates the finding for alternative lipids to replace fish oil in aquaculture feeds **(Chen *et al.*, 2024)**. Vegetable oils are potential and sustainable candidates to partially replace fish oils in aquaculture feeds **(Montero *et al*., 2003; Lin & Shiau, 2007)** and their use in the diet of fish represents a promising initiative due to their availability and affordability **(Ayisi & Zhao, 2014)**. Oil derivatives of plants play significant roles as appetite enhancers, growth promoters, and immunostimulators for aquatic animals **(Dawood *et al.*, 2022)**.

Vegetable oils are rich in polyunsaturated fatty acids, including the essential fatty acids such as linoleic acid (C18:2n-6) and linolenic acid (C18:3n-3), easily bioconverted by freshwater fish. They have different fatty acid profiles, which can influence the growth and nutritional quality of fish. **Shen *et al*. (2022)** found that an optimal lipid levels promote growth, whereas excessive dietary lipid levels lead to negative consequences, such as lipid accumulation in the liver and muscles, changes in antioxidant status, and potential physiological stress. Some work has been carried out on the use of vegetable oils in the feed of fish fingerlings in breeding. According to **Otchoumou *et al*. (2011)**, the incorporation of 9% palm oil in the diet of *Heterobranchus longifilis* juveniles enables these fish to grow well. Similarly, the results of **Ble *et al*. (2018)** suggest that incorporating palm oil into the diet of *Heterobranchus longifilis* modifes its mineral body composition, without having major impact on its health or nutritional quality. Other works such as those by **Jiang *et al*. (2013)** have revealed that partial replacement of fish oil with soybean oil does not compromise fish growth, but improve fish immunity of juvenile darkbarbel catfish. The dietary lipid in fish feeds and its demand quality and quantity varies with the species, feeding habits, and life stages **(Zhang *et al*., 2022)**. Information on which vegetable oils would provide a better aquaculture product at a lower cost would benefit fish farmers. Hence the need to study the comparative effects of locally available vegetable oils on fish production performance. To our knowledge, no comparative study of the effects of refined palm oil, soybean and peanut oils has been carried out on *Clarias gariepinus* which is a species widely cultivated and consumed in Africa in general. This study aimed to evaluate the effects of locally available vegetable oils on the survival, growth performance and nutritional quality of *Clarias gariepinus*.

MATERIALS AND METHODS

Study area

The study was conducted from April to June 2024 at the Application and Research Farm and the Ichthyology and Applied Hydrobiology Laboratory of the Faculty of Agronomy and Agricultural Sciences of the University of Dschang (5°17’0” to 5°44’ LN and 10°04’ to 10°11’ LE). The city lies at an average altitude of 1,420m.

Animal material

A total of 180 *Clarias gariepinus* fry, weighing 7.3 ± 0.45 g and measuring 10.35 ± 2.0 cm were randomly assigned to three treatment groups, with three replicates per treatment (20 fry per replicate). These fry specimens were obtained by artificial reproduction in a hatchery located in the region of Central Cameroon and transported using a hatchery bucket to the FAR (*Ferme d’Application et de Recherche*) of the University of Dschang. During two weeks, they were acclimatized in polystyrene cages installed in a pond (100 m^2) and were fed twice a day with a local food containing 40% and made with fish meal, corn meal, wheat bran, bone meal, shellfish meal, palm oil, prémix 2%.

Experimental rations

Three experimental iso-protein and iso-energetic rations of RHP, RHS and RHA corresponding respectively to treatments composed of refined palm oil, soybean oil and peanut oil (Table 1) purchased at the local market were used. The standard lipid profiles of these oils are summarized in Table (2). Each ration was made with the ingredients previously ground, homogenized manually and wetted with water (30-50 cl for 5 Kg of food) so as to obtain a homogeneous dough, then granulated using a pellet machine with a sieve mesh diameter of 5mm **(Pouomogne, 2007)**. The pellets obtained were then sun dried during 2 days and stored in labeled bags. The crude protein, gross energy, lipids and ash contents of the different rations were determined using the method of **AOAC (2000)**. The minerals were analyzed according to the method of **APA *et al*. (2012)**.

