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Evaluating the Impact of *Moringa oleifera* (Linnaeus, 1753) and *Eucalyptus globulus* (L' Heritier (1789) Leave Extract on *Clarias gariepinus* Fingerlings' Growth

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ABSTRACT
The need to improve quality of aquafeed that would bring about higher aquaculture yield has attracted attention for the inclusion of Plant materials into fish feed. This study investigated the inclusion of *Moringa oleifera* and *Eucalyptus globulus* leaf extracts into the diets of *Clarias gariepinus* fingerings. A feeding trials of 56 -days duration was involved in this study. The feeding trial was made of eight isonitrogenous 40%CP diets comprising six experimental diets, a control diet (ZSD) and a reference commercial diet (CRD). Three of the six diets had each with 2% inclusion level of any two out of the aqueous, ethanol and hexane extracts of Moringa leaf at 1:1 ratio. The remaining three diets had similar combination of Eucalyptus leaf extracts. The experiment was conducted in a Completely Randomise design (CRD) made of eight treatments. The experimental set-up was conducted in flow-through system made of 50litres plastic basins and each treatment made in triplicates. Results of the feeding trials indicated significant differences ($P<0.05$) among each of the growth and feed utilization parameters evaluated from the treatments. The control diets and the reference diets gave better growth of the fingerlings and feed utilization efficiency than the experimental diets. The control diet had 42.68% higher specific growth rate (SGR) than the top performing Eucalyptus-extract base diet (EHEA) and 43.81% than the top performing Moringa-extract base diet (MAME). Possible reason for the poor performance might be attributed to the inclusion level of the Eucalyptus extracts been higher than 1% established optimum level in an earlier study. Equally, poor performance of the Moringa extracts inclusion might be due to the relatively low level of its inclusion in the present study compared with better results recorded from some earlier studies with higher inclusion levels. Further study is hereby recommended into possible impact of the extraction solvents used in this study on the poor growth recorded.

Keywords: Plant materials, *Moringa oleifera*, *Eucalyptus Globulus*, Extract and *Clarias Gariepinus* Fingerlings.

INTRODUCTION
Aquaculture plays a major role in augmenting the ever-increasing global demand for seafood products(Kari *et al.*, 2020). To ensure the sustainable growth of aquaculture industry, it is imperative to explore innovative approaches that will enhance the growth, feed utilization and general performance of cultured aquatic species. One such approach involves the use of natural additives and supplements to increase the nutritional quality of aquafeed, subsequently optimizing the growth and overall well-being of the cultured fish (Munglue, 2016).

In recent years, interest in the application of herbal extracts as dietary supplements in aquaculture is increasing (Olaniyi *et al.*, 2020; Nyadjeu *et al.*, 2021). Among these, moringa (*Moringa oleifera*) attracts attention for its potential to enhance the performance of various aquatic species(Idowu *et al.*, 2017). Moringa, is renowned for its high nutrient profile, including high levels of vitamins, minerals, and protein (David-oku *et al.*, 2018). Eucalyptus, on the other hand, has substantial amount of antimicrobial and immunomodulatory items, which can contribute to improved disease resistance and general well-being in aquaculture settings(Nurudeen*et al.*, 2022).

This study seeks to explore the synergistic potential of moringa and eucalyptus extracts when incorporated into the diets of *Clarias gariepinus* fingerlings. *Clarias gariepinus*, commonly called African catfish or African sharp tooth catfish is a commercially important freshwater species with significant aquaculture potential(Ebuka *et al.*, 2021). Assessing the impact of these plant extracts on the growth, feed utilization, and health status of *Clarias gariepinus* fingerlings will not only bring development to sustainable aquaculture practices but also provides valuable insights into the utilization of plant supplements in aquatic feed formulations.

In this article, evaluation of the results of combined inclusions of extracted diets of Moringa and Eucalyptus of different solvent extraction (Aqueous, Ethanol and Hexane) on growth, feed utilization and carcass compositions of *C. gariepinus* fingerlings was done. Our findings shed light on the potential of inclusion of different extracts of these two plants towards improving aquaculture productivity.

