Direct RESEARCH JOURNALS

Direct Research Journal of Health and Pharmacology
Vol.8 (6), pp. 102-108, October 2020
ISSN 2449-0814
DOI: https://doi.org/10.26765/DRJHP22408976325
Article Number: DRJHP22408976325

https://directresearchpublisher.org/drjhp/

Full Length Research Paper

Biochemical Assessment of the Effects of Aqueous Stem Bark Extract of *Detarium Microcarpum* on Wistar Strain Rats

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Received 6 September 2020; Accepted 13 October, 2020

ABSTRACT: This study revealed the presence of alkaloids, tannins, saponins, phenols, phlobatannins, and flavonoids when the aqueous stem bark extract of *Detarium microcarpum* was subjected to qualitative phytochemical screening. Quantitatively, alkaloids (1.32±0.02); tannins (0.42±0.01); saponins (20.45±0.46); phenols (1.86±0.06) and flavonoids (0.39±0.03) were estimated. Antimicrobial susceptibility test of the aqueous stem bark extract using *Escherichia coli, Neisseria gonorrhoeae, Staphylococcus aureus,* and *Klebsiella pneumoniae* as test organisms showed varying zones of inhibition with 10mm zone of inhibition of the growth of *Staphylococcus aureus* exhibited by the extract which corresponded to that exhibited by ofloxacin for the same bacteria. Similarly, the 15mm zone of inhibition of the growth of *Neisseria gonorrhoeae* exhibited by the extract corresponded with that exhibited by ampicillin for the same organism. Minimum Inhibitory Concentration (MIC) was 16µg/ml for both *Staphylococcus aureus* and *Neisseria gonorrhoeae* and 32µg/ml for both *Escherichia coli* and *Klebsiella pneumoniae*. Minimum Bactericidal Concentration (MBC) of the extract was 64µg/ml for *Staphylococcus aureus* and none for the remaining three test organisms. Treatment of experimental animals with the aqueous stem bark extract for a period of six weeks and subsequent assessment of its effect biochemically showed that aspartate aminotransferase (AST), alanine aminotransferase (ALT), and lactate dehydrogenase (LDH) levels were significantly higher than normal suggesting certain degree of liver injury. Acid phosphatase and alkaline phosphatase levels were significantly lower ($p<0.05$) as compared to normal. Glucose, cholesterol, total bilirubin, and direct bilirubin levels were significantly lower than normal while albumin and total protein levels were significantly higher ($p<0.05$) than normal. Urea and creatinine levels were significantly higher ($p<0.05$) than normal/control values indicating some degree of kidney injury.

Keywords*: Detarium microcarpum*, aqueous stem bark extract, zone of inhibition, aspartate and alanine aminotransferases, and test organisms

INTRODUCTION

A medicinal plant is defined as any plant which, in one or more of its organs, contains substances that can be used for therapeutic purposes or which are precursors for the synthesis of useful drugs (Sofowora, 1982). In every developing country it is necessary that the documentation of medicinal plants be treated as a national emergency. Many traditional medicinal practitioners are old and in many cases, the information they hold has not been properly documented. There is therefore a danger that this cultural heritage and basis for future research may be

lost forever (Sofowora, 1982). A look at the situation in Nigeria shows that there is need to promote the use of medicinal plants for drug manufacture. The situation is probably similar for many other developing countries except for India and China. Indeed, higher plants have been described as the "Sleeping Giant" of drug development by Farnsworth and Morris (1996) who showed that, over the period 1959-1973, the total number of prescriptions dispensed in public pharmacies in the USA had consistently contained about 25 percent of plant-derived drugs in the form of: i) crude plant material; ii) crude extracts or iii) purified active principles obtained from plants.

