In vitro anti-radical and anti-salmonella activities of sarocephalus latifolius, laneea barteri, uvaria chamae, parkia biglobosa and khaya senegalensis

Abstract

This study aims to analyze the chemical compounds and evaluate the anti-radical and anti-Salmonella activities of extracts from Sarcocephalus latifolius, Lannea barteri, Uvaria chamae, Parkia biglobosa and Khaya senegalensis using respectively standards phytochemical methods, phosphomolybdates reduction method and micro dilution method in liquid medium associated with plating on agar medium. Qualitative phytochemical tests revealed the presence of alkaloids, flavonoids and tannins in all extracts. Quantitative phytochemical analysis showed that the stem bark of Khaya senegalensis, Parkia biglobosa and Lannea barteri displayed high anti-radical properties with respectively 9.12±0.17mgEAA/g, 9.30±0.15mgEAA/g and 8.28±0.23mg EAA/g values of antioxidants. Antimicrobial tests on Salmonella strains yielded MIC that varied with plants extracts: 6.25 to 12.5mg/ml for Sarcocephalus latifolius and Lannea barteri, 25mg/ml for Uvaria chamae, 50mg/ml for Khaya Senegalensis and Parkia biglobosa. These observations could be use to design new drugs that will provide better therapeutic options for the treatment of Salmonellosis and oxidative-related diseases.

Keywords: plant extract, phytochemical analysis, anti-radical and anti-salmonella activities

Abbreviations: S. latifolius, sarcocephalus latifolius; L. barteri, laneea barteri; U. chamae; uvaria chamae; P. biglobosa, parkia biglobosa; K. senegalensis, khaya senegalensis; MIC, minimum inhibitory concentration; MBC, minimum bactericidal concentration; S. typhi, salmonella typhi; S. enteric, salmononella enteric; S. paratyphi, salmonella paratyphi; S. typhimurium, salmonella typhimurium; FCR, folin ciocaulte reagent; ND, not determined; EGA, equivalent gallic acid; EC, equivalent catechin; EAA, equivalent ascorbic acid; CERMETRA-TOGO, centre d’étude et de recherche en médecine traditionnelle apliquée du togo

Introduction

Infectious diseases account for 45% of deaths in low-income countries. Bacterial infections account for 70% of the mortality caused by microorganisms. The genus Salmonella, more specifically the serotype typhi or less frequently the serotypes paratyphi A, B or C are responsible of typhoid fever and paratyphoid fever. Tens of millions of cases are recorded every year in the world, with over one hundred thousand deaths a year, the majority of them in developing countries. The increased resistance of microorganism’s strains to the molecules presents on the market and the new WHO recomendations that require each country to introduce natural treatment methods into their health system are pushing many universities and pharmaceutical laboratories to explore medicinal plants, which are less expensive and have fewer side effects. It is in this perspective that the anti-radical and the anti-Salmonella potential of the extracts from five medicinal plants used in the Togolese pharmacopoeia to treat fevers and gastroenteritis, has been done. These include Sarcocephalus latifolius, Lannea barteri, Uvaria chamae, Parkia biglobosa and Khaya senegalensis.

Sarcocephalus latifolius is a shrub of family Rubiaceae that usually grows in humid areas of tropical Africa. Its roots are used for several applications in traditional medicine. Its anti-radical properties have been reported by Antia et al. Its roots extracts also have antibacterial activities against Salmonella and other bacteria. Lannea barteri is a tree of family Anacardiaceae whose preparation is used in the treatment of gastritis, fever among others. Njinga et al. showed the anti-Salmonella activity of its leaves extract. Uvaria chamae belong to the family Annonaceae. It is a plant from the Togolese Pharmacopoeia that is used in the treatment of gastrointestinal pain, yellowing, wound healing, fever and constipation. A phytochemical study conducted by Kone et al. showed that the aqueous extracts of the roots of the plant have anti-radical properties. Ogbulie et al. in 2007 reported its bactericidal effect against bacteria including Salmonella typhi. Parkia biglobosa is a tree of family Mimosaceae. It bears fruit in the form of long pods suspended in clusters, containing numerous black seeds coated with yellow pulp. Its trunk bark has been successfully used in the treatment of many diseases including fevers, diarrhea, and severe stomach aches. The anti-radical properties of trunk bark extract have been reported by Komelafe et al. The same extract is active against a large number of microorganisms including Salmonella typhi and Shigella dysenteriae. Khaya senegalensis is a tree of family Meliaceae that is used in the African pharmacopoeia to treat dermatitis, malaria, fever, jaundice and stomachaches. Atawodi et al. reported the anti-radical properties of the plant trunk bark.
extraction. The anti-Salmonella action of the same extracts was shown in a previous study conducted by Abdallah et al.\textsuperscript{17}

**Material and methods**

**Framework of study**

Extractions, phytochemical and microbiological tests were carried out in "Laboratoire de Microbiologie et de Contrôle de qualité des Denrées Alimentaires (LAMICODA)", of the University of Lomé.

