

Traditional Eye Medicines in Tanzania: Products, Health Risk Awareness and Safety Evaluation

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Abstract

Background information: Eyes are delicate sensory organs necessary to give comfort for our life. Eye treatment requires special attention to avoid serious medical problems including blindness. Traditional eye medicines (TEM) are in most cases of unknown chemical nature, and vital parameters like sterility and pH are not controlled subjecting users to partial or total vision disability.

Aims: This work was aimed at systematic presentation of previously documented Tanzania TEM, documenting similar products, assessment of awareness of TEM health risks and safety evaluation.

Methodology: Data from previous studies was obtained from published journal articles and books. Ethno pharmacological study was conducted in Kigoma district by interviewing traditional healers and knowledgeable people guided by the structured questionnaire. Awareness on TEM associated health risks and later Safety evaluation was done based on pH values determination and culturing of lizard droppings on three culture media.

Results: TEM reported in this study are 80 medicinal plants belonging to 42 families, animal excreta and unrefined salt. Among the interviewees, 65% were unaware of health risks associated with the use of TEM. The pH of the tested product was ranging between 2.5 and 6.57. Lizard droppings showed contamination of Gram positive and Gram negative bacteria and fungi.

Keywords: Ethnopharmacology; Traditional eye medicine; Kigoma district; Tanzania

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Introduction

Traditional eye medicines (TEM) are commonly used in different countries. Products used vary from healer to healer and from country to country. Eye problems are many and may be categorized as; (i) Eye infections when pathogenic microorganisms invade any part of the eyeball or surrounding area. The infection may cause redness, pain, discharge, watering and light sensitivity (ii) Eye conditions e.g., cataract, dry eyes and eye allergies and, (iii) Vision impairment e.g., glaucoma, double vision (Diplopia) [1,2].

In Tanzania, like other developing countries the demand for eye care is growing. The dependency on TEM for care and treatment is attributed to several reasons including; few ophthalmologist, inability of medicines purchase and inadequate/distant health

facilities to the majority [3]. The drawback of TEM is that, methods and products employed in treatment /management may lead to serious health problems including blindness.

Although TEMs is common in many countries, very few documentation focusing on plants/products used for traditional eye treatment do exist. Our literature search noted a systematic documentation from the study conducted in the Eastern Cape Province, South Africa where 12 plant species medicinal plants belonging to 9 families were documented [4]. Plants used for treatment of eyes diseases/conditions in Tanzania are documented in ethno pharmacological journal articles and books but in a scattered manner while the epidemiological data associated with TEM caused medical problems is scanty.

The study was divided in parts namely; Part I dealt with the compilation of previous documented TEMs of Tanzania, Part II concerned with ethno pharmacological survey of TEM in Kigoma District, Part-III involved in assessment of knowledge and awareness of health risks associated with TEM and, Part IV covered safety evaluation based on determination of pH and microbial contamination.

Methodology

Literature survey and data compilation

Information on Tanzania medicinal plants for the treatment of eye diseases/conditions was compiled from journal articles and books. Main resources were the publications on the work done by Herdberg et al. [5-7], Chhabra et al. [8-13] and the books of Haerdi [14], Watt and Breyer-brandwijk [15], Kokwaro [16] and Ruffo et al. [17]. Other appropriate Tanzanian published articles are herein cited.

Ethnopharmacological study

Study site: Ethnomedical study was conducted in 9 wards (Bangwe, Buzebazeba, Gungu Kasingilima, Kitongoni, Mwanga Kusini, Mwanga Kasikazini, Machinjioni, Rusimbi) and 6 villages (Ilagala, Simbo, Luiche, Muyobozi, Mwandiga and Sunuka) of the Kigoma district, Tanzania.

Study design: The study followed five steps as outlined below.

Interview: Traditional healers and people who are knowledgeable about medicinal plants were interviewed to obtain traditional products used for treatment of eye problems. The interviews were conducted in their homes guided by the questionnaire (see the attached questionnaire in the annex). Both Kiswahili and vernacular languages were used to obtain reliable information.

Plant material collection, herbaria preparation and identification: In the field, information providers showed the mentioned plants to enable plant materials collection for safety evaluation and herbaria preparation. Identification of the prepared herbaria was done in Botany department, University of Dar Es Salaam.

Awareness on health risks associated with TEM

During the interview information providers tested on awareness of risks associated with the use of TEM based on three selected parameters namely; pain after administration, low vision and blindness.

Safety evaluation

pH determination and microbial detection were carried out in the Pharmacognosy Laboratory and Microbiology and virology Laboratory at the Muhimbili University of Health and Allied sciences using pH meter and following standard microbiology procedures.

pH determination: Preparation of each sample depending on product nature is outlined below. For each tested sample determination was carried out in triplicate, the mean of the obtained values was reported.

Extract preparation: 1g of plant material from *Vernonia amagdalina*, *Bidens pilosa*, *Ageratum conyzoides* and *Commiphora edulis* were each macerated with 20 mL of distilled water for 12 hours, filtered to obtain the micelle.

