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Evaluation of Biochemical Indices of Liver and Kidney Tissues of Albino Wistar Rats Treated with Anthelmintic Drug (Albendazole)

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Abstract

Anthelmintics are compounds that demonstrate antiparasitic activity against helminths, which settle in the human intestine. There have been reported cases of abuse in oral administration in Africa especially among Nigerians and thereby necessitated the need to evaluate their effects on two key physiological tissues. This study was designed to evaluate the biochemical indices of liver and kidney tissues of albino Wistar rats treated with antihelmintics drug - albendazole. This study was conducted in the animal house of the Faculty of Basic Medical Sciences, Chukwuemeka Odumegwu Ojukwu University, Uli and JoyManuel Medical Diagnostic Laboratories, Nnewi, Anambra State. A total of fifty-two (52) Albino Wistar rats were purchased from Chris animals and Research Farm Mgbakwu, Awka, Anambra State. The rats were acclimatized for a period of two weeks (14 days) before they were grouped into four (4) for the administration of albendazole. Group 1 (Control) received only feed and water, Group 2 received 400mg/70kg, Group 3 received 800mg/70kg group and Group 4 received 1600mg/70kg of albendazole at the beginning of every 3 months for a period of 12 months in addition to daily feed and water. At the end of every 3 months, the animals were sacrificed. The rats were anaesthetized by chloroform in a closed jar, sacrificed by cervical dislocation, blood samples were collected and biochemical indices for liver and kidney function tests were determined using spectrophotometric methods. The obtained data were subjected to statistical analysis using Microsoft Excel. The results of the study revealed that there was no significant difference in all the liver function and kidney function parameters assayed for ($p>0.05$) when all the groups were compared till the 12th month. Thus, the insignificant differences in the levels of hepatic enzymes and renal electrolytes as observed in this study does not indicate hepatic or renal dysfunctions and albendazole administered at a prescribed dosage may not cause any known biochemical adverse effects.

Keywords: Adverse effect, Africa, Antihelmintics, Albendazole, Biochemical index

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1. Introduction

Parasites infect more than 200 million people worldwide. Chronic infestations may elicit inflammation, lead to cancer formation and deaths (International Agency for Research and Cancer, (IARC), 1994). Infections from parasitic worms and protozoa are the major cause of human and wildlife morbidity and mortality. In tropical and sub-tropical regions, *Plasmodium* species, the parasitic protozoan responsible for human and animal malaria, is the leading cause of morbidity and mortality with children highly vulnerable, accounting for about 1 - 2 million deaths annually (Greenwood and Mutabingwa, 2002). Similarly, schistosomiasis, lymphatic filariasis, ascariasis, enterobiasis and onchocerciasis caused by helminths and nematodes, are common health issues in most tropical and sub-tropical countries (WHO, 2002). In endemic situations, these protozoan and worms coexist in human and animals to cause severe infestation and death (Raso *et al.*, 2004). In this situation, mass drug administration is usually the recommended treatment strategy for effective parasite clearance (WHO, 2012).The series of events initiated by exposure of a chemical or toxin, its progression through distribution and metabolism and most importantly, its

interactions with macromolecules of a cell (DNA or protein) resulting in expressing its outcome in the form of various endpoints or phenotypical outcomes is called toxicity (Saganuwan, 2012).

Drugs are administered to humans for health reasons, though these drugs can be therapeutic at one dose and toxic at another (Sharif *et al*., 2015). Thus, drug toxicity is the level of damage that a drug or its metabolite can cause to an organism (Riley and Kohut, 2010). Albendazole, a benzimidazole derivative is a drug often used in the treatment of echinococcosis, a parasitic worm whose presence leads to cysts in the kidney and liver (NCBI, 2021). It has proven to be effective against helminths and since 1996 has been approved for use in the United States. Studies have shown that oral administration of albendazole can lead to slight and transient elevations in serum liver enzyme activities and rarely can lead to slight and transient elevations in serum liver enzyme activities and rarely can lead to clinically apparent acute liver injury (NCBI, 2021).

Due to poor hygiene and health status of the middle class and poverty-stricken masses in Africa, they are susceptible to attack by helminths especially echinococcus. To cushion this effect, oral administration of albendazole or other derivatives of benzimidazole is normally advised. With this and by coining the term "De-worming", the general populace believes in taking these drugs monthly or on a 3-month interval. Long-term exposure to some of these drugs has been shown to lead to organ damage resulting from its side effects. As the site of the first-pass metabolism, the liver is subject to certain deleterious effects of drugs which could adversely affect hepatic functions. Although albendazole is said to have no pharmacological effect in humans (Critchley *et al.*, 2005), but its use has been linked to various degrees of derangement in liver enzymes and hepatic function parameters (Yarsan *et al*., 2003). Thus, chronic administration of albendazole could compromise the integrity of the renal and hepatic functions (Arise and Malomo, 2009). As a consequence of the above, it is essential to evaluate the biochemical indices of liver and kidney tissues of albino Wistar rats treated with antihelmintics drug - albendazole inorder to provide a comprehensive database at different dosage regimens.

2. Materials and Methods

2.1 Site of Study

This study was conducted in the animal house of the Faculty of Basic Medical Science, Chukwuemeka Odumegwu Ojukwu University, Uli and JoyManuel Medical Diagnostic Laboratories, Nnewi, Anambra State. A total of 52 Wistar rats were acclimatized for a period of two weeks (14 days) before the administration of albendazole (Uba *et al*. 2020a; 2020b).

