Herbal medicine used for the treatment of diarrhea and cough in Kampala city, Uganda

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Abstract

**Background:** Globally, diarrheal and respiratory diseases are among the main causes of mortality and morbidity. In Uganda, cities are facing proliferation of trade in herbal medicines (HM), including those for diarrhea and/or cough. Information on the economic, and the ethnopharmacological aspects of these HM is scarce, deterring the sector from achieving optimal capacity to support national development. We profiled the anti-diarrhea and/or anti-cough HM, and the basic economic aspects of HM trade in Kampala city, to support ethnopharmacological knowledge conservation and strategic planning.

**Methods:** A cross-sectional survey was conducted on 65 herbalists using semi-structured questionnaires. This was supplemented by an observational survey using a high-resolution digital camera. Data were collected following the guidelines for research on HM, established by Uganda National Drug Authority, and World Health organization.

**Results:** Eighty-four plant species from 41 families were documented. Fabaceae and Myricaceae had the highest number of species (9, 10.7% each). *Citrus limon* (L.) Osbeck was the most commonly cited for cough, with a relative frequency of citation (RFC) of 1.00, and its relative medical importance was not significantly different from the other top 5 species except for *Azadirachta indica* A.Juss (RFC = 0.87). *Entada abyssinica* A. Rich (RFC = 0.97) was the most cited for diarrhea. Trees (34, 40.5%) were mostly used, and mainly harvested from wild habitats (55.2%) in 20 districts across Uganda. These HM were mainly sold as powders and concoctions, in markets, shops, pharmacies, and roadside or mobile stalls. The highest prices were Uganda Shillings (UGX) 48,000 ($13.15)/kg for *Allium sativum* L, and UGX 16,000 ($4.38)/kg for *C. limon*. All participants used HM trade as a sole source of basic needs; majority (60.0%) earned net monthly profit of UGX. 730,000 ($200) ≤ 1,460,000 ($400). The main hindrances to HM trade were the; disruptions caused by the COVID-19 pandemic (n = 65, 100%), and the scarcity of medicinal plants (58, 89.2%).

**Conclusion:** There is a rich diversity of medicinal plant species traded in Kampala to treat diarrhea and cough. The HM trade significantly contributes to the livelihoods of the traders in Kampala, as well as the different actors along the HM value chain throughout the country.

**Keywords:** Herbal medicine, Trade, Cough, Diarrhea, Herbalists, Kampala, Uganda

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**Background**

Diarrheal and respiratory infections are among the major causes of global mortality and morbidity, triggering approximately 1.8 and 2.4 million annual deaths, respectively [1–4], especially in low and middle-income countries (LMIC) [3]. For example, in Tanzania and Uganda, diarrheal and respiratory illnesses are ranked among the six major causes of both adult and childhood mortality.
Consequently, diarrhea and cough are the commonest syndromes for which humans seek medical care in both the rich and resource-poor countries [4, 6]. In Kampala, the capital city of Uganda, diarrhea and respiratory ailments are diseases of major concern, with estimated prevalence of 19% and 31%, respectively [7]. The infections associated with diarrhea and cough are mostly caused by microbial pathogens such as bacteria, viruses, parasites, and fungi [8–12].

The rising burden of antimicrobial resistance (AMR) is increasingly counteracting the potential of conventional medicines to manage these complications [13]. The AMR burden, coupled with other factors such as the high cost and limited availability of synthetic medicine, especially in resource-poor countries, lure most communities to resort to herbal medicine (HM) as an alternative treatment strategy [14–16]. The use of HM for healthcare needs in Uganda is estimated at 90% in rural settings [17]. In the recent decades, the trade of HM by herbalists in Uganda’s urban settings is on the rise. Herbalists are persons that have empirical medicinal plant knowledge; they offer consultation services, and/or sell HM for managing common community ailments [18]. Kampala district, being Uganda’s capital and commercial city, has a high number of herbalists compared to other urban districts [18]. This could partly be attributed to the high demand, and the lucrative market offered by the large population of residents, travelers, and the business community in the city [19]. The resident population in Kampala city mostly comprises low-income earners that live in the suburbs, and have high inclination to HM [18, 20–22].

Besides healthcare provision, the HM industry in Kampala and Uganda at large, has become one of the significant sources of employment for communities [23]. The sector provides an avenue for traditional experts to enter the urban cash economy [23, 24]. The need for strategic plans is paramount to nurture the HM trade industry to achieve its optimal capacity, and to effectively support Uganda’s fight against escalation of poverty and unemployment [25, 26]. According to the World Bank, over 21.7% of this country’s population currently live below the poverty line of US$ 1.90 per person per day [27, 28]. Also, the government of Uganda has estimated that an additional 2.6 million people could slide into extreme poverty due to the socio-economic impacts of the COVID-19 pandemic [29]. Development of the HM sector might broaden income generation for not only the herbalists, but also the other various stakeholders (e.g., farmers, collectors, transporters, and pharmacies) along the HM value chain in Uganda.

Though Kampala city is now perceived to be potentially rich in medicinal plant biodiversity stocks, the ethnopharmacological research related to these plant species is scarce. Further, the commercial aspects of HM commonly traded in Kampala city are poorly understood due to limited research on the sector. The development of urban HM trade requires comprehensive research on various aspects of the sector, such as the ethnopharmacology, and the economic aspects. The aim of this study was to document the plant species sold for the treatment of diarrhea and cough in Kampala, and information on their usage, trade, the sector-challenges. The findings could support conservation of ethnopharmacological knowledge and guide strategic planning and designing of regulatory frameworks; to enhance the potential use of HM in counteracting health burdens and poverty.

Methods
Study area
The study was conducted in the five administrative divisions of Kampala, located in the central region of Uganda, stretching over an area between DMS Lat: 0° 12’ 46.755” N, Long: 32° 30’ 32.567” E and DMS Lat 0° 12’ 20.692” N, Long: 32° 40’ 14.054” E. It is bordered by Mukono district to the East; Lake Victoria to the South East; and Wakiso district to the West, South, and North (Fig. 1). Its five administrative divisions are; Kampala central, Kawempe, Nakawa, Makindye and Rubaga divisions. According to the recent Uganda national population census, Kampala city is populated by between 1,680,601 and 2,915,200 residential occupants [30]. In addition, a large number of individuals enter and leave the city on a daily basis either for work or as travelers [19].

Study design and sampling technique
A cross-sectional survey was conducted on 65 traditional herbalists, between May and August 2021. Pre-tested, semi-structured questionnaires were administered to the respondents by research assistants, to collect information such as the socio-demographic profile of respondents, local names of plant species used in treatment of diarrhea and/or cough, and how they were prepared and packaged, prices, and the challenges impeding HM trade. In addition, qualitative data, such as, HM packaging patterns, categories of traditional HM outlets, and the pharmaceutical forms of HM sold, were examined through field observations which were supplemented using photography.