**Plant material**

It is made up of different organs of medicinal plants harvested in the maritime region of Togo, in the localities of "Aképé", "Noépé" and "Badja" on 02-10-2016. These are: the trunk bark of *Khaya senegalensis*, *Parkia biglobossa* and *Lannea barteri*, root bark of *Sarcocephalus latifolius* and roots of *Uvaria chamae*. The plants were authenticated in the Botanical Laboratory of the University of Lomé. The herbarium numbers are respectively TG01797, TG15084, TG09467, TG07536 and TG01950.

**Preparation of plants extracts**

The plant material is cut into small blocks and then dried out of the sun at the Laboratory temperature between 16 and 24 degrees Celsius before being pulverized. 500ml of the ethanol-water mixture (70%-30%) is added to 100g of vegetable powder previously weighed in a beaker. The whole is stirred for 24 hours and filtered on Wattman paper. The various filtrates obtained are evaporated at 40°C with a rotary evaporator. A solution of 100mg/ml of the extracts was prepared by dissolving 5g of dry extract in 50 ml of distilled water. This extract solution was filtered through 0.45μm millipore membrane. The sterilized extract was used for antimicrobial test.

**Test organism**

Four strains of *Salmonella* were tested; two clinical strains (*Salmonella typhi* and *Salmonella enterica*) isolated in the Bacteriology Laboratory of “Institut National d’Hygienne (INH)” of Lomé in October 2017, and two reference strains (*Salmonella typhimurium* ATCC 14028 and *Salmonella paratyphi* ATCC 9150). These strains were isolated and then stored at 2-8°C on the nutrient agar. The two clinical strains tested are multirésistant. *Salmonella enterica* is resistant to more molecules than *Salmonella typhi*. *Salmonella enterica* is resistant to ampicillin, ticarcillin, cefalotin, cefoxitin, amikacin, gentamicin, tobramycin and nalidixic acid. *Salmonella typhi* is resistant to cefalotin, cefoxitin, amikacin, gentamicin and tobramycin.

**Bacteriological tests**

The authentication and antibiogram of the clinical strains were carried out on the VITEK 2 bioMérieux device, with the identification and antibiogram cards of the bioMérieux brand. The technique used for antibacterial tests is the microdilution in liquid medium combined with the determination of the Minimal Inhibitory Concentration (MIC) and Minimal Bactericidal Concentration (MBC). The second step consists in oxidizing these monomers under the action of Fe$^{2+}$ as described by Singleton et al.\textsuperscript{21} The standard used is gallic acid. The Butanol/ HCl method was used to assay proanthocyanidins. It is a colorimetric reaction that takes place in two stages. In a first step, the polymers of flavan-3-ol are hydrolyzed in a butanol-HCl medium. The hydrolysis is complete and releases monomers of catechin and epicatechin type. The second step consists in oxidizing these monomers under the action of Fe$^{2+}$ to give the cyanidin whose red coloring is a function of the concentration of proanthocyanidines. The standard used is Catechin. The method used for the *anti-radical* tests is the phosphomolybdates reduction. The principle is based on the reduction of Mo$^{VI}$ molybdate to Mo$^{V}$ molybdate by the antioxidant compounds with the formation of a Mo$^{V}$ phosphomolybdate green complex which has a maximum absorption at 695nm.\textsuperscript{24}

**Statistical analysis**

A pre-test was carried out before the first manipulation. The tests were repeated twice. In each case, averages and errors were calculated for the concentrations measured in the two sets of experiments. These averages were statistically compared using one-factor ANOVA at P<0.05.
Results and discussion