2.2 Ethical Approval

The ethical approval for this study was obtained from the Faculty of Basic Medical Sciences Ethical Committee, Chukwuemeka Odumegwu Ojukwu University, Uli.

2.3 Duration of Study

This study lasted for a period of 12 months.

2.4 Drug Procurement

In this study, 400 mg of Albendazole manufactured by GlaxoSmithKline South Africa was purchased from Key-N Pharmaceutical Shop Onitsha Head Bridge, Anambra State.

2.5 Animal Studies

2.5.1 Purchase of Animals

Fifty - two Wistar rats were purchased from Chris Animals and Research Farm, Mgbakwu, Awka, Anambra State.

2.5.2 Grouping of Animals

Following the method of Gabriel *et al.* (2013), the animals were grouped into 4:

a) Control group: This group received only feed and water for a period of 12 months.

b) 400 mg/70kg group: This group received an oral albendazole dose of 400 mg/70kg at the beginning of every 3 months for a period of 12 months in addition to daily food and water.

c) 800 mg/70kg group: This group received an oral albendazole dose of 800 mg/70kg at the beginning of every 3 months for a period of 12 months in addition to daily food and water.

d) 1600mg/70kg group: This group received an oral albendazole dose of 1600mg/70kg at the beginning of every 3 months for a period of 12 months in addition to daily food and water.

2.6 Sacrifice and Sample Collection

Blood samples were collected via cardiac puncture at the end of every 3 months for a period of 12 months (Ezeamama *et al*., 2025a; 2025b). Blood samples for hematology were transferred into EDTA bottles while others were put in plain bottles. The samples in plain bottles were taken to the laboratory and spun in a centrifuge at 3500rpm to get the serum for other biochemical analysis (Uba *et al.* 2020a; 2020b).

2.7 Biochemical Parameters

2.7.1 Liver function assessment

Assays of Aspartate Amino Transferase (AST) Activity, Alanine Amino Transferase (ALT) Activity, Alkaline Phosphatase (ALP) Activity, Total and Direct bilirubin estimation were carried out according to the methods of Egurefa *et al*. (2020a) and Uba *et al*. (2021).

2.7.2 Kidney function assessment

Determination of Blood Urea Concentration, Creatinine Concentration, Sodium concentration, Potassium concentration, Chloride Concentration Determination and Bicarbonate Concentration Determination were carried out **(**Egurefa *et al*. 2020; Uba *et al*. (2021).

2.8 Statistical Analysis

This was carried out using the Analysis tool pack of Microsoft Excel. Tables and bar charts were used to show the averages of each parameter. ANOVA tables were used to check for significant differences in each parameter on each period of measurement. A significant difference was assumed when the p value was less than 0.05 ($P<0.05$) **(**gbodika *et al*., 2014;Anukam *et al*. 2020a; 2020b; Egurefa *et al.*, 2020b; Uba 2018; 2019a; 2019b; Uba *et al.*, 2018a; 2018b; 2019a; 2019b; 2020a; 2020b; 2020c; 2020d; 2024; 2025; Chude *et al*., 2021;

Dokubo and Uba (2023); Ezenwata *et al*. 2022a; 2022b;Uba and Anidu, 2023; Uba and Obiefuna 2023; Ubani *et al*., 2024; 2025; Ekwenze *et al*., 2025; Mere *et al*., 2025; Ubajekwe *et al*., 2025).

3. Results

3.1 Liver Function Parameters

The bar chart below showed the average AST activity of the various groups (Figure 1.0). After 3 months of the experiment, the control had the least AST activity (23.00±1.70U/L) while the 800mg/70kg group had the highest AST activity (28.60±1.94U/L). The difference in AST activity was not significant after 3 months during the experimental period ($p>0.05$). After 6 months of the experiment, the 1600mg/70kg group had the least average AST activity (24.60±2.20U/L) while the 800mg/70kg group had the highest AST activity (27.00±2.02U/L). This difference in AST activity was not significant ($p>0.05$). After 9 months, the control group had the least AST activity (25.00±1.58U/L) while the 800mg/70kg group had the highest AST activity (25.60±2.23U/L). This difference in AST activity was not significant ($p>0.05$). After 12 months of the experiment, the 1600mg/70kg group had the highest AST activity (26.20±3.37U/L) while the 800mg/70kg group had the least (23.40±2.93U/L). This difference in AST activity was still not significant ($p>0.05$). These results showed that routine oral administration of albendazole did not significantly increase AST activity above the upper limit. Thus, it may not lead to liver dysfunction.

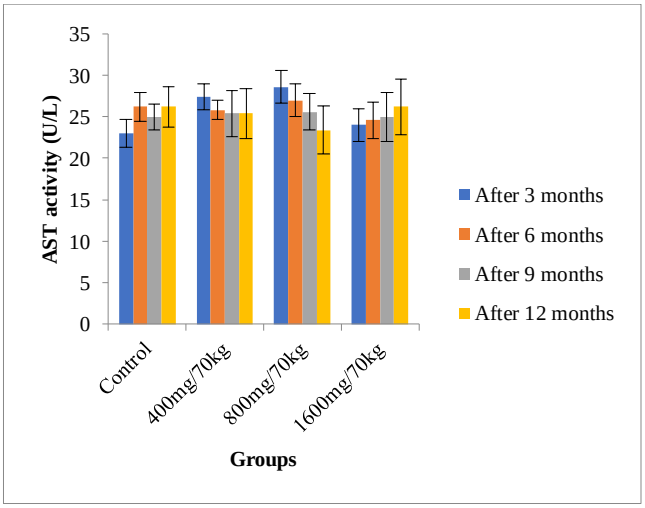

Figure 1: Average AST activity of the various groups during the experimental period.