Study population
The study focused on herbalists in Kampala city. The sampling frame exclusively involved herbalists that were engaged in trade, harvesting, and/or preparation of the HM.
Sampling

Sample size determination

The sample size for this study was calculated by using the formula for unknown population, by Kothari [31]:

\[ n = \frac{Z^2 \cdot SD^2}{e^2} \]

where \( Z \) = standard error from the mean, \( \approx 1.96 \) at 95% confidence interval; standard deviation (SD) \( \approx 0.205 \) or 20.5% [32]; and \( e \) = tolerable sampling error/precision, \( \approx 0.05 \) at 95% confidence interval. Then, the sample size was calculated as:
\[ n = \frac{\left(1.96\right)^2 \times (0.205)^2}{(0.05)^2} \approx 65. \]

Therefore, 65 herbalists were recruited into this study.

**Selection of respondents**

Prior informed consent was obtained from all the participants, and ethical approval for the study was also obtained from the School of Health Sciences Research and Ethics Committee of Makerere University. Basing on the required sample size of 65 participants, 13 respondents from each of the five divisions of Kampala were recruited using a systematic random sampling approach [33]. In brief, at each of the sampling sites, the traditional healthcare units such as herbal shops and herbal-market stalls were visited, and the available population of eligible herbalists was determined through direct counting. The resultant population size was divided by the required number of respondents to deduce the sampling interval \((K)\). Then, every \(K\)th member of the population at the respective sampling site was recruited until the required sample size was attained.

**Data collection**

Pre-tested, researcher administered questionnaires were used to collect data regarding the HM used for treating diarrhea and cough in the study community. The observational survey was conducted using an observation guide, and a high-resolution digital camera inbuilt in a Phantom-9 Mobile Phone, model AB7/2019, Techno Mobile Limited [34]. All data were collected following the guidelines for research on HM products, established by the Uganda National Drug Authority (NDA) and the World Health organization [35, 36].

**Collection and identification of plant specimens**

Voucher specimens of the medicinal plant species of interest were procured from HM markets and surrounding environs, in randomly selected market stalls, herbal shops, roadside stalls, and mobile stalls. The voucher specimens were pressed and transported to Makerere University Herbarium for identification. The identified plant species were authenticated according to the database at [https://www.theplantlist.org](https://www.theplantlist.org), accessed on 21st Aug 2021. The plant families were checked against the Angiosperm Phylogeny Group IV.

**Demand, supply and challenges of HM trade in Kampala city**

Pre-tested, researcher administered questionnaires were used to collect data regarding the demand, supply and challenges of HM trade. This was supplemented by the observational survey which was conducted using an observation guide, and a high-resolution digital camera inbuilt in a Phantom-9 Mobile Phone, model AB7/2019, Techno Mobile Limited [34]. All data were collected following the guidelines for research on HM products, established by the Uganda National Drug Authority (NDA) and the World Health organization [35, 36].

**Data analysis**

Descriptive, and inferential statistics like frequencies, percentages, and Chi-square were used to analyze the data. The Relative Frequency of Citation (RFC) was used to evaluate the ethnopharmacological data. The data were analyzed using STATA version-15.0 software.

**Relative frequency of citation (RFC)**

The relative frequency of citation (RFC) for each HM was computed to determine the number of herbalists that considered particular plant species as being worth mentioning in the management of diarrhea and cough. The RFC values range between 0 and 1 (where 1 indicates the highest level of respondents’ consensus on the use of that species to manage a particular disease). The value was calculated using a formula described by Tardio and Santayana [37]:

\[
RFC = \frac{\sum_{i=1}^{N} uRi}{N},
\]

where \( FC \) is the number of herbalists who cited a particular species, and \( N \) is the total number of herbalists (Table 2).

**Results**

**Socio-demographic profile of participants**

Majority \((n=36, 55.4\%)\) of the respondents recruited were men, while females constituted 44.6\% \((n=29)\). Most of the participants were in the age categories of the youths \((n=24, 36.9\%)\), and the middle-aged \((n=39, 60\%)\); only two \((3.1\%)\) were elderly. The majority of the participants \((n=26, 40.0\%)\) had attended secondary education, while three \((4.6\%)\) had attained tertiary education. The participants who had practiced traditional medicine for a duration of between 5 and 15 years constituted 72.3\% \((n=47)\). Sixty-five \((100\%)\) participants unanimously perceived the importance of medicinal plants and the need to trade these remedies, viz; all participants indicated that they generated significant profits to meet their basic livelihood needs, and that they were optimistic about the future of herbal medicine trade in Uganda. A net monthly profit of UGX 730,000 \($200\) \leq UGX 1,460,000 \($400\) was earned by 39 \((60.0\%)\), while 5 \((7.7\%)\) earned above UGX 1,825,000 \($500\) from HM sales (Table 1).
Diversity of medicinal plants traded for treatment of diarrhea and cough in Kampala

A total of 84 medicinal plant species belonging to 41 families and 73 genera used in the management of diarrhea and cough were documented in the commercial HM establishments surveyed (Table 2). The families; Fabaceae and Myricaceae were the most dominant; contributing 9, (10.7%) species each. These were followed by family Asteraceae (7, 8.3%). Forty-four species (52.4%) were cited for diarrhea treatment, 31, (36.9%) for cough, and 9, (10.7%) for both ailments. Most of the plant species cited were trees (34, 40.5%) (Table 2).

Methods of preparation and modes of administration

All (84, 100%), of the plant species recorded were administered orally, in four main forms, that is, decoctions (n = 70, 83.3%), infusions (n = 13, 15.5%), powders licked (n = 2, 2.4%), and fresh plant materials chewed (n = 2, 2.4%) (Table 2). Leaves were the major plant part used (n = 61, 93.8%) followed by the stem bark (n = 21, 32.3%) (Fig. 2).

Highly traded species for management of diarrhea and cough in Kampala

*Citrus limon* attained the highest RFC of 1.00 for cough treatment, followed by *M. foetida* (RFC = 0.98). *E. abyssinica* was the most highly cited HM in the management of diarrhea (RFC = 0.97). *C. edulis* and *G. senegalensis* were least mentioned (each with RFC = 0.02) for cough treatment, while *T. fassoghlen* and *P. granatum* were least mentioned for diarrhea treatment. The most frequently cited plant species (RFC ≥ 0.70) are summarized in Table 3 and some illustrated in Fig. 3a–e.

Herbal medicine trade in Kampala city

Sources of herbal medicines traded in Kampala

Among the 65 herbalists interviewed, 59 (90.8%) had information about of the habitats from where the medicinal plants were harvested. Although the rest were knowledgeable about the HM they sold, they were unable to provide information about the habitats of some plants. These participants attributed the knowledge-deficit to the fact that they often purchased most of the HM from fellow herbalists who were whole sellers, hence minimal knowledge on the natural settings from where some of the HM were sourced. Most participants claimed to obtain the HM from wild habitats such as bushes (56.9%) and forests (44.6%) (Fig. 4a). Most HM were sourced from Mukono (64.6%) and Wakiso (58.5%) districts, which border Kampala City (Fig. 4b). Only 16.9% (n = 11) of the participants identified the source of their raw materials as Mabira central Forest Reserve, which covers the districts of Mukono, Jinja and Buikwe in the Central and Eastern Uganda (Fig. 4b).