Table 1. Composition of the different experimental diets

	Rations		
Ingredient	**(RHP)**	**(RHS)**	**(RHA)**
Maize	10	10	10
Cassava	3	3	3
Wheat bran	8	8	8
Soybean meal	3	3	3
Peanut meal	8	8	8
Fishmeal	60	60	60
Shellfish meal	1	1	1
Bone meal	1	1	1
Premix 2%	2	2	2
Oil	4	4	4
Total	100	100	100
Analyzed proximate composition			
Dry matter (%)	94.28	91.45	92.89
Organic matter (%DM)	60.21	65.09	59.80
Ash (%DM)	39.79	34.91	40.20
Crude protein (%DM)	46.73	45.44	44.55
Fat (%DM)	6.02	6.94	5.82
Crude Cellulose (%DM)	3.92	3.42	4.39
Crude energy (Kcal/kg)	2957.29	3199.53	2886.19

DM : Dry Matter; RHP: Refined palm oil ration; RHS: Soybean oil ration; RHA: Peanut oil ration.

Table 2. Fatty acid profile of palm oil (RHP), soybean oil (RHS) and peanut oil (RHA)

	Type of oil		
Fatty acid	**RHP***	**RHS****	**RHA*****
lignoceric acid	-	< 0.5	-
Arashdonic acid	-	< 0.5	-
Margaric acid	-	< 0.1	-
Lauric acid	0.2	-	-
Myristic acid	1.1	< 0.2	-
Palmitic acid	44.0	8.0-13.5	8.39-15.63
Palmitoleic acid	-	< 0.2	-
Heptadecenoic Acid	-	< 0.1	-
Stearic acid	4.5	2.0-5.4	3.56-4.76
Oleic acid	39.2	17-30	40.96-63.47
Linoleic acid	10.1	48.0-59.0	17.35-34.78

Linolenic acid	0.4	4.5-11.0	-
Arashidic acid	0.1	0.1-0.6	0.50-0.89
Ecosinoic acid	-	0-0.2	0.28-0.64
Behenic acid	-	< 0.7	-
Lignoceric acid	-	-	0.55-1.11
Behenic acid		-	-

Sources: * **Mancinni *et al*. (2015)**, ** **Codex Alimentarius (1999)**, *** **Misuna *et al*. (2008).**
RHP: Refined palm oil ration; RHS: Soybean oil ration; RHA: Peanut oil ration.

Rearing structure and experimental setup

The test was carried out in 9 happas (polystyrene cages) measuring 0.175m^3, installed in a pond of 100m^2 with a water depth of approximately 1m. The pond was equipped with a water supply channel and an overflow pipe. Each treatment group was assigned one of three experimental rations containing palm oil (RHP), soybean oil (RHS) and peanut oil (RHA) in triplicate.

Conduct of the trial and data collection

The food was distributed twice a day (7-8 a.m. and 4-5 p.m.). The quantities distributed daily corresponded to 5% of the ichthyo biomass and were adjusted after each control fishing carried out every 15 days. During this fishing, all the fish from each repetition were weighed and measured individually using an electronic scale with 0.1g precision and an ichthyo meter graduated in centimeters, respectively. Mortality cases were noted during the trial. The temperature and pH of the water were measured *in situ* every week using the method described by **Rodier *et al*. (2009)**. At the end of the trial, fish were randomly sampled from each replicate and were taken to the nutrition laboratory and soil science laboratory of the Faculty of Agronomy and Agricultural Sciences of the University of Dschang for chemical and mineralogical analysis of the flesh, respectively. Briefly, fish samples were sacrified, dried in an oven at 50°C during 48h and then crushed to ensure homogeneity and used for the proximate or chemical analysis using the method described by the **AOAC (2000)**.

Studied parameters

- **Survival rate (%)**

Sr = Nf/Ni x 100   Nf: final number of fish, Ni: Initial number of fish

- **Growth characteristic**

Weight gain (g)
WG = Wf − Wi
WG: Weight gain, Wf: final average weight, Wi: initial average weight;
LG = Lf − Li
LG: Lenght gain, Lf: final average lenght, Li: initial average Lenght;

Average daily gain ($g.d^{-1}$)

ADG = wg/T

ADg: Average daily gain,Wg: Weight gain (g), T: duration of the assay (day);

Specific growth rate (%. d^{-1})

$$SGR = \frac{[\ln(wf) - \ln(wi)]x100}{T}$$

SGR: Specific growth rate, wf: final average weight, wi: initial average weight, T: duration of the assay (day);

K = 100 (TW / $(TL)^3$, with TW = Total weight (g), TL = Total length (cm).