MATERIALS AND METHODS

Experimental Location

The study was conducted at the farm complex of the Department of Fisheries and Aquaculture, New Site, Bayero University Kano, Nigeria. The experimental se-up was located at the indoor hatchery unit of the farm complex of the department on latitude 11°59′50.4″N, longitude8°25′24.2″E and altitude 528.48 m (Figure 1).

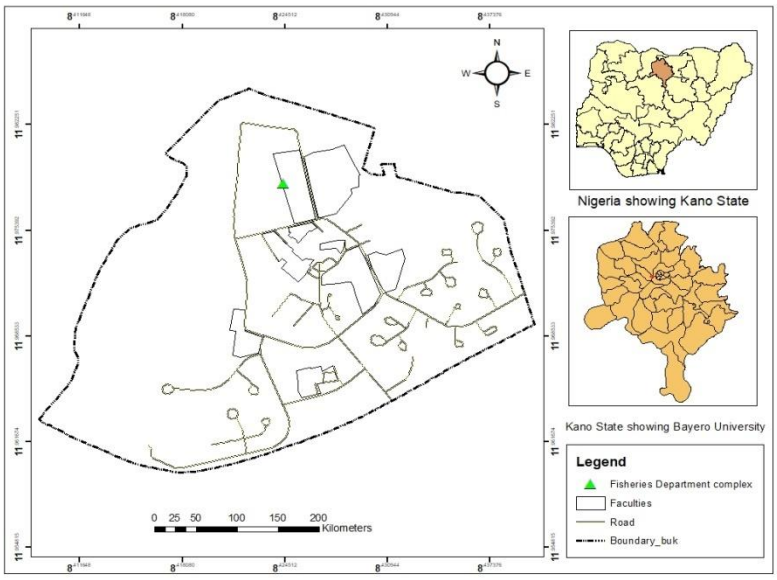

Figure 1: Experimental Site Location

Extraction Procedure

The Moringa and Eucalyptus leaf meals extraction were done at the WAFT's Laboratory, FUT, Minna. Three solvents were used for the extraction; water, ethanol and hexane. The three solvents were used to extract each of the *E. globules* and *M. oleifera* leaves separately using Soxhlet extractor (Electrothermal heating mantle ME). The extraction detail follows the description of Ncube *et al.*, (2008) and Nweze & Nwafor (2014).After the extraction, the extracts' solutions were made to evaporate by heating using electronic oven at 80ºC for 12 hours for the separation of the extracts from the solvents.The extracts thereafter were kept in refrigerator until further usage (Hussain *et al.*, 2009; Chakraborty *et al.*, 2018).

Procurement of Fingerlings and Experimental Set-up

A total of 500 fingerlings of *Clarias gariepinus* with average bodyweight of 9.8 g were procured from Gerrit Fleuren Hatchery, Kuje, Abuja, Nigeria. The fish were acclimatized for two weeks to adapt to the experimental environment and fed with Blue crown commercial Catfish feed. They were starved for 24 hours before commencing the experiment. Twenty fingerlings were randomly collected and stocked into each of the prepared 24-tanks. Each of the experimental units serve as replicates representing the eight dietary treatments. The feeding trial was conducted in flow through system setup, as water outlet regulator (Suleiman *et al.*, 2018) using central drain pipe that regulate water levels water outlets.

Feed Formulation

The research features seven 40% CP isonitrogenous diets formulated diets formulated using trial and error method. Three of the diets have 2% inclusion of combined two different Moringa-extracts at ratio 1:1contribution and similar arrangement for some other three Eucalyptus-extracts base diets. The seventh diet was made as the control treatment (ZSD) while Skretting feed, a commercial reference diet (CRD) was made the eightieth diet of the feeding trial. Detail of the formulated diets and the inclusions are in Table 1. After formulation, all the ingredients were measured and thoroughly mixed.

