

# Original Research Article

## Quantification of the antiradical potential and evaluation of the antibacterial activity of the stem and root barks of *Cassia sieberiana*: a plant used in traditional medicine

### ABSTRACT :

**Aims :** The general objective of this study was to justify or invalidate the use of *C. sieberiana* stems and roots as natural antibiotics and antioxidants capable of treating traditional pathologies.

**Methodology:** Specifically, extractions were first carried out with water, ethanol and the binary water/ethanol mixture from stem and root bark powders. The various extracts obtained were then used to assess antioxidant activity by spectrophotometry and antibacterial activity by the solid-state diffusion and liquid-state dilution methods.

**Results:**The yields of the different extractions gave values ranging from 17.02±0.79 to 27.05±0.40 %. Antioxidant activity shows that the stems and roots of *C. sieberiana* contain a notable antioxidant profile. However, the antioxidant activity of the stems can be considered slightly better than that of the roots. The antibacterial activity assessed showed that *C. sieberiana* stem and root extracts were active against the *Staphylococcus aureus* strains tested. The stem extracts were absolutely bactericidal, while the root extracts were bacteriostatic. However, stem extracts were more effective than root extracts.

**Conclusion:**We can conclude that both organs of *C. sieberiana*, but more strongly the stems, could be used to treat bacterial infections and diseases linked to oxidative stress.

*Key words: Cassia sieberiana, antioxidant activity, antibacterial activity, Ivory Coast.*

### 1. INTRODUCTION

Plant organs are subject to biotic stresses of microbial origin. This stress can lead to the formation of free radicals which, through successive reactions, can cause the plant to wither and/or die [1]. Despite this constant stress, plants can survive, develop and multiply [2]. This implies that plants develop natural substances with antioxidant and antimicrobial properties, which could justify their long-standing use by humans to feed, defend and treat themselves [3]. With this in mind, we are interested in the roots and stems of *Cassia sieberiana* with a view to confirming or invalidating its use against diseases linked to oxidative stress and bacteria. Infectious diseases are one of the leading causes of mortality worldwide. Estimates show that infectious diseases are responsible for 14 million deaths a year worldwide, and account for 43% of deaths in developing countries [4, 5]. It has also been noted that bacteria alone are responsible for 70% of these deaths [6]. As for free radicals, they are the ultimate cause of numerous pathologies and are thought to be at the root of certain chronic diseases (cardiovascular, neurodegenerative and Alzheimer's diseases, cancer and diabetes) as well as ageing [7, 8, 9]. However, antioxidant molecules of synthetic origin do exist, but they are currently often called into question because of the potential toxicological risks they may pose [10, 11]. Similarly, with the advent of modern medicine and its advances in the treatment of bacterial diseases, synthetic

antibiotics have been developed, but these are increasingly encountering resistance from bacteria [12]. This growing multi-resistance is due to the continued and even uncontrolled use of conventional antibiotics [6, 13, 14, 15]. To alleviate this situation, which comes on top of the high cost of modern medicines, many hopes are being pinned on the secrets of medicinal plants and the emergence of an alternative medicine based on these plants. The aim of this research is to quantitatively assess the antioxidant activity of aqueous, ethanolic and hydro-ethanolic extracts of *Cassia sieberiana* stem and root bark, and to evaluate their antimicrobial activity.

## 2. MATERIAL AND METHODS

### 2.1. Material

#### 2.1.1. Plant material

The plant material consists of stem and root barks of *Cassia sieberiana*. The various organs were harvested in February 2022 in the town of Korhogo (9° 27' 28" North, 5° 37' 46" West), specifically in the village of Kapékaha. The various organs were dried for 5 days in a room at room temperature, ground in a mortar and then sieved. The fine powders obtained were used to prepare the various extracts to be tested. [42]

#### 2.1.2. Laboratory equipment and chemical products

The laboratory equipment consisted of laboratory glassware, an oven, an electronic balance, a hot plate and a JENWAY 7315 spectrophotometer. The analytical-grade chemicals consisted of ethanol, acetone, DPPH and ascorbic acid (vitamin C).

#### 2.1.3. Bacterial strains

Five (05) bacterial strains were used:

- 03 *Staphylococcus aureus* species: *S. aureus* ATCC 29213, *S. aureus* 06 UB/22 and *S. aureus* 27 UB/22: all collected from infected skin.
- 01 *Pseudomonas aeruginosa* species: *P. aeruginosa* 97 UB/22.
- 01 species of *Enterobacteriaceae*: *Escherichia coli* 78 UB/22.

