

REVIEW

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East African quintessential plants claimed to be used as blood purifiers, cleansers, detoxifiers and tonics: an appraisal of ethnobotanical reports and correlation with reported bioactivities

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Abstract

Background: Blood cleansing, purification, detoxification or strengthening is an ancient folkloric East African practice without any validated scientific underpinnings. This study was undertaken to retrieve ethnobotanical information and reported bioactivities of plants claimed to be blood purifiers, cleansers, detoxifiers and tonics in Eastern Africa and correlate their claimed use with scientific studies to find out whether there is any justification for their use in this ancient practice.

Method: An elaborate review was performed in electronic databases (PubMed, Science Direct, Scopus, Springer Link, Wiley Online Library, Taylor & Francis Online, SciFinder, Google Scholar, Web of Science) and the Google search engine to retrieve information on ethnomedicinal plants used in East Africa in blood purification, detoxification, cleansing or strengthening and their investigated bioactivities related to their use in this traditional practice.

Results: The search retrieved 74 plant species from 45 families distributed among 66 genera with some documented bioactivities, though, with little correlation with their traditional utilization in blood purification, cleansing, detoxification and strengthening. Some justification of the link between blood purification, cleansing, detoxification and strengthening and the use of the plants as antiplatelet aggregation, vasorelaxant, bronchodilatory, antihyperlipidaemic, cardioprotective, antiatherosclerotic and immunomodulatory agents were evident, but majorly antimicrobial activity has been investigated in most species. Thus, only 15 (20.2%) of the plant species (*Allium sativum*, *Moringa oleifera*, *Olea capensis*, *Clausena anisata*, *Centella asiatica*, *Nasturtium officinale*, *Solanum nigrum*, *Withania somnifera*, *Rubus apetalus*, *Delonix elata*, *Persia americana*, *Aloe vera*, *Azadirachta indica*, *Echinacea angustifolia* and *Dioscorea bulbifera*) could be directly correlated with studies pertaining to blood health.

Conclusion: Medicinal plants used in blood purification, cleansing, detoxification and strengthening in East Africa play a holistic role in rejuvenation of overall human health. Few studies have examined their bioactivities pertaining to blood health. Thus, bioactivities and pharmacological activities (such as blood thinning, hypolipemic, cardioprotective, immunomodulatory, tonic and renoprotective properties) and phytochemicals of the claimed plants warrant

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further research as these could lead to discovery of chemical scaffolds of lead compounds that can be used in modern blood purification.

Keywords: Antimicrobial, Bronchodilator, Cardioprotection, Immunomodulator, Invigorant, Traditional medicine, Vasorelaxant

Background

Natural products continue to be well recognized as the source of most known therapeutically effective commercial drugs. This is due to their distinct features and their being the origin of many pharmaceutical products, including digoxin, acetylsalicylic acid, atropine, morphine and colchicine (Atanasov et al. 2021). Plants are the most widely used natural products for their supposed medicinal potential from time immemorial. They are reportedly used by more than 60% of the global population for treatment of various diseases and conditions (WHO 2019). This is evident in developing countries where there are shrinking health services, poverty and the aphorism that herbal medicines are more effective, safe, accessible, affordable and culturally acceptable (Schultz et al. 2020; Tabuti et al. 2010; Tugume et al. 2016). Therefore, increased ethnobotanical surveys and pharmacological investigations have been done for medicinal flora worldwide in the past decades.

In Africa, and particularly Eastern Africa, which is a treasure trove of medicinal plants, several plants have been reported to be used in traditional medicine. The range of diseases and conditions treated span from simple wounds, cough and fevers to complicated conditions such as cancer, snakebites and blood purification (Schultz et al. 2020; Omara et al. 2021a; Kathambi et al. 2020; Anywar et al. 2020). Blood cleansing, purification, detoxification or strengthening is an old complementary and alternative medicine practice which has involved the use of plants in many cultures. However, there are no clearly established scientific evidences which indicate the role of plants in this ancient practice (Vuuren and Frank 2020; Keville 1990; Akter et al. 2012). In the current study, ethnobotanical information and bioactivities of plants popularly claimed to be used as blood purifiers, blood cleansers, blood detoxifiers or blood tonics in Eastern Africa were explored. The bioactivities were correlated with the claimed use of the plants to discern if there is any justification for their use in this ancient practice.

Methodology

This non-systematic review retrieved scholarly information on ethnomedicinal plants claimed to be used in East Africa for blood purification, detoxification, cleansing or strengthening dated until August 2021. East Africa was taken as East African community, the region including

Uganda, Kenya, Tanzania, Rwanda, Burundi and South Sudan (Omara et al. 2021b). An elaborate electronic review was performed in PubMed, Science Direct, Scopus, Springer Link, Wiley Online Library, Taylor & Francis Online, SciFinder, Google Scholar and Web of Science Core Collection. A more general search was further performed using the Google search engine to capture documents, reports, botanical databases and theses from various University repositories. This gathered all the published work (ethnobotanical books, reviews, reports, theses and primary scientific articles) with data on medicinal plants related to the six countries. For this review and in the traditional use context, the terms “blood purifier, blood cleanser, blood detoxifier, blood tonic, blood invigorant or blood strengthener” were used as the search key words in the retrieved reports. Those reports relating to plant usage as tonics (invigorants) and blood thinners, in blood clotting and bloodletting or for treating blood in the stool and blood pressure were excluded as these denoted treatments relating to specific blood diseases (Vuuren and Frank 2020).

Missing information in some studies such as local names and misspelled botanical names was checked from the Google search engine and botanical databases: The Plant List, International Plant Names Index, NCBI taxonomy browser and Tropicos. Most plant names were checked manually in the botanical databases at the point of entry, while the remainder were part of the checked list of ethnomedicinal flora of East Africa (Omara et al. 2021b; Omara 2020a). Another targeted review was undertaken to examine supportive evidences for the potential medical use of the claimed species to discern if scientific explanations could be advanced about their blood purifying, cleansing, detoxifying or strengthening potential.

Causes of sicknesses and the need for blood purification

In East Africa, sicknesses are usually correlated with their possible causes and as such, the medication and posology are contingent on the cause of the disease (Omara 2020b; Chhabra et al. 1984, 1993). For life-threatening illnesses or incidences where concerns cite that supernatural forces are behind diseases, diviners may be consulted (Sindiga 1994; Fratkin 1996). Communities attribute illnesses to external polluting influences that interferes with the normal body physiology (impairs digestive and

blood circulatory systems) (Fratkin 1996). These may include consuming the “wrong” foods (such as *Cheko che makiyo*-fresh unboiled milk, dirty water, *ikwek*-vegetables such as *Solanum nigrum* and *Gynadropis gyandra*), introduction of contagious substances from ill people, transgression of a social rule by the victim or a family member. Sometimes, it may also be due to conflicts in relationships between the patient and the spirits, or a violation of witchcraft-related rites and fetishes, and in extreme cases witchcraft (sorcery attacks) (Chhabra et al. 1984; Fratkin 1996; Kaendi 1994; Schlage et al. 2000; Irakiza et al. 2016; Salinitro et al. 2017; Kigenyi 2016). Therefore, determining the origin of an illness is pivotal in the prescription of the appropriate remedy and posology. Traditional treatment regimens are thus meant to relieve intestinal blockages through herbal purgatives and laxatives, or in the case of sorcery, consulting diviners who at their own discretion dispense ritually protective herbal medicines (Fratkin 1996; Salinitro et al. 2017). If evil and ancestral spirits or gods are blamed for the malady, a ritual or ceremony to placate them is arranged. If broken cultural rules or taboos are named as the cause, an act of penance or restitution is prescribed.