The bar chart below showed the average ALT activity of the various groups during the experimental period (12 months) (Figure 2.0). After 3 months of the experiment, the control group that did not receive any dose of albendazole had the highest ALT activity (35.60±1.83U/L) while the 1600mg/70kg group had the least activity. This difference was not significant ($p>0.05$) when all the groups were compared. After 6 months of the experiment, the 800mg/70kg group had the highest ALT activity (36.40±2.87U/L) while the 1600mg/70kg group had the least activity (27.80±1.24U/L). The difference in ALT activity when all the groups were compared was not significant ($p>0.05$). After 9 months and 12 months of the experiment, the 400mg/70kg had the highest average ALT activity (34.20±3.12 U/L and 34.21±3.10U/L respectively). These differences in ALT activity were still not significant during the respective experimental periods ($p>0.05$).

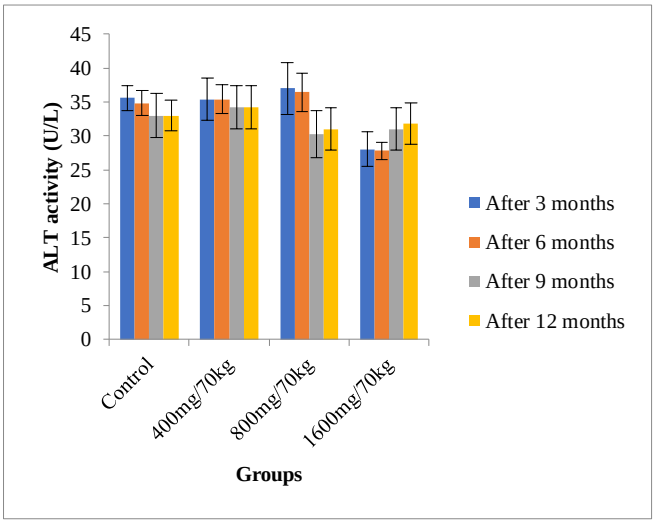

Figure 2: Average serum ALT activity in the various groups during the experimental period.

The bar chart below showed the average ALP activity of the various groups during the experimental period (Figure 3.0). There was no linear increase in ALP activity with increase in dosage of albendazole since the 800mg/70kg and 1600mg/70kg groups had the least ALP activity throughout the experimental period (After 3, 6, 9 and 12 months). This difference in ALP activity was not significant during the experimental period ($p>0.05$). This showed that oral routine administration of albendazole doesn't significantly increase ALP activity.

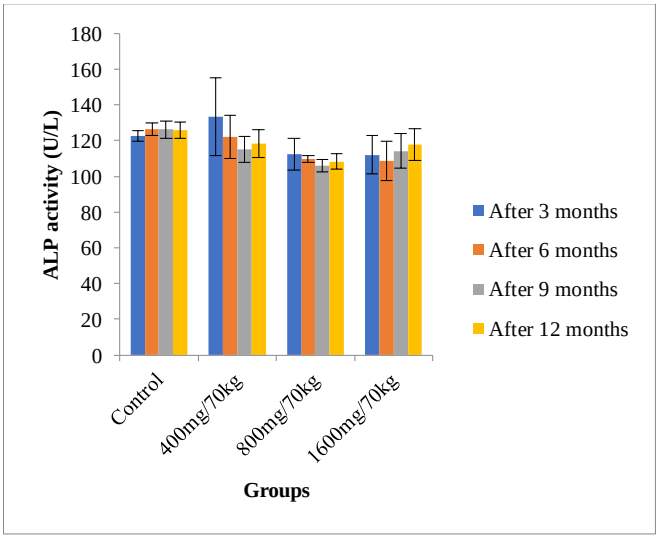

Figure 3: Average serum ALP activity of the various groups during the experimental period.

The bar chart below showed the average direct bilirubin levels of the various treatment groups and the control with the error bars showing the levels of deviation within each group (Figure 4.). The 800mg/70kg group had the highest total bilirubin level (9.68±0.55mg/dl) while the control group had the least (8.20±0.67) after the first three months during the

experimental period. This difference was not significant ($p>0.05$) when all the groups were compared. After 6 months of the experiment, the 400mg/70kg had the highest direct bilirubin level (9.20±0.54mg/dl) while the control group had the least (8.16±0.58mg/dl). This difference in total bilirubin level between the groups was not significant ($p>0.05$) during this period. After 9 months of the experimental period, it was observed that the 400mg/70kg group had the least direct bilirubin level (8.42±0.60 mg/dl) while the 800mg/70kg group had the highest total bilirubin level (9.00±0.75 mg/dl). The difference in total bilirubin level was not significant when the groups were compared. After 12 months of oral administration, the 1600mg/70kg group had the highest total bilirubin level (9.34±0.99 mg/dl) while the 400mg/70kg group had the least (8.86±0.44 mg/dl). This difference was not significant when all the groups were compared ($p>0.05$). The result showed that routine oral administration of albendazole at even a dosage of 1600mg/70kg can't significantly increase total bilirubin level in the systemic circulation.

