Evaluation and Application of Anti-Tick Natural Products Used by the Bukusu in Livestock Health Management in Bungoma District, Kenya.

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Ethnoknowledge of Bukusu community on livestock tick prevention and control in Bungoma district, western Kenya

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ABSTRACT

Ethnopharmacological relevance: To date, nomadic communities in Africa have been the primary focus of ethnoveterinary research. The Bukusu of western Kenya have an interesting history, with nomadic lifestyle in the past before settling down to either arable or mixed arable/pastoral farming systems. Their collective and accumulative ethnoveterinary knowledge is likely to be just as rich and worth documenting.
Aim of the study: The aim of the present study was to document indigenous knowledge of the Bukusu on the effect of livestock ticks and ethnopractices associated with their management. It was envisaged that this would provide a basis for further research on the efficacy of these practices that could also lead to the discovery of useful tick-control agents.
Materials and methods: Non-alienating, dialogic, participatory action research (PAR) and participatory rural appraisal (PRA) approaches involving 272 women and men aged between 18 and 118 years from the Bukusu community were used.
Results: Ticks are traditionally classified and identified by colour, size, host range, on-host feeding sites, and habitat preference. Tick-associated problems recognised include *kamabumba* (local reference to East Coast fever, Anaplasmosis or Heartwater diseases transmitted by different species of livestock ticks) and general poor performance of livestock. Traditional methods of controlling ticks include handpicking, on-host use of ethnobotanical suspensions (prepared from one or more of over 150 documented plants) to kill the ticks and prevent re-infestation, fumigation of infested cattle with smoke derived from burning ethnobotanical products, burning pastures, rotational grazing ethnopractices, and livestock quarantine.
Conclusions: The study confirms that the Bukusu have preserved rich ethnoveterinary knowledge and practices. It provides some groundwork for elucidating the efficacy of some of these ethnopractices in protecting livestock from tick disease vectors, particularly those involving the use of ethnobotanicals, which may lead to the discovery of useful ant-tick agents.

1. Introduction

Bungoma district is located in western province of Kenya between latitude 00°28′ and 10°30′N and longitude 34°20′ and 35°15′E (Fig. 1). It occupies an area of 3074 km^2 on the southern slopes of Mt. Elgon (Fig. 1), with a population of about 2 million people. It lies in an agro-ecological zone stretching from Tropical Alpine Zone to Lower Midland Zone with tea, wheat/maize, pyrethrum, coffee, sunflower, maize, sugarcane and cotton plantations (Martina, 1998, 2001). The predominant off-farm vegetation patterns are riverine forests, rocky forested hillsides, hedgerows, wooded grassland relicts, woodlands or colline forest relics and tree groves whereas the noticeably tree rich on-farm management units are home gardens, homesteads, live fences, coffee and banana groves and annual cropping fields (Martina, 2001).

The Bukusu community (also known as *Babukusu* and/or *Bakitoshi*) represents one of 19 ethnic groups (sub-tribes) of the Luhya people of interlacostrine Bantu group of East Africa (Central Bureau

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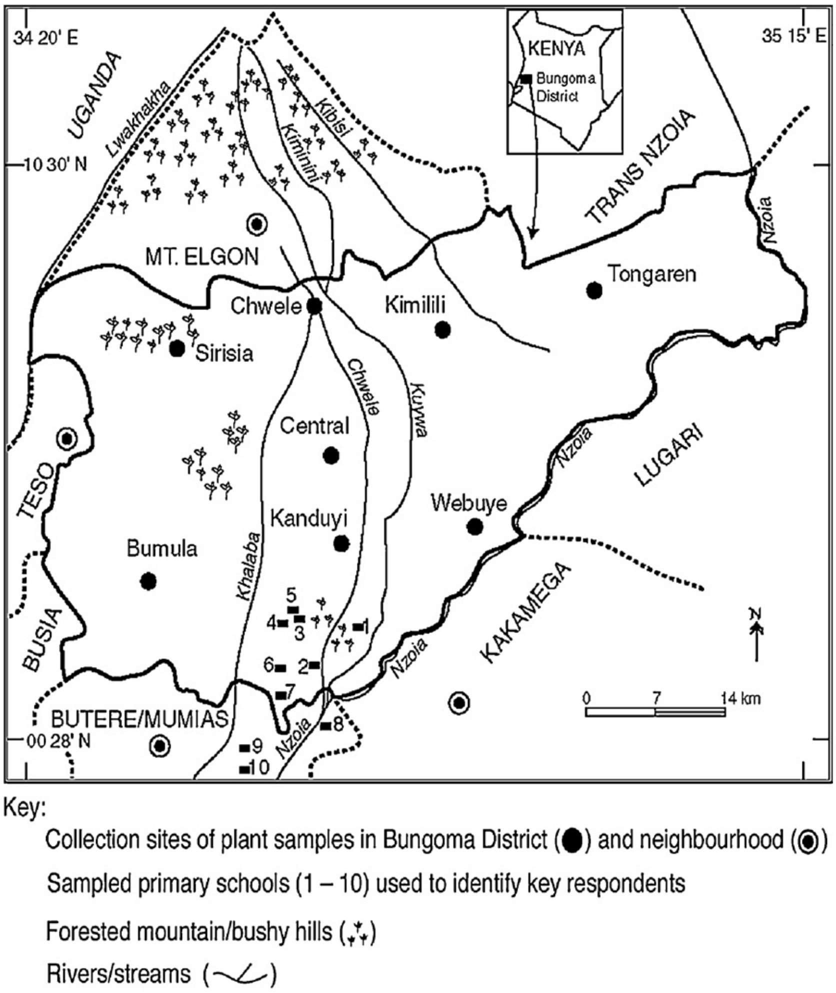