Statistical analysis

Normal distribution and homogenity of variances were tested by the Shapiro-Wilk and Levene test, respectively. Statistical analyses were conducted by using one-way analysis of variance (ANOVA). When there were significant differences between the means, they were separated by the Duncan test at a significance level of 5%. Results were expressed as mean ± standard deviation. SPSS software (Statistical Package for Social Sciences) version 26.0 were used to carry out the analyses, and the Microsoft Excel 2013 spreadsheet was used to organize and process the raw data collected to produce the graphs.

RESULTS

Effect of oil source in the ration on survival rate and growth characteristics of *Clarias gariepinus*

Survival rate

The Effect of oil source on survival rate is shown in Fig. (1). It appears that the survival rate was significantly affected by oil type ($P < 0.05$). However, the higher survival rate (90.02 ± 4.04%) was recorded with the ration containing soybean oil (RHS) and the lower value (81.66 ± 4.34%) with the peanut oil ration (RHA) which however, was comparable to that obtained (85.52 ± 4.48%) with the refined palm oil ration (RHP).

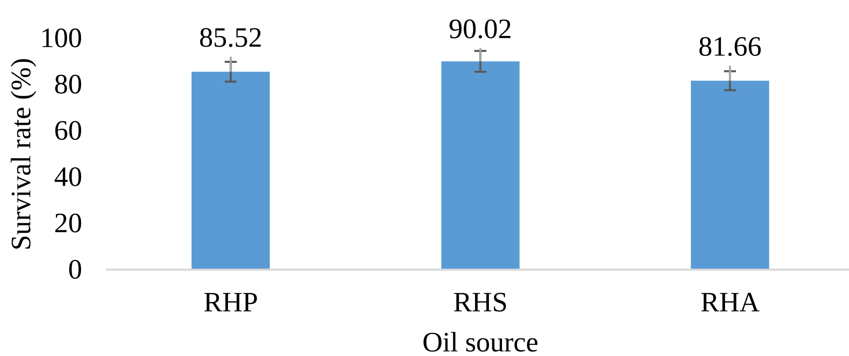

Fig. 1. Effect of oil source in the ration on survival rate

RHP: Refined palm oil ration; RHS: Soybean oil ration; RHA: Peanut oil ration.

Growth characteristics

Table (3) summarizes the effect of the type of oil in the feed on growth characteristics of *Clarias gariepinus*. It appears that with the exception of specific growth rate (SGR), total length (TL), length gain (LG) and condition factor K, all other characteristics were affected by the type of oil in the ration. However, the highest values of growth characteristics were recorded in fish fed with food containing soybean oil.

Table 3. Effect of oil source in the diet on growth characteristics in *Clarias gariepinus*

Growth characteristic	Oil sources			*P*
	RHP	RHS	RHA	
Wi (g)	7.375 ± 0.100^{a}	7.416 ± 0.072^{a}	7.458 ± 0.144^{a}	0.579
Wf (g)	29.300 ± 0.200^{b}	30.400 ± 0.205^{a}	28.130 ± 0.251^{c}	0.000
WG (g)	21.925 ± 0.200^{b}	22.983 ± 0.263^{a}	20.675 ± 0.132^{c}	0.000
ADG (g. d^{-1}**)**	0.365 ± 0.003^{b}	0.383 ± 0.004^{a}	0.344 ± 0.002^{c}	0.000
SGR (%. d^{-1}**)**	1.021 ± 0.009^{a}	1.025 ± 0.018^{a}	0.994 ± 0.020^{a}	0.120
TL (cm)	19.136 ± 0.119^{ab}	19.281 ± 0.159^{a}	18.880 ± 0.240^{a}	0.085
LG (cm)	8.770 ± 0.111^{a}	8.8611 ± 0.188^{a}	8.483 ± 0.235^{a}	0.103
K	0.418 ± 0.005^{a}	0.424 ± 0.007^{a}	0.418 ± 0.014^{a}	0.708

a and **b:** the means with the same letter on the same line are not significantly different (*P*>0.05) ***P*=** Probability**, Wi =** initial weight**, Wf =** final weight, **TL =** Total Length**, WG =** Weight gain**, ADG =** Average Daily Gain**, SGR** = Specific Growth Rate**, K =** Condition factor**, RHP :** Ration with refined palm oil, **RHS :** Ration with soya oil, **RHA :** Ration with peanut oil.

