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Antibacterial Activity and Phytochemical Screening of Eleven Plants Used as Poultry Ethnomedicines in Southern Uganda

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Abstract: This study evaluated the antibacterial activity of aqueous extracts of eleven plants against gram positive (*Staphylococcus aureus*, *Streptococcus faecalis*) and gram negative (*Escherichia coli* and *Salmonella typhimurium)* bacteria using the agar well diffusion assay and tube dilution method. Qualitative tests were carried out to investigate the phytochemical composition for ether, ethanol and aqueous extracts of these plants. In general, gram-positive bacteria were more susceptible than gram-negative bacterial species. The aqueous extract of *Moringa oleifera* had activity on all the four bacteria species. The aqueous extracts of *Persea americana* had the lowest MIC (0.25 g mL^{-1}) and therefore, the best activity on *Salmonella typhimurium*. *Leonotis nepetifolia* with MIC (0.25 g mL^{-1}) and *Lantana trifolia* with MIC (0.15 g mL^{-1}) had the lowest MICs and therefore, the best activity on *Staphylococcus aureus*. The most prominent phytochemicals of medicinal importance established in the extracts of most test plants were tannins, sterols, basic alkaloids and alkaloid salts. These results suggest that *Moringa oleifera* extracts could be of value in the discovery of compounds which may be effective in the treatment of a number of bacterial diseases. Similarly, *Persea americana* extracts may contain active compounds that could be used for treatment of salmonellosis while *Leonotis nepetifolia* and *Lantana trifolia* may contain compounds effective against staphylococcal infections. All the 11 tested plants contain phytochemicals with potentially beneficial therapeutic effects.

Key words: Antibacterial activity, phytochemicals, aqueous extracts, poultry, potentially, Uganda

INTRODUCTION

Medicinal plants have been used as traditional treatments for numerous diseases for thousands of years in many parts of the world. In rural areas of the developing countries, they continue to be used as the primary source of medicine (Chitme *et al*., 2003). Different phytochemicals display various mechanisms of action such as increasing colonic water and electrolyte reabsorption and inhibition of intestinal motility while some components have been shown to inhibit specific pathogens (Ahmad *et al*., 2006). Phytochemicals such as saponins, terpenoids, flavonoids, tannins, steroids and alkaloids have anti-inflammatory effects (Liu, 2003). Steroids and triterpenoids have analgesic properties (Sayyah *et al*., 2004; Malairajan *et al*., 2006).

Mucilages check bacterial growth and adsorb toxins and wastes helping their elimination from the body. Some carbohydrates have been shown to have immunomodulatory effects (Pengelly, 2004).

The search for newer sources of antibiotics is a global challenge preoccupying research institutions, pharmaceutical companies and academia, since many infectious agents are becoming resistant to synthetic drugs (Latha and Kannabiran, 2006). Use of similar or identical antibiotics in both human and veterinary medicine has come under increasing scrutiny by concerned regulators (Cox and Popken, 2006). There is also increased public and scientific concern regarding the administration of therapeutic and sub-therapuetic doses of antimicrobials to animals due to the emergence and dissemination of multiple antibiotic resistant zoonotic bacterial pathogens (McDermott *et al*., 2002). Infection with antibiotic resistant bacteria negatively impacts on public health due to an increased incidence of treatment failure and severity of disease (Walsh and Fanning, 2008) and increased health care expenditures (Lathers, 2002). There is hence, a need for clinical pharmacologists to limit the development of bacterial resistance and the associated morbidity and mortality through development of newer antimicrobials.

Investigations into the chemical and antimicrobial activities of plant extracts for more active therapeutic agents should therefore be carried out (Rao and Roja, 2002). As there are approximately 5,00,000 plant species occurring worldwide of which only 1% has been phytochemically investigated, there is great potential for discovering novel bioactive compounds (Palombo, 2009).

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This study hence evaluated the antibacterial activity of aqueous extracts and qualitatively investigated the phytochemical composition of eleven plants used to treat poultry diseases in Masaka district of Uganda.

MATERIALS AND METHODS

The plants used in the study were identified at the Herbarium of the Department of Botany, Makerere University. The identification of the phytochemicals present in the crude extracts from the eleven plants was done at the Natural Chemotherapeutics Laboratory of the Ministry of Health, Uganda. Antibacterial screening tests against selected bacteria were then carried out using the aqueous extract at the Microbiology Laboratory of the School of Veterinary Medicine, Makerere University.