Fig. 1. The location of Bungoma district in Kenya. Note the positioning of the district along the southern slopes of Mt. Elgon.

of Statistics, 1996) and are dominant in the Bungoma district (Fig. 1). Although arable farming is now the main occupation of the community, livestock farming is still held in high esteem and livestock products are highly valued in all traditional and cultural practices. To date, research on ethnoveterinary knowledge has focused mainly on pastoral and/or nomadic communities (ITDG and IIRR, 1996). Settled or mixed farming communities such as the Bukusu have been neglected and their ethnoveterinary practices are at risk of being lost (Kofi-Tsekpo and Kioy, 1998). Almost all of these communities, the Bukusu included, largely led nomadic lifestyle before settling down to either arable or mixed arable/pastoral farming systems (Makila, 1978). Their collective and accumulative ethnoveterinary knowledge is likely to be just as rich as that of nomadic communities (ITDG and IIRR, 1996).

In this study, we discuss the results of a survey conducted to document and analyse anti-tick ethnoveterinary practices of the Bukusu community in western Kenya. The study demonstrates an important link between plant biodiversity and livestock healthcare ethnoknowledge systems in the Bukusu community.

1.1. Bungoma district and the Bukusu community

Bungoma is a district with a wide range of ethnic diversity of populations in western Kenya (Fig. 1). This is partly due to its establishment as the last stop on the Kenya–Uganda railway in the 1920s, rapidly growing into a complex commercial and colonial and post-colonial administrative centre along the railway line (Port, 2000). However, the majority of the residents of Bungoma still belong to the indigenous Bukusu, who have lived near the border with Uganda along the southern slopes of Mt. Elgon ever since their migration from the Sudan/Egypt border during the second half of the last century (Were, 1967; Makila, 1978). The Bukusu community comprises 16.35% of the Luhya population (Central Bureau of Statistics, 1996). Their cultural and traditional life has been heavily shaped in time and space by immigrants of both Bantu and Nilotic origin (Makila, 1978; Wandibba, 1998; Roach, 2003). Members of the Bukusu community hold livestock keeping and livestock per se in high esteem, as livestock is used as a measure of one's wealth, power, authority and societal class status (Kenya National Archives, 1954; Nasimiyu, 1985; Nangendo, 1994). Moreover, the animals' blood and meat are highly valued in different traditional and cultural practices, including funeral ceremonies (where cattle skin is used as a coffin), circumcision, agricultural festivals, bride wealth exchanges, and during cleansing ceremonies and sacrifices to appease the spirits (Were, 1967; Makila, 1978). Plants have been highly valued for their nutritional and economic value, as well as in ethnomedicinal and veterinary applications, traditional education and socio-cultural life (Martina, 1998; Mann, 2001; UNEP World Conservation Monitoring Centre, 2003). For centuries, plants have been part of the Bukusu's land-use system and agro-ecological layout. This is reflected in the practice of selective clearing of trees, forests, and bushes, leaving trees and woodlots that are perceived to be useful to grow in the arable fields for fodder, timber, food, medicines, windbreaks, fences/boundaries, supporting crops, shrines, etc. (Martina, 1998; Mann, 2001). A significant proportion of Bukusu poems, riddles, and proverbs touch on the symbolic value attached to indigenous plants, in daily life experiences as well as in philosophical reflections, which elders considered to be essential skills to equip growing children (Makila, 1978; Wandibba, 1998; Mweseli, 2004). Some plants were not put to regular use, but were specifically preserved for ancestors or for certain functions and cultural occasions (Martina, 1998). A great deal of information regarding the use, management, and socio-cultural roles of plants has been preserved by the older generation and this has been considered a useful basis of community-specific conservation strategy (Juma, 1989).

Although the Bukusu continue to maintain a strong attachment to their culture, traditions and superstitions (Corbitt and Wanyama, 2004), there is evidence of gradual erosion of their ethnoscientific knowledge base and ethnopractices (Wandibba, 1998; Roach, 2003; Corbitt and Wanyama, 2004). This has risen from a combination of factors. First, as sedentary pastoralists, they have had more time for arable farming at the expense of their original livestock farming. Early in the last century, they lived mainly on millet, cassava and livestock, practising mixed farming with arable farming bias. Now they have diversified to maize, beans, potatoes, bananas and cabbage for food, and sugarcane, cotton, tobacco and sunflower for cash. This expanded range of arable farming activities is currently dominating land use and threatens the survival of grasslands, woodlands, bushes and forests, the source of ethnopharmacologically active agents upon which ethnoknowledge is based (Biosafety News, 2002). Other factors contributing to the erosion of ethnoknowledge of the Bukusu include: (1) untimely deaths of persons with ethnoknowledge without this being documented, (2) extinction of specific plant and animal species and ritual practices, (3) encroachment of development and modernization on cultural and traditional life, (4) adoption of lifestyles and education systems that do not embrace ethnoknowledge, (5) shifting bias in religious beliefs, (6) perception of certain socio-cultural practices as unhygienic and satanic, and (7) cost- and health-related risks involved in certain socio-cultural practices. The result is that either little or no information is being passed on to the next generation (Wandibba, 1998; Roach, 2003; Corbitt and Wanyama, 2004).

