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In vitro Evaluation of Antimicrobial Activities of Crude Extracts and Nutritional Potentials of Six Wild Vegetables Commonly Consumed in Ekiti State, Nigeria

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ABSTRACT:

Wild vegetables are widely consumed in rural parts of Nigeria and enjoy extensive acceptability especially among the aged. There is a decline in the consumption of these species despite their agronomic, cultural and culinary importance. This study therefore aimed at screening the nutritional, antimicrobial and anti-nutritional qualities of the six wild vegetables using standard chemical and microbiological methods. The hydroalcoholic extracts of the plants were tested against eight bacteria and five fungi. *Lonchocarpus cyanescenes*, *Triplochiton sleroxylon* and *Sterculia tragacantha* were very effective against the test bacteria. *Enterococcus faecalis* ATCC 4532, *Escherichia coli* ATCC 8739 and *Klebsiella pneumoniae* ATCC 4532 were most susceptible to the extracts of the wild vegetables. On *E. coli* ATCC 25922 the combinations of antibiotic with *Ceiba pentandra* and *L. cyanescenes* produced a synergistic effects. The minimum fungicidal concentrations of the plant extracts ranged between 0.625 and 20.00 mg/ml**.** *Penicillium chrysogenum* was most susceptible to the extracts followed by *Candida tropicalis*. The proximate analyses of the plants varied among the plants. Out of the six wild vegetable screened *Myrianthus aboreus* had the highest ash content (11.00 g/100g) followed by *C. pentandra* (8.50 g/100g). *Vitex* sp. had the highest amounts of carbohydrate and metabolizable energy. The anti-nutritional (phytate and tannin), minerals, Na/K and Ca/P ratios of the samples were determined and their implications discussed.

Keyword: *Wild vegetables, Antibacterial, Antifungal, Anti-Nutritional, Synergism*

INTRODUCTION

Vegetables are fresh and edible part of plants which are eaten raw or cooked. Most of the time leafy parts of the vegetables are consumed while in some cases succulent parts or tender stem are also consumed along [1]. Vegetables are hardly eaten as main meals and or as snacks in western Nigeria rather they are used to consume with food made from cereals or tubers [2]. The nutritional content of vegetables varies considerably, though generally they contain little amount of protein, fat and varying proportions of vitamins, minerals, fibre and carbohydrates [1].

Wild vegetables are native of specific regions and they are eaten as green leafy vegetables and form part of the traditional diets or food systems for generations [2, 3]. Wild vegetables live in their natural state as they neither domesticated, cultivated nor inhabited. They take a relatively longer period to grow to maturity and their yield is lower compared to the propagated vegetables [4, 5]. Wild vegetables are used in ethnomedicines apart from being the sources of food [5].

Vegetables generally contain phytochemicals which have been reported to possess antioxidant, antimicrobial and anti-carcinogenic properties [6]. Most wild vegetables are used in the treatment of external and in most cases internal infections. They have been reported to inhibit the growth of some clinically important pathogens [7, 8]. The antimicrobial activity of these species are due to the phytochemicals present. Compounds like flavonoids, alkaloids, steroids, triterpenoids, lipids and lignins have been reported in wild vegetables [8].

The knowledge on the nutritional and antimicrobial quality of wild species is very important to determine so as to know whether it consumption and cultivation should be encouraged. Despite the acclaimed popular nutritional qualities of the six wild vegetables there is dearth of information to justify or refute the claims. Therefore, this study was aimed at investigating the nutritional and antimicrobial quality of the hydro-alcoholic extracts of the wild vegetables.