In East Africa, blood is considered sacred (Merker 1904; Arhem 1989). For example, when drunk from ritually slaughtered animals among the Maasai of Kenya, it is a sacred food and is symbolically associated with death and rebirth (Arhem 1989). A trial ordeal is reported in which this ethnic group uses blood to prove the innocence of people: a person under trial is made to drink blood under a special curse; if he survives the trial he is declared innocent, if he gets sick or dies he is proven guilty (Arhem 1989; Hollis 1905). Among the Maasai of

Tanzania, *motori*—a blood-based medicinal soup is commonly consumed with meat and also eaten by the sick. It is typically composed of boiled fat and blood of cows, sheep and goats mixed with medicinal herbs to aid digestion or act as a prophylactic (Roulette et al. 2018). Within the context of traditional medicine, several conditions may induce the need for blood purification, cleansing, detoxification or strengthening (Table 1). However, the plants may also be administered to individuals as a prophylactic or solace therapy during recuperation (Kigen et al. 2017).

In modern medicine however, blood purification is sought as an extracorporeal therapy in extreme cases of renal, hepatic, blood circulatory or immune-inflammatory disease conditions (Thongboonkerd 2010). In this case, blood is taken from a patient’s circulation through an extracorporeal circuit; a purification process is applied to it before it is recirculated back into the body. The common purification procedures medically recommended include haemodialysis, hemofiltration, apheresis, autotransfusion and plasmapheresis (Zhou et al. 2013) which adjusts leukocyte recruitment and responsiveness, boosts body immunity, enhances white blood cells’ antigen-presenting and phagocytic capability, as well as oxidative burst of immune cells (such as neutrophils and monocytes) (Peng et al. 2010).

Ethnomedicinal plants used in blood purification, cleansing, detoxification and strengthening in East Africa

Allopathic blood purification (and detoxification) is strongly rooted in advanced techniques (involving use of resins, polymers and nanoparticles) which filter out toxic or pathogenic substances from blood (Ju et al.

Table 1 Conditions linked with the need for a blood purifier, cleanser, detoxifier or tonic according to East African folk medicine diagnoses

Medical condition	References
Anaemia, allergies and inappetence	Kigen et al. 2017; Gumisiriza et al. 2019; Kimondo et al. 2015
Renal problems, splenomegaly and pancreatitis	Kigen et al. 2017; Muriuki 2011; Koch et al. 2005
Cerebrovascular and ocular disorders	Kigen et al. 2017
Gynaecology and childbirth. To “clean” women after giving birth or facilitate placenta expulsion	Kigen et al. 2017; Kiringe 2006
Aches, pains, dermal diseases, oedema	Fratkin 1996; Kigen et al. 2017; Odongo et al. 2018; Posthouwer 2015; Maundu et al. 2001
Malaria	Odongo et al. 2018; Maundu et al. 2001
Circulatory system disorders, menstrual cramps, hypertension, postmenopausal syndrome	Fratkin 1996; Kigen et al. 2017; Posthouwer 2015; Maundu et al. 2001
Compromised/weakened immunity	Anywar et al. 2020
<i>Diabetes mellitus</i> (hyperglycaemia), hyperlipidaemia	Kigen et al. 2017
Toxins in blood	Fratkin 1996
Wrong eating habits (digestive system disorders), food poisoning, brucellosis, constipation	Fratkin 1996; Muriuki 2011; Maundu et al. 2001

2019). East African traditional healers, however, connect the use of blood purifiers to their use as rejuvenators (tonics) (Table 2). Though used for blood purification, these plants are used to treat a range of other diseases and conditions including cancer, venereal diseases, epilepsy, fatigue, fevers, asthma and drug addiction. For example, *Rotala tenella* (Guill and Per) Hiern is used for management of peripheral neuropathy, muscle cramps, joint pains, pre- and postmenopausal syndromes, lumbago, obesity, cardiovascular/cerebrovascular disorders and hyperlipidaemia other than being used as a blood cleanser. The plant is also popularized among athletes as it is believed to house nutrients that prevent muscle injury (Kigen et al. 2017). Only *Citrullus lanatus*, *Cymbopogon citratus* (DC.) Stapf, *Dioscorea bulbifera* L., *Delonix elata* (L.) Gamble, *Vachellia seyal* (Delile) P.J.H. Hurter were reported to be used primarily for blood purification.

A total of 74 plants from 45 families distributed among 66 genera have been reported for use in blood purification, detoxification, cleansing or strengthening in East Africa (Table 2). Two unidentified plants (*Mukururiti* and *Ruguru*) were also reported to be used as blood cleansers in Kenya (Muriuki 2011). The most represented families were Fabaceae (with 7 species), Asteraceae and Rutaceae (4 species each), Amaranthaceae, Meliaceae and Solanaceae with 3 species each. *Aloe* was the most common genera (represented by 3 species) followed by *Acacia*, *Amaranthus*, *Dioscorea* and *Solanum* (represented by 2 species each). The *Aloe* genus is known as a common ingredient of most blood purifier products sold in East Africa (Ugabox 2021; Pigiambe 2017).

The herbal remedies are principally prepared as decoctions, chewed, steamed, eaten as a vegetable (e.g. *Chenopodium album* and *Solanum anguivi*) or taken as spices in food (e.g. *Allium sativum* and *Persia americana*). These remedies are obtained from plant leaves (30.8%), roots (20.6%), bark (12.1%) and fruits (10.3%) (Fig. 1). These are sometimes dried and powdered prior to administration and sometimes mixed with soup, especially for bitter plants (blood tonics). Other recipes included soot from burnt flowers, roots and leaves which are licked. Raw honey (*Kumat* in native Markweta of Kenya) was also reported to be consumed as a blood cleanser (Kigen et al. 2017).

The relatively frequent use of roots is related to the fact that blood—which is internal to the body—is hidden, just as root structures are hidden in the ground. This gives a correlation to the doctrine of signature concept, i.e. herbs with shape or colour resemblances to body parts could be used to manage ailments of those body parts (Efferth and Greten 2016). Further, a pharmacognostical tenet exists in East African traditional medicine in

which red-coloured plants, their parts or herbal preparations cognate with their potential to be used to treat blood-related conditions such as fever, pimples, acne and venereal diseases. For example, a decoction of *Vismia orientalis* roots is taken as a remedy for lassitude, and because the plant exudes a red gum which resembles blood, it is thought that this can strengthen the blood. Similarly, the sundried and stone-ground *Vismia orientalis* bark powder is made into a paste with castor oil which is rubbed onto pimples, acne, smallpox, chickenpox or primary syphilis (Kokwaro 1993).

Evidently, there is an East African traditional link between the magical properties of the identified plants and bloodletting, the spilling of blood or connection to spiritual uses (Table 3). This could be because some of the conditions that require blood purification are linked to spiritual causes such as sorcery (Fratkin 1996; Salinitro et al. 2017). In this context, some plants are used to dissuade evil spirits, provide protection against witchcraft, “summon” the rains and other rituals of purification. Similar spiritual linkage of plants used in blood purification has been reported in various communities in Southern Africa (Wyk and Gericke 2000; Moteetee 2017; Maroyi 2011).