1.2. The significance of archiving and valuing ethnoveterinary knowledge

The pastoral lifestyle was initially the mainstay of the Bukusu economy before arable farming overtook it, as evidenced by the rich archaeology, nomadic and pastoral vocabulary, traditions and socio-cultural anthropology of the Bukusu people (Makila, 1978). The community has a long history of ethnoveterinary practices in curing, preventing, controlling and managing livestock diseases and vector-borne problems. A rich set of anti-tick ethnoveterinary practices has evolved to avert tick-related losses and promote livestock survival in a tick-prone environment (Lewis, 2001). These ethnopractices have withstood the test of time and have a number of advantages over the modern equivalents. They integrate different health-based tactics that are cost-effective, easily applied, locally suitable, easily accessed, and environmentally friendly (Mathias-Mundy and McCorkle, 1989; Hamburger et al., 1991; Martin et al., 2001). Moreover, these community-specific ethnopractices are an integral part of the people's daily lives and are based on experience gained over centuries and adapted to local culture and environment. Ethnoknowledge is largely transmitted orally through demonstrations, songs, poems, drawings, paintings and stories from generation to generation (Kokwaro, 1993; Mweseli, 2004), and is only sketchily recorded in books (Abegaz and Demissew, 1998). In certain communities, the collective knowledge is believed to be owned by the ancestors and kept under the custody of presently living elderly men and women whose mortality can lead to loss of potentially useful information.

This study was undertaken to survey, generate and document a database of anti-tick ethnopractices and knowledge amongst the Bukusu community. This resource may provide useful information for further scientific research, which can clarify the relative efficacies of different products and ethnopractices in controlling ticks and diseases they transmit (Alghali, 1992). In so doing, value-added knowledge can be provided back to the community in the form of useful products and services, and help ethnopractitioners gain incremental confidence in their own ethnoknowledge. This may help establish active links with the modern science network for sustainable use and management of local environment and its resources for improved animal productivity and livelihood.

2. Materials and methods

Before the start of this project, official permission was sought from the Government of Kenya (GOK) through the ministries of Education, Internal Security, Livestock Development, and the Department of Culture and Social Services. Through the ministry Education (Bungoma District Education Office) permission was sought to use upper primary school pupils (from standard 6 to 8) to identify and access some of the key respondents, particularly, ethnopractitioners (para-veterinarians). Prior informed consent was also sought from individual key respondents through the local administration in the office of the president, GOK.

2.1. The source of anti-tick ethnoknowledge

Anti-tick ethnoknowledge was surveyed from 13 different sources in the study area. The survey involved a sample of 272 key respondents of mixed sex and age (18–118 years old) who were identified through a number of sources, including the upper primary school questionnaire method. The ages of key respondents were confirmed from their: (1), birth certificates and (2), national Identity Cards (ID)/passports in Kenya. The sources included primary school pupils, who provided leads to key respondents, and local school teachers/education officers who helped select candidate schools, gave permission to distribute and explain the questionnaire to pupils, and helped to clarify the information being sought where possible. Local veterinarians, para-veterinarians, and agricultural extension officers responsible for providing extension services to farmers were also able to identify some key respondents. We also attended public meetings organized by local administrators to identify potential respondents. Local livestock traders and dealers, as well as individual livestock farmers, contributed their knowledge on tick control based on their professional and economic activities, whereas community/village/clan leaders/elders had information on communal tick control and management programmes funded by the Government and NGOs. Local ethnopractitioners, including traditional healers/herbalists/spiritualists/ritualists, formed a particular subset of knowledgeable people from whom key respondents were drawn. Other sources of data included NGOs such as the Council for Human Ecology-Kenya, the German Development Service and the Bungoma Indigenous Trees Conservation Club, which had prior experience and close interaction with local livestock farmers and had earlier documented part of their ethnoveterinary knowledge (Martina, 1998, 2001; Mann, 2001; Buteyo, 2004). Centres known for preparation of a local brew (locally known as *Busaa*) were the most important meeting points of old men and women and formed important venues for the discussion sessions. Secondary data were obtained from the Bungoma District Veterinary Office (DVO) records on livestock tick prevention and control. All these groups were consulted because each was associated with a specific aspect of ethnoknowledge relevant to the study.

2.2. Key steps to accessing anti-tick ethnoknowledge

2.2.1. Constitution of a sampling group

The first step was the generation of a purposive sample of key respondents from the 13 sources mentioned above. Key respondents were local experts or people in the study area with knowledge of a particular issue or technology of interest (in this case, anti-tick ethnoknowledge) (Etkin, 1993; Waters-Bayer and Bayer, 1994; McCorkle et al., 1997). They have a more extensive understanding of local social and veterinary-cultural systems than others in the community. A purposive sample referred to a particular subset of knowledgeable people in the area of traditional control and management of livestock ticks. Intensive and extensive collaboration and interaction with these key respondents was considered to be an effective research strategy (Oakley, 1981; Warry, 1992). A random sample would not have been appropriate for this type of socio-cultural set-up, as not everyone sampled randomly may have the required knowledge (Etkin, 1993; Martin, 1996).

2.2.2. Local primary school pupils: the questionnaire method

This was the main method used to identify key respondents and obtain local and anti-tick ethnoknowledge from largely illiterate people. The use of children to collect such information has had precedents in the field (Lans and Brown, 1998; Lans, 2001), but there is very little published literature on this method (Campbell, 1994).

