Effects of feeding waterleaf (*Talinum triangulare*) on the performance of meat type chicken

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By

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Date:

CERTIFICATE-I

This is to certify that the thesis entitled **"Effects of feeding waterleaf (*Talinum triangulare*) on the performance of meat type chicken"** submitted in partial fulfilment of the requirements for the award of the degree of **Master of Veterinary Science (Poultry Science)** to the Odisha University of Agriculture and Technology is a faithful record of bonafide and original research work carried out by **Aman Mishra** under my guidance and supervision. No part of this thesis has been submitted for any other degree or diploma.

It is further certified that the assistance and help received by him from various sources during the course of investigation has been duly acknowledged.

CHAIRMAN

ADVISORY COMMITTEE

CERTIFICATE-II

This is to certify that the thesis entitled **"Effects of feeding waterleaf (*Talinum triangulare*) on the performance of meat type chicken"** submitted by **Aman Mishra** to the Odisha University of Agriculture and Technology, Bhubaneswar in partial fulfilment of the requirements for the degree of **Master of Veterinary Science (Poultry Science)** has been approved/disapproved by the students' advisory committee and the external examiner.

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Place: **(Aman Mishra)**

Dated:

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LIST OF ABBREVIATIONS

AIA	:	Acid insoluble ash
AICRP	:	All India Coordinated Research project
ALP	:	Alanine phosphatase
ALT	:	Alanine aminotransferase
ASAT	:	Aspartase aminotransferase
CAM	:	Crassulacean acid metabolism
CF	:	Crude fibre
cm	:	Centimeter
CO_2	:	Carbon dioxide
Cum.	:	Cumulative
CP	:	Crude Protein
DM	:	Dry Matter
EE	:	Ether extract
et al.	:	and other (Latin et alii)
etc.	:	so on (Latin et cetera)
FCR	:	Feed Conversion Ratio
FI	:	Feed intake
Fig.	:	Figure
GNC	:	Groundnut cake
Hb	:	Hemoglobin
HDL	:	High density lipoprotein
ICAR	:	The Indian council of Agricultural Research
i.e.	:	that is
I/N	:	Intranasal
I/O	:	Intraocular
IU/L	:	International unit per liter
IS	:	International standard
Kcal	:	Kilocalorie
Kg	:	Kilogram
LDL	:	Low density lipoprotein
ME	:	Metabolizable energy
Mg/dl	:	Milligram per deciliter
NFE	:	Nitrogen free extract
PCV	:	Packed cell volume
RBC	:	Red blood cell
RD	:	Reference diet
SBM	:	Soyabean meal
Tchol.	:	Total cholesterol
TEC	:	Total erythrocyte count
TLC	:	Total leukocyte count
TD	:	Treatment diet
WBC	:	White blood cell
WL	:	Waterleaf
WLE	:	Waterleaf extract
WLM	:	Waterleaf meal

ABSTRACT

The feed cost has always been a huge concern for the poultry sector. So, it is desirable to look out for an alternate, cheaper and locally available feed ingredient. Leafy vegetables can be one of the best options. That is why the study was under taken to evaluate the performance of meat type chicken fed Waterleaf meal (WLM). Ninety 21 days old Red Cornish chicken were distributed into 3 treatments groups T1, T2 and T3 assigned to diets containing 0, 5 and 10 % WLM respectively. The experiment was conducted for 3 weeks in the poultry farm of ILF of C.V.Sc & A.H, OUAT, Bhubaneswar. A reference finisher diet was prepared to contain 3050 Kcal ME/Kg diet with 20% CP (ICAR 2013). The other two test diets were prepared by incorporating 5% and 10% of WLM respectively by replacing equal parts of reference diets. Results show that the DM of the fresh waterleaf was 8.90%. The CP, CF, EE, Total Ash, Ca and P of WLM on DM basis were 28, 13.7, 1.22, 14.24, 1.10 and 0.75 percent respectively. The 6^{th} week body weight of T1 (Control), T2 (5%WLM) and T3 (10%WLM) groups were 897.08±42.65g, 937.4±27.04g and 927.43±40.14g without any significant differences (p>0.05) among treatment groups. The average 6^{th} week cumulative feed intake of T3 group was highest which was significantly (p<0.01) higher than the T1 and T2 groups. Similarly, the average 6^{th} week cumulative feed intake of T2 group was significantly (p<0.01) higher than T1 group. The 6^{th} week cumulative FCRs of T1, T2 and T3 treatment groups were 3.99, 3.68 and 5.02 respectively. The 6^{th} week cumulative FCR of T3 was significantly (p<0.01) higher than T1 and T2 groups. The 6^{th} week cumulative FCR of T2 group was the lowest and significantly (p<0.01) lower than T1 group. Haematological parameters like Haemoglobin, DC and serum bio chemicals such as AST, Urea, Creatinine, total protein and Glucose of treatment groups were similar. However, inclusion of WLM in the diet reduced total cholesterol and increased HDL cholesterol significantly. The liver & kidney showed normal histological pictures in all the groups. From the above study it was concluded that WLM is fairly rich in protein and a good source of minerals like calcium and phosphorus. Inclusion of WLM in the diet of broiler finisher reduced serum total cholesterol and increased HDL cholesterol. It may be concluded that WLM can be used as an alternate low cost protein source for broiler finisher up to 10% in the diet without adversely affecting growth, hematological, biochemical and histological parameters.

INTRODUCTION

Poultry farming is regarded as a distinguished activity contributing significantly to farmers' sustainable livelihood. It has greater potential of creating jobs and ensuring family health by supplying high quality animal protein. The economic efficiency of poultry production is dependent on how inputs and outputs are correlated. Feed inputs are usually expensive and accounts for 60-70% of the cost of production of meat and egg. Traditionally, maize and soya are the major feed ingredients used for formulating poultry ration. Limited availability and high cost of these ingredients have been a major challenge for the fast growing poultry sector in India. Therefore, exploring alternative newer feed resources have been the thrust of poultry nutrition research now. Further, backyard poultry sector, with rural farmers rearing smaller size flocks of low input birds is growing at a faster rate than the commercial/industrial poultry sector in India. In order to sustain such a production system, ensuring poultry feed at a reasonable cost has come up as a major challenge so that the rural farmers can maximize their profit as rural farmers usually have very less access to capital. So, besides conventional ingredients, by-products and different foraging plants have attracted attention.

Water leaf (*Talinum triangulare*), is a type of eatable green vegetables that fit in the family *Portulaceae*. It is a perennial herb that grows to a height of 85-100 cm long. It has fleshy leaves, moist & tender stem along with pinkish flowers. The leaves which are spoon shaped are arranged in spiral manner. It grows in almost every area and mainly developed in most of the tropical countries such as West Africa, South America & Asia where humidity is high. As it can adopt CAM pathway, it can tolerate drought conditions due to its effective utilization of available moisture and absorption of CO_2 during the night time (Fontem & Schippers, 2010).

Due to increase in demand for low cost unconventional feed ingredients as various research are being carried out to know the nutritional value of Waterleaf plant. Due to its high moisture content of around 90.8g/100g of eatable portion, this vegetable is known as waterleaf. Its crude protein is found to be comparable with that of millet, cowpea & cashew nuts. Akachuku & Fawusi (1995) found the crude protein% of leaves of waterleaf plant to be as high as 29.4%. Sridhar &

Lakshminarayana, (1993) reported that it was having higher total lipids, some essential oils and alpha & beta-tocopherols. Adequate amount of minerals like Iron, Calcium, Potassium, Magnesium and vitamin A & C are present. The plant is also known for its antioxidant properties. The plant contains phyto-chemicals like phenol, flavonoids, carotenoids which are helpful in managing cardiovascular diseases like obesity, stroke, liver disease & enhance cerebral functioning. According to previous medicine literature, the waterleaf is used to cure internal heat, polyuria, gastrointestinal disorders, measles and cancer. But due to presence of certain toxic biochemicals such as oxalic acid and tannin, its consumption is to be restricted by those people who are suffering from gout, kidney disorders and rheumatoid arthritis. The macerated leaves are also applied locally to treat wound, scabies and cuts.

But still despite the pharmacological importance of *Talinum triangulare*, there is scarcity of information about the effects of feeding and beneficial nutritional properties of the vegetable. Though some experiments have been conducted on feeding of waterleaves to poultry in different countries, the information generated are scanty and not conclusive.

Looking at the fast growth of the plant across widely variable climates and soil types, its utilization in poultry feeding could be a boon to the farmers. Therefore, this investigation has been planned with the following objective to study the performance of broilers finisher chicken fed different levels of waterleaf meal in their diet.

REVIEW OF LITERATURE

Talinum triangulare is a type of fleshy green vegetable that can be treated as a traditional medicine to cure various diseases as well as food in form of curry, soup etc. But still, there is lack of awareness regarding the effects of feeding WLM, its nutritional properties and its possible mechanism of actions through which this vegetables shows health benefits. Therefore, this study has been reviewed.

2.1 Proximate composition of Waterleaf (*Talinum triangulare)*

Sanda *et al.* (2015) conducted an experiment on waterleaf plant at the Research farm of Kogi state university, Anyigba. The fresh leaves of WL were collected and dried at a temperature of 43^0C for 2 weeks after which it was milled and then included in the layers (Lohman brown pellets) feed. According to their report, the proximate composition of dried waterleaf meal was found to be DM% - 94.56, CP% - 30.94, CF% - 5.88, EE% - 1.56, Ash% - 7.84 & NFE%- 53.78

Akachuku *et al.* (1995) conducted an experiment on nutritional importance of WL in a Semi Wild environment discovery. They found the CP% of leaves and tender stems of WL to be as high as 29.4% and 13.4% respectively.

Amusat *et al.* (2018) conducted experiment on fresh leaves of waterleaf. The results of proximate analysis indicated that the plant contained important nutrients such as crude protein (14.65%), crude fibre (7.92%), Ash (7.92%), Fat (1.98%) and Moisture (12.87%) on DM basis.

Nworgu *et al.* (2015) conducted experiment on Anak 2000 broiler chicks so as to assess the performance of broilers fed waterleaf meal as supplements for eight weeks. They reported that the proximate composition of waterleaf meal was found to have DM% - 89.40, CP% - 19.89, EE% - 3.85, CF% - 8.10,Total ash% - 10 and NFE% - 58.16.

Eleazu *et al.* (2013) conducted experiment on samples of fresh waterleaf which were brought from Abia state of Nigeria. The leaves were properly washed and then chopped into homogenous pieces. They found the proximate composition of raw waterleaf to be Moisture% - 89.82, Ash% - 1.75, CF% - 3.25, Lipid% - 1.14, CP% - 3.24 on fresh basis.

2.2 Effects of feeding waterleaf meal on body weight and weight gain

Ekine *et al.* (2020) experimented to assess performance of broiler chickens fed diverse levels of *Talinum triangulare* in diets. Around 120 broiler chickens were chosen for the study. WLM was given to the 4 weeks old broiler chicken after grouped into 4 treatments randomly. Treatment 1 (control) do not have Waterleaf supplement and Treatment 2, 3 & 4 had 100 gram, 200 gram & 300 gram of WL mixed with a measured amount of commercially available poultry feed. The findings from the study gave insights that the final weight & weekly weight gain showed a significant difference ($P<0.5$) between the treatments with the treatment 4 showing highest value.

Sanda & Oyinane (2015) carried out an experiment to know the effects of WLE on the performance of layers. This study was carried out with 5 treatments (T1, T2, T3, T4 and T5) in CRD. WLE was mixed with clean tap water in the ratio of 0:1000ml, 50:1000ml, 100:1000ml, 150:1000ml & 200:1000ml in T1, T2, T3, T4 and T5 respectively. T2 layers appeared to have a excellent weight when the weight gain and final weight were taken into account. In conclusion, 50 & 100 ml WAE gave better weight gain.

Nworgu *et al.* (2015) conducted an experiment involving Anak 2000 broiler chicks to know the performance by feeding WLM supplement. The birds were distributed into 5 treatments which were fed 0 gram, 30 gram, 60 gram, 90 gram, 120 gram WLM per Kg of the feed respectively. In place of SBM & GNC, WLM was used partially. Final live weight (FLW) & weight gain (WG) at starter phase were decreased significantly ($P<0.05$) and progressively with the increased WLM inclusion levels. The weight gain increment in the finisher stage depicted safe effects on feeding WLM at 3-12% and thus proved to be of very good feedstuff finisher stage of chicken.

Sanda (2015) experimented on broiler chicks of Isa white which are of day old age to estimate the effects of WLE on its growth parameters. The treatment groups were given 0ml (Control), 100ml, 200ml, 300ml & 400ml WLE per litre of drinking water respectively. The final weight of T5 broilers given 400ml WL extract was significantly higher ($P < 0.05$) than others. Thus, chicken fed 400 ml waterleaf extract had the highest final weight.