Sap preparation: Leaves of *Rumex usambarensis* and *Solanum lycopersicum* were each pounded in the mortar and the sap/juice squeezed and filtered.

Unrefined salt preparation: A solution of the salt was prepared by dissolving 0.9 g of salt in 100 mL of water.

Palm oil: pH determined using the oil without any dilution.

Determination of microbial contamination: Dry lizard droppings sample was collected from one of the MUHAS offices. The sample was enriched in Brain Heart Infusion Broth, incubated at 37°C for 18 hours. It was then direct cultured on solid media namely; Blood Agar (BA), Chocolate Agar (CA), MacConkey Agar (MCA) and Sabourad Dextrose Agar (SDA) followed by incubation of 48 hours and 72 hours respectively. This was followed on sub-culturing on similar media and preliminary identification of the microorganisms.

Results

TEM data compiled from previous studies

Data retrieved from journal articles and books gave 65 plant species belonging to 36 families summarized in **Table 1**. According to this data, proportions of the various plant parts used are presented in **Figure 1** and the frequency of mention for the diseases/conditions is presented in **Figure 2**.

Ethnopharmacological study in the Manyema Tribe

Recorded TEM: This study was conducted in areas not covered in previous ethnopharmacological surveys done over two decades ago. Recorded products and their corresponding eye disease/conditions are summarized in **Tables 2 and 3**.

Sources and dosage forms of TEM used by the Manyema tribe: Our study afforded to record 19 TEMs where fifteen are of plant origin belonging to 11 families (**Table 2**) with the frequency of mention for each plant shown in **Figure 3**.

Disease/conditions treated by TEM among the Manyema tribe: Six categories eye diseases/condition treated are as shown in **Figure 4**.

Awareness of health risks associated with TEM

Responses from information providers on the four negative health risks of TEM asked are presented in **Table 4**.

Safety evaluation

Based on the importance of pH and freeness from microbes in eye medicines, some products were evaluated. pH of tested products were acidic in nature as shown in **Table 5** Microbial contamination was observed in the lizard droppings, as presented in **Figure 3** and the preliminary identification of microorganisms in **Table 6**.

Table 1 Previous Reported Tanzanian plants used for treatment of eye disease/conditions.