Specific growth rate

The highest specific growth rate (1.025 ± 0.018% d^{-1}) was obtained with the RHS ration and the lowest value (0.994 ± 0.020% d-1) with the RHA ration. However, no significant difference was recorded between the treatments ($P > 0.05$).

Condition factor K

The condition factor K presented in Table (2) was not significantly ($P > 0.05$) affected by oil type. However, the highest value (0.424 ± 0.007) was recorded with the RHS ration. The lowest values were observed with the RHP (0.418 ± 0.005) and RHA (0.418 ± 0.014) rations.

Evolution of live weight

The evolution of the live weight according to the treatments is illustrated in Fig. (2). It appears that all the curves during the entire period of the tests had the same appearance and the same trend. At the end of the test the most significantly ($P < 0.05$) high value (30.400 ± 0.205 g) was obtained with the ration containing soybean oil, while the lowest value (28.130 ± 0.251 g) was observed with the ration containing peanut oil (RHA).

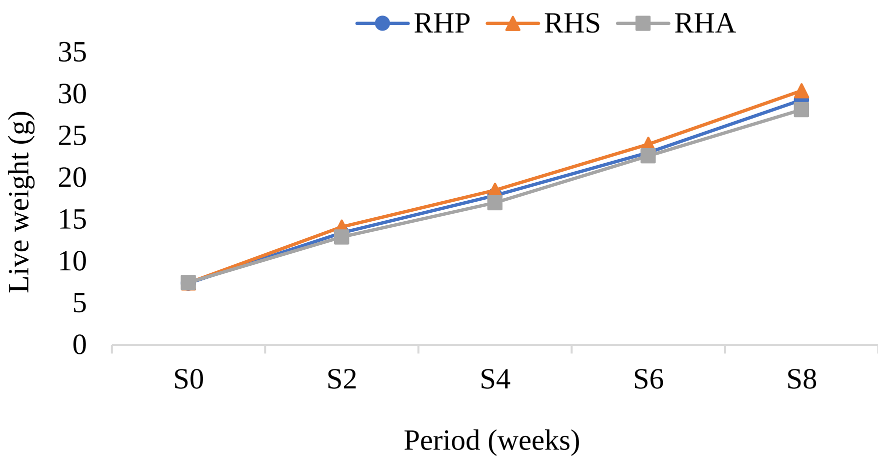

Fig. 2. Evolution of live weight depending on the source of oil in the ration of *Clarias gariepinus*

RHP: Refined palm oil ration; RHS: Soybean oil ration; RHA: Peanut oil ration.

Evolution of total length

The evolution of the total length depending on the type of oil is illustrated in Fig. (3). It appears that all the curves during the entire period of the test had the same appearance and the same trend. The highest average total length (19,281 ± 0.159 cm) was recorded with RHS, and the lowest total length (18,880 ± 0.240 cm) with RHA. However, no significant difference (*P> 0.05*) was observed between the different rations.

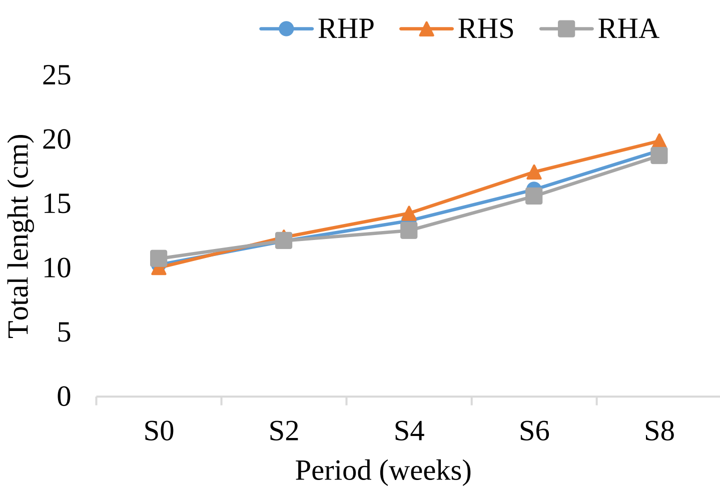

Fig. 3. Evolution of total length depending on the source of oil in the ration of *Clarias gariepinus*