***Detarium microcarpum* (Guill. and Perr.)**

This plant belongs to the family *Caesalpiniaceae*. Local names: Taura (Hausa); Konkehi (Fulfulde); Atapo (Kanuri); Abu leile (Shuwa Arabic); Gungorochi (Nupe); Agashidam (Tiv); Aikperlarimi (Etsako); Ofo (Igbo). *Detarium microcarpum* is particularly associated with dry savannah country being widespread from Senegal to Sudan and is locally abundant. There are three species of *Detarium* and all the three species are much alike. The tree is up to 9m high with a twisted bole and widely spreading crooked branches. The bark which is slate-grey and rough usually flakes off in angular sections and is often slash hard and reddish. The leaves have a common stalk 5-13cm long-fairly stout and sometimes finely hairy but swollen at the base. The flowers which appear throughout the wet season are usually creamy-white and fragrant, are closely crowded in a narrow panicles 2.5 - 7.5cm long arising singly from the leaf axils or more usually in clusters. The fruits which usually appear around November-January and May are more or less circular and disc shaped about 2.5 - 5cm across and 2.5cm thick with a dark brown fairly smooth skin closing a sweet greenish pulp mixed with a tangled network of fibres surrounding the hard disc-shaped wrinkled stone containing one seed. Galled fruits about 1- 2.5cm across commonly occur mixed with the normal fruits. The wood is usually dark brown tough and hard (Keay, 1989).

Objective of the study

The objective of this study is to determine the presence of some phytochemicals in the aqueous stem bark extract of *Detarium microcarpum* qualitatively and quantitatively, determine the antimicrobial activity of the stem bark extract on some selected microorganisms such as *Neisseria gonorrhoeae, Klebsiella pneumoniae, Escherichia coli* and *Staphylococcus aureus*, determine serum enzyme activities of alanine and Aspartate aminotransferases (ALT/AST), alkaline phosphatase (ALP), acid phosphatase (ACP), and lactate dehydrogenase (LDH), determine the serum levels of glucose, cholesterol, bilirubin (total and direct), albumin, total protein, urea and creatinine of the experimental animals.

MATERIALS AND METHODS

Detarium microcarpum was collected from within the premises of Modibbo Adama University of Technology Yola, Nigeria. The plant was identified at the Forestry Department of School of Agriculture and Agricultural Technology, Modibbo Adama University of Technology Yola, Nigeria. The stem bark was washed with tap water and then dried in an oven at 50°C over a 72 h period. The dried sample was cut into small pieces with a clean knife and then ground to powder using mortar and pestle. Fifty grammes of powdered stem bark were soaked in 200ml of sterile distilled water, shaken and allowed to stand for 24 h. The mixture was filtered using whatman No.1 (115cm) filter paper. The filtrate was concentrated over a water bath at 50°C. Dried extract was kept in sterile universal bottles and stored in a refrigerator for further use.

Bacterial specimens were obtained from the microbiology laboratory of the Pathology Department of the Federal Medical Centre Yola Adamawa State, Nigeria. The test organisms were *Klebsiella pneumoniae* (Gram-negative rod), *Escherichia coli* (Gram-negative rod), *Neisseria gonorrhoeae* (Gram-negative cocci), and *Staphylococcus aureus* (Gram positive cocci).The test organisms were kept in slants of nutrient agar.

Male Wistar strain rats weighing between 100– 120g were purchased from the animal house National Veterinary Research Institute Vom in Jos, Plateau State Nigeria. The animals were stabilized using standard laboratory chaw. Twenty-five rats were randomly divided into five groups of five rats each. Group 1 was the normal/control and groups 2, 3, 4, and 5 were administered daily with graded doses of 200,300,400 and 500 mg/kg body weight of the aqueous stem bark extract of *Detarium microcarpum* by intubation. Treatment was done for the period of six weeks. Experimental animals were fed *ad libitum* with laboratory chaw throughout the period of the study.

The animals anaesthetized with diethyl-ether were sacrificed and the blood collected by cardiac puncture. The blood was allowed to clot, centrifuged for 10 min at 3000rpm in a desktop centrifuge. Serum was collected carefully with Pasteur pipette and transferred into clean sample bottles. The serum was used to determine serum levels of AST, ALT, LDH and ACP, alkaline phosphates, glucose, cholesterol, bilirubin (Total and Direct bilirubin), albumin, total protein, urea and creatinine.

Test for alkaloids

Test for alkaloids was carried out according to the methods

described by Harborne (1973) and Trease and Evans (1978). Zero point five grammes of each extract was stirred with 5ml of 1% aqueous hydrochloric acid on a steam bath before being filtered and 1ml of the filtrate was treated with a few drops of Mayer's reagent. A second 1ml portion was treated similarly with Dragendrorff's reagent. Turbidity or precipitation with either of these reagents was observed indicating the presence of alkaloids.