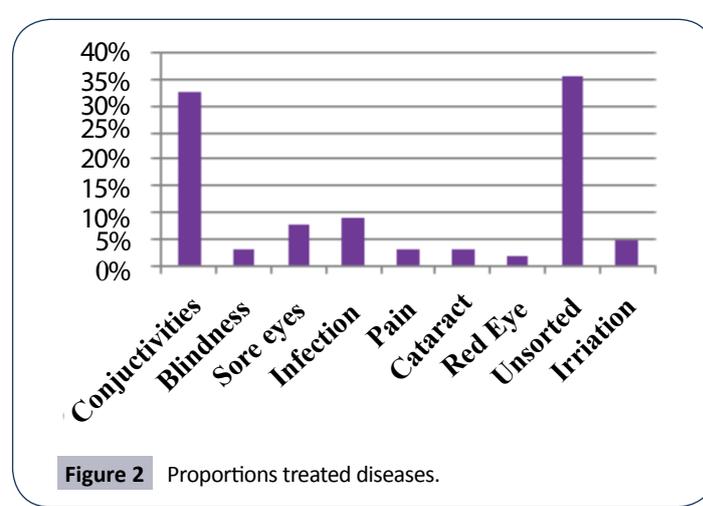
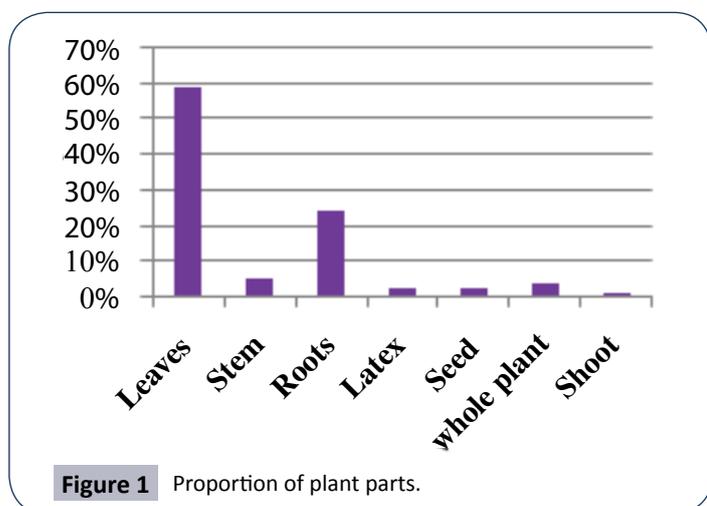
Family	Plant Name	Plant Part Used Preparation	Application	References
Acanthaceae	<i>Thunbergia alata</i> Boj. Ex Sims	Whole plant used	Conjunctivitis	[14]
Amaranthaceae	<i>Aerva lanata</i> (L) Juss. Ex schutt	Leave crushed and the juice used	Sore eyes	[16,17]
	<i>Achyranthes asperata</i> L	Entire plant/aerial parts juice	Used to dissipate opacity of the cornea	[15]
Asparagaceae	<i>Asparagus africanus</i> Lam.	Seeds swallowed	eye disease	[17]
Anacardiaceae	<i>Ozoroa insignis</i> Del	Stem bark	Pink eyes	[15]
Annonaceae	<i>Annona senegalensis</i> Pers	Roots Leaves	Eye lotion	[15]
Apocynaceae	<i>Diplorhynchus condylocarpon</i> Mull. Arg	Roots	Sore eyes	[16]
Arecaceae (Palmae)	<i>Phoenix reclinata</i> Jacq.	Leaves	Conjunctivitis	[16]
Asparagaceae	<i>Asparagus africanus</i> Lam	The leaves infusion for washing the eyes.	Blindness	[8]
Asteraceae (Compositae)	<i>Aspilnia mosambicensis</i> (Oliv) Wild	Roots decoction vapor directed into eye and Leaves juice as eye drops.	Conjunctivitis	[9]
	<i>Blepharispermum zanguibaricum</i> Oliv and Hiern	The leaves pounded with water and the juice used.	Eye trouble	[9]
	<i>Conyza pyrhoppa</i> A. Rich	Leaves maceration	Ophthalmic application in cattle	[15]
	<i>Emilia coccinea</i> (Sims) G. Don	Infusion of the leaves mixed with those of <i>Ipomea eriocarpa</i> used as eye drops	Eye disease	[17]
	<i>Microglossa pyrifolia</i> Lam.	Juice of roots as eye drops	Cataract	[5]
Bignoniaceae	<i>Mackhamia obtusifolia</i> (Barker) Spragae	Decoction of roots drunk	Improve eye sight and conjunctivitis	[10]
Boraginaceae	<i>Cordia ovalis</i> R. Br	Leaves	Eye ache	[5]
	<i>Cordia monoica</i> (Roxb)	Leaves	Eye disease	[17]
Bombacaceae	<i>Adansonia digitata</i> L.	Leaves infusion used as eye drops	Eye disease	[17]
Caesalpiniaceae	<i>Afzelia quanzensis</i> Welw	Pounded leaves, filtered and the juice used as eye drops	Conjunctivitis	[8]
	<i>Brachystegia spiciformis</i> Benth	Decoction of roots together with an infusion of leaves	Conjunctivitis	[15]
	<i>Cassia auriculata</i> (L)	Powdered dry stem bark mixed with water drunk.	Conjunctivitis	[8]
Capparidaceae	<i>Capparis tomentosa</i> Lam	Roots decoction is drunk	Eye problems Conjunctivitis	[16]
Commelinaceae	<i>Commelina benghalensis</i> (L)	Sap used as eye drops Roots decoction is warmed with camphor used as eye drop.	Eye ailments Conjunctivitis	[9,17]
Convolvulaceae	<i>Ipomea eriocarpa</i> R. Br.	Infusion of the leaves mixed with those of <i>Emilia coccinea</i> used as eye drops	Eye disease	[17]
Euphorbiaeae	<i>Acalypha fructosa</i> Forssk	Aerial part decoction Leaves used decoction Root decoction Either of the above applied into the eye.	Conjunctivitis	[15-17]
	<i>Bridelia micrantha</i> Hochst	Leaf sap	Sore eyes	[17]
	<i>Euphorbia hirta</i> (L)	Whole plant infusion used as eye drop Leaves	Conjunctivitis Eyes trouble	[14] [16]
	<i>Euphorbia candelabrum</i> Tremaux	The latex	Eye tumor	[15]
	<i>Euphorbia tirucalli</i> L.	Latex is applied into the eye.	Eyes infection	[18]
	<i>Felicia grantii</i> (Oliv. & Hiern) Grau,	Plant sap is used as eye drops	Eye infection	[18]
	<i>Pseudolachnostylis maprouneifolia</i> Pax	Leaves	Eyes trouble	[14]
	<i>Spirostachys africana</i> Sond	Leaves pounded then boiled with water and the vapor let into eyes	Eye trouble	[10]
Fabaceae	<i>Crotalaria retusa</i> L.	Leaf juice used as eye drops	Eye infection	[18]