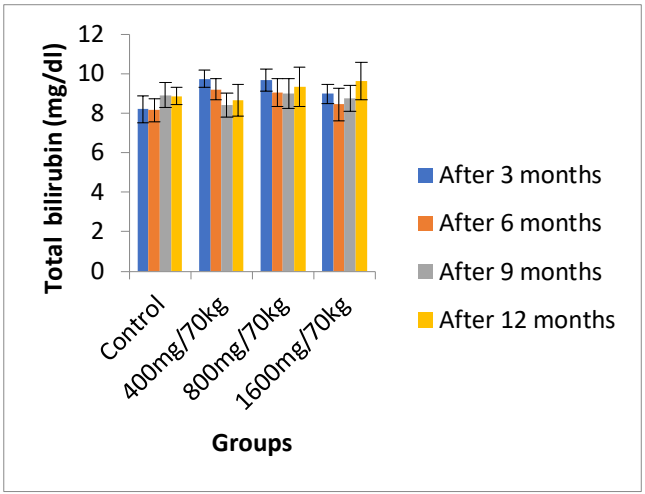

Figure 4: Average Total bilirubin levels in the various groups during the experimental period.

The bar chart below showed the average conjugated (direct) bilirubin levels with the error bars showing the various levels of deviation (Figure 5.0). After the first 3 months during the experimental period, the 800mg/70kg group had the highest conjugated bilirubin level (2.80±0.18 mg/dl) while the control group that received no dose of albendazole had the least (2.40±0.14 mg/dl). The difference in conjugated bilirubin level was not significant after the first 3 months of albendazole administration during the experimental period ($p>0.05$). After 6 months of administration, the control group had the least conjugated bilirubin level (2.34±0.18 mg/dl) while the 400mg/70kg group had the highest (2.82±0.26 mg/dl). This difference was not significant ($p>0.05$) when all the groups were compared. After 9 months of administration, the control group had the highest conjugated bilirubin level (3.00±0.53 mg/dl) while the 400mg/70kg group had the least conjugated bilirubin level (2.24±0.35 mg/dl). This difference in average conjugated bilirubin levels within the group wasn't significant ($p>0.05$). After the 12th month, the 1600mg/kg group had the highest conjugated bilirubin level while the control group had the least (2.30±0.25 mg/dl). This difference was still not significant ($p>0.05$) when all the groups were compared. These results showed that routine oral administration of albendazole does not lead to a significant rise in conjugated bilirubin level which is a marker of liver damage, thus, no liver damage.

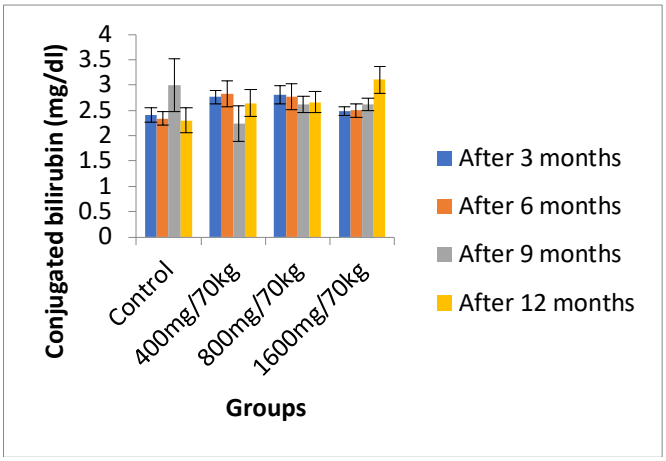

Figure 5: Average conjugated bilirubin levels in the various groups during the experimental period.

3.2 Kidney Function Parameters

The bar chart below showed the urea levels of the various rat groups during the experimental period (Figure 6.0). After the first 3 months during the experimental period, the 800 mg/70kg group had the highest urea level (9.90±1.16 mg/dl) while the 1600 mg/70kg group had the least (7.14±0.33 mmol/l). This difference in urea level was significant when all the groups were compared especially when the 800 mg/70kg group was compared with the rest of the groups, though this increase in urea level did not correlate with increase in dosage of albendazole. After 6 months of the experiment, the control had the highest average urea level (8.24±0.69 mmol/l) while the 1600mg/70kg group had the least urea level (7.58±0.29 mmol/l). The difference in urea level was not significant ($p>0.05$) when the groups were compared. There was no significant difference ($p>0.05$) in urea levels when the groups were compared after 9 months and 12 months. Also, there was no association between the urea levels, dosage of albendazole and time of exposure (number of months of administration).