Types of traditional healthcare establishments where HM are traded

The herbal medicine-selling establishments (HMSE) were classified into two major categories namely; (i) formal and (ii) informal. The formal establishments included the HMSE found in places gazetted for trade by the government of Uganda. In this category, three main types were observed namely; herbal shops, market stalls, and pharmacies. The informal HMSE included roadside stalls, and mobile stalls (Fig. 5A–J).
### Table 2  Medicinal plants used for treatment of diarrhea and cough in Kampala city, Uganda

| Family, voucher no. | Serial no., local name | Scientific name | Life form | Parts used | Mode of administration | RFC |
|---------------------|-------------------------|-----------------|-----------|------------|------------------------|-----|
| **Species used against cough** | | | | | | |
| **Alliaceae** | | | | | | |
| KHM03 | 1. Katungulchamua<sup>a</sup> Tungulucumud | Allium sativum L. | Herb | Bulb | Decoction + minced ginger, drunk | 0.64 |
| | | | | | | |
| **Asparagaceae** | | | | | | |
| KHM05 | 2. Kajjolwenju | Dracaena steudneri Engl. | Tree | Leaves | Decoction drunk/ powder licked | 0.07 |
| | | | | | | |
| **Asteraceae** | | | | | | |
| KHM06 | 3. Artemesia<sup>a</sup> | Artemisia annua L. | Herb | Leaves | Infusion + salt drunk | 0.03 |
| KHM07 | 4. Muluuluza<sup>a</sup> | Vernonia amygdalina Delile | Shrub | Leaves, roots | Decoction drunk | 0.61 |
| | | | | | | |
| **Bignoniaceae** | | | | | | |
| KHM36 | 5. Mussab | Kigelia africana (Lam.) Benth. | Tree | Leaves | Decoction + honey drunk | 0.09 |
| KHM37 | 6. Kifabakazi<sup>a</sup> | Spathodea campanulata PBaev. | Tree | RB | Decoction drunk | 0.04 |
| | | | | | | |
| **Caricaceae** | | | | | | |
| KHM08 | 7. Mupapaali<sup>b</sup> | Carica papaya L. | Tree | Leave, roots | Decoction drunk | 0.10 |
| | | | | | | |
| **Celastraceae** | | | | | | |
| KHM09 | 8. Mayirunji<sup>a</sup> | Catha edulis Forssk. | Shrub | Leaves | Chewed, extract swallowed | 0.02 |
| KHM10 | 9. Muwaiswa<sup>c</sup> | Gymnosophia senegalensis (Lam.) Loes. | Shrub | Roots, leaves | Decoction drunk | 0.02 |
| KHM14 | 10. Musali<sup>a</sup> | Symphonia globulifera L.f. | Tree | Roots | Decoction drunk | 0.03 |
| | | | | | | |
| **Crassulaceae** | | | | | | |
| KHM15 | 11. Kiyondo Ekyeru<sup>a</sup> | Kalanchoe deniflora Rolfe | Herb | Leaves | Decoction drunk | 0.06 |
| | | | | | | |
| **Cucurbitaceae** | | | | | | |
| KHM11 | 12. Suuns<sup>a</sup> | Cucurbita maxima Duch. | Creeper | Leaves | Decoction drunk | 0.11 |
| KHM16 | 13. Mangholu<sup>a</sup> | Euclea schimperi (A.DC.) Dandy | Shrub | Leaves | Decoction drunk twice a day before meals | 0.02 |
| | | | | | | |
| **Ebenaceae** | | | | | | |
| KHM17 | 14. Akasaana<sup>a</sup> | Acacia hockii De Wild. | Shrub | SB | Decoction drunk | 0.05 |
| KHM20 | 15. Nkooge<sup>a</sup> | Tamarindus indica L. | Tree | Fruit, SB, leaves | Decoction drunk | 0.18 |
| | | | | | | |
| **Fabaceae** | | | | | | |
| KHM19 | 16. Akasandasanda<sup>a</sup> | Euphorbia hirta Lnn. | Herb | Leaves | Decoction drunk | 0.06 |
| | | | | | | |
| **Rubiaceae** | | | | | | |
| KHM18 | 17. Owong<sup>b</sup> | Gardenia ternifolia Schumach. & Thomn. subsp. jovis-tonantis (Welw.) Verdc. var. jovis-tonantis | Tree | Root bark | Infusion of dry powder drunk | 0.02 |
| | | | | | | |
| **Lamiaceae** | | | | | | |
| KHM01 | 18. Kyewamala<sup>a</sup> | Tetradenia riparia (Hochst.) Codd | Shrub | Leaves | Infusion drunk | 0.22 |
| KHM02 | 19. Kibwankulata<sup>a</sup> | Plectranthus cyaneus Gürke | Shrub | Leaves | Decoction drunk | 0.39 |
| KHM21 | 20. Kachumita<sup>d</sup> | Basilicum polystachyon (L.) Moench | Shrub | Leaves | Decoction drunk | 0.02 |
| | | | | | | |
| **Lauraceae** | | | | | | |
| KHM22 | 21. Ovakedo<sup>a</sup> | Persea americana Mill. | Tree | Leaves, SD, SB | Decoction drunk | 0.66 |
| Family, voucher no. | Serial no., local name | Scientific name | Life form | Parts used | Mode of administration | RFC |
|---------------------|-------------------------|-----------------|-----------|------------|------------------------|-----|
| KHM23               | 22. Lusaalaa<sup>a</sup> | Hibiscus fuscus Garcke | Herb | Leaves | Ash licked | 0.08 |
| Moraceae            |                         |                 |           |            |                        |     |
| KHM24               | 23. Muvule<sup>a</sup>  | Miliciaxcelis (Welw.) C.C.Berg | Tree | Leaves, SB | Decoction drunk | 0.21 |
| Moringaceae         |                         |                 |           |            |                        |     |
| KHM25               | 24. Moringa<sup>a</sup>  | Moringa oleifera Lam. | Tree | Leaves, roots, SD | Decoction drunk | 0.32 |
| Myricaceae          |                         |                 |           |            |                        |     |
| KHM26               | 25. Nkikimbo<sup>a</sup> | Moreilla kanthiana (Engl.) Verdc. & Polhill | Shrub | Roots | Decoction drunk | 0.02 |
| KHM13               | 26. Kalitunsi<sup>a</sup> | Eucalyptus grandis W. Hill | Tree | Leaves, SB | Infusion drunk | 0.74 |
| KHM62               | 27. Kalatuc<sup>c</sup>  | Eucalyptus viminalis Labill. | Tree | Leaves, RB | Decoction drunk | 0.06 |
| KHM27               | 28. Mwambalabutonyaa<sup>a</sup> | Callistemon citrinus (Curtis) Skeels | Shrub | Leaves | Decoction drunk | 0.95 |
| KHM28               | 29. Kalitunsi<sup>a</sup> | Corymbia citriodora (Hook.) K.D.Hill & L.A.S.Johnson | Tree | Leaves, SB | Connocion drunk | 0.05 |
| KHM29               | 30. Jambula<sup>ac</sup>  | Syzygium cumini (L.) Skeels | Tree | Leaves | Decoction drunk | 0.66 |
| KHM30               | 31. Mupeera<sup>a</sup>  | Psidium guajava L. | Tree | Leaves | Decoction drunk | 0.75 |
| Rutaceae            |                         |                 |           |            |                        |     |
| KHM04               | 32. Niimu<sup>a</sup> Ndima<sup>a</sup> | Citrus limon (L.) Osbeck | Shrub | Fruits | Decoction of whole fruit/infusion of fresh mesocarp drunk, or juice squeezed out and swallowed | 1.00 |