Preparation of extracts: Eleven plants which are claimed to treat poultry diseases in Masaka were collected, identified and air dried under a shade at room temperature, i.e., 24°C for at least 2 weeks. The plant material from plant parts specified by the farmers was ground in a grinding machine. The barks of the trees were further dried at 45°C in an oven overnight to completely remove residual moisture before milling into fine powder. The powders were then sealed in air-tight polyethylene bags and stored in a cool dry place.

Extracts were prepared using the cold extraction methods. The plant samples were extracted using polar solvents, i.e., distilled water and ethanol (BDH, UK) and a non polar solvent (diethyl ether, BDH, UK) to obtain aqueous, ethanol and ether extracts. The extracts were concentrated by evaporation using a rotary evaporator (Perkins, UK), weighed and reconstituted in DMSO (BDH, UK) to a concentration of 1 g mL^{-1}. These were then stored in a refrigerator at 4°C and latter used in the proceeding phytochemical tests and antibacterial activity studies.

Phytochemical screening: This was done following the standard methodologies (Harborne, 1998; Houghton and Raman, 1998; Woo, 2001; Sumitra *et al*., 2006). The extracts were screened for carbohydrates, mucilages, saponins, tannins, flavone aglycones, anthracenoside aglycones, coumarins, sterols, carotenoids, alkaloid salts, basic alkaloids, reducing sugars, coumarins derivatives, flavonosides and steroid glycosides.

To identify carbohydrates, 2 mL of aqueous extract were put into porcelain capsule and evaporated to dryness. Then 3 drops of concentrated sulphuric acid (Fisher Scientific, UK) were added and allowed to stand for 5 min followed by 3 drops of an alcoholic solution saturated with thymol (Molisch's reagent, Fisher Scientific, UK) were added. The occurrence of a red colour denoted presence of carbohydrates.

For the identification of mucilages, 2 mL of the aqueous extract were added drop wise in a test tube where 10 mL of alcohol or acetone (Fisher Scientific, UK) had already been placed. A thick precipitate was formed and it was separated off by centrifugation and washed away with alcohol, then stained with methylene blue (Fisher Scientific, UK). The occurrence of a blue precipitate denoted presence of mucilages.

For saponins, the aqueous extract was diluted in distilled water in a ratio of 1:1 and 2 mL of the diluted solution was put in a 1.6 cm diameter test tube and shaken for 15 min. The occurrence of foam column indicated presence of saponins.

The identification of tannins was done by mixing 1 mL of aqueous extract with a solution of ferric chloride (sigma). If the extract contained both types of tannins, a hydrochloric formaldehyde solution (Styassny's reagent) was boiled with reflux. Under these conditions, the catechol tannins were condensed as a red precipitate which was then filtered. The solution, thus obtained was neutralized with sodium acetate and some drops of ferric chloride were added. A deep blue colour indicated presence of gallic tannins.

To identify flavone aglycones, 3 mL of the ether extract were evaporated to dryness and a residue was obtained. The residue was redissolved in 1-2 mL of 50% methanol (Fisher scientific, UK) in a round bottomed flask kept in the water bath set at 40°C. Metallic magnesium (Fisher Scientific, UK) and 4-5 drops of concentrated hydrochloric acid (Fisher Scientific, UK) were added. An orange or red colour indicated presence of flavonic aglycones (Shibata's reaction or Cyanidin test).

The identification of anthracenoside aglycones (emodols) was done by transferring 3 mL of ether extract to a test tube. The 1 mL of 25% ammonia solution (Phillip Harris, England) was added and shaking was done. A red colour indicated presence of emodols.

To determine the presence of coumarins, 3 mL of ether extract were evaporated to dryness. The residue was dissolved in hot water. After cooling, the solution was divided into two tubes; one tube served as the reference while the aqueous solution of the second tube was made alkaline with 0.5 mL of 10% ammonium solution (Phillip Harris, England). The occurrence of an intense fluorescence under UV light indicated presence of coumarins.

To identify sterols, the ether extract was evaporated to dryness. The residue was redissolved in 0.5 mL of acetic acid (Fisher Scientific, UK) and then in 0.5 mL of

chloroform. The solution was transferred to a dry tube and 2 mL of concentrated sulphuric acid (Fisher Scientific, UK) were added at the bottom of the tube (Libermann-Burchard's reaction). If there is formation of a brownish-red or violet ring at the contact zone of the two liquids and the supernatant layer becomes green or violet, it indicated presence of sterols.