Adverse side effects, toxicity and antidotes of the identified plant species

From the reviewed studies, toxicity of plants with reported use as blood purifiers, cleansers, detoxifiers or tonics was not a very common occurrence. However, *Aloe* species reportedly caused stomach ache, diarrhoea, general body weakness and mild headache (Kamau et al. 2016c). *Rhamnus prinoides* and *Prunus africana* had diuretic side effects (Kamau et al. 2016c), while *Euclea divinorum* and *Ricinus communis* had purgative and laxative effects (Kamau et al. 2016c; Kigen et al. 2014). From the foregoing, traditional medicine practitioners tended to add animal fats, bovine milk, bone soup or used more than one plant part to neutralize toxic herbal preparations. For example, *R. prinoides* are used along with *Periploca linearifolia*, *Carissa edulis* and *Rothea myricoides*, while *P. africana* could be prepared with *Acacia nilotica* or *Tremma orientalis*. About half a glass of *Achyranthes aspera* leaves and *Ficus natalensis* (roots) were added to the preparation of *Euclea divinorum* (Kamau et al. 2016c). However, some practitioners prepare formulations with more than one plant (or plant parts) as a trick of keeping the secrecy of their formula (Kuria et al. 2001). Overall, it should be emphasized that plant toxicity is important in initiating purgation and emesis which are regarded as the key treatment regimen for diseases in Eastern Africa (Omara 2020b; Kaendi 1994; Kiringe 2006). Thus, it is one route of freeing the body of toxins,

Table 2 Plants used in blood purification, cleansing, detoxification or strengthening in East Africa and their reported bioactivities

Plant family	Botanical name	Local name	Part used (preparation method)	Ethnobotanical uses (Ailments treated)	Reported bioactivities
Alliaceae	<i>Allium sativum</i> L	Katunguluccumu (<i>Luganda</i>)	Bulb (chew & swallow)	Reduce heartbeats, blood cleanser , bad breath, stomach ache, constipation, swollen rib cage, snakebites (Tugume et al. 2016)	Antidiabetic, anticancer, hepatoprotective, antimicrobial and antihyperlipidaemic activities (Omara et al. 2020; Kaur et al. 2016), antiplatelet aggregation, cardioprotective and antiatherosclerotic effects (Sobenin et al. 2019; Silagy and Neil 1994; Bordia et al. 1996) No relevant investigation
Aloaceae	<i>Aloe tweediae</i> Christian	Cheretwo (<i>Markweta</i>)	Leaves (Sap used)	Peptic ulcers, blood cleanser , infertility, arthritis, respiratory disorders, allergies, obesity, wounds (Kigen et al. 2017)	
Aloaceae	<i>Aloe vera</i> (L.) Burm.f	Rukaka	Leaves (Not specified)	Malaria, blood cleanser , allergy, typhoid, yellow fever, stomach ache, worms (Gumisitza et al. 2019)	Antimicrobial, wound healing, anti-inflammatory, antifungal, hypoglycaemic, anticancer, immunomodulatory and gastroprotective properties (Mukherjee et al. 2014)
Amaranthaceae	<i>Amaranthus graciazans</i>	Rwoga/terere (<i>Embu, Mbeere, Meru</i>)	Not specified	Blood purifier , immunity booster, increase blood , AIDS, diabetes (Muriuki 2011)	Antinociceptive, anti-inflammatory and protease inhibition activities (Ishtaq et al. 2017)
Amaranthaceae	<i>Amaranthus retroflexus</i> L	Tsimboka	Leaves (Not specified)	Blood purifier , brain health, constipation, wound healing (Advertiser 2020)	Antioxidant, antimicrobial activities (Pacifico et al. 2008; Pojata et al. 2016; Marinaş et al. 2014; Terzieva et al. 2019)
Amaranthaceae	<i>Beta vulgaris</i> L	Beetroot (<i>English</i>), no local name	Bulb (Eaten/prepared juice from it is drunk)	Purifying blood and liver (Beetroot in Uganda 2019)	Cytotoxicity (Kapadia et al. 2011), cardioprotective, antihypertensive and renoprotective properties (Mirmiran et al. 2020)
Anacardiaceae	<i>Lannea schweinfurthii</i> Engl	Mubindabindi (<i>Mbeere</i>), Mumbu (<i>Swahili</i>)	Leaves (Not specified)	Allergies, arthritis, back/bone joints problems, blood purifier , blood tonic , cough/colds/flu, diabetes, dislocation, gout, joints, liver, pneumonia, prostate cancer (Muriuki 2011; Posthouwer 2015)	Antiviral, anti-giardial, acetylcholinesterase inhibitory, antiapoptotic, antibacterial, anti-inflammatory, antioxidant, antiparasitodal, antirypanosomal, hepatoprotective and cytotoxic properties (Maroyi 2019)
Apiaceae	<i>Centella asiatica</i>	Mbutamu/ Kutukumu/Kabo Kabakyala (<i>Luganda</i>)	Whole plant (Decoction taken)	Blood purifier , leprosy, psoriasis, respiratory infections, ulcers, colds, eczema, hepatitis, epilepsy, fatigue, fevers, asthma and syphilis among others (Komakech 2017)	Hepatoprotective, cardioprotective, antioxidant, antidepressant, antibacterial, antifungal, anticancer, antinociceptive and anti-inflammatory, antimycotic, sedative and anxiolytic properties (Das 2011)
Asteraceae	<i>Artemisia annua</i> L	Artemesia (<i>English</i>)	Leaves (ingested with rock salt)	Cancer, cough, indigestion, blood cleanser , malaria/fever (Anywar et al. 2020)	Antimalarial, antihypertensive, antimicrobial, anticancer, antioxidant, antiviral and anti-inflammatory activities (Sadq et al. 2014)

Table 2 (continued)

Plant family	Botanical name	Local name	Part used (preparation method)	Ethnobotanical uses (Ailments treated)	Reported bioactivities
Asteraceae	<i>Echinacea angustifolia</i> DC	Echinacea	Roots, leaves (Decoction, taken)	Used for infections, e.g. cough, sinusitis and a blood cleanser (Anywar et al. 2020)	Immunomodulatory, antitumour and anti-inflammatory activities (Barnes et al. 2005; Tragni et al. 1988; Voaden and Jacobson 1972) Antitumor activity (Orabi 2009)
Asteraceae	<i>Senecio hadiensis</i> Forsk	Chepchirimitit (<i>Marakwet</i>)	Stem, roots, leaves (Decoction)	Myalgia, kidney disease, blood cleanser , soap (Kigen et al. 2017)	Antibacterial activity (Nigussie et al. 2020)
Asteraceae	<i>Vernonia myriantha</i>	Tebengwo (<i>Tugen</i>)	Not specified	Colic pain, blood purification (Rufford 2020)	Antimicrobial, anti-inflammatory antiviral, antidiabetic, antioxidant, hepatoprotective, immunomodulatory activities (Deshmukh and Gaikwad 2014; Kumar et al. 2013)
Basellaceae	<i>Basella alba</i> L	Kiraita (<i>Markwera</i>)	Leaves (Decoction)	Abdominal upsets, joint pains, lumbago, anaemia, blood cleanser (Kigen et al. 2017)	Antibacterial, antifungal, antiprotazoal, anticonvulsant, anti-inflammatory, analgesic, antidiabetic, antiproliferative and antioxidant activities (Nabatanzani et al. 2020)
Bignoniaceae	<i>Kigelia africana</i> Lam	Mwegea (<i>Swahili</i>)	Roots, leaves, bark, fruits (Decoction taken)	Gonorrhoea, syphilis, drug addiction, jaundice, madness, cataract, blood cleanser , increase blood , high blood pressure, measles and postpartum bleeding (Posthauer 2015; Loice 2018)	Immunomodulatory, hypolipemic, antioxidant, anticancer, antidiabetic, anti-inflammatory, antibacterial and cardioprotective effects (Klimek-Szczykutowicz et al. 2018)
Brassicaceae	<i>Nasturtium officinale</i> W.T. Aiton	Kibira, N'giyondo kop Elijah (<i>Marakwet</i>)	Leaves (Decoction)	Peptic ulcers, anaemia, allergies, blood cleanser (Kigen et al. 2017)	Antidiabetic, antiradical and hepatoprotective activities (Yang et al. 2008; Saleem et al. 2015; Valente et al. 2010)
Cactaceae	<i>Opuntia monacantha</i> Haw	Makatar (<i>Marakwet</i>)	Roots, leaves, fruits (Boiled or burnt to soot; fruits chewed)	Oral candidiasis, diabetes, pancreatitis, blood cleanser (Kigen et al. 2017)	Antimicrobial, anticancer, anti-inflammatory, neuroprotective, anxiolytic, analgesic, renoprotective, antioxidant, myorelaxant activities (Lim et al. 2021)
Cannabaceae	<i>Cannabis sativa</i> L	Njagga (<i>Luganda</i>), jai (<i>Lango</i>)	Leaves (Decoction taken, maybe taken in tea or milk)	Treat tuberculosis, cancer, pain, blood cleanser , asthma, diarrhoea (Anywar et al. 2020)	Antifungal activity (Kiswii et al. 2014)
Capparidaceae	<i>Boscia coriacea</i>	Kiare (<i>Mbeere</i>), Muthangira (<i>Meru</i>)	Not specified	Dental problems, blood detoxifier , eye problems, meat appetite, pneumonia, prostate cancer, tonsillitis (Muriuki 2011)	
Capparidaceae	<i>Capparis tomentosa</i> Lam	Mukolokombi (<i>Luganda</i>), Agodaman (<i>Lango</i>)	Roots (Decoction)	Blood cleanser , diarrhoea, pain (Anywar et al. 2020)	Antiplasmodial, antimalarial, antioxidant, anti-inflammatory, antidiabetic and antimicrobial activities (Gebrehiwot and Chaithanya 2020)