Hydnoraceae	<i>Vismia orientalis</i> Engl	The leaves burned and the ashes mixed with water and used as eye drop.	Sore eyes	[10]
Labiatae	<i>Leonotis mollissima</i> (Gurke)	Young leaves and buds juice applied to the eyes	Conjunctivitis	[6]
	<i>Ocimum suave</i> Wild	Leaves	Sore eyes Conjunctivitis	[16]
Loganiaceae	<i>Strychnos madagascanensis</i> Poir.	Infusion of the leaves is used to wash the eyes.	Conjunctivitis	[11]
	<i>Strychnos spinosa</i> Lam.	Leaves	Conjunctivitis	[15]
Mimosaceae	<i>Albizia versicolor</i> Welw Ex oliv	Stem bark	Irritating eyes	[14]
Moraceae	<i>Ficus capensis</i> Thumb	The leaves are pounded, mixed water then filtered and the juice used to wash eyes.	Septic eye Conjunctivitis	[15]
	<i>Ficus exasperate</i> Vahl	Leaves	Eyes trouble	[15]
Ochnaceae	<i>Brackenridgea zanguebarica</i> Oliv	Stem bark is boiled with water and the vapor let into eye.	Conjunctivitis	[11]
Olacaceae	<i>Ximenia caffra</i> Sond	Leaf juice mixed with little water.	Itchy eye in the treatment of trachoma, especially in children.	[6]
Papilionaceae	<i>Abrus precatorius</i> (L)	Leaves juice/decoction Seeds infusion	Conjunctivitis/ inflamed eyes Purulent eye infections	[7,14]
	<i>Cajanus cajan</i> (L) Mill sp	Leaves juice	Bad vision	[7]
	<i>Crotalaria emargiata</i> Benth	Leaves juices	Eye disease Eye sores	[16]
	<i>Dolichos trilobus</i> L	Leaf juice is boiled, cooled and applied.	Cataract.	[7]
	<i>Desmodium salicifolium</i> (Poir) DC	Leaves	Eye trouble	[16]
Polygonaceae	<i>Carpolobia goetzei</i> Gurke	Roots infusion with the decoction of <i>Vigna unguiculata</i> taken orally in the porridge.	Conjunctivitis	[16]
	<i>Oxygonum sinuatum</i> (Hochst. & Steud ex Meisn.) Dammer	Leaves squeezed and juice used as eye drops	Conjunctivitis	[17]
	<i>Securidaca longependunculata</i> Fresen.	Roots barks cold infusion	Used as eye remedy	[7]
Rubiaceae	<i>Agathesanthemum bojeri</i> Klotzsch	The leaves juice is used as eye drop.	Eye pain.	[12]
	<i>Crossopteryx febrifuga</i> (G. Don) Benth.	Leaves as an ingredient in ointment	Conjunctivitis. Filaria of connective tissues in the eye	[7,16,19]
	<i>Polysphaeria parvifolia</i> Hiern	The roots are infusion taken orally.	Blindness	[12]
Rutaceae	<i>Vepris glomerata</i> (F. Hoffm) Engl	The powdered dried root bark is added to boiling water and the eye exposed to the vapors	Eye trouble	[12]
Sapindaceae	<i>Allophylus rubifolius</i> (Rochst. Ex a. Rich) Engl.	The root decoction is drunk.	Conjunctivitis	[12]
Sapotaceae	<i>Sideroxylon inerme</i> L	The dried powdered root in porridge and eaten.	Conjunctivitis	[13]
	<i>Paullinia pinnata</i> L.	Leaves	Blindness and other eyes troubles.	[16]
Smilacaceae	<i>Smilax kraussiana</i> Meisn	Leaves	Eye troubles	[16]
Solanaceae	<i>Solanum incanum</i> L	Extract juice of leaves	Eye diseases	[7]
Sterculiaceae	<i>Waltheria indica</i> L	Roots used as an astringent Leaves juice	Eye ache	[16]
Tiliaceae	<i>Grewia plagiophylla</i> K. Schum	Fibres infusion used to wash the eyes.	Eye irritation due to any irritating substances like pepper	[16]
	<i>Carpodiptera africana</i> Mast.	The roots or stem bark infusion the face and eyes washing	Eyes trouble	[13]
	<i>Grewia villosa</i> Wild	Leaves decoction	Eye pain	[16]
	<i>Triumfetta rhomboidea</i> Jacq.	Roots infusion or decoction is drunk	Eyes trouble	[15]
Verbenaceae	<i>Lantana camara</i> L	Leaf ashes	Conjunctivitis	[16,17]

	<i>Lantana trifolia</i> L	Leaves	Eyes trouble	[16]
	<i>Vitex doniana</i> (Sweet)	Leaves juice squeezed in the eyes.	Eyes disease	[17]

Table 2 Recorded herbal traditional eye medicines used by the Manyema tribe.