To identify carotenoids, 10 mL of the ether extract was evaporated to dryness and 3 drops of saturated solution of antimony trichloride (Fisher Scientific, UK) in chloroform (sigma) were added (Carr price reaction). The pigments were at 1st blue and later become red.

The identification of basic alkaloids was carried out on the residue obtained by evaporating 10 mL of the ether extract. The residue was dissolved in 1.5 mL of 2% hydrochloric acid (Fisher Scientific, UK). From this, a sample made up of 0.5 mL acidic aqueous solution was got and 2-3 drops of Mayer's reagent (Fisher Scientific, UK) was added to 0.5 mL of acidic aqueous solution. An opalescence which was a cream coloured precipitate indicated presence of alkaloids.

The presence of reducing sugars was assessed by diluting 1 mL of the ethanol extract with 2 mL of water. Fehling's solution (sigma) was added and heated in a water bath maintained at 40°C. A brick-red precipitate denoted the presence of reducing sugars.

Identification of alkaloid salts was done by adding 8 mL of 10% hydrochloric acid (Fisher Scientific, UK) to the ethanol extract and the content stirred using a glass rod in a water bath (100°C). This was then cooled and 0.5 g of sodium chloride (Fisher Scientific, UK) was added and stirred again. The solution was filtered and the filtrate was washed with 3 mL of hydrochloric acid (Fisher Scientific, UK). About 1 mL of this acidic extract was then used to perform a test with Mayer's reagent (Fisher Scientific, UK). The occurrence of precipitate indicated presence of alkaloid salts.

The determination of coumarins derivatives, flavonosides and steroid glycosides was done by 1st hydrolysing the alcohol extract. Briefly, 15 mL of 10% hydrochloric acid (Fisher Scientific, UK) were added to 25 mL of alcohol extract by refluxing and heated up for 30 min. After cooling, the solution was extracted three times with 12 mL of diethyl ether (Fisher Scientific, UK) in a separating funnel. The ether fraction was dehydrated with anhydrous sodium sulphate (Fisher Scientific, UK). The ether fraction was used in the identification of coumarin derivatives, flavonosides and steroid glycosides as described above.

Antibacterial assays: The antibacterial assays were carried out using Agar well diffusion tests and broth dilution techniques. The antimicrobial activity of the plant extracts was tested on four standard bacteria species namely; *Streptococcus feacalis* (wild strain), *Staphylococcus aureus* b. (ATCC 25923) representing gram positive bacteria and *Escherichia coli* (ATCC25922) and *Salmonella typhimurium* (ATCC14028) representing the gram negative bacteria. These were standard laboratory cultures whose susceptibility on commonly used antibiotics was already established. These bacteria species were chosen because they are major causes of bacterial diseases in poultry. A standardized bacterial suspension was prepared by picking a colony of respective bacteria using sterile wire loop and suspending it in 5 mL of Brain heart infusion liquid media (Mast Diagnostics, UK). The dilutions formed the bacterial stock solutions for use in the Agar well diffusion assays as follow:

Agar well diffusion assay: The Agar well diffusion technique (Agarry *et al*., 2005) was the standard method used to determine the antibacterial activity of the aqueous extracts. Briefly, Mueller Hinton agar (Becton Dickinson, MD, USA) was prepared and treated according to manufacturer's guidelines, i.e., 35 g of media was mixed with one litre of distilled water and enclosed in a container and autoclaved at 121°C for 15 min. The media was later dispensed into 90 mm sterile agar plates (Oxoid, UK) and left to set. The agar plates were incubated for 24 h at 37°C to confirm their sterility. Absence of growth after 24 h showed that the plates were sterile.

The sterile Mueller Hinton agar plates were inoculated with the test culture by surface spreading using sterile wire loops and each bacterium evenly spread on the entire surface of the plate to obtain uniformity of the inoculum. The culture plate then had at most 4 wells of 6 mm diameter and 5 mm depth made into it using a sterile agar glass borer. Gentamicin was used as a positive control while normal saline was used as a negative control.

Approximately, 0.2 mL of the aqueous extract (concentration 1 g mL^{-1}) was suspended in the wells and thereafter inoculated plates were incubated for 24 h at 37°C. The plates/cultures were examined for the presence of bacterial inhibition zones around each well. Antibacterial activity was determined by the presence of a zone of inhibition around the wells. Single readings were carried out. Absence of an inhibition zone was deemed to indicate nonexistence of antibacterial activity. The zones of inhibition were measured using a ruler and a pair of dividers (Picfare, Uganda) and results were reported in millimetres (mm). All zone diameters were considered important since, the extracts from the plants were still

crude. A zone size interpretive chart was then drawn to show the different plant extracts and their corresponding inhibition zone diameter to the nearest millimetre.