Table 2 (continued)

Plant family	Botanical name	Local name	Part used (preparation method)	Ethnobotanical uses (Ailments treated)	Reported bioactivities
Capparidaceae	<i>Cleome gynandra</i> L	Sakiat (<i>Marakwet</i>)	Leaves and roots (Chewed, or decoction taken)	Colic pain in infants, ear infection, blood cleanser (Kigen et al. 2017)	Antioxidant, anticancer, immunomodulatory and antidiabetic activities (Moyo et al. 2018; Mishra et al. 2011)
Capparidaceae	<i>Maerua subcordata</i> (Gig.) DeWolf	Chepan'yiny (<i>Marakwet</i>)	Roots (Chewed)	Colic pain in adults, anorexia, blood cleanser (Kigen et al. 2017)	Antifungal activity (Tegege and Pretorius 2007)
Celastaceae	<i>Maytenus senegalensis</i> (Lam.) Exell	Jirgelwo (<i>Marakwet</i>)	Bark, roots (Decoction)	Lumbago, blood cleanser (Kigen et al. 2017)	Antiplasmodial, antiproliferative, analgesic, anti-inflammatory, antimicrobial activities (Silva et al. 2011; Umar et al. 2019; Nabende et al. 2014)
Chenopodiaceae	<i>Chenopodium album</i> L	Montrichot (<i>Markweta</i>)	Whole plant (Boiled & eaten as a vegetable)	Abdominal upsets in infants, blood detoxifier in pregnancy (Kigen et al. 2017)	Antimicrobial, antipruritic, antinociceptive (Poonia and Upadhyay 2015), anti-arthritic (Arora et al. 2014), spasmolytic, anti-inflammatory, antipruritic, antinociceptive, analgesic, anticancer activities (Karwani and Sisodia 2015)
Chrysobalanaceae	<i>Parinari curatellifolia</i> Planch. ex Benth	Mnazi (<i>Hayal</i>), Naji (<i>Sukuma</i>)	Root bark (Decoction)	Threatened abortion, malaria, as a blood tonic and cardiac stimulant (Watt and Breyer-Brandwijk 1962)	Antibacterial, antimycobacterial, haemolytic (Karou et al. 2011; Bhunu et al. 2017), antioxidant, hypoglycaemic, anti-hyperlipidaemic, hepatoprotective, anti-antivenom and cardioprotective activities (Ogbonnia et al. 2008; Olaleye et al. 2014; Josiah et al. 2020; Hallu et al. 2020; Manuwa et al. 2017)
Convolvulaceae	<i>Cuscuta</i> L./Dodder species	Kabula kikolo (<i>Luganda</i>)	Leaves (Powder mixed with honey, water and taken)	Baldness, gonorrhoea, stomach ache, blood purifier , liver cirrhosis, libido, sperm quality (Quick Herbal Remedies Uganda 2018)	Hepatoprotective activity (Yen et al. 2008)
Convolvulaceae	<i>Ipomoea lapidosa</i> Wilhelm Vatke	Ndaria (<i>Marakwet</i>)	Twigs, roots, leaves (Decoction taken)	Ocular disorders, toothache, paraesthesia, blood cleanser (Kigen et al. 2017)	No relevant investigation
Crassulaceae	<i>Kalanchoe lanceolata</i> (Forssk.) Pers	Kipchebes (<i>Marakwet</i>)	Flowers (Burnt to soot and used)	Splenomegaly, hepatomegaly, blood cleanser (Kigen et al. 2017)	No relevant investigation

Table 2 (continued)

Plant family	Botanical name	Local name	Part used (preparation method)	Ethnobotanical uses (Ailments treated)	Reported bioactivities
Cucurbitaceae	<i>Citrullus lanatus</i>	Watermelon (English)	Fruits (Not specified)	Blood cleanser (Muriuki 2011)	Antioxidant, antiproliferative, cardioprotective, antihypertensive, anti-inflammatory activities (Zamuz et al. 2021)
Dioscoreaceae	<i>Momordica foetida</i> Schumach	Ebombo	Flowers (Decoction taken)	Cleansing stomach and blood vessels (Asimwe et al. 2021)	Antioxidant (Acquaviva et al. 2013), antidiabetic (Venter et al. 2008), antimicrobial (Odeleye et al. 2009) activities
Dioscoreaceae	<i>Dioscorea bulbifera</i> L	Kamahunyu	Bulb (Eaten)	Blood cleanser (Anywar et al. 2020)	Anticancer, antibacterial, antiviral, immunomodulatory, anti-inflammatory, antidiabetic, anti-obesity, analgesic, antioxidant, antidiabetic and neuroprotective activities (Galani and Patel 2017; Kundu et al. 2021)
Dioscoreaceae	<i>Dioscorea minutifolia</i> Engl	Rukwa rwa ngoma/ mbiti (Embu)	Not specified	Blood cleanser , viral diseases, rheumatism (Muriuki 2011)	No relevant investigation
Ebenaceae	<i>Euclea divinorum</i> Hiern	Kapcheptuin (Marakwet)	Fruits	Chewed. Abdominal upsets, skin disorders, blood cleanser , invigorant, prophylaxis of cancer and respiratory disorders (Kigen et al. 2017)	Cytotoxic (Mebe et al. 1998) and antimicrobial activities (Ngari et al. 2013; Nyambe 2014; Mbabazi et al. 2020)
Euphorbiaceae	<i>Croton macrostachyus</i> Hochst. Ex Delle	Mutuntu	Leaves, roots, stem bark (Not specified)	Wounds, cough, cleansing digestive and blood circulation system (Odongo 2013)	Antibacterial, antifungal, antimycobacterial, antidiarrhoeal, sedative, antidiabetic, anti-inflammatory, antioxidant, anticonvulsant, hepatoprotective and antiplasmodial activities (Maroyi 2017; Tafere et al. 2020)
Euphorbiaceae	<i>Ricinus communis</i> L	Kiariki, Mbariki, Mubariki, Mucariki (Embu, Mbeere), Mwariki (Meru)	Roots, seeds (Not specified)	Bites, blood cleanser , burns, constipation, cough, detoxifier , family planning, hard stool, indigestion, wounds, libido (Muriuki 2011)	Antioxidant, analgesic, bone regeneration, antinociceptive, hepatoprotective, antimicrobial, antiplasmodial and anti-inflammatory activities (Marwat et al. 2017)
Fabaceae	<i>Acacia hockii</i> De Wild	Akaasana (Luganda), Okuto atino (Lango)	Bark (Decoction)	HIV symptoms, anaemia, blood cleanser , cough (Anywar et al. 2020)	Anti-inflammatory, wound healing, antioxidant and antipyretic activities (Kamau et al. 2016a, 2016b; Zaruwa et al. 2020; Guchu et al. 2020)

