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Ethnobotanical Survey on Awareness of Medicinal Plants Used for Treatment of Urinary Tract Infection in Biharamulo District: Tanzania

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Introduction: In struggles to overcome a catastrophic disaster of antimicrobial resistance (AMR), many researchers are interested with safe and active medicinal plants. Kagera region is famous for uses of traditional medicines (TMs).
Aim: This study aimed to identify medicinal plants used for treatment of urinary tract infection (UTI) in Biharamulo district, Tanzania.
Methodology: To assess awareness of communities on UTI and its TMs, semi-structured questionnaires were administered to 400 respondents during ethnobotanical survey conducted in Biharamulo district at Kagera region. UTI medicinal plants were identified and collected. Data were analysed by using Chi-square test in SPSS version 16. Awareness of participants were justified at the statistical significance difference of p-values < 0.05.

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Results: The present study revealed that participants had awareness on UTI and its medicinal plants, because they identified clinical signs (85.2%), mode of transmissions and aetiologies (41%), UTI medicinal plants (99.5%) and used herbs to treat UTI (92.8%). Out of 42 medicinal plants identified for treating UTI, 29 (69%) of them had complementary ethno-medical claims or constituted active antimicrobial phytochemicals or pharmacologically proven for treating UTI and related microbial infections in literatures. The 29 medicinal plants belonged in 20 families where by the dominant were Myrtaceae, Leguminosae and Lamiaceae. Therapeutically, *S. guineense*, *S. cordatum*, *C. citrinus*, *T. mollis*, *T. sercea*, *X. caffra*, *A. muricata, P. granatum,* and *J. mimosifolia* were documented by the present study to be medicinal plants which elicit strong antimicrobial activities against UTI microbes.
Conclusion: Findings from this study concurred with the previous ones for Biharamulo societies to have awareness on UTI and its phytomedicines. Research's outcomes accentuate antimicrobial efficacies of the selected medicinal plants for treating UTI as claimed by traditional healers, significantly supported their uses and provided directions for further discovery of new UTI drugs.

Keywords: Ethnobotanical survey; awareness; medicinal plants; urinary tract infection; Biharamulo.

1. INTRODUCTION

Since from antiquity, medicinal plants had a dependable and affordable therapeutic efficacies against microbial infections compared to orthodox medications, due to their sophisticated mechanisms in curing varieties of ailments and some of them are sources of nutrients. More than 75% of people use TMs worldwide [1]. De Zoysa et al. [2] reported that at least 80% of native Africans use TMs for treating diseases. The Holy Bible strongly supports the use of herbal medicines since from creation by Almighty God (Genesis 1: 29). To uphold that, Egyptians and Israelis used spice and balm to treat their nosocomial infections (Genesis, 37:25 and Jeremiah 8:22). The holy Bible depicted at least 30 medicinal plants while Hippocrates highlighted about 400 medicinal plants around 380 BC [3]. Ancient societies in Mesopotamia, Egypt, Greece, China, and India, had been documented to utilize medicinal plants since from 26th, 18th 5th, 11th and 11th centuries BC respectively up to date [4]. Ajaibu et al. [5] reported about 50,000 of patients to die daily from microbial infections. An ethnobotanical survey is a useful tool for gathering hidden information about herbs from local residents based on their traditions and beliefs [6,7]

UTI occurs when bacteria and fungi colonize and infect parts of the urinary system [8]. Occupation of 10^5 microbes/ml of urine may lead into UTI [9]. *Escherichia coli* accounts for more than 80% of UTI aetiology [10]. The rest causative agents being *Proteus mirabilis*, *Klebsiella pneumonia*, *Staphylococcus aureus*, *Enterococcus faecalis*, and *Candida albicans* [11]. Previous studies indicated that prevalence of UTI was 30.9% among pregnant women in Mwanza Tanzania [12]. When UTI is accompanied with risk factors, which deteriorate immune system like diabetes, HIV/ AIDS, kidney failure, bladder catheterization, prostate cancer, old age and pregnancies, it is regarded as complicated UTI [8]. UTI is transmitted through genital organs to contact with infected agents, poor personal hygiene, crossing of *E. coli* from alimental canal to urinary system and sexual intercourse.

Pathogenesis occurs when host inflammation and neutrophil phagocytosis fail to eliminate the UTI pathogens after to invade superficial umbrella cells and continue to infect the bladder while releasing toxins and protease which kills host cells [13]. UTI is diagnosed by urinalysis and media-based microbial culture tests. Clinical signs of UTI are pain during urination, high rate of urination, fever, shivering, vomiting, aches in the lower abdomen and back [8,14]. Effects of UTI includes cystitis formations, discomfort, deterioration of reproductive systems, body impairments, miscarriages in females and deaths. UTI is treated by using antibiotics, probiotics, and medicinal plants, while controlled by equipping with proper person hygiene [15].

Biharamulo district has sub-equatorial medicinal plants utilized by herbalists who acquired herbal knowledge and skills from neighbourhood nations like Burundi, Uganda and Rwanda through informal education [16]. Word health organisation (WHO) associated folk and western medicines in contemporary and alternative medications [8]. TMs were made inferior and discredited during colonial era in Africa but later on, researches had revealed their phytochemicals to have pharmacological

significances [7]. Ethnobotanical survey is a crucial tool for taking hearsays into perspectives in order to support what claimed and believed by traditional healers. The oral and informal herbal knowledge has resulted into concealment of some critical details and lead into scarcity of their accessibility to the next generations [17]. To address the issue, an ethnobotanical survey was carried out to verify the information narrated by key informants and traditional healers with regard to the use of specific medicinal plants for treating UTI. Therefore, the revealed medicinal plants for treating UTI and other related microbial infections in Biharamulo district were identified and documented in this study for the future health prosperities of the societies.

2. METHODOLOGY

2.1 Description of the Study Area

The research was conducted in Biharamulo district in Kagera region, which is allocated North Western part of Tanzania. The area is characterized by tropical-equatorial climatic conditions with bimodal rainfall. Peasant agriculture is the economic backbone of the societies. Its dominant tribes are Subi, Ha and Haya who are affiliated to Christianity, Muslim and paganism. Out of 17 wards, the 5 namely Biharamulo town, Kabindi, Kalenge, Nyarubungo and Nyakahura wards were selected for the study (Fig. 1).

2.2 Study Designs

It employed cross-sectional study design. Cross-sectional study design involved to conduct an interview during ethnobotanical survey among five wards of Biharamulo district.

2.3 Sample Size and Sampling Techniques

Snowball sampling technique was used to recruit 400 participants in interview by using semi-structured questionnaires during ethnobotanical survey in Biharamulo district; it involved five wards, namely Biharamulo town, Kabindi, Kalenge, Nyarubungo and Nyakahura. According to Israel [18] sample size was calculated from Yamane's formula: -

$$n=N/ (1+Ne^2)$$

$$n=124\ 368/ (1+124\ 368*0.05^2)$$

Where n = desired sample size, e= acceptable error (5%), N=124368 people as known population from the census of 2012 in five wards of Biharamulo district. Therefore, the sample size was 399 people, but the study enrolled 400 participants.

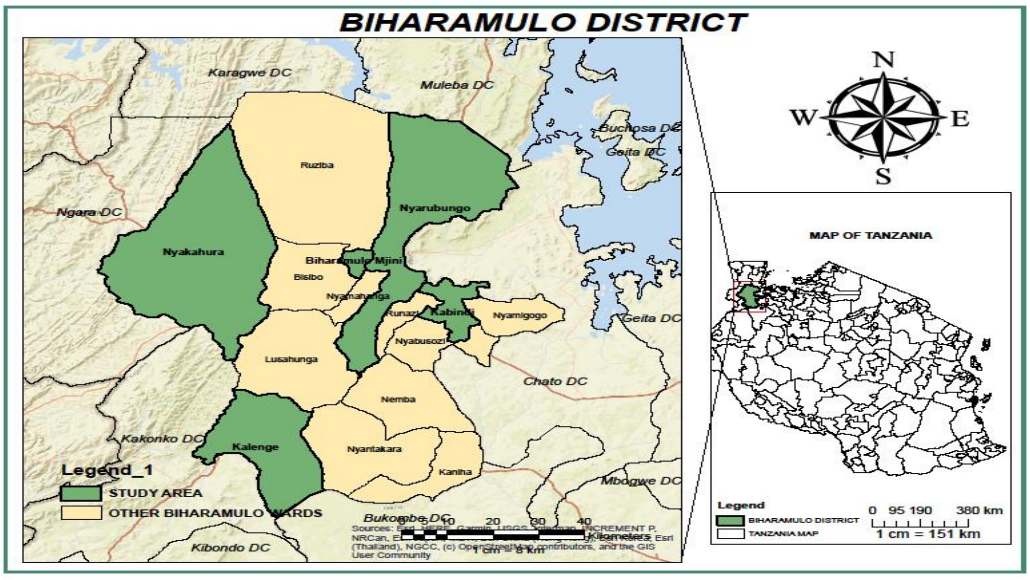

Fig. 1. A map of Biharamulo district in Kagera
Source: Created by GIS program (2021)

2.4 Ethnobotanical Survey and Identification of Medicinal Plants

During ethnobotanical survey, villagers, traditional healers and key informants in five wards of Biharamulo district were interviewed by using semi-structured questionnaires with open and closed ended questions. Their information about medicinal plants' vernacular names or morphologies helped to identify the plants by matching their pictures with those in plant net identification software and confirmed through the literatures.

2.5 Method of Data Analysis

The ethnobotanical survey data were analysed by using the Chi-square test in Statistical Package for Social Sciences (SPSS) software version 16. Statistical significant differences between interviews' awareness on UTI and their medicinal plants were determined at the p-values < 0.05.

3. RESULTS

3.1 Demographic Characteristics of Participants in Wards of Biharamulo District, Kagera

The ethnobotanical survey on medicinal plants for treating UTI was conducted in Biharamulo district, where by 400 respondents were interviewed by using semi-structured questionnaires on assessment of the effects of medicinal plants used for treatment of urinary tract infections in humans. Female respondents were many (65%) than males. In ages, most respondents were youths (60.5%) followed by adulthoods (28%) and elders (11.5%). Most participants attained secondary and primary educations by 43.5% and 41.8% respectively (Table 1). In the occupations participated, most of them were non dominant occupations (45.2%) like teachers, medical service providers, housewives, and motorcycle riders, followed by farmers (34.8%), businessmen (11.8%), and traditional healers (8.2%) (Table 1).