2.3 Effects of feeding waterleaf meal on feed intake (FI) and FCR

Nworgu *et al.* (2015) conducted an experiment involving Anak 2000 broiler chicks to evaluate the performance by feeding WLM supplement for 8 weeks. The birds were grouped into 5 treatments having 0g, 30g, 60g, 90g & 120g WLM per Kg of the feed respectively. At starter phase, it was seen that there was growth rate depression and increase in FCR. Commonly, inclusion of WLM in diets at starter stage decreased FI specially at 12% level when compared with the control. From this result we came to know that the feed were not appropriately utilized by the broiler starters which were given WLM added diets. FCR values ranged from 1.97 to 2.49 with graded application of WLM as the broilers in the control group had the best FCR (1.97) as in opposition to 2.49 in the birds fed 12% WLM.

Agboola *et al*. (2018) researched an experiment to know the reaction of broiler chickens to WLM under normal and subnormal diets. Around, 271 Arbor acres broiler chicks of age one day old were chosen. Each treatment consisted of 5 replicates with each replicate containing 6 chicks. Normal diets & subnormal diets were formulated by mixing different feed ingredients in proper amount. The test ingredients were added to the main diets @10%. All the treatments having subnormal diets were having higher FI than the treatments with normal diets.

Sanda and Oyinane (2015) experimented on layers in order to know the performance by feeding WLE. This study consisted of 5 treatments T1, T2, T3, T4 and T5. WLE mixed with drinking water in the ratio of 0:1000ml, 50:1000ml, 100:1000ml, 150:1000ml & 200:1000ml in T1, T2, T3, T4 and T5 respectively. 40 Nera black hens which are of age 24 weeks old were grouped randomly into 5 treatments of 2 replicates with 8 hens per treatment. It was seen that daily FI was significantly higher ($P<0.05$) in T2 than others, while T3 was significantly higher ($P<0.05$) than T5 but not significantly higher than T4 and the control. The FCR of T3 was significantly higher ($P<0.05$) than those of the other treatment groups including the control. Also, FCR of T2 was significantly higher ($P<0.05$) than T4 and T5 but the value is significantly lower than the control.

Sanda (2015) carried out study on broiler chicks of Isa white which are of day old age to know the effects of WLE on its performance. The treatments containing

0ml, 100ml, 200ml, 300ml & 400ml WLE per liter of drinking water was given. There was insignificant difference in the FI of T1, T2, T3 and T4, but T5 was significantly higher ($p<0.05$) than T3. It was seen that with increment in the doses of WLE, there will be decrease in FCR. Therefore, 300ml & 400ml of WLE gave the best FCR.

Ekine *et al.* (2020) experimented to know the growth of broilers fed *Talinum triangulare* at various inclusion doses. 120 broilers were chosen. WLM was supplied to the birds at 4 weeks of age. They were distributed into 4 dietary treatments randomly. Treatment 1 did not get Waterleaf. Treatment 2, 3 and 4 get 100g, 200g and 300g of Waterleaf mixed with measured amount of commercially available poultry feed. The findings from this study was that the weekly FI and feed efficiency% depicted significant difference ($P<0.5$) between the treatments, signifying higher feed utilization by Treatment 4.

2.4 Effects of feeding waterleaf meal on hematological parameters

Aronu *et al.* (2018) carried out experiment on *Talinum triangulare* extract on the hematology of Isa Brown pullets. 210 pullets of age 18 weeks old were used for this study. They were distributed into 7 treatment groups (T1, T2, T3, T4, T5, T6 & LC). Dried pulverized form of WL extract were provided at rate of 62.5, 250 & 1000 mg/L doses in the drinking water for treatment groups T1, T2 and T3, respectively, while freshly harvested WLE were administered at 62.5, 250, and 1000 mg/L doses to groups T4, T5, and T6, also in their drinking water. The layers in the LC group were control who did not receive extract. PCV, RBC count, Hb% and WBC count in all treatment groups from Month 0 to Month 8 were reduced. But, it was seen that there were insignificant variations ($P>0.05$) across the groups for all these hematological values during the study period.

Nworgu *et al.* (2015) conducted study consisting of 150 day-old Anak 2000 broiler chicks to get the data regarding hematological parameters of the broilers which are fed WLM for 8 weeks. The birds were distributed into 5 treatments having 0, 3, 6, 9 & 12% WLM. The birds were given experimental diet containing 0g, 30g, 60g, 90g, 120g WLM per Kg of the feed respectively. Each treatment was replicated thrice. The value of lymphocyte percentage in broiler fed 0 and 3 % WLM inclusion diets were significantly higher ($P<0.05$) than that of 6, 9 and 12% WLM supplementary diets.

The augmentation in WLM inclusion rates in the diets from diet 3 to diet 5 boosted Neutrophil sedimentation rate. PCV value of the control was similar to 6% and 12 % WLM inclusion level while the PCV of 3% and 9% WLM inclusion level were significantly ($P<0.5$) superior. The WBC in the control was significantly ($P<0.5$) lower than those of the entire treatments..

Agboola *et al*. (2018) did an experiment to get the performance of broilers by feeding Waterleaf under normal & subnormal diets. 270 one day old Arbor acres broiler chicks were chosen. Normal diets & subnormal diets were made and formulated with proportionate amounts of ingredients. The test ingredients were given @10% of the main diets. Those broilers fed normal diet with waterleaf in a separate manner were having highest WBC among the other treatment groups.

Ekine *et al.* (2020) did an experiment to know the performances of broiler fed different inclusions of WL in diets. 120 broilers were chosen for this study. Waterleaf was provided to the birds at 4 weeks of age. Treatment 1 group was not given Waterleaf in diet. Treatment 2, 3 and 4 were given 100g, 200g and 300g of Waterleaf mixed with measured amount of commercially available poultry feed. The Lymphocyte value showed significant difference ($P <0.5$) amongst the treatment.

2.5 Effects of feeding waterleaf meal on serum biochemical parameters

Nworgu *et al.* (2015) conducted an experiment involving Anak 2000 broiler chicks to know the performance on the broiler chicken who were fed WLM supplements in diet. The broilers were grouped into 5 treatments having 0g, 30g, 60g, 90g, 120g WLM per Kg of the feed diet respectively. Cholesterol values were reduced (102 - I05mg/dl) for the broilers given 9-12%WLM when compared to those placed on 3 and 6% WLM. The value of K^+ in serum was maximum at 12% WLM inclusion level followed by 9% while control was having the least value. Alkaline phosphate increased with the increasing levels of WLM. ASAT was least for broilers in the control and highest in the birds fed 12% WLM supplement.

Aronu *et al*. (2018) found out the effects of different doses of *Talinum triangulare* extract on the serology of Isa Brown pullets. 210 pullets were taken for the study. They were randomly grouped into 7 treatments (T1, T2, T3, T4, T5, T6 & LC). Dried pulverized form of WLE were given at dose of 62.5mg, 250mg and 1000 mg/L doses in their drinking water for the treatment groups T1, T2 & T3, respectively, while freshly harvested WLE were administered at 62.5mg, 250mg and 1000 mg/L doses to groups T4, T5, and T6, also in their drinking water. Birds in the LC group do not get extract. The control group recorded the highest levels of TChol, triglyceride & LDL concentrations. The triglyceride concentration in the serum was reduced at higher inclusion doses of dried *T. triangulare* (T3) but lower doses had little effect on triacylglycerol. On the other hand, at a low dose inclusion level of fresh *Talinum triangulare* (T4), triacylglycerol was significantly lowered, whereas at a high dose (T6) inclusion level the effect showed the opposite effects. Nevertheless, the dried-pulverised sample had an enhanced effect on HDL than that of freshly harvested, and the highest dose was significantly superior than the medium and the low doses.

Ekine *et al.* (2020) experimented to know the performance of broiler when gave various levels of *Talinum triangulare* in diets. 120 broilers were taken. At 4 weeks of age, they were distributed randomly into 4 treatment groups and then they were given WLM. Treatment 1 was the control having no Waterleaf, Treatment 2, 3 & 4 had 100 gram, 200 gram and 300 gram of Waterleaf mixed with measured amount of commercial poultry feed. The serum enzymes analysis showed that AST and ALP have significant differences ($P<0.5$) between the treatments. Also, the lipid profile in the serum highlighted a significant difference ($P<0.5$) in the HDL.

Sanda (2015) experimented on the quality & cholesterol level of eggs of laying hens by feeding WL mucilage. Five treatments (T1, T2, T3, T4 and T5) were made containing 0 ml, 50 ml, 100 ml, 150 ml and 200 ml of WLM respectively in their drinking water. It was seen that the layers on 200ml WLM (T5) had significantly lowered cholesterol level than others including the control (two times lower cholesterol level). The findings illustrated that the cholesterol level of the egg yolk decreases with increase in WL mucilage.

Igbayilola *et al.* (2017) performed the biochemical effects of WLE in female Sprague-Dawley rats. Twenty Four female Sprague-Dawley rats weighing 150-180gram were grouped into 4 treatments. Treatment A is control group birds which were administered (10ml/kg body weight) of normal saline. The other treatments were administered the aqueous leaf extract of *Talinum triangulare* thus: treatment B -

50mg/kg, treatment C - 100mg/kg, and treatment D – 150mg/kg. After fourteen (14) days, serum samples were collected for lipid profile analysis. The findings revealed significant increase in AST (aspartate amino transferase) at 150ml/kg, when it was compared with that of the control group (P>0.05). The ALT (alanine amino transferase) was significantly decreased (P>0.05) at 100ml/kg when compared with control group and treatment B with significant elevation at 150ml/kg. The ALP (alkaline phosphatase) was significantly increased in all the tested doses (P>.0.05). Outcomes from the lipid profile analysis showed significant decrease in all the doses tested (P>0.05) for Tchol, triglyceride & HDL levels except for CHOL and HDL which showed significant increase (P>0.05) at 150ml/kg. The low density lipoprotein (LDL), protein and albumin levels showed significant increase in the tested doses expect, protein and albumin which was significantly decreased (P>0.05) at 100ml/kg and 150ml/kg. Also the creatinine level was significantly decreased in all the doses tested (P>0.05). However, at 150ml/kg the aqueous leaf extract of *Talinum triangulare* gave rise to increase in liver enzymes' activity and increased low density lipoprotein.

Airaodion *et al.* (2019) did an experiment on dried Waterleaf. This was extracted using Soxhlet instrument where methanol played the role of the solvent. Twenty Wistar rats were randomly alloted into 4 groups. Animals in groups A and B were given saline while those in groups C and D were given WLE for around 21 days. The animals were given the extract & saline solution at a dose of 4ml per 100g body weight 12 hourly orally. It was seen that animals pretreated with WLE before the induction of oxidative stress by ethanol was found to be significant decline in the activities of AST, ALT, ALP & LDH.

Afolabi *et al.* (2015) experimented on the performance of WLE to find out the activities of serum biochemical enzymes such as AST, ALT, ALP & total protein of an adult albino rats. The rats were alloted into 4 treatment groups from A to D randomly; with groups B to D given 100, 200 and 400 mg/kg body weights orally respectively. Group A was given water orally. The serum total protein (g/dl) was significantly dissimilar (p < 0.05) when compared with the control. Also, there exist significant difference (p>0.05) in ALT values as observed in the groups when compared with that of control group.

2.6 Effect of feeding waterleaf meal on mortality

Nworgu *et al.* (2015) did an experiment involving Anak 2000 broiler chicks to investigate the performance on the broiler chicken that are fed WLM for 8 weeks. The broilers were distributed into 5 treatments having 0, 3, 6, 9 and 12% WLM. It was found that the mortality % in the starter phase of the subsequent treatments were 2.03, 2.07, 2.23, 1.97 & 2.28 respectively while that in the finisher phase will be 1.97, 2.08, 2.03, 2.49 & 2.15 respectively.

Sanda (2015) experimented on broiler chicks of Isa white to know the performance of WLE. The treatments had 0ml, 100ml, 200ml, 300ml & 400ml WLE per litre of drinking water respectively int CRD. There was insignificant ($p>0.5$) effects on mortality.

Ekine *et al.* (2020) experimented to find out the performance of broiler chickens that were given various doses of *Talinum triangulare*. 120 broilers were chosen for this study. T1 do not receive any Waterleaf. Treatment 2, 3 and 4 had 100 gram, 200 gram & 300 gram of Waterleaf mixed with measured amount of commercially poultry feed. They found that the mortality to be 0.33% at T1, T2 and T4 and 0 at T3.

2.7 Effects of feeding waterleaf meal on histopathology study

Ajayi *et al.* (2016) conducted an experiment on 28 male Wistar rats to investigate the function of methanolic extract of *Talinum triangulare* in healing of gastric ulcer and its mechanism of action involved. These rats have been grouped into A: Control, B: ulcerated untreated, C: ulcerated treated with omeprazole (20mg/kg b.w) and D: ulcerated treated with (METT) methanolic extract of *Talinum triangulare* (100mg/kg b.w). The ulceration in gastric mucosa was induced by injecting 0.2 millilitres of 40% ethanoic acid into the glandular part of the stomach for around 45 seconds atleast. The distilled water and extracts were given orally with an orogastric tube for 14 days and then they were sacrificed. It was found that the METT treated group showed predominantly normal gastric mucosa when compared to deep ulceration with mild inflammation seen in ulcerated untreated and Omeprazole treated animals.

Iweala & Lawal (2011) conducted experiment on hepatoxic rats to evaluate the histological effects on feeding of WL complemented diet. Around 30 female rats were divided into 6 groups for the control, the hepatotoxic & the non-hepatotoxic groups and were fed 5% or 10% WL complemented diet. It was seen that there was necrosed liver in hepato-toxic rats and restoration of liver in those group that were fed with WL complemented diet.

