EFFECTS OF *Terminalia catappa, Chromolaena odorata* AND *Psidium guajava* LEAF EXTRACTS ON GROWTH, BIOCHEMICAL AND HAEMATOLOGY OF *Clarias gariepinus*

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Abstract: This study evaluated the effects of *T. catappa* (TC), *C. odorata* (CO), and *P. guajava* (PG) leaf extracts as feed additive on growth, haematological and biochemical indices of African catfish, *Clarias gariepinus* juvenile. Fish were put under 10 treatments; 0 (control), 2, 4 and 6 ml for TC, CO and PG extracts for 6 weeks. The results showed that weight gain, specific growth rate (SGR) and relative growth rate (RGR) were significantly improved ($p<0.05$) by 6 ml TC. Also, total feed intake (TFI), protein intake (PI) and protein efficiency ratio (PER) showed significant differences ($p<0.05$), while diet 10 (6 ml TC) had the best value for feed conversion ration (FCR). There were no significant differences ($p>0.05$) in WBC, ESR,MCHC, neutrophil, leukocytes and haemoglobin across treatments. Also, no significant differences ($P>0.05$) in serum protein and albumin were observed however, significant decreased ($p<0.05$) was observed in cholesterol and triglyceride levels in blood serum. Significant reduction ($p<0.05$) in low density lipoprotein (LDL) activity was observed among the group of fish fed diet 10 (6 ml TC) whereas, no significant increase was observed in HDL. In addition, significant differences ($p< 0.05$) in the values of AST and ALT were recorded when treated diets were compared with the control group. Hence, inclusion of 6 ml *T. catapa* in the diet of catfish would enhance its growth and well-being.

Keywords: Herbs, growth performance, health status, catfish

Introduction

The role of aquaculture in ensuring a constant supply of fish for human consumption cannot be overstated and medically, health benefits of frequently consumed fish is bounteous (Mohanty, 2011). Hence, good nutrition in fish production system is essential to economically produce a healthy and high quality fish product. Fish nutrition has advanced in recent years in the production of varied balanced commercial feeds, that promote optimal growth and sound health in cultured fishes (Hixson, 2014).

There are wide range of feed additives available to improve fish growth and health status, some of these additives, which include hormones and antibiotics are chemical products and may cause deleterious effects on fish (Bello *et al*., 2012). Also, the continuous use of synthetic antibiotics in aquaculture to treat diseases caused by bacteria, pose threats to consumers and non-target organism in the environment (Muniruzzaman and Chowdhury, 2004).

Therefore, in order to find a lasting solution to the aforementioned issues, several studies have been carried out to find bioactive compounds from plants, with antibacterial and antimicrobial properties that could be used to prevent diseases causing organisms in aquaculture (Abutbul *et al.*, 2005; Ahmed *et al*., 2019). Interestingly, many plants are known to possess the following properties which include; anti-stress, growth promoting, improve immunity and prevent infections in fish under culture (Shakya, 2017). The properties are due to the presence of bioactive compounds such as flavonoids, steroids, alkaloids, phenolics, terpenoids, and other essential oils in those plants (Citarasu *et al.*, 2002; Jung *et al*., 2009). Herbs can also act as immunostimulants (Citarasu *et al*., 2002, 2003) and enhance immune response in fish (Pandey, 2012). Herbal drugs are efficacious in the treatment of numerous infectious diseases without deleterious effects that are usually linked with synthetic antibiotics (Punitha *et al*., 2008; Aderolu *et al*., 2017).

Thus, the present study investigated the dietary effects of *Terminalia catappa, Chromolaena odorata* and *Psidium guajava* leaves extracts on growth, haematological and biochemical profiles of *Clarias gariepinus* juveniles.