Ten grams of each of the two extracts combined in a diet (i.e., making 2% inclusion) were dissolved in 350 ml of water and subsequently added to make 1000g feed. Dough prepared was thereafter fed into a manual pelletizer of 2 mm mounted die. The feeds were oven dried at 60ºC for 24 hours, package and stored in a deep freezer prior to usage. Proximate compositions of the experimental diets were done after drying (Table 1). Carcass compositions of the experimental fish were analysed before and after the feeding trial experiment

Table 1: Formulation and Proximate Composition of Interaction of Experimental Diets at 2% Inclusion Rate

Ingredients	Inclusion Levels							
	CRD	ZSD	EAEE	EEEH	EHEA	MAME	MEMH	MAMH
FM (61.45)	-	25.71	25.17	25.17	25.17	25.17	25.17	25.17
SBM (40.05)	-	51.42	50.34	50.34	50.34	50.34	50.34	50.34
MM (9)	-	17.87	17.49	17.49	17.49	17.49	17.49	17.49
Moringa	-	0.00	0.00	0.00	0.00	2.00	2.00	2.00
Eucalyptus	-	0.00	2.00	2.00	2.00	0.00	0.00	0.00
Oil	-	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Lysine	-	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Methionine	-	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Bone Meal	-	0.50	0.50	0.50	0.50	0.50	0.50	0.50
VMP	-	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Total		100	100	100	100	100	100	100
Proximate Composition of Diet Interaction Within each Plant extract combinations								
Ash (%)	10.5	12.63	6.31	6.04	5.74	5.69	5.18	7.77
Crude Fibre (%)	5.55	4.07	3.10	3.00	2.80	5.40	3.00	4.20
Fat (%)	15.25	16.52	16.31	15.59	17.4	15.82	16.19	14.49
Crude Protein (%)	40.71	43.22	42.62	34.75	40.00	42.27	40.07	38.00
Moisture Content (%)	5.30	7.05	9.59	8.82	7.02	10.60	9.84	8.11
Carbohydrate (%)	22.84	16.51	22.07	31.80	27.04	20.22	25.72	27.43
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

CRD = Commercial Reference Diet, ZSD = Zero Supplemented Diet, EAEE = Eucalyptus Aqueous Eucalyptus Ethanol, EEEH = Eucalyptus Ethanol Eucalyptus Hexane, EHEA = Eucalyptus Hexane Eucalyptus Aqueous, MAME = Moringa Aqueous Moringa Ethanol, MEMH = Moringa Ethanol Moringa Hexane, MAMH = Moringa Aqueous Moringa Hexane,

Feeding of Experimental Fish and Data Collections

Fish were fed 5% of their body weight at two feeding frequency (8:00 am and 6:00 pm). Regular siphoning of leftover feed and fecal materials were observed to maintain good water quality in addition to the flow-through drainage system. Average Body weight of fingerlings in each experimental units was taken fortnightly using a digital weighing scale and recorded to the nearest grams. Daily recording of fish mortality was also observed. Water quality parameters were taken weekly throughout the experimental period. Potential hydrogen ion concentration (pH), electrical conductivity (EC), salinity, Total Dissolved solids (TDS) and temperature were measured using Exstik® II digital meter. On the other hand, Milwaukee Portable Dissolved Oxygen Meter (MW600) was used for Dissolved Oxygen (DO) measurement. All the data were appropriately recorded in Microsoft 2016 Excel sheets. The trial lasted for eight weeks.

Evaluation of Fish Weight (g)

Biological evaluations were calculated according to the descriptions of Bondi (1987) and Bbole *et al.* (2016):

Fish's Initial Weight

This is expressed as the average weight of the fish in a tank at the commencement of the experiment and was calculated as follows.

$$\text{Fish Initial Weight (g)} = \frac{\text{Total Initial Fish Body Weight (g)}}{\text{Total number of Fish per Tank at Initial}}$$

Fish's Final Weight (g)

This is expressed as the average weight of the fish in a tank at the end of the experiment calculated as.

$$\text{Fish Final Weight (g)} = \frac{\text{Total Final Fish Body Weight (g)}}{\text{Number of Fish Per Tank at final}}$$

Average Weight Gain (g)

This is expressed as the difference between the final and initial fish body weight at the end of the experiment and expressed as.