Ofusori *et al*. (2008) conducted experiment on cerebrum of Swiss albino mice by feeding the aqueous extract of waterleaf. 40 mice were grouped into 4 treatment groups including the control group. Group B, C and D received 20mg, 30mg & 40mg/kg level of WLE and the same amount of normal saline given to group A for 14 days. The findings were that the treated section did not show any degenerative changes and also no inter-cellular vacuolation in stroma. Also, there was dose dependent decline in Malonialdehyde activity in the treatment groups.

Adefolaju *et al*. (2008) conducted experiment by feeding the aqueous extract of Waterleaf to Wistar rats where Carbon tetrachloride was introduced to induce liver damage. 25 Wistar rats were allotted into 5 groups of 5 rats each. The 1st group was treated as control; group B rats were fed 0.5ml/kg of CCl_4, Group C, D & E given 200mg/kg, 400mg/kg & 600mg/kg of *Talinum triangulare* extract respectively & 0.5ml/kg of CCl_4 intraperitoneally once daily for seven days. It was seen that the histology of tissue depicted some progress in the condition of the degenerated liver cells in the groups treated with *Talinum triangulare* extract.

MATERIALS AND METHODS

The current study was experimented to acertain maximum level of inclusion of waterleaf meal in the diet of broilers.

3.1 Location of the trial and genetic stock

The research work was done in the Instructional Livestock Farm of the College of Veterinary Science & Animal Husbandry, OUAT, Bhubaneswar. Red Cornish chickens were used for the study. The experiment commenced on 8th February, 2020 & continued up to 21st March, 2020 covering 6 weeks period.

3.2 Collection and processing of waterleaf

Waterleaf was harvested from the farm of Poultry Science Department. Tender stems with leaves were cut at pre flowering stage. The leaves were separated from the stems and the leaves were air dried & sun dried on cemented floors for 6-8 days. The leaves were desiccated to 12% moisture content as stipulated by D′Mello (1995). The dried leaves were milled using home grinder to produce leaf meal which was stored in air tight bags for incorporation in the experimental diets. Samples of the dry ground leaves were collected for analysis of proximate composition (AOAC, 2019). Calcium value was found out according to the method modified by Talapatra *et al.* (1940) & total phosphorus content was found out as per IS: 1374-1968.

3.3 Experimental technique

One hundred straight run Red Cornish day-old chicks were procured from the hatchery of the Central Poultry Development Organization, Bhubaneswar. The chicks were raised up to 21 days on broiler starter diet (ICAR, 2013). On 21st day, chicks were weighed individually and 90 chicks were distributed in nine replicate groups of 10 chicks each so as to have similar group average body weight. Three replicate groups were randomly distributed to each of the three dietary treatments as detailed below. A finisher reference diet (RD) was prepared to contain 3050 KcalME/kg diet with 20%CP (ICAR 2013). Two test diets, TD-I and TD-II were prepared by incorporating 5% and 10% of waterleaf meal (WLM) respectively by replacing equal parts of the reference diets.

T1- Control (Reference diet 0% WL)

T2- Test diet–I (Contains 5% WL)

T3-Test diet-II (Contains 10% WL)

The reference, as well as the test diets was analyzed for proximate compositions as per AOAC (2019). Calcium value was found out according to the method modified by Talapatra *et al.* (1940) & total phosphorus content was found out as per IS: 1374-1968. The compositions of the starter and reference finisher diets (as per feeding standard ICAR- 2013) used in the experiment have been shown in Table 3.1 and proximate composition presented in Table 3.2.

Table 3.1 Gross composition (%) of experimental diets (as per ICAR 2013)

Ingredient	Starter diet	Reference Finisher diet
Maize	57.5	52
Soyabean	34.5	39
Oil	5	6
Mineral mixture	3	3
Total	100	100

Table 3.2 Proximate composition of experimental diets (% on DM basis)

Ingredients (%)	Starter Diet	Finisher Diets		
		Reference Diet	Test Diet-1	Test diet-II
Dry Matter	89.04± 01	90.53 ± 0.14	90.41±0.20	90.29±0.04
Crude Protein	21.6± 0.02	20.01±0.06	20.55±0.06	21.075±0.004
Ether Extract	3.0±0.11	3.51±0.06	3.72±0.004	4.55±0.02
Crude Fibre	5.0±0.02	3.15±0.03	4.06±0.03	5.7±0.11
NFE	64.4±0.01	57.73±0.02	56.39±0.01	55.06±0.01
Calcium	1.04±0.03	1.47±0.01	1.46±0.04	1.45±0.04
Total Phosphorus	0.45±0.04	0.48± 0.02	0.50 ± 0.01	0.49±03
Total ash	6±0.01	6.13±0.01	7.56±0.02	8.17±0.02
AIA	2.5±0.02	1.53 ±0.02	1.07±0.001	2.93±0.03

3.4 Feeding of experimental diets

During the first 3 weeks of the experimental period, the chicks were fed a common starter diet. For the next three weeks the chicks were fed experimental finisher diets. *Ad libitum* feeding was practiced. Pure & hygienic water was supplied to the birds throughout day and night. Required types and sizes of feeder and drinker were provided at different stages of growth to ensure easy access of birds to feeders and drinkers and to check wastage.

3.5 General management

3.5.1 Housing

Before beginning of the experiment, the brooder house, experimental pens & poultry equipments were thoroughly washed, cleaned, germ-free & dried. Brooding as well as rearing was done under deep litter system of management.

3.5.2 Brooder house

In the brooding area, rice husk was spread and covered with paper. Chick guards were placed around the brooding area. Brooders were fitted with electric bulbs to provide 1 foot candle light at chick level. Feeding trays and water fountains were placed in the brooding areas. The temperature on the brooding floor, at the edge of the heat source was maintained at 32 to 35°C (90-95°F) for the three weeks of brooding period. During brooding, chicks were provided floor space @0.5sq ft / chick. The chicks were given 23 hours of lighting & a dark period of 1 hour per day during brooding.

3.5.3 Rearing house

On 21st day, the chicks were distributed in to nine replicate groups and were transferred to separate experimental pens and maintained under deep litter system of management. Chicks were provided a minimum floor space @2sq ft/ chick from 3-6 weeks. The chicks were given 23 hours of lighting & a dark period of 1 hour per day up to 6 weeks.

3.5.4 Collection and processing of waterleaf

Waterleaf was harvested from the farm of Poultry Science department and around the O.U.A.T campus. The leaves were separated from the stems and were air & sun dried on cemented floors for 6-8 days. The leaves were desiccated to 12% moisture content as stipulated by D′Mello (1995). The dried leaves were pulverized using home grinder to produce leaf meal which was then included into the diet.

3.5.5 Medication and vaccination

Routine medication and vaccination procedures were carried out as per standard operating procedures. The vaccination schedule followed has been presented in Table 3.3.

Table 3.3 Vaccination schedule followed for the experimental chicks

Age	Vaccine	Route of administration	Dose
7th day	RD (F1 strain) vaccine	I/O or I/N	One drop
14th day	IBD (Intermediate strain) vaccine	I/O	One drop
28th day	RD (Lasota strain) vaccine	I/O or I/N	One drop
35th day	IBD (Intermediate strain) vaccine	I/O	One drop

3.6 Proximate Analysis

The experimental diets as well as water leaf samples were analysed for the proximate composition as per (AOAC, 2019) on Dry Matter basis. Calcium value was found out according to the method modified by Talapatra *et al.* (1940) & total phosphorus content was found out as per IS: 1374-1968.

3.7 Data collection

Data on the body weight, FI & mortality etc. were collected during the experimental period. A brief description of the methods followed is given below.

3.7.1 Recording of body weight

Body weights of broilers were measured individually at the starting of the experiment (3rd week of age) & at weekly interval up to 6th week of age. A digital electronic balance was used to record body weight nearest to 1.0 g accuracy. The body weights were taken at a particular time during morning hours before feeding. From individual body weights, the group mean body weights were calculated.

3.7.2 Calculation of body weight gain

Body weight gain at weekly interval was measured by subtracting the body weight of previous week from that of current week body weight. Similarly, weekly cumulative body weight gain was measured by subtracting the 3rd week body weight from that of respective week body weight.

3.7.3 Recording of feed and nutrient consumption

The feed consumption of the experimental birds was recorded by subtracting the left over feed from the total feed offered during that week. Cumulative feed consumption was calculated by adding the feed consumption from 3rd week upto the desired week. Similarly, the weekly & cumulative nutrient utilization such as CP and ME were calculated from the feed consumption and the proximate composition.

3.7.4 Efficiency of feed and nutrient utilization

From the weekly body weight & feed consumed, weekly and cumulative FCR were measured using the following formula.

$$\text{Weekly Feed Conversion Ratio} = \frac{\text{Weekly feed consumption (kg)}}{\text{Weekly body weight gain (kg)}}$$

$$\text{Cumulative Feed Conversion Ratio} = \frac{\text{Cumulative feed consumption (kg)}}{\text{Cumulative body weight gain (kg)}}$$

3.8 Mortality

Daily mortality of the bird was recorded. The mortality of all the birds in different replicates was added and expressed treatment wise on weekly basis.

3.9 Blood collection

Blood collection for estimation of hematological and serum biochemical parameters was undertaken at the end of sixth week. Blood collection was carried out very early in the morning. Three broilers from each treatment groups (1 broiler from each replicate) were selected randomly for blood collection. Area near wingvein was cleaned with rectified spirit. Blood was collected from the birds by puncturing the wing vein with a sterilized syringe. Blood of around 5ml amount was collected per bird out of which 2 ml and 3 ml were separately transferred immediately into EDTA and plain blood collection vials respectively for hematological and serum biochemical tests respectively. All hematological tests were performed within 48 hours of blood collection whereas plain vials containing blood were kept overnight to facilitate serum separation. Then they were centrifuged to obtain uniformly clear serum. Biochemical assays were performed using the standard recommended procedures.

3.10 Haematological investigations

3.10.1 Haemoglobin estimation

It was carried out by following Sahli hemoglobinometer method.

3.10.2 Total Erythrocyte Count (TEC) and Total Leucocyte Count (TLC)

TEC and TLC both were measured using Neubauer's Haemocytometer instrument.

3.11 Serum Biochemical Assays:

Serum biochemical parameters were estimated by using the kit prepared by TRANSASIA BIO- MEDICALS LTD., using Erba Semi Automatic biochemistry analyser.

3.12 Histological study

Representative portions of liver and kidney of 6^{th} week broiler birds were collected in 10% formal saline solution. The formalin fixed tissues were processed by routine histological techniques. The tissues after fixation were washed in running tap water over night and then dehydrated in increasing grades of alcohol and cleaned in xylene. Paraffin blocks were prepared as per the routine procedure and sections were cut at around five micron thickness and then stained by routine haematoxylin and eosin method (H&E). The slides after staining were observed under the instrument named LeicaDM500 light microscope. Then the representative photographs were taken and used for histological interpretation.

3.13 Economics

For calculation of economics, the actual market prices of feed ingredients were taken in to considerations. The cost of waterleaf meal was calculated at Rs. 2.00 per kg which includes the cost of processing. The body weight gain during the period from 3^{rd} to 6^{th} week was taken into consideration. The sale price of broiler on live weight basis was as per the prevailing market price.

3.14 Data analysis

Data obtained from the study were analysed under one way analysis of variance (ANOVA) statistically, using SPSS version. Variant means were separated using the least significant difference method. Significance was accepted at $P<0.05$.

Fig. 3.1: Waterleaf plant **Fig. 3.2: Collection of waterleaf**

Fig. 3.3: Dried Waterleaf **Fig. 3.4: Destalking of leaves**

Fig. 3.5: Packaged Waterleaf **Fig. 3.6: Brooding of chicks**

Fig. 3.7: Treatment groups **Fig. 3.8: Vaccination through drinking water**

Fig. 3.9: Weighing of chicks **Fig. 3.10: Blood collection from wing vein**

Fig. 3.11: Organs and tissue collection **Fig. 3.12: Histopathology study**

Fig. 3.13: Serum biochemical estimation **Fig. 3.14: Total ash estimation**

Fig. 3.15: Grinding of feed **Fig. 3.16: Mixing of feed ingredients**

RESULTS

The present investigation was undertaken to study the effects of feeding waterleaf meal (*Talinum triangulare*) on the performance of Red Cornish finisher chicken from 3rd to 6th week of age. The results obtained from this experiment are detailed in this section underneath.

4.1 Proximate and mineral composition of Waterleaf (*Talinum triangulare*)

The percentage of dry matter of fresh leaves was found to be 8.90%. The Crude protein, Crude fiber, Ash, Ether extract, Nitrogen free extract were found to be 28%, 13.7%, 14.24%, 1.22% and 31.02% respectively. The Calcium and Total Phosphorus were found to be 110 and 75mg/100g respectively (Table 4.1).