MATERIALS AND METHODS

Plant Materials

Fresh and tender leaves of *Ceiba pentandra*, *Lonchocarpus cyanescenes*, *Myrianthus arboreus*, *Sterculia trangacantha*, *Triplochiton sleroxylon* and *Vitex* sp. (as shown in Plate 1) were collected from abandoned farmlands in Osan-Ekiti, Ekiti State, Nigeria. The plants were authenticated in the Department of Plant Science, Ekiti State University, Ado-Ekiti, Nigeria. The fresh tender leaves were air-dried and ground to fine powder. A 50 g of ground plant sample was soaked in 500 ml of 90% ethanol for 12 h and shook periodically. The samples were then suction-filtered through Whatman No. 1 filter paper and washed with another 200 ml solvent. The filtrate was concentrated with Laborata 4000-efficient (Heldoph, Germany). The dried extract was dissolved in 4% dimethyl sulfoxide (DMSO) and in their extracting solvent and made up with water to make the required

concentrations. The reconstituted extracts were filtered using 0.45 µm pore size membrane filter according to David and Afolayan [9].

Plate 1: The wild vegetable screened for the antimicrobial and anti-nutritional qualities

Antibacterial Activity

Source and standardization of test bacteria

The bacteria and fungi used in this study were collected from the Department of Microbiology, Ekiti State University, Ado-Ekiti, Nigeria. The test bacteria used include: *Enterococcus faecalis* ATCC 29212, *Escherichia coli* ATCC 25922, *Escherichia coli* ATCC 8739, *Klebsiella pneumoniae* ATCC 10031, *Klebsiella pneumoniae* ATCC 4532, *Proteus vulgaris* ATCC 6830, *Pseudomonas aeruginosa* ATCC 19582 and *Staphylococcus aureus* ATCC 6538. While the test fungi were *Absidia corymbifera*, *Penicillium chrysogenum*, *Aspergillus fumigatus*, *Candida albicans* and *Candida tropicalis.* The test bacteria used were cultured at 37°C in Nutrient broth (Oxoid, England) for 18 h and diluted to an optical density of 0.1 (0.5 McFarland Standard) at 625 nm according to CLSI [10].

Determination of minimum inhibitory concentration (MIC)

Macrobroth dilution method was used for the determination of minimal inhibitory concentration (MIC) of the extract as described by CLSI [10]. Different concentrations of the hydroalcoholic extracts of the wild vegetables was prepared by serial dilutions and added to the sterile Mueller Hinton broth (Oxoid) to make the requited concentrations. Each prepared concentration in tubes was inoculated with 100 µl of each of the standardized culture of the test bacteria. Tube containing Mueller Hinton broth without extract was used as negative control. The cultures were incubated aerobically at 37°C for 18 h. The first tube in the series with no sign of visible growth was taken as the MIC.

Determination of minimum bactericidal concentration (MBC)

A loopful of culture from the first three broth tubes that showed no sign of growth in the MIC tubes were inoculated on Mueller Hinton Agar plates and observed for growth after incubation at 37°C for 24 h. The least concentration of the extracts that showed no growth was taken to be the minimum bactericidal concentration (MBC). The MIC index (MICI) of each of the extract was calculated as the ratio of MBC and MIC of each of the isolate. The result was interpreted as follows: MBC/MIC ≤ 2.0 was considered bactericidal, if greater than 2 but less than 16 it was considered bacteriostatic and if the ratio is ≥16.0, the extract was considered ineffective [11].

Synergistic Interaction of Plant Extracts With Antibiotics

Synergistic interaction between the extract of the wild vegetables and amoxicillin/clavulanic acid (10µg/ml) was determined according to Chattopadheya *et al.* [12]. Wells were made on seeded agar plates at distances that the inhibitory zones will touch each other peripherally. The antimicrobial were introduced into the well separately. After incubated at 37°C, for 18 hours the plates were read and recorded.

Determination of Antifungal Properties of the Wild Vegetable

The method of Egbontan *et al.* [13] was used to harvest the spores of the test moulds. The spores were serially diluted while the broth cultures of the two test yeasts were diluted to 0.5 MacFarland standard, inoculated on and radially streaked on the potato dextrose agar containing different concentrations of the extracts of the plants. The plates were incubated and observed for growth at 25°C for 48 h. The least concentrations of the extracts that showed no visible sign of growth was taken to be the minimum fungicidal concentrations of the extracts.