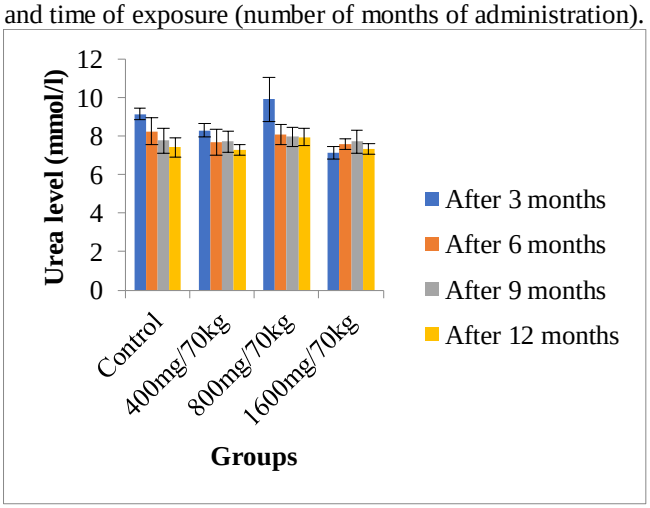

Figure 6: Average urea levels of the various groups during the experimental period.

The bar chart below showed the average creatinine levels of the various groups during the experimental period (Figure 7.0).

There was a significant difference in creatinine level after 3 months of albendazole administration when all the groups were compared ($p<0.05$) with this difference highlighted when the control group and 800mg/70kg group were compared with the 1600mg/70kg group. The 800mg/70kg group had the highest creatinine level (89.80±4.53 mmol/l) while the 1600mg/70kg group had the least (71.20±2.75 mmol/l). In subsequent periods of measurement of creatinine level, this difference was not significant. The results also showed a non-linear relationship between creatinine level and dosage of albendazole.

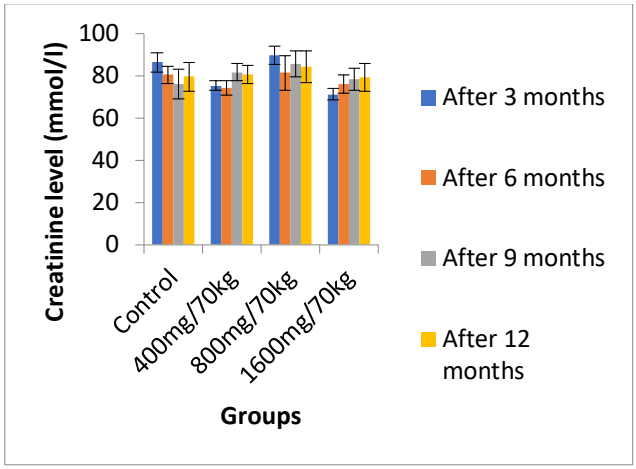

Figure 7: Average creatinine levels in the various groups during the experimental period.

The bar chart below showed the average serum ion level of the various groups during the experimental period in meq/l (Figure 8.0). The values of the sodium levels were so close to each other during the experimental period, thus, no significant difference throughout the assay period. There was a general decrease in sodium level by the 12th month in all the groups. This does not indicate pointed as an abnormality since the decrease occurred even in the control and thus cannot be attributed to as an effect of albendazole administration. Also, there was no association between the average level of sodium and dosage of albendazole administered throughout the experimental period.

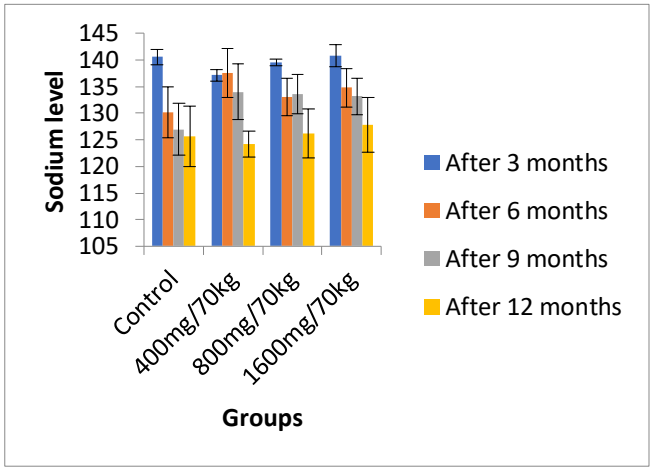

Figure 8: Average sodium levels in the various groups during the experimental period.

The bar chart below showed the average serum potassium levels in the various groups during the experimental period (Figure 9.0). Generally, on the average, the differences in potassium levels were not significant when all the groups were compared at different periods of the experiment. The control had the least average potassium level throughout the experimental period. Also, there was no linearity (linear trend) associated between serum potassium levels and dosage of albendazole.

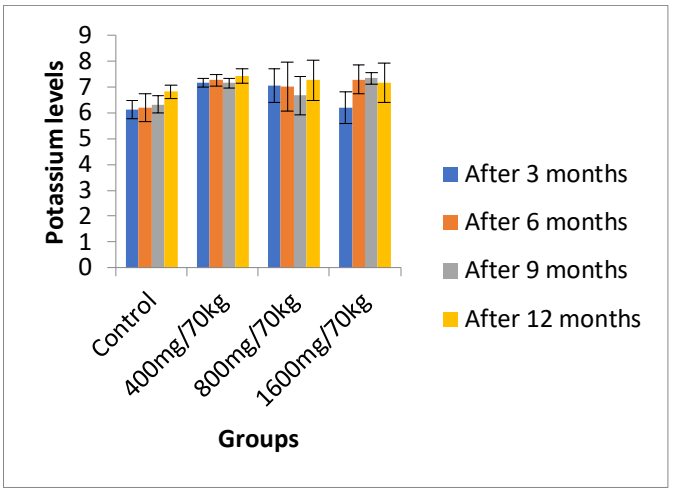

Figure 9: Average potassium levels in the various groups during the experimental period.