3.2 Correct Responses on Awareness of UTI and Its Medicinal Plants According to Sexes, Age Groups, Educational Levels, Wards and Occupations of Participants

Awareness of UTI among the 400 interviews indicated that there were people diagnosed or heard patients with UTI (98.2)%, those able to give causes and mode of transmissions (41%), who said UTI can be treated by using medicinal plants (53.5%), people mentioned at least one medicinal plant (99.5%), those used the herbs (92.8%), who know herbs locations (93.5%), understanding safety of herbs (85%), people sold medicinal plants (13.8%), those mentioned medicinal plants for treating other related microbial infections including typhoid, sexual transmitted diseases (STDs) like gonorrhoea and syphilis (15%) and those appreciated medicinal plants for treating UTI (68.8%) (Table 2).

Table1. Demographic characteristics of respondents

	N = 400 interviews	
Characteristics	**Frequencies**	**Percentage (%)**
Sex		
Males	140	35
Females	260	65
Age		
Youth age: 18 - 35 years old	242	60.5
Middle age: 36 - 55 years old	112	28
Old age: 56 years and above	46	11.5
Occupations		
Farmers	139	34.8
Businessmen	47	11.8
Traditional healers	33	8.2
Others	181	45.2
Education level		
Informal education	20	5
Primary education (standard (std) 1 - 7)	167	41.8
Secondary education (std 9 - 12)	174	43.5
Tertiary education (above std 12)	39	9.8

Source: Field data (2022)

Table 2. Awareness of UTI and its medicinal plants according to demographic characteristics (sexes, age groups and educational levels) of respondents

Awareness on UTI and its medicinal plant in	Total frequencies (%)	Sexes' correct answer frequencies (%)			Age groups in in years, correct answer frequencies (%)				Education levels' correct answer frequencies (%)				
		Male	Female	Chi-square p-value	Youth (18-35)	Adulthood (36-55)	Old age (55 +)	Chi-square p-value	Informal	Primary (std 1 - 7)	Secondary (std 9 - 12)	Tertiary (above std 12)	Chi-square p-value
	n=400 (100)	n = 140 (35)	n = 260 (65)		n = 242 (60.5)	n = 112 (28)	n = 46 (11.5)		n = 20(5)	n = 167 (41.8)	n = 174(43.5)	n = 39(9.8)	
People diagnosed or heard UTI	393 (98.2)	138 (34.5)	255 (63.8)	0.532	237 (59.2)	110 (27.5)	46 (11.5)	0.619	19 (4.8)	166 (41.5)	169 (42.2)	39 (9.8)	0.213
Mentioning UTI clinical signs	341 (85.2)	116 (29.0)	225 (56.2)	0.199	204 (51.0)	99 (24.8)	38 (9.5)	0.520	17 (4.2)	141 (35.2)	146 (36.5)	37 (9.2)	0.360
Understanding of UTI transmissions	167 (41.8)	56 (14.0)	111 (27.8)	0.340	101 (25.2)	49 (12.2)	17 (4.2)	0.734	5 (1.2)	67 (16.8)	66 (16.5)	29 (7.2)	**0.000**
Understanding of UTI aetiologies	164 (41.0)	59 (14.8)	105 (26.2)	0.407	101 (25.2)	47 (11.8)	16 (4.0)	0.660	6 (1.5)	61 (15.2)	71 (17.8)	26 (6.5)	**0.005**
People who said herbs treat UTI	214 (53.5)	62 (15.5)	152 (38.0)	**0.001**	108 (27.0)	74 (18.5)	32 (8.0)	**0.000**	15 (3.8)	113 (28.2)	67 (16.8)	19 (4.8)	**0.000**
Identification of UTI medicinal plants	398 (99.5)	139 (34.8)	259 (64.8)	0.578	240 (60.0)	112 (28.0)	46 (11.5)	0.519	20 (5.0)	167 (41.8)	173 (43.2)	38 (9.5)	0.231
People treated UTI by using herbs	371 (92.8)	121 (30.2)	250 (62.5)	**0.002**	218 (54.5)	107 (26.8)	46 (11.5)	0.114	20 (5.0)	164 (41.0	151 (37.8)	36 (9.0)	**0.003**
Selling UTI medicinal plants	60 (15.0)	17 (4.2)	43 (10.8)	0.152	28 (7.0)	18 (4.5)	14 (3.5)	**0.004**	7 (1.8)	28 (7.0)	19 (4.8)	6 (1.5)	**0.030**
Availability of UTI medicinal plants	374 (93.5)	127 (31.8)	247 (61.8)	0.221	220 (55)	108 (27.0)	46 (11.5)	0.52	19 (4.8)	165 (41.2)	153 (38.2)	37 (9.2)	**0.007**
Safety of UTI medicinal plants	340 (85.0)	112 (28.0)	228 (57.0)	0.120	191 (47.8)	104 (26.0)	45 (11.2)	**0.000**	17 (4.2)	163 (40.8)	127 (31.8)	33 (8.2)	**0.000**
Knowing herbs to treat other microbes	152 (38.0)	54 (13.5)	98 (24.5)	0.473	76 (19.0)	54 (13.5)	22 (5.5)	**0.003**	9 (2.2)	64 (16.0)	54 (13.5)	25(6.20)	**0.002**
Appreciation of UTI medicinal plants	275 (68.8)	85 (21.2)	190 (47.5)	**0.053**	155 (38.8)	88 (22.0)	32 (8.0)	0.209	15 (3.8)	128 (32.0)	106 (26.5)	26 (6.5)	0.214
Total percentages of items (%)		**(66.6)**	**(72.3)**		**68.7**	**76.6**	**76.8**		**(70.4)**	**(71.2)**	**(62.4)**	**(75.0)**	

Significant p-values (<0.05) according to Chi-square test
Source: Field data (2022)

Table 3. Awareness of UTI and its medicinal plants according to demographic characteristics (wards and occupations) of respondents

Awareness on UTI and its medicinal plant in:	Correct answer frequencies in wards (%)						Correct answer frequencies in occupations (%)				Chi-square p-value
	Biharamulo	Kabindi	Kalenge	Nyakahura	Nyarubungo	Chi-square p-value	Farmers	Business	Healer	Others	
	n = 80 (20)	n = 80(20)	n = 80(20)	n = 80(20)	n = 80 (20)		n = 139(34.8)	n = 47(11.8)	n = 33(8.2)	n = 181 (45.2)	
People diagnosed or heard UTI patients	80 (20.0)	77 (19.2)	79 (19.8)	78 (19.5)	79 (19.8)	0.437	137 (34.2)	47 (11.8)	33 (8.2)	176 (44.0)	0.598
Mentioning UTI clinical signs	73 (18.2)	68 (17.0)	59 (14.8)	73 (18.2)	68 (17.0)	**0.011**	115 (28.8)	43 (10.8)	29 (7.2)	154 (38.5)	0.547
Understanding UTI transmissions	43 (10.8)	31 (7.8)	27 (6.8)	36 (9.0)	30 (7.5)	0.089	44 (11.0)	24 (6.0)	17 (4.2)	82 (20.5)	**0.044**
Understanding of UTI aetiologies	40 (10.0)	29 (7.2)	32 (8.0)	34 (8.5)	29 (7.2)	0.370	44 (11.0)	23 (5.8)	16 (4.0)	80 (20.3)	0.088
People who said herbs treat UTI	52 (13.0)	29 (7.2)	28 (7.0)	48 (12.0)	57 (14.2)	**0.000**	89 (22.2)	30 (7.5)	25 (6.2)	70 (17.5)	**0.000**
Identification of UTI medicinal plants	80 (20.0)	80 (20.0)	79 (19.8)	79 (19.8	80 (20.0)	0.555	139 (34.8)	47 (11.8)	33 (8.2)	179 (44.8)	0.639
People treated UTI by using herbs	80 (20.0)	70 (17.5	66 (16.5)	77 (19.2)	78 (19.5)	**0.000**	134 (33.5)	44 (11.0)	33 (8.2)	160 (40.0)	0.134
Selling UTI medicinal plants	17 (4.2)	10 (2.5)	12 (3.0)	8 (2.0)	13 (3.20	0.341	9 (2.2)	3 (0.80	30 (7.5)	18 (4.5)	**0.000**
Availability of UTI medicinal plants	78 (19.5)	70 (17.5)	71 (17.8)	79 (19.8)	76 (19.0)	**0.029**	136 (34.0)	44 (11.0)	33 (8.2)	161 (40.2)	0.071
Safety of UTI medicinal plants	77 (19.2)	62 (15.5)	50 (12.5)	74 (18.5)	77 (19.2)	**0.000**	133 (33.2)	45 (11.2)	29 (7.2)	113 (33.2)	**0.000**
Knowing Herbs to treat other microbes	57 (14.2)	21 (5.2)	30 (7.5)	20 (5.0)	24 (6.0)	**0.000**	46 (11.5)	13 (3.2)	19 (4.8)	74 (18.6)	**0.021**
Appreciation for UTI medicinal plants	69 (17.2)	59 (14.8)	44 (11.0)	53 (13.2)	50 (12.5)	**0.000**	102 (25.5)	36 (9.0)	30 (7.5)	107 (26.8)	**0.036**
Total percentages of items (%)	**(77.7)**	**(63.1)**	**(60.1)**	**(72.2)**	**(68.8)**		**(67.63)**	**(70.74)**	**(82.58)**	**(63.26)**	

Significant p-values (<0.05) according to Chi-square test
Source: Field data (2022)

Awareness of UTI and its medicinal plants according to sexes indicated that females participants had good understanding (72.3%) compared to males (66.6%). On other hand females were more knowledgeable in using medicinal plants than males as most of them agreed for UTI to be treated by medicinal plants, used their surrounding medicinal plants to treat UTI in daily life and have positive attitudes toward medicinal plants by appreciating them compared to male respondents at a significant difference p-value < 0.05 (Table 2).

Awareness of UTI and its medicinal plants according to age groups shown that old and middle-aged people had good understanding (76%) compared to youth age (68.7%). On the other hand, old and middle-aged people including traditional healers were more knowledgeable for treating UTI and other related microbial infections by using medicinal plants and sold experienced safe medicinal plants at a significant difference p-value of < 0.05 (Table 2).

Based on education levels, tertiary education level had awareness on UTI (75%) than primary (71.2%), informal (70.4%), and lastly secondary educated members (62.4%). Tertiary education has good awareness in UTI aetiologies, transmissions and treatments in comparison to other levels, while informal education level followed by primary level were most aware on how to use medicinal plants, selling medicinal plants, their availability locations and herbs for treating other microbial infections in contrast to other levels at a significant difference p-value of < 0.05 (Table 2).

Awareness on UTI and its medicinal plants indicated that people from Biharamulo town ward had good awareness (77.71%, followed by, Nyakahura (72.19%), Nyarubungo (68.85%), Kabindi (63.13%) and finally Kalenge ward (60.10%). Participants from Biharamulo town were aware in knowing UTI patients, clinical signs, use of medicinal plants, knowing availability of herbs, insurance of herbs' safety to users, understanding medicinal plants for treating UTI and other microbial infections and they appreciated medicinal plants compared to other wards at a significant difference p-value of < 0.05 (Table 3).