RHP: Refined palm oil ration; RHS: Soybean oil ration; RHA: Peanut oil ration.

Evolution of weight gain and average daily gain

The evolution of weight gain depending on the type of vegetable oil in the ration is denoted in Fig. (4). Just like live weight and total length, the evolution of weight gain throughout the period of tests had the same appearance and the same trend. The significantly ($P< 0.05$) highest average daily gain value (0.338 ± 0.263 g) was obtained with the RHS ration while the lowest value was recorded with the RHA ration (0.334 ± 0.002 g).

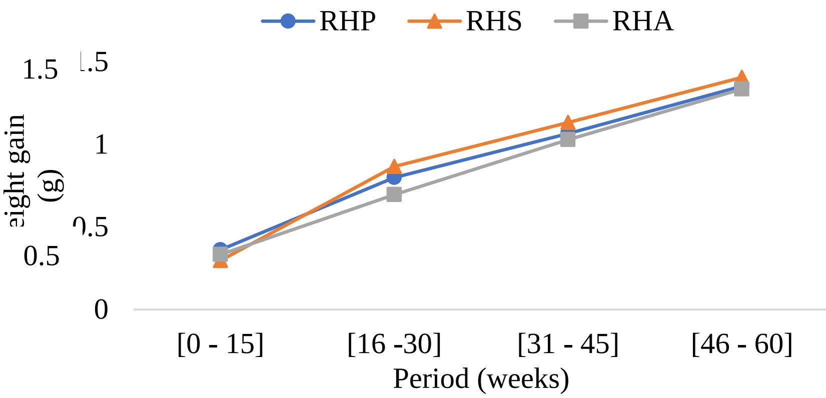

Fig. 4. Evolution of weight gain depending on the source of oil in the ration of *Clarias gariepinus*

RHP: Refined palm oil ration; RHS: Soybean oil ration; RHA: Peanut oil ration.

Effect of oil source in the ration on chemical compostion of *Clarias gariepinus* flesh

Table (4) illustrates the results of the chemical composition of the flesh of *Clarias gariepinus* that were fed three rations containing, respectively, refined palm oil (RHP), soybean oil (RHS) and peanut oil (RHA). Water content ranged between 75.64 and 76.27% and did not differ significantly ($P> 0.05$) among the samples. Similarly, no significant variations were observed in organic matter, ash, crude protein, or lipid contents across the treatments ($P> 0.05$). Crude protein levels remained relatively stable, varying from 50.74 to 51.70%, while lipid contents ranged from 19.55 to 20.73%.

In contrast, a significant difference ($P< 0.05$) was recorded for dry matter content. The RHS sample exhibited a higher dry matter content (95.03 ± 0.54%) compared to RHP (94.13 ± 0.22%) and RHA (93.81 ± 0.15%).

Table 4. Proximate composition of the flesh of *Clarias gariepinus* depending on the vegetable oils in the ration

Chemical characteristic	Oil sources			*P*
	RHP	RHS	RHA	
Water content (%)	75.88 ± 0.16[a]	75.64 ± 0.63[a]	76.27 ± 0.67[a]	0.412
Dry matter (%)	94.13 ± 0,22[a]	95.03 ± 0.54[b]	93.81 ± 0.15[a]	0.013
Organic matter (%)	85.2733 ± 1.591[a]	84.9883 ±1.56[a]	87.21 ± 0.29[a]	0.154
Ash (%)	14.72±1.59[a]	15.01 ± 1.56[a]	12.78 ± 0.29[a]	0.154
Crude protein (%)	50.74±1.9[a]	51.70 ± 1.64[a]	51.64 ± 2.64[a]	0.833
Lipids (%)	19.55±0.92[a]	20.73 ± 1.31[a]	20.09 ± 1.10[a]	0.479

a and **b:** the means with the same letter on the same line are not significantly different (P>0.05)
P= Probability**, RHP :** Ration with refined palm oil, **RHS :** Ration with soya oil, **RHA :** Ration with peanut oil.