Family	Plant name and frequency of mention	Vernacular name (Manyema)	Plant part, Preparation and Administration	Eye disease or condition
Asteraceae (Compositae)	<i>Bidens pilosa</i> L.	Kasisa	Fresh leaves are squeezed and juice used as eyes drop, 3 drops, three times a day for seven days	Cataract and eye infections
	<i>Ageratum conyzoides</i> L.	Mkokoa	Fresh leaves are squeezed and juice used as eyes drops, three times a day for seven days.	Vision disability Eye infections
	<i>Vernonia amygdalina</i> Del.	Kilulugunja	Fresh leaves are squeezed and juice used as eyes drops, 2-3 drops used three times a day for seven days.	Cataract
Arecaceae	<i>Elaeis guineensis</i> Jacq	Mawese	Palm oil is used as eye drops. Once a day preferably at night.	Vision improvement
Burseraceae	<i>Commiphora edulis</i> (Klotzsch) Engl.	Msubesube	Fresh latex produced after leaves detaches from the stem three applied daily until recovery.	Cataract
Crassulaceae	<i>Kalanchoe lanceolata</i> (Forssk.)	Mchawi hanaakili	Fresh leaves are warmed and the squeezed juice used as eye drops. 2-3 drops two times a day	Sore eyes and itching.
Eupobiaceae	<i>Phyllanthus amarus</i> Schum. & Thonn.	Mnyumanyuma	Fresh leaves are squeezed and juice used as eyes drops, 2-3 drops used three times a day for seven days.	Cataract
	<i>Euphorbia hirta</i> L.	Songosongo	Fresh latex from detached leaves, three drops used for three times a day	Cataract
Moraceae	<i>Ficus natalensis</i> Hochst	Murumba	Fresh latex produced from bark, 2 - 3 drops is used three times a day	Eye tumour
Meliaceae	<i>Swietenia macrophylla</i> King	Mninga	Fresh latex produced from bark, one drop is used once a day	Cataract
Papilionaceae	<i>Abrus prectorius</i> L.	Sikesike	Fresh leaves are squeezed and juice used as eyes drops. 3 drops three times a day for seven days.	Cataract
Pedariaceae	<i>Sesamum angustifolium</i> (Oliv.) Engl	Mulenda	Fresh leaves are squeezed and juice used as eyes drops.	Eye infection (newly born babies' eyes are affected with measles).
Polygonaceae	<i>Rumex usambarensis</i> (Dammer) Dammer	Lusaba	Aerial parts are squeezed and the juice used as eye drops two times daily until recovery.	Cataract
Solanaceae	<i>Solanum lycopersicum</i> L.	Nyanya	Fresh leaves are squeezed and juice used as eyes drops.	Cataract, vision problems
	<i>Solanum tuberosum</i> L.	Viazi mviringo Viazi mbatata	Raw of potato tuber are crushed in a mortar and strained to obtain the juice is applied as eye drops.	Improves the poor vision



Discussion

In previous studies, the use of ambiguous terminologies such as; eye problems, eye diseases, eye trouble, eye ailments, eye

ache/pain could not clearly state the disease /condition. This is a drawback if one would wish to conduct scientific research for drug development. Leaves were ranking highest followed by roots. By disregarding the unsorted disease/condition (37%); eye

conjunctivitis (33%) was the most treated disease followed by eye infection (12%) (Figures 4).

Among the recorded TEM in the Manyema tribe, five plants namely; *Abrus precatorius*, *Ageratum conyzoides*, *Bidens pilosa*, *Euphorbia hirta* and *Sesomum angustifolia* had previously been reported. Majority of the products (78.9%) were herbal preparation, 15.8% were animal wastes and the unrefined salt as the only mineral product. This is in line with the fact that, botanicals are the main source of traditional medicine. The most used photo-organs are leaves constituting 60%. Product-wise; palm oil was the most frequently mentioned followed by latex of *Euphorbia hirta* and a solution of unrefined salt. Dosage forms comprised of liquid (juices/saps; 52.6%, latex; 21.1%), and oil; 5.2%) and solid (21.1%) as powders from animal source.

Unlike the data obtained from previous studies, information providers clearly stated the eye disease/condition yielding quality/reliable data for further scientific studies. In part this is due the well-structured questionnaire that gave proper guidance during the interview. Cataract was the most reported among mentioned six eye disease/problem. In part, this could be due to inadequate hospital services or dislike of undergoing surgical operation. It is worth investigating cataract treating TEM as efficacy can easily be assessed by disappearance of the cataract. Another area of interest for future research is on TEM used for vision improvement in order to confirm efficacy and establish safety and mechanism of action(s).

It should be clear that, we are not advocating the use TEM products reported in this work. However, ethno medical data and little scientific data from literature provide association and conviction on the use of the mentioned plants as TEM as presented below;

Bidens pilosa is used to treat cattle eye keratitis [20]. *In vitro* studies on extracts of *B. pilosa* have demonstrated antimicrobial activity against a wide range of bacteria including *Klebsiella pneumonia*, *Bacillus*, *Neisseria gonorrhoea*, *Pseudomonas*, and *Salmonella*, *Mycobacterium tuberculosis* and *M. smegmatis* [21]. Aqueous leaf extract showed significant anti-yeast activity towards *Candida albicans*. Polyacetylenes are linked with most of the observed antimicrobial activity and particularly phenylheptatriyne that had shown strong *in vitro* activity against numerous human and animal viruses, bacteria, fungi and molds in low concentrations [22,23]. Some of these pathogenic microbes are responsible for causing eye infection justifying the antimicrobial use this plant.

