ASSESSMENT OF GINGER (*ZINGIBER OFFICINALE)*, GARLIC (*ALLIUM SATIVUM),* BLACKSEED (*NIGELLA SATIVA),* CLOVE *(SYZYGIUM AROMATICUM)* AND NUTMEG (*MYRISTICA FRAGRANS)* OILS ON GROWTH PERFORMANCE, AND MORPHOMETRIC INDICES OF *CLARIAS GARIEPINUS* JUVENILES

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ABSTRACT
Medicinal plant extracts, have been demonstrated to be efficient to replace chemical additives or antibiotics, decreasing metabolic waste production, and improving fillet quality. Thus, plants extracts have been widely studied to discover their potential use in aquaculture. Thus, this study was carried out to determine effect of essential oils extracted from Zingiber officinale (ginger, ZO), Allium sativum (garlic, AS), Nigella sativa (Black seed, NS), Myristica fragrans (nutmeg, AF) and Syzygium aromaticum (clove, SA) on growth performance and morphometric indices of Clarias gariepinus juveniles. Two hundred and fifty (250) juveniles of Clarias gariepinus of average weight 17.05 ± 0.02g were used for the experiment with 20 fish per treatment, replicated twice and fed at 3% body weight. Effects of the therapeutic oils were assessed using growth performance such as weight gain, feed conversion ratio and production productive index and morphometric parameters (standard length, total length, height, dorsal width) for the period of 56 days. Results indicated that dietary group T3 had the highest growth performance (30.34g) and survival rate (95%) among the treatments. Diets containing AS, SA, and MF oils had higher total length, standard length and heights when compared to the oil. The oils were observed to have positive effects on growth performance, and morphometric indices. By harnessing the benefits of these oils, fish farmers can improve the growth rates and reduce the reliance on synthetic additives and antibiotics, thus promoting environmentally friendly and health-conscious aquaculture practices.
Keyword: Feed utilization; *Clarias gariepinus*; Essential oils; Morphometric indices; Growth

INTRODUCTION
Nutrition is a fundamental parameter in intensive fish production, being dependent on factors such as the availability of diets and the potential for investment in production (Chung, 2021). Natural feed additives, such as medicinal plant extracts, have been demonstrated to be efficient in reducing the need for chemical treatments or antibiotics, decreasing metabolic waste production, and improving fillet quality. Thus, plants extracts have been widely studied to discover their potential use in aquaculture. Several studies demonstrated positive effect of medical herbs and oil on growth performance and feed utilization in different types of fish (Sönmez *et al*., 2015). Plants oils has been traditionally used for medicinal purposes and has proven to be effective in enhancing the growth and health status of fish. Medicinal plants have proved to possess stimulating, anti-inflammatory, antibacterial, hepatoprotective and antioxidant properties (Charles, 2012). The African catfish, *Clarias gariepinus* is an excellent aquaculture species. They are hardy, tolerate captivity conditions, attain bigger table-size in ponds, more fecund than other farmed fish species and are highly marketable. Several research studies have found therapeutic oils obtained from plants as an effective feed additive ingredient in the growth and development of *Clarias gariepinus*. The aim of the study is to determine the effect of therapeutic oils extracted from *Zingiber officinale* (Ginger)*, Allium sativum* (Garlic)*, Nigella sativa* (Black seed), *Myristica fragrans* (Nutmeg) and *Syzygium aromaticum* (Clove) on growth performance and morphometric parameters of *Clarias gariepinus* juveniles.

MATERIALS AND METHODS
Plant Collection and Extraction of oil
The rhizomes of *Zingiber officinale* (ZO)*,* bulbs of *Allium sativum* (AS)*,* and the seeds of *Nigella sativa* (NS)*, Syzygium aromaticum* (SA) and *Myristica fragrans* (MF) were purchased from Okitipupa

market, Ondo State, Nigeria. Dried ZO, AS, NS, SA and MF were rinsed in a cup of water thoroughly, and dried using an oven for 30 minutes, the plants were grinded into smaller particles. Extra Virgin Olive Oil (140ml) was added to the grinded plants and mix well leaving it under low heat for at least two hours until it becomes brownish. Then unbleached cheese cloth was use to sieve and take out the bits of large pieces of particles of plants. Once all the oil has been sieved, the oils were then transferred into clean bottles and stored in a cool dry place until ready for use.