Table 2 (continued)

Plant family	Botanical name	Local name	Part used (preparation method)	Ethnobotanical uses (Ailments treated)	Reported bioactivities
Fabaceae	<i>Acacia seyal</i> (L.) Willd	Naibeere (<i>Lusoga</i>)	Leaves, branches, fruits (Decoction)	Fever, blood tonic , skin infections, diarrhoea, fatigue (Anywar et al. 2020)	Antioxidant, anticancer, anti-inflammatory and antibacterial activities (Elmi et al. 2020; Zingue et al. 2018; Elhour et al. 2018)
Fabaceae	<i>Delonix elata</i> (L.) Gamble	Mwarange	Not specified	Blood purifier (Muriuki 2011)	Antioxidant, antibacterial, wound-healing, prophylactic, antioxi-ceptive, hepatoprotective, anti-hyperlipidaemic, activities (Chitra 2011; Ravindra and Priyanka 2018; Krishnappa et al. 2016)
Fabaceae	<i>Entada abyssinica</i> A. Rich	Mwolola (<i>Luganda, Lusoga</i>)	Branches, leaves (Decoction)	Syphilis, blood tonic , fever, chest and abdominal pain, fatigue, anaemia, ulcers, skin ulcers/lesions (Anywar et al. 2020)	Antioxidant, anti-inflammatory, antimicrobial, antitrypanosomal and anticancer activities (Teke et al. 2011; Sempombe et al. 2014; Olajide et al. 2005; Kuete et al. 2013)
Fabaceae	<i>Erythrina abyssinica</i> Lam. ex DC	Omurembe	Bark, roots (Decoction taken)	Body swellings, chest problems, blood cleanser (Odongo et al. 2018)	Antioxidant, antiviral, antimycobac-terial, antiplasmodial, anti-inflam-matory, antianaemic, antibacterial and antifungal activities (Obakiro et al. 2021)
Fabaceae	<i>Indigofera swaziensis</i> Bolus	Amaari (Iraqw)	Roots (Decoction)	Relieve general body pains, purify blood and give the body a stimu-lating effect (Kokwaro 1993)	No relevant investigation
Fabaceae	<i>Vachellia seyal</i> (Delile) P.J.H. Hurter	Len'gnet (<i>Marakwet</i>)	Bark (Decoction)	Blood cleanser (Kigen et al. 2017)	No relevant investigation
Flacourtiaceae	<i>Dovyalis abyssinica</i> (A. Rich) Warb	Mindlilwo (<i>Marakwet</i>)	Bark, roots, fruits (Decoction, dried and powdered, fruits chewed)	Seizures (epilepsy), muscle pains, joint pains, invigorant, blood cleanser , skin rashes (Kigen et al. 2017)	Antibacterial, antifungal and anti-trypanosomal activities (Legesse et al. 2019; Tadesse et al. 2015; Geyid et al. 2005)
Hypericaceae	<i>Vismia orientalis</i> Engl	Mpera, Mguwe (Digo)	Roots (Decoction)	Pimples, acne, smallpox, chick-enpox or primary syphilis. It strengthens the blood (Kokwaro 1993)	Antiprotozoal activity (Mbwambo et al. 2004)
Labiatae	<i>Leonotis mollissima</i> Guerke	Olbibi	Leaves (Infusion or decoction taken)	Antiseptic, skin rashes, blood purifier (Kigen et al. 2019)	Antimicrobial (Kinuthia 2019) and antiplasmodial (Waiganjo et al. 2020) activities

Table 2 (continued)

Plant family	Botanical name	Local name	Part used (preparation method)	Ethnobotanical uses (Ailments treated)	Reported bioactivities
Lamiaceae	<i>Ocimum gratissimum</i> L	Omujaaja (<i>Luganda</i>)	Leaves (Taken as tea)	Blood cleanser , boots appetite, hypertension and prevents insomnia (Vision 2010)	Anticonvulsant, sedative, anxiolytic, antidepressant-like antifungal, hepatoprotective, antidiabetic, anticancer activity, antibacterial, antidiarrhoeal and antioxidant activities (Priyanka et al. 2018; Nasazi et al. 2020)
Lauraceae	<i>Persia americana</i> Mill	Avocado (<i>English</i>), Ovakedo (<i>Luganda</i>)	Leaves, fruits (Decoction or eaten with food)	Amoebiasis, blood purifier , cancer, cough, immune booster, increase blood , malaria, prostate cancer, rheumatism, ulcers, anaemia, blood tonic , respiratory infections, herpes zoster (Anywar et al. 2020; Muriuki 2011)	Immunomodulatory, hypoglycaemic, antiviral, analgesic, anti-inflammatory, hypotensive, anticonvulsant, vasorelaxant, antiskickling and antioxidant activities (Bittencourt et al. 2020; Iweala et al. 2009; Yasir et al. 2010)
Lythraceae	<i>Rotala tenella</i> (Guill and Per) Hiern	Chepkitiot/Kitonde (<i>Marakwet</i>)	Whole plant (Boiled or consumed raw)	Blood cleanser , lumbago, obesity, cerebrovascular disorders, hyperlipidaemia (Kigen et al. 2017)	No relevant investigation
Malvaceae	<i>Adansonia digitata</i> L	Dakaumo, gendar-yandi	Leaves (Not specified)	Inflammation, kidney and bladder diseases, blood cleaning , diarrhoea, asthma (Hines and Eckman 1993)	Antimicrobial, antiskickling, analgesic, hepatoprotective, antidiabetic, antioxidant, antiviral, hepatoprotective, anticancer and antipyretic properties (Sundarambal et al. 2015)
Malvaceae	<i>Hibiscus acetosella</i> Welw. ex Hiern	Mask mallow (<i>English</i>)	Fresh leaves (Decoction mixed with salt)	Blood purifier (blood tonic) , increase blood in the body (UgMed 2020)	Antibacterial and antioxidant activities (Lyu et al. 2020)
Meliaceae	<i>Azadirachta indica</i> A. Juss	Muarubaini (<i>Kamba</i>), Mwarobaini (<i>Mbeere, Meru</i>)	Leaves (Not specified)	Amoebiasis, blood purifier , brucellosis, cough, dental problems, diabetes, hypertension, wounds, inappetence, malaria, typhoid (Muriuki 2011; Waiganjo 2013)	Antibacterial, antifungal, antioxidant, antiviral, hepatoprotective, anticancer, immunomodulatory and antipyretic properties (Singh et al. 2020; Isias et al. 2020)
Meliaceae	<i>Ekebergia capensis</i> Sparrrm	Not reported	Roots (Decoction/pounding)	Blood cleanser , fever, diarrhoea, skin infections, malaria (Anywar et al. 2020)	Antiplasmodial activity (Koch et al. 2005; Clarkson et al. 2004)
Meliaceae	<i>Melia azedarach</i> L	Mwarubaine	Leaves, bark, roots (Decoction taken orally/applied topically)	Malaria, blood cleanser , skin diseases, stomach and headaches (Odongo et al. 2018)	Antibacterial, antifungal, antioxidant, antiviral, hepatoprotective and antipyretic properties (Singh et al. 2020)