Ageratum conyzoides in combination with *Dichrocephala integrifolia* leaf sap is applied as eye drops in Tanzania and other African countries [24]. It is also used for treatment of blindness, conjunctivitis and related ocular infections in cattle [25]. Among several antimicrobial testing studies, water and ethanolic extracts had exhibited activity against methicillin-resistant *Staphylococcus aureus* (MRSA). Phytochemical constituents of *A. conzyoide* include alkaloids, coumarins, essential oils, tannins various flavonoids including polymethoxylated flavones and polyhydroxyflavones [26]. The plant has limited medicinal applications due toxicity [27].

The use of leaf juice/decoction of *Abrus precatorius* is reported for treatment of conjunctivitis and inflamed eyes and seeds infusion against purulent eye infections [7,15]. In cases of cataracts, refractive errors while ocular pain, some healers ask patients to take the seeds of *Abrus precatorius* orally, and apply root sap into the conjunctival sac [28]. In Africa, powdered seed is added to women's traditional eye makeup in African countries [29]. The methanolic seed extracts showed comparable antibacterial activity to Streptomycin when tested against *Enterococcus faecalis*, *Escherichia coli*, *Micrococcus luteus*, *Lactobacillus fermentum*, *Klebsilla pneumonia*, *Staphylococcus aureus*, *Streptococcus thermophilus*, *Streptococcus mitis* and *Streptococcus mutans* [30].

In India, the stem latex of *Euphorbia hirta* is used for the treatment of eyelid styes and eye sores. Flower decoction is used against eye infections and inflammations such as conjunctivitis or pink eye [31]. Various parts of *E. hirta* had shown various degrees of antibacterial and antifungal activity against *Staphylococcus aureus*, *Micrococcus sp.*, *Bacillus subtilis*, *Bacillus thuringensis*, *Escherichia coli*, *Klebsiella pneumonia*, *Salmonella typhi*, *Proteus mirabilis* and the yeast *Candida albicans* [32]. Interesting antiviral activity had been reported and associated with tannins for the high antiretroviral activity [33].

Leaf juice of *Kalanchoe lanceolata* is reported to treat sore and itching eyes and other *Kalanchoe* species are used to treat ailments such as infections, rheumatism and inflammation [34]. *Ficus natalensis* leaf latex is used to treat cataract [35] and for cattle treatment with regard to blindness, conjunctivitis and related ocular infections [25]. Similarly, latex of the related species *Ficus thorningii* is used as eye drops for eye wound treatment [19].

Palm oil obtained from *Elaeis guineensis* is rich in natural carotenes as well as tocopherols and tocotrienols that are normally converted into vitamin A in the body when taken orally [36]. The oil is known for faster healing of bruises, sunburn and cuts [37]. In connection to the popular use of palm oil as eye drops to improve vision among the Manyema tribe, studies to confirm its efficacy and mechanism of action(s) is worth undertaking. *Swietenia macrophylla* is an endangered species but widely used in folk medicine to treat various diseases. It has shown several pharmacological activities *inter alia*, antimicrobial, anti-inflammatory, antiviral, anticancer and antitumor activities [38].

This work reports the use of *Solanum lycopersicum* leaf juice for treatment of cataract and visual improvement. In Australia it used for unspecified eye problems [39]. Leaf decoction taken orally is useful in optic nerve and eye weakness [40]. The observed leaf juice pH was 5.3 is too acidic for the application into the eyes. Unpublished data from Mbeya region, Tanzania associate application of leaf juice with blindness in that locality. From the same genus, we report about *Solanum tuberosum* sap for improvement of the poor vision. This may be linked with the previous report on the potato pulp claimed to reduce the inflammation of the veins that arise under the eyes [41] and is in agreement with the anti-inflammatory effects of potato glycoalkaloids [42]. Despite the mentioned benefits, lack of sterility, is likely to be the source of microbial introduction leading to eye infection.

Table 3 Recorded non herbal Traditional Eye Medicines used by the Manyema tribe.

Product	Scientific name	Swahili name	Preparation and Administration	Eye disease or condition
Crude salt	Sodium Chloride (Unrefined)	Chumvi ya mawe	1-2 teaspoons is raw salt is dissolved in 250 ml. of clean water.	Red eyes
Lizard droppings	-	Mavi ya mujusi	Powdered lizard's excreta is applied directly to the eyes. The treated eyes should remain closed for a minimum of one hour. The treatment is repeated once daily until the cataract disappears.	Cataract
Snail shells	Molluscs	Gamba la konokono	The shell's powder is used for treatment of cataract	Cataract
Python's excreta	-	Mavi ya chatu	Powdered python's excreta is applied directly to the eye. The treated eye should remain closed for a minimum of one hour. The treatment is repeated once daily until the cataract disappears.	Cataract.

Table 4 Awareness on Risks of Traditional Eye Medicine.