Table 4.1 Proximate and mineral composition of Waterleaf (on DM basis)

Determined Analysis	Percentage
Dry Matter	8.90
Crude protein	28
Crude fiber	13.7
Ether extract	1.22
Nitrogen free extract	31.02
Total ash	14.24
Calcium	1.10
Total Phosphorus	0.75

4.2 Body weight

The mean weekly body weights of the experimental chicks from 3rd to 6th week of age have been presented in Table 4.2 and depicted in Fig 4.1. The chicken of T1 (Control), T2 (5%WLM) and T3 (10%WLM) groups grew from their initial 3rd week body weight of (464.5±16.53g), (471±12.95g) and (478.75±19.89g) to (897.08±42.65g), (937.4±27.04g) and (927.43±40.14g) in 6th week respectively. There were no significant differences ($p>0.05$) in body weights among treatment groups at any age for which data were recorded.

Table 4.2 Average weekly body weight of birds fed different levels of waterleaf meal

Dietary treatment	Average weekly body weight (g)			
	3rd week	4th week	5th week	6th week
T1 (0%WLM)	464.5±16.53	602.92±22.91	734.08±31.66	897.08±42.65
T2 (5%WLM)	471±12.95	607.6±16.69	743.43±20.34	937.4±27.04
T3 (10%WLM)	478.75±19.89	588.71±23.48	746.07±3.741	927.43±40.14
P value	0.834	0.796	0.939	0.731

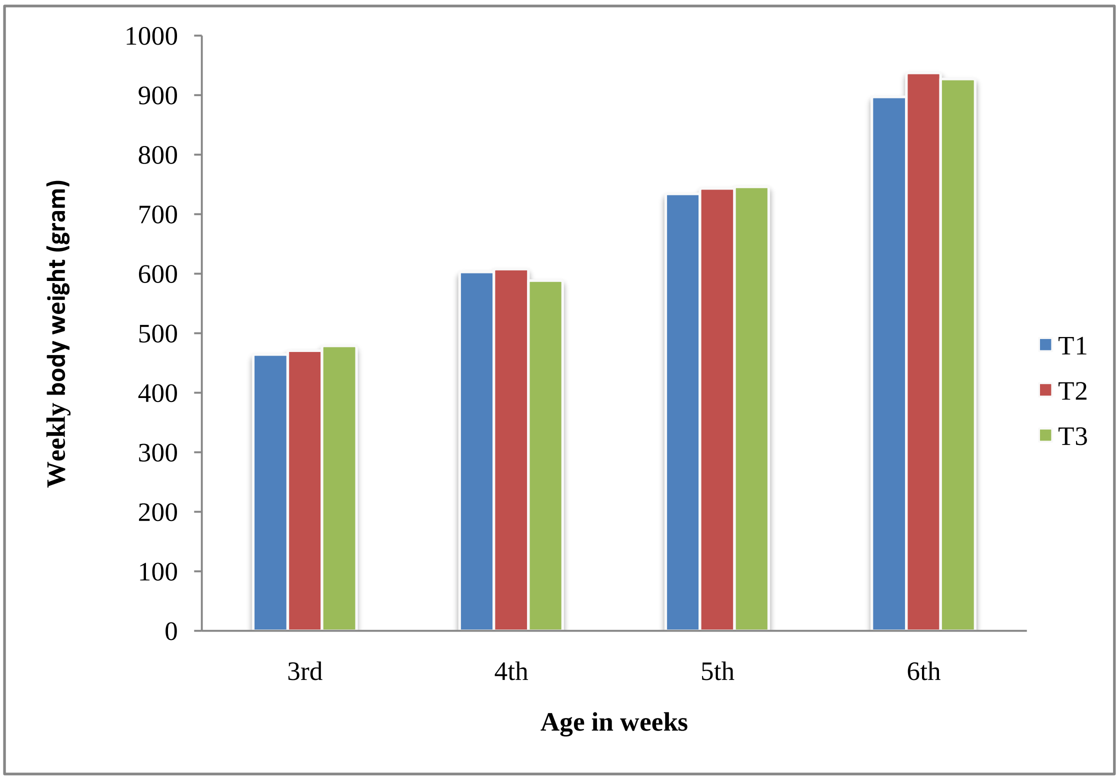

Fig 4.1 Weekly body weight (g) of chicken

4.3 Body weight gain

The mean weekly body weight gain of the chicken are shown in Table 4.3 and presented in Fig 4.2. The weight gain increased progressively from 21 days till the end of the 6th week. In the control group T1 and treatment groups T2 and T3, the highest body weight gain (181.35±11.43g), (191±8.29g) and (163±12.52g) were recorded in the 6th week respectively. It was found that the body weight gain between control and the treatment groups were found to be insignificant ($p > 0.05$) at all the ages.

4.4 Cumulative body weight gain

The cumulative body weight gain of the chicken are presented in Table 4.4 and depicted in Fig 4.3. The 6th week cumulative body weight gain of T1, T2 and T3 groups were (462.92±25.94g), (466.4±17.98g) and (418.33±25.40g) respectively. At all ages, the cumulative body weight gain between treatment groups did not differ significantly (p>0.05).

Table 4.3 Average weekly body weight gain of birds fed different levels of waterleaf meal

Dietary treatment	Average weekly body weight gain (g)		
	4 week	**5 week**	**6 week**
T1 (0%WLM)	124.21±8.60	157.36±8.15	181.35±11.43
T2 (5%WLM)	136.6±5.73	138.8±5.78	191±8.29
T3 (10%WLM)	124.1667±7.07	131.16±10.46048	163±12.52
P value	0.366	0.075	0.194

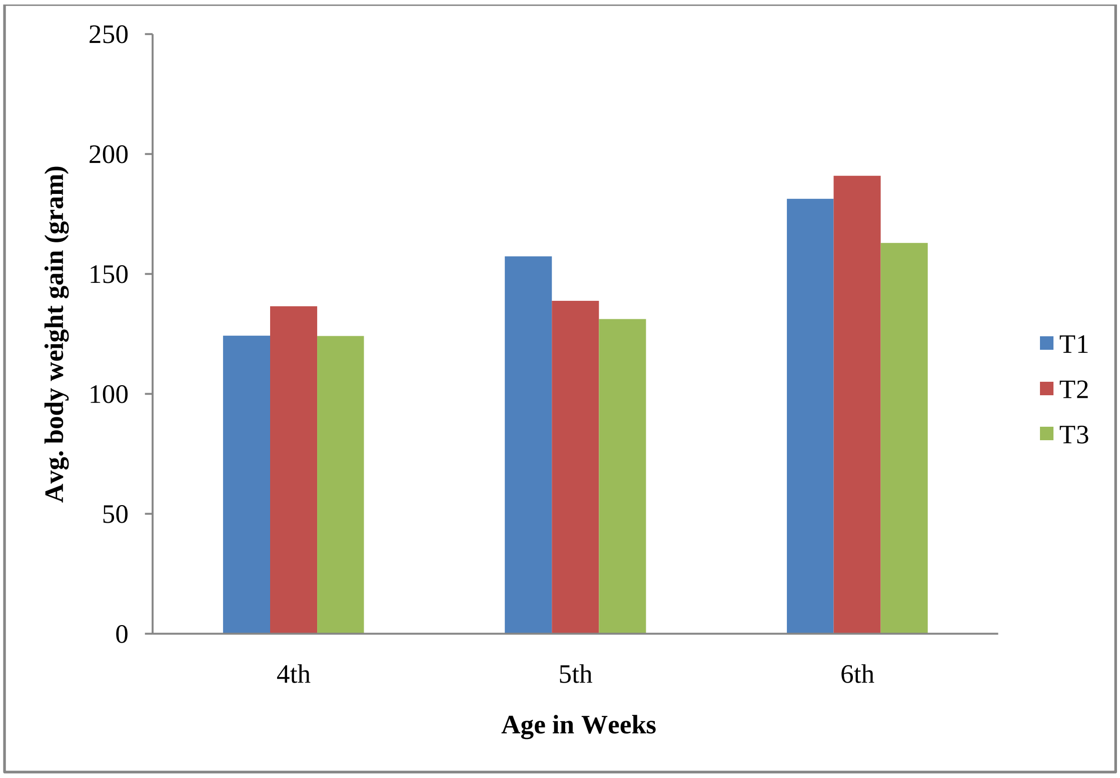

Fig 4.2 Body weight gain (g) of chicken

Table 4.4 Average cumulative body weight gain of birds fed different levels of waterleaf meal

Dietary treatment	Average cumulative body weight gain (g)		
	4 week	**5 week**	**6 week**
T1 (0%WLM)	124.21±8.60	281.57±15.26	462.92±25.94
T2 (5%WLM)	136.6±5.73	275.4±10.20	466.4±17.98
T3 (10%WLM)	124.1667±7.07	255.33±14.77	418.33±25.40
P value	0.366	0.386	0.386

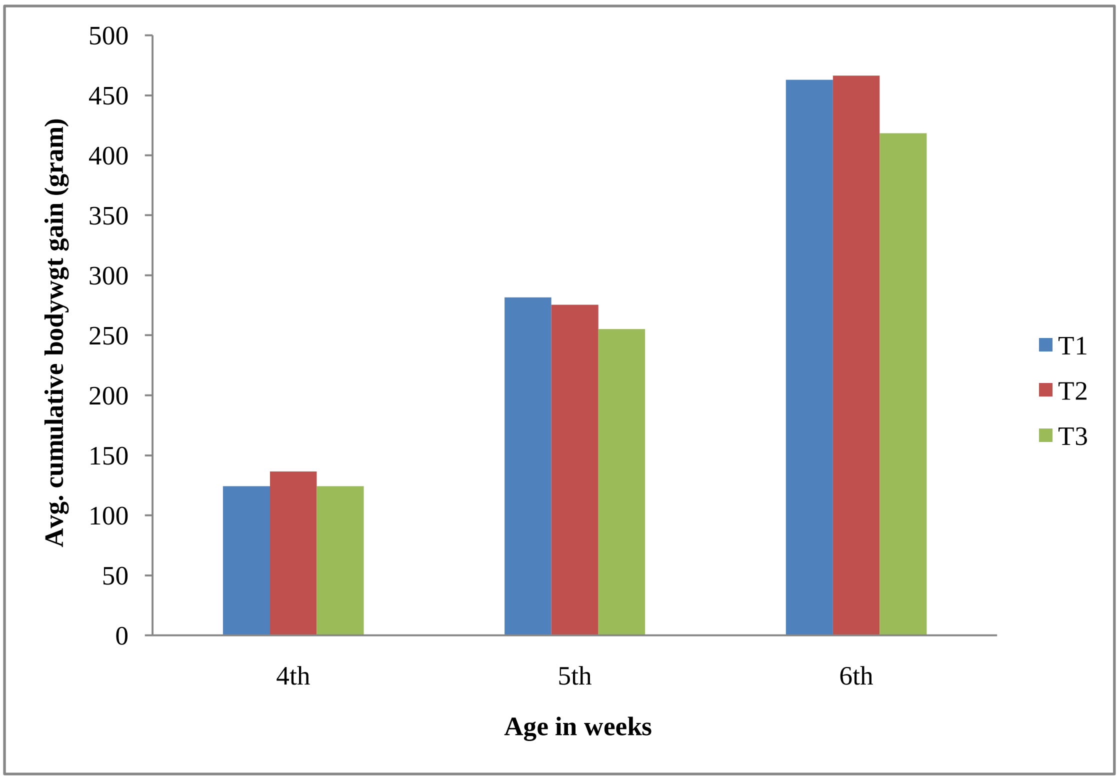

Fig 4.3 Cumulative body weight gain (g)

4.5 Feed intake

The average weekly feed intake and average weekly cumulative feed intake for the chicken in the three treatments are presented in Table 4.5 and Table 4.6 and depicted in Fig 4.4 and Fig 4.5 respectively. The feed intake increased progressively in successive weeks from 4th to 6th week. The chicken in the T3 group showed highest intake in every week followed by T2 group and T1 (control) groups at all ages. The differences in feed intake among treatment groups were found to be highly significant ($p<0.01$) at 4th, 5th, 6th week.

The average 6th week cumulative feed intake of T1, T2 and T3 groups were (1847.10g), (1716.45g) and (2096.00g) respectively. The average 6th week cumulative feed intake of T3 group was highest which was significantly ($p<0.01$) higher than the T1 and T2 groups. Similarly, the average 6th week cumulative feed intake of T2 group was significantly ($p<0.01$) higher than T1 group.