Materials and Methods

Collection of plant materials, aqueous extraction and feed formulation

Samples of fresh leaves of *T. catappa* (TC) LUH 3861, *C. odorata* (CO) LUH 4021 and *P. guajava* (PG) LUH 8511 were collected from the Botanical garden, University of Lagos, identified and authenticated at the Herbarium, Department of Botany, University of Lagos, Nigeria. Herbarium abbreviation is as indicated. The leaves were thoroughly rinsed with clean water to remove dirt, evenly spread on a mosquito net-size mesh to air dry under shade and were pulverized to fine powdered using an electric blender (Mbagwu and Adeniyi, 1988). 20 g of air dried leaf from each plant was placed in a conical flask containing 200 ml hot distilled water, placed on an orbital shaker (200 rpm) for 72 h and filtered. The filtrate was evaporated to dryness using a water bath at 50°C. A greasy filtrate obtained for each plant specimen was transferred to screw-cap bottles, labeled and refrigerated at 4°C (Ifesan *et al*., 2009). Ten experimental diets were formulated at varying levels of inclusion, pelleted and sun-dried for eight hours; Diet 1 (control, 0 ml plant extract), Diet 2 (2 ml PG), Diet 3 (4 ml PG), Diet 4 (6 ml PG), Diet 5 (2 ml CO), Diet 6 (4 ml CO), Diet 7 (6 ml CO), Diet 8 (2 ml TC), Diet 9 (4 ml TC) and Diet 10 (6 ml TC) (Table 1).

Table 1: Nutrient composition of experimental diets

Ingredient	Diet 1 (control)	Diet 2 (2ml PG)	Diet 3 (4ml PG)	Diet 4 (6ml PG)	Diet 5 (2ml CO)	Diet 6 (4ml CO)	Diet 7 (6ml CO)	Diet 8 (2ml TC)	Diet 9 (4ml TC)	Diet 10 (6ml TC)
Fish meal	30	30	30	30	30	30	30	30	30	30
Soya bean meal	30	30	30	30	30	30	30	30	30	30
Groundnut cake	10	10	10	10	10	10	10	10	10	10
Maize	17	17	17	17	17	17	17	17	17	17
Indomie	7	7	7	7	7	7	7	7	7	7
Oil	3	3	3	3	3	3	3	3	3	3
DCP	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Lysine	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Methionine	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Vitamin premix	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Total (kg)	100	100	100	100	100	100	100	100	100	100
CalculatedCP (%)	41.27	41.27	41.27	41.27	41.27	41.27	41.27	41.27	41.27	41.27
Calculated Energy %	2949.4	2949.4	2949.4	2949.4	2949.4	2949.4	2949.4	2949.4	2949.4	2949.4

Procurement, acclimatization of experimental fish and feeding trial

Three hundred (300) *C. gariepinus* juveniles were purchased from a fish farm in Lagos and transported in aerated aquaria. The fish were acclimatized for 14 days in transparent rectangular plastic holding tanks (52.5 x 33.5 x 21 cm^3) and fed 3 mm Coppens feed under standard condition; temperature (27.5 – 29.5^{o}C), dissolved oxygen (4.5 - 4.8 mg/l) and pH (7.3 - 8.0) during the experimental period (Aderolu and Akpabio, 2009).

Fish were weighed, randomly stocked into the plastic tanks at the rate of 10 fish per tank (average weight 8.9 ± 0.44 g) and the experiment was carried out in triplicates. They were starved overnight before the commencement of the feeding trials to empty their stomachs. Fish were fed experimental diets to satiation by hand, twice daily (9.00 and 16.00 h) for a period six weeks. The weight of the experimental fish were measured using a digital balance (Camry EK 5055) at the beginning of the experiment and at the end of every week to determine the average weight gain while the quantity of the feed fed for each week was also recorded. The water of the tanks was changed regularly at every other day to maintain good water quality while fish mortality was monitored daily. The fish were bulk weighed on weekly basis after which the mean body weight and mean feed intake were determined accordingly.