Risks/Consequences	Response	Percentage
Pain after administration	2	10%
Low vision	1	5%
Blindness	4	20%
Not aware	13	65%

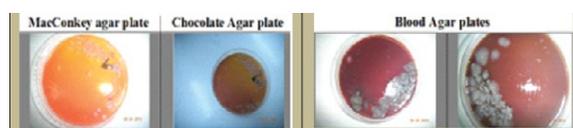


Figure 5 Plates showing microbial growth.

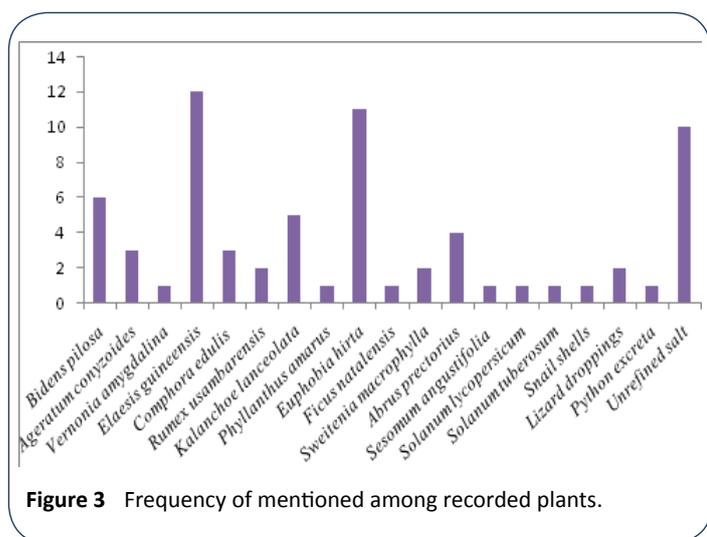


Figure 3 Frequency of mentioned among recorded plants.

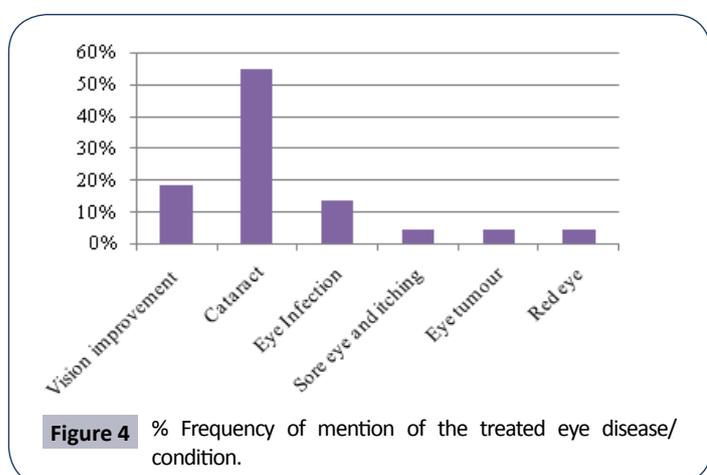


Figure 4 % Frequency of mention of the treated eye disease/condition.

In the Indian Ayurvedic system of medicine *Phyllanthus amarus* is used for treatment of various diseases including ophthalmopathy. The extracts and compounds isolated from *P. amarus* showed a

Table 5 pH of Traditional Eye Medicine Products.

Plant/Product	Extraction	pH
<i>Vernonia amagdalina</i>	Extract	5.61
<i>Bidens pilosa</i>	Extract	5.21
	Extract (1:40 dilution)	5.7
<i>Ageratum conyzoides</i>	Extract	5.3
<i>Commiphora edulis</i>	Extract	5.6
<i>Rumex usambarensis</i>	Sap	2.5
<i>Solanum lycopersicum</i>	Sap	5.7
Palm oil (local market quality)	Unaltered	4.91
Palm oil and isotonic solution	1:1 (V:V)	4.54
Palm oil and Water	1:100	4.78
Distilled water	Pure	6.81
Unrefined salt	0.9 g in 100mls water	6.6
Isotonic solution	0.9 g in 100mls water	6.57

Table 6 Preliminary identification Microbes in the lizard droppings.

Bacteria	Gram positive bacteria: <i>Streptococcus</i> species, <i>Bacillus</i> species <i>Staphylococcus aureus</i>
	Gram negative bacteria: <i>E. coli</i>
	Fungi Yeast and molds: <i>Candida albicans</i> , <i>Aspergillus</i> species

wide spectrum of pharmacological activities including antiviral, antibacterial, anti-inflammatory, antimicrobial etc. [43]. The leaf juice of another reported plant *Sesamum angustifolia* is used as eye drops and lubricant in Zimbabwe [44]. Supporting our report on *Rumex usambarensis*, the plant is also used as eye drops in other countries of Africa [45]. In addition to humans application, the fresh leaf juice is used for cattle eye diseases including eye filariasis and malignant tumour [20]. Related species had shown antimicrobial activities e.g., *Rumex nepalensis* that showed significant antibacterial activity [46] and *Rumex cypricus* fruits reported to have antiviral activity [47]. Finally, is the plant *Vernonia*

amygdalina whose leaf extract showed antibacterial activity against *Staphylococcus aureus*, *Bacillus cereus*, *Escherichia coli*, *Salmonella typhi*, and *Shigella dysenteriae* [48,49] though not related with cataract treatment as reported herein.