Chloride ion level is a very important electrolyte showing onset of renal dysfunction. In combination with bicarbonate level, they show when there was an anionic imbalance in the system which could be as a result of a dysfunction in ultrafiltration or selective reabsorption. The bar chart below showed the average chloride levels of the various animals during the experimental period (Figure 10.0). After 3 months, the 800mg/70kg group had the highest average serum chloride level (100.80±0.58) while the 400mg/70kg had the least (98.20±1.28). This trend wasn't the same during the other periods of the experiment (After 6,9 and 12 months). Though, these differences were not significant when compared ($p>0.05$).

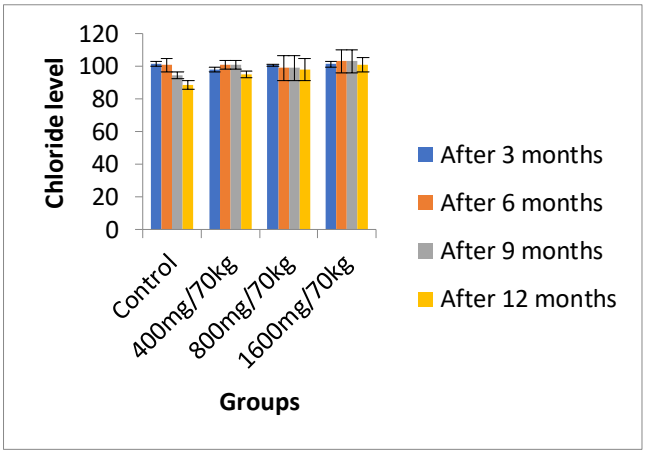

Figure 10: Average chloride levels in the various groups during the experimental period.

The bar chart below showed the average serum bicarbonate levels in the various groups during the experimental period (Figure 11.0). After 3 months of the experimental period, the control group had the highest serum bicarbonate level (24.40±0.51) while the 800mg/70kg group (22.20±0.73) had the least. This was not the same during other periods of experimentation, though the control group had the highest average serum bicarbonate levels throughout the experimental period. The differences in bicarbonate levels were not significant throughout the assay period (p>0.05).

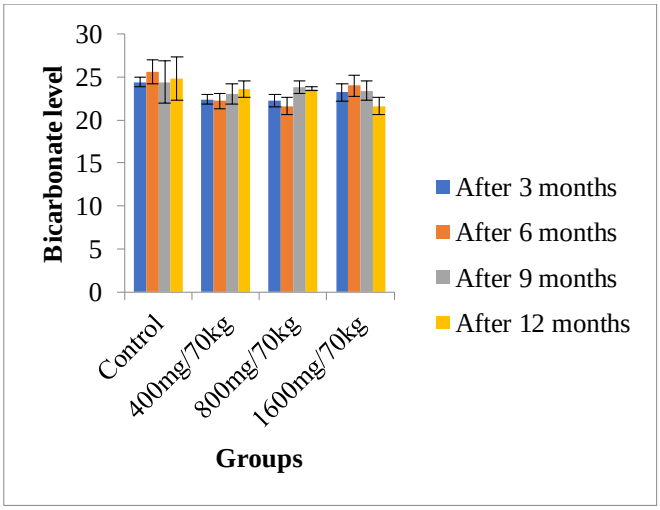

Figure 11: Average bicarbonate levels in the various groups during the experimental period.

4. Discussion

This study was carried out at Animal House of Faculty of Basic Medical Sciences, Chukwuemeka Odumegwu Ojukwu University, Uli Campus and Joy Manuel Medical Diagnostic Laboratories, Nnewi, Anambra State to determine the effects of anthelminthic drug (albendazole) on biochemical, histological and hematological parameters of the kidney and liver of wistar rats. Fifty- two rats were used for this study and were sacrificed on a 3 months interval till the 12th month. Oral administration took place on the beginning of every 3 months interval while sacrifice took place at the end of each 3-month interval. Various clinical tests like liver function parameters and kidney function parameters were carried out. Thus, biochemical indices serve as very good markers of drug induced chronic or acute toxicity.

Alanine amino transferase (ALT) is a liver enzyme that catalyses the transfer of an amino group from alanine to alpha-ketoglutarate in the alanine cycle to form pyruvate and glutamate (Mcgill, 2016). It has remained a standard biomarker for non-invasive diagnosis and monitoring of hepatocellular liver injury and disease, both in the clinical setting and in the drug regulation process. From the results of this study, there was no linear increase in ALT activity with increase in dosage of albendazole and increase in time of exposure (number of months) (Figure 1). The differences in ALT activity were also not significant throughout the experimental period. This shows no level of hepatotoxicity associated with oral administration of albendazole since ALT is a more specific marker for liver injury (hepatotoxicity). This also entails that these enzymes activities are not elevated in the systemic circulation indicating that the liver is in normal state without any sort of blockage or damage. The findings of the present study are in comparison with the result of the study done by Gabriel *et al*. (2013) on liver enzymes derangement and the influence of diet in animals given oral albendazole. They observed a significant increase in the level of serum ALT between animals in Groups D and E on a 3-days oral administration of albendazole at 15mg/kg/d and 30mg/kg/d respectively. On the other hand, they also observed that among the low dose groups B, C and D, which received same dose of albendazole (15 mg/kg/d) under different dietary conditions, Group B animals had the lowest serum level of ALT, while Group D had the highest and in most cases, the differences between the three groups were statistically significant ($P < 0.05$). The reason for this variation could be attributed to the difference duration of the administration of albendazole in the previous and present studies. The present study used a 3-months interval for the administration of albendazole which could possibly give enough recovery time to the experimental animals.