## 2.2. Methods

### 2.2.1. Preparation of aqueous, ethanolic and hydro-ethanolic crude extracts

**Aqueous crude extracts (Aq):** a mass of 10 g of powder from each organ (stems and roots) of *Cassia sieberiana* was mixed with 100 mL of distilled water. The decoctions were obtained after 20 min of boiling at temperatures varying progressively up to 120°C. After filtration, the decoctions were placed in an oven at 50°C for 4 days to obtain the aqueous crude extracts.

**Ethanolic crude extracts (Et):** 10 g of powder from each organ studied was macerated in 100 mL of ethanol for 24 h. After filtration, the different macerates were placed in an oven at 50°C for 4 days to obtain the ethanolic crude extracts.

**Hydro-ethanolic crude extracts (H-et):** 10 g of each organ powder was macerated in 100 mL of a binary ethanol/water mixture (70 mL/30 mL) for 24 h. After filtration, the macerates were incubated at 50°C for 4 days to obtain the hydro-ethanolic crude extracts.

The various aqueous, ethanolic and hydro-ethanolic crude extracts of the stem and root barks of *C. sieberiana* were then used to evaluate the antioxidant and antibacterial activities.

### 2.2.2. Assessment of antioxidant activity against DPPH by spectrophotometry

The antioxidant potential of crude aqueous, ethanolic and hydro-ethanolic extracts of the stem and root barks of *C. sieberiana* Cassia was assessed using the Blois method [16].

DPPH was solubilised in absolute ethanol to obtain a solution with a concentration of 0.03 mg/mL. Different concentration ranges (2 mg/mL, 1 mg/mL, 0.5 mg/mL, 0.25 mg/mL, 0.125 mg/mL and 0.0625 mg/mL) of each extract were prepared in absolute ethanol. 2.5 mL of plant extract and 1 mL of

ethanolic solution of DPPH were added to dry, sterile tubes. After shaking, the tubes were placed in a dark place for 30 min. The absorbance of the mixture was then measured at 517 nm against a blank consisting of 2.5 mL absolute ethanol and 1 mL DPPH solution. The reference control, ascorbic acid (vitamin C), was treated under the same conditions as the plant extracts. The percentages of DPPH radical inhibition by plant extracts and vitamin C were calculated using the following formula:

$$I(\%) = (A_b - A_e) / A_b \times 100$$

I: inhibition percentage

$A_b$  : absorbance of the white

$A_e$  : absorbance of the sample

The concentrations required to trap 50% (IC<sub>50</sub>) of the DPPH radical are determined on the graphs representing the percentage inhibition of the DPPH radical as a function of the concentrations of the plant extracts or vitamin C.

### 2.2.3. Study of antibacterial activity

The antibacterial activity of aqueous, ethanolic and hydroethanolic extracts was studied in 4 stages:

- The first involved carrying out a sterility test on the different plant extracts studied. To 10 mL of thioglycolate broth was added 0.1 g of each plant extract to be tested, and the mixture was incubated at 37°C for 24 h. A nutrient agar plate was then inoculated with the broth and incubated at 37°C. The substance is declared sterile if no colonies are visible on the agar [17];

- The second stage was the choice of bacteria. The strains had to be young for the results to be reliable. This involved streak inoculation using a loop calibrated to 2 µL on Mueller Hinton agar, followed by incubation at 37°C for 24 hours. After growth, the young bacteria were used for the experiment;

- The third step was to determine the antibacterial efficacy of the extracts using the method described by Wiegand et al [18] and Biyiti et al [19]. The dishes were first inoculated with the bacterial strains. Wells were then dug in the culture media, into which the extracts to be tested were added at a concentration of 50 mg/mL. Once the media were dry, they were incubated at 37°C for 24 hours. The presence of a zone of inhibition greater than 08 mm in diameter indicates that the extract has antibacterial activity;

- The fourth step was to determine the MIC and MBC using the methods described by Dosso and Faye-kette [20]. These biological parameters were used to verify the bactericidal or bacteriostatic properties of the extracts.

## 3. RESULTS

### 3.1. Extraction yields

The various extractions carried out by maceration and decoction with *Cassia sieberiana* stem and root bark powders were used to calculate the different extraction yields. The values obtained, ranging from 17.02±0.79 to 27.05±0.40 %, are given in Table 1.