The broth dilution assay: The MIC was determined using the tube dilution method for plant aqueous extracts which showed activity on any of the test bacteria (Adesokan *et al*., 2007; Oyeleke *et al*., 2008; Cheruiyot *et al*., 2009). Dilutions of the extract were incorporated in Muller Hinton broth (Oxoid, UK) and then inoculated with 0.01 mL of standardized suspension of the test organisms. The test was performed using four concentrations of each extract (0.5, 0.251, 0.125 and 0.0625 g mL^{-1}). For each extract, 1 mL of the resultant broth and 1 mL of the extract were added in a test tube and serial dilution was carried out using a two fold dilution and the last 1 mL was discarded.

Each organism was separately suspended in 5 mL of Brain Heart infusion broth and incubated overnight. Thereafter, 0.1 mL of the extract was added to all the test tubes and the preparation incubated at 37°C for 18 h. After incubation, a loop full from each tube was sub cultured on nutrient agar to see if bacteria growth was inhibited. Growth of bacteria on solid media indicated that particular concentration of the extract was unable to inhibit the bacteria. The lowest concentration of extract (g mL^{-1}) showing no growth indicated the amount of extract to which the organism is susceptible. This was the Minimum Inhibitory Concentration (MIC).

RESULTS AND DISCUSSION

The phytochemical screening results were reported basing on the intensity of the reaction. The antibacterial activity of the aqueous extracts were expressed both as zones of inhibition and Minimum Inhibitory Concentrations (MICs).

Phytochemicals in the plants: The presence of carbohydrates, mucilages, tannins and saponins was determined from the aqueous extract. The phytochemicals tested for in the ether extract were sterols, carotenoids, basic alkaloids, flavonoic aglycones, anthracenoside aglycones and coumarins while reducing compounds, alkaloids salts, sterol glycosides, coumarin derivatives and flavonones were identified using the ethanol extract. For aqueous extracts, carbohydrates and tannins were the phytochemicals that were present in a large number of test plants. About 91% of the plants contained tannins and carbohydrates. *Syzygium cuminii* and *Albizia coriaria* had the highest levels of a wide range of phytochemicals (Table 1).

For the phytochemicals identified from ether extracts, basic alkaloids and sterols showed the most widespread presence in the plants studied (91% of the plants). *Desmodium salicifolium* ether extracts had the highest levels of a wide range of phytochemicals (Table 2). For phytochemicals identified from ethanol extracts, alkaloid salts showed the most widespread presence in the

Table 1: The aqueous extract was screened for mucilages, carbohydrates, tannins and saponins (phytochemicals of aqueous extracts of test plants)

Phytochemicals	Mucilages	Carbohydrates	Tannins	Saponins
Moringa oleifera	+	++	+ (catecols)	-
Lantana trifolia	-	+	++ (catecols)	+
Sida cuneifolia	+	++	++ (catecols)	-
Vernonia cineria	-	++	+ (catecols)	-
Tetredenia riparia	-	+++	+ (catecols)	-
Desmodium salicifolium	-	+	-	+
Persea americana	+	-	++ (catecols)	+
Aspilia africana	-	++	++ (catecols)	-
Syzygium cuminii	-	+++	++ (gallic)	+
Albizia coriaria	+	+++	++ (catecols)	+
Leonotis nepetifolia	+	+	++ (catecols)	-

- indicates the extract remained clear with no change and hence absence of the phyto-chemical; + indicates faint changes against dark background and presence of traces of the phytochemical; ++ means a definite change was noticed, thus presence of the phytochemical; +++ represents a heavy change and an intense presence of the phytochemical

Table 2: The ether extract was screened for sterols, carotenoids, basic alkaloids, flavone aglycones, anthracenoside aglycones and coumarins (phytochemicals of ether extracts of test plants)

Phytochemicals	Sterols	Carotenoids	Basic alkaloids	Flavone aglycones	Anthracenoside aglycones	Coumarins
Moringa oleifera	+	-	-	+	++	+
Lantana triflolia	++	+	++	-	+	-
Sida cuneifolia	+	-	++	+	-	++
Vernonia cineria	+	+	++	-	-	-
Tetredenia riparia	-	+	+++	-	-	-
Desmodium salicifolium	+++	++	++	+	+++	-
Persea americana	++	-	++	-	-	+
Aspilia africana	+	-	++	+	-	+
Syzygium cuminii	+	-	+	-	-	+
Albizia coriaria	+++	-	+	-	-	+
Leonotis nepetifolia	+	+	++	-	-	+