Test for saponins

Test for saponins was done according to the method described by Wall *et al.* (1954). Zero point five grammes of the extract was shaken with water in a test tube and frothing which persisted on warming indicated the presence of saponins. This is called frothing test. To confirm the presence of saponins, 0.5g of the extract was boiled briefly with 50ml phosphate buffer pH 7.4. The mixture was allowed to cool and after filtration about 5ml of the filtrate was passed (after 3 hours) through an asbestos disc (1.5mm thick and 7mm in diameter) which had been previously soaked in 3 drops of 1% cholesterol in ether and dried. The disc was washed with 0.5ml distilled water. After drying, it was heated in 20ml of boiling oxylol for 2h in order to decompose the complex formed between cholesterol and any saponins. This disc was then washed in ether and after drying, it was placed on a 7% blood nutrient agar. Complete haemolysis of red blood cells around the disc after 6h occurred which indicated the presence of saponins.

Test for tannins

Test for tannins was carried out according to the method described by Trease and Evans, (1978). Five grammes of each portion of plant extract was stirred with 10ml of distilled water and then filtered and ferric chloride reagent added to the filtrate. A blue-black precipitate observed indicated the presence of tannins.

Test for phlobatannins

Test for phlobatannins was carried out according to the method described by Trease and Evans, (1978). Five millilitres of the aqueous extract was mixed with 5ml of 1% aqueous hydrochloric acid and boiled. The appearance of a reddish green colour indicated the presence of phlobatannins.

Test for anthraquinones

Test for anthraquinones was carried out according to the method described by Trease and Evans (1978). Borntrager's test was used for the detection of anthraquinones. Five grammes of each plant extract were shaken with 10ml benzene. After filtration, 5ml of 10% ammonia solution was added to the filtrate, the mixture was shaken and the none appearance of a pink or violet colour in the ammoniacal (lower) phase indicated the absence of free anthraquinones. For combined anthraquinones, 5g of each plant extract was boiled with 10ml aqueous Sulphuric acid and filtered while hot. The filtrate was shaken with 5ml benzene and the benzene layer was separated and half its own volume of 10% ammonia solution added. The none appearance of a pink, red, or violet colour in the ammoniacal (lower) phase indicated the absence of anthraquinones derivatives**.**

Test for flavonoids

Test for flavonoids was carried out according to the method described by Sofowora (1982). Five millilitres of dilute ammonia solution was added to 0.5g of the extract and 5ml of concentrated H_2SO_4 was added. A yellow colouration observed indicated the presence of flavonoids.

Test for phenols

Test for phenols was carried out according to method described by Trease and Evans (1978). Two millilitres of Ferric chloride was added to 2ml of the extract. A deep blue-green colouration observed indicated the presence of phenols.

Quantitative determination of phytochemicals components of the plant extract

Determination of total phenols

The total phenolic content was determined using the Folin-Ciocalteau procedure described by Siddhuraju and Becker (2003). To 1g of the extract, 1ml of distilled water was added. Then 0.5ml of diluted Folins-phenols reagent (1:1 ratio with water) and 2.5ml of 20% sodium carbonate were added. The mixture was shaken and incubated for 40 min at room temperature for the development of colour. Absorbance was measured at 760nm using Thermo Fisher double beam spectrophotometer. Gallic acid was used as standard and the result was expressed as microgramme of gallic acid equivalent per gramme dry mass of extract (µGAE/gDM).

Determination of alkaloids

Alkaloids determination was done according to the method described by Harborne, (1973). About 5g of the sample was weighed into a 250ml beaker and 200ml of

10% acetic acid in ethanol was added and covered and allowed to stand for 4h. This was filtered and the extract was concentrated on a water bath to one-quarter of the original volume. Concentrated ammonium hydroxide was added drop wise to the extract until the precipitation was complete. The whole solution was allowed to settle and the precipitate was collected and washed with dilute ammonium hydroxide and then filtered. The residue is the alkaloid, which was dried and weighed.

$$\text{Percentage total alkaloids} = \frac{\text{Weight of residue} \times 100}{\text{Original weight of the sample}}$$

Determination of tannins

Tannins content of the leaf extract was determined by the method described by Siddhuraju and Manian (2007). A total of 0.5ml of the extract was taken into a test tube separately and treated with 100mg of polyvinyl polypyrrolidone and 0.5ml of distilled water. The solution was incubated at 4^{o}C for 4h. Then the mixture was centrifuged at 5000rpm for 5min and 0.02ml of the supernatant was taken. This supernatant contains simple phenolics only free of tannins (tannins were precipitated along with the polyvinyl polypyrrolidone). The phenolics content of the supernatant was measured at 725nm and expressed as the content of free phenolics on a dry matter basis. From the above result, the tannins content of the extract was calculated as follows:

Percentage tannins (mgGAE/g) = Total phenolics (mgGAE/g) – Free phenolics (mgGAE/g).