Among participants' occupations, traditional healers had, good awareness (85.7%) compared to businesspersons (72.7%), farmers (70.9%) and lastly were other less dominant occupations (65%). On other hand traditional healers had good awareness on UTI causes, uses of medicinal plants, preparations, selling herbs, safety, active herbs against UTI and other related microbial infections and appreciated medicinal plants compared to other occupations at the significant difference of p-values of < 0.05 (Table 3).

3.3 Information Dissemination on UTI and Its Medicinal Plants in Baramulo's Societies

Information dissemination on UTI and its medicinal plants among Biharamulo societies were enhanced by villagers among themselves (49.5%) followed by medical and public health extension expertise (18.8%), parents (11.8%), traditional healers (5.5%), other occupations (2.3%) and lastly those who did not remember where they acquired UTI information (0.8%). These findings indicated that there was a need for further investigations and provision of UTI education from responsible institutions. Most of UTI education were provided by villages themselves, who were not professional to diseases (Fig. 2)

3.4 Medicinal Plants and Their Information

Based on interviews' information in ethnobotanical survey, among the 42 medicinal plants identified 29 (69%) were supported from literature survey to have pharmacological significances for treating UTI. Furthermore, details about their vernacular and botanical names, families, parts used, usable states, preparation methods, and diseases treated were documented. Pharmacologically the selected active 29 medicinal plants treated UTI (96.6%), typhoid (48.3%), malaria (27.6%), sexual transmitted infections (STIs) (17.3%), cough, wounds or ulcers and helminthic infections each one constituted 13.8%, fungal infections (10.7%), cancer and diabetes mentioned each at 6.9%, anaemia, toothache, dysentery and heart diseases were represented each by 3.4% (Table 4). The 29 medicinal plants belonged in 20 families where by the dominants were Myrtaceae, Leguminosae and Lamiaceae, each one constituted 15% (Table 4).

Table 4. Medicinal plants of Biharamulo district used to treat diseases

S/N	Botanical names (family)	Vernacular name	Parts used	Frequency	Preparation methods	Disease treated	Supporting literature for antimicrobial efficacies of crude extracts of the selected medicinal plants for treating UTI, expressed as minimum inhibitory concentration (MIC) in (mg/ml) against UTI causing microbes (*E. coli, K. pneumonia, P. aeruginosa, E. faecalis, S. aureus* and *C. albicans*)	
							MIC in mg/ml	References
1	*Annona muricata* (Annonaceae)	Mstafeli (Swahili)	Whole	5	Maceration and infusion	UTI, fungal diseases and cancer	0.04 – 6.25	[19,20]
2	*Aloe vera* (Asphodelaceae)	Shubiri (Swahili)	Leaves	101	Maceration and infusion	UTI, typhoid, fungus and malaria	0.63 – 20.0	[21]
3	*Azadirachta indica* (Meliaceae)	Mwarobaini (Swahili)	Leaves	108	Infusion	UTI, typhoid and malaria	3.41 – 67.9	[22,23]
4	*Bidens pilosa* (*L*) (Asteraceae)	Shanda (Subi)	Leaves	60	Decoction and infusion	UTI, anaemia and ulcers	0.22 – 10.0	[4,24,25]
5	*Callistemon citrinus* (*Myrtaceae*)	Crimson brush (English)	Leaves	3	Maceration and decoction	UTI, typhoid and malaria	0.025 – 1.25	[26–28]
6	*Cinnamomum verum* (Lauraceae)	Mdalasini (Swahili)	Barks	1	Maceration and decoction	UTI and ulcers	0.15 – 5.0	[29]
7	*Cymbopogan citratus* (Poaceae)	Mchaichai (Swahili)	Whole	205	Maceration and decoction	UTI, allergies and microbial infections	4.66 – 12.5	[30,31]
8	*Erythrina abyssinica* (Leguminosae)	Omlinzi (Subi)	Barks	40	Maceration and decoction	UTI, STDs, ulcers, typhoid and diabetes	0.1 – 10.0	[32,33]
9	*Fluoggea virosa* (Euphorbiaceae)	Mturuka (Haya)	Roots	3	Infusion and decoction	UTI, syphilis, gonorrhoea and induce birth	0.03 – 25.0	[5,34,35]
10	*Ipomoea cairica* (*L*) (Comnvulvulaceae)	Kalandarugo (Haya)	Whole	93	Concoction and decoction	UTI and typhoid	10.0 -30.0	[36–38]
11	*Jacaranda mimosifolia* (Bignoniaceae)	Mmea (Subi)	Whole	3	Maceration and decoction	UTI and typhoid	0.8 – 5.0	[39,40]
12	*Jatropher curcas* (*L*) (Euphorbiaceae)	Mbono (Ha)	Whole	19	Maceration and decoction	UTI, wounds, STDs, cough and toothache	3.0 – 7.0	[41,42]
13	*Kleinia fulgens* (*L.*) (Asteraceae)	Kanyoro (Haya)	Roots	3	Maceration and decoction	UTI, syphilis and gonorrhoea	>1.0	[43,44]
14	*Lantana camara* (*L.*) (Verbenaceae)	Nyanunda (Subi)	Leaves	4	Concoction and infusion	UTI	0.16 - 8.0	[45–47]
15	*Leonotis leonurus* (*L*) (Lamiaceae)	Kitatelante (Subi)	Leaves	5	Infusion and decoction	UTI, helminthic infections and malaria	0.02 – 2.1	[48,49]
16	*Moringa oleifera* (Moringaceae)	Mlonge (Swahili)	Whole	26	Maceration and decoction	UTI, typhoid, B.P, diabetes and cancer	6.25 – 12.5	[50]
17	*Neocarya macrophylla*	Omnazi (Swahili)	Roots	7	Maceration and	UTI and typhoid	2.82 – 5.0	[51,52]

S/N	Botanical names (family)	Vernacular name	Parts used	Frequency	Preparation methods	Disease treated	Supporting literature for antimicrobial efficacies of crude extracts of the selected medicinal plants for treating UTI, expressed as minimum inhibitory concentration (MIC) in (mg/ml) against UTI causing microbes (***E. coli, K. pneumonia, P. aeruginosa, E. faecalis, S. aureus*** and ***C. albicans***)	
							MIC in mg/ml	**References**
	(Chrysobalanaceae)				decoction			
18	*Ocimum sanctum* (Lamiaceae)	Kashwagara (Swahili)	Leaves	156	Tisane and decoction	UTI, typhoid and malaria	7.80 – 50.0	[53–55]
19	*Physalis peruviana* (*L*) (Solanaceae)	Ntuntunya (Subi)	Leaves	69	Infusion and decoction	UTI and typhoid	0.025 – 2.50	[56,57]
20	*Punica granatum* (*Punicaceae*)	Mkomamanga (Swahili)	Fruits		Maceration and decoction	UTI, typhoid and amebiasis	0.6 – 25.0	[9,58]
21	*Senna didymobotrya* (Leguminosae)	Mbagabaga (Ha)	Leaves	1	Maceration and infusion	Cough and helminthic infections	0.31 – 10.0	[59]
22	*Senna siamea* (Leguminosae)	Mjoholo (Swahili)	Roots	16	Maceration and infusion	UTI, malaria, typhoid and STDs	3.13 – 12.5	[60]
23	*Syzygium cordatum* (Myrtaceae)	Mgege (Ha)	Barks	1	Maceration and decoction	UTI and fungus	3.13 – 6.3	[61]
24	*Syzygium guineense* (Myrtaceae)	Msalazi (Subi)	Roots	5	Maceration and decoction	UTI, typhoid, wounds and worm infections.	0.13 – 0.5	[62]
25	*Terminalia mollis* (*L*). (Combrelaceae)	Mhongoro (Subi)	Whole	2	Maceration and decoction	UTI, worm infections and cough	1.0 – 25.0	[63–65]
26	*Terminalia sercea* (Combrelaceae)	Mhenya (Subi)	roots	2	Maceration and decoction	UTI, diarrhoea and cough	0.5 – 5.0	[66,67]
27	*Tetradenia riparia* (Lamiaceae)	Mlavumba (Hangaza)	Leaves		Maceration and decoction	UTI, cough and malaria	0.05 – 6.25	[68–70]
28	*Ximenia caffra* (Olacaceae)	Mseka (Subi)	Roots	2	Maceration and decoction	UTI, gonorrhoea, typhoid and malaria	0.19 – 5.0	[66,71,72]
29	*Zingiber offcinale* (Zingiberaceae)	Tangawizi (Swahili)	Rhizomes	4	Maceration and tisane	UTI, typhoid and cough	0.62 – 17.7	[29,31,73]

Source: Field data (2022)

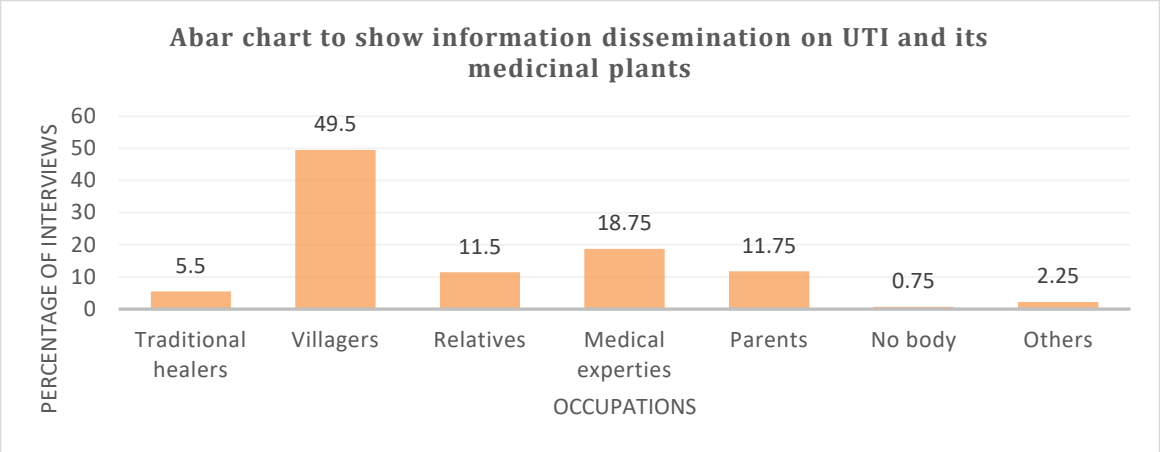

Fig. 2. A bar chart for UTI information disseminations
Source: Field data (2022)

4. DISCUSSION

This study has revealed for Biharamulo's inhabitants to have awareness on microbiological infections like UTI, typhoid, gonorrhoea, syphilis, peptic ulcers and jaundice, as well as their medicinal plants. Based on sexes, females were more knowledgeable on UTI and its medicinal plants compared to males, it was attributed to the fact that women have genital anatomical structures that expose them to susceptibility to UTI infections compared to males. In addition to that, they play roles of maintaining health status of their families. Support for the same argument came from Bruschi et al. [74] and Cock et al. [8] who realized that women had the major responsibility of providing healthcare in families, a circumstance that sparked their keen interest in searching affordable effective medicinal plants.