Average Weight Gain (g) = Mean final fish body weight – Mean initial fish body weight.

Specific Growth Rate (SGR)

The SGR is expressed as the average percentage weight change per day of fish and expressed as:

$$\text{SGR (\%)} = \frac{(\ln W2 - \ln W1)}{T} \times 100$$

Where, W1 = Fish Initial Weight
W2 = Fish Final Weight
Ln = Natural Logarithm
T = Number of Days in the Experiment

Food Conversion Ratio (FCR)

FCR is the weight of feed fed in dry weight per fish live weight gain and evaluated as:

$$\text{FCR} = \frac{\text{Feed Consumed (g)}}{\text{Live Weight gain (g)}}.$$

Protein Efficiency Ratio (PER)

PER is expressed as fish weight gained per gram of crude protein fed, indicating protein utilization efficiency and expressed as:

$$\text{PER} = \frac{\text{Live weight gain (g)}}{\text{Crude protein fed (g)}}$$

Apparent Net Protein Utilization (ANPU)

ANPU was calculated as the percentage of ingested protein by deposition in the carcass and expressed as.

$$\text{ANPU (\%)} = \frac{(P2 - P1)}{\text{Total protein consumed (g)}} \times 100$$

Where, P1 = Protein in Fish Carcass (g) at the initial level of the experiment
P2 = Protein in Fish Carcass (g) at the end of the experiment

Survival Rate

The survival rate was evaluated as a percentage of survival expressed as.

$$\text{Survival Rate} = \frac{\text{Initial Number of Fish Stocked} - \text{Mortality}}{\text{Number of Fish stocked}} \times 100$$

Statistical Analysis

All data generated from the feeding trial were subjected to one way analysis of variance (ANOVA) using R Statistical and programming software(R core Team, 2021) to determine significant differences($P<0.05$) between means of treatments. Post-hoc LSD tests were conducted between treatments' pairs after significant difference result of ANOVA.

RESULTS

Growth Performance, Feed Utilization and Survival Rate.

The results for growth performance, nutrient utilization and survival rate of fish fed the eight experimental diets are shown in Table 3.The ANOVA results indicated a significant difference ($P<0.05$) in mean final weight (MFW), Mean weight gain (MWG) and specific growth rate (SGR) among the treatments. These growth indices are significantly higher ($P<0.05$) in the control diet (ZSD) followed by the reference diet (CRD) than in the other treatments. Among the experimental diets, the EHEA diet had the highest MFW (22.54g), MWG (12.66g) and SGR (1.47g). Next to that in highest growth performance was the MAME diet with MFW, MWG and SGR of 22.06g, 12.18g and 1.43g respectively. The least growth performing treatment was with the MEMH diet with MFW, MWG and SGR values of 19.25g, 9.38g and 1.19g respectively.

There is also significant difference ($P<0.05$) between treatment means of each of the feed utilization indices (Table 4). The treatments' diets recorded higher values of the feed utilization indices than the control and the reference diets. The control diet (ZSD) had the lowest values of FCR (1.08), PER (1.66) and highest ANPU value (96.25).The next lowest was the reference diet (CRD) with FCR and PER values of 1.36 and 3.48 respectively. Its ANPU value was also next to the control diet at 84.20. Among the experimental diets' treatments, treatment EHEA had lowest FCR (2.48) whereas MEMH treatment had the lowest PER value of 23.45. Diet EEEH recorded the lowest ANPU value of 2.25. Percentage fingerlings survival recorded throughout the eight weeks experiment ranges between 85.00 and 98.33 across the different treatments.

Compositions of Carcass of Fish Fed the Eucalyptus and Moringa Extracts' diets.

The summary of carcass proximate compositions of the fish fed the experimental diets is shown in Table 5.The results indicated ash content of the fish carcass was higher (11.28%) at the initial carcass prior to feeding with the experimental diets. The MAMH (7.81%) treatment recorded the highest ash content, while the least was recorded in CRD (0.91%) treatment.