Species used against diarrhea

Acanthaceae
- KHM41 33. Wankuura<sup>a</sup> | Thunbergia alata Bojer ex Sims | Climber | Leaves | Decoction drunk | 0.02 |

Anacardiaceae
- KHM43 34. Muziru<sup>a</sup> | Pseudospondias microcarpa (A. Rich) Engl. | Tree | Roots | Decoction drunk | 0.22 |

Annonaceae
- KHM44 35. Mugaali<sup>a</sup> | Annona senegalensis Pers. | Tree | SB, leaves | Decoction drunk | 0.02 |

Apocynaceae
- KHM45 36. Mulondo<sup>ab</sup> | Mandia whytei (Hook.f.) Skeels | Climber | Roots | Infusion/chew | 0.49 |

Aristolochiaceae
- KHM39 37. Nakasero<sup>a</sup> Musujia avialaba<sup>a</sup> | Aristolochia littoralis Parodi | Herb | Leaves | Decoction drunk | 0.70 |

Asteraceae
- KHM46 38. Akalulusa ahasinde<sup>a</sup> | Microglossa angolensis Oliv. & Hiern. | Shrub | Leaves | Decoction drunk | 0.03 |
- KHM47 39. Kafugankande<sup>a</sup> | Conyza pyrrotopapp Sch. Bip. ex A. Rich | Herb | Leaves | Decoction drunk | 0.95 |
- KHM12 40. Etutum<sup>b</sup> | Microglossa pyrrotopapp (Lam.) O.Kuntze | Herb | Roots, leaves | Decoction drunk | 0.09 |
- KHM48 41. Mugango<sup>a</sup> | Solanecio mannii (Hook.f.) C.Jeffrey | Herb | Leaves | Decoction drunk | 0.04 |
- KHM42 42. Ssere<sup>a</sup> | Bidens pilosa L. | Herb | Leaves | Decoction drunk | 0.33 |

Balanitaceae
- KHM49 43. Liggwa limu<sup>a</sup> | Balanites aegyptiaca (L.) Deille | Tree | Roots | Decoction drunk | 0.11 |

Burseraceae
Table 2 (continued)