Fish growth and nutrient utilization parameters

The following parameters were measured from the records of feed intake and weight gain

Mean weight gain (MWG) (g) = Mean final body weight (g) – Mean initial body weight (g)

Specific Growth Rate (SGR) %/day = (Log W_2 – Log W_1 / T) × 100

Feed conversion ratio (FCR) = Feed intake (FI) (dry weight in g)/Fish wet weight gain (g)

Protein Efficiency Ratio (PER) = Mean weight gain / Total protein intake

Protein Intake (PI) (g) = Total feed intake / Protein content of feed

Relative growth rate (RGR) = (Weight gain/Initial body weight) × 100

Where: W_2 = Mean final weight; Wi = Mean initial weight of fish, and T = Feeding trial period in days.

Collection of Fish Blood for Haematological and Biochemical Analyses

Blood samples were collected from the caudal peduncle of randomly picked fish from each treatment in a 2 ml syringe and transferred to ethylene-diamine-tetra-acetic acid (EDTA) bottles and to sterile plain sample bottles. The specimens were taken to Lagos University Teaching Hospital, Idi-Araba, Lagos for analysis. Haematological parameters examined were white blood cell (WBC), packed cell volume (PCV), haemoglobin (Hb), erythrocyte sedimentation rate (ESR), neutrophil (Neut), leukocytes (Leuk) counts and Mean corpuscular haemoglobin concentration (MCHC) as described by standard method (Joshi *et al*., 2002). Samples of blood in the plain bottles were spun at 3000 rpm to collect serum for biochemical analysis. Aspartate aminotransferase (AST) and alanine aminotransferase (ALT) were analysed by the method of Reitman and Frankel (Reitman and Frankel, 1957), total protein (Tietz, 1995), albumin and globulin (Doumas *et al*., 1971), cholesterol (Allain *et al*., 2074), triglyceride and high density lipoprotein (HDL) (Ochei and Kolhatkar, 2008) and low density lipoprotein (LDL) as described by Friedewald *et al*. (1972).

Statistical analysis

Data obtained during the experimental period were subjected to one-way analysis of variance (ANOVA) and comparisons among treatment means were carried out by Duncan multiple range test (Duncan, 1955) at a significance level of ($P<0.05$). The computations were carried out using the statistical package SPSS 16.0 (SPSS Inc., Chicago, IL, USA).

Results and Discussion

The results of growth performance and nutrients utilization parameters are shown in Table 2. The highest significant ($p<0.05$) mean weight gain was recorded in fish fed diet 10 (13.83±0.38 g), and the lowest value in fish fed diet 7 (7.60±0.67 g). The increase in weight recorded from each treatment showed that the fish fed with *T. catappa* (6 ml) had the best growth performance compared with other experimental diets. This result was corroborated by the study of Ikhwanuddin *et al*. (2014) who reported that *P. monodon* survived and grew better in *T. catappa* leaf extract. The remarkable weight gain in *C. gariepinus* juvenile fed with *T. catappa* aqueous leaf extract underscores the presence of high degree of organic materials such as tannins, flavanoids, isovitexin and triterpenoiods in its leaf (Ahmed *et al*., 2005). Because, some medicinal plants promote the utilization of cellular lipid and fatty acid in addition to protein accumulation thereby resulting in good growth performance in fish (Ji *et al*., 2007).

The highest values for total feed intake (17.07± 0.66) and voluntary feed intake (1.05±0.25) were recorded among the group of fish fed diet 2; these values were significantly different ($p<0.05$) from other groups of fish fed experimental diets. However, feed intake which is the determinant of fish performance did not decrease consistently with the inclusion of graded levels of *T. catappa* leaf extract in the diets. Similar observation was reported by Julius and Muriatu (2015) when they fed cat fish with graded levels of *T. catappa* seed meal. The specific growth rate (SGR) and relative growth rate (RGR) showed significant differences ($p<0.05$) across the experimental diets with the highest values (1.67±0.30 and 155.43±4.22, respectively) recorded in diet 10 while the lowest values (1.10±0.70 and 85.30±7.23, respectively) were recorded in diet 7. These results further confirmed that *T. catappa* has the potentials to promote growth in cat fish.