- indicates the extract remained clear with no change and hence absence of the phytochemical; + indicates faint changes against dark background and presence of traces of the phytochemical; ++ means a definite change was noticed, thus presence of the phytochemical; +++ represents a heavy change and an intense presence of the phyto-chemical

Table 3: The ether extract was screened for reducing sugars, alkaloid salts, sterol glycosides, coumarin derivatives and flavonones (phytochemicals of ethanol extracts of test plants)

Phytochemicals	Reducing sugars	Alkaloid salts	Sterol glycoside	Coumarin derivatives	Flavonones
Moringa oleifera	+	++	+	++	+
Lantana triflora	+	++	+	+	-
Sida cuneifolia	-	++	+	+	+
Vernonia cineria	+	++	+	+	-
Tetredenia riparia	-	++	+	+	-
Desmodium salicifolium	+	+	++	+	-
Persea americana	++	++	+	+	-
Aspilia africana	++	++	++	++	-
Syzygium cuminii	++	++	+	++	-
Albizia coriaria	++	++	-	+	-
Leonotis nepetifolia	+	++	+	+	-

- indicates the extract remained clear with no change and hence absence of the phytochemical; + indicates faint changes against dark background and presence of traces of the phytochemical; ++ means a definite change was noticed, thus presence of the phytochemical; +++ represents a heavy change and an intense presence of the phytochemical

Table 4: The activity of the aqueous extracts was assessed by determination of the presence or absence of a zone of inhibition. The inhibition zones were expressed in mm (antibacterial screening of aqueous extracts)

	Inhibition zone diameter (to the nearest mm)			
Plant extract	*Strep. faecalis*	*Staph. aureus*	*E. coli*	*S. typhymurium*
Moringa oleifera	1.0	1.3	1.4	1.4
Lantana trifolia	1.2	2.1	0.0	2.1
Sida cuneifolia	0.0	1.2	0.0	0.0
Vernonia cineria	0.0	1.3	0.0	0.0
Tetredenia riparia	0.0	0.9	0.0	0.0
Desmodium salicifolium	0.0	0.0	0.0	1.1
Persea americana	0.0	2.0	1.3	1.8
Aspilia africana	0.0	0.0	1.1	1.4
Syzygium cuminii	1.4	1.6	0.0	0.0
Albizia coriaria	1.6	1.9	0.0	0.0
Leonotis nepetifolia	0.0	0.9	0.0	0.0

test plants. About 100% of the plants contained alkaloid salts. *Aspilia africana* ethanol extracts had the highest levels of a wide range of phytochemicals (Table 3).

Antibacterial activity of aqueous extracts: All the tested plants had antibacterial activity against at least one of the 4 bacteria species as shown in Table 4. About 9% of the aqueous extracts had activity on all the four bacteria species, 18% on three bacteria species, 27% on only 2 bacteria species and 46% on one bacteria species. Of the plant extracts with activity, 82% were active on gram positive bacteria and all were active on *Staph. aureus* while 36% were active on *Strep. feacalis*. Of all the plants whose aqueous extracts showed antibacterial activity, 45% were active on gram negative bacteria and all these were active on *S. typhymurium* while 27% were active on *E. coli* (Table 4).

Minimum inhibition concentration: Plants whose aqueous extracts showed activity were tested further on the same bacteria species to determine the minimum inhibition concentrations. All the four plants whose water extracts were active against *Strep. faecalis* had a Minimum Inhibition Concentration (MIC) of 0.5 g mL^{-1} and these were *Moringa oleifera*, *Lantana trifolia*, *Syzygium cuminii* and *Albizia coriaria*. For *Staph. aureus*, *Lantana trifolia* had the least MIC, i.e., 0.125 g mL^{-1} while *Leonotis nepetifolia* had a MIC of 0.25 g mL^{-1}. The rest of the plants whose extracts had activity on *Staph. aureus* had a MIC of 0.5 g mL^{-1} (Table 5). All the three plants whose extracts were active on *E. coli* had a minimum inhibition concentration of 0.5 mL^{-1}. For *S. typhimurium* and *Persea americana* had the least MIC, i.e., 0.25 g mL^{-1} while the rest had 0.5 g mL^{-1} (Table 5).