**Table 1: Yields of different *Cassia sieberiana* extracts**

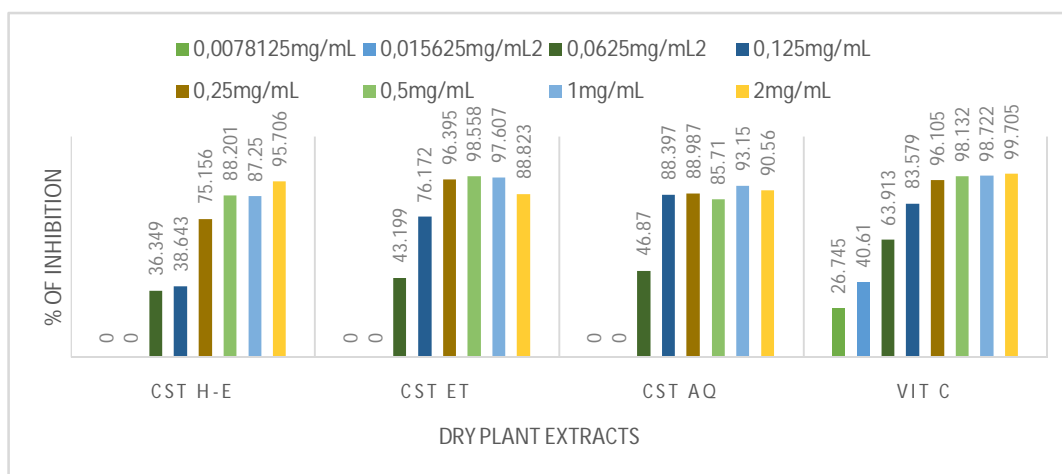
	Stems	Roots
Aqueous extracts (Aq)	18.17±1.00 %	27.05±0.40 %
Ethanolic extracts (Et)	17.02±0.79%	19.46±0.18%
Hydro-ethanolic extracts (H-et)	22.02±1.40%	17.46±0.43%

### 3.2. Antioxidant activity by spectrophotometry

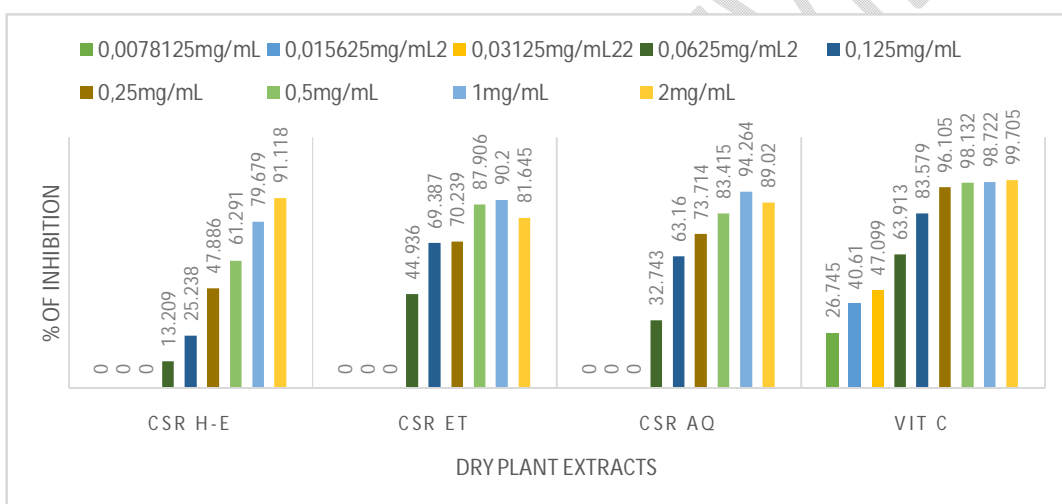
#### 3.2.1. Percentage inhibition of vitamin C and crude plant extracts

The different percentages of DPPH radical inhibition by aqueous, ethanolic and hydro-ethanolic extracts and vitamin C are shown in Figures 1 and 2.

The different extracts show a significant antioxidant potential whatever the concentration of the extract. Inhibition percentages for plant extracts ranged from 36.349 ± 1.224 to 98.558 ± 0.219% and for vitamin C from 63.913 ± 0.131 to 99.705 ± 0.000% at the same concentration ranges.



**Fig 1. DPPH radical inhibition by aqueous, ethanolic and hydro-ethanolic extracts of *C. sieberiana* stem bark and vitamin C.**



**Fig 2. DPPH radical inhibition by aqueous, ethanolic and hydroethanolic extracts of *C. sieberiana* root bark and vitamin C.**

### 3.2.2. Determination of IC50s for vitamin C and plant extracts

The inhibition percentages were used to calculate the sample concentrations required to reduce 50% of the DPPH radicals. The IC50s of the various plant extracts studied and of vitamin C were determined graphically using EXCELL software. The IC50 values obtained are shown in Table 2. Those for the plant extracts vary between 0.07539 mg/mL and 0.28943 mg/mL, while that for vitamin C is 0.03664 mg/mL.