From a list of local primary schools at the District Education Office (DEO) in Bungoma, 10 schools were selected for participation in the survey studies. The selection of schools was based on variables such as rurality vs. urbanization, ethnicity, gender, on-going teaching activities and geographical spread of the schools within the study area. In selected schools, pupils were visited and the basics of participatory research (Baldwin and Cervinskas, 1993) were explained, and the importance of their contribution was stressed. Pupils were asked to interview parents, guardians, relatives, friends, neighbours, etc. about traditional practices of tick control and to fill the answers of the respondents in a structured questionnaire. The questionnaire consisted of 15 questions: (1) the location where questionnaire is administered, (2) identity of the person being interviewed, (3) type and number of livestock kept by the person interviewed, (4) what ticks mean to the livestock farmer, (5) the kind of tick-related problems experienced by the livestock farmers, (6) responses to tick-related problems, (7) association between ethnoremedies and identified tick-related problem, (8) tick ethnocontrol remedies based on ethnobotanicals, (9) how these ethnobotanicals are harvested, processed, and applied, (10) when do livestock farmers apply their ethnoremedies, (11) mode of application of these ethnoremedies, (12) monitoring of cases after application, (13) any observations made regarding side-effects of these ethnoremedies, (14) any collaboration sought during tick prevention, control and management, and (15) personal observation of tick infestation made by the interviewer in the candidate livestock herd of the interviewee.

From the questionnaires, key respondents were identified based on whether the essay of the primary pupils and/or their responses indicated that a respondent had potentially useful information on anti-tick ethnopractices. This method was considered very useful and robust because it reduced the following sources of bias: (1) modeling bias, which was the projection of the interviewer's views on to those studied, (2) strategic bias, which was the expectation of benefits by the subject, (3) familiar relationships between interviewer and interviewee (children and parents/neighbours) which would reduce resistance to questioning but could lead to rote answers and outsider bias (Sutton and Orr, 1991). These three preconceived notions would therefore lead to poor selection of key respondents (Etkin, 1993; Waters-Bayer and Bayer, 1994).

2.2.2.1. Personal interviews with selected key respondents. The third step involved interviews/discussions with the selected respondents. These were guided exchanges, semi-structured by a mental checklist of relevant points to confirm the validity of the information in the questionnaires.

2.2.2.2. Collection of plant specimens. Following a personal interview with the selected key respondents, a field trip was made to identify and collect the listed plant specimens and/or ethnobotanical products. The specimens were harvested, prepared, packaged and stored according to the herbarium rules and regulations until transported to the University of Nairobi Herbarium, Kenya for botanical identification using voucher specimens and according to the Hutchinson system of plant taxonomy based on the plants' probable phylogeny. While in the herbarium, further non-experimental studies were also conducted. For each plant species collected from the field, a voucher specimen was prepared and doposited in the Herbarium of the University of Nairobi, Kenya.

2.2.3. Focus-group discussions

The fourth step involved holding joint focus-group discussions with all stakeholders. In the study area, 11 focus-group discussions were formed, each comprising between 15 and 20 stakeholders based on their geographical location, ethinicity, conventional profession, economic activities, age, interest and practices of ethnohealth. A focus-group discussion was an exploratory discussion designed to obtain perceptions on a specific theme from a target group in a non-threatening environment (Krueger, 1988; Etkin, 1993). This kind of group interaction produced data and insights that would have otherwise been less accessible (Morgan, 1988). The interaction between all stakeholders formed the collaborative and non-alienating, dialogic, participatory action research (PAR) and participatory rural appraisal (PRA) approaches utilized to build a consensus and verify that the information from other interviewees was accurately recorded (IIRR, 1994). The group interaction also minimized the objectification of the respondents as the only source of data (Oakley, 1981). One purpose of this form of collaborative research was to shift decision making based on theoretical knowledge to the community, rather than conceding this role to the conventionally trained expert (Warry, 1992).

2.2.4. Collection of secondary data

The fifth step involved the collection of secondary data on anti-tick plants and ethnopractices from the District Veterinary Office (DVO) in Bungoma. This was followed by an extensive literature search on the taxonomy of the plant specimens collected and their ethnobotanical applications from the internet, livestock research institutions, non-governmental organizations (NGOs), East Africa and University of Nairobi herbaria libraries and laboratories.

2.2.5. Enumerations of documented plants with effects on livestock ticks

An extensive list of plants used as sources of ethnobotanicals, including their scientific and vernacular names, growth habits, family names and other information about their usage was prepared (Appendix 1). The plants are arranged according to their family names in an alphabetical order. Family taxonomic ranks and/or units are more stable than lower taxonomic levels such as genera and species and facilitate identification of new species particularly during field surveys (Sahney and Benton, 2008; Sahney et al., 2010). Because of the ethnic diversity amongst communities living in the study area (Bungoma County), more than one vernacular name may be used to refer to a particular plant species and/or any other related plant species within a given genus or family. Two or more different plant species were found to have the same vernacular name depending on their geographical locations, uses, and associated ethnic group(s). In Appendix 1, the classification of the plant specimens and/or ethnobotanical products into the column of growth life forms and/or habits was based on the definition and description of Yumoto et al. (1994).