Studies on *Oreochromis niloticus* and *Cyprinus carpio* revealed that *Quillaja saponin* plant added to the feed reduced the feed conversion ratio, increased protein efficiency ratio and specific growth rate (Francis *et al*., 2001, 2002). Also, it was reported that garlic used in the feed of tilapia, O. *niloticus* caused an increase in the specific growth ratio and protein efficiency ratio (Shalaby *et al*., 2006). There was no significant difference ($p>0.05$) recorded in feed conversion ratio (FCR) across all diets however, the best value for (FCR) was recorded in diet 10 (1.19±0.39), while the worst value (1.81±0.22) was recorded in diet 7. The protein efficiency ratio (PER) for diets 10 and 7 recorded the highest (29.80±0.95) and lowest (19.95±2.31) values respectively, and were also significantly different ($p<0.05$) from other diets. These results were supported by Zheng *et al*. (2009) who reported that the extract of thyme (*Origanum heracleoticum L.*) increased condition factor and provided a good feed conversion ratio in channel catfish (*Ictalurus punctatus*). Similarly, it was reported that the use of red clover in the feed of tilapia (*Oreochromis aereus*), improved the feed conversion ratio, protein efficiency ratio and apparent protein utilization (Turan, 2006), while *Oreochromis niloticus* x *O. aureus* fed with basil had increased specific growth ratio and protein efficiency ratio (El-Dakar *et al*., 2008).

The haematological parameters results are recorded in Table 3. There were no significant differences ($P>0.05$) in all the parameters measured across diets. However, the highest values for haemoglobin (9.05±1.34) and packed cell volume (28±4.24), were recorded for the fish fed with 2 ml TC, while their lowest values (6.6±0.71 and 20±2.83, respectively) were recorded for the fish fed diet 4 ml TC. Also, the WBC count was highest (16400.0±1414.2) and lowest (11000.0±1414.2) in the groups of fish fed diets 4 ml TC and the 2 ml CO, respectively. The highest values (15.5±6.36 and 90.5±0.71) for neutrophil and leukocytes were recorded for fish fed 2 ml PG and 4 ml CO respectively while, the least values (9.5±0.71 and 84.5±6.36)) for these parameters were recorded in fish fed 4 ml CO and 2 ml PG, respectively. Furthermore, The highest values (56.50 ±10.6 and 33.86 ± 2.03) for ESR and MCHC were observed with fish fed 4ml TC and control diet respectively while, their lowest values (34.00±8.4 and 31.91±0.69) were recorded in group of fish fed 2 ml TC and 2 ml PG, respectively. The haematological parameters in the present investigation such as white blood count(WBC), erythrocyte sedimentation rate (ESR), neutrophil, leukocytes counts, haemoglobin and the value of MCHC recorded no significant differences when groups of fish fed with leaves extracts were compared with control group. These observations are in agreement with the results from previous studies; Hamid *et al*. (2018) reported that dietary *Origanum vulgare* extract incorporated into test diets of rainbow trout had no significant effect on RBC, WBC and haemoglobin. Also, Nugroho *et al*. (2017) reported no significant differences in WBC, RBC, Hb counts of *Betta* sp. treated with *T. catappa* leaf extract. Additionally, these observations are in agreement with reports of Abdelwahab and El-Bahr (2012) on the inclusion of Black Cumin Seeds and Turmeric mixture in the diet of Asian Sea Bass. Moreover, the non-significant reduction in PCV and Hb was equally found by Aderolu (2018) when he feddiet supplemented with *Gongronema latifolia* (Benth) extract to African catfish juvenile. Furthermore, the haemoglobin concentration which was not significantly different across diets, may indicate that the herbal extracts as feed additive, did not impose any kind of stress on the fish (Bahrami *et al*., 2015). Because, reports has shown that under stressful condition, there will be an increase in the release of immature RBCs from head kidney as a haematopoietic tissue and this can enhance the level of haemoglobin concentration in blood of fish (Misra *et al.*, 2006).