In order to study the anti-Salmonella activities of extracts from Sarcocephalus latifolius, Lannea barteri, Uvaria chamae, Parkia biglobosa and Khaya senegalensis a microdilution technique was performed.\textsuperscript{18,19} Table 1 shows the MIC and the MBC of plants extracts on Salmonella strains. The anti-Salmonella investigation revealed MIC from 6.25 to 12.5mg/ml with Sarcocephalus latifolius, 12.5mg/ml with Lannea barteri and 25mg/ml with Uvaria chamae. The anti-Salmonella activities depend on plants extracts studied. But in general, all the different strains of Salmonella tested had the same behavior with the same extract. The hydroethanolic extracts of the root bark of Sarcocephalus latifolius had a bactericidal effect on strains at MIC of 6.25mg/ml on Salmonella typhi, Salmonella typhimurium, Salmonella paratyphi, and 12.5mg/ml on Salmonella enterica. This was consistent with the works of Deeni et al.\textsuperscript{6} and Aguera et al.\textsuperscript{7} on the antibacterial properties of the roots of Sarcocephalus latifolius. They found respectively MIC of 5mg/ml with the hydromethanolic extracts and 10mg/ml with aqueous extracts on Salmonella strains.

Table 1 MIC and MBC of Plants Extracts

| Plant          | MIC (mg/ml) | MBC (mg/ml) | Plant          | MIC (mg/ml) | MBC (mg/ml) | Plant          | MIC (mg/ml) | MBC (mg/ml) | Plant          | MIC (mg/ml) | MBC (mg/ml) |
|----------------|-------------|-------------|----------------|-------------|-------------|----------------|-------------|-------------|----------------|-------------|-------------|
| S. Typhi       | 6.25        | 12.5        | S. enterica    | 12.5        | 12.5        | S. paratyphi   | ATCC 9150   | 6.25        | 12.5           | 25          | 50          |
| S. typhimurium | ATCC 14028  | 6.25        | P. biglobosa   |             |             | K. senegalensis|             |             |                |             |             |

ND, not determined

Hydroethanolic extracts of the trunk bark of Lannea barteri had a bactericidal effect on the tested strains at a MIC of 12.5mg/ml. Njingga et al.\textsuperscript{8} also reported the anti-Salmonella activity of the plant, but he tested the chloroform and ethyl acetate fractions of the leaves on Salmonella typhi ATCC 9184 and find respectively MIC of 2.5 and 5mg/ml. Antibacterial properties of extracts from the trunk bark of the same plant have been reported by several authors, but they did not test Salmonella strains. Donkor et al.\textsuperscript{21} studied the bactericidal and bacteriostatic activity of the aqueous and ethanol extracts of the trunk bark of Uvaria chamae on another three Enterobacteriaceae; they found MIC from 6.25mg/ml to 12.5mg/ml with the aqueous and the ethanolic extracts.

Uvaria chamae’s MIC and MBC did not change from one strain to another (25mg/ml and 50mg/ml respectively). According to the value of the ratio MBC/MIC, the extract has a bactericidal effect on the strains tested.\textsuperscript{26} Ogbulie et al.\textsuperscript{11} also found bactericidal activity of ethanolic extracts from the roots of the same plant, but they used the disk diffusion technique on agar; and obtained an inhibition zone of 16 mm diameter with a concentration of 100μg/ml on Salmonella typhi. Antibacterial properties of root extracts of the same plant have been reported by Kone et al.\textsuperscript{10} but they tested a species of enterobacteria (Shigella) which has many characteristics in common with Salmonella and obtained MIC of 3.125mg/ml for the ethanol extract and 6.25mg/ml for the aqueous extract.

Results also showed a bactericidal effect of the hydroethanolic extracts of the trunk bark of Parkia biglobosa on the tested strains with a MIC of 50mg/ml. The bactericidal effect of the extracts of this plant has been previously proven by Millogo-Kone et al.\textsuperscript{14} with a MIC lower than that obtained in this study. They found a MIC of 2.5mg/ml with the hydroalcoholic extracts of trunk bark on Salmonella enterica CIP 105 140. Bukar et al.\textsuperscript{27} also obtained anti-Salmonella activities with extracts of the same plant; but this study focused on the leaves and pods. Hydroethanolic extracts of Khaya senegalensis trunk bark inhibited strains of Salmonella typhi, Salmonella enterica and Salmonella paratyphi at an initial concentration of 50mg/ml. The extract had no activity on Salmonella typhimurium at the initial concentration of 50mg/ml. There is no significant difference with the results obtained by Abdallah et al.,\textsuperscript{11} who found a MIC of 50mg/ml for the aqueous extract and 25mg/ml for the ethanolic extract of the trunk bark of Khaya Senegalensis on a strain of the genus Salmonella. These values are lower than those obtained by Ugoz et al.\textsuperscript{28} who also conducted antimicrobial tests of aqueous and ethanolic extracts of the trunk bark of Khaya senegalensis and found a MIC of 200mg/ml for both extracts on a strain of Salmonella typhi.