The age groups were associated with acquisition of UTI herbal knowledge. Elders were more knowledgeable followed by adults and finally youths. This was linked to the prolonged exposure of elders to herbs against different ailments, especially traditional healers, who acquired herbal knowledge, skills and experiences throughout their lifetime. Bruschi et al. [74] gave a similar finding that the level of understanding of TMs and experiences in a community varies directly proportion to seniority, provided that senescence had not deteriorated the mental abilities. The same ideal was narrated by Kigen et al. [75] who argued that youths' ignorance in medicinal plants was associated with seniors' concealment on herbs and youths' preferences to orthodox over herbal remedies.

Participants from Biharamulo town wards were more knowledgeable on UTI and its medicinal plants due to exchanges and extensive connection with different individuals who brought herbal knowledge from rural to urban areas. The previous studies from Lagos Nigeria narrated by Oreagba et al. [1] and Mounanga et al. [76] provided a proof that about 66% of urban inhabitants recognized and used medicinal plants against contagious infectious ailments including UTI at affordable expenses. Furthermore, neighbouring nations like Burundi and Rwanda had historically swapped information on traditional medicines, dating back to colonial era [16]. In additional to that, people from Biharamulo town ward were able to participate by disclosing the UTI herb details, unlike to other rural wards with few tribes fixed to a limited number of herbal medicines.

Participants with higher educational levels had good awareness on UTI but they were less knowledgeable in its medicinal plants as most of them used synthetic antibiotics and ignored medicinal plants. Vice versa was true to the informal and primary levels where most of them were aware on medicinal plants compared to higher levels of education (Table 3). Similar findings from Kidane et al. [77] pointed out for existence of a negative relationship between attained education level and knowledge of folk medicines, with the argument being that as education levels rises it initiates the loss of interests in folk medicines, they supported their argument by providing evidences that

uneducated exemplified more herbal medicines than scholars.

Compared to other professions, traditional healers had a better understanding on UTI and its medicinal plants as they treated a large number of patients and marketed TMs as commodities, a circumstance that gave them high exposure to different antimicrobial plants. Aspects similar to these were addressed by Bruschi et al. [74]. According to popular belief, traditional healers keep secret in disseminating herbal information [75], this could account for Haya tribal which was suspected to know many medicinal plants but they mentioned few UTI medicinal plants. The majority of participants from Biharamulo utilized leaf decoctions and infusions as preparation methods for UTI medications. This scenario was in line with a previous study conducted by Penido et al. [78] who credited for accessibility of consistent leaves throughout the year with the exceptions of few arid climate zones. Furthermore Moshi et al. [79] appreciated people from Kagera for utilizing leaves of medicinal plants with regard to environmental conservations.

Villagers disseminated information on UTI and its medicinal plants for less than 50%. Public health extension educators, traditional healers and parents have educated the society on UTI to a small extent, that is why most of the respondents had less understanding on causes and transmissions of UTI. Comparable research from Kenya by Chebii et al. [80] shown that non-traditional healers, particularly older women are the best sources of herbal information for over 50% and he claimed for traditional healers to hinder the reliability of herbal details. With reference to Ozioma and Chinwe [7], African folk medicine innovations had been hampered by the absence of reliable and secure supervisions, inconsistent dosages, toxicity assessments, and records' keeping. Herbalists are advised to adhere to these restrictions.

Biomedical Justifications for Efficacies of UTI Medicinal Plants

Literature surveys revealed that the 29 selected medicinal plants had sufficient antimicrobial potentials for treating UTI. Herbal efficacies were supported by ethno-medical claims from interviews, minimum inhibitory concentrations (Table 4) and constituted phytochemicals from literature reviews. Based on antimicrobial ranking criterion, plant extracts are considered to have significant or excellent active antimicrobial activities if their MIC values are below 0.1mg/ml, good and acceptable efficacy when 0.1≤MIC≤ 0.6 mg/ml and are weak when MICs > 0.6 mg/ml. The same concept was stated by Thapa et al. [81] and Fabry et al. [82] that crude extracts of medicinal plants with MIC values less than 8 mg/ml have antimicrobial potentials while MIC < 1mg/ml have good antimicrobial potentials to be considered as antibiotics. Based on these ranking indexes, the investigated medicinal plants had antimicrobial potentials against UTI microbes (Table 4).

Pure and isolated compounds have significant antimicrobial activities when MIC < 0.01 $mgml^{-1}$, moderate when 0.01 ≤ MIC ≤ 0.1 $mgml^{-1}$, and less susceptible when MIC > 0.1 $mgml^{-1}$ [83,84]. Literature surveys revealed active antimicrobial activities at MIC values ≤ 0.1 mg/ml for isolated phytochemicals among medicinal plants of the present study, including phenols (punicalagin, ellagic acid, gallic acid, arjunolic acid, gingerol, emodin, anolginan B and palmarumycins), flavonoids (quercetin, hyperoside, caempferol, cinnamaldehyde, abyssinone VII, sigmoidin B and myrcetin), terpenoids (arjunolic acid, 5-sandaracopimadiene-7-α,18-diol, eugenol, β-caryophyllene, betulinic acid stigmasterol, limonoids, octadecadienoic acid, citronellol and phytol), alkaloids (atropine) and polyacetylene (polyynes).

In mechanisms of phytochemicals against microbes, alkaloids interfere with DNA replication and RNA transcription, flavonoids induce permeability of cell membrane and destruction of cell wall, terpenoids and essential oil destruct cell membranes, increase cell permeability and influx of cell components while stopping drug efflux [85,86]. Quinones avoid biofilm formation, destroy cell walls and inactivate enzymes, while lectins acts as competing inhibitors in binding to host receptors [87]. Tannins prevents protein synthesis and inhibit enzymatic activities [66,88]. Saponins bind to membrane cholesterol, lyse microbe cells and boost the host immunity by enhancing lysosomes production [89]. Coumarin lyse cell membrane, boost immune system and inhibits quorum sensing for biofilm aggregates [90,91]. The majority of the recognized medicinal plants contained tannins, phenols, and flavonoids, with minor extinction of phytochemicals as indicated below;

The family Myrtaceae was characterized by its anticancer myrtucommulones which have also

antimicrobial, hypoglycaemic, anthelmintic and virucidal activities [92]. In this study, Myrtaceae species (*S. guineense*, *S. cordatum* and *C. citrinus*) had significant active antimicrobial activities (Table 4). *S. guineense* is an remedy for liver impairments, diabetes, hypertension, haemorrhoids, tuberculosis, diarrhoea, helminthic infections, HIV, STIs, malaria, cancer, ulcers, dysentery and deserved as active antimicrobial drug due to its constituted isoprenoids, elagtannins, myricetins, terminolic acid, asiatic acid, ursolic acid, arjulonic acid and caryophylene [93]. *S. cordatum* treats stomachache, diarrhoea, wounds and has antimicrobial potentials based on its gallic acid, arjunolic acid, vinillic acid, caffeic acid, *p*. coumaric acid, oleanolic acid, betulinic acid, hexadecanoic acid and epifriedelinol [94]. *Callistemon citrinus* is used to treat tuberculosis, UTI, haemorrhoids, neurodegrative diseases, malaria, trypanosome and its antimicrobial agent is associated with constituted eucalyptol, cineol, pinene, limonene, myrcene, phloroglucinol derivatives, linalool, stearic and palmitic acids [27,28,95].

It was ascertained that *Terminalia mollis and Terminalia sercea* of Combrelaceae family are used to treat diarrhoea, malaria, AIDs adjuvant, diabetes, cough, hypertension and their pure isolated compounds had good antimicrobial activities at MIC values less than 0.1mg/ml against UTI microbes and possess low cytotoxic effects [3,66,96]. Active antimicrobial compounds in *T. mollis* are resins, 3-*O*-methyllellagic 4'-*O*-α-rhamnopyranoside, 2α-hydroxyursolic acid, catechin, friedelin, saponins, gallic acid, arjunolic acid, butulinic acid, ursolic acid and combrelatannins (punicalagin) which kill microorganisms by precipitating their amino acids in cell walls [97,98]. On other hand antimicrobial activities in *T. sercea* was associated with termilignan B, arjunetin, arjungenin, anolginan B, sericic acid, elagic acid, flavogalonic acids, stilbene, resveratrol-3-rutinoside, catechins, lupeol and quercetin [67].

It was contended by Mbowen [66] that members of Olacaceae family, notably *X. caffra*, had anticarcinogenic, antiparasitic, ant-infertility or ant-impotence, anti-diarrhoea and antimicrobial significances. Its antimicrobial pharmacology is influenced by its gallic, procyanidine, isoquercetin (hyperoside), caempferol, sanguinarine, vomifolic acid, atropine, 3-*p*-coumaroylquinic acid, hexadecanoic acid and robinobioside [99,100]. *Annona muricata* is used to treat cancer, diabetes, helminthic pathogenesis, malaria, liver and pancreas impairments, insomnia and its antimicrobial activities was allied to constituted muricin (acetogenin), anonaine, isolaureline, anonamine, asimilobine, leticuline, axylopine, stnorcorydine, R(4,*O*-methyl-10-claurinee, kaempferol, quercetin-3-O-α-rhamnosyl, gallic acid, epicatechin, chlorogenic acid, vomifoliol, gallic, hexadecanoic acid, annonacin and gentisic acid [20,101].

Bidens Pilosa is used to heal malaria, diabetes, ulcers, haemorrhoids, hypertension, allergies, induction of the immune system by centaureidin and its antimicrobial potentials are caused by octadecadienoic acid, quercetin, β-caryophyllene, stigmasterol, astragalin, sandaracopimara-8, (14), 15 diene, iso-vanillin derivatives, axillaroside, vitexin and polyynes [4,73,102]. *Kleinia fulgens* had oleanolic acid, ursolic acid, lupine derivatives, germacranes, triterpenoids, kaempferol, quercetin, senecionine and pyrrolizidine alkaloids, which accounts for its antimicrobial activities [43,44].