Minerals

The results of the mineralogical composition of the flesh of *Clarias gariepinus* depending on the type of oil are presented in Table (5). It appears that all the minerals varied significantly (P< 0.05) depending on the treatments. The highest values of calcium (32.00 ±1.00%), magnesium (9.54 ± 0.185 mg/100 g), potassium (646.05 ± 2.01 mg/100 g), sodium (79.47 ± 0.38 mg/100 g) and iron (7.21 ± 0.020 mg/100 g) were recorded with the RHP ration and the lowest values were recorded with the RHS rations and RHA, respectively. However, the highest potassium values (353.56 ± 2.51 mg/100 g) were observed with the RHS ration, while the lowest values (267.20 ± 1.97 mg/100 g) were recorded with the RHA ration.

Table 5. Mineralogical characteristics of the flesh of *Clarias gariepinus* depending on the sources of vegetable oils in the ration

Mineralogical Characteristic	Oil sources			
	RHP	RHS	RHA	*P*
Ca(mg/100 g)	32.00 ± 1.00[a]	16.33 ± 0.57[b]	15.31 ± 0.38[b]	0.000
Mg(mg/100 g)	9.54 ± 0.185[a]	9.50 ± 0.11[b]	9.30 ± 0.09[b]	0.000
K(mg/100 g)	646.05 ± 2.01[a]	592.17 ± 2.12[b]	545.94 ± 1.75[c]	0.000
Na(mg/100 g)	79.47 ± 0.38[a]	62.66 ± 0.69[b]	60.08 ± 0.58[c]	0.000
Fe(mg/100 g)	7.21 ± 0.020[a]	5.18 ± 0.04[b]	5.18 ± 2.13[c]	0.000
P(mg/100 g)	327.570 ± 2.138[b]	353.56 ± 2.51[a]	267.20 ± 1.97[c]	0.000

a and **b:** the means with the same letter on the same line are not significantly different (P>0.05)
P= Probability**, RHP :** Ration with refined palm oil, **RHS :** Ration with soya oil, **RHA :** Ration with peanut oil.
Ca= calcium, Mg= magnésium, K= potassium, N= sodium F=fer, P= phosphorus mg = milligram, g= gram.

DISCUSSION

The best survival rate recorded during this study was observed in fish fed with the ration containing soybean oil (RHS). This would be due to the biochemical properties of this ration which would improve the ability to resist stress. This result can be attributed to the presence of saturated, monounsaturated, and polyunsaturated fatty acids in soybean oil, which serve as essential energy sources for fish. This result could be also explained by the fact that soybean oil would contain more polyunsaturated fatty acids, especially omega-3-fatty acids which have potent anti-inflammatory effects that guard against autoimmune diseases **(Tintle *et al*., 2023)**. Soybean oil contains vitamin E which is an antioxidant which protects the lipids, proteins and DNA of fish against all forms of oxidative stress due to its environment **(Brigelius-Flohé, 2006; Konda *et al*., 2020)**. Different result was observed by **Larbi *et al.* (2018)**, who obtained a survival rate of 100% in all treatments during a study on *Oreochromis nuloticus* fed with fish oil and crude palm oil. This could be related to the species and age of fish used in their study which were different for those used in our trial. Similarly, work carried out by **Sourabié *et al*. (2018)** on the same species of fish, showed that the survival rate was higher in all groups and was not significantly affected by the sources of dietary oil tested. However, high survival rates were reported by **Imorou Toko *et al*. (2008)** in African catfish fed fish oil diets.