**Table 2: IC50 values (mg/mL) for plant extracts and vitamin C**

Extracts	CST H-et	CST Et	CST Aq	CSR H-et	CSR Et	CSR Aq	Vit C
<b>IC50 (mg/mL)</b>	<b>0.16388</b>	<b>0.07539</b>	<b>0.09776</b>	<b>0.28943</b>	<b>0.07544</b>	<b>0.09796</b>	<b>0.03664</b>

### 3.3. Antibacterial activity

#### 3.3.1. Sterility of plant extracts

The sterility tests on the plant extracts consisted in checking that they were not contaminated. No colonies were observed on the various agar plates after 24 h. As a result, the crude aqueous, ethanolic and hydro-ethanolic extracts of *Cassia sieberiana* stem and root barks do not appear to show any signs of contamination.

### 3.3.2. Antibacterial activity of plant extracts in liquids

The antibacterial activity in a solid medium was used to investigate the sensitivity of the bacteria to aqueous, ethanolic and hydro-ethanolic extracts of *Cassia sieberiana* stem and root bark at a concentration of 50 mg/mL, and then to check their behaviour in relation to the various antibiotics used. Antibiotics were chosen on the basis of their specificity for the different groups of bacteria used in the tests. Cefoxitin (FOX) and erythromycin (E) were used for *Staphylococcus aureus*. For *Pseudomonas aeruginosa*, ceftriaxone (CRO) and ticarcillin+clavulanic acid (TCC) were used. Finally, imipenem (IPM) and ciprofloxacin (CIP) were tested on Enterobacteriaceae species. These antibiotics acted as positive controls and distilled water as a negative control.

The results of bacterial sensitivity to aqueous, ethanolic and hydro-ethanolic extracts of *C. sieberiana* stem and root barks and antibiotics shown in Figure 3 are reported in Table 3.

The diameters of the inhibition discs for aqueous, ethanolic and hydro-ethanolic extracts ranged from 06.0±0.0 to 13.67±0.44 mm and those for antibiotics from 06.0±0.0 to 28.00±0.0 mm.

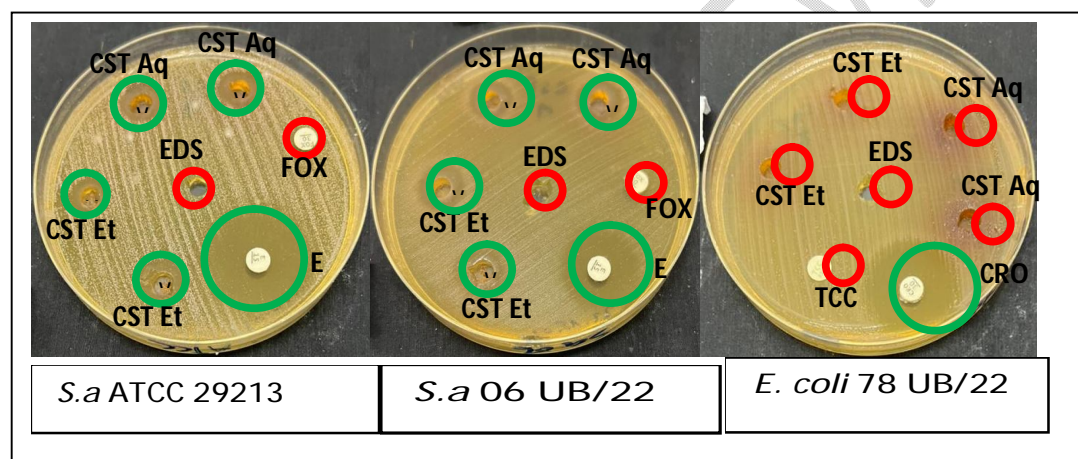


Fig 3. Susceptibility testing of study extracts and antibiotics against bacteria

○ : Sensible ; ○ : Resistant

Table 3: Inhibition diameters (mm) of bacteria against aqueous, ethanolic and hydro-ethanolic crude extracts and reference antibiotics