The family Lamiaceae consisted *Leonotis leonurus, Ocimum sanctum* and *Tetradenia riparia. O. sanctum,* is used to treat diarrhoea, diabetes, memory and stress enhancer, cardiac impairments, typhoid, infertility and its antimicrobial activities are portrayed by its eugenol, cadinene, limonene, cineol, bisabolol, orintin, rosmarinic, ursolic and chicolic acids [13]. Mazimba [48] repoted that *L. leonurus* is a remedy for diabetes, haemorrhoids, menstrual imbalance, skin infections, hypertension, tuberculosis, jaundice, kidney, obesity, cancer, diarrhoea, epilepsy, malaria and activate the immune system. Its antimicrobial cure is initiated by luteolin, labdane, leonurine, marrubin, apigenin, geniposidic acid, limonene, ocimene, terpinolene, β-cubenene, caryophyllene, germacrenoipipe, spathulenol and iridoids [48]. *T. riparia* was described by Njau et al. [70] for treating malaria, worm infections, STIs, diarrhoea, dental pains and its antimicrobial properties are associated with constituted 5-sandaracopimadiene-7-α,18-diol, ibozol, 5,6-dihydro-α-pyrone, abieta-7,9 (11)-dien-13-β-ol, caryophyllen, stigmasterol, deacetylumuravumbolide, astragalin, luteolin, tetradenolide and limonene [69,103].

Oladeji et al. [104], González-Stuart et al. [105] and Alshehri et al. [106] reported the family Leguminosae (*S. siamea*, and *S. didymobotrya*)

to possess resins, quinolizidine alkaloids, stigmasterol, bianthraquinones, luteolin, kaempferol, quercetin, vitexin, betulinic acid, vanillic acid, stigmasterol, catechin, emodin, sennosides, cassine, luteolin, knipholone, physicion, chrysophanol, quinquangulin, naphthalene and proanthocynidins with pharmacological significances on microbial, helminthic and plasmodia pathogenesis. *E. abyssinica* (Leguminosae) is used to treats diabetes, ulcers, cancer, snake dote, diarrhoea, tuberculosis, malaria, ant HIV I, jaundice and infertility while its antimicrobial functions were shown by presence of eryvarin, licoagrochalcone A, erythrabyssin , indicanine B, 3-methylbutein, abyssinone, isoflavone, sigmoidin B, phaseolin and 9-ethyldodecyl-4methoxybenzoate [32,33].

Both *Flueggea virosa* and *Jatropher curcas* belongs in Euphorbiaceae family. *F. virosa* is used to treat kidney, liver, ulcers, tumour, STIs, UTI, dote, hypertension, diabetes, impotence, birth difficulties, cough, worm and viral infections, sickle cell anaemia and malaria. Its antimicrobial properties is associated with fluevirosine, bergenine, fluvirin, securinine derivatives, gallic acid, friedelin, virosine, rutin, elagic acid, phyllanthidine, flueggenine, butulic acids, indolizidine glycsides, hordenine and barboline [34,107]. On other hand *J. curcas* has therapeutical beneficials as anti-HIV, relieving toothache, wound healing, antitumor, antiplasmodial, anticoagulant and its antimicrobial properties are attributed to its gallic acid, palmarumycin JC1 and JC2, pyrogallol, taraxasterol, jatrophidin, caniojane, vitexin, vanillic acid, stigmasterols, hexadecanoic acid, sapogenin and sitosterols, however jatrophin and curcin in seed oil are toxic [42,108,109].

Punica granatum is a remedy for cancer, hypertension, obesity, plague, typhoid and UTI due to its corresponding pelletierine alkaloids, stigmasterol, ellagitannins, punicalin, punicalagin, gallic acid, heptacosane, anthocynins, ellagic acid, coumarins and lectins [9,110,111]. *Physalis peruviana* was reported by Kasali et al. [112] and Elbeltagi et al. [113] for curing cancer, diabetes, hormonal imbalance, activation of immune system, helminthic infections, liver, neurodegration and malaria. Its antimicrobial potential are due to presence of *p*-coumaric acid, caffeic acid, vanillic acid, cinnamic acid, gallic acid, caempferols, quercetin, physoperuvine and ursolic acid [56,112].

Cinamomum verum contains aroma benzylisoquinoline, benzyl benzoate, terpenoids, cinnamaldehyde, linalool, cinnamyl acetate, eugenol, transcinnamyl, proanthocyanidins and camphor, which elicits antimicrobial, antidiabetic and anti-ulcers properties [13,114]. *Cymbopogon citratus* was investigated and found to possess a scent citral, limonene, quercetin, kaempferol and geraniol, which are utilized as ant carcinogenic and had ability to kill bacteria [31,115]. Back to *Ipomoea cairica*, it has anticancer, antidiabetic, antihypertension, ant jaundice, ant HIV transcriptase and antimicrobial activities was elevated by its coumarin derivatives, lignans, cairicoside, scopoletin, glycoresins, arctigenin, convolvine, cyanogenic glycoside, matairesinol, trachelogenin, caempferol and indole alkaloid [38,116,117]

Ursolic acid, butulic acid, jacaranone, gallic, quercetin, betulinic acid, maslinic acid, caempferol, iridoids, quinones, phenylpropanoids, phytol, piperidinone, N-[4-bromo-n-butyl], hexadecanol, caryophyllene, caffeic acids and coniferol were reported by Kaur et al. [118], Naz et al. [40] and Mostafa et al. [119], to be found in *Jacaranda mimosifolia* and are accountable for the antibacterial, antiprotozoal, antidiabetic and antitumor. *Aloe vera* contains aloe-emodin, aloesin, aloin, chrysophanol and phenols which are responsible for the antibacterial, antiplasmodial and anticancer pharmacology [21,120,121]. *Azadirachta indica* contains mahmoodin, octadecanoic acid, nimbolide, azadirachtin, margolone derivatives, gedunine, peptidoglycan and cyclic trisulphide that are antimicrobial compounds [122,123]. Other biomedical significances of *A. indica* includes antimalarial, virucidal, analgesic and antiulcer [13,124].

Lantana camara yields lantadene, boswellic acid, gautin, verbascoside, betulinic acid, ursolic acid, oleanolic acid, phytol, gautin penduletin, linaroside, isocaryophylene, bicyclogermacrene, 2-dodecene, amphetamine, isoquinoline, pectolinarigenin, imidazole and pyrrolizidine alkaloids which give antimicrobial activities [125,126]. Other diseases treated by *L. Camara* were reported by Naz and Bano. [46] to be cancer, chiken pox, measles, asthma, ulcers, hypertension, tetanus, malaria and nematode infections. *Moringa oleifera* exudates niazimicine, benzyl-isothiocyanate, benzyl glucosinolates, gallic acid kaempferol, acetylated carbamate, amino acids, moringine, and spirochin which signify for the plant to have antimicrobial, anticancer, ant-hyperglycaemic, anti-infertility

properties and modulating the immune system [13,73,127,128].

According to the previous study conducted by Yusuf et al. [52] indicated that *Neocarya macrophyla* was used to treat asthma, wounds, dysentery, tumour, tooth decay, venom, inflammation and eye diseases. Its antimicrobial biocidal incorporates with its stigmasterol, hydroxybenzoic acid, isocarthamidin, glucosamines, microphylose, epicatechin, β-sitosterol, and quercetin [129]. Finally phytochemical analysis conducted by Mao et al. [130] and Shaheen et al. [13] revealed synthesis of gingerol isomers, zingiberene, zingiberol, dihydroparadols and shogaols as antimicrobial compounds in *Zingiber officinale*.

Isolated phytochemicals and sensitivity tests in literatures revealed that famous medicinal plants, mentioned at high frequencies in the present ethnobotanical survey, might have weak antimicrobial activities compared to those mentioned by few people. It indicated that active UTI medicinal plants are known by few people due to secrecy of traditional healers. This was a gap to be bridged by the present study. Out of the 42 medicinal plants identified, 29 (69%) of them were found to have related antimicrobial implications, ethnobotanical assertions and pharmacological justifications or possessed potential phytochemicals enough to treating UTI or related microbial infections in literatures.

5. CONCLUSION

This study had succeeded to document and disseminate medicinal plants used for treatments of UTI in Biharamulo district rather than oral herb information proclamation practiced by indigenous. *S. guineense*, *S. cordatum*, *C. citrinus*, *T. mollis*, *T. sercea*, *X. caffra*, *A. muricata, P. granatum,* and *J. mimosifolia* were portrayed by the contemporary research to be the best medicinal plants with strong antimicrobial activities for treating UTI. The present study justified claims of traditional healers and herbalists on the uses of selected medicinal plants to have efficacies against UTI causing microbes or related microbial infections. Therefore, the present study may provide evidences and scope for further discovery of new UTI drugs for combating antimicrobial resistances.

6. RECOMMENDATIONS

Further considerations should act upon in evaluation of antimicrobial effectiveness, phytochemical screening and cytotoxicity tests on selected medicinal plants to ensure their safety and efficacies to users. Traditional healers, herbalists, health welfare programs and public health extension officers should educate people who are not aware on UTI and its medicinal plants. Due to the significances of herbal medications, societies are advised to apply environmentally friendly utilization of the herbal leaves instead of roots and barks so that the phytomedicines become reliable in the next generations.

SIGNIFICANCE OF THE STUDY

The study justified the efficacies of medicinal plants for treating UTI in regard to ancient African traditions among Kagera region. These antiquated medications should be evaluated carefully in the light of new millennium science and technology and become utilized effectively if recognized and realized their therapeutical potentialities.