Table 4.5 Average weekly feed intake (g) of birds fed different levels of waterleaf meal

Dietary treatment	Average weekly feed intake (g)		
	4 week	**5 week**	**6 week**
T1 (0%WLM)	$552.36^{b}\pm0.09$	$573.92^{b}\pm2.98$	$723.78^{b}\pm0.11$
T2 (5%WLM)	$452.05^{a}\pm0.24$	$551.60^{a}\pm0.17$	$712.80^{a}\pm0.09$
T3 (10%WLM)	$622.92^{c}\pm0.04$	$696.84^{c}\pm0.08$	$776.25^{c}\pm0.07$
P value	0.000**	0.000**	0.000**

** Mean with different superscripts differ significantly ($p<0.01$)

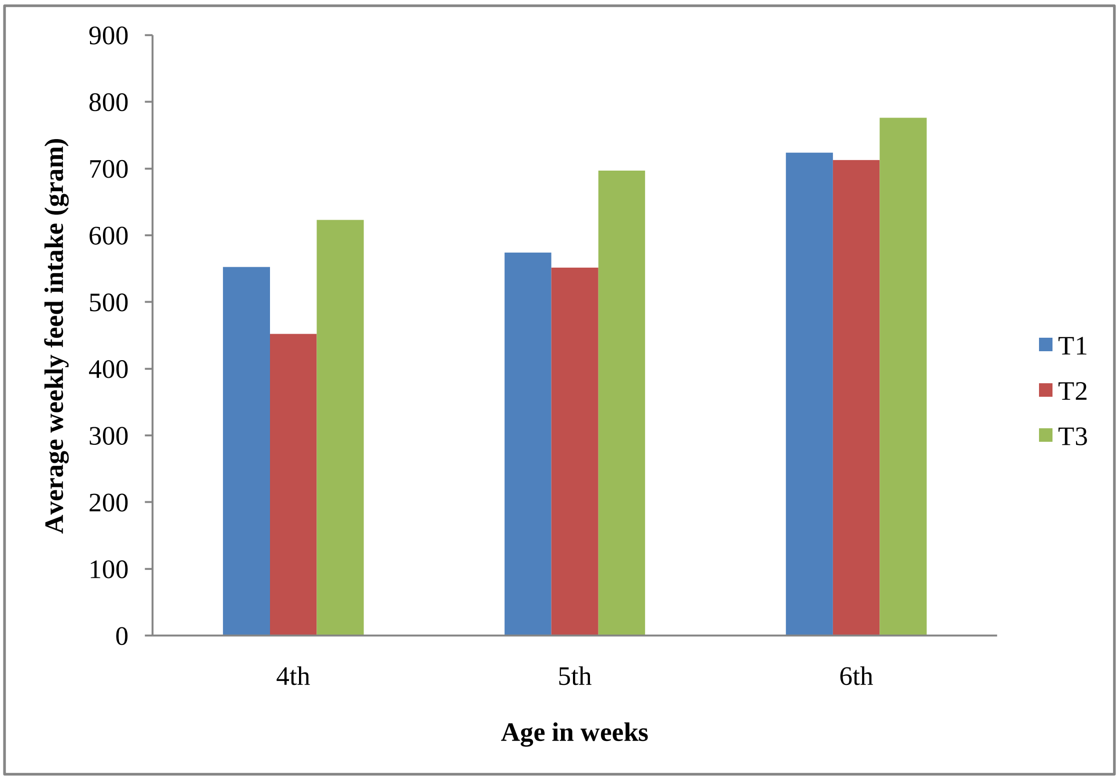

Fig 4.4 Average weekly feed intake (g) of chicken

Table 4.6 Average cumulative weekly feed intake (g) of birds fed different levels of waterleaf meal

Dietary treatment	Average cumulative weekly feed intake (g)		
	4 week	5 week	6 week
T1 (0%WLM)	552.36^{b}±0.03	1123.28^{b}±0.16	1847.10^{b}±0.19
T2 (5%WLM)	452.00^{a}±2.31	1003.61^{a}±0.22	1716.45^{a}±0.29
T3 (10%WLM)	622.92^{c}±0.04	1319.74^{c}±0.14	2096.00^{c}±0.29
P value	0.000**	0.000**	0.000**

** Mean with different superscripts differ significantly (p<0.01)

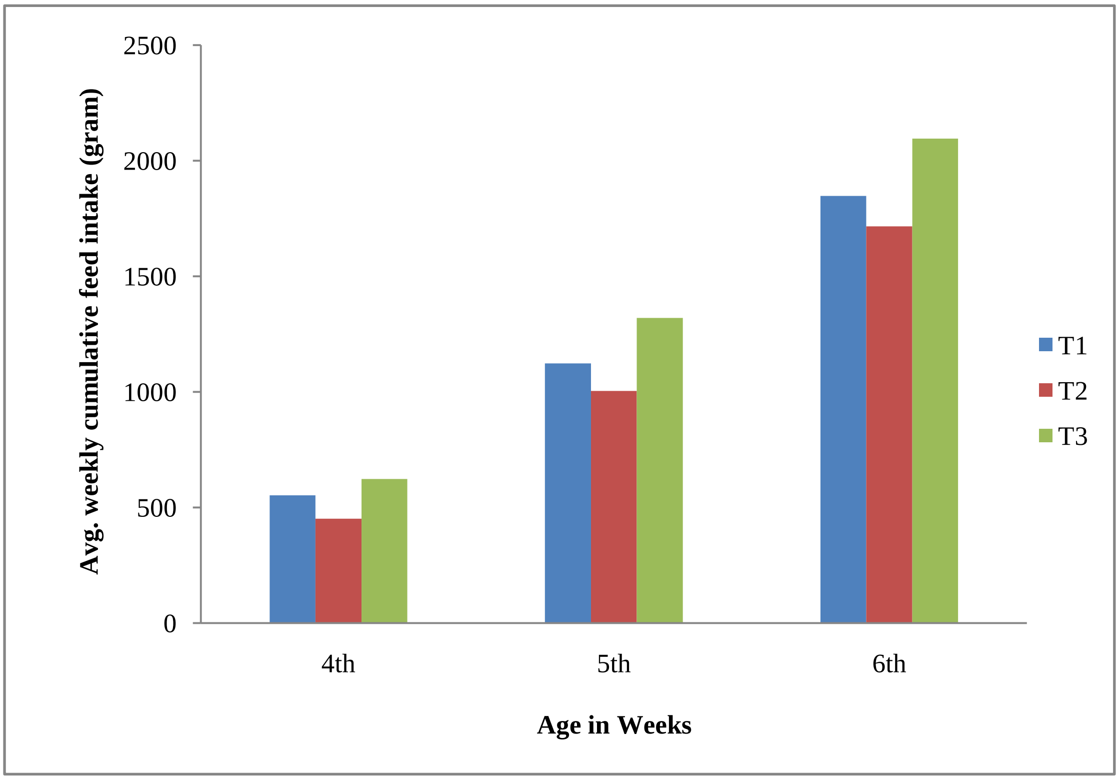

Fig 4.5 Average weekly cumulative feed intake (g) of chicken

4.6 Feed conversion ratio

The mean weekly FCRs for the chicken in the three treatment groups including the control group are presented in Table 4.7 and depicted in Fig 4.6

For the chicken in the control group (T1), the FCR were (4.453±0.08), (3.663±0.136) and (4.449±0.075) at 4th, 5th and 6th weeks respectively. Similarly, the FCR for T2 which were fed 5% WLM, FCR were found to be (3.303±0.025), (3.974±0.007) and (3.732±0.015) respectively and that of T3 which are fed with 10%

WLM, the FCR were (5.009±0.028), (5.319±0.096), (4.767±0.0702) at 4th, 5th and 6th weeks respectively. The chicken in the T3 group showed highest FCR which was significantly ($p<0.01$) higher at all ages than the other two groups. The 4th and 6th week FCR of T1 group was significantly ($p<0.01$) higher than T2 group but the 5th week FCR of T1 and T2 groups were similar ($p>0.05$).

Table 4.7 Average weekly FCR of birds fed different levels of waterleaf meal

Dietary treatment	Average weekly FCR		
	4 week	**5 week**	**6 week**
T1 (0%WLM)	4.453^{b}±0.08	3.663^{a}±0.136	4.449^{b}±0.075
T2 (5%WLM)	3.303^{a}±0.025	3.974^{a}±0.007	3.732^{a}±0.015
T3 (10%WLM)	5.009^{c}±0.028	5.319^{c}±0.096	4.767^{c}±0.0702
P value	0.000**	0.000**	0.000**

** Mean with different superscripts differ significantly ($p<0.01$)

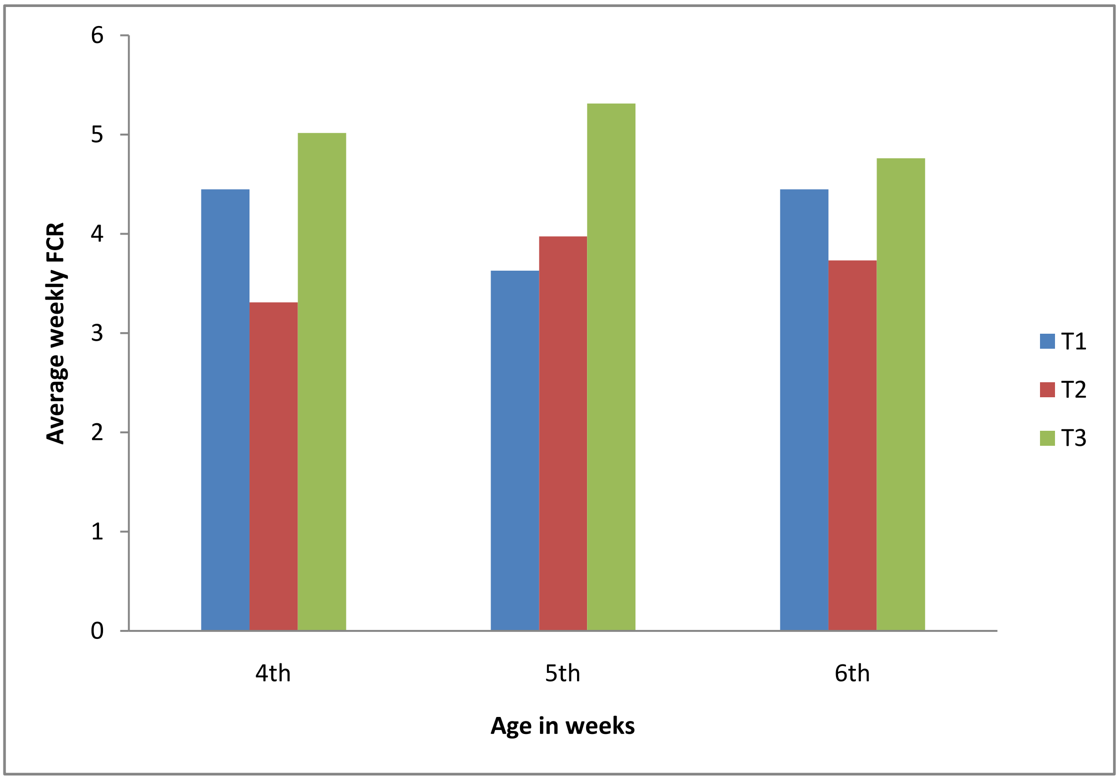

Fig 4.6 Average weekly feed conversion ratio

4.7 Cumulative feed conversion ratio

The weekly cumulative feed conversion ratio for the chicken in the three treatment groups are presented in Table 4.8 and depicted in Fig 4.7.

The 6th week cumulative FCRs of T1, T2 and T3 treatment groups were 3.99, 3.68 and 5.02 respectively. The 6th week cumulative FCR of T3 was significantly ($p<0.01$) higher than T1 and T2 groups. The 6th week cumulative FCR of T2 group was the lowest and significantly ($p<0.01$) lower than T1 group.

Table 4.8 Average cumulative FCR of birds fed different levels of waterleaf meal

Dietary treatment	Average cumulative FCR		
	4 week	**5 week**	**6 week**
T1 (0%WLM)	$4.447^{b}\pm0.004$	$3.997^{b}\pm0.002$	$3.988^{b}\pm0.007$
T2 (5%WLM)	$3.309^{a}\pm0.006$	$3.645^{a}\pm0.003$	$3.677^{a}\pm0.049$
T3 (10%WLM)	$5.017^{c}\pm0.004$	$5.169^{c}\pm0.006$	$5.02^{c}\pm0.038$
P value	0.000**	0.000**	0.000**

** Mean with different superscripts differ significantly ($p<0.01$)

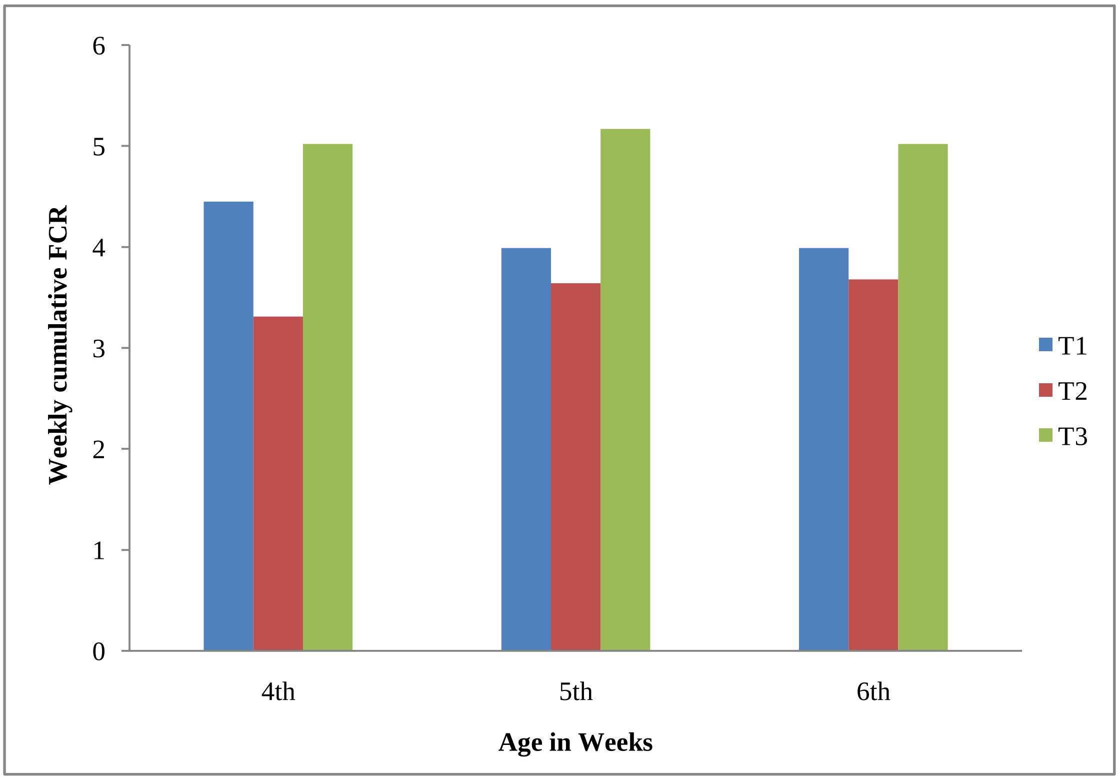

Fig 4.7 Weekly cumulative FCR of broiler chicken

4.8 Mortality

The weekly wise incidences of mortality recorded, for the chicken from 3rd to 6th week of age was nil.