Table 2 (continued)

Plant family	Botanical name	Local name	Part used (preparation method)	Ethnobotanical uses (Ailments treated)	Reported bioactivities
Moringaceae	<i>Moringa oleifera</i> Lam	Moringa (English)	Leaves, roots, bark, seeds (Chewed/make juices-infusion)	Cleansing blood and liver, treating AIDS, amoebiasis, asthma, blood cleanser , blood purifier , cancer, detoxifier , fibroids, general body health, malaria, rheumatism, stomach disorders, typhoid (Muriuki 2011; Wamai 2019)	Anticancer, antihypertensive, antioxidant, cardioprotective, antibacterial, hepatoprotective, bronchodilatory activity, immunomodulatory, antiulcer and anti-inflammatory activities (Fidrianny et al. 2021; Vergara-Jimenez et al. 2017)
Myrtaceae	<i>Syzygium cordatum</i>	Muritu	Leaves (Infusion taken)	Blood cleanser , tea (Kathambi et al. 2020)	Antibacterial, antifungal, antidiarrhoeal, anti-inflammatory, antiproliferative, antioxidant, antidiabetic activities (Maroyi 2018)
Oleaceae	<i>Olea capensis</i> L OR <i>Olea europaea</i> (Olive)	Masat (Marakwet)	Bark (Decoction/pounding dry material)	Dewormer, blood cleanser (Kigen et al. 2017)	Antidiabetic, anticancer, antimicrobial, anti-inflammatory, antinociceptive, neuroprotective, gastroprotective, antioxidant, antihypertensive and cardioprotective activities (Hashmi et al. 2015)
Phyllanthaceae	<i>Antidesma venosum</i> E.Mey. ex Tul	Muthithia, Mwithethuko (Embu)	Not specified	Amoebiasis, back/joint/bone problems, blood purifier , cough/colds/flu, diabetes, immune booster, low libido, malaria, pneumonia, rheumatism, stomach disorders, tonsillitis (Muriuki 2011)	Anti-inflammatory (Fawole et al. 2009), antimicrobial and antioxidant activities (Gitu 2009)
Phyllanthaceae	<i>Bridelia micrantha</i> (Hochst.) Baill	Mukwego (Embu, Mbeere, Meru), Mukoigo (Embu)	Bark, leaves (Not specified)	Blood purifier , brucellosis, cancer, hypertension, increase blood , malaria, typhoid (Muriuki 2011)	Anti-diarrhoeal (Lin et al. 2002) and anti-oxidant (Nwaehujor and Udeh 2011) activities, anticonvulsant and sedative effects (Bum et al. 2012)
Poaceae	<i>Cymbopogon citratus</i> (DC.) Stapf	Kisubi (Luganda), Lum cai (Lango)	Leaves (Not specified)	Blood cleanser (Anywar et al. 2020)	Antimalarial and antitumor activity (Omara et al. 2020; Tchoumboung-nang et al. 2005)
Poaceae	<i>Yushania alpina</i> (K.Schum) W. C. Lin	Tegaa (Marakwet)	Stem (powdered)	Oedema, blood cleanser (Kigen et al. 2017)	No relevant investigation
Primulaceae	<i>Myrsine melanophloeos</i> (L.) Mez	Kigeta/mugeta (Mbeere)	Seeds (Not specified)	After-birth pains, amoebiasis, back/bone/joints pains, blood purifier , constipation, diarrhoea, kidney disorders , inappetence, malaria, prostate cancer, skin diseases, stomach disorders, typhoid (Muriuki 2011)	No relevant investigation

Table 2 (continued)

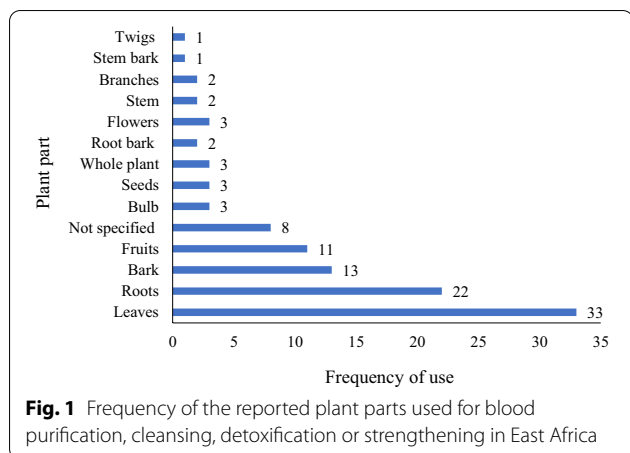
Plant family	Botanical name	Local name	Part used (preparation method)	Ethnobotanical uses (Ailments treated)	Reported bioactivities
Rhamnaceae	<i>Rhamnus prinioides</i> L'Hér	Mukithia (<i>Embu</i>), Mugarona (<i>Meru</i>)	Roots (Not specified)	Allergies, amoebiasis, back/joint/bone problems, blood cleanser , dental problems, general body health, inappetence, malaria, pneumonia, stomach disorders, typhoid (Muriuki 2011)	Antimalarial, antioxidant, anti-inflammatory, antibacterial, antimycobacterial (Nigussie et al. 2021) and acetylcholinesterase inhibition (Crowch and Okello 2009) activities
Rosaceae	<i>Prunus africana</i> (Hook.f.) Kalkm	Mwiria (<i>Embu</i>), Muiri (<i>Meru</i>)	Bark, leaves (Decoction)	Amoebiasis, arthritis, blood cancer, blood cleanser , brucellosis, cancer, diabetes, diarrhoea, epilepsy, hypertension, increase blood , indigestion, inappetence, malaria, meat allergy, pneumonia, prostrate problems, typhoid (Kathambi et al. 2020; Muriuki 2011; Kamau et al. 2016c)	Antimicrobial, antiandrogenic, antiangiogenic, analgesic, astringent, anti-inflammatory, anticancer, antioxidant, antifungal and antimalarial activities (Omara et al. 2020; Clarkson et al. 2004; Mwitari et al. 2013; Mutuma et al. 2020)
Rosaceae	<i>Rubus apetalus</i> Poir	Momonio (<i>Marakwet</i>)	Fruits (Eaten)	Blood cleanser , malnutrition, prophylaxis of cancer (Kigen et al. 2017)	Antidiabetic, antioxidant, antihyperlipidaemic and antiatherogenic activities (Raghavendra et al. 2019)
Rutaceae	<i>Citrus limon</i>	Mutimu (<i>Embu</i> , <i>Mbeere</i>) Ndimu, Murimu (<i>Embu</i>)	Fruits (Not specified)	Asthma, back/joint/bone problems, blood cleanser , chest congestions, cough, lack of appetite, malaria, rheumatism, typhoid (Muriuki 2011)	Hepatoregenerating, anti-obesity, anticancer, antioxidant, anti-allergic, antidiabetic, antimicrobial and anti-inflammatory activities (Klimek-Szczykutowicz et al. 2020)
Rutaceae	<i>Clausena anisata</i> (Willd.) Hook.f. ex Benth	Chebunoowo (<i>Marakwet</i>)	Bark (Decoction)	Emetic, blood cleanser (Kigen et al. 2017)	Antidiabetic (Ojewole 2002), antibacterial, cytotoxic (Tatsimo et al. 2015), anticonvulsant (Makanju 1983; Kenechukwu et al. 2012), antifungal (Hamza and van den Bout-van den Beukel CPJ, Matee MIN, Moshi MJ, Mix FHM, Selemani HO, Mbwambo ZH, Van der Ven AJAM, Verweij PE, 2006), antihypertensive (Duncan et al. 1999), anti-inflammatory (Adebayo et al. 2015), antimalarial, analgesic (Okokon et al. 2012), antimicrobial (Senthilkumar and Venkatesalu 2009; Osei-Safo et al. 2010; Agyepong et al. 2014; Christensen et al. 2015; Lawal et al. 2015a) and anti-oxidant activities (Lawal et al. 2015b)