3. Results and discussion

3.1. Local primary school pupil – the school questionnaire method

From the questionnaires administered to more than 300 pupils in 10 selected schools (Fig. 1), about 250 well-filled questionnaires were collected for evaluation of the anti-tick ethnoknowledge and 200 persons in the questionnaires were selected to form the key respondent team. The school method was instrumental in allowing the participation of a cross-section of local residents in the research survey. This helped us to obtain much useful information and ensured that plants with more than one vernacular name were correctly identified and their uses accurately recorded. In addition, it allowed a considerable number of illiterate individuals, ethnopractitioners and other key knowledgeable respondents living in remote areas to be reached and to meet the survey targets (Sutton and Orr, 1991). Many of these people gave useful leading viewpoints as shown in Tables 1–4. Nevertheless, this approach was also realized to provide a bridge between elders and school pupils in terms of transmission of ethnoknowledge between generations. This had another great contribution in this study, because school schedules do not add local and indigenous knowledge into their curiccula and school pupils rarely appreciate this knowledge from their illiterate parents, guardians, relatives and neighbours. But when they do provide such useful information for the research and it is well appreciated, the pupils recognise how elders of all ages kept and continue to keep important knowledge.

3.2. Interviews with key respondents and focus-group discussions

Focus-group discussions were instrumental in enabling us to transcribe the local Bukusu language accurately, especially with regard to local plant names and their meanings. The series of discussion sessions helped to harmonise amongst interviewees the use of multiple names referring to one plant and vice versa. A consensus was thus built on the identity of plants used locally, their local names, processing methods and uses. This facilitated the selection of the anti-tick plants that merited further scientific investigation. The experience with the respondents highlighted need for conventionally trained scientists to: (1) foster communication with different respondents and take time to establish a strong, trusting relationship based on openness and cooperation, (2) demonstrate respect for the ownership, source and origin of ethnoknowledge and the needs and sensitivities of its holders, and (3) undertake to provide value-added knowledge back to the community in the form of useful products (such as reports) and to share equitably with the key holders any benefits arising from the use of their ethnoknowledge. Specifically, ethnopractitioners need to be made aware of legislation protecting their ethnoknowledge base through relevant state ministries and possible threats from biopiracy.

3.3. Responses to questionnaires and results from the discussion groups

Despite initial constraints in accessing anti-tick ethnoknowledge, there was sufficient goodwill amongst most participating stakeholders to ensure substantial success in the research process.

Table 1a
Tick description by colour, size and life cycle type in relationship to on-host feeding site and habitat preference as a percentage of the responses ($n = 987$).[a]

Tick description	Site preference of the described ticks											NMAS	% total
	On host animals									Habitat			
	Ear	Head	Dewlap/neck/brisket	Forelegs	Belly	Back/body sides	Hind legs	Tail/anal region	Udder/scrotum	Bush	Grass		
Colour													
Red	5.37	1.32	2.43	1.52	0.51	1.11	1.62	2.74	3.34	0.00	0.51	0.30	20.77
Brown	5.88	1.93	3.34	2.13	0.61	1.01	2.23	4.05	4.56	0.00	0.30	0.30	26.34
Blue	6.08	2.13	1.95	2.03	0.61	1.11	2.13	3.55	4.76	0.00	0.41	0.10	24.86
Black	0.61	0.10	0.20	0.10	0.00	0.00	0.10	0.41	0.41	0.00	0.00	0.10	2.03
Multicolour	1.11	0.00	0.20	0.30	0.00	0.20	0.41	0.10	0.10	0.00	0.10	0.10	2.62
Grey	0.10	0.00	0.00	0.10	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.10	0.40
Yellowish	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10
Size													
Small	1.32	0.10	0.51	0.41	0.20	0.10	0.51	0.30	1.01	0.00	0.00	0.41	4.87
Big	1.52	0.10	0.30	0.41	0.30	0.10	0.41	0.30	1.22	0.00	0.00	0.30	4.96
Life cycle type													
1-Host tick	0.71	0.41	0.30	0.00	0.00	0.00	0.20	0.61	0.51	0.20	0.20	0.10	3.24
2-Host tick	1.52	0.51	0.51	0.20	0.20	0.00	0.30	1.11	0.71	0.20	0.20	0.10	5.56
3-Host tick	1.11	0.51	0.41	0.10	0.20	0.00	0.20	0.61	0.71	0.10	0.10	0.20	4.25
% total	25.43	7.11	10.15	7.30	2.63	3.63	8.21	13.78	17.33	0.50	1.82	2.11	100.00

NMAS, no mention of association with any site of either host or habitat.
[a] More than one response was received from each of the 272 respondents.

Table 1b
Observation records by interviewees on the individual animals of their herds ($n = 233$).

Categories of observations	No. of herds observed	Mean no. of animals per herd	% of interviewees who made an observation
Many ticks (>∼20 per animal)	19	11 ± 1	8
Few ticks (∼5 to 20 per animal)	21	10 ± 2	9
Very few ticks (<∼5 per animal)	16	8 ± 1	7
No tick was observed on any animals in the candidate herd	37	7 ± 1	16
No observation was made on individual animals in the candidate herd	140	10 ± 1	60

From the survey studies, it became apparent that although for a long time (since the coming on of conventional methods) the role of ethnoveterinary medicine and its potential contribution to livestock health have been neglected (Kofi-Tsekpo and Kioy, 1998), a large proportion of Bukusu people still depend on it for the welfare of their livestock. This was evidenced by the complex composition of the purposive sample ($n = 272$) of key respondents, and their voluminous and high-quality responses (Tables 1a and 1b). Even more important was the commitment and determination of all the stakeholders to have their local anti-tick ethnoknowledge recognised, documented and evaluated (Table 2). They also demonstrated interest in the results of scientific research on their ethnoknowledge and in any improvements that may be developed.