There was a significant difference ($p<0.05$) of crude fibre content of fish carcasses across the treatments. The level of carcass crude fibre was significantly ($p<0.05$) low before the commencement of the trial (i.e., at initial, 0.88%). However, the value increased in all the treatments at the end of the experiment. The highest carcass crude fibre content was recorded in the ZSD (10.7%), followed by CRD (7.65%) and the least was recorded in MAMH (1.56%). The carcass lipid content was also significant difference ($p<0.05$) across all treatments. The lipid contents of the carcasses of all the experiments were higher than the lipid content at initial stage of the experiment. Diet EHEA produce carcass with the highest lipid content (17.16%) while the CRD diet had the least (13.47%).

The carcass crude protein (CP) content of all the experimental fish significantly increased ($p<0.05$) over their initial levels. The carcass crude protein levels from diets EEEH (43.12%) and MEMH (45.12%) were however, lower than what is obtainable in the fish carcass at the onset of this experiment. The highest carcass CP was recorded in treatment EHEA 53.25%). The carcass moisture content in all the treatments are significantly different ($p<0.05$) from each other. Moisture content was highest in CRD and ZSD (11.28%and 11.90%respectively). The least moisture content was recorded in the carcass of fish fed the EEEH diet (7.34%). The Nitrogen Free Extract (NFE) was also significantly different ($p<0.05$) among the diets. The least value of NFE was recorded in carcass from fish fed diet ZSD (9.54%) while the highest NFE occurred in treatment EEEH (23.14%). Only treatments EEEH and MEMH had increased NFE values over the NFE of the fish carcass at the commencement of the experiment.

Table4:*Clarias gariepinus* Fingerlings Growth and Feed Utilization Parameters Base on Diet Treatment.

Treatment	MIW	MFW	MWG	SGR	FCR	PER	ANPU	Survival
CRD	9.86 ± 0.00^{a}	52.30 ± 0.17^{b}	42.44 ± 0.17^{b}	2.98 ± 0.01^{b}	1.36 ± 0.01^{e}	3.48 ± 0.01^{h}	84.20 ± 0.37^{b}	85.00 ± 0.00^{e}
ZSD	9.83 ± 0.01^{b}	76.40 ± 0.10^{a}	66.57 ± 0.10^{a}	3.66 ± 0.00^{a}	1.08 ± 0.01^{f}	1.66 ± 0.00^{g}	96.25 ± 0.40^{a}	88.33 ± 0.31^{d}
EAEE	9.88 ± 0.00^{a}	20.34 ± 0.07^{f}	10.45 ± 0.07^{g}	1.29 ± 0.01^{g}	2.70 ± 0.01^{b}	26.13 ± 0.18^{e}	38.17 ± 0.12^{d}	96.67 ± 0.61^{a}
EEEH	9.88 ± 0.00^{a}	20.51 ± 0.01^{f}	10.63 ± 0.01^{f}	1.30 ± 0.00^{f}	2.61 ± 0.01^{c}	26.58 ± 0.03^{d}	2.25 ± 0.01^{g}	93.33 ± 0.81^{b}
EHEA	9.88 ± 0.00^{a}	22.54 ± 0.04^{c}	12.66 ± 0.04^{c}	1.47 ± 0.00^{c}	2.48 ± 0.00^{e}	31.65 ± 0.09^{a}	40.33 ± 0.17^{c}	98.33 ± 0.31^{a}
MAME	9.88 ± 0.00^{a}	22.06 ± 0.00^{d}	12.18 ± 0.00^{d}	1.43 ± 0.00^{d}	2.53 ± 0.00^{d}	30.45 ± 0.01^{b}	17.13 ± 0.66^{e}	96.67 ± 0.61^{a}
MEMH	9.88 ± 0.00^{a}	19.25 ± 0.07^{g}	9.38 ± 0.07^{h}	1.19 ± 0.01^{h}	2.98 ± 0.02^{a}	23.45 ± 0.17^{f}	3.82 ± 0.23^{f}	85.00 ± 1.06^{d}
MAMH	9.88 ± 0.00^{a}	21.42 ± 0.02^{e}	11.54 ± 0.02^{e}	1.38 ± 0.00^{e}	2.52 ± 0.01^{d}	28.84 ± 0.06^{c}	16.36 ± 0.08^{e}	93.33 ± 0.61^{b}
p-value	0.020	0.050	0.030	0.050	0.046	0.010	$2.39e^{-4}$	0.044