Experimental Fish and Diets

Two hundred and fifty juveniles of *Clarias gariepinus* of average weight 17.05 ± 0.02g were obtained from a farm in Okitipupa. They were transported to the Fisheries and Aquaculture Technology Laboratory, Olusegun Agagu University of Science and Technology, Okitipupa. The fish were then stocked in the prepared indoor experimental bowls at the rate of 20 juvenile per bowl and starved overnight before the commencement of the feeding trial to stimulate their appetite. Six sets of diets at 40% crude protein were formulated and prepared as recommended by Faturoti *et al.* (2002) for *Clarias gariepinus*. Each of the different essential oils, (ZO, AS, NS, SA, and MF) was measured 120ml each and incorporated into the diets at different treatments respectively.

Biological Evaluation

The weights of treated and untreated (control) test media were recorded at the commencement and termination of the experiment (after 56 days). Weight changes in the fish were measured at 14day intervals of the experiments to reduce the introduction of handling stress in the animals. The following biological evaluation were measured:

Weight gained = Final Body Weight – Initial Body Weight.

$$\text{Percentage weight gain} = \frac{\text{Final Body Weight – Initial Body Weight)} \times 100}{\text{Initial body weight}}$$

$$\text{Specific Growth Rate (SGR)} = \frac{100(\log \text{Final Body Weight – Initial Body Weight})}{\text{Experimental days}}$$

$$\text{Feed Conversion Ratio (FCR)} = \frac{\text{Dry weight of the feed}}{\text{Fish weight gained}}$$

$$\text{Production Performance Index} = \frac{\text{Survival rate} \times \text{Weight gained}}{\text{Experimental day}}$$

$$\text{Survival Rate (SR)} = \frac{\text{Initial number of fish stocked – Mortality}}{\text{Initial number of fish stocked}} \times 100$$

$$\text{Nitrogen metabolism} = \frac{(0.549)(a+b)h}{2}$$

Where; a = Initial mean weight of fish
b = Final mean weight of fish
h = Experimental periods in days (Adebayo, 2017).

Morphometric indices

Morphometric indices evaluation was carried out after 56 days of the feeding trial by using three fish samples from each treatment. The samples were drained and fresh weight taken using an electronic weighing balance. The morphometric measurements were taken as described by Fischer *et al.,* (1981). The data included the standard length (SL), height (H), total length (TL), head length (HL) and dorsal width (DW). Measurements were taken using measuring tape with the samples placed on a wooden board. Eye diameter was measured using a protractor and then the length was obtained by placing the protractor on a metre rule.

Statistical analysis

Data were statistically analyzed using one–way analysis of variance (ANOVA) using SPSS (Statistical Package for Social Sciences 2006 version 20.0). Duncan Multiple Range Test was used to compare differences among individual means.

RESULTS

There were significant ($p>0.05$) differences in the values obtained in final body weight, weight gain, percentage weight gain, specific growth rate, feed conversion rate, survival rate, nitrogen metabolism and production performance index of the experimental fish in all the dietary treatments as shown in Table 1. Dietary group T3 had the highest growth performance (30.34g) and survival rate (95%) among the treatments. Table 2 showed morphometric studies and which revealed higher values were

in total length, standard length and height in the fish treated with AS, SA and MF when compared to the control.