4.9 Effects on hematological parameters

The mean Hb(g/dl), Heterophile(%), Eosinophils(%), Monocyte(%), Basophils(%) and Lymphocyte(%) of the experimental chicken at the end of 6^{th} week have been presented in Table 4.9 and Fig 4.8. The Hb, Heterophile, Eosinophils, Monocyte, Basophils and Lymphocyte count did not differ significantly (p>0.05) between treatment groups

Table 4.9 Mean value for hematological parameters (mean ± SE) of different treatment groups

Parameters	Dietary treatments			P value
	T1(0%WLM)	T2(5% WLM)	T3(10% WLM)	
Hb (g/dl)	7.80±0.12	8.2±1.51	7.64±0.6	0.90
Heterophile (%)	32.33±2.33	28.33±2.33	30±3	0.57
Eosinophil (%)	1.67±0.33	1.67±0.33	2±0.58	0.82
Monocyte (%)	2.00±0.58	1.33±0.33	1.33±0.33	0.49
Lymphocyte (%)	63.33±2.60	68.67±2.60	66.67±2.40	0.38
Basophil (%)	0	0	0	0

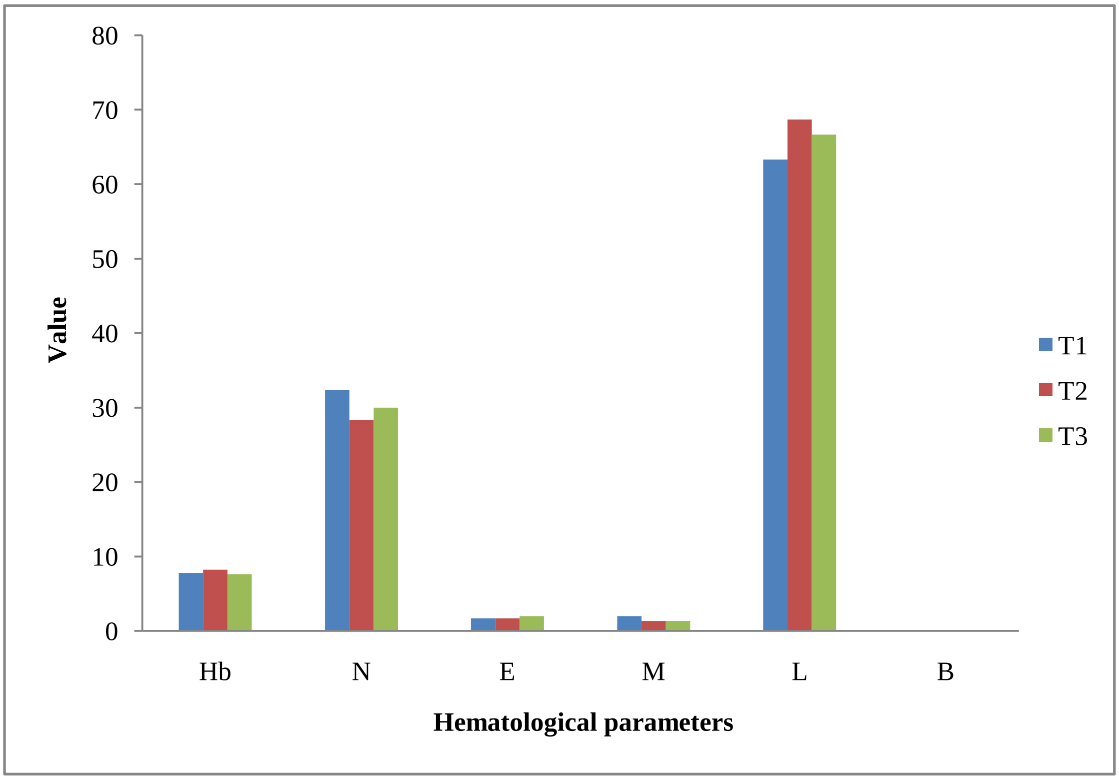

Fig 4.8 Hematological parameters

4.10 Effects on biochemical parameter

Mean of serum biochemical parameters of experimental chicks at 6th week of age have been presented in Table 4.10. The serum AST, total protein, urea, creatinine and glucose values of the treatment groups did not differ significantly ($p>0.05$).

Serum ALT value for T1, T2 and T3 treatment groups has been presented in the Figure 4.9 and the values were (6.95±0.25), (7.60±1.54) & (11.06±0.60) IU/L respectively. The ALT values for T1 and T2 groups were similar ($p>0.05$) and significantly ($p<0.05$) lower than T3 group.

Serum triglyceride values in T1, T2 & T3 treatment groups has been presented in the Figure 4.10 and the values were (94.67±1.70), (113.44±9.47) & (72.32±8.62) mg/dl respectively. The serum triglyceride values of T1 and T2 were similar and those of T1 and T3 were also similar ($p>0.05$). The value of T3 is significantly ($p<0.05$) lower than that of T2 group.

Serum HDL value for T1, T2 and T3 treatment groups has been presented in the Figure 4.11 and the values were (15.45±1.36), (54.36±7.02) & (48.76±4.33) mg/dl respectively. It was found that HDL values of T2 and T3 groups were similar ($p>0.05$) but significantly ($p<0.05$) higher than T1 group.

Total cholesterol value in T1, T2 and T3 treatment groups has been presented in the Figure 4.12 and the values were (239±8.96), (151.84±11.03) and (173.23±24.77) mg/dl respectively. It was seen that T2 and T3 groups had similar but significantly ($p<0.05$) lower total cholesterol values than the T1 (control) group.

Table 4.10 Mean serum biochemical parameters (mean ± SE) of different treatment groups at 6 weeks of age

Parameters	Dietary treatments			P value
	T1(0%WLM)	T2(5% WLM)	T3(10% WLM)	
ALT(IU/l)	6.95^{a}±0.25	7.60^{a}±1.54	11.06^{b}±0.60	0.05
AST(IU/l)	151.23±15.88	151.1±17.35	157.02±16.96	0.48
Total protein(g/dl)	3.05±0.29	4.17±0.75	2.92±0.09	0.19
Urea(mg/dl)	4.65±0.05	5.05±0.47	6.98±1.09	0.06
Creatine(mg/dl)	0.35±0.05	0.31±0.01	0.33±0.03	0.70
Glucose(mg/dl)	217.1±23.98	257.3±13.61	211.38±46.72	0.56
Triglyceride (mg/dl)	94.67^{ab}±1.70	113.44^{b}±9.47	72.32^{a}±8.62	0.02
HDL(mg/dl)	15.45^{a}±1.36	54.36^{b}±7.02	48.76^{b}±4.33	0.002
Total cholesterol(mg/dl)	239.5^{b}±8.96	151.84^{a}±11.03	173.23^{a}±24.77	0.02

Mean with different superscripts differ significantly ($p<0.05$)

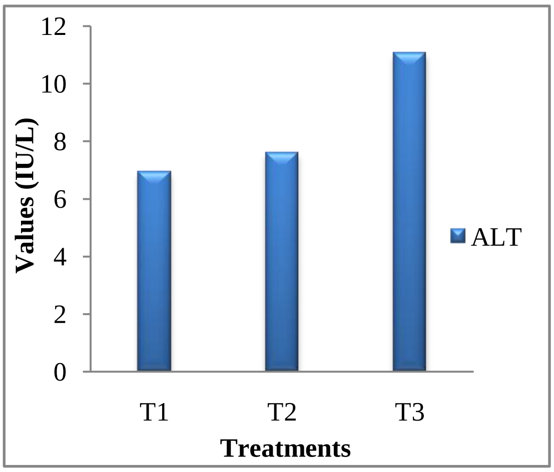

Fig 4.9 ALT concentration (IU/L)

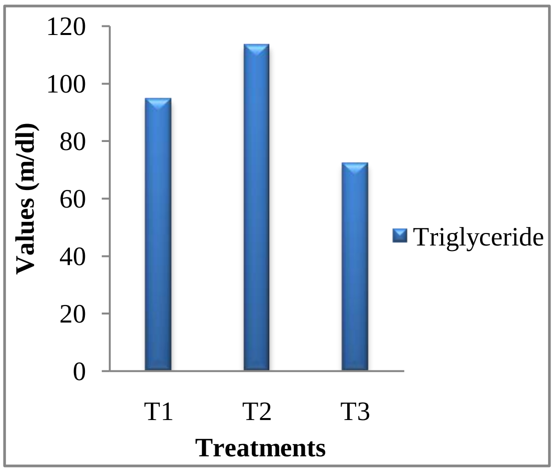

Fig 4.10 Triglyceride concentration (mg/dl)

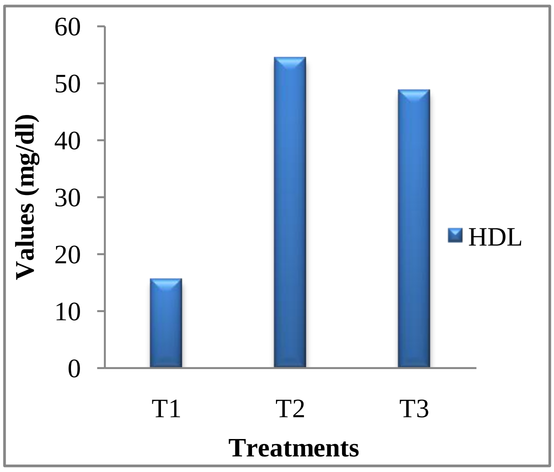

Fig 4.11 HDL concentration (mg/dl)

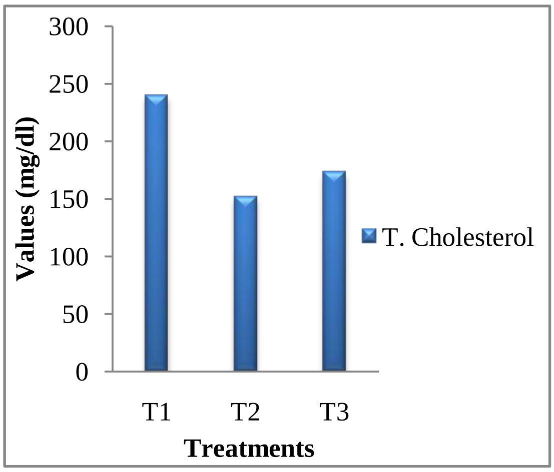

Fig 4.12 Total Cholesterol concentration (mg/dl)

4.11 Effects on histology of Liver & Kidney

In group T1, liver showed mild congestion with intact hepatocytes (Fig 4.13) and kidney showed mild intertubular congestion with intact tubular lining epithelial cells (Fig 4.14).

In group T2, liver showed mild congestion and mild hepatocellular cell swelling (Fig 4.15) and kidney revealed mild intertubular congestion and cell swelling of lining tubular epithelial cells (Fig 4.16).

In group T3, liver showed mild congestion and mild cell swelling of hepatocytes (Fig 4.17) and in kidney, there was mild cell swelling of tubular lining epithelial cells (Fig 4.18).