Table 2 (continued)

Plant family	Botanical name	Local name	Part used (preparation method)	Ethnobotanical uses (Ailments treated)	Reported bioactivities
Rutaceae	<i>Harrisonia abyssinica</i> Olive	Mutagataga (<i>Embu</i>)	Not specified	Blood purifier , malaria (Muriuki 2011)	Antimalarial (Oduor 2016) antimicrobial, antioxidant (Kilonzo and Munisi 2021; Madivoli et al. 2018), antipyretic (Nthiga et al. 2016) activities
Rutaceae	<i>Vepris nobilis</i> (Delile) Mziray	Kuryot (<i>Marakwet</i>)	Bark, roots (Decoction)	Arthritis, backache, blood cleanser , invigorant, immunostimulant (Kigen et al. 2017)	Analgesic, antipyretic, antimalarial, antiplasmodial, antimicrobial, anti-inflammatory, anti-caseolytic, anti-leishmanial and anti-trypanosomal activities (Omujal 2020)
Santalaceae	<i>Osyris lanceolata</i> Hochst. & Steudel	Mutero (<i>Mbeere</i>), Muchai (<i>Meru</i>)	Roots (Not specified)	AIDS, allergies, blood purifier , malaria, pneumonia, prostate cancer, rheumatism, stomach disorders (Muriuki 2011)	Antimicrobial (Ooko 2014), antioxidant (Ochanga and Kilonzo 2018) activities
Solanaceae	<i>Solanum anguivi</i> Hook	Katunkuma (<i>Luganda</i>)	Fruits (Steam and eat as a vegetable)	Treat measles, hypertension, weakness during sickness and as a blood cleanser (Tugume et al. 2016)	Antioxidant (Abbe et al. 2019; Elekofehinti et al. 2013), antidiabetic (Nakitto et al. 2021), antihyperlipidaemic, antiperoxidative and hypoglycaemic effects (Molehin et al. 2020)
Solanaceae	<i>Solanum nigrum</i>	Managu/ Lisutsa	Not specified	Asthma, bronchitis, earache, stomach cramp, jaundice. For blood purification (Advertiser 2020)	Immunomodulatory, antidiabetic, hepatoprotective, antimicrobial, antioxidant, analgesic, anticancer, anti-seizure and cardioprotective activities (Chauhan et al. 2012)
Solanaceae	<i>Withania somnifera</i> (L.) Dunal	Olesayiet	Root bark (Not specified)	Blood tonic and rejuvenator , back and joint aches, galactagogue and for appetite (Kimondo et al. 2015)	Antimicrobial, anti-tumour, cardioprotective immunomodulatory, antioxidant, anti-convulsant and anti-inflammatory effects (Kalra and Kaushik 2017)
Urticaceae	<i>Urtica massaica</i> Mildbr	Thabai (<i>Kikuyu</i>)	Not specified	Arthritis, blood purifier , diabetes, energy booster, wounds, heartburns, hypertension, inappetence, low libido, pneumonia (Muriuki 2011)	Antimicrobial activity (Kipruuto et al. 2019) and aphrodisiac effects (Oloro et al. 2016)
Verbenaceae	<i>Lantana trifolia</i> L	Kayukiyuki (<i>Luganda, Lusoga</i>)	Leaves, flowers (Not specified)	All HIV/AIDS symptoms, blood cleanser , cough, ear infections (Anywar et al. 2020)	Anti-inflammatory, antinociceptive and antipyretic effects (Uzcátegui et al. 2004)

Table 2 (continued)

Plant family	Botanical name	Local name	Part used (preparation method)	Ethnobotanical uses (Ailments treated)	Reported bioactivities
Xanthorhoeaceae	<i>Aloe species</i>	Kibiricha, Kirunja, Murucha, Sukurui (<i>Meru</i>), Eshikaha	Leaves (sap), roots (Decoction taken)	Allergies, amoebiasis, athlete's foot, blood purifier, detoxifier , diabetes, goitre, HIV/AIDS, wounds, malaria, muscle cramps, pneumonia, prostate cancer, skin diseases, typhoid, ulcers, diabetes, blood cleanser (Muriuki 2011; Odongo et al. 2018; Dharani and Yenesew 2010)	Various bioactivities reported in this genus, some of which are relevant to blood purification



resulting in blood purification, detoxification, cleansing or strengthening.

Bioactivities of the identified plants

From the reviewed bioactivities of the plants, most investigations were centred on the antimicrobial activity of extracts of the plant parts (upto 65%). This is supported by the reports of ethnobotanical surveys which tended to report the use of the plant parts in treatment of gastrointestinal, dermatological and respiratory ailments (Table 2). The plausible explanation for this could be the ease and relatively low cost of in vitro antimicrobial testing compared to other reported complex uses of the plants such as treating tuberculosis, HIV/AIDS and malignancies. The current upsurge in antibiotic resistance by genetically versatile microbes could be another explanation (Omara et al. 2021c).

Despite the foregoing observation, few studies have investigated bioactivities of the identified species against pathogenic infections (such as tuberculosis, malaria, viral hemorrhagic fever, hepatitis B and C, syphilis and HIV) which are related directly to blood. The most studied plant species (*Allium sativum*, *Basella alba*, *Centella asiatica*, *Citrus limon*, *Clausena anisata*, *Dioscorea bulbifera*, *Erythrina abyssinica*, *Kigelia africana*, *Lannea schweinfurthii*, *Moringa oleifera*, *Nasturtium officinale*, *Solanum nigrum* and *Withania somnifera*) also have extensive reviews of their various bioactivities (Table 2). However, few of these bioactivities are confirmatory of the supposed use of the plants in purifying, cleansing, detoxifying or strengthening blood and possess little direct positive correlation with (good) blood health. Only 15 (20.2%) species could be correlated with studies pertaining to blood health, for instance, anti-platelet aggregation, vasorelaxant, bronchodilatory, antihyperlipidaemic, cardioprotective and

anti-atherosclerotic effects of *Allium sativum* (Kaur et al. 2016; Sobenin et al. 2019; Silagy and Neil 1994; Bordia et al. 1996; Fehri et al. 2011) and *Moringa oleifera* (Acuram and Hernandez 2019; Aniss et al. 2020; Mehta and Agrawal 2008; Dillasamola et al. 2018; Arabshahi-Delouee et al. 2009; Cáceres et al. 1992; Aekthamarat et al. 2020), antihypertensive and cardioprotective activities of *Olea capensis* (Susalit et al. 2011; Circosta et al. 1990; Scheffler et al. 2008) and antihypertensive activity of *Clausena anisata* (Duncan et al. 1999; Lechaba et al. 2016). Cardioprotective activities were also reported for *Centella asiatica* (Das 2011), *Nasturtium officinale* (Fogarty et al. 2013), *Solanum nigrum* (Bhatia et al. 2011) and *Withania somnifera* (Mohanty et al. 2008), while antihyperlipidaemic and vasorelaxant activities were reported for *Rubus apetalus* (Raghavendra et al. 2019) and *Delonix elata* (Ravindra and Priyanka 2018) and *Persia americana* (Owolabi et al. 2005), respectively. These constitute the first 11 species with notable bioactivities relating to blood health.