Determination of saponins

The method used was that of Obadoni and Ochuko (2001). The samples were ground and 20g of the sample were put into a conical flask and 100 cm^3 of 20% aqueous ethanol were added. The samples were heated over a hot water bath for 4h with continuous stirring at about 55°C. The mixture was filtered and the residue re-extracted with another 200ml 20% ethanol. The combined extracts were reduced to 40ml over water bath at about 90°C. The concentrate was transferred into a 250ml separator funnel and 20ml of diethyl ether was added and shaken vigorously. The aqueous layer was recovered while the ether layer was discarded. The purification process was repeated. Sixty (60ml) millilitres of n-butanol was added. The combined n-butanol extracts were washed twice with 10ml of 5% aqueous sodium chloride. The remaining solution was heated in a water bath. After evaporation the samples were dried in the oven to a constant weight; the saponins content was calculated as percentage.

$$\text{Percentage total saponins} = \frac{\text{Weight of residue} \times 100}{\text{Original weight of the sample}}$$

Determination of flavonoids

Determination of flavonoids was done by the method described by Boham and Kocipai (1994). Ten grammes of the plant sample were extracted repeatedly with 100ml of 80% aqueous methanol at room temperature. The whole solution was filtered through whatman No 42 filter paper (125mm). The filtrate was later transferred into a crucible and evaporated in into dryness over a water bath and weighed to a constant weight.

$$\text{Percentage total flavonoids} = \frac{\text{Weight of residue} \times 100}{\text{Original weight of the sample}}$$

Determination of antimicrobial activity of the stem bark extract

Agar diffusion method described by Edward (1983) was used. The paper discs were put into the extract whose concentration was 20µg/ml and allowed to soak for some time. The discs were then removed and dried. The dried paper discs containing the absorbed extract were impregnated onto the surface of dried agar medium that has already been inoculated with the test organisms. These were left on the work bench for prediffusion and later incubated at 37°C for 18 to 24h. The plates were then observed and the diameter of zone of inhibition of growth was measured.

Determination of minimum inhibitory and minimum bactericidal concentration of the plant extract

Minimum Inhibitory and Minimum Bactericidal Concentrations were determined by the method described by Nester *et al.* (2004). Six test tubes containing serially diluted crude extracts in a nutrient broth were set. The dilutions were 64, 32, 16, 8, 4, and 0µg/ml respectively, and the sixth test tube with 0µg/ml served as the control. One millilitre of test organism's suspension was introduced into each test tube and then incubated for 24h. The dilution was repeated with 32, 16, 8, 4, and 2µg/ml respectively. The test tubes were incubated for 24h and then observed for growth. The test tube having the lowest concentration of the extract that does not show any growth was considered the one with minimum inhibitory concentration (MIC). The minimum bactericidal concentration (MBC) was determined by using

Table 1: Phytochemical components detected in the stem bark extract of *Detarium microcarpum*.

Phytochemical component	Alkaloids	Anthraquinones	Flavonoids	Phenols	Phlobatannins	Quinones	Saponins	Tannins
Inference	+	-	+	+	+	-	+	+

Key: + = Presence of Phytochemical component; - = Absence of Phytochemical component.
Alkaloids, phlobatannins, flavonoids, phenols, saponins, and tannins were detected while anthraquinones and quinones were not detected in the stem bark extract of *Detarium microcarpum*.

Table 2: Percentage composition of some phytochemical components in stem bark extract of *Detarium microcarpum* (g/100g).

Alkaloids	Tannins	Saponins	Phenols	Flavonoids
1.32±0.02	0.42±0.01	20.45±0.46	1.68±0.06	0.39±0.03

Table 3: Zones of inhibition of standard antibiotics /crude stem bark extract against test organisms (mm).

Test organisms	Ofloxacin	Streptomycin	Ampicillin	*Detarium microcarpum* stem bark extract
Staphylococcus aureus	10	15	15	10
Klebsiella pneumoniae	10	-	-	-
Neisseria gonorrhoea	25	25	15	15
Escherichia coli	-	20	15	-

Key: Resistance of the test organism on the antimicrobial substance

those test tubes that do not show any growth in the MIC determination. One millilitre suspension of each of the test tubes that showed no growth was introduced into test tubes containing extract – free nutrient broth and incubated for 24h. The test tubes were later observed for growth. Amongst the test tubes that do not show any growth, the one having the minimum bactericidal concentration (MBC).