	C.S.T			C.S.R			FOX	E	CRO	TCC	IPM	CIP	S.d.w
	Aq	Et	H-et	Aq	Et	H-et							
S.a ATCC 29213	13	11	11	10	09	09	06	23					06
	14	13	11	11	08	09	06	24					06
	14	12	11	11	09	09	06	22					06
	<b>13.67</b>	<b>12.00</b>	<b>11.00</b>	<b>10.67</b>	<b>09.67</b>	<b>09.00</b>	<b>06.00</b>	<b>23.00</b>					<b>06.00</b>
M.s.d.	0.44	0.67	0.00	0.44	0.44	0.00	0.00	0.67					0.00
S.a 06 UB/22	12	14	13	10	08	09	06	20					06
	13	13	12	11	10	09	06	20					06
	13	14	12	11	09	09	06	20					06
	<b>12.67</b>	<b>13.67</b>	<b>12.33</b>	<b>10.67</b>	<b>09.00</b>	<b>09.00</b>	<b>06.00</b>	<b>20.00</b>					<b>06.00</b>
M.s.d.	0.44	0.44	0.44	0.44	0.67	0.00	0.00	0.00					0.00
S.a	13	13	11	08	08	06	06	18					06

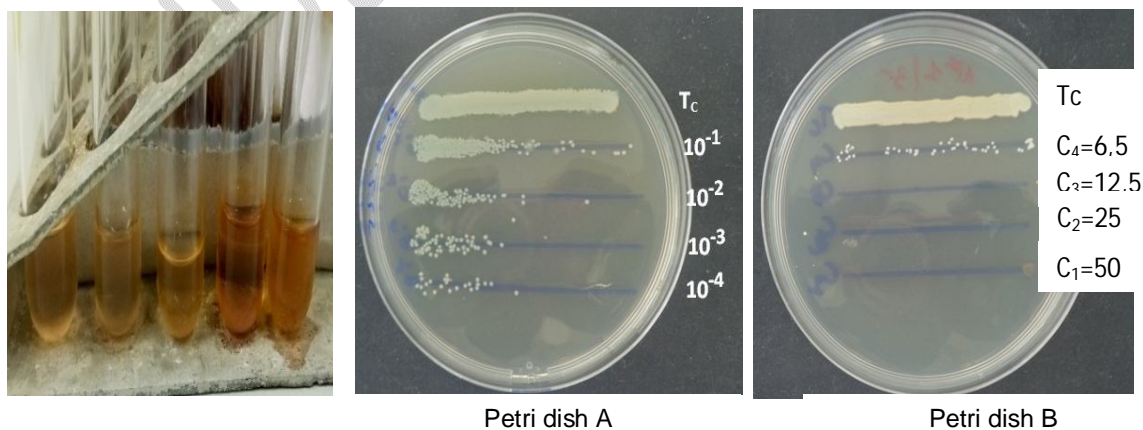
27 UB/22	14	12	10	09	08	06	06	18					06
	14	13	11	09	08	06	06	19					06
	<b>13.67</b>	<b>12.67</b>	<b>10.67</b>	<b>08.67</b>	<b>08.00</b>	<b>06.00</b>	<b>06.00</b>	<b>18.33</b>					<b>06.00</b>
M.s.d.	0.44	0.44	0.44	0.44	0.00	0.00	0.00	0.44					0.00
E. coli 78 UB/22	06	06	06	06	06	06			24	06			06
	06	06	06	06	06	06			23	06			06
	06	06	06	06	06	06			24	06			06
	<b>06.00</b>	<b>06.00</b>	<b>06.00</b>	<b>06.00</b>	<b>06.00</b>	<b>06.00</b>			<b>23.67</b>	<b>06.00</b>			<b>06.00</b>
M.s.d.	0.00	0.00	0.00	0.00	0.00	0.00		0.44	0.00			0.00	
P. a 97 UB/22	06	06	06	06	06	06					06	28	06
	06	06	06	06	06	06					06	28	06
	06	06	06	06	06	06					06	28	06
	<b>06.0</b>	<b>06.0</b>	<b>06.0</b>	<b>06.0</b>	<b>06.0</b>	<b>06.0</b>					<b>06.0</b>	<b>28.0</b>	<b>06.0</b>
M.s.d.	0.00	0.00	0.00	0.00	0.00	0.00				0.00	0.00	0.00	

C.S.T: *Cassia sieberiana* stem bark; C.S.R: *Cassia sieberiana* root bark; H<sub>2</sub>O : water ; EtOH : Ethanol ; FOX : Cefoxitin ; E : Erythromycin ; CRO : ceftriaxone ; TCC : Ticarcillin+Clavulanic acid; IPM :Imipenem; CIP : Ciprofloxacin ; S.d.w : Sterilised distilled water; S.a ATCC 29213 : *Staphylococcus aureus* ATCC 29213 ; S.a 06 UB/22 : *Staphylococcus aureus* 06 UB/22; S.a 27 UB/22 : *Staphylococcus aureus* 27 UB/22; E. coli 78B/22 : *Escherichia coli* 78 UB/22, et P. a 97 UB/22 : *Pseudomonas aeruginosa* 97 UB/22 ; M.s.d.:Mean standard deviation.