Earlier studies among the rural Maasai people of East Africa indicated that they possessed lower blood cholesterol levels compared to those in urban centres and some Europeans, despite their high customary fat diet (Biss et al. 1971a, b; Mann et al. 1964). Day et al. (1976) later suggested that the low serum cholesterol levels of rural Maasai populace could be attributed to their frequent use of medicinal herbs, though the same team never published something more to confirm or reject their assertion. It is hypothesized that the low number of studies focusing on westernized aspects of blood purification, cleansing, detoxification or strengthening potential of the identified plant species could be because this concept from an African perspective is rarely used independently, and possess strong connections with rituals (Table 3) and other religious practices (Cumes 2013; White 2015) that cannot be commingled with modern medicine (Vuuren and Frank 2020).

Other important conditions associated with bad blood health and may be the reason for medicating with a blood purifier (Table 1) such as inappetence and hyperlipidaemia (high serum levels of one or more of total cholesterol, low-density lipoprotein cholesterol, triglycerides or both) have not been investigated for most of the identified species. Evidently, blood purification, cleansing and detoxification procedures in East Africa are strongly correlated with overall human health status. This fact is attested to by the inclusion of parts of common culinary spices, vegetables and food plant species such as *Allium sativum* (garlic), *Amaranthus graeciazans*, *Amaranthus retroflexus*, *Beta vulgaris* (beetroot), *Citrullus lanatus* (watermelon), *Cleome gynandra*, *Persia americana* (avocado) and *Citrus limon* (lemon) in the herbal preparations.

Table 3 Reported blood purifying, cleansing, detoxifying or strengthening plant species in East Africa with spiritual/ritual uses

Plant	Spiritual/ritual uses	References
<i>Clausena anisata</i> (Willd.) Hook. F. ex Benth	Treat conditions caused by witchcraft, spirits and "magic," i.e. chase away bad spirits	Schlage et al. 2000; Posthouwer 2015
<i>Cleome gynandra</i> L.	For rituals	Musinguzi et al. 2006
<i>Croton macrostachyus</i> Hochst. Ex Delile	Used in rituals against evil spirits and against witchcraft (as protection)	Posthouwer 2015; Hines and Eckman 1993; Kakudidi 2004
<i>Cuscuta</i> L. species	Used by bad people to make others roam up and down without settling. To grow taller if you are below 23 years; the plant leaves is mixed with <i>mucuna</i> seed powder and taken with milk at night	Quick Herbal Remedies Uganda 2018
<i>Entada abyssinica</i> A. Rich	Used in rainmaking rituals and to cleanse twins and religious ceremonies. Used with some incantations in cases where lightning stroke a person or near a home, to cleanse the family from evils that caused the incidence	Hines and Eckman 1993; Kakudidi 2004
<i>Erythrina abyssinica</i> Lam. ex D.C	Used in rituals and for protection from evil spirits. It is planted on graves and in religious ceremonies for Manni (a god)	Irakiza et al. 2016; Hines and Eckman 1993; Kakudidi 2004
<i>Euclea divinorum</i> Hiern	Given to candidates during initiation by the Sebei of Uganda or used in important "koresek" (Sebei) ceremonies (rituals of purification). The root and bark are made into a soup which is taken as a tonic among Sebei of Uganda, Maasai and Batemi of Tanzania	Kokwaro 1993; Johns et al. 1999
<i>Kigelia africana</i> Lam	Used in rituals, especially against evil spirits. Fruits if applied on a girls' nipples make the breasts grow long, make her ugly and she cannot be married	Posthouwer 2015; Hines and Eckman 1993; Kakudidi 2004
<i>Lantana trifolia</i> L.	Roots and stems used for cleansing and blessing animals. Used in many rituals, including those involving livestock	Maundu et al. 2001; Mweru 2018
<i>Lannea schweinfurthii</i> Engl	Roots boiled and then the bewitched washes in the water, which is poured out at the nearest road junction	Hines and Eckman 1993
<i>Olea capensis</i> *	A sacred tree used during the ceremony of initiating the <i>olorip-olasar</i> (a highly respected young leader among the Maasai of Kenya). The night after his selection, he leans against one of the trees regarded as "peaceful" or "harmless" without flinching	Maundu et al. 2001
<i>Osyris lanceolata</i>	Treating conditions caused by witchcraft, spirits and magic	Schlage et al. 2000
<i>Urtica massaica</i> Mildbr	Plants are cut and placed in a sting line of two rows where boys for circumcision run through it several times until their bodies are numb, making them ready for the ritual	Amuka et al. 2014
<i>Withania somnifera</i> (L.) Dunal	Intestinal parasites introduced by witchcraft	Watt and Breyer-Brandwijk 1962

* Used with those of *Olea europaea* subspecies *africana*, *Podocarpus* species and a fig (*Ficus thonningii*)

It is interesting to note that *Acacia seyal*, *Entada abyssinica*, *Hibiscus acetosella*, *Lannea schweinfurthii*, *Parinari curatellifolia* and *Persia americana* were also indicated to be utilized as blood tonics, while *Euclea divinorum*, *Dovyalis abyssinica* and *Vepris nobilis* were indicated as invigorants (tonics). Use of bitter tonics is an old time practice believed to confer beneficial effects on appetite and digestion, through *amarum* effect, which enhances the flow of saliva, gastric juices via the pneumogastric *nervus vagus* and the bile (Wyk and Wink 2004; McMullen 2017). Such bitter plant

extracts have also been established to exert an effect on the cardiovascular system through reduction of the heart beat rate and cardiac stroke volume (Schulz et al. 2001). Among the species identified in this study, only *Withania somnifera* (with bitterness values between 2000 and 5000, i.e. moderately bitter) was previously reported to possibly improve digestion and appetite (Olivier and Wyk 2013). Thus, the role of the identified species as tonics in correlation to their claimed use as blood purifiers, cleansers and detoxifiers warrants further probing research.

Another school of thought in relation to the holistic health effect of the identified species is their potential immunomodulatory properties. Positive immunomodulatory effect has been reported for *Allium sativum* (Mirabeau and Samson 2012), *Aloe vera* (Im et al. 2010), *Azadirachta indica* (Durrani et al. 2008), *Centella asiatica* (Das 2011), *Echinacea angustifolia* (Kim et al. 2002), *Dioscorea bulbifera* (Cui et al. 2016), *Moringa oleifera* (Li et al. 2020), *Nasturtium officinale* (Schulze et al. 2021), *Persea americana* (Bittencourt et al. 2020), *Solanum nigrum* (Hanifa 2011) and *Withania somnifera* (Ziauddin et al. 1996; Davis and Kuttan 2000; Chandran and Patwardhan 2017). These constitute the last 4 species with a bioactivity relating to good blood health. Thus, immunomodulatory effect could also be investigated for other species such as *Amaranthus graeciazans* and *Antidesma venosum* which were in addition to blood cleansing indicated as immune system boosters. Of the 74 species identified, there were 9 species (12.2%) for which no positive health-related research existed (Table 2). This presents a research gap for future studies on the pharmacological activities of these species.

Conclusions

Blood is considered sacred in East Africa, and ethnomedicinal plants used in blood purification, cleansing, detoxification and strengthening play a revered holistic role. The claimed use of the plants identified could be due to their various biological properties which exert an overall positive effect on human health. However, these bioactivities in most species identified could not be directly correlated with their claimed use in this traditional practice. Further studies should explore blood thinning, hypolipemic, cardioprotective, immunomodulatory, tonic and renoprotective properties of the understudied species. Of the 9 species with no reported bioactivities, *Aloe tweediae*, *Ipomoea lapidosa*, *Kalanchoe lanceolata*, *Rotala tenella* and *Yushania alpina* need to be investigated as they have been indicated to be used in the treatment of other conditions directly linked with blood purification, cleansing or detoxification, for example, hyperlipidaemia, obesity, cerebrovascular disorders, viral diseases, paraesthesia, splenomegaly, hepatomegaly, oedema, kidney disorders and inappetence.

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