| Family, voucher no. | Serial no., local name | Scientific name | Life form | Parts used | Mode of administration | RFC |
|---------------------|------------------------|-----------------|-----------|------------|------------------------|-----|
| KHM50               | 44. Muwafua<sup>a</sup> | Canarium schweinfurtii Engl. | Tree | SB | Decoction drunk | 0.26 |
| Capparaceae         |                        |                 |           |            |                        |     |
| KHM51               | 45. Mukolokombi<sup>a</sup> | Capparis tomentosa Lam. | Shrub | Roots | Decoction drunk | 0.04 |
| Convolvulaceae      |                        |                 |           |            |                        |     |
| KHM53               | 46. Lumonde<sup>a</sup> | Ipomoea batatas (L.) Lam. | Vine | Leaves | Decoction drunk | 0.31 |
| Crassulaceae        |                        |                 |           |            |                        |     |
| KHM52               | 47. Kiyondo<sup>a</sup> | Bryophyllum pinnatum (L.) Oken | Herb | Leaves | Decoction drunk | 0.41 |
| Euphorbiaceae       |                        |                 |           |            |                        |     |
| KHM59               | 48. Ahadungae<sup>a</sup> | Euphorbia heterochroma Pax | Tree | SB | Decoction drunk | 0.04 |
| Fabaceae            |                        |                 |           |            |                        |     |
| KHM55               | 49. Murangara<sup>d</sup> | Croton macrostachyus Hochst. ex Delile | Tree | Leaves | Decoction drunk | 0.02 |
| KHM69               | 50. Lusiisi<sup>ab</sup> | Abrus precatorius L. | Tree | Leaves | Decoction drunk | 0.13 |
| KHM57               | 51. Muwologoma<sup>a</sup> | Acacia amyntophylla A. Rich. | Shrub | Roots | Decoction drunk | 0.17 |
| KHM58               | 52. Katasubwa<sup>b</sup> | Acacia senegal (L.) Willd. | Shrub | Roots | Decoction | 0.06 |
| KHM59               | 53. Mugavu<sup>a</sup> | Albizia coriaria Oliv | Tree | Stem bark | Decoction drunk | 0.35 |
| KHM60               | 54. Nkolimbo<sup>ab</sup> | Cajanus cajan (L.) Millsp. | Herb | Leaves | Decoction/infusion drunk | 0.24 |
| KHM61               | 55. Jiirikit<sup>a</sup> | Erythrina abyssinica DC. | Tree | SB, roots | Decoction drunk | 0.05 |
| KHM67               | 56. Kyuyejuuge<sup>b</sup> | Tylosema fassoglenis (Schweinf.) Torre & Hillc. | Tree | Shoot | Infusion/decoction drunk | 0.05 |
| Lauraceae           |                        |                 |           |            |                        |     |
| KHM66               | 57. Mukomatayawa<sup>a</sup> | Punica granatum L. | Shrub | SB | Decoction drunk | 0.02 |
| Meliaceae           |                        |                 |           |            |                        |     |
| KHM65               | 58. Musonko<sup>a</sup> | Lovoa trichiloides Harms | Tree | SB, SD, leaves | Infusion drunk | 0.05 |
| Moraceae            |                        |                 |           |            |                        |     |
| KHM64               | 59. Mutuva<sup>a</sup> | Ficus natalensis Hochst. | Tree | SB | Decoction drunk | 0.16 |
| Myricaceae          |                        |                 |           |            |                        |     |
| KHM63               | 60. Kalitunsia<sup>a</sup> | Eucalyptus globulus Labill. | Tree | SB, leaves | Decoction drunk | 0.03 |
| KHM68               | 61. Kalitunsia<sup>a</sup> | Eucalyptus saligna Sm. | Tree | Leaves | Decoction drunk | 0.06 |
| Onagraceae          |                        |                 |           |            |                        |     |
| KHM70               | 62. Kajampunic<sup>c</sup> | Oxalis latifolia Kunth | Herb | Shoot | Decoction drunk | 0.24 |
| Poaceae             |                        |                 |           |            |                        |     |
| KHM72               | 63. Mubarama<sup>d</sup> | Clutia abyssinica Jaub. & Spach | Shrub | Leaves | Infusion/decoction drunk | 0.02 |
| Phyllanthaceae      |                        |                 |           |            |                        |     |
| KHM31               | 64. Katazamitia<sup>3</sup> | Bridelia micrantha (Hochst.) Baill | Tree | Leaves, SB | Decoction drunk | 0.06 |
| KHM32               | 65. Mutulika<sup>a</sup> | Phyllanthus ovalifolius Forssk. | Shrub | Leaves | Decoction drunk | 0.05 |
| Poaceae             |                        |                 |           |            |                        |     |
| KHM71               | 66. Ekyisubia<sup>c</sup> | Cymbopogon flexuosus (Nees ex Steud.) W. Watson | Grass | Leaves | Infusion drunk | 0.96 |
| KHM73               | 67. Lumbuguku<sup>a</sup> | Digitaria abyssinica (A. Rich.) Stapf | Grass | Leaves | Decoction drunk | 0.48 |
| Family, voucher no. | Serial no., local name | Scientific name                  | Life form | Parts used | Mode of administration | RFC |
|--------------------|------------------------|----------------------------------|-----------|------------|------------------------|-----|
| Polygalaceae        | KHM33 68. Mukondwe<sup>a</sup> | Secunda longipedunculata Fresen. | Tree      | Roots, leaves | Concoction drunk        | 0.11 |
| Rosaceae            | KHM34 70. Ntaseesa<sup>b</sup> Ngwabuzito<sup>a</sup> | Prunus africana (Hook.f.) Kalkman | Tree      | SB, leaves  | Decoction drunk         | 0.13 |
| Lamiaceae           | KHM38 71. Ensaali<sup>b</sup> | Eriobotrya japonica (Thumb) Lindl. | Shrub     | Leaves     | Decoction drunk         | 0.08 |
| Verbenaceae         | KHM76 74. Enkami<sup>a</sup> | Privileafelliformis (Moldenke) R. Fern. | Herb      | Leaves     | Decoction drunk         | 0.47 |
| Zingiberaceae       | KHM35 75. Ntangawuzia<sup>a</sup> | Zingiber officinale Roscoe | Herb      | Rhizome    | Tincture drunk          | 0.14 |
| Anacardiaceae       | KHM54 76. Muyembe<sup>a</sup> Mengu<sup>i</sup> | Mangifera indica L. | Tree      | Leaves     | Decoction drunk         | 0.75<sup>c</sup>, 0.21<sup>d</sup> |
| Canellaceae         | KHM77 77. Kakwansokwanso<sup>a</sup> | Searsia pyroides (Burch. ex Spreng.) Swingle & M.Kellerm | Shrub     | Leaves, Roots | Decoction drunk          | 0.19<sup>c</sup>, 0.07<sup>d</sup> |
| Cucurbitaceae       | KHM79 78. Omuya<sup>a</sup> | Warburgia ugandensis Sprague | Tree      | Leaves, SB, roots | Decoction/infusion drunk | 0.03<sup>c</sup>, 0.08<sup>d</sup> |
| Meliaceae           | KHM81 80. Neem<sup>i</sup> | Azadirachta indica A.Juss. | Tree      | Roots, leaves, SB | Decoction drunk         | 0.87<sup>c</sup>, 0.03<sup>d</sup> |
| Passifloraceae      | KHM82 81. Katunda<sup>a</sup> | Passiflora edulis Sims | Climber   | Leaves     | Decoction drunk         | 0.04<sup>c</sup>, 0.26<sup>d</sup> |
| Poaceae             | KHM80 82. Teete<sup>a</sup> | Cymbopogon citratus Stapf | Grass     | Leaves     | Decoction or infusion drunk | 0.32<sup>c</sup>, 0.06<sup>d</sup> |
| Rutaceae            | KHM78 83. Muchungwa<sup>a</sup> Chungwa<sup>i</sup> | Citrus sinensis (L.) Osbeck | Shrub     | Leaves, roots, SB, fruit | Decoction drunk         | 0.03<sup>c</sup>, 0.71<sup>d</sup> |
| Fabaceae            | KHM84 84. Mwolola<sup>a</sup> | Entada abyssinica A. Rich | Tree      | SB, leaves  | Infusion/decoction drunk | 0.97<sup>c</sup>, 0.20<sup>d</sup> |

*Diarrhea, C cough, SB stem bark, SD seeds, RB root bark

Languages spoken: aLuganda, bLusoga, cLugishu, dRunyankore, eLunyole, fLugbara, gLangi, hAteso, iLuo, jK/Karamojong, klocal name not available
The HM were presented in two broad categories namely: (a) herbal medicine products (defined as finished, labeled medicinal products containing active ingredients in form of plant parts. These may be in crude state, or as preparations, or in combination with other excipients which are not of plant origin); and (b) herbal substances (defined as either whole or fragments of fresh or dry plants that have not been subjected to isolation and purification of active ingredients) [35] (Fig. 6). The packaging of HM fell into three categories namely; (i) original packaging materials (bought from manufacturer/supplier and had never been used for other purposes); (ii) Recycled/re-used packages (previously used for other purposes), and (iii) non-packaged (plainly displayed for sale) (Fig. 6).

**Demand and supply of commonly traded herbal medicine used for treating diarrhea and cough in Kampala**

Among the 84 plant species identified in this survey, 15 were categorized as commonly used by virtue of having high relative frequency of citation (RFC ≥ 0.70). The rate at which these HM were purchased was also examined, and categorized as: high (H), moderate (M), and low (L). The majority (8, 53.3%) were highly demanded, while five species were on low demand (Table 4). Declining availability in the natural habitats was reported for nine (60%) of the frequently used species (Table 4). Except for *E. grandis*, all the 15 most frequently mentioned species were reported to be out of stock in ≥3 traditional healthcare establishments during the survey. The most expensive plant species (fresh material), were: *A. sativum* sold at UGX 48,000 ($13.15), *C. limon* at UGX 16,000 ($4.38) and *E. grandis* at UGX 13,500 ($3.70) per kilogram, respectively. The least priced were *P. americana*, and *S. cumini* each sold at UGX 4000 ($1.10) per kilogram (Table 4).