Means in the same column having different superscripts differ significantly ($p<0.05$). EAEE = Eucalyptus Aqueous Eucalyptus Ethanol, EEEH = Eucalyptus Ethanol Eucalyptus Hexane, EHEA = Eucalyptus Hexane Eucalyptus Aqueous, MAME = Moringa Aqueous Moringa Ethanol, MEMH = Moringa Ethanol Moringa Hexane and MAMH = Moringa Aqueous Moringa Hexane.

Table 5: Carcass Proximate Composition for Fish Fed Interaction Extracts Within Eucalyptus and Moringa Diets

Treatments	ASH	Crude Fibre	Lipid	Crude Protein	Moisture Content	Nitrogen Free Extracts
Initial	11.28 ± 0.01^{a}	0.88 ± 0.01^{i}	12.76 ± 0.04^{f}	48.20 ± 0.02^{abc}	7.65 ± 0.02^{f}	19.23 ± 0.01^{abc}
CRD	0.91 ± 0.03^{h}	7.65 ± 0.01^{b}	13.47 ± 0.71^{ef}	48.30 ± 0.10^{abc}	11.28 ± 0.02^{b}	18.39 ± 0.84^{abc}
ZSD	1.09 ± 0.02^{g}	10.7 ± 0.03^{a}	14.30 ± 0.03^{de}	52.47 ± 0.01^{a}	11.90 ± 0.01^{a}	9.54 ± 0.01^{e}
EAEE	7.25 ± 0.01^{e}	2.72 ± 0.01^{c}	15.95 ± 0.01^{bc}	52.5 ± 0.01^{a}	7.65 ± 0.01^{f}	13.93 ± 0.01^{cde}
EEEH	7.52 ± 0.01^{d}	1.98 ± 0.01^{e}	16.90 ± 0.02^{ab}	43.12 ± 2.67^{c}	7.34 ± 0.01^{h}	23.14 ± 2.67^{a}
EHEA	7.52 ± 0.01^{d}	2.04 ± 0.01^{d}	17.16 ± 0.01^{a}	53.25 ± 0.01^{a}	7.56 ± 0.01^{g}	12.47 ± 0.01^{de}
MAME	7.63 ± 0.01^{c}	1.78 ± 0.02^{f}	15.44 ± 0.01^{cd}	50.96 ± 0.01^{a}	7.90 ± 0.01^{e}	16.29 ± 0.01^{cd}
MEMH	6.96 ± 0.01^{f}	1.75 ± 0.01^{g}	16.36 ± 0.01^{abc}	45.12 ± 1.74^{bc}	7.96 ± 0.01^{d}	21.85 ± 1.74^{ab}
MAMH	7.81 ± 0.01^{b}	1.56 ± 0.01^{h}	15.72 ± 0.01^{c}	50.10 ± 0.02^{ab}	8.12 ± 0.01^{c}	16.69 ± 0.01^{bcd}
p-value	$<2e^{-16}$	$<2e^{-16}$	$<2e^{-16}$	$8.1e^{-08}$	$<2e^{-16}$	$3.39e^{-11}$

Means in the same column of treatments followed by different superscripts differ significantly ($p<0.05$)

DISCUSSION

The water culture medium used for the feeding trials on *Clarias gariepinus* fingerlings was maintained in favourable conditions fit for the normal development and growth of the fish. The inclusion of plant materials in animal diets has been documented to lead to increased growth and better health conditions (Bahi *et al.*, 2017). However, the effects of different plants' extracts on the growth and development of the animals depend on factors such as plant species, part of the plant involved, processing or extraction method and the species of the animals fed (Nurudeen *et al.*, 2022).