Table 2: Growth and nutrient utilization parameters of *C. gariepinus* juveniles fed different levels of *P. guajava* (PG), *C. odorata* (CO) and *T. catappa* (TC) aqueousleavess extracts

Parameter	Diet 1 (control)	Diet 2 (2ml PG)	Diet 3 (4ml PG)	Diet 4 (6ml PG)	Diet 5 (2ml CO)	Diet 6 (4ml CO)	Diet 7 (6ml CO)	Diet 8 (2ml TC)	Diet 9 (4ml TC)	Diet 10 (6ml TC)
FNW (g/fish)	20.80± 1.14^{bc}	20.30± 1.66^{abc}	18.37± 1.56^{ab}	19.37± 0.53^{abc}	21.30± 0.93^{bc}	19.27± 0.54^{abc}	16.50± 0.69^{a}	20.00± 2.54^{abc}	22.37± 0.66^{bc}	22.73± 0.38^{c}
INW (g/fish)	8.90± 0.00	8.90± 0.58	8.90± 0.58	8.90± 0.58	8.90± 0.58	8.90± 0.58	8.90± 0.58	8.90± 0.58	8.90± 0.33	8.90± 0.00
MWG (g/fish)	11.90± 1.14^{bc}	11.40± 1.72^{abc}	9.47± 1.54^{ab}	10.47± 0.48 ^{abc}	12.40± 0.95^{bc}	10.370±.55^{abc}	7.60± 0.67^{a}	11.10± 2.50^{abc}	13.43± 0.64^{bc}	13.83± 0.38^{c}
TFI (g/fish)	16.90± 0.52^{e}	17.07± 0.66^{e}	14.87± 0.42^{abc}	14.97± 0.20^{abcd}	16.30± 0.30^{cde}	14.53± 0.12^{ab}	13.43± 0.44^{a}	16.43± 0.52^{cde}	15.87± 0.27^{abc}	16.53± 0.98^{de}
VFI (g/fish)	1.02± 0.29^{ab}	1.05± 0.25^{b}	0.98± 0.35^{ab}	0.95± 0.13^{ab}	0.97± 0.29^{ab}	0.92± 0.12^{ab}	0.95± 0.57^{ab}	1.03± 0.68^{ab}	0.91± 0.22^{a}	0.93± 0.44^{ab}
SGR (%/day)	1.51± 0.96^{bc}	1.46± 0.16^{abc}	1.28± 0.15^{ab}	1.39± 0.40^{abc}	1.56± 0.81^{bc}	1.38± 0.54^{abc}	1.10± 0.70^{a}	1,41± 0.23^{abc}	1.64± 0.48^{bc}	1.67± 0.30^{c}
RGR (g/fish)	133.71± 12.78^{bc}	128.35± 20.20^{abc}	106.29± 17.13^{ab}	117.56± 4.85^{abc}	139.38± 10.88^{bc}	116.52± 6.51a^{bc}	85.36± 7.23^{a}	124.45± 27.65^{abc}	150.33± 6.65^{bc}	155.43± 4.22^{c}
FCR	1.44± 0.11	1.55± 0.17	1.64± 0.23	1.43± 0.54	1.33± 0.99	1.41± 0.63	1.81± 0.22	1.67± 0.42	1.19± 0.53	1.19± 0.39
PI	0.48± 0.01^{e}	0.49± 0.19^{e}	0.42± 0.12^{ab}	0.43± 0.06^{abcd}	0.47± 0.01^{dce}	0.42± 0.00^{abc}	0.38± 0.01^{a}	0.47± 0.01^{cde}	0.45± 0.01b^{cde}	0.47± 0.03^{de}
PER	24.59± 1.85^{ab}	23.20± 2.71^{ab}	22.13± 3.01^{ab}	24.47± 0.93^{ab}	26.63± 1.95^{abc}	24.95± 1.15^{ab}	19.95± 2.31^{a}	23.36± 4.72^{ab}	29.64± 1.38^{bc}	29.80± 0.95^{b}

Value across the rows with different superscripts are significantly difference ($p<0.05$)

Table 3: Haematological profiles of *C. gariepinus* juveniles fed different levels of*P. guajava (*PG), *C. odorata* (CO) and *T. catappa (*TC) aqueous leavess extracts