DISCUSSION

The growth performance and nutrient utilization of *C. gariepinus* revealed that the highest mean weight gain was achieved in the experimental fish fed AS diet and lowest mean weight gain was achieved in the fish fed SA diet. Mean final weight, total weight gain and mean weight gain exhibited significant differences ($p>0.05$) in its value. The increase observed in the growth performance of the treated fish could be attributed to the presence plant oils in the experimental diets. This agrees with the report of Olusola *et al.* (2022) that dietary supplementation of *Carpolobia lutea* improved the growth indices of *Clarias gariepinus*. The findings of this study indicate that the treated groups exhibited increased total length, dorsal width, and height compared to their initial value. It was observed that as the level of the oil increased, there was a corresponding increase in head length, standard length, total length, dorsal width, and height. The result obtained in this study is in agreement with Agbebi *et al.* (2023) who reported that there was an increase in head length, standard length, total length, dorsal width, and height in the treated groups when compared to the control of fish fed turmeric (*Curcuma Longa*), rhizome and soursop (*Annona Muricata*) leaves supplemented diets.

Table 1: Nutrient Utilization and Growth Performance of *Clarias gariepinus* fed dietary essential oils for 56 days

	CONTROL	T2	T3	T4	T5	T6
IBW	17.05±0.02^{a}	17.05±0.01^{a}	17.05±0.03^{a}	17.05±0.02^{a}	17.05±0.01^{a}	17.05±0.02^{a}
FBW	28.28±0.77^{bc}	24.99±1.12^{ab}	30.34±1.01^{c}	22.57±1.64^{a}	26.55±2.03^{abc}	26.97±1.57^{abc}
WG	11.23±0.78^{bc}	7.94±1.12^{ab}	13.29±1.01^{c}	5.51±1.04^{a}	9.50±2.03^{abc}	9.92±1.57^{abc}
PWG	65.84±4.55^{bc}	46.54±6.54^{ab}	77.95±5.93^{c}	32.34±9.59^{a}	55.68±11.88^{abc}	58.15±9.18^{abc}
SGR	0.40±0.01^{a}	0.31±0.04^{a}	0.46±0.03^{a}	0.22±0.06^{a}	0.35±0.06^{a}	0.22±0.19^{a}
FCR	0.14±0.01^{ab}	0.17±0.04^{ab}	0.11±0.01^{a}	0.25±0.05^{ab}	0.16±0.05^{ab}	0.12±0.01^{a}
SR	92.50±2.50^{a}	87.50v7.50^{a}	95.00±5.00^{a}	77.50±2.50^{a}	82.50±12.50^{a}	82.50±7.50^{a}
NM	696.75±11.95^{bc}	640.16±17.14^{ab}	728.48±15.52^{c}	608.97±25.14^{a}	670.16±31.14^{abc}	676.65±24.05^{abc}
PPI	3.75±0.35^{bc}	2.50±0.60^{bc}	4.50±0.60^{c}	1.50±0.40^{a}	2.70±0.20^{ab}	2.90v0.20^{ab}

Key: WG = Weight gain, PWG = Percentage weight gain, SGR = Specific growth rate, FCR = Feed conversion rate, SR = Survival rate, NM = Nitrogen metabolism, PPI = Production performance index, mean followed by the same letter in a column is not significantly different ($p>0.05$)

Table 2: Morphometric Characteristics of *Clarias gariepinus* fed dietary essential oils for 56 days