Photomicrography of the histology of Liver and Kidney of experimental chicken (H&EX400)

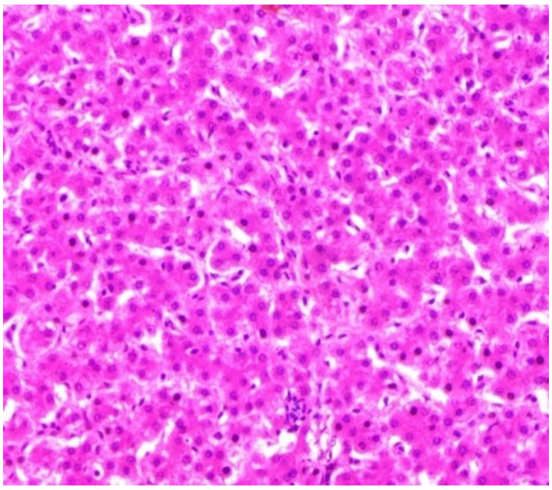

Fig 4.13 Liver: Mild congestion with intact hepatocytes

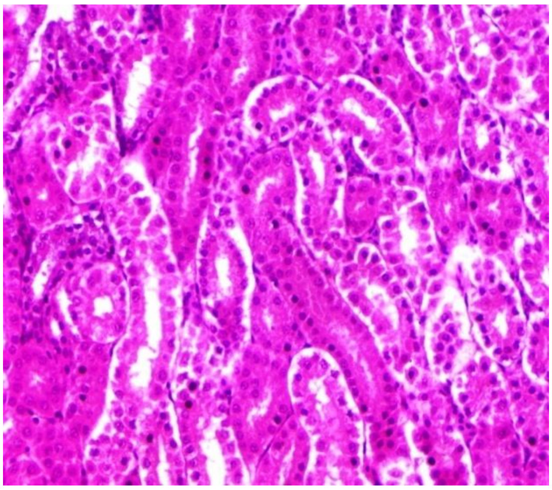

Fig 4.14 Kidney: Mild intertubular congestion with intact tubular lining epithelial cells

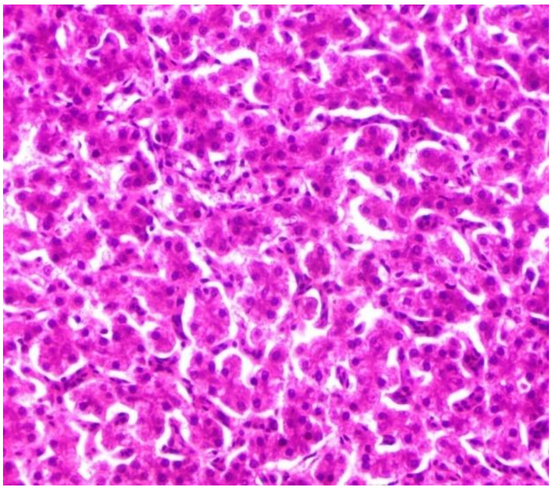

Fig 4.15 Liver: Mild congestion and mild hepatocellular cell swelling

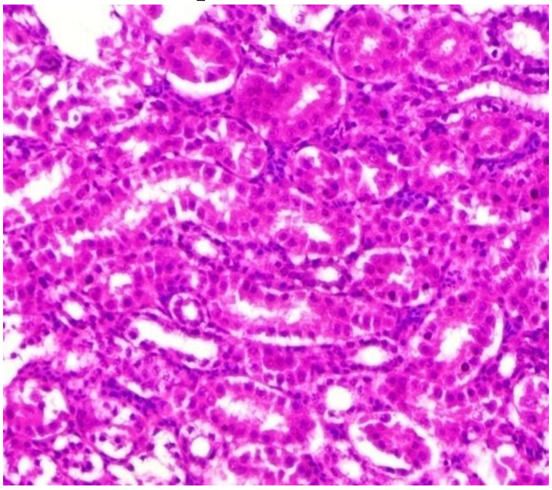

Fig 4.16 Kidney: Mild intertubular congestion and cell swelling of lining tubular epithelial cells

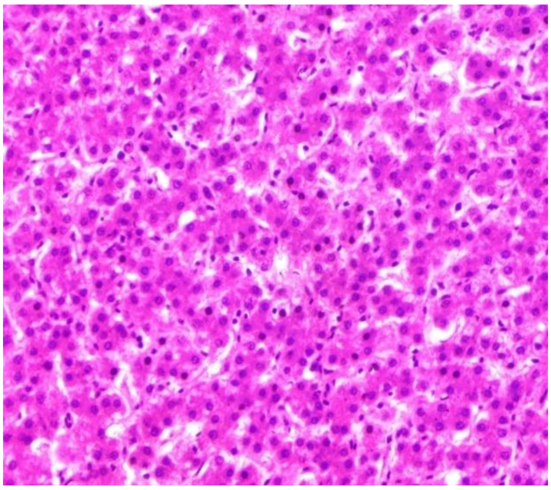

Fig 4.17 Liver: Mild congestion and mild cell swelling of hepatocytes

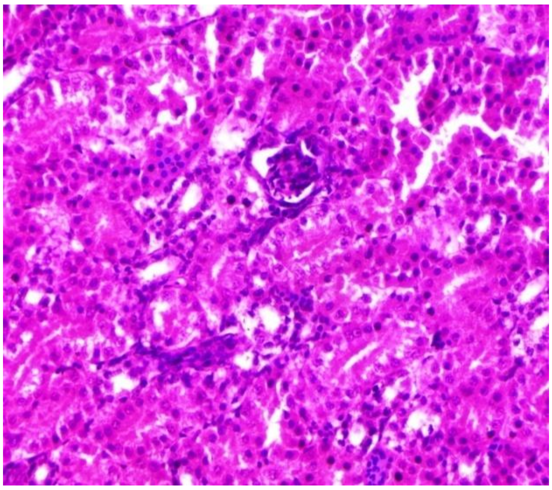

Fig 4.18 Kidney: Mild cell swelling of tubular lining epithelial cells

4.12 Effects on economics of raising broiler finisher (3-6 weeks)

The economics of raising broiler finishers fed different levels of WLM has been presented in Table 4.11. The feed cost for T1, T2 and T3 were Rs. 28, Rs. 27.7 and Rs. 27.4 per Kg respectively. Similarly, the feed consumptions per bird during the period of 3rd to 6th week were 1.85, 1.72 & 2.1 kg respectively. The profit over feed cost were Rs. 8.38, Rs. 12.99 and -Rs. 3.16 per bird respectively. Highest profit over feed cost was found in T2 group followed by T1 (control group) and T3 group.

Table 4.11 Economics of raising broiler finisher (3-6 weeks) fed different levels of WLM

Parameters	T1	T2	T3
Feed cost (Rs./Kg)	28	27.7	27.4
Feed consumed (Kg/bird)	1.85	1.72	2.1
Cost of feed consumed (Rs./bird)	51.8	47.64	57.64
Income from sale of bird			
Mean live wt gain/bird (Kg) from 3rd to 6th week	462.92	466.4	418.33
Sale price/bird (@ Rs. 130/Kg live weight)	60.18	60.63	54.38
Profit over feed cost (Rs./bird)	8.38	12.99	-3.16

DISCUSSION

The current investigation was carried out to study the effects of feeding of waterleaf (*Talinum triangulare)* on the growth parameters of broiler chicken. The results obtained from the investigation have been discussed and interpreted with reference to previously reported results on similar studies in this chapter.

5.1 Proximate composition of waterleaf

The result of the proximate composition of Water leaf meal (WLM) on dry matter basis has been presented in Table 4.1.

The dry matter content of fresh waterleaf in this study was found to be 8.90%. However, Eleazu and Eleazu, 2013 (10.18%) reported little bit more moisture percentage level. High moisture content of leaves increases the palatability. This high moisture level in the vegetable may be the reason why this is often sun dried for few hours before use. The moisture content of plants is affected by several factors such as stage of harvest and season.

It revealed that water leaf is rich in crude protein (28%). The CP% of the waterleaf finding in this study was nearer to the value reported by Ogungbenle *et al*., 2018 (28.22%) & Sanda *et al*., 2015 (30.94%). However, this value obtained is higher than the values reported by Amusat *et al*., 2018 (14.65%), Nworgu *et al*., 2015 (19.89%), Ezekwe *et al.*, 2002 (21.9%) and Agboola *et al.*, 2018 (21.53%). The CP% of water leaf as found in the present study (28%) is well comparable with leguminous fodders like Cowpea, Peanut, Millet & Cashew nuts (Ofusor *et al*., 2008). Therefore, it could be a cheaper source of protein substituting other traditional high cost protein sources.

The finding for CF% of waterleaf in the present study (13.7%) was in agreement with the values reported by Ogungbenle *et al*., 2018 (11.45%), Leung *et al*., 1968 (10.77%) and Agboola *et al.*, 2018 (10.51%). But the other researchers like Sanda *et al*., 2015 (5.88%) and Ezekwe *et al.*, 2002 (1.5%).reported lower values for crude fibre of waterleaf. The difference can be linked to the soil nutrients available for the formation of fiber in leaves (Bruinenberg *et al*., 2001) and stage of growth of the plant. The ether extract content of waterleaf in this study (1.22%) was closer to values reported by Sanda *et al*., 2015 (1.56%) and Amusat *et al*., 2018 (1.98%). However, Leung *et al.* (1968), Ogungbenle *et al*. (2018), Ezekwe *et al.* (2002) and Nworgu *et al*. (2015) reported higher values for ether extract (4.31%, 7.45%, 4.2%, and 3.85%) respectively.

The total ash% of water leaf was found to be 14.24% in the present study. Similar values for crude fibre have been reported by Agboola *et al.*, 2018 (14.08%). But, Ogungbenle *et al*. (2018) and Ezekwe *et al.* (2002) reported higher value of ash at 26% & 19.6% respectively. On the other hand, Sanda *et al*. (2015) & Amusat *et al*. (2018) reported lower values of ash 7.84% and 7.92% respectively. The difference in ash% reported by different authors with that of the present study may be due to varying degree of soil compositions at the planting sites and soil contaminations while harvesting and processing the leaves.

The Calcium content of waterleaf in the present study was found to be (110mg/ 100g). However, Leung *et al*. (1968) and Nworgu *et al*. (2015) reported the values to be 121mg/100g and 139mg/100g respectively. Similarly, the value of the Total Phosphorus in the study was found to be (75mg/100g). But, Kwenin *et al.* (2011), Nworgu *et al.* (2015) and Leung *et al*. (1968) found the value of the Total Phosphorus to be (81.90mg/100g), (37mg/100g) and (67mg/100g) respectively. The calcium and phosphorus obtained in the present investigation were similar to previously reported values. The feed is good if the Ca:P ratio is above one and poor if the ratio is less than 0.5 (D.C Nieman *et al.*, 1992). Considering the Ca:P ratio of more than one, waterleaf may be considered as a good and balanced source of these macro minerals.

The variations in some of the proximate principles of waterleaf in the present study when compared to the findings of some researchers could be due to several factors. The proximate composition of plants/plant parts vary with the plant variety, growth, stage of harvest, soil, climate and season. Most of the references available is from African countries where the climate may be different from that of ours. Further the variety and stage of harvest could also be different. However, considering the high protein and calcium content and low crude fiber level in the plant leaves, it could be viewed as a suitable substitute for traditional poultry feed ingredient.

5.2 Body weight and body weight gain

The weekly body weight & body weight gain of treatment and control groups have been presented in Table 4.2 and Table 4.3 respectively. The 6^{th} week body weight of the treatment groups were 897.08±42.65, 937.4±27.04 and 927.43±40.14g respectively. Analysis of data revealed no significant difference in body weight as well as body weight gain among treatment groups fed diets containing 0, 5 or 10% waterleaf meal.

Nworgu *et al*. (2015) reported that at finisher phase, with the increase in conc. of WLM in diets led to increase in body weight & body weight gain at 3, 6 and 9% WLM level as compared to control (0% WLM). But, at 12% WLM level the final live weight and the weight gain were significantly lower than the control, 3, 6 and 9% WLM levels. Agboola *et al.* (2018) reported that birds fed waterleaf mixed @10% of main diet had better weight gain than birds fed with normal diet with Pawpaw leaf. Ekine *et al.* (2020) reported that the broiler fed diet containing water leaf @ 300g mixed with measured amount of feed has best final weight gain & weekly weight gain as compared to other treatment groups where waterleaf was mixed @ 0g, 100g and 200g with measured amount of feed.

The beneficial effects of using waterleaf extract in poultry have been reported by several workers. Sanda *et al*. (2015) reported that waterleaf of 50ml/litre of drinking water extract was found to be more economical to raise layers when compared to the other treatment groups consisting of 0,100,150 and 200 ml WL extract. The layers given drinking water supplemented with 50ml WLE, were having highest weight gain and final weight when compared to the others. Sanda *et al*. (2015) conducted experiment on broilers fed with 0. 100, 200, 300 & 400ml WL extract. They found that the final weight of birds when given 400ml WLE was significantly higher than those of others. The gain in body weight of the broilers that are fed higher dose of WL extract were significantly higher ($p<0.05$) than those fed with reduced dose.

The increment in weight gain highlighted that WLE has mouth-watering & digestion stimulating properties which is also reported by Langhout (2000) in his work entitled “New additives for broiler chicken”.

The body weight data as recorded in the present experiment is in agreement with the previous findings where inclusion of WLM up to 10% in the diet did not adversely affect the body weight of finisher birds.

5.3 Feed intake and feed conversion ratio

The mean weekly feed intake and mean cumulative weekly feed intake of the chicken have been presented in Table 4.5 & 4.6 respectively, which increased progressively in successive weeks from 4^{th} to 6^{th} week in all treatment groups. The chicken fed with 10% WLM had significantly higher feed intake than 0% and 5% WLM levels. It was interesting to note that the feed intake at 5% WLM was significantly lower than that of the control (0%WLM) group.