Determination of the Effects the Extracts of the Wild Vegetable on the Dry Mycelia Weight

Test fungi were grown in potato dextrose broth in 50 ml conical flasks containing maximum tolerable concentrations of plant extracts. Nystatin was used as positive control while cultures without extract was used as negative control. Each of the flasks was inoculated with 0.5 ml of a suspension of hyphal fragments of each of the fungi and incubated statically at 25°C for 7 days. At the end of the incubation, the content of the flask was harvested and filtered through cheesecloth. The mycelia were rinsed properly with distilled water and dried at 80°C until constant weight is obtained. The weight of the mycelia was obtained. The percentage antifungal effectiveness of the extract was calculated as

Percent Antifungal Effectiveness (%AE) = [(WFEE-WFEN)/WFEE] x 100

while percentage inhibition in mycelia growth was calculated as

Percentage Inhibition (%PI) = [(WFWtE-WFEE)/WFWtE] x100

Where: WFEE= Weight of fungi exposed to extract, WFEN= Weight of fungi exposed to nystatin, WFWtE= Weight of fungi not exposed to either the plant extract or nystatin.

Determination of Proximate Composition of the Wild Vegetables

The leaves used to the determination of proximate analyses were oven-dried separately to a constant weight and kept in air-tight containers. The method of AOAC [14] was used to determine ash, crude fibre, ether extract (crude fat) and moisture content. Nitrogen content of the vegetables was determined by the micro-Kjeldahl method [15] and the crude protein was taken as %N x 6.25. Carbohydrate was determined by difference.

Determination of Minerals Contents of the vegetables

The solutions obtained by dry ashing of the samples at 550°C was used to determine the minerals in the samples using Buck atomic absorption spectrophotometer (Buck Scientific, Model 200A/200, Inc. East Norwalk, Connecticut, U.S.A.). Sodium and potassium were measured with a Corning 405 flame photometer (Corning, Halstead, Essex, UK, Model 405) as described by AOAC [14]. The method of Harland and Oberleas [16] was used to determine the level of the phytate in the vegetables. The method of Kilgour [17] was used to determine the level of metabolizable energy in the vegetables by adding up the values obtained for carbohydrates (x 17 kJ), crude protein (x17kJ) and crude fat (x37kJ) for each of the wild vegetable.

Calcium/phosphorus (Ca/P) and sodium/potassium (Na/K) ratios were calculated for all the samples as described by Nieman *et al.* [18] while Phy: Zn, Ca:Phy and Ca x Phy:Zn values were calculated according to the method of Wyatt and Triana-Tejas [19].

RESULTS AND DISCUSSION

Lonchocarpus cyanescenes, *T. sleroxylon* and *S. tragacantha* were very effective against the test organisms. Their hydroalcolic extracts exhibited bactericidal effect on the test organisms. Extract of *C. pentandra* had the least effect on the test bacteria. *Enterococcus faecalis* ATCC 4532, *E. coli* ATCC 8739 and *K. pneumoniae* ATCC 4532 were most susceptible to the extracts of the wild vegetables. The extracts had bactericidal effects on them except the extract of *C. pentandra* that exhibited bacteriostatic on the three test bacteria (Table 1). The result of this work confirms the reports of many workers who have reported that plant extracts are more active against Gram-positive than Gram-negative bacteria [20-22]. The activity of these plants extract could be attributed to the active phytochemical compounds present in the extract at different concentrations and are potent enough to inhibit or kill test organisms.

Table 1: Minimum inhibitory concentration index of different wild vegetables screened against test bacteria

Test organism	MA	LC	TS	CP	ST	VS
S. aureus ATCC 6538	4.00**	0.25*	0.50*	10.00**	2.00*	4.00**
E. faecalis ATCC 4532	1.92*	0.25*	2.00*	5.20**	1.00*	2.00*
E. coli ATCC 8739	0.50*	0.25*	1.00*	5.00**	2.00*	1.00*
K. pneumoniae ATCC 10031	1.00*	1.00*	2.00*	40.00***	2.00*	1.00*
K. pneumoniae ATCC 4532	1.00*	1.00*	2.00*	10.00**	2.00*	1.00*
Ps. aeruginosa ATCC 19582	1.00*	1.00*	1.00*	20.00***	2.00*	4.00**
E. coli ATCC25922	0.06*	1.00*	2.00*	40.00***	1.00*	4.00**
P. vulgaris ATCC 6830	4.00**	2.00*	0.50*	20.00***	1.00*	2.00*