RESULTS AND DISCUSSION

Phytochemically screened stem bark extract of *Detarium microcarpum* revealed the presence of alkaloids, saponins, tannins, phenols, flavonoids, and phlobatannins qualitatively. Quantitatively, tannins (0.42±0.01), saponins (20.45±0.46), flavonoids (0.39±0.03), phenols (1.68±0.06) and alkaloids (1.32±0.02) (Tables 1 and 2) were estimated in the plant extract. Phytochemicals are regarded as the active principles of plant extracts and so some of the phytochemicals observed in this study have been implicated in the treatment of certain ailments and diseases like diarrhoea, syphilis and gonorrhoea. This assertion seemed to agree with what was reported earlier by Ghoshal *et al.* (1996) that alkaloids have antidiarrhoeal effect which is probably due to their effect on transit time in the small intestine.

The zones of inhibition exhibited by the crude stem bark extract of *Detarium microcarpum* could be compared to those exhibited by the standard antibiotics such as ampicillin and streptomycin (Table 3). It could be seen that the diameter of zone of inhibition produced by the crude stem bark extract of *Detarium microcarpum* against *Neisseria gonorrhoea* is the same with that of ampicillin (i.e. 15mm each). Similarly, the diameter of zones of inhibition of the growth of *Staphylococcus aureus* by the crude stem bark extract and ofloxacin are 10mm each. It was also observed that the stem bark extract as well as ofloxacin were unable to inhibit the growth of *Escherichia coli.* Although in some areas the diameter of zones of inhibition produced by the standard antibiotics are higher compared to those produced by the crude stem bark extract, the plant extract was able to exhibit its antimicrobial effect even though with lower diameter of zones of inhibition. The difference observed in this phenomenon could possibly be due to the fact that the standard antibiotics contained industrially purified active principles devoid of any impurities as compared to the crude extract which may contain some impurities as the case may be. The minimum inhibitory concentration (MIC) of the stem bark extract of *Detarium microcarpum* against the test organisms are 16µg/ml each for *Staphylococcus aureus* and *Neisseria gonorrhoeae*; and 32µg/ml each for *Klebsiella pneumoniae* and *Escherichia coli* (Table 4). It could be stated here that the plant extract with 16µg/ml minimum inhibitory concentration each for *Staphylococcus aureus* and *Neisseria gonorrhoeae* could be further harnessed for development of antibiotic against these two organisms. It was observed that the Minimum Bactericidal Concentration (MBC) of the crude stem bark extract of *Detarium microcarpum* was 64µg/ml for *Staphylococcus aureus* and none for the remaining three test organisms (Table 5). The MIC is the lowest concentration of an antibacterial agent necessary to inhibit visible growth, while MBC is the minimum concentration of antibacterial agent that results in bacterial death.

Table 4: Minimum inhibitory concentration of test substance (µg/ml).

Detarium microcarpum stem bark extract	*S. aureus*	*K. pneumoniae*	*N. gonorrhoeae*	*E. coli*
Minimum Inhibitory Concentration	16	32	16	32

Table 5: Minimum bactericidal concentration of test substance (µg/ml).

Detarium microcarpum stem bark extract	*S. aureus*	*K. pneumoniae*	*N. gonorrhoeae*	*E. coli*
Minimum Bactericidal Concentration	64	-	-	-

Key: - = No inhibition

Table 6: Serum levels of some biochemical parameters in the experimental animals.