**Challenges associated with herbal medicine trade in Kampala city**

The herbalists interviewed in this study reported 25 challenges (Fig. 7). HM trade challenges were grouped into six themes using thematic analysis (Fig. 7i). These included: (i) HM trade regulations and policies (n = 9); (ii) financing (n = 5); (iii) attributes of traditional

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**Table 3** Species that are frequently used for diarrhea and cough treatment in Kampala

| Plant species          | Disease treated | RFC | χ²  | p-value | Previous reports on diarrhea and/or cough treatment |
|------------------------|----------------|-----|-----|---------|---------------------------------------------------|
| Citrus limon           | Cough          | 1.00 REF | 1.303  | 0.2537 | [95]                                               |
| Momordica foetida      | Cough          | 0.98  | 1.964 | 0.1611 | [96]                                               |
| Entada abyssinica      | Diarrhea       | 1.964 | 2.631 | 0.1048 | [56]                                               |
| Cymbopogon flexuusus   | Diarrhea       | 0.96  | 3.305 | 0.0691 | [97]                                               |
| Callistemon citrinus   | Cough          | 0.95  | 8.923 | 0.0028 | [56, 48]                                           |
| Cynza pyrrhopappa      | Diarrhea       | 0.95  | 3.305 | 0.0691 | [98]                                               |
| Azadirachta indica     | Cough          | 0.87  | 10.48 | 0.0001 | [99]                                               |
| Psidium guajava        | Cough          | 0.75  | 18.047| 0.0001 | [100]                                              |
| Mangifera indica       | Cough          | 0.75  | 18.047| 0.0001 | [101]                                              |
| Eucalyptus grandis     | Cough          | 0.74  | 18.830| 0.0001 | [49]                                               |
| Citrus sinensis        | Cough          | 0.71  | 21.232| 0.0001 | [49]                                               |
| Aristolochia littoralis| Diarrhea       | 0.70  | 22.068| 0.0001 | [52]                                               |

χ²: Chi-square; RFC: relative frequency of citation; REF: reference value
herbalists \((n=4)\); (iv) HM quality and safety \((n=3)\); (v) HM availability and efficacy \((n=2)\); and (vi) geographical stature of the study area \((n=2)\). The national COVID-19 preventive measures \((n=65, 100\%)\) were the most frequently mentioned challenge under theme (i) (Fig. 7vii). This was followed by the scarcity of some herbal medicine stocks \((n=58, 89.2\%)\) which aligned with theme (v) (Fig. 7ii). The least cited challenge was the report of adverse reactions among some HM consumers \((n=3, 4.6\%)\), which aligned with theme (iv) (Fig. 7v).

**Discussion**

**Socio-demographic profiles of participants**

The predominance of men in HM trade was also reported previously in some parts of South Africa [38], Tanzania
Where do you obtain herbal medicines that you use for treating diarrhea and/or cough in Kampala city?

- Wild bushes: 37
- Forests: 29
- Homestead farms: 9
- Wetlands: 4
- Herbal shops: 27
- Markets: 18

Fig. 4 a, b Sources of HM traded by herbalists in Kampala
[39], and Malawi [40]. However, in the KwaZulu-Natal, Gauteng, and Mpumalanga provinces in South Africa, the majority of the commercial herbalists were women [41]. In the current study, 36% of the participants were aged between 18 and 24 years. The age bracket of 15 to 24 years is classified as the youthful group according to the World Health Organization [42, 43]. Therefore, HM trade in Kampala city has the potential for future expansion since a large proportion of the herbalists belonged to the very active age group. The relatively high profits obtained from HM sales, as reported in this study, highlight the potential contribution of the herbal medicine industry to Uganda’s national economy, and the role these plant species play towards the attainment of the participants’ livelihood needs, primary health care services, and cultural heritage. Cunningham [44] also reported that medicinal plants constitute an important feature of the cultural, economic, medicinal, and ecological components of all cities in the world.

**Herbal medicine diversity, methods of preparation, and administration**

The majority of the medicinal plant species identified in this study were in the family Fabaceae, Myricaceae and

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**Fig. 5** Some traditional health care establishments in Kampala city, where herbal medicines are traded: formal HMSE (A–C herbal shops; D, E market stalls; F pharmacy). Informa HMSE (G, H roadside stalls; J mobile stalls)
Asteraceae. Previous studies showed similar trends where Asteraceae, Fabaceae, and Cucurbitaceae were the most commonly traded botanical families in Botswana [45], and South Africa [46]. Plant families such as Fabaceae, Asteraceae, and Euphorbiaceae have the greatest number of species traded as herbal medicine possibly because these families are large and characterized by numerous species (http://www.thepplantlist.org/). Plant species belonging to these families have been reported to possess numerous bioactive compounds of medical importance, such as alkaloids, quinones, saponins, anthocyanins, coumarins, flavonoids, tannins, terpenoids phenols, steroids, and stereoisomeric neolignanes [47]. Some of the plants documented in the current study, such as *C. flexuosus*, *C. limon*, and *A. sativum* have been reported to have nutritional and commercial values, and they are used in the treatment other ailments besides diarrhea and/or cough [48–51].

The number of medicinal plant species reported in the current study is generally small compared to previous ethnobotanical and/or ethnopharmacological surveys conducted in Uganda [48, 50–55]. The earlier studies were mostly based in rural settings, and focused on documenting HM used for treating all the health complications prevalent in the study communities; this resulted in higher numbers of species reported by those studies, as compared to the current study. The low number of plant species reported by the current study may be attributed to the fact that herbalists that use HM as a cardinal source of income were potentially hesitant to divulge out all the ethnopharmacological information for fear that the researchers could use this knowledge to start a similar HM business. Nevertheless, to the best of our knowledge, some of the plant species cited in the current study, such as those under family Rubiaceae, are mentioned for the first time in the management of cough and/or diarrheal diseases in this part of Uganda. These plants, for
example *Gardenia ternifolia* were previously reported in for the management of other ailments though; such as the opportunistic diseases in people living with HIV/AIDS [56]. In *Gardenia ternifolia*, some bioactive compounds with inhibitory activity against deadly viruses such as the Human immunodeficiency virus (HIV), Herpes simplex virus type 1 (HSV-1), and the African swine fever virus (ASFV) were reported in earlier studies [47, 57]. Such compounds include alkaloids and flavonoids among others [47]. Studies that aim at profiling the plant species used for treating selected ailments, such as diarrhea and/or cough, can be more suitable for informing the discovery of specialized medicine for the ailments of interest, compared to those that document all the medicinal plants in a study community.