Except for final live weight, weight gain and average daily gain, the different oil sources did not significantly ($P> 0.05$) affect growth characteristics. However, the highest values were recorded with the diet containing soybean oil and the lowest with the peanut oil diet. Our results are similar with those of **Gou *et al*. (2021)**, who observed that vegetable oil with a high content of PUFA (polyunsaturated fatty acid) like soybean oil are better utilized than other vegetable oil by fish. The results recorded in this study are different from those observed by **Larbi *et al.* (2018)**, who obtained the highest values of live weight in Nile tilapia fed with the diet containing palm oil. This difference could be due to the species and the nutritive quality of the feed that was used. The values of the condition factor K recorded were less than 3, showing that the fish were apparently not in body condition. The decrease in the K factor observed during the last weeks of the trial would be due to environmental factors that could not be controlled. Indeed, **Fulton (1902)** reports that K less than 3 indicates poor fish body condition and K greater than 1 indicates that the fish are healthy.

The average daily gain recorded during this study is well below the value of 3 g/day recommended by **Laroix (2004)** during the breeding of *Clarias gariepinus*. The highest daily weight gain at the end of the study was recorded with the RHS ration. However, these results are lower than those obtained by **Bakhtaoui (2018)**, who obtained a daily weight gain of 0.95g in *Clarias gariepinus* after 60 days fed with a ration containing 2.84% sunflower oil. This could be explained by the breeding conditions and by the fact that sunflower oil would better promote the absorption of nutrients. Saturated lipids are less digested than unsaturated lipids **(Enyidi & Asuquo, 2024)**. This could be the reason for the fish's better digestibility of RHS compared to other experimental feed. Our results on growth characteristics corroborate those of **Jiang *et al*. (2013)**, who found that higher growth performance was observed in juvenile black barbel catfish fed diets containing soybean oil, probably due to the n-3 to n-6 ratio from these diets that were suitable for enhancing black barbel catfish growth. According to these authors, the fatty acid (FA) ratio may affect fish growth through the interaction between dietary n-3 and n-6 FA on endogenous FA elongation and desaturation enzyme systems, especially by Δ6 and Δ5 desaturase enzymes **(Tan *et al*., 2009)**.

The different sources of vegetable oil had no significant effect ($P > 0.05$) on the proximate composition of *Clarias gariepinus* flesh. However, the diet containing soybean oil recorded the highest values. The highest water content of the flesh was observed with the RHA ration. This result is similar to that of **Houcine (2017)** for tilapias fed with rations containing different level of fat. The highest value in lipid and protein was obtained in fish that consumed the RHS ration. This could be explained by the fact that soybean oil would contain an excess of saturated fatty acids that would have promoted lipid deposits **(Siddiqua & Khan, 2022)**, without however significantly affecting the absorption of nutrients. Furthermore, the protein values recorded during this study remain much higher than those obtained by **Otchoumou *et al*. (2011)** in *Heterobrancus longifilus* fed with rations containing different levels of palm oil.

The mineralogical characteristics observed in this study show that the oil source significantly affected ($P < 0.05$) minerals, except magnesium (Mg). The highest values were obtained with the diet containing refined palm oil. This could be attributed to the presence of refined palm oil in the fish feed that would have favored the absorption of nutrients necessary for the synthesis of minerals. This result is similar to that of **Ble *et al*. (2018)**, who found that the incorporation of palm oil in the diet of juveniles of *Heterobranchus longifilis* affected their whole-body mineral composition. The improvement in the nutritional quality of *Clarias gariepinus* flesh due to the presence of vegetable oil makes this species more economically profitable and appreciated by consumers.

CONCLUSION

This study evaluated the effects of refined palm oil, soybean oil, and peanut oil on the growth performance and nutritional quality of *Clarias gariepinus*. The key findings are as follows :

The source of oil did not significantly affect the growth characteristics except for the survival rate, total length, length gain, k factor, specific growth rate. Thus, the lowest survival rate was obtained with the peanut oil ration (RHA). In general, all growth characteristics were higher with the soybean oil ration (RHS). The source of oil did not significantly affect the nutritional quality of the flesh except for dry matter. The highest dry matter was obtained with the soybean oil ration (RHS). The type of oil in the feed significantly affected the mineralogical composition of the fish flesh, except magnesium (Mg) which remained significantly different. As a perspective for future work, it would be important to assess long-term effects of these oils on fish health or fatty acid composition. We recommend using the soybean oil-containing ration (RHS) when breeding *Clarias gariepins*.

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