### 3.3.3. Antibacterial activity in liquids

The antibacterial activity in liquid medium was used to determine the antibacterial parameters MIC and MBC respectively minimum inhibitory concentration and minimum bactericidal concentration of the plant extracts that showed activity on the bacterial strains used. These were the aqueous, ethanolic and hydro-ethanolic extracts of the stems and roots of *Cassia sieberiana* on the three *Staphylococcus aureus* used in this study.

Figure 4 illustrates the techniques used to determine antibacterial parameters and their values are given in Table 4.



**Fig 4. Illustration of the determination of MIC and MBC of plant extracts**

**Table 4: Antibacterial parameters of plant extracts on the strains tested**

Extracts	Strains	MIC mg/mL	MCB mg/mL	MBC/MIC	Interpretation
<b>CST Aq</b>	<i>S.a</i> ATCC 29213	<b>6.25</b>	<b>6.25</b>	<b>1</b>	<b>Absolute bactericide</b>
	<i>S.a</i> 06 UB/22	<b>6.25</b>	<b>6.25</b>	<b>1</b>	<b>Absolute bactericide</b>
	<i>S.a</i> 27 UB/22	<b>6.25</b>	<b>6.25</b>	<b>1</b>	<b>Absolute bactericide</b>
<b>CST Et</b>	<i>S.a</i> ATCC 29213	<b>6.25</b>	<b>6.25</b>	<b>1</b>	<b>Absolute bactericide</b>
	<i>S.a</i> 06 UB/22	<b>6.25</b>	<b>6.25</b>	<b>1</b>	<b>Absolute bactericide</b>
	<i>S.a</i> 27 UB/22	<b>6.25</b>	<b>6.25</b>	<b>1</b>	<b>Absolute bactericide</b>
<b>CST H-et</b>	<i>S.a</i> ATCC 29213	<b>6.25</b>	<b>6.25</b>	<b>1</b>	<b>Absolute bactericide</b>
	<i>S.a</i> 06 UB/22	<b>6.25</b>	<b>6.25</b>	<b>1</b>	<b>Absolute bactericide</b>
	<i>S.a</i> 27 UB/22	<b>6.25</b>	<b>6.25</b>	<b>1</b>	<b>Absolute bactericide</b>
<b>CSR Aq</b>	<i>S.a</i> ATCC 29213	<b>12.5</b>	<b>50</b>	<b>4</b>	<b>Bacteriostatic</b>
	<i>S.a</i> 06 UB/22	<b>12.5</b>	<b>50</b>	<b>4</b>	<b>Bacteriostatic</b>
<b>CSR Et</b>	<i>S.a</i> ATCC 29213	<b>12.5</b>	<b>50</b>	<b>4</b>	<b>Bacteriostatic</b>
	<i>S.a</i> 06 UB/22	<b>12.5</b>	<b>50</b>	<b>4</b>	<b>Bacteriostatic</b>
<b>CSR H-et</b>	<i>S.a</i> ATCC 29213	<b>12.5</b>	<b>50</b>	<b>4</b>	<b>Bacteriostatic</b>
	<i>S.a</i> 06 UB/22	<b>12.5</b>	<b>50</b>	<b>4</b>	<b>Bacteriostatic</b>

**MIC:** Minimum Inhibitory Concentration; **MBC:** Minimum Bactericidal Concentration.

#### 4. DISCUSSION

This study began with extractions by maceration and decoction using *Cassia sieberiana* stem and root bark powders. The highest yield was obtained from the roots using the aqueous decoction, with an extraction percentage of  $27.05 \pm 0.40\%$  compared with  $18.17 \pm 1.00\%$  for the stems. The roots also showed the highest yield ( $19.46 \pm 0.18\%$ ) during ethanolic maceration compared with  $17.02 \pm 0.79\%$  for the stems. It would appear that the roots concentrate the phytochemicals better than the stems when water and ethanol are used as extraction solvents.