`*= bactericidal effect, **= Bacteriostatic effects, ***= ineffective

Table 2. Effects of *C. pentandra* and amoxicillin/clavunanic acid interaction on the test bacteria (zone of inhibition in mm)

Test organisms	rA	rB	rC=rA+rB	rD	Interaction
E. coli ATCC 8739	10	10	20	24	Synergistic
E. coli ATCC 25922	9	11	20	25	Synergistic
Ps. aeruginosa ATCC 19582	12	9	21	22	Synergistic
K. pneumoniae ATCC 10031	9	3	12	10	Inhibitory
K. pneumoniae ATCC 4532	8	0	8	10	Synergistic
P. vulgaris ATCC 6830	7	3	10	12	Synergistic
E. faecalis ATCC 29212	9	4	13	9	Inhibitory
S. aureus ATCC 6538	5	2	7	9	Synergistic

rA=radius of antibiotic, rB= radius of extract, rD=radius of interaction

Table 3. Effects of *M. aboreus* and amoxicillin/clavunanic acid interaction on the test bacteria (zone of inhibition in mm)

Test organisms	rA	rB	rC=rA+rB	rD	Interaction
E. coli ATCC 8739	10	4	14	16	Synergistic
E. coli ATCC 25922	9	6	15	10	inhibitory
Ps. aeruginosea ATCC 19582	12	5	17	12	inhibitory
K. pneumoniae ATCC 10031	9	7	16	17	Synergistic
K. pneumoniae ATCC 4532	8	8	16	15	Inhibitory
P. vulgaris ATCC 6830	7	7	14	17	Synergistic
E. faecalis ATCC 29212	9	5	14	10	Synergistic
S. aureus ATCC 6538	5	3	8	8	Addictive

rA=radius of antibiotic, rB= radius of extract, rD=radius of interaction

Table 4. Effects of *L. cyanenses* and amoxicillin/clavunanic acid interaction on the test bacteria (zone of inhibition in mm)

Test organisms	rA	rB	rC=rA+rB	rD	Interaction
E. coli ATCC 8739	10	7	17	20	Synergistic
E. coli ATCC 25922	9	13	22	24	Synergistic
Ps. aeruginosea ATCC 19582	12	14	26	26	Synergistic
K. pneumoniae ATCC 10031	9	7	16	18	Synergistic
K. pneumoniae ATCC 4532	8	10	18	16	Inhibitory
P. vulgaris ATCC 6830	7	6	13	12	Inhibitory
E. faecalis ATCC 29212	9	11	20	14	Inhibitory
S. aureus ATCC 6538	5	5	10	20	Synergistic

rA=radius of antibiotic, rB= radius of extract, rD=radius of interaction

Table 5: Effects of *S. tragacantha* and amoxicillin/clavunanic acid interaction on the test bacteria (zone of inhibition in mm)

Test organisms	rA	rB	rC=rA+rB	rD	Interaction
E. coli ATCC 8739	10	5	15	23	Synergistic
E. coli ATCC 25922	9	8	17	14	Inhibitory
Ps. aeruginosa ATCC 19582	12	9	21	22	Synergistic
K. pneumoniae ATCC 10031	9	4	13	15	Synergistic
K. pneumoniae ATCC 4532	8	2	10	6	Inhibitory
P. vulgaris ATCC 6830	7	7	14	15	Synergistic
E. faecalis ATCC 29212	9	4	13	15	Synergistic
S. aureus ATCC 6538	5	3	8	10	Synergistic