The mean weekly FCR and cumulative FCR have been presented in Table 4.7 and 4.8 respectively. The chicken in T3 group showed highest FCR which was significantly ($p<0.01$) higher than other two groups at all ages. The 4^{th} and 6^{th} week FCR of T2 group was significantly ($p<0.01$) lower than T1 group. Available information on effects of waterleaf meal on feed intake and FCR are contradictory.

Nworgu *et al.* (2015) reported that the feed intakes of broiler finishers declined and the FCR values increased significantly with incorporation of WML in the diet. Agboola *et al.* (2018) reported that the lowest FCR was obtained when birds fed normal diet mixed with chopped *Talinum triangulare* as well as when fed with normal diet separate & *Talinum triangulare* separate.

Sanda (2015) reported that the birds fed with 400:1000ml waterleaf extract had the highest feed intake and the best FCR (2.50). With increase in dose of WLE, FCR decrease from 2.97 to 2.50. But, it contradicts the finding of Sanda (2015) who reported that the birds which were given 50ml & 100ml WLM extract had both significantly higher ($p<0.05$) daily feed intake and a good FCR. Ekine *et al*. (2020) reported that the weekly feed consumption and feed efficiency showed that the diet containing 300g of freshly chopped waterleaf mixed with a measured amount of feed when given, the birds show highest feed efficiency% than the birds which were fed 100g of WL mixed with a measured amount of feed showed lowest feed efficiency%.

The increase in feed intake in the present experiment could be due to the fact that incorporation of WLM reduced the ME content of the diets. As birds eat to satisfy their energy requirement, feed intake in WLM groups increased as it contains less ME as compared to the control. There are reports that WLM increases the appetite because of digestion stimulating properties (Langhout, 2000). As there was no significant difference in the body weight of the treatment groups, increase in feed intake led to the increased FCR values in T3 as compared to control. But, no such trend was seen in T2 when compared to control.

5.4 Mortality

Zero mortality was seen during the experimental period. This is in line with the report of Sanda (2015). However, Nworgu *et al.* (2015) reported the mortality % 1.97, 2.08, 2.03, 2.49 & 2.15% at 0, 3, 6, 9 & 12% inclusion levels respectively. Ekine *et al.* (2020) conducted experiment on broilers fed 0g, 100g, 200g and 300g of Waterleaf mixed with a measured amount of commercially available poultry feed each. They found that the mortality to be 0.33 % at T1, T2 and T4 and 0% at T3.The zero mortality in this study may be due to proper managemental practices being carried out and suitable climatic conditions of the environment.

5.5 Effect of feeding WLM on hematological parameters

The mean Hb(g/dl), Heterophile(%), Eosinophils(%), Monocyte(%), Basophils(%) and Lymphocyte(%) have been presented in Table 4.9 and depicted in Fig 4.8. It was found that the Hb, Heterophile, Eosinophils, Monocyte, Basophils and Lymphocyte count between treatment groups did not differ significantly ($p>0.05$).

However, Nworgu *et al*. (2015) reported that the lymphocyte% in broilers that were given 0% & 3% WLM inclusion diets were significantly ($p<0.05$) higher than those given 6%, 9% and 12% WLM treated diet. The WBC in the control was significantly ($p<0.05$) lower than those of treatment groups which were similar. The hemoglobin% of broiler chicks fed 9 and 12% WLM inclusion diets were found to have significantly ($p<0.05$) higher value than that of other treatments including control.

The one of the major factor causing increase in lymphocyte% in blood may be due to oxidative stress. As D. Liang *et al*. (2011) reported that waterleaf has antioxidant activities, the increase in waterleaf inclusion level in diet may reduces stress and thus decreases lymphocyte level. Also, the low value of WBC in the control group may signify liver ailment. Various useful bioactive compounds such as Quercetin, Kaemferol, Lycopene which were found in the waterleaf seem to have hepatoprotective effects when given in diet at graded level (Ikewuchi *et al*., 2016). The increase hemoglobin% at higher dose of WLM may be due to presence of folate and iron that will play an essential part in hemoglobin production. However the reasons for which the haematological parameters remained unaffected even at 10% WLM level could not be explained.

5.6 Effect on serum biochemical parameters

Serum metabolites of broiler fed WLM supplements are presented in Table 4.10. Careful examination of the table revealed that dietary WLM supplements in the diets of broiler had significant influence on ALT, Triglyceride, HDL and Total Cholesterol. These have been presented in figure 4.9, 4.10, 4.11 and 4.12 respectively.

In the present study, ALT values for T1 (0%) & T2 (5%) groups were similar ($p>0.05$) and significantly ($p<0.05$) lower than T3 (10%) group. This is in agreement with Nworgu *et al.* (2005) who reported that Alkaline phosphate was significantly ($p<0.05$) lower in control than the treatment groups. Generally, ALT and ALP are generally found in the liver in large amount. This is not to say that it is exclusively located in liver, but that is where it is most concentrated. Thus, these both will act as specific indicator of liver status. Both, ALT and ALP decreases with the higher graded dose of waterleaf upto certain level. It may be due to its hepatoprotective effect (Ikewuchi *et al*., 2016). Increase ALT value signifies underlying liver problem or hepatic disorder, which may be due to certain toxic phytochemicals such as oxalate, tannin which at high level cause hepatotoxicity. On the other hand, AST is found in various tissues including heart, muscle, kidney and brain. The increase in AST with the increase in doses of WLM may be due to result of other injured tissues other than the liver (Charles Patrick Davis, 2020).

In the study conducted, it is found that the Total Cholesterol values of T2 and T3 groups are similar and significantly lower ($p<0.05$) than that of T1 group. This is at par with Nworgu *et al.* (2005) report which stated that total cholesterol decreased for birds fed 9-12% dried WLM. Also, Ezekwe *et al.* (2006) reported that when freeze dried supplement of water leaf was given to hypercholesterolemic human adult patients @ 6g/day, total cholesterol decreased with subsequent weeks. Airaodion *et al*. (2019) reported that when methanolic extract of dried water leaf was given to adult rat @ 3ml/100g bodyweight 12 hourly orally, then it was seen that there was decrease in total cholesterol. Sanda (2015) also reported that when fresh waterleaf blended with water and given to layers @ 0, 50, 100, 150 & 200 ml/1 litre of water, then cholesterol level in egg was found to be lowest in those layers who were fed 200ml/1 litre of water. While going through the above discussion, it can be predicted that waterleaf contain certain phytochemicals such as flavonoid that inhibit hepatic cholesterol & fatty acid synthesis. Phenolic compounds (flavonoid) in the waterleaf inhibit HMG-CoA reductase activity which will then inhibit cholesterol synthesis. Thus, this will prevent atherosclerosis plague from clogging the heart blood vessel area and will cure us from cardiovascular diseases.

In the present experiment, HDL values of T2 and T3 groups were similar ($p>0.05$) but significantly ($p<0.05$) higher than T1 group. Airaodion *et al*. (2019) reported that when methanolic extract of dried water leaf was given to adult rat, then it was seen that there was increase in HDL & HDL/LDL ratio. Ezekwe *et al.* (2006) reported that when freeze dried supplement of water leaf was given to hypercholesterolemic human adult patients, HDL value increases with subsequent weeks. Aronu *et al.* (2018) reported that the broiler when fed dried-pulverised form of waterleaf at certain level there was increase in HDL at highest dose (1000mg/L). The above findings of various authors may suggest that due to its high crude fiber content along with soluble fiber like pectin and presence of omega-3 fatty acid (Ezekwe *et al*., 2002), HDL value is comparatively higher in treatment groups. HDL clear out LDL from the arteries & transfer back to the liver, where LDL is broken down & removed out from the body.

In the present study, it was found that the Triglyceride values of T3 is significantly lower ($p<0.05$) than T2 and the value of T1 is at par with that of T2 and T3. Ezekwe *et al.* (2006) reported that when freeze dried supplement of water leaf was given to hypercholesterolemic human adult patients, no effect on triglyceride was observed. Aronu *et al.* (2018) reported that when the broiler fed dried-pulverised form of waterleaf at certain level, Triglyceride value decreases at higher inclusion levels but with low dose of WL, there exist very little or no effect on Triglyceride value. Also, when fed fresh form of waterleaf, Triglyceride reduces at low dose but the effect seems to be reverse at high dose. The untreated group broilers were having highest Triglyceride. Airaodion *et al*. (2019) reported that when methanolic extract of dried water leaf was given to adult rat, then it was seen that there was decrease in triglyceride.

In our study, Triglyceride values obtained did not show any definite trends.

5.7 Effect on histology of liver and kidney

In the present study, it was found that there was apparently normal histological picture in liver and kidney with some mild changes without any significant difference between the groups. Dong Liang *et al*. (2011) found that when *Talinum triangulare* extract was given to mice, both ALT & AST values decreased significantly. Ajayi *et al.* (2016) reported that the methanolic extract of *Talinum triangulare* treated animals showed normal mucosa when compared with that of ulcerated untreated and Omeprazole treated animals which showed deep ulceration and mild inflammation respectively. The normal histological findings in the study indicate that probably the intake of hepatotoxins and nephrotoxins in the WLM were not sufficient enough to induce any changes in the liver and kidney during the 3 weeks feeding period. More over the antioxidant and hepatoprotective activities of *Talinum triangulare* have been reported (Ajayi *et al*., 2016). The antioxidant properties of WLM may be due to appreciable amount of saponins and flavonoids in the leaves.

5.8 Effects on economics of raising broiler finisher (3-6 weeks)

From the study of economics of rearing broiler finisher, it was evident that the highest profit over feed cost (Rs. 12.99/bird) was seen in the group fed 5% WLM (T2). In the control group (0%WLM), the profit over feed cost was Rs. 8.38/bird. In 10% WLM group (T3) the profit was –Rs. 3.16. It was seen that raising broiler finisher by incorporating 10% WLM in the diet is not profitable.

SUMMARY AND CONCLUSION

Ensuring supply of quality feed at reasonable cost is the key to success of poultry farming. High cost of conventional feed ingredients has led to more and more focus on research to exploit newer feed resources. Waterleaf (*Talinum triangulare*), is a perennial herb that grows in almost all types of soil and climate with high protein content. The present investigation aimed at studying the effects of inclusion of different levels of waterleaf meal on the performance of broiler finisher.

The research was done in ILF of C.V.Sc & A.H, OUAT, Bhubaneswar. Ninety Red Cornish chicken at age of 21 days were distributed randomly into 3 treatment groups (T1, T2 & T3).Each treatment group was having 3 replicates with 10 chicken in each replica. By following ICAR 2013 feeding standard, test diets were prepared by incorporating 5% & 10% WLM by replacing equal parts of reference diets.

All the data related to different parameters were analyzed for one way ANOVA using SPSS version.

The proximate composition of Waterleaf was found out according to AOAC, 2019. The fresh leaf contained 8.90% dry matter. The CP%, CF%, Total ash%, EE% and NFE% were found to be 28%, 13.7% 14.24%, 1.22% and 31.02% respectively. The calcium & Total phosphorus were found out to be 110 and 75 mg/100g respectively.

The 6th week body weight of T1 (Control), T2 (5%WLM) and T3 (10%WLM) groups were 897.08±42.65g, 937.4±27.04g and 927.43±40.14g without any significant differences ($p>0.05$) among treatment groups.

The average cumulative feed intake (from 3rd to 6th week) of T1, T2 and T3 groups were (1847.10g), (1716.45g) and (2096.00g) respectively. The average 6th week cumulative feed intake of T3 group was highest which was significantly ($p<0.01$) higher than the T1 and T2 groups. Similarly, the average 6th week cumulative feed intake of T2 group was significantly ($p<0.01$) higher than T1 group.

The 6th week cumulative FCRs of T1, T2 and T3 treatment groups were 3.99, 3.68 and 5.02 respectively. The 6th week cumulative FCR of T3 was significantly (p<0.01) higher than T1 and T2 groups. The 6th week cumulative FCR of T2 group was the lowest and significantly (p<0.01) lower than T1 group.

Haematological parameters like Hb %, Heterophile %, Eosinophils %, Monocytes %, Basophils % and Lymphocytes % values were within normal range and did not differed significantly (p>0.05) between treatment groups.

WLM inclusion in the diet of broiler did not have any significant effect on serum AST, Urea, Creatinine, Total protein and Glucose. The ALT values for T1 & T2 groups were similar (6.95-7.60 IU/L) but, T3 group showed significantly higher (p<0.05) value (11.06 IU/L) than the other treatments groups. Serum triglyceride value of T3 was significantly lower than T2 & the value of T1 was at par with that of T2 and T3. Serum HDL values of T2 & T3 were similar (48.76 and 54.36 mg/dl) but significantly higher than T1 group (15.45 mg/dl). Total cholesterol values of T2 & T3 were similar (151.84 and 173.21 mg/dl) but significantly lower than T1 group (239.5 mg/dl).

The liver & kidney showed that there were apparently normal histological pictures in organs with some mild changes without any significant difference between treatment groups.

Feeding of WLM @ 5% in the diet resulted in a profit of Rs. 13/- per bird over feed cost whereas when fed at 10% level, profit per bird was -Rs. 3.16

It may be concluded that WLM can be incorporated at 5% in the diet profitably without affecting growth, FCR, hematological parameters, serum biochemical parameters and histology of vital organs like liver and kidney.

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