The present feeding trials clearly show the different inclusions of Moringa, and *Eucalyptus* extracts resulted in lower growth and feed utilization efficiency performances. Low growth, feed utilization efficiency, and haematological parameters of Nile tilapia (*Oreochromis niloticus*) fed *Eucalyptus globulus* leaf extracts was reported (Nurudeen *et al.*, 2022). The authors discovered Nile tilapia fed with more than 10ml inclusion (in 500g feed) experienced a decline in weight gain, FCR, PER, and haematological parameters. Afe *et al.* (2019) also established the optimum inclusion level of *Eucalyptus globulus* leaf to the diet of *Heterobranchus bidorsalis* fingerlings to be 1% and that inclusion levels higher than the optimum will lead to reduced fish performance. Therefore, the low performance of *C. gariepinus* fingerlings in the present study could be ascribed to the 2% inclusions of the combined Eucalyptus extracts that is higher than the optimum.

On the other hand, the results of the different inclusions of moringa extracts diet on the growth and feed efficiency of *C. gariepinus* contradict many earlier findings. Idowu *et al.* (2017) reported best growth and feed utilization of *C. gariepinus* post fingerlings was achieved at 15% substitution of fish meal (at 23.74% fish meal) with *Moringa oleifera* leaf meal. It was also discovered that 10% supplementation of 10% *Moringa oleifera* leaf plus 20% shrimp meals gave better growth performance of *Clarias gariepinus* fingerlings than at 20% and 30% moringa inclusion levels (David-oku *et al.*, 2018). The growth and feed utilization performance of *C. gariepinus* in this study could be partly ascribed to the very low inclusion level (i.e., 2%) of the moringa extracts when compared with better performances recorded in the aforementioned studies with higher inclusion levels.

A plausible reason for the observed decline in the growth performance of fish fed the plant-extract-based diets may be linked to the potential presence of residue from these extracts in the experimental fish diets. Past investigations have extensively explored the lethal and sublethal concentrations of ethanol, methanol, and other organic extraction solvents to determine their impact on various aquatic animals (Hutchinson *et al.*, 2006). In contrast, there was positive effects of the ethanol extract of *Basella alba* leaves (1.0 g/kg), ethanol extract of *Tribulus terrestris* seeds (2.0 g/kg), and methanol extract of *Asparagus racemosus* seeds (0.2 g/kg) on sex reversal, growth, and innate immunity in Nile Tilapia(Ghosal *et al.*, 2020).

It is however necessary to state that lipid and crude protein contents of the fish carcass of fish fed experimental diets significantly increased from the initial and even higher than the control and reference diet. The carcass crude protein and lipid contents of the fish in the present study is higher than what was observed on the carcass of *Heterobranchus bidorsalis* fingerlings fed Eucalyptus leaf included diets (Nurudeen *et al.*, 2022) but lower in only crude protein of *C. gariepinus* fed diets with Moringa leaf inclusions (Idowu *et al.*, 2017)**.**

CONCLUSION AND RECOMMENDATION

The findings of this study indicated that *Clarias gariepinus* diets prepared by combining different extracts of Moringa and Eucalyptus leaves did not result into improved growth performance and efficient feed utilization. The control diet had 42.68% higher specific growth rate (SGR) than the top performing Eucalyptus-extract base diet (EHEA) and 43.81% than the top performing Moringa-extract base diet (MAME). The control diet also had 46.79% better FCR than the top Moringa-extract base diet (MEMH) and 42.86% better than the best feed conversion Eucalyptus-extract base diet (EAEE).The reference commercial diets performed relatively better in all the evaluated indices except in some proximate compositions such as lipid, Crude protein and Nitrogen free extract.

Poor performance of Eucalyptus-extract base diet might be due to higher amount of its inclusions above optimum level as established in an earlier study. On the other hand, poor performance of the different Moringa-extract base diet could be possibly ascribed to very low amount of its inclusions when compared with inclusion levels reported in some earlier studies.

Additional research on the potential impact of residual of the extraction solvents contained in the plants' extracts on growth and feed utilization efficiency of *C. gariepinus* is hereby recommended.

This exploration could offer more insights into the appropriate application of these solvents in plant extractions intended for use as feed additives in fish feed formulations.

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