rA=radius of antibiotic, rB= radius of extract, rD=radius of interaction

The interaction of extracts of the wild vegetables with the test antibiotic produced synergistic effect on *E. coli* ATCC 8739. The interaction effects of the herbal-drug on the *Ps. aeruginosa* ATCC 19582 were synergistic except for when *M. aboreus* extract was combined with amoxycillin clavulanic acid. While the active components in the crude extract may be acting synergistically with the antibiotics to produce good antimicrobial effects as suggested by Eloff [23], the interactions observed between the antibiotics and the extracts of the plants could be potential sources for resistance-modifying agents that could be used to stem the upsurge of multiple antibiotic resistant bacteria. The extracts of five of the six plants produced synergistic effect on *K. pneumoniae* ATCC 10031 when combined with antibiotic. On *K. pneumoniae* ATCC 4532, the antibiotic alone performed better than the plant extract. Also the combinations produced three different effects. The combination of the test antibiotic and the extracts of *L. cyanensis* and *Vitex* sp. produced inhibitory effects on *P. vulgaris* ATCC 6830, also extracts of two of the six plants investigated produced synergistic effect on *E. faecalis* ATCC 29212 when combined with amoxicillin clavulanic acid. The drug and the extracts showed the least effect on *S. aureus* ATCC 6538 while the herbal-drug interaction did not show any inhibitory effect on *S. aureus* ATCC 6538 was not inhibitory. Medicinal plants that synergistically interacted with antibiotics have been reported to prevent the gradual decline in efficacy frequently observed when antibiotics are used singly over a long period of time [24].

The extract of *C. pentandra* positively interacted with amoxicillin clavunanic acid and produced synergistic effect on six of the eight bacteria tested in this study. The combinations of the extract and the antibiotic (amoxicillin clavunanic acid) produced a better effect than either of them use singly (Table 2). Also the extracts of the plants produced different interactive effects (synergistic, addictive and inhibitory) shown on Table 3 to 7. There is a need to differentiate antibiotic-herbal interactions types (synergistic, additivity and antagonistic) when phytomedicines are used in combination with the orthodox medicines especially antibiotics [25]. The synergistic effects indicated that the antibacterial combinations were more effective than the activity of the individual agents. The increase in the sizes of the zone of inhibition resulting from the extract and antibiotic combinations indicated improved bactericidal potentials of the extract and the antibiotics. These synergistic effects are as a result of different mechanisms of action [26].

The minimum fungicidal concentrations (MFCs) of the plant extracts ranged between 0.625 and 20.00 mg/ml**.** *Penicillium chrysogenum* was most susceptible to the extracts followed by *Candida tropicalis*. In decreasing order *A. fumigatus, C. albicans* and *A. corymbifera* showed relative resistance to the plant extracts. *Sterculia trangacantha* was most effective against the fungi tested. The antifungal activity was ten, five and three times more effective than *C. pentandra, T. sleroxylon* and *M. arboreus* respectively (Table 8).

Compared with nystatin *S. trangacantha* followed by *T. sleroxylon* had the least effect on the mycelia weight development of the mould tested in this study, while *L. cyanescenes* had the highest antifungal activity. The antifungal properties of the extracts on the test fungi could be due to the ability of the phytochemicals to disrupt the cell membrane or cell wall integrity [27] of the test fungi. The percentage inhibition of the mycelia weight of the three fungi tested ranged between 8% and 79%. Out of the six wild vegetable, extracts of *T. sleroxylon* had the highest effect on the fungi while extract of *L. cyanescenes* showed the least effects. The effect of extract *T. sleroxylon* doubled all other plants as shown in Table 9. The mechanisms of action of the extracts might be their ability to inhibit mycelial growth, potential to block morphogenetic transformation, indirect inhibition of cell wall synthesis and/or spore germination [28-30].

Out of the six wild vegetable screened *M. aboreus* had the highest ash content (11.00 g/100g) followed by *C. pentandra* (8.50 g/100g). The mean value of the ash content of the vegetable was 6.167 mg/100g. The corresponding levels of the fat in the vegetable were lower than the crude fibre in the plants sample except *Vitex* sp. The moisture content of the plans ranged between 4.0 and 11.0 g/100g. *Vitex* sp. had the highest amounts of carbohydrate and metabolizable energy (Table 10).