This study aimed at determining the phytochemical composition and the antibacterial activity of aqueous extracts of several medicinal plants used by poultry farmers in Masaka district of Uganda. *Moringa aloefera* was active on all the bacteria species, indicating broad spectrum activity. Other studies have demonstrated that the fresh leaf juice and aqueous extracts from the seeds inhibit the growth of *Pseudomonas aeruginosa* and *Staphylococcus aureus* (Caceres *et al*., 1991). *Persea americana* and *Aspilia africana* were active on both gram negative bacteria. Similar results were obtained in an evaluation of the aqueous extracts of the leaves of *Aspilia africana* in Sierra Leone which exhibited antibacterial activities on both gram-positive and negative bacteria species at concentrations ranging from 0.1-0.5 g mL^{-1} (Macfoy and Cline, 1990). Extracts from these plants may be of great value since previous studies have reported that antimicrobial resistance has emerged in gram negative zoonotic enteropathogens such as *Salmonella* sp. and *Escherichia coli* (McEwen and Fedorka-Cray, 2002) justifying the search for newer compounds with activity against such pathogens. The aqueous extracts of *Persea americana* had the lowest MIC on *S. typhymurium* while *Leonotis nepetifolia* and *Lantana trifolia* had the lowest

Table 5: The MICs obtained for the aqueous extract of the test plants when evaluated for antibacterial activity against the four test bacteria using the broth dilution assay (Minimum Inhibition Concentration (MIC) of active aqueous extracts on bacteria)

Bacteria	Species susceptible	(MIC) g mL^{-1}	Plant species
Gram-positive	*Staph. aureus*	0.125	*Lantana trifolia*
		0.250	*Leonotis nepetifolia*
		0.500	*Moringa oleifera, Sida cuneifolia, Vernonia cineria, Tetredenia riparia, Persea americana, Syzygium cuminii, Albizia coriaria*
	Strep. faecalis	0.500	*Moringa oleifera, Lantana. trifolia, Syzygium cuminii, Albizia coriaria*
Gram-negative	*S. typhymurim*	0.250	*Persea americana*
		0.500	*Moringa oleifera, Desmodium salicifolium, Lantana trifolia, Aspilia africana*
	E. coli	0.500	*Moringa oloefera, Persea americana, Aspilia africana*

MIC on *Staph. aureus* bacteria. Similar promising results have been reported for *Persea americana* aqueous leaf extracts on *S. typhi* and *E. coli* (Tomani *et al*., 2003) and for *Lantana trifolia* against *Streptococcus mutans* (Odongo *et al*., 2011).

Majority of the plants in this study demonstrated presence of tannins. Tannins have been found to form irreversible complexes with proline-rich proteins resulting in the inhibition of cell protein synthesis, bind proteins and adhesins, inhibit enzymes and complex with cell walls (Iqbal *et al*., 2006). Many human physiological activities such as stimulation of phagocytic cells, host-mediated tumor activity and a wide range of anti-infective actions have been assigned to tannins (Haslam, 1996). Thus, their mode of antimicrobial action may be related to their ability to inactivate microbial adhesins, enzymes, cell envelope transport proteins and to complex with polysaccharides (Brownlee *et al*., 1990). This probably explains the reason as to why the plants containing tannins showed good antibacterial activity. It is hence not surprising that farmers use these plants in the management of poultry diseases.

Basic alkaloids and alkaloid salts were also present in most of the plants tested. Alkaloids have been reported to be responsible for the antibacterial activity in some plants (Doughari, 2006). Earlier studies have also shown that alkaloids possess antimicrobial properties (Osbourn, 2003) which may be associated with inhibition of nucleic acid, protein and membrane phosipholipids biosynthesis (Shelton, 1991) or their ability to intercalate with DNA (Phillipson and O'Neill, 1987). This probably explains the use of plants which contain these phytochemicals in treatment of poultry diseases by the community. Furthermore, sterols and sterol glycosides also showed widespread presence in the test plants. Earlier studies have shown that sterols possess antibacterial and antimycotic activity and have been shown to act as inhibitors of tumor promotion *in vivo* (Yasukawa *et al*., 1991). The presence of sterols has been reported to account for the antimicrobial activity exhibited by plants containing them (Vander and Johan, 2001) which may explain the use of such plants in treatment of poultry diseases by the community.

CONCLUSION

In this study, the results showed that the test plants contained phytochemicals of medicinal importance. It is probable that these constituents were responsible for the antibacterial activity exhibited and this supports the use of these plants in treatment of various bacterial infections in poultry. Researchers therefore, recommend clinical trials, toxicity tests and isolation of active compounds for possible use in treatment of disease.

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