Parameter	Diet 1 (control)	Diet 2 (2ml PG)	Diet 3 (4ml PG)	Diet 4 (6ml PG)	Diet 5 (2ml CO)	Diet 6 (4ml CO)	Diet 7 (6ml CO)	Diet 8 (2ml TC)	Diet 9 (4ml TC)	Diet 10 (6ml TC)
Hb (g/dl)	8.35±3.32	8.45±0.49	7.75±0.07	7.45±1.91	7.35±0.49	6.75±3.18	8.6±1.27	9.05±1.34	6.6±0.71	6.75±0.49
PCV (%)	25±11.31	26.5±2.12	24±0.00	22.5±6.36	22±2.83	20.5±9.19	26.5±3.53	28±4.24	20±2.83	20.5±2.12
WBC (mm)	11950.0± 5727.6	13400.0 ± 3677.0	13100.0 ± 2969.8	14100.0 ± 2687.0	11000.0 ±1414.2	11800.0 ±565.7	13000.0 ± 1414.2	11700.0 ± 3252.7	16400.0 ±1414.2	11400.0 ±4808.3
Neut. (%)	14.5 ±7.78	15.5 ±6.36	11.5 ±4.95	12 ±2.83	14.5 ±2.12	9.5 ±0.71	15 ± 4.24	13.5 ±3.54	15.5 ±4.95	15±1.41
Leuk. (%)	85.5±7.78	84.5±6.36	88.5±4.95	88±2.83	85.5±2.12	90.5±0.71	85±4.24	86.5±3.54	84.5±4.95	85±1.41
ESR (mm/hr)	43.50 ±21.92	40.00 ±11.31	39.00 ±0.00	41.00 ±15.56	50.50 ±4.95	50.00 ±22.63	36.00 ±8.49	34.00 ±8.49	56.50 ±10.61	50.00 ±0.00
MCHC (%)	33.86±2.03	31.91±0.69	32.29±0.29	33.24±0.92	33.54±2.06	32.74±0.84	32.42±0.48	32.33±0.10	33.08±1.14	32.98±1.00

Table 4: Biochemical profiles of *C. gariepinus* juveniles fed different levels of *P. guajava (PG), C. odorata* (CO) and *T. catappa (*TC) aqueousleavess extracts

Paramet.	Diet 1 (control)	Diet 2 (2ml PG)	Diet 3 (4ml PG)	Diet 4 (6ml PG)	Diet 5 (2ml CO)	Diet 6 (4ml CO)	Diet 7 (6ml CO)	Diet 8 (2ml TC)	Diet 9 (4ml TC)	Diet 10 (6ml TC)
PROT. (g/dl)	3.6±1.13	3.15±0.49	3.7±0.42	3.6±1.13	2.85±1.34	2.7±0.14	2.55±0.49	3.75±0.21	2.5±1.27a	3.85±0.07
ALB. (g/dl)	1.73±0.04	1.65±0.07	1.65±0.07	1.72±0.17	1.67±0.18	1.68±0.19	1.65±0.21	1.765±0.09	1.575±0.11	1.58±0.25
Chol (mg/dl)	142.5±13.44	138.5±54.45	146.5±6.36	162.5±31.82	124.5±20.51	123±21.21	138±0.00	130.5±6.36	131±7.07	134.5±20.51
Trig (mg/dl)	121.5±43.13ab	118±16.97ab	108±5.66ab	93.5±7.78ab	126±53.74b	66±45.25a	144.5±43.13b	114±8.49b	116±19.80b	95.5±4.95a
HDL (mg/dl)	59±53.74	79.5±48.79	45.5±10.61	76.5±54.45	48±0.00	55.5±4.95	78.5±6.36	71±22.63	50.5±4.95	88±18.38
LDL (mg/dl)	58.5±50.20ab	35.5±9.19ab	79.5±16.26b	67±21.21ab	51±9.90ab	44±11.31ab	39.5±0.71ab	47.5±14.85ab	55.5±7.78ab	27.5±0.71a
ALT (U/L)	34±2.83ab	19±1.41a	53.5±20.51b	20±1.41a	27.5±13.44a	23.5±10.61a	37±12.73ab	41±11.31ab	27.5±9.19a	54±0.00b
AST (U/L)	25±5.66ab	19.5±12.02a	46.5±17.68ab	21.5±9.19a	24.5±21.92ab	20±2.83a	42±16.97ab	44±11.31ab	23±5.66a	61±28.28b