A major factor limiting the wide use of many plants is the presence of compounds commonly referred to as anti-nutritional factors which occur naturally and are widely distributed. The phytate content can further be lowered by processing. The knowledge of the phytate level in foods is necessary because high concentration can cause adverse effects on the digestibility [31]. Phytic acid binds calcium, iron, zinc and other minerals and can result in mineral deficiencies [32]. The phytate composition of the samples are lower and might not pose any health hazard when compared to a phytate diet of 10-60 mg/100g which if consumed over a long period of time decreases bioavailability of minerals in monogastric animals [33]. Table 11 contains the anti-nutritional (phytate and tannin), minerals, Na/K and Ca/P ratios of the samples. High level of these anti-nutritional components of plant materials has been associated with gastroenteritis manifested by diarrhea and dysentery [34]. These results suggest that, all levels of anti-nutritional determined in the samples are all below the recommended toxic levels caused by the presence of anti-nutritional factors [34]. The concentrations detected were low and within the ranges reported for leafy vegetables [35].

Table 6. Effects of *T. sceleroxylon* and amoxicillin/clavunanic acid interaction on the test bacteria

Test Organisms	rA	rB	rC=rA+rB	rD	Interaction
E. coli ATCC 8739	10	10	20	21	Synergistic
E. coli ATCC 25922	9	8	17	15	Inhibitory
Ps. aeruginosa ATCC 19582	12	9	21	26	Synergistic
K. pneumoniae ATCC 10031	9	6	15	23	Synergistic
K. pneumoniae ATCC 4532	8	7	15	15	Addictive
P. vulgaris ATCC 6830	7	5	12	19	Synergistic
E. faecalis ATCC 29212	9	7	16	12	Inhibitory
S. aureus ATCC 6538	5	8	13	15	Synergistic

rA=radius of antibiotic, rB= radius of extract, rD=radius of interaction

Table 7. Effects of *Vitex* sp and amoxicillin/clavunanic acid interaction on the test bacteria (zone of inhibition in mm)

Test organisms	rA	rB	rC=rA+rB	rD	Interaction	
E. coli ATCC 8739	10	8	18	20	Synergistic	0.14
E. coli ATCC 25922	9	10	19	16	Inhibitory	0.07
Ps. aeruginosea ATCC 19582	12	6	18	26	Synergistic	0.21
K. pneumoniae ATCC 10031	9	10	19	24	Synergistic	0.17
K. pneumoniae ATCC 4532	8	8	16	21	Synergistic	0.22
P. vulgaris ATCC 6830	7	5	12	10	Inhibitory	0.11
E. faecalis ATCC 29212	9	8	17	16	Inhibitory	0.10
S. aureus ATCC 6538	5	6	11	17	Synergistic	0.43

rA=radius of antibiotic, rB= radius of extract, rD=radius of interaction

Table 8: Minimum inhibitory and minimum fungicidal concentrations of the hydroalcoholic extracts of wild vegetables

Wild Vegetables	*Absidia coryeribefera*	*Penicillium notatum*	*Aspergillus fumigatus*	*Candida albicans*	*Candida tropicalis*
T. sleroxylon	5.0	1.25	10.0	5.0	5.0
Vitex spp	0.625	0.625	0.625	5.0	2.5
L. cyanescenes	5.0	0.625	5.00	2.5	2.5
C. pentandra	5.0	0.625	20.00	20.0	5.0
M. arboreus	10.0	0.625	2.50	1.25	2.5
S. trangacantha	0.625	1.25	1.25	0.625	1.25

Table 9: Biomass estimation of the hydroalcoholic extract of the wild vegetables

Test Organisms	Wild vegetables											
	T. sleroxylon		*Vitex* sp		*L. cyanescenes*		*C. pentandra*		*M. arboreus*		*S. trangacantha*	
	PAE	PI	PAE	PI	PAE	PI	PAE	PI	PAE	PI	PAE	PI
A. coryeribefera	0.1	8	0.12	57	0.42	39	0.53	23	0.29	58	0.43	74
P. notatum	0.63	15	0.44	41	0.14	81	0.55	26	0.44	41	0.43	42
A. fumigates	0.42	48	0.32	60	0.17	79	0.15	81	0.24	70	0.32	60
C. albicans	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
C. tropicalis	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