CONSENT AND ETHICAL APPROVAL

Sokoine University of Agriculture granted permission for the research. In addition to that, participants were ensured confidentiality of their information and requested to fill consent forms for determination of their willingness in participation.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Oreagba IA, Oshikoya KA, Amachree M. Herbal medicine use among urban residents in Lagos, Nigeria. BioMed

Central Complementary and Alternative Medicine. 2011;11(1): 1-8.
2. De Zoysa MH, Rathnayake H, Hewawasam RP, Wijayaratne WM. Determination of *In vitro* antimicrobial activity of five Sri Lankan medicinal plants against selected human pathogenic bacteria. International Journal of Microbiology. 2019;743-1439.
3. Ibrahim YK, Tytler BA, Ogunsola YK. Phytochemical and antimicrobial screening of crude extracts (aqueous and ethanolic) of Terminalia mollis linn (Combretaceae) root. Nigerian Journal of Pharmaceutical Research. 2006;5(1):109- 115.
4. Bartolome AP, Villaseñor IM, Yang WC. *Bidens pilosa* L. (Asteraceae): Botanical properties, traditional uses, phytochemistry, and pharmacology. Evidence-based Complementary and Alternative Medicine. 2013;1- 51
5. Ajaib M, Shafi F, Zahid MT, Siddiqui MF. Antimicrobial and Antioxidant screening of Flueggea. Bioscience Research. 2021;17(4):2791-2798.
6. Debalke D, Birhan M, Kinubeh A, Yayeh M. Assessments of antibacterial effects of aqueous-ethanolic extracts of Sida rhombifolia's aerial part. The Scientific World Journal. 2018 Dec 18;2018.
7. Ozioma EO, Chinwe OA. Herbal medicines in African traditional medicine. Herbal medicine. 2019;10:191-214.
8. Cock I, Mavuso N, Van Vuuren S. A review of plant-based therapies for the treatment of urinary tract infections in traditional Southern African Medicine. Evidence-based Complementary and Alternative Medicine. 2021;2021:1-20.
9. H Alamshani W, Al-Sarraj F, A Algamdi M. The inhibitory effect of Punica granatum on Escherichia coli and Klebsiella pneumonia Extended spectrum β-lactamase strains. Novel Research in Microbiology Journal. 2023;7(1):1836-1856.
10. Lagha R, Ben Abdallah F, Al-Sarhan BO, Al-Sodany Y. Antibacterial and biofilm inhibitory activity of medicinal plant essential oils against Escherichia coli isolated from UTI patients. Molecules. 2019;24(6):1161.
11. Elamary RB, Albarakaty FM, Salem WM. Efficacy of Acacia nilotica aqueous extract in treating biofilm-forming and multidrug resistant uropathogens isolated from patients with UTI syndrome. Scientific Reports. 2020;10(1):11125.
12. Masinde A, Gumodoka B, Kilonzo A, Mshana SE. Prevalence of urinary tract infection among pregnant women at Bugando medical centre, Mwanza, Tanzania. Tanzania Journal of Health Research. 2009;11(3):154-159.
13. Shaheen G, Akram M, Jabeen F, Ali Shah SM, Munir N, Daniyal M, Riaz M, Tahir IM, Ghauri AO, Sultana S, Zainab R. Therapeutic potential of medicinal plants for the management of urinary tract infection: A systematic review. Clinical and Experimental Pharmacology and Physiology. 2019;46(7):613-624.
14. Chen YC, Chang CC, Chiu TH, Lin MN, Lin CL. The risk of urinary tract infection in vegetarians and non-vegetarians: A prospective study. Scientific Reports. 2020;10(1):1-9.
15. Das S. Natural therapeutics for urinary tract infections—A review. Future Journal of Pharmaceutical Sciences. 2020;6:1-3.
16. Moshi MJ, Otieno DF, Mbabazi PK, Weisheit A. Ethnomedicine of the Kagera region, North western Tanzania. Part 2: The medicinal plants used in Katoro Ward, Bukoba district. Journal of Ethnobiology and Ethnomedicine. 2010;6(1):1-5.
17. Mbunde MV, Innocent E, Mabiki F, Andersson PG. Ethnobotanical survey and toxicity evaluation of medicinal plants used for fungal remedy in the Southern Highlands of Tanzania. Journal of Intercultural Ethnopharmacology. 2017; 6(1):84-96.
18. Israel GD. Determining sample size 1 the level of precision. Biometrics. 1992;42.
19. Harahap D, Niaci S, Mardina V, Zaura B, Qanita I, Purnama A, Puspita K, Rizki DR, Iqhrammullah M. Antibacterial activities of seven ethnomedicinal plants from family Annonaceae. Journal of Advanced Pharmaceutical Technology and Research. 2022;13(3):148 -153.
20. Aguilar-hern G, Brandon AL, Alejandro P, Ruvalcaba-g M, Castellanos-huerta I, Tellez-isaias G. Antibacterial activity of crude extract and purified acetogenins from Annona muricata seeds. Applied Sciences. 2023;13(1):558.
21. Arsene MM, Viktorovna PI, Sergei GV, Hajjar F, Vyacheslavovna YN, Vladimirovna ZA, Aleksandrovna VE, Nikolayevich SA, Sachivkina N. Phytochemical analysis, antibacterial and antibiofilm activities of Aloe vera aqueous extract against selected resistant gram-

negative bacteria involved in urinary tract infections. Fermentation. 2022;8(11):626.

22. Parveen G, Ali M. Extraction, isolation and phytochemical screening of leaves and stems of Bidens Pilosa and evaluation of antifungal potential of extracts. IOSR J Pharm Biol Sci e-ISSN [Internet]. 2019; 14(4):73-76.
Available:www.Iosrjournals.Org
23. Mishra MP, Rath S, Swain SS, Ghosh G, Das D, Padhy RN. *In vitro* antibacterial activity of crude extracts of 9 selected medicinal plants against UTI causing MDR bacteria. Journal of King Saud University-Science. 2017;29(1):84-95.
24. Singh G, Passsari AK, Singh P, Leo VV, Subbarayan S, Kumar B, Singh BP, Lalhlenmawia H, Kumar NS. Pharmacological potential of *Bidens pilosa* L. and determination of bioactive compounds using UHPLC-QqQ LIT-MS/MS and GC/MS. BMC Complementary and Alternative Medicine. 2017;17(1): 1-6.
25. Son NH, Tuan NT, Tran TM. Investigation of chemical composition and evaluation of antioxidant , antibacterial and antifungal activities of ethanol extract from Bidens pilosa L . 2022;2061:1–8.
26. Mabhiza D, Chitemerere T, Mukanganyama S. Antibacterial properties of alkaloid extracts from *Callistemon citrinus* and *Vernonia adoensis* against *Staphylococcus aureus* and *Pseudomonas aeruginosa*. International Journal of Medicinal Chemistry. 2016;2016:1-7.
27. Oyedeji OO, Lawal OA, Shode FO, Oyedeji AO. Chemical composition and antibacterial activity of the essential oils of *Callistemon citrinus* and *Callistemon viminalis* from South Africa. Molecules. 2009;14(6):1990–1998.
28. Chitemerere TA, Mukanganyama S. In vitro antibacterial activity of selected medicinal plants from Zimbabwe. The African Journal of Plant Science and Biotechnology. 2011;5(1):1-7.
29. El-Kelany A, El-Swaify Z, Nour M, Elsaied ED. Phytochemical and biological studies on some medicinal plants. Journal of Pharmaceutical Sciences. 2020;62.
30. Akpoka OA, Okwu MU, Imade OS, Nwangwu SCO, Omonegho EG, Uti C. A comparative study of the antibacterial effect of three ethnomedical plants (*Ocimum gratissimum, Vernonia amygdalina* and *Cymbopogon citratus*) on certain clinical isolates. Herbal Medicines Journal. 2019;4(2):65–75.
31. Guerrini A, Tacchini M, Chiocchio I, Grandini A, Radice M, Maresca I, Paganetto G, Sacchetti G. A comparative study on chemical compositions and biological activities of four Amazonian Ecuador essential oils: *Curcuma longa* L. (Zingiberaceae), *Cymbopogon citratus* (DC.) Stapf, (Poaceae), *Ocimum campechianum* Mill. (Lamiaceae) and *Zingiber officinale* Roscoe (Zingiberaceae). Antibiotics. 2023;12(1):177.
32. Obakiro SB, Kiprop A, Kigondu E, K'Owino I, Odero MP, Manyim S, Omara T, Namukobe J, Owor RO, Gavamukulya Y, Bunalema L. Traditional medicinal uses, phytoconstituents, bioactivities, and toxicities of *Erythrina abyssinica* Lam. ex DC.(Fabaceae): A systematic review. Evidence-Based Complementary and Alternative Medicine. 2021;2021:1-43.
33. Machumi F, Bojase-Moleta G, Mapitse R, Masesane I, Majinda RR. Radical scavenging-flavonoids from *Erythrina abyssinica*. Natural Product Communications. 2006;1(4):2-7.
34. Kouangbe MA, Tchumou M, Monon KO, Ouattara K, N'guessan JD. Assessment of antibacterial activity of some extracts of *Securinega virosa* (Roxb. ex Willd.) Baill on pathogens bacteria. Journal of Drug Delivery and Therapeutics. 2023;13(1):116-122.
35. Amenu JD, Neglo D, Abaye DA. Comparative study of the antioxidant and antimicrobial activities of compounds isolated from solvent extracts of the roots of *Securinega virosa*. Journal of Biosciences and Medicines. 2019;7(08): 27–41.
36. Chawla R, Kumar S, Sharma A. The genus Clematis (Ranunculaceae): Chemical and pharmacological perspectives. Journal of Ethnopharmacology. 2012;143(1):116-150.
37. Srivastava D, Shukla K. Ipomoea cairica: A medicinal weed with promising health benefits. International Journal of Information Research and Review. 2015; 2(5):687-694.
38. Dhale DA. Antifungal activity of *Ipomoea cairica* (L.) Sweet (Convolvulaceae) against plant pathogenic fungi. Dogo Rungsang Research Journal. 2022; 12(10):157-160.
39. Sidjui LS, Toghueo RMK, Menkem Zeu E, Mbouna CDJ, Leddet VM, Herbette G.

Antibacterial activity of the crude extracts, fractions and compounds from the stem barks of Jacaranda mimosifolia and Kigelia africana (Bignoniaceae). Pharmacologia. 2016;7(1):22–31.