On the other hand, hydro-ethanol maceration showed a higher yield for *C. sieberiana* stems with  $22.02 \pm 1.40\%$  compared with  $17.46 \pm 0.43\%$  in the roots. It would appear that the stems concentrate the phytochemicals better than the roots when the binary water/ethanol mixture (70/30) is used as the extraction solvent.

Thus, aqueous decoction is favourable for the extraction of phytochemicals from *C. sieberiana* root barks, whereas hydroethanol maceration is the best for stem barks.

The antioxidant activity of the plant extracts was then assessed spectrophotometrically. This analysis consisted of determining the inhibition percentages of the extracts with respect to the DPPH radical and the inhibitory IC<sub>50</sub> concentrations.

This study showed, through the values of the inhibition percentages, that the various plant extracts studied showed antioxidant activity whatever the concentration of the extract. This oxidising activity observed for all the plant extracts is thought to be due to the synergistic action of the secondary metabolites present in the stems and roots of *C. sieberiana*. In fact, several researchers have identified numerous chemical compounds in the stems and roots of *C. sieberiana* [21, 22] whose antioxidant potential has already been demonstrated. These include phenolic acids, tannins, coumarins, flavonoids, saponins, alkaloids, sterols and terpenes [23, 24, 25, 26, 27].

These inhibition percentages, which represent the extract's capacity to trap free radicals, were used to determine the IC<sub>50</sub>. The IC<sub>50</sub> provides more information about the antioxidant quantification of extracts. For an extract, this chemical quantity represents the value of its concentration that results in a 50% loss of DPPH activity [28]. The lower the IC<sub>50</sub>, the greater the antioxidant activity of the extract. We note that IC<sub>50</sub> (CST Et) < IC<sub>50</sub> (CST Aq) < IC<sub>50</sub> (CST H-et) and IC<sub>50</sub> (CSR Et) < IC<sub>50</sub> (CSR Aq) < IC<sub>50</sub> (CSR H-et). This means that for both organs, the antioxidant power of the ethanolic extract is greater than that of the aqueous extract, which in turn is greater than that of the hydro-ethanolic

extract. However, vitamin C, the reference molecule with the lowest IC<sub>50</sub>, has the best antioxidant power.

Comparison of the antioxidant activity of extracts from stems and extracts from roots shows that the IC<sub>50</sub>s of ethanolic extracts from stems and roots are equal (IC<sub>50</sub>=0.075 mg/mL). However, the antioxidant power of the stem hydroethanol extract (IC<sub>50</sub>=0.164 mg/mL) was greater than that of the root hydroethanol extract (IC<sub>50</sub>=0.289 mg/mL).

At the end of this quantitative analysis of antioxidant capacity, the crude aqueous, ethanolic and hydro-ethanolic extracts of the stems and roots of *Cassia sieberiana* revealed a significant DPPH neutralising capacity, but this was greater with the aqueous and ethanolic extracts of these two organs. These antioxidants could therefore be recommended for preventing or curbing the damage caused by oxidative stress, namely cancer, accelerated ageing, arterial hypertension, Alzheimer's disease, Parkinson's disease and diabetes [29, 30]. These results seem to justify the de facto use of these two organs of *C. sieberiana* in traditional medicine against pathologies linked to oxidative stress.

Finally, the antibacterial activity of the plant extracts studied, all of which were declared sterile, was evaluated. This study was then used to determine the inhibition diameters of the plant extracts against bacteria using the solid medium diffusion method, and the MIC and MBC parameters of those that were effective using the liquid medium dilution method.

The solid-state diffusion test was carried out on three (03) *Staphylococcus aureus*, one (01) *Pseudomonas aeruginosa* and one (01) species of *Enterobacteriaceae*. The tests carried out on *Staphylococcus aureus* showed that practically all the inhibition disc diameter values were greater than the limit diameter (08 mm) [31], except for the hydroethanol extracts of roots on *Staphylococcus aureus* 06 UB/22, which showed no activity. This indicates that virtually all the extracts analysed were effective against the *Staphylococcus aureus* used. In fact, a bacterium is said to be resistant to an extract when its inhibition diameter around this extract is less than or equal to 8 mm, sensitive if this diameter is between 9 and 14 mm, very sensitive when it is between 15 and 19 mm and extremely sensitive for a diameter greater than 20 mm [31].

In addition, the inhibition diameters observed indicate that the aqueous and ethanolic extracts are the most active.

The diameters of the inhibition discs of the stem extracts were greater than those of the root extracts.