PAE = Percent antifungal effectiveness, PI = Percentage inhibition, ND = Not determined

Table 10: Proximate analysis of selected wild vegetables (g/100g)

Wild Vegetables		Ash	CP	Moisture	CF	Fat	CHO	ME
M. aboreus		11.00	5.000	9.500	18.75	9.00	46.750	1212.75
Vitex sp		3.00	4.550	4.000	6.50	0.00	71.950	1670.50
T. sceleroxylon		2.50	6.125	5.000	8.75	8.00	69.625	1583.75
S. tragacantha		7.00	6.475	4.500	15.25	6.00	60.775	1365.25
C. pentandra		8.50	5.760	11.000	17.25	9.00	48.490	1255.25
L. cyanensis		5.00	1.925	4.000	9.25	8.00	71.825	1549.75
Mean		6.167	4.973	6.333	12.625	6.667	61.569	1439.5
Standard deviation		3.296	1.654	3.093	5.094	3.445	11.568	188.26
Confidence CienceQInterval (95%)	Lower	2.707	3.237	3.087	7.279	3.051	49.427	1241.9
	Upper	9.627	6.708	9.580	7.971	0.282	3.711	1637.1

Key words: CP=crude protein, CF=crude fibre, CHO =carbohydrate, ME= metabolizable energy

Table 11: Mineral and anti-nutritional analyses of selected wild vegetables (mg/100 g)

Minerals	Wild vegetables						95% CI		SD
	MA	VS	TS	ST	CP	LC	Min	Max	
K	19.40	28.30	46.00	36.70	43.50	31.90	23.90	44.70	9.91
Na	11.00	1.80	37.00	34.80	36.70	20.20	7.86	39.31	14.98
Ca	5.39	8.35	3.97	6.57	4.57	7.95	4.25	8.016	1.79
Mg	10.38	12.20	8.62	2.74	3.63	2.54	2.24	11.14	4.24
Zn	0.29	1.31	1.24	1.82	1.43	2.19	0.71	2.05	0.64
Fe	1.79	2.58	2.56	1.88	1.17	1.49	1.32	2.51	0.57
P	113.95	83.04	111.29	134.21	69.32	45.34	58.36	127.36	32.87
Phytate	0.03	0.62	0.02	0.89	0.23	0.41	0.01	0.92	0.34
Tannins	1.87	1.32	0.84	1.08	2.20	1.36	0.73	1.98	0.50
Ca/P	0.05	0.10	0.04	0.05	0.07	0.18	0.03	0.14	0.05
Na/P	0.10	0.02	0.33	0.26	0.53	0.45	0.07	0.49	0.20
Phy/Zn	0.10	0.47	0.02	0.49	0.16	0.19	0.03	0.44	0.20
Phy/Fe	0.02	0.24	0.01	0.47	0.20	0.28	0.01	0.37	0.60
[(Ca)(Phy)/(Zn)]	0.56	3.95	0.06	3.21	0.74	1.49	0.02	3.31	1.57

The plants contained different minerals that are very useful in the system [36, 37]. The amount of minerals in the wild vegetables varied among the plants. Phosphorus was highest in all the plants. During the uptake of iron potassium has been identified to aid the mechanism in the body [38, 39]. It has also been mentioned in the management of hypertension [40]. These plants could supply sodium to the body in needed quantity. Calcium help ease insomnia and aids muscle contraction [38]. Magnesium is important in tissue respiration, especially in oxidative phosphorylation leading to formation of adenosine triphosphate (ATP) [41].

CONCLUSIONS

In view of the systemically active antimicrobial potency of the six wild vegetables, they have clearly demonstrated broad spectrum activity and potency against bacteria (Gram-positive and Gram-negative) and fungi. These indications that justify their added advantages as edible flora that could be recommended for the immune-compromised. The observed concentrations of metals in the vegetables were presented as P > K > Na > Mg > Ca > Fe. The result obtained in this study show that the plants were better sources of Mg, Ca, K, and P. Since the antimicrobial and the nutritional status of the plants have been confirmed, the full identification of a bioactive phytocompounds should be determined.

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