	Week			
	2	**4**	**6**	**8**
		Total length		
Control	15.70±0.20^{a}	15.10±1.80^{ab}	16.65±0.95^{a}	16.90±0.60^{ab}
ZO	12.75±1.05^{a}	13.65±0.15^{ab}	14.54±1.57^{a}	17.34±0.37^{ab}
AS	13.80±0.70^{a}	16.80±0.70^{b}	15.54±0.57^{a}	16.33±0.10^{ab}
NS	12.95v0.55^{a}	13.05±0.55^{a}	14.57±0.04^{a}	14.25±1.65^{a}
SA	14.45±2.05^{a}	14.87±1.17^{ab}	15.92±2.02^{a}	17.52±0.62^{b}
MF	13.90±0.00^{a}	14.95±0.55^{ab}	15.05±0.15^{a}	16.02±0.82^{ab}
		Standard length		
Control	14.50±0.60^{a}	13.10±1.50^{a}	14.10±0.81^{a}	14.10±0.50^{a}
ZO	11.35±1.25^{a}	11.50±0.20^{a}	12.20±1.40^{a}	14.60±0.60^{a}
AS	11.75±0.45^{a}	14.10±0.20^{a}	13.43±0.60^{a}	13.08±0.15^{a}
NS	11.45±0.45^{a}	11.30±0.20^{a}	12.42±0.67^{a}	12.37±1.53^{a}
SA	12.35±1.45^{a}	12.55±1.65^{a}	13.65±1.95^{a}	14.97±0.67^{a}
MF	11.70±0.70^{a}	12.90±0.80^{a}	12.85±0.35^{a}	13.72±0.69^{a}
		Head length		
Control	3.15±0.05^{a}	2.80±0.40^{a}	2.65±0.25^{a}	3.07±0.24^{b}
ZO	2.29±0.32^{a}	2.45±0.05^{a}	2.45±0.25^{a}	2.82±0.02^{ab}
AS	2.50±0.20^{a}	2.87±0.07^{a}	2.67±0.17^{a}	2.65±0.05^{ab}
NS	2.95±0.15^{a}	2.10±0.10^{a}	2.40±0.10^{a}	2.30±0.20^{a}
SA	2.85±0.45^{a}	2.70±0.40^{a}	2.25±0.85^{a}	2.95±0.65^{ab}
MF	2.50±0.20^{a}	2.90±0.20^{a}	2.47±0.04^{a}	2.68±0.15^{ab}

		Dorsal width		
Control	2.45±0.05 [a]	2.55±0.35 [ab]	2.45±0.05 [a]	2.85±0.15 [a]
ZO	2.15±0.05 [a]	2.35±0.05 [ab]	2.13±0.50 [a]	2.67±0.13 [a]
AS	2.17±0.24 [a]	2.55±0.05 [b]	2.22±0.02 [a]	2.67±0.14 [a]
NS	2.45±0.15 [a]	1.77±0.04 [a]	1.82±0.34 [a]	2.23±0.30 [a]
SA	2.30±0.60 [a]	2.27±0.34 [ab]	2.00±0.40 [a]	2.60±0.20 [a]
MF	1.95±0.05 [a]	2.17±0.07 [ab]	2.05±0.05 [a]	2.62±0.19 [a]
		Height		
Control	1.50±0.10 [a]	1.72±0.09 [a]	1.89±0.09 [a]	1.93±0.10 [a]
ZO	1.45±0.05 [a]	1.77±0.04 [a]	1.77±0.27 [a]	2.20±0.10 [a]
AS	1.75±0.05 [a]	2.09±0.12 [a]	1.87±0.04 [a]	1.95±0.05 [a]
NS	1.90±0.20 [a]	1.62±0.09 [a]	1.72±0.09 [a]	1.67±0.24 [a]
SA	1.77±0.34 [a]	2.13±0.30 [a]	1.79±0.19 [a]	2.10±0.13 [a]
MF	1.45±0.15 [a]	1.82±0.09 [a]	1.80±0.10 [a]	2.00±0.30 [a]

ZO= Zingiber officinale, AS= bulbs of *Allium sativum,* NS= the seeds of *Nigella sativa,* SA=*, Syzygium aromaticum,* MF= *Myristica fragrans,* mean followed by the same letter in a column is not significantly different ($p>0.05$)

CONCLUSION

From this study, essential oils (ZO, AS, NS, SA and MF) improved the growth performance, feed utilization and morphological parameters of *Clarias gariepinus*. By harnessing the benefits of these oils, fish farmers can improve the growth rates, overall health of their stocks and reduce the reliance on synthetic additives and antibiotics, thus promoting environmentally friendly and health-conscious aquaculture practices.

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