Aspartate amino transferase (AST) is an enzyme found in abundance in the heart muscle, liver cells, skeletal muscle and kidneys. Injury to these tissues results in the release of the enzyme into the systemic circulation just like (AST). A sustained elevated level of the activity of this enzyme is a good marker for liver injury which is a sign of toxicity (Acute or chronic). AST catalyzes the transfer of amino groups between L-aspartate and alpha ketoglutarate to form oxaloacetate and glutamate. Thus, an increase in the formation of oxaloacetate shows an increase in AST activity, thus, a likely sustained case of liver or any other organ damage. From the results of the present study in Figure 2, there was no positive correlation or association between the activity of AST and dosage of albendazole. Thus, even a high dosage albendazole at 1600mg/70kg is not capable of significantly raising AST activity and may not lead to liver damage. This dosage may even have more anti-helminthic potential without leading to any chronic or acute liver damage. The result of this study contradicted the findings of the research conducted by Gabriel *et al*. (2013) on liver enzymes derangement and the influence of diet in animals given oral albendazole. They noted that serum activity of AST increased in all the groups compared with the Control, being highest in rats given 15 mg/kg/d albendazole on normal rat pellets. They equally found out that the increase was only statistically significant in Group C ($P < 0.05$) that received 15 mg/kg/d albendazole with fatty diet, compared to the Control. Gabriel *et al*. (2013) also reported that Group D that got a lower dose (15 mg/kg/d) of the drug had a higher serum AST compared with Group E given a higher dose (30 mg/kg/d) and this difference was however not statistically significant ($P > 0.05$). Again, that animals (Group C) given the low dose with rat pellets had a statistically significant higher level of AST compared with those animals (Group B) that fasted. The reason for this variation could be attributed to the difference in in the mode of the feeding of the experimental animals used by Gabriel *et al*. (2013).

Alkaline phosphatase catalyses the hydrolysis of a wide variety of physiologic and non-physiologic phosphoric acid esters in alkaline medium (pH medium 10). The liver and

biliary tract are the source of alkaline phosphatase in normal sera. ALP is one of the tests of choice for evaluating cholestasis and obstructive jaundice. Elevated levels are found in many diseases including hepatitis, cirrhosis, malignancy and in bone diseases. This study demonstrated that there was no linear increase in ALP with increase in dosage or period of administration (Figure 3). This implied that oral administration of albendazole on three months interval cannot lead to cholestasis or obstructive jaundice which are known drug induced disorders. The non-linear increase in ALP observed in this study contradicted with the findings of Gabriel *et al*. (2013) on liver enzymes derangement and the influence of diet in animals given oral albendazole. They found out that there were differences in the activities of serum ALP in between groups, and in comparison with the Control were but that they were not statistically significant ($P > 0.05$). They asserted that the increase or reduction of the ALP level between the groups could also be based on dietary factors.

The kidney as an organ of metabolism is really susceptible to drug induced damage (Fuchs and Hewitt, 2011). The pathogenesis of this damage could be through direct toxicity of drugs for the kidney, effect of some drugs on renal flow which could reduce glomerular filtration rate and obstruction by drugs due to acidification of renal tubules and urine pH changes. Urea formed in the body, from protein and amino acid catabolism is eliminated via the urinary system and accounts for about half of the urinary salts. The result of this study revealed that increase in urea level of the 800mg/70kg group after 3 months of the experimental period does not indicate chronic kidney toxicity since the urea concentration in this group later normalized in subsequent months during the experimental period (Figure 6). Also, the non-significant urea difference in the subsequent study periods shows that oral administration of albendazole may not lead to increase in blood urea nitrogen.

On the other hand, creatinine is a breakdown product of creatine phosphate in muscles and is usually produced at a fairly constant rate by the body depending on muscle mass. It is a better marker for kidney toxicity than urea because unlike urea, it is not affected by non-renal factors like high-protein food intake. A creatinine clearance test is used to monitor the progression of renal disease. As observed in the creatinine levels in Figure 7 above, the 800mg/70kg group had a significant increase ($p < 0.05$) in creatinine level as to when compared with the rest of the groups, though this cannot be labeled toxicity since the creatinine levels normalized in subsequent months during the experimental period.
Again, electrolytes refer to positively and negatively charged ions that are found within cells and extracellular fluids, including intestinal fluid, plasma and blood. Tests for electrolytes includes assaying for sodium, potassium, chloride and bicarbonate to cover both total cationic and anionic imbalances. Sodium on the other hand, is the major cation of the extracellular fluid. It plays a central role in the maintenance of the normal distribution of water and the osmotic distribution of water and the osmotic pressure in the various fluid compartments. From the results of the present study in Figure 8, there was no significant difference (either on the increase or decrease) in sodium level throughout the experimental period, thus, no alteration in serum sodium level. This showed that albendazole did not interfere with the kidney function of maintaining normal distribution of water and the osmotic pressure in the various fluid compartments thus not resulting in conditions associated with hypernatremia and hyponatremia.