From discussions during one of the focus-group sessions held in Bungoma district under the auspices of Bungoma Indigenous Trees Conservation Club (BITCC) and Bungoma Herbalists Association (BHA), it was evident there was concern that the community could lose its rich socio-cultural heritage evidenced by lack of generalized use of this ethnobotanical knowledge across the Bukusu community (Wandibba, 1998; Corbitt and Wanyama, 2004; Buteyo, 2004). There was thus a consensus that efforts to conserve ethnobotanical knowledge of the Bukusu be intensified. Throughout the colonial era, indigenous knowledge was equated with witchcraft and wholly dismissed and actively suppressed. However, the use of this knowledge base continued in a clandestine manner to avoid punishment by the colonial administration, and only after independence did trends towards strengthening national and socio-cultural identities began to re-emerge (Mubukusu, pers. comm.). Succeeding governments encouraged integration of indigenous knowledge into existing health services. However, there was no clear legal framework for its operation. The conventially trained doctors and various religious faith groups often took the advantage of lack of legal recognition of indigenous knowledge to denounce it. This attitude facilitated exploitation of ethnobotanical information without due recognition of indigenous source. Indeed, during our study, Bungoma ethnopractitioners complained about malpractices and biopiracy by researchers involved in bioprospecting, some of whom reported their findings without giving the community appropriate recognition. This behavior has caused fear amongst ethnopractitioners and has contributed to their reluctance to share indigenous knowledge with foreigners. It also accounts for a discrepancy between knowledge availability and its use, as well as mistrust amongst stakeholders (Simon, 1998; Hempel, 2002). It is hoped that the present study, based on participatory research, will make some contribution towards reinforcing ownership and recognition of indigenous ethnobotanical knowledge amongst the Bukusu. Moreover, local community approval and active involvement in projects conducted by researchers may help to restore confidence of ethnopractitioners and provide insights into factors that underlie conservation and management of biodiversity and local ecosystems in rural settings.

3.4. Associated tick and tick-related problems

The Bukusu community appears to be well aware of livestock ticks and associated tick-borne problems. The community participants involved in the survey described to the locals the nature of ticks and the objectives of the study in the layman's language that was well understood. From their responses, it was clear that the interviewees consistently recognised the parasitic (on-host) tick stages, which were more commonly seen than the non-parasitic stages (off-host) of ticks (Tables 1a and 1b), as well as the intensity of infestations (Table 1b).

Results from Table 1b correspond to tick-related problems identified in Table 2. This confirms that every domestic animal hosts a variety of tick species. Ticks were traditionally recognised by their colour, size, type of life cycle and on-host feeding sites and habitat preference (Table 1a). A considerable proportion of local people were familiar with the locations of different ticks on livestock, including ears, udder, scrotum, tail/anal region, dewlap/neck, between legs and head. They also recognised tick and tick-related problems (T&TRPs) as serious constraints to livestock production in the study area (Table 2). The description of ticks on the host animals

Table 2
Tick-borne diseases and/or related problems identified by livestock farmers as percentage of the respondents ($n = 272$).

Tick-borne diseases and/or related problems	Equivalent *Bukusu* name(s) used to describe tick-borne diseases and/or related problems	% respondents identifying the problems
Livestock diseases per se without specifications	*Bulwale bwechikhafu*	16.50
Anaemia	*Kamafuki khupungukha*	13.97
Poor performance of the animals	*Fayida yechikhafu embii*	12.87
Inflicted wounds and damage to skin	*Bulwale bwa kamakonjo khwisielo*	12.13
Irritation to animals	*Khukhwiyakala*	9.56
East Coast fever (ECF)	"*Kamabumba*"	7.72
Deaths	*Lifwa*	6.62
Weakening animals	(*Búúlui*) (*Butekhele*) *Khukhaywa kamani*	5.88
Anaplasmosis	"*Kamabumba*"	2.94
Heartwater	"*Kamabumba*"	2.57
General economic losses	*Asarah khulondekhana nende bulwale bwechikhafu*	2.57
Fever	*"Walusee"*	1.84
Gall sickness (disease)	–	1.25
Non-respondents	*Sibamanyilekhwo bulwale bwechikhafu tawe*	3.58

No appropriate/equivalent Bukusus name/statement describing the tick-borne disease and/or related problems.

(Table 1a) together with the problems caused by ticks (Table 2) reflected the different tick species that occurred in the study area.

Ticks are known to cause a number of serious livestock problems in the study area (Table 2). Descriptions of the ticks, including their predilection feeding sites on their host animals (Table 1a), were sufficient to confirm their taxonomic status to the genus level using voucher specimens from the Kenya National Museums (KNM) as *Rhipicephalus* spp., *Amblyomma* spp. and *Boophilus* spp. A majority of respondents classified ticks by their colours (77.1% of the responses), followed by type of life cycle (13.1% of the responses) and last by tick size (9.8% of the responses). However, classification by type of life cycle appears to be influenced by modern scientific knowledge. The highest number of responses identified the ear (25.4% of responses) as the most preferred site of tick attachment on the host animals (Table 1a), in all probability associated with the vector of East Coast fever, *Rhipicephalus appendiculatus*. A good proportion of respondents knew that ticks cause diseases to livestock (16.5%), poor productivity in affected animals (12.9%), death to livestock (6.6%), and some individuals (2.6%) were also aware of economic losses resulting from tick infestation in livestock populations (Table 2). The generation of ethnoknowledge through this type of interaction between community ethnopractitioners and conventionally trained scientists yielded valuable epidemiological information on historic and present patterns in livestock tick infestation and distribution (Hempel, 2002).