Treatment	AST(U/l)	ALT (U/l)	ACP (U/l)	ALP (U/l)	LDH (U/l)	Glucose (mg/dl)	Cholesterol (mmol/l)	Total bilirubin (µmol/l)	Direct bilirubin (µmol/l)	Albumin (g/l)	Total protein (g/l)	Urea (mmol/l)	Creatinine (mg/dl)
Group1 Normal/control	16.7±0.3	32.0±0.6	30.9±0.4	29.6±0.3	47.5±0.7	73.0±0.3	4.9±0.3	1.4±0.1	2.0±0.1	41.0±0.3	115.0±0.9	3.2±0.0	0.1±0.0
Group 2 200mg/kg	18.0±0.6	36.0±0.6$^{\beta}$	27.6±0.3*	24.8±0.3*	247.1±0.8$^{\beta}$	61.5±0.3*	4.2±0.0	0.8±0.0*	0.6±0.2*	42.0±0.9	146.9±3.4$^{\beta}$	5.4±0.1$^{\beta}$	0.2±0.0
Group 3 300mg/kg	20.0±0.6$^{I\beta}$	36.0±0.6$^{\beta}$	24.2±0.4*	23.0±0.2*	434.3±0.6$^{\beta}$	70.8±0.6*	3.5±0.0*	0.6±0.0*	3.0±0.3$^{\beta}$	45.3±0.0$^{\beta}$	122.4±4.7	4.9±0.3$^{\beta}$	0.3±0.1$^{\beta}$
Group 4 400mg/kg	20.3±0.7$^{\beta}$	35.3±0.9$^{\beta}$	24.2±0.1*	22.2±0.5*	612.6±1.3$^{\beta}$	79.8±0.3$^{\beta}$	3.1±0.1*	0.4±0.0*	2.3±0.3	43.0±0.7	132.9±0.3$^{\beta}$	5.6±0.4$^{\beta}$	0.3±0.1$^{\beta}$
Group 5 500mg/kg	21.3±0.3$^{\beta}$	38.3±0.6$^{\beta}$	22.4±0.3*	18.6±0.4*	235.2±1.3$^{\beta}$	78.1±1.7$^{\beta}$	3.2±0.3*	0.4±0.2*	0.7±0.0*	44.9±1.2β	141.3±1.1$^{\beta}$	5.5±0.3$^{\beta}$	0.3±0.0$^{\beta}$

Key: Values represent Mean ± SEM (n=3). P<0.05; *=significantly lower than normal/control; β= significantly higher than normal

Aspartate aminotransferases and alanine aminotransferases (AST, ALT) which represent tissue marker enzymes were observed to have increased significantly as compared to normal/control while acid and alkaline phosphatases (ACP/ALP) showed a decrease in their levels as compared to the normal/control (Table 6). When tissue damage occurs, cellular enzymes may be released into the serum and the elevation of certain enzymes is often associated with damage to specific tissues or organs. It is a basic fact that the enzymes AST, ALT, ACP, ALP and LDH are present throughout the body; their elevation (particularly in combination) is most often associated with liver injury or disease. It was observed in this study that whenever an elevation of AST activity occurs, a corresponding increase in the activity of ALT will follow suit. Elevation of these enzymes is a pointer for a possible primary liver disease. This observation was in agreement with the earlier report by the American Society of Clinical Pathologist (ASCP, 2003). The elevated level of Lactate Dehydrogenase (LDH) activity indicates some degree of cell damage to those organs where the enzyme is localized. It was reported by Devlin, (1986) that high serum LDH indicates liver congestion. Infact, the level of this enzyme would suggest liver damage even though the myocardium is the most probable one. The result of this study revealed an elevation in serum levels of albumin and total protein in the treated groups as compared to the normal group which is statistically significant ($p<0.05$). An increase in total protein may possibly be as a result of increased protein synthesis, while a high level of albumin is usually characterized by dehydration. This assertion was in agreement with the report on albumin levels by Mohamadi-Nejad *et al.* (2002). A statistically significant decrease ($p<0.05$) in the serum levels of glucose,

cholesterol, total and direct bilirubin in the treated rats as compared with the normal/control was observed. Serum urea and creatinine levels of the treated animals were observed to have increased above the normal/control group. The results indicated a statistically significant ($p<0.05$) increase in urea and creatinine levels (Table 6). Elevation of urea and creatinine which are indicators of kidney function could possibly be due to the effect of the extract thereby suggesting kidney injury. This observation seemed to agree with what has been reported by Smith, (2005).

Conclusion

Detarium microcarpum contained some bioactive compounds such as alkaloids, tannins, saponins, phenols, flavonoids, and phlobatannins which may be responsible for the various biochemical effects of the stem bark extract of the plant. The plant extract has exhibited its antimicrobial potentials on some microorganisms especially *Staphylococcus aureus* and *Neisseria gonorrhoeae*. The result indicates that prolonged administration of the stem bark extract on experimental animals will tantamount to both liver and kidney injury as shown by the elevations of AST, ALT, LDH, Urea and Creatinine levels.

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