As for the antibiotics tested, inhibition diameters ranging from 6±0.0 to 23.00±0.67 mm were observed. While erythromycin (E) exhibited large inhibition diameters on the *Staphylococcus aureus* tested (18.33±0.44 to 23.00±0.67 mm), cefoxitin (FOX) showed total resistance to the same *S. aureus*. This shows that the plant extracts studied have greater antibacterial activity than cefoxitin (FOX).

The action of the various plant extracts studied against the three *Staphylococcus aureus* could be justified by the combined action of the active phytochemicals contained in these two organs [21, 22, 32]. The antibacterial activities of these phytochemicals have also been published by Ouattara and colleagues [26], Osho [33] and Lunga and colleagues [34]. Several other authors have also highlighted the antibacterial activity of these secondary metabolites [27, 35, 36].

These results are in agreement with those reported by Schmelzer and colleagues [37]. Their work on extracts of *Cassia sieberiana* roots and stems revealed their antibacterial activity [37]. This would justify the traditional use of these two organs for the treatment of toothache [38], skin diseases, gonorrhoea [39], schistosomiasis, intestinal worms [40] and venereal diseases [37].

With regard to the tests of these various plant extracts on the *Pseudomonas aeruginosa* species and the *Enterobacteriaceae* species, analysis showed that these extracts had no activity on these two bacterial strains, as their inhibition diameters were 06.0±0.0 mm. The reference antibiotics ceftriaxone (23.67±0.44 mm) and ciprofloxacin (28.0±0.0 mm) showed antibacterial activity, while ticarcillin+clavulanic acid (TCC) and imipenem (IPM) had no activity. These results further confirm bacterial resistance to synthetic antibiotics, as shown by several authors [6, 12, 13, 14, 15]. In view of the increasing multi-resistance to synthetic antibiotics observed in our work, it is imperative to explore other treatment options, in this case plant-based treatments. The effective extracts were then used to determine the CMI and CMB parameters in order to attribute bacterial properties to them. According to Fauchere and Avril, if CMB/CMI = 1, the extract is said to be 'absolutely bactericidal', if CMB/CMI ≤ 2, the extract is bactericidal, and if CMB/CMI > 2, the extract is bacteriostatic [41]. Thus, we note that all the extracts from the stems are absolute bactericidal on the three *Staphylococcus aureus* strains (*S. aureus* ATCC 29213, *S. aureus* 06 UB/22 and *S. aureus* 27 UB/22), on the other hand those from the roots showed a bacteriostatic character against only *S. aureus* ATCC 29213 and *S. aureus* 06 UB/22. It can be concluded that the extracts from the stems are more active than those from the roots with regard to the bacterial strains used in our work.

## 5. CONCLUSION

The aim of this work was to justify or refute the use of *Cassia sieberiana* as a good antibiotic on the one hand and on the other hand as an excellent antioxidant which would be capable of traditionally treating various pathologies. Thus, the evaluation of the antioxidant activity of extracts of stems and roots of *C. sieberiana* shows that these organs contain an antioxidant profile. Quantitatively, the aqueous and ethanolic extracts of the bark of the stems and roots of *C. sieberiana* have practically the same antioxidant power, on the other hand that of the hydro-ethanolic extract of the stems is greater than that of the hydro-ethanolic extract of the roots. Therefore, the antioxidant activity of the stems can be considered to be slightly better than that observed in the roots.

The antibacterial activity evaluated against five strains showed that the extracts of the stems and roots of *C. sieberiana* are only active against the *Staphylococcus aureus* strains tested (*S.a* ATCC 29213, *S.a* 06 UB/22 and *S.a* 27 UB/22). The extracts from the stems are absolute bactericidal while those from the roots showed a bacteriostatic character. This gives both organs the ability to treat infections caused by *Staphylococcus aureus* bacterial strains. However, extracts from the stems are more effective than those from the roots.

The study of the stem and root bark of *C. sieberiana* showed that these two organs contain antioxidant and antibacterial potential, so they could be used to treat bacterial infections and diseases linked to oxidative stress. However, the antioxidant and antibacterial potentials of the stems are better than those of the roots.

In perspective, this work must continue with the aim of proving the safety of these organs for the human body with a view to formulating a phytomedicine with antioxidant and antibacterial significance which will be accessible to all.

### DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

### ACKNOWLEDGEMENTS

The authors would like to acknowledge Antibiotics, Natural Substances and Surveillance of Microorganisms and Anti-infective Unit (ASSURMI) of the Bacteriology and Virology Department of the Institut Pasteur of Côte d'Ivoire (IPCI).

### COMPETING INTERESTS

Author has declared that no competing interests exist.

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