The use of salt solution as TEM is in agreement with the traditional practice where unrefined salt solution is used for washing the eyes and regarded harmless [50] or flushing of eyes with salt solution for treating conjunctivitis caused by viruses or allergies since antibiotics are not useful in such cases [51]. Furthermore, the study conducted in Tanzania among patients at the ophthalmology clinics in Dar es Salaam reported 16% of those using TEM applied salt solution [52].

In Tanzania the epidemiological data pertaining to the drawbacks of using TEMs is scanty. A study conducted in Tanzania by Foster and Johnson [53] showed 25% of corneal ulcers associated with the use of traditional eye medicines indicating the magnitude of the problem. In our study pH and microbial contamination were used to assess safety since ophthalmic products are supposed to be isotonic and sterile. Ophthalmic solutions are recommended to have the same pH as the lacrimal fluid i.e. 7.4 although pH values ranging 7 to 9 are tolerated by the eye without marked irritation [54]. The pH obtained was ranging from 2.5 to 6.57. Acidic products are not safe to the eyes as they are known to cause considerable redness and burning effects [55].

Python excreta, Lizard droppings are harmful TEM and sources of microbial contamination likely to cause infection. It is unfortunate similar products are also used as TEM in other countries, they include; a ground cowries, donkey and cow dung, human sputum, bird urine, etc. [50]. Culturing of the lizard droppings revealed contamination with Gram positive and Gram negative bacteria as well as yeast and molds. Applying this product introduces pathogenic microbes that may cause suppurative keratitis, followed by endophthalmitis and panophthalmitis leading to blindness. Keeping in mind that, TEM are

commonly used in poor countries with the majority of the patients with AIDS, microbial contaminated TEM products subject them to contract many different fungal infections of the eye [2]. Noted during the interview was lack of sterility in TEM products during preparation and packing. In case of prolonged use, the product is kept for some days until mold growth is visible with naked eyes. This is another way of contaminating TEM with pathogenic microorganisms.

Due to unawareness on the negative health risks associated with TEM traditional healers prefer using substances that cause pain and irritation. The effects are considered as temporary and painful medications in particular as therapeutically effective. TEMs causing pain are likely to bring great damage to both extraocular tissues and/or intraocular tissues of perforated eyes [3]. The reported case from Nigeria where a 39 old man suffered from ocular discomfort and eventually blindness after applying the raw cassava extract in eyes [56] is a good example to disqualify such thinking.

Conclusion

Majority of TEMs reported in this study are from botanical sources. Waste products from animals normally contaminated with pathogenic microbes are also used. 65% among the information providers were unaware of the risks associated with TEMs use. Pain experienced does not worry majority of the information providers although ignoring such complains subject users to health risks of eye damage. Sterility which is a vital aspect for ophthalmic products is lacking, traditional healers need to be informed on the importance of this aspect. All samples whose pH was determined were acidic in nature; a state that is not safe for the eyes. Since TEM is a common practice in Tanzania and other developing countries, there is a need to educate the public on this situation so as to rescue the users from blindness. On the other hand, scientific studies are essential to identify bioactive compounds and develop safe products.

ANNEX: QUESTIONNAIRE FOR ETHNOMEDICAL STUDY ON TRADITIONAL EYE DISEASES/CONDITIONS

1. Source of information:
 - i) Name of traditional healer/ herbalist/ others
 - ii) Age and education level:
 - iii) Sex:
 - iv) Date:
 - v) Address:
 - vi) Level of education:
 - vii) Tribe:
2. Do you treat any eye diseases/condition? Yes/No.
3. If yes, what are they?
4. Which of the mentioned diseases/condition do you treat and have obtained positive results?
.....
5. Which plant(s) and plant part(s) do you use?
.....
6. Do you use a one or a mixture of plants in treating your patients?
7. Besides plant material(s) do you use other products like minerals or animal products? Yes/No.
.....
8. If yes what are they? (Vernacular names):
9. Do you have any specific time/season for collection and storage conditions for you plant material?
10. How to you prepare your medicine? (e.g. soaking/boiling in water, powdering, juice, latex etc.)
.....
11. How do you administer your medicine to your patients (e.g. orally, topical application, eye drop etc.):
12. What amount/quantity of medicine do you administer to your patient at one time?
.....
13. How many times per day is the medicine to be taken?
14. With regard to the amount of medicine given, does the age/ weight matter? Yes/No
15. If yes, how do you determine the amount to be given to your patients:
16. How long does the patient have to take the medicine?
17. Are you aware of any side effect (madhara) such as blindness that can be caused for using your medicine?
.....
18. Do make any follow - up of your patient to see if they fully recovered?
.....
19. Are you willing to show me the plant(s) so that we can carry out some scientific research to confirm their efficacy.
Yes/No
20. If No, what reasons do you have for that? If Yes, what are your future expectations from scientific findings:

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