40. Naz R, Roberts TH, Bano A, Nosheen A, Yasmin H, Hassan MN, Keyani R, Ullah S, Khan W, Anwar Z. GC-MS analysis, antimicrobial, antioxidant, antilipoxygenase and cytotoxic activities of Jacaranda mimosifolia methanol leaf extracts and fractions. PLoS One. 2020;15(7): e0236319.
41. Dada EO, Ekundayo FO, Makanjuola OO. Antibacterial activities of *Jatropha curcas* (LINN) on coliforms isolated from surface waters in Akure, Nigeria. International Journal of Biomedical Science: IJBS. 2014;10(1):25-30.
42. Omoregie EH, Folashade KO. Broad spectrum antimicrobial activity of extracts of *Jatropha curcas*. Journal of Applied Pharmaceutical Science. 2013;3(4):83-87.
43. Jesus JA, Lago JH, Laurenti MD, Yamamoto ES, Passero LF. Antimicrobial activity of oleanolic and ursolic acids: An update. Evidence-Based Complementary and Alternative Medicine. 2015;2015:1-14.
44. Sewawa K. Phytochemical investigation of the aerial parts of Kleinia longiflora. Dissertation for Award of MSc Degree at University of Botswana International University of Science and Technology, Botswana. 2021;1–51.
45. Joshi B, Lekhak S, Sharma A. Antibacterial property of different medicinal plants: *Ocimum sanctum, Cinnamomum zeylanicum, Xanthoxylum armatum* and *Origanum majorana*. Kathmandu University Journal of Science, Engineering and Technology. 2009;5(1):143-150.
46. Naz R, Bano A. Phytochemical screening, antioxidants and antimicrobial potential of Lantana camara in different solvents. Asian Pacific Journal of Tropical Disease. 2013;3(6):480-486.
47. Sharma A, Verma R, Ramteke P. Antibacterial activity of some medicinal plants used by tribals against UTI causing pathogens. World Applied Sciences Journal. 2009;7(3):332-339.
48. Mazimba O. Leonotis leonurus: A herbal medicine review. Journal of Pharmacognosy and Phytochemistry. 2015;3(6):74-82.
49. Ratsoma MF. Antidiabetic and phytochemical properties of four selected medicinal plants. Dissertation for Award of MSc Degree at University of KwaZulu-Natal, South Africa, 2019;118.
50. Delelegn A, Sahile S, Husen A. Water purification and antibacterial efficacy of *Moringa oleifera* Lam. Agriculture and Food Security. 2018;7(1):1-10.
51. Garba J, Oba A, Ofili A, John B, Isah H, John KV, Musa JA. Phytochemical screening, proximate composition and mineral element analysis of *Neocarya macrophylla* (gingerbread) plum and its effects on microorganisms. Journal of Biochemistry, Microbiology and Biotechnology. 2022;10(1):76-81.
52. Yusuf AJ, Abdullahi MI, Haruna AK, Musa AM, Abdullahi MS, Ibrahim ZY, Halilu M, Odiba O. Phytochemical and antimicrobial evaluations of the methanol stem bark extract of Neocarya macropylla. Journal of Chemical and Pharmaceutical Research. 2015;7(1):477-481.
53. Chanthaboury M, Choonharuangdej S, Shrestha B, Srithavaj T. Antimicrobial properties of Ocimum species: An *In vitro* study. Journal of International Society of Preventive and Community Dentistry. 2022;12(6):596-602.
54. Dalhat AD, Taura DW, Musa DA, Ayuba SS, Shu'aibu M, Muhammad AU. Evaluation of antibacterial activity of *Momordica charantia, Ocimum sanctum* and *Prosopis juliflora* against some selected bacteria. Asian J Pharm Pharmacol. 2020;6(3):217–23.
55. Kumar A, Tantry BA, Rahiman S, Kumar S. Antibacterial evaluation and phytochemical screening of methanolic extract of Ocimum sanctum against some common microbial pathogens. Aus J Bas Appl Sci; 2011.
56. Muñoz P, Parra F, Simirgiotis MJ, Sepúlveda Chavera GF, Parra C. Chemical characterization, nutritional and bioactive properties of Physalis peruviana fruit from high areas of the Atacama desert. Foods. 2021;10(11):2699.
57. Kathare JM. Antimicrobial, cytotoxicity, acute oral toxicity effects and phytochemical composition of aqueous and methanolic extracts of *Physalis peruviana, Bridellia micrantha,* and *Croton megalocarpus*. Dissertation for Award of MSc Degree at University of Nairobi, Kenya. 2021;1-68.
58. Zam W, Khaddour A. Anti-virulence effects of aqueous pomegranate peel extract on

E. coli urinary tract infection. Progr. Nutr. 2017;19:98-104.

59. Odongo EA, Mutai PC, Amugune BK, Mungai NN, Akinyi MO, Kimondo J. Evaluation of the antibacterial activity of selected Kenyan medicinal plant extract combinations against clinically important bacteria. BMC Complementary Medicine and Therapies. 2023;23(1):100.
60. Nas FS, Oyeyi TI, Ali M. Antibacterial efficacy and phytochemical screening of *Senna siamea* leaves extracts on some pathogenic bacteria. Journal of Microbiology and Experimentation. 2018; 6(3):159-63.
61. Maliehe TS, Shandu JS, Basson AK, Simelane MB, Lazarus G, Singh M. Pharmacodynamic and cytotoxicity effects of Syzygium cordatum {S Ncik, 48 (UZ)} fruit-pulp extract in gastrointestinal tract infections. Tropical Journal of Pharmaceutical Research. 2017;16(6): 1349-55.
62. Cimanga Kanyanga R, Kikweta Munduku C, Tshodi Ehata M, Nsaka Lumpu S, Mbamu Maya B, Manienga K, et al. Antibacterial and antifungal screening of extracts from six medicinal plants collected in Kinshasa-Democratic Republic of Congo against clinical isolate pathogens. J Pharmacogn Phyther. 2014;6(3):24–32.
63. Maregesi SM, Pieters L, Ngassapa OD, Apers S, Vingerhoets R, Cos P, Berghe DA, Vlietinck AJ. Screening of some Tanzanian medicinal plants from Bunda district for antibacterial, antifungal and antiviral activities. Journal of Ethnopharmacology. 2008;119(1):58-66.
64. Moshi MJ, Mbwambo ZH, Kapingu MC, Mhozya VH, Marwa C. Antimicrobial and brine shrimp lethality of extracts of *Terminalia mollis* Laws. African Journal of Traditional, Complementary and Alternative Medicines. 2006;3(3):59-69.
65. Ravisankar P, Rao CVP, Qureshi NA, Alsubaie HA, Alharbi MK, Ali GIM. Trends in pharmaceutical research and development. Book Publisher International (A part of Sciencedomain International); 2020;1.
66. Mbowen HF. Antimicrobial, cytotoxic and preliminary phytochemical analysis of four medicinal plants and their formulation. Dissertation for award of MSc degree at University of Venda, South Africa; 131.
67. Anokwuru CP, Tankeu S, van Vuuren S, Viljoen A, Ramaite ID, Taglialatela-Scafati O, Combrinck S. Unravelling the antibacterial activity of Terminalia sericea root bark through a metabolomic approach. Molecules. 2020;25(16):3683.
68. Itumeleng TB, Idowu JA, Abdullahi AY, Sekelwa C. Antibacterial, antiquorum sensing, antibiofilm activities and chemical profiling of selected South African medicinal plants against multi-drug resistant bacteria. Journal of Medicinal Plants Research. 2022;16(2):52–65.
69. Panda SK, Gazim ZC, Swain SS, Bento MC, Sena JD, Mukazayire MJ, Van Puyvelde L, Luyten W. Ethnomedicinal, phytochemical and pharmacological investigations of *Tetradenia riparia* (Hochst.) Codd (Lamiaceae). Frontiers in Pharmacology. 2022;13:896078.
70. Njau E., Alcom J, Buza J, Trejo M. Antimicrobial activity of Tetradenia riparia (Hochst.) Lamiaceae, amedicinal plant from Tanzania. European Journal of Medicinal Plants. 2014;4(12):1462–1478.
71. Munodawafa T, Moyo S, Chipurura B, Chagonda L. Brine shrimp lethality bioassay of some selected Zimbabwean traditional medicinal plants. International Journal of Phytopharmacology. 2016;7.
72. Otieno JN, Hosea KM, Lyaruu HV, Mahunnah RL. Multi-plant or single-plant extracts, which is the most effective for local healing in Tanzania? African Journal of Traditional Medicine Complementary and Alternative Medicine. 2008;5(2): 165-172.
73. Arsene MM, Viktorovna PI, Davares AK, Esther N, Nikolaevich SA. Urinary tract infections: Virulence factors, resistance to antibiotics, and management of uropathogenic bacteria with medicinal plants—A review. Journal of Applied Pharmaceutical Science. 2021;11(7):001-12.
74. Bruschi P, Sugni M, Moretti A, Signorini MA, Fico G. Children's versus adult's knowledge of medicinal plants: An ethnobotanical study in Tremezzina (Como, Lombardy, Italy). Revista Brasileira de Farmacognosia. 2019;29:644-55.
75. Kigen G, Some F, Kibosia J, Rono H, Kiprop E, Wanjohi B, Kigen P, Kipkore W. Ethnomedicinal plants traditionally used by the Keiyo community in Elgeyo Marakwet County, Kenya. Journal of Biodiversity, Bioprospecting and Development. 2014; 1(3):11

76. Mounanga MB, Mewono L, Angone SA. Toxicity studies of medicinal plants used in sub-Saharan Africa. Journal of Ethnopharmacology. 2015;174:618-27.
77. Kidane L, Gebremedhin G, Beyene T. Ethnobotanical study of medicinal plants in Ganta Afeshum District, Eastern Zone of Tigray, Northern Ethiopia. J Ethnobiol Ethnomed. 2018;14(1):1-9.
78. Penido AB, De Morais SM, Ribeiro AB, Silva AZ. Estudo etnobotânico de plantas medicinais em imperatriz, estado do Maranhão, Nordeste do Brasil. Acta Amaz. 2016;46(4):345–354.
79. Moshi MJ, Otieno DF, Weisheit A. Ethnomedicine of the Kagera Region, north western Tanzania. Part 3: plants used in traditional medicine in Kikuku village, Muleba District. Journal of Ethnobiology and Ethnomedicine. 2012;8(1):1-1.
80. Chebii WK, Muthee JK, Kiemo K. The governance of traditional medicine and herbal remedies in the selected local markets of Western Kenya. Journal of Ethnobiology and Ethnomedicine. 2020; 16(1):1-24.
81. Thapa B, Singh A, Tuladhar R. *In vitro* antibacterial effect of medicinal plants against multidrug resistant gram negative bacteria. Tribhuvan University Journal of Microbiology. 2018;5:25–31.
82. Fabry W, Okemo PO, Ansorg R. Antibacterial activity of East African medicinal plants. Journal of Ethnopharmacology. 1998;60(1):79-84.
83. Kuete V, Efferth T. Cameroonian medicinal plants: pharmacology and derived natural products. Frontiers in Pharmacology. 2010;1: 1–19.
84. Leme DE, Rodrigues AB, Almeida-Apolonio AA, Dantas FG, Negri MF, Svidzinski TI, Mota JD, Cardoso CA, Oliveira KM. In vitro control of uropathogenic microorganisms with the ethanolic extract from the leaves of *Cochlospermum regium* (Schrank) Pilger. Evidence-Based Complementary and Alternative Medicine. 2017;2017 :4687154.
85. Gorlenko CL, Kiselev HY, Budanova EV, Zamyatnin Jr AA, Ikryannikova LN. Plant secondary metabolites in the battle of drugs and drug-resistant bacteria: New heroes or worse clones of antibiotics?. Antibiotics. 2020;9(4):170.
86. Khameneh B, Iranshahy M, Soheili V, Fazly Bazzaz BS. Review on plant antimicrobials: A mechanistic viewpoint. Antimicrobial Resistance and Infection Control. 2019;8(1):1-28.
87. Gupta PD, Birdi TJ. Development of botanicals to combat antibiotic resistance. Journal of Ayurveda and Integrative Medicine. 2017;8(4):266-275.
88. Oyedeji O, Taiwo FO, Ajayi OS, Ayinde F, Oziegbe M, Oseghare CO. Biocidal and phytochemical analysis of leaf extracts of *Annona muricata* (Linn.). Int J Sci Basic Appl Res. 2015;24(7):76-87.
89. Khanal S. Qualitative and quantitative phytochemical screening of *Azadirachta indica* Juss. Plant parts. Int J Appl Sci Biotechnol. 2021;9(2):122–127.
90. Han S, Yang L, Wang Y, Ran Y, Li S, Ding W. Preliminary studies on the antibacterial mechanism of a new plant-derived compound, 7-methoxycoumarin, against *Ralstonia solanacearum*. Frontiers in Microbiology. 2021;12:697911.
91. Reen FJ, Gutiérrez-Barranquero JA, Parages ML, O´ Gara F. Coumarin: A novel player in microbial quorum sensing and biofilm formation inhibition. Applied Microbiology and Biotechnology. 2018;102:2063-73.
92. Aung EE, Kristanti AN, Aminah NS, Takaya Y, Ramadhan R. Plant description, phytochemical constituents and bioactivities of Syzygium genus: A review. Open Chemistry. 2020;18(1):1256-1281.
93. Abera B, Adane L, Mamo F. Phytochemical investigation the root extract of *Syzygium guineense* and isolation of 2, 3, 23-trihydroxy methyl oleanate. Journal of Pharmacognosy and Phytochemistry. 2018;7(2):3104-11.
94. Samie A, Obi CL, Bessong PO, Namrita L. Activity profiles of fourteen selected medicinal plants from Rural Venda communities in South Africa against fifteen clinical bacterial species. African J Biotechnol. 2005;4(12):1443–1451.
95. Larayetan RA, Okoh OO, Sadimenko A, Okoh AI. Terpene constituents of the aerial parts, phenolic content, antibacterial potential, free radical scavenging and antioxidant activity of *Callistemon citrinus* (Curtis) Skeels (Myrtaceae) from Eastern Cape Province of South Africa. BMC Complement and Alternative Medicine. 2017;17(1):1-9.