Table 2 Chemical components of plants extracts

| Chemical Components | S. latifolius | L. barteri | U. chamae | P. biglobosa | K. senegalensis |
|---------------------|--------------|------------|-----------|--------------|----------------|
| Acaloïdes           | ++           | ++         | ++        | +            |                |
| Flavonoïdes         | ++           | ++         | ++        | ++           |                |
| Tanins              | ++           | +          | +         | +            |                |
| Saponosides         | ++           | +          | +         | +            |                |

\textsuperscript{-}, absence; +, Trace; ++, scanty; ++++, Abundant

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The differences observed with the other authors could be explained by several factors, including the nature of the solvents of extractions and the antimicrobial tests used. In other to access to chemical components of this extracts, qualitative and quantitative evaluation were performed using standard phytochemical and phosphomolybdates reduction procedures. Regarding the qualitative evaluation, results showed that all extracts studied contained alkaloids, flavonoids and tannins (Table 2). Saponinodides has been revealed in extracts of the trunk bark of Khaya senegalensis, Parkia biglobosa, roots of Sarcocephalus latifolius and Uvaria chamae; but they were tested negative in the extracts of the trunk bark of Lannea barteri.

Table 3 Chemical contents of plants extracts

|                  | Total Polyphenols (mg EGA/g) | Proanthocyanidines (mg EC/g) | Antioxydants (mg EAA/g) |
|------------------|------------------------------|------------------------------|-------------------------|
| K. senegalensis  | 18.53±0.03                   | 62.85±0.67                   | 9.12±0.17               |
| P. biglobosa     | 33.24±0.14                   | 57.14±0.08                   | 9.30±0.15               |
| L. barteri       | 18.03±0.14                   | 67.14±0.23                   | 8.28±0.23               |
| S. latifolius    | 05.29±0.21                   | 35.71±0.26                   | 5.53±0.06               |
| U. chamae        | 11.66±0.08                   | 60.00±1.19                   | 5.76±0.18               |

EGA, equivalent gallic acid; EC, equivalent catechin; EAA, equivalent ascorbic acid

The concentrations of total polyphenols are 18.53±0.03mg EGA/g for Khaya senegalensis, 33.24±0.14mg EAG/g for Parkia biglobosa and 18.03±0.14mg EAG/g for Lannea barteri. All extracts possess antioxidants. This shows that they displayed anti-radical potential. The stem bark of Khaya senegalensis, Parkia biglobosa and Lannea barteri displayed the high anti-radical properties with respectively 9.12±0.17mg EAA/g, 9.30±0.15mg EAA/g and 8.28±0.23mg EAA/g values of antioxidants. This confirms the anti-radical properties reported by many authors with the extracts of Khaya senegalensis, Parkia biglobosa, Sarcocephalus latifolius and Uvaria chamae. These results also showed that total polyphenols and antioxidants concentrations are higher in trunk bark extracts than in root extracts. By comparing these results with those of qualitative phytochemical analysis, a hypothesis could be deduced that there would probably be a relationship between the levels of tannins, total polyphenols and antioxidants.

Conclusion

This study showed that the plants extracts tested contain alkaloids, flavonoids and tannins. The reduction of the phosphomolybdates by these various extracts proved that they are endowed with the anti-radical properties. The anti-Salmonella tests allowed classifying the extracts into three categories according to their activities. Extracts of the trunk bark of Khaya senegalensis and Parkia biglobosa had low activity on some Salmonella strains at MIC 50mg/ml. Uvaria chamae root extract gave an average activity on all strains at MIC 25mg/ml. The strongest activities are obtained with extracts of Sarcocephalus latifolius root bark and Lannea barteri trunk bark at MIC ranging from 6.25 to 12.5mg/ml. This study therefore supports the traditional use of these plants in Togo and different regions of the world, and may serve as a good source of new drugs against Salmonellosis and oxidative-related diseases.

These results confirmed the report of several authors with extracts of Khaya senegalensis, Parkia biglobosa, Lannea barteri, Sarcocephalus latifolius and Uvaria chamae. It also show that the tannins are more concentrated in the trunk bark extracts than the root extracts. The anti-Salmonella properties obtained with these extracts would probably be related to the isolated or conjugated action of one or some of these chemical compounds highlighted.

According to the qualitative evaluation, Table 3 shows the contents of total polyphenols, proanthocyanidins and antioxidants.

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Conflict of interest

The authors declare there is no conflict of interest.

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