In addition, potassium is also an important constituent of the extracellular fluid due to its influence on muscle activity. Its intracellular function parallels that of its extracellular function like: influencing acid-base balance and osmotic pressure, including water retention, thus, it is among the major biomarker of kidney function parameter since these functions are carried out by the kidney. From the findings of this study as shown in Figure 9, the general decrease in average potassium levels by the 12^{th} month cannot be pointed as a kidney dysfunction since it was the same case with the control and the difference in potassium levels between the groups after comparison was not significant ($p>0.05$). Oral administration of albendazole even at a dosage of 1600mg/70kg may not alter K^+ level, and will not affect acid-base balance, osmotic pressure and water retention of the kidney adversely. Hence, albendazole administration can eliminate its target (helminths) without altering the cationic balance of the individual even at a dosage of 1600mg/70kg.

Chloride and bicarbonate are the principal anions. Chloride ions are involved in regulation and water distribution between the tissues by maintaining osmotic pressure and normal cation and anion balance between intracellular and extracellular fluids. Elevated levels are seen in conditions like dehydration and congestive cardiac failure. Decreased levels are seen in conditions such as salt losing nephritis, diabetic acidosis and renal failure. The average levels of chloride in all the groups were not significantly different from each throughout the experimental period ($p>0.05$) (Figure 10). This showed that there was no elevated or decreased chloride level due to routine albendazole administration and thus no risk of salt losing nephritis, congestive heart failure or renal failure at large.

Like chloride, assaying for bicarbonate level is used in the diagnosis of the acid-base balance in the blood. Elevated and decreased values indicate disorders associated with disturbances of the metabolic (especially kidney) and respiratory systems. The difference in serum bicarbonate levels in all the groups was not significant ($p>0.05$) throughout the experimental period (Figure 11). This showed a normal ranged serum bicarbonate level throughout the study period with no perturbations caused by the albendazole administration.

The above finding on the effect of albendazole on the renal and hepatic functions of the experimental animals in the present study contradicted the finding of the study done by Arise and Malomo (2009) on the effects of ivermectin and albendazole on some liver and kidney function indices in rats. Arise and Malomo (2009) demonstrated that administration of albendazole led to significant increase ($P < 0.05$) in serum urea, creatinine, glucose and cholesterol concentrations while albumin was significantly reduced ($P < 0.05$). Generally,

activities of ALP, ACP, LDH, AST, ALT, Na^{+}-K^{+} ATPase and Ca^{2+}-Mg^{2+} ATPase of liver and kidney were significantly altered ($P < 0.05$). According to Arise and Malomo (2009), these observations may be suggestive of deranged membrane structures and functions. They went further to report that malfunction in the glomerular filtration results in the retention of substances including urea and creatinine, and this may be responsible for their high serum levels in all the treatment groups. A minimal transient elevation of serum creatinine following repeated administration of albendazole has been described by Ismail *et al*. (2008). Again, the significant increase in serum ALP activity of all the treatment groups is suggestive of a possible damage to tissue cell plasma membrane by the combined administration with albendazole either singly or in combination (Arise and Malomo, 2009). Thus leading to leakage of membrane components into the extracellular fluid (Akanji *et al*., 2003). From their observation, they also asserted that the albendazole may have deleterious effects on both liver and kidney functions.

Similarly, the results of the present study on the biochemical parameters of the renal and hepatic functions of the experimental animals are in comparison with the findings Obiajunwa *et al*. (2019) on biochemical, histopathological and mutagenic changes following the co-administration of antihelminthic and antimalarial drugs in wistar rats. They observed that liver enzyme profile across experimental groups showed that at least one treatment group has significantly lower levels of AST, ALT and ALP. Also, the result of the analysis of the biochemical parameters showed that drug-treatment groups showed significantly higher levels of albumin compared to the control while creatinine was higher in serum of control animals. They went further to show that other biomolecule variables such as glucose, urea and cholesterol did not differ significantly between drug-treatment groups and control. Obiajunwa *et al*. (2019) equally revealed that electrolyte profile analysis depicted that $ALB^{+}IVM$ combination treatments showed significantly higher levels of sodium ion in serum compared to the control while all treatment groups showed significantly lower levels of potassium ion compared to the control. They also showed that all treatment groups showed significant elevated levels of calcium ion in serum compared to the control while all treatment groups except the ACT combination treatment group showed significantly lower levels of phosphate ion in serum compared to the control. Obiajunwa *et al*. (2019) also reported that bicarbonate ion levels were significantly elevated in treatment groups compared to the control while significant loss of chlorine ion in serum was recorded in the IVM drug-treatment group compared to the control. The reason for this variation can be attributed to combination treatments used by Obiajunwa *et al*. (2019) which are synergistic and most likely to induce metabolic disruptions, antidiuretic effects and dehydration among the experimental animals.

5. Conclusion

In conclusion, this 12-month study on albino Wistar rats found that albendazole, at prescribed dosages (400-1600mg/70kg), did not significantly alter liver or kidney function biochemical indices ($p > 0.05$). The results suggest that albendazole, when used as directed, is likely safe for liver and kidney tissues.

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