3.5. Ethnocontrol of livestock ticks in the community

While community-based traditional knowledge of tick control and management was not widely shared, it was apparent that ticks have been traditionally controlled and managed by a variety of methods (Table 3). These methods included: handpicking, on-host use of ethnobotanical suspensions (prepared from one or more of over 150 documented plants) to kill the ticks and prevent re-infestation, fumigation of infested cattle with smoke derived from burning ethnobotanical products, burning pastures, rotational grazing ethnopractices, livestock quarantine, predation by birds, cleaning cattle shed and burning residues believed to contain ticks and dusting of livestock with ash made from ethnobotanical products. These ethnotactics appear to be used in a complementary and integrated way, depending upon the level of tick infestations that resembles the modern integrated pest management (IPM) strategy. The ethnobotanicals were deployed in a number of methods that targeted a wide range of livestock tick species, either on-host or off-host, including pouring the suspension on the animal's body, fumigation (gaseous from ethnobotanical products directed to the animals in the cattle shed to suffocate or poison the ticks within), rubbing livestock body with ethnobotanical products, dusting livestock body with ethnobotanical products, development of tick free pastures, steaming (steam from ethnobotanical products directed to the animals in the cattle shed to suffocate or poison the ticks within) and hanging bouquet in the cattle shed to repel livestock ticks (Table 4). However, in-depth scientific studies have not been conducted to elucidate the efficacy of these ethnopractices in protecting livestock from tick disease vectors, particularly those involving the use of ethnobotanicals, which may lead to the discovery of useful ant-tick agents. These may have potential in modern integrated tick management (ITM) strategy that best fits the rural smallholder livestock farmer.

Table 3
Frequency of the ethnomethods used by respondents in tick control and management ($n = 272$).

Ethnomethods	% respondents using the ethnomethod
Handpicking	34
Ethnobotanical products (plants and plant products)	20
Pasture spelling/grazing practices	14
Burning pastures infested with livestock ticks	14
Fumigation with smoke from burning ethnobotanical products	6
Application of kerosene, magadi soda, livestock urine, soap, fish residues, cow dung and grease (alone or mixed) on cattle	3
Livestock quarantine	3
Predation by birds	3
Cleaning cattle shed and burning residues believed to contain ticks	2
Dusting of livestock with ash from ethnobotanical products	1

Table 4
Methods of deployment of ethnobotanical products ($n = 272$).

Methods of use	% of respondents using the method
Pouring the suspension on the animal's body surface	74
Fumigation with smoke from burning ethnobotanical products	11
Rubbing livestock body with ethnobotanical products	5
Dusting the body of animals with ethnobotanical products	5
Pastures with anti-tick vegetation	2
Steaming by boiling ethnobotanical products soaked in water	1
Hanging bouquet in cattle shed to repel livestock ticks	1
Other methods	1

3.6. Secondary data and documented anti-tick ethnobotanicals

In total, 154 plants were identified as being used by different communities, tribes, clans and sub-clans living in Bungoma district. An extensive literature search was undertaken to document the current status of research on the plants (Appendix 1). Some of the plant species were reported in literature to be used in ethnomedicine and other cultural activities of other communities. However, no scientific literature was uncovered for a large number of plants (about 101 plant species, particularly those species belonging to the families: Lamiaceae, Flacourtiaceae, Acanthaceae and Ebenaceae) used by the communities for their apparent acaricidal and/or insecticidal effects. For some of these documented plants, literature search was extended to taxonomically related species. A large group of other plants that were repeatedly mentioned in the survey had been investigated for pesticidal, insecticidal, acaricidal or other bioactive properties and/or constituents (Appendix 1). On the other hand, some plant species (e.g. *Cleome gynandra*), that previously had been shown to have very good acaricidal properties in laboratory studies, were mentioned only once or twice by the respondents. This presented some dilemma in selecting promising candidate anti-tick plant species for detailed follow up investigations. However, based on key respondents' information, as well as acaricidal, insecticidal, pesticidal or bioactivity information from literature, eight plant species (*Tagetes minuta* L. (029-BGM-Mwi/2002), *Tithonia diversifolia* (Hemsl.) A. Gray (015-BGM-Muf/2002), *Juniperus procera* Endl. (134-BGM-Elg/2002), *Solanecio manii* (Hook. f.) C. Jeffrey. (106-BGM-Mwi/2002), *Senna didymobotrya* (Fresen.) H.S. Irwin & Barneby (132-BGM-Web/2002), *Lantana camara* L. (043-BGM-Mwi/2002), *Securidaca longepedunculata* Fres. (018-BGM-Mec/2002) and *Hoslundia opposita* Vahl.

(133-BGM-Bul/2002) were initially selected for laboratory evaluations. Of these, two plants (*Tagetes minuta* and *Tithonia diversifolia*) were chosen for in-depth detailed scientific studies in the laboratory and the field. The results of these studies will be reported elsewhere.

Additionally, some tick ethnocontrol applications that were found in the lay literature and mentioned by some respondents but that did not emerge in a scientific literature search include the use of cow dung, cattle urine, fish residues and soap. The acaricidal and behavioral effects of these on ticks and in their control would be interesting to evaluate.