96. Mokgoatsane SI, Unin BP. The isolation and characterization of antibacterial compound from *Terminalia sambesiaca* (Combretaceae). Dissertation for award of MSc degree at University of North-West University. 2011;96.
97. Ibrahim YKE, Tytler BA, Ogunsola YK. Phytochemical and antimicrobial screening of crude extracts (aqueous and ethanolic) of *Terminalia mollis* Linn (Combretaceae) root. Nigerian Journal of Pharmaceutical Research. 2006;5(1):109–15.
98. Liu M, Katerere DR, Gray AI, Seidel V. Phytochemical and antifungal studies on *Terminalia mollis* and *Terminalia brachystemma*. Fitoterapia. 2009;80(6): 369–373.
99. Oosthuizen D, Goosen NJ, Stander MA, Ibrahim AD, Pedavoah MM, Usman GO, Aderinola T. Solvent extraction of polyphenolics from the indigenous African fruit Ximenia caffra and characterization by LC-HRMS. Antioxidants. 2018;7(8): 103.
100. Zhen J, Guo Y, Villani T, Carr S, Brendler T, Mumbengegwi DR, Kong AN, Simon JE, Wu Q. Phytochemical analysis and anti-inflammatory activity of the extracts of the African medicinal plant Ximenia caffra. Journal of Analytical Methods in Chemistry. 2015;2015.
101. Moghadamtousi SZ, Fadaeinasab M, Nikzad S, Mohan G, Ali HM, Kadir HA. *Annona muricata* (Annonaceae): A review of its traditional uses, isolated acetogenins and biological activities. International Journal of Molecular Sciences. 2015;16(7):15625-15658.
102. Deodata V. A review on the potential of underutilized Blackjack (*Biden pilosa*) naturally occurring in sub-Saharan Africa. Heliyon. 2022;8(2022):e09586.
103. Fernandez ACAM, Rosa MF, Fernandez CMM, C. Bortolucci W, Melo UZ, Siqueira VLD. Antimicrobial and antioxidant activities of the extract and fractions of *Tetradenia riparia* (Hochst.) Codd (Lamiaceae) leaves from Brazil. Current Microbiology. 2017;74(12):1453–60.
104. Oladeji OS, Adelowo FE, Oluyori AP. The genus Senna (Fabaceae): A review on its traditional uses, botany, phytochemistry, pharmacology and toxicology. South African Journal of Botany. 2021; 138:1-32.
105. González-Stuart AE, Dhan Prakash DP, Charu Gupta CG. Phytochemistry of plants used in traditional medicine.', CABI Books. Nigeria: CABI International. 2014;1.
106. Alshehri MM, Quispe C, Herrera-Bravo J, Sharifi-Rad J, Tutuncu S, Aydar EF, Topkaya C, Mertdinc Z, Ozcelik B, Aital M, Kumar NV. A review of recent studies on the antioxidant and anti-infectious properties of Senna plants. Oxidative Medicine and Cellular Longevity. 2022;2022:1-38.
107. Peng YL, Zeng N, Yao QY, Peng CY, Sheng WB, Li B, Wang W. A Review of the medicinal uses, phytochemistry and pharmacology of genus Flueggea. Current Chinese Science. 2023;3(3):213-41.
108. Abdelgadir HA, Van Staden J. Ethnobotany, ethnopharmacology and toxicity of *Jatropha curcas* L.(Euphorbiaceae): A review. South African Journal of Botany. 2013;88:204-18.
109. Length F. Phytochemical compounds and antibacterial activity of *Jatropha curcas* Linn. extracts. Journal of Medicinal Plants Research. 2011;5(16):3982-3990.
110. da Silva PM, da Silva BR, de Oliveira Silva JN, de Moura MC, Soares T, Feitosa AP, Brayner FA, Alves LC, Paiva PM, Damborg P, Ingmer H. *Punica granatum* sarcotesta lectin (PgTeL) has antibacterial activity and synergistic effects with antibiotics against β-lactamase-producing Escherichia coli. International Journal of Biological Macromolecules. 2019;135:931-939.
111. Tan MA, Sharma N, An SS. Phyto-carbazole alkaloids from the rutaceae family as potential protective agents against neurodegenerative diseases. Antioxidants. 2022;11(3):493.
112. Kasali FM, Tusiimire J, Kadima JN, Tolo CU, Weisheit A, Agaba AG. Ethnotherapeutic uses and phytochemical composition of *Physalis peruviana* L.: An overview. The Scientific World Journal. 2021;2021.
113. El-Beltagi HS, Mohamed HI, Safwat G, Gamal M, Megahed BM. Chemical composition and biological activity of *Physalis peruviana* L. Gesunde Pflanzen. 2019;71(2):113-22.
114. Damasceno CSB, . HNTF, Dias JDFG, Miguel MD, Miguel OG. Chemical composition and biological activities of essential oils in the family Lauraceae: A systematic review of the literature. Planta Medica. 2014;85(13):1054–1072.
115. Mukarram M, Choudhary S, Khan MA, Poltronieri P, Khan MM, Ali J, Kurjak D,

Shahid M. Lemongrass essential oil components with antimicrobial and anticancer activities. Antioxidants. 2021; 11(1):20.
116. John GN, Onwugbuta GC, Chima D. Phytochemical and proximate analysis of Ipomoea cairica tuber. Global Journal of Pure and Applied Sciences. 2021; 27(1):11–16.
117. Srivastava D, Rauniyar N. Medicinal plants of genus Ipomoea: A glimpse of potential bioactive compounds of genus Ipomoea and its detail. LAP LAMBERT Academic Publishing; 2020;1-76
118. Kaur R, Nizard S, Pollack E, Rafferty B, Priano C, Fernández Romero JA. Biology, Chemistry, and Pharmacological Activity of Kigelia africana (Bignoniaceae) and Garcinia kola (Clusiaceae) - A Review. Journal of Medicinally Active Plants. 2022; 11(1):1–21.
119. Mostafa NM, Eldahshan OA, Singab AN. The genus Jacaranda (Bignoniaceae): An updated review. Pharmacognosy Communications. 2014;4(3):31-39.
120. Fayisa Diriba T, Mirete Deresa E. Botanical description, ethnomedicinal uses, phytochemistry, and pharmacological activities of genus Kniphofia and Aloe: A review. Arabian Journal of Chemistry. Elsevier B.V. 2008;119(3):462-472.
121. Van Vuuren SF. Antimicrobial activity of South African medicinal plants. Journal of Ethnopharmacology. 2008;119(3):462-472.
122. Herrera-calderon O, Ejaz K, Wajid M, Shehzad M, Tinco-jayo JA, Enciso-roca E. *Azadirachta indica* : Antibacterial activity of Neem against different strains of bacteria and their active constituents as preventive in various diseases. Pharmacognosy Journal. 2019;11(6): 1597–1604.
123. Baby AR, Freire TB, Marques GD, Rijo P, Lima FV, Carvalho JC, Rojas J, Magalhães WV, Velasco MV, Morocho-Jácome AL. *Azadirachta indica* (Neem) as a potential natural active for dermocosmetic and topical products: A narrative review. Cosmetics. 2022;9(3):1-17.
124. Oyedeji-Amusa MO, Sadgrove NJ, Van Wyk BE. The ethnobotany and chemistry of South African Meliaceae: A review. Plants. 2021;10(9):1796.
125. Ayalew AA. Chromatographic and spectroscopic determination of solvent-extracted Lantana camara leaf oil. Journal of International Medical Research. 2020;48(10):0300060520962344.
126. Patel J, Qureshi MS, Kumar G., Kumar DB, Kumar KA. Phytochemicals and pharmacological activities of Lantana camara Linn. Research Journal of Pharmacology and Pharmacodynamics. 2010;2(6):418–422.
127. Azlan UK, Mediani A, Rohani ER, Tong X, Han R, Misnan NM, Jam FA, Bunawan H, Sarian MN, Hamezah HS. A comprehensive review with updated future perspectives on the ethnomedicinal and pharmacological aspects of Moringa oleifera. Molecules. 2022;27(18) :5765.
128. Kashyap P, Kumar S, Riar CS, Jindal N, Baniwal P, Guiné RP, Correia PM, Mehra R, Kumar H. Recent advances in Drumstick (Moringa oleifera) leaves bioactive compounds: Composition, health benefits, bioaccessibility, and dietary applications. Antioxidants. 2022;11(2): 402.
129. Jega Yusuf A, Ismail Abdullahi M, Alhaji Muhammad A, Ghandi Ibrahim K. Neocarya macrophylla (Sabine) Prance: Review on taxonomy, ethnobotany, phytochemistry and biological activities [Internet]; 2021.
Available:www.preprints.org
130. Mao QQ, Xu XY, Cao SY, Gan RY, Corke H, Beta T, Li HB. Bioactive compounds and bioactivities of ginger (*Zingiber officinale* Roscoe). Foods. 2019;8(6): 185.

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