Highly traded plant species and their parts for diarrhea and cough management

The fact that *C. limon* was cited by all the participants for the treatment of cough highlights its great potential in the management of respiratory infections. Nonetheless, its relative medical importance was not significantly different from the rest of the plant species except those with RFC less than 0.95 such as *A. indica*. The frequent use of *C. limon*, *M. foetida*, and *C. citrinus* for the management of cough as reported in the current study corroborates with previous studies in other parts of Uganda [49, 51]. Additionally, *F. flexuosus* used as a diarrhea remedy, is also an aromatic herb in hot drinks and beverages in Nepal [58]. In the current study, leaves were majorly used as medicine, followed by the stem bark. The use of leaves is commendable since this promotes sustainable utilization of the plant species and preservation of their genetic stocks, as opposed to the usage of roots, stems and/or

### Table 4 Availability, demand and prices of frequently traded diarrhea and cough herbas in Kampala (N=65)

| Species name          | Disease treated | Availability in HM selling premises during survey | Demand | Availability in natural habitats | Average price, UGX (USD)/kg |
|-----------------------|-----------------|---------------------------------------------------|--------|---------------------------------|-----------------------------|
| *Citrus limon*        | Cough           | Available (n = 28, 43.1%) Out of stock (n = 12, 18.5%) | H (n = 65, 100%) | Declining (n = 12, 18.5%) Out of stock (n = 25, 39.2%) | 16,000 (4.38) |
| *Momordica foetida*   | Cough, Diarrhea | Available (n = 50, 76.9%) Out of stock (n = 9, 14.1%) | H (n = 59, 91%) | Rare (n = 49, 75.4%) | 11,000 (3.01) |
| *Callistemon citrinus*| Cough           | Available (n = 47, 72.3%) Out of stock (n = 10, 15.7%) | H (n = 57, 88%) | Declining (n = 52, 80%) Out of stock (n = 4, 7.3%) | 10,000 (2.74) |
| *Entada abyssinica*   | Cough, Diarrhea | Available (n = 30, 46.2%) Out of stock (n = 10, 15.7%) | M (n = 58, 89.2%) R (n = 5, 0.77) | Declining (n = 3, 4.6%) Out of stock (n = 11, 16.9%) | 7000 (1.92) |
| *Psidium guajava*     | Diarrhea        | Available (n = 18, 27.7%) Out of stock (n = 37, 56.3%) | M (n = 11, 16.9%) L (n = 44, 67.7%) | Declining (n = 55, 84%) Out of stock (n = 7, 20.5%) | 9500 (2.60) |
| *Conyza pyrthropappa* | Diarrhea        | Available (n = 7, 20.5%) Out of stock (n = 46, 61.3%) | M (n = 5, 0.37%) L (n = 48, 78.3%) | Rare (n = 5, 82%) Out of stock (n = 5, 20.7%) | 6000 (1.64) |
| *Azadirachta indica*  | Cough           | Available (n = 16, 24.7%) Out of stock (n = 34, 52.3%) | H (n = 50, 77%) | Declining (n = 50, 77%) Out of stock (n = 12, 19.4%) | 10,000 (2.74) |
| *Psidium guajava*     | Cough           | Available (n = 31, 47.7%) Out of stock (n = 18, 27.7%) | H (n = 10, 15.4%) | Abundant (n = 42, 64.6%) Out of stock (n = 44, 67.7%) | 7000 (1.92) |
| *Mangifera indica*    | Cough           | Available (n = 44, 67.7%) Out of stock (n = 4, 7.3%) | M (n = 48, 75.0%) L (n = 5, 0.77) | Abundant (n = 48, 75.0%) Out of stock (n = 7, 20.5%) | 5000 (1.37) |
| *Eucalyptus grandis*  | Cough           | Available (n = 48, 74.0%) | H (n = 48, 74.0%) | Declining (n = 48, 74.0%) Out of stock (n = 7, 20.5%) | 13,500 (3.70) |
| *Allium sativum*      | Cough           | Available (n = 29, 44.6%) Out of stock (n = 12, 19.4%) | H (n = 41, 64%) | Declining (n = 8, 12.3%) Out of stock (n = 5, 20.7%) | 48,000 (13.15) |
| *Vernonia amygdalina* | Cough           | Available (n = 36, 55.4%) Out of stock (n = 4, 5.6%) | M (n = 40, 61%) | Abundant (n = 31, 47.7%) Out of stock (n = 18, 27.7%) | 5000 (1.37) |
| *Persea americana*    | Cough           | Available (n = 27, 41.5%) Out of stock (n = 16, 24.5%) | M (n = 6, 9.2%) L (n = 37, 56.8%) | Abundant (n = 43, 66.0%) Out of stock (n = 37, 56.8%) | 4000 (1.10) |
| *Syzygium cumini*     | Cough           | Available (n = 30, 46.2%) Out of stock (n = 13, 19.8%) | M (n = 8, 12.3%) L (n = 33, 53.7%) | Abundant (n = 43, 66.0%) Out of stock (n = 37, 56.8%) | 4000 (1.10) |
| *Citrus sinensis*     | Cough           | Available (n = 43, 66.2%) Out of stock (n = 3, 4.8%) | H (n = 46, 71.0%) | Declining (n = 46, 71.0%) Out of stock (n = 3, 4.8%) | 8000 (2.19) |
| *Aristolochia littoralis* | Diarrhea      | Available (n = 20, 30.8%) Out of stock (n = 25, 39.2%) | M (n = 12, 18.5%) L (n = 33, 51.5%) | Abundant (n = 20, 30.8%) Out of stock (n = 25, 39.2%) | 5500 (1.51) |

UGX Uganda shillings, USD United States dollars, kg kilogram, HM herbal medicine, H high, M moderate, L low

* Average exchange rate of USD 1.0 = UGX 3650 [102]
whole plants which would rather cause obliteration of the plants [59]. However, indiscriminate plucking of leaves of highly used plant species may eventually become unsustainable [60], while use of bark may result in death of some medicinal species.

**Sources of herbal medicines traded**

Forests were the main source of HM, followed by bushes and homestead farms, with minimal reports of obtaining HM stocks from wetlands and herbal shops. In Uganda, earlier studies also reported the harvesting of HM from forests [53, 61]. In the current study, the report of high dependence on Mabira Central Forest Reserve as a source of HM might be attributed to several factors: (i) it is the largest natural forest in central Uganda; (ii) it is endowed with enormous medicinal plant species diversity; (iii) relatively close proximity (54 km) to Kampala; (iv) easily accessible, and (v) it is legally acceptable to harvest non-timber vegetation resources from this forest [53, 61, 62]. The minimal dependence on herbal shops within Kampala, as sources of HM stocks, could partly be explained by the scarcity of whole sale herbal shops, which lures most herbalists to obtain medicinal plant materials directly from their natural habitats. In addition, the knowledge of HM is generally personalized and confidential [46], which potentially lures each herbalist into searching and harvesting the plants from the natural habitats.

The HM stocks were sourced from 20 (14.8%) of the 135 districts of Uganda [30], and these were evenly distributed all over the country. Hence, the findings reported in this study somewhat represent the ethnopharmacological information of the plants used for diarrhea and cough treatment in the five regions of Uganda (Central, Eastern, Northern, Western and Southern).