Value across the rows with different superscripts are significantly difference (p<0.05)

The results of biochemical parameters are recorded in Table 4. In the present study there were no significant differences (P>0.05) in serum protein and albumin across diets when compared with control group. These findings are similar to the reports of Al-Salahy (2002) and Naeiji *et al*. (2013) who recorded no significant changes in the levels of albumin and total protein in plasma of fish fed with diets enriched with onion and garlic extract. Phytochemicals such as flavonoid prevents the biosynthesis of cholesterol by inhibiting the activity of fatty acid synthesis (Yamamoto and Oue, 2006). Hence, this could be responsible for the significant decreased (p<0.05) in cholesterol and triglyceride levels in the blood serum of the experimental fish fed with 2, 4 and 6 ml of *C. odorata* and *T. catappa*, respectively. Similarly, Bahabadi *et al*. (2014) observed reduction in triglycerides and cholesterol levels in plasma of the fish fed with diets having 0.5 and 1% yarrow extract. Equally, reduction in cholesterol and triglyceride levels were reported in blood of rainbow trout and catfish respectively fed with silymarin extract (Banaee *et al.*, 2011), onion and garlic extract (Al-Salahy, 2002).

Likewise, significant reduction (p<0.05) in low density lipoprotein (LDL) activity was observed among the group of fish fed diet 10 (6 ml TC) whereas, no significant increase was observed in high density lipoprotein (HDL) activity when different groups of fish were fed varying diets (2, 4 and 6 ml) of *P. guajava*, *C. odorata* and *T catappa* compared with the control group. These observations are corroborated by earlier studies, that the cholesterol synthesized in liver is transported to other tissues of the body through LDL activity, while HDL through its acivity moves the cholesterol of peripheral tissues to liver resulting to increased excretion of cholesterol through bile (Asgary *et al*., 2000), which decreased the cholesterol level in blood of the fish fed with yarrow extract (Bahabadi *et al*., 2014).

There were significant differences (p< 0.05) in the values of AST and ALT when treated diets were compared with the control group. The highest value (54±0.00) was recorded in fish fed diet 10 and the lowest value (19±1.41) was observed in group of fish fed diet 2. Similarly, the highest value (61±28.28) of ALT was observed with experimental fish fed diet 10 and the lowest value (19.5±12.02) was found among fish group fed diet 2. According to Banaee *et al*. (2011) AST and ALT are found in various tissues of fish, when injuries or diseases affect these tissues, their cells are destroyed and these enzymes are released into plasma. Above all, in order to meet energy demand of organisms in various adaptive situations (Gabriel *et al*., 2009) both the AST and ALT function as a link between carbohydrate and protein metabolism by catalyzing the introversion of strategic compounds such as alanine and α-Ketoglutarate to glutamic acid and pyruvic acid, respectively (Nelson and Cox, 2000) and the processes release the energy demand for such organs in crisis (Gabriel *et al*., 2009). This could be the reasons for the elevated values recorded for AST and ALT among the fish fed 6 ml *T.*

catappa. These results were similar to the reports of Bahabadi *et al*. (2014) in which treatment with 0.5 and 1% yarrow extract resulted in significant increase in AST and ALP activities on day 15 in the plasma of fish fed with treated diets when compared with the control group.

Conclusion

The present study showed that *C. gariepinus* fish fed with *T. catapa* aqueous leaf extract recorded the best results for growth performance, nutrient utilization and blood indices compared to other experimental diets. Therefore, inclusion of 6 ml *T. catapa* in the diet of catfish would enhance its growth and well-being.

Conflict of Interest

The authors declare that there is no conflict of interest.

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