**Demand and supply of traded medicinal plants used for diarrhea and cough treatment in Kampala**

More than half of the respondents indicated that some species were on high demand but either rare or their populations declining in the habits where they were harvested. Though the top five wild species frequently cited in the current study were not Red-listed as nationally threatened species [63], several other plants identified in this study are on the Red List [63]. These include; *C. articulata* (African Cherry Orange), *P. africana* (African Almond), and *L. trichilioides* (African Walnut), all cited in the treatment of diarrhea; as well as *M. excelsa* (African Teak), *T. indica*, and *W. ugandensis*, for cough [63]. The rising demand for many wild medicinal species leads to a potential increase in the harvesting pressure, making the affected species susceptible to local extinction. The local extinction of medicinal plant species may have global implications for human health [44]. Additionally, the recent increase in market demand for cultivated species such as *C. limon*, and *C. sinensis* is global and has been attributed to their perceived roles in the management of patients of Coronavirus disease-2019 (COVID-19) [64, 65]. Citrus fruits are some of world’s most important vegetal reservoirs of zinc, selenium, and vitamins C & D [66–69]. These minerals have been reported as effective boosters of natural immunity, and are essential in the management of respiratory viral pathogens such as SARS-Cov-2, the causative agent of COVID-19 [64, 70, 71].

Consequently, medicinal plants are known for their historical roles in counteracting the previous pandemics [72]. As such, some countries like China [73], and Uganda [74, 75] have already approved the use of herbal products as part of the medical interventions against the COVID-19 pandemic. Similarly in Madagascar, combination of *Artemisia annua*, *C. sinensis*, *A. sativum* and *Z. officinale* has been adopted as an important anti-COVID agent [76]. In the current study, though *A. sativum* was perceived to be abundant, it was the most expensive HM, sold at a price of UGX 48,000 ($13.15) per kilogram. This may not only be attributed to its role as a spice, but also as medicine for a wide spectrum of common ailments like respiratory diseases, gastrointestinal upsets, and cardiac complications [77, 78]. Many farmers in Uganda do not locally grow *A. sativum* but it is mostly imported from China and India [79]. The least priced medicinal plant species were sold at UGX 4000 ($1.10) per kilogram. The findings of this study revealed a price discrepancy with the amounts previously reported in HM markets in Eastern Cape province of South Africa; on the latter, the
Scarcity of some plant species; b -> Inadequate scientific evidence on HM efficacy & composition; c -> Inadequate monitoring and guidance by authorities; d -> HM not recognized as formal health care; e -> Scarcity of policy-awareness programs; f -> Unregulated advertisement and misinformation; g -> National COVID-19 preventive measures impede trade; h -> Traditional medical practices are discouraged by some clergy; i -> Duplication of herbal products; j -> High cost, and delays in certification and registration processes; k -> Some TMP operate without registration/certification; l -> High prices of HM stock materials; m -> High costs paid as rent and transport fares; n -> Unstable demand for HM; o -> Original packaging materials are costly; p -> Heavy taxation; q -> Inadequate environmental hygiene; r -> Usage of recycled packages retained from communal wastes; s -> Reports of adverse reactions from some HM consumers; t -> Long distance from the harvesting sites; u -> Climate change

Fig. 7 (See legend on previous page.)
most expensive herbal drugs were sold at $10.30 and the cheapest at $1.90 [80]. Therefore, HM trade in Kampala may offer better financial gains than in some cities elsewhere [41, 46].

Types of herbal-selling establishments and packaging of HM in Kampala
The HM were sold in herbal shops, market stalls, pharmacies, roadside stalls, and mobile establishments. Similarly, these types of HM ventures were reported in other urban settings in south Africa [46], Kenya [81], Tanzania [82], Malaysia [83], and China [46, 84]. In Uganda, the sale of indigenous herbal products in pharmacies is symbolic of the recent widespread innovations related to improved packaging and branding of HM, comparable to the standards that are acceptable in pharmacies. Ultimately, this might raise the confidence levels among pharmacists and physicians on the use of HM in Uganda, boosting the country’s HM industry. The presence of mobile and semi-mobile HM sellers in Kampala could pose health safety concerns since the effective monitoring and regulation of such arrangements can be difficult [85]. Further, the re-use of packaging materials that had been discarded as wastes in Kampala, has been associated with the introduction of pathogenic microbial contaminants in HM, threatening public health elsewhere [18, 81, 86–89].

Challenges hindering herbal medicine trade in Kampala city
The current study revealed that herbalists in Kampala operated under numerous challenges. Most of these hindrances were linked to HM regulation and policy (Fig. 7), despite the existence of legal frameworks that are supposed to streamline HM practices in the country. Such regulatory frameworks include the herbal medicine guidelines established by Uganda National Drug Authority [35], as well as the “Traditional and Complementary Medicine Act, 2019” ascended to by the president of Uganda on 14th September 2020 [90]. Other major constraints included the inadequacy of financial capital, and COVID-19 related disruptions. The disruption of economic activities by COVID-19 has also been reported globally [64, 91, 92]. Some herbalists were able to follow up their clients, hence the reports of side effects of some HM. This action is commendable since it promotes herbalist–patient/client trust and pharmacovigilance, though it is rare among herbalists worldwide [93].

Conclusions
There is a rich diversity of medicinal plant species traded in Kampala to treat diarrhea and cough. The HM trade significantly contributes to the livelihoods of the traders in Kampala, as well as the different actors along the HM value chain throughout the country. These medicines are collected from numerous habitats especially in the wild across the country. Most of the frequently used species for management of these diseases were reported to be rare or their availability declining in their natural habitats. Therefore, in addition to the validation of the therapeutic claims, the conservation and preservation of these species is warranted. Although the trade of herbal remedies in Kampala is limited by various hindrances, most of which are linked to the policies and regulation of the herbal medicine industry, it offers a unique opportunity for rural traditional herbalists to enter the urban cash economy. Further research focusing on streamlining of herbal medicine trade, more so in urban settings, should be conducted, to support the formulation of regulatory frameworks, and to bridge the knowledge gaps in herbal medicine safety, quality, and dosages.

Abbreviations
HM: Herbal medicine; TMP: Traditional medical practitioners; WHO: World Health Organization; COVID-19: Coronavirus disease-2019; KCCA: Kampala capital City Authority.

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Authors’ contributions
AW, and SA conceived the research idea, and were involved in field data collection and manuscript writing. JES and GA were involved in data analysis and manuscript writing. MN was involved in data collection and manuscript writing. All authors read and approved the final manuscript.

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Availability of data and materials
All data generated and analyzed during this study are included in the article.

Declarations
Ethics approval and consent to participate
The study sought ethical approval from the Makerere University School of Health Sciences Research Ethics Committee (Ref: MAKSHSREC-2020-72), Uganda National Council for Science and Technology (Ref. H51278E), and Kampala Capital City Authority (Ref: DPH/E/KCCA/1301). The research was conducted in conformity to the national guidelines for the conduct of research in the COVID-19 era established by the Uganda National Council for Science and Technology (UNCST) [94]. Informed consent to participate in this study was obtained in writing from the study participants. Respondents’ identifiers were recorded in form of assigned codes instead of names to ensure anonymity.

Consent for publication
Consent to publish the findings of this study was obtained in writing from the study participants.
Competing interests

The authors declare that they have no competing interests.

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