4. Conclusions

The survey of indigenous tick-management knowledge of the Bukusu community revealed a wealth of preserved knowledge on plants, plant products, and anti-tick ethnopractices associated with the traditional management of ticks by rural livestock farmers. Evidence from respondents' information revealed that some of the plants used were brought from their original area/location to Bungoma by immigrants. Some plants and anti-tick ethnopractices had very few ethnoknowledge references in the literature; perhaps, they were truly indigenous to the Bukusu community or perhaps relevant references could not be accessed. Those plants thought to be indigenous to the Bukusu community and with traditionally claimed effects on livestock ticks numbered more than 101, in families such as Lamiaceae, Flacourtiaceae, Acanthaceae and Ebenaceae etc. Ritual anti-tick practices were complex and comprised burning pastures, livestock quarantine, types of grazing practices, cleaning cattle sheds, burning or burying residues of cattle sheds, bird predation, feeding animals on natural salty soils locally called "*silongo*", and applying kerosene, soap, fish residues, cowdung, cattle urine, grease, ash, magadi soda, and sisal juices on cattle. Nevertheless, some of the local claims of acaricidal properties of the ethnobotanicals have been supported by scientific studies reported in the literature. Further elucidation of the science underlying the efficacy of these plants, plant products, and anti-tick ethnopractices may lead to the discovery of useful anti-tick agents and tactics that can be integrated in tick control and management programmes for the wellbeing of livestock industry in Africa. This may also foster wider acceptance of these ethnoremedies by different stakeholders and help restore recognition accorded to ethnopractices held in the past.

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Appendix 1. An enumeration of the documented plants and plant products used for the management of livestock ticks in the Bukusu community, western Kenya

Scientific name	Local and/or indigenous name(s)	Family name	Growth habit or life form	Frequency of mention for use	Plant part(s) used (application form)	Plant uses	References
Acanthus pubescens (Thomson ex Oliv.) Engl.	Kamarakaru	Acanthaceae	Shrub/herb	√	Leaf/stem (ash/powder/decoction)	B, C	Baerts and Lehmann (1989, 1991)
						C	Desouter (1991)
						B	Ssegawa and Kasenene (2007)
Acanthus arboreus Forssk.	Kamarakaru	Acanthaceae	Shrub/herb	√	Leaf/root (ash/powder/decoction)	B	Johns et al. (1995), Neuwinger (2000), UWMG (2003), Amer et al. (2004)
Agave sisalana Perrine ex Engelm.	Kamakonge or Kumukonge	Agavaceae	Forb (subacaulescent perennials) (succulent rosette, up to 6 feet tall (1.8 m), 6 feet spread (1.8 m))	√√√√√√√ √√√√√√√ √√√√√√√ √√√√√√√ √√√√√√√ √√√√√√√ √√	Juice/fleshy leaves (smoking-using dried leaves; leaves and stems fermented in urine and applied; leaves dried and ground to flour and applied as dust; aqueous extract made from chopped leaves and stem and applied while still fresh)	B, I	Wilcox and McGeorge (1912), Schwartz et al. (1957), Faninger and Markovic-Brisk (1960), Morton (1977), Lin (1984), Nobel and Berry (1985), Ding and Chen (1989), Zullo and Azzini (1989), Pires and Purchio (1991), Chand (1991), Xu and Xu (1993), Ding and Tian (1993), FAO (1993), Adoyo et al. (1997), Chang and Chen (1997), Assefa and Williamson (2001), Schmidt (2003a)
Aloe latifolia Haw.	Kimitiokotioko 1	Aloeaceae	Herb/shrub	√√√	Leaf/juice (aqueous)	B, T	Watt and Breyer-Brandwijk (1962), Getahun (1976), ITDG and IIRR (1996)
Aloe elgonica Bullock	Kimitiokotioko 2	Aloeaceae	Herb/shrub	√	Leaf/juice (aqueous)	B, T	Watt and Breyer-Brandwijk (1962), Getahun (1976), ITDG and IIRR (1996)
Ozoroa insignis Del. ssp. *reticulata* (Baker f.) J.B.Gillett	Kumwandanda	Anacardiaceae	Tree	√√	A milky resin, bark/root/leaf	I, B, F	He et al. (2000), Araya (2001), He et al. (2002), Nyazema (2002)
Rhus natalensis Bernh. ex Krauss var. *macrocarpa* (Schweinf.) Cufod.	Kumusangula kumukhasi	Anacardiaceae	Tree	√	Aerial parts/root/seed	I, F, C, B	Janet (1986), Berger (1994), Hyde et al. (2011)
Rhus vulgaris Meikle	Kumusangula kumusecha	Anacardiaceae	Tree	√	Aerial parts/root/seed	I, F, C, B	Berger (1994)
Lannea schimperi (Hochst.ex A.Rich.) Engl.	Kumubumbu	Anacardiaceae	Tree	√	Bark/root/leaf	F, C, B	Marin (1999), Jeruto et al. (2008)
Annona senegalensis Pers. ssp. *senegalensis*	Kumufwora	Annonaceae	Tree	√	Leaf/bark/root	I, F	Stockbauer (2003)
						B	Toyang et al. (1995)
Annona chrysophylla Boj.	Kumufwora	Annonaceae	Tree	√	Leaf/bark/root	I, B, F	Stockbauer (2003)
Carisa edulis Vahl.	Sirwa	Apocynaceae	Shrub	√√√	Leaf/fruit/root	F	Zemede and Mesfin (2001)
						B	Ibrahim et al. (1999), Jawaid et al. (2011)
Bidens pilosa L.	Engwesi Ingwesi (Wanga)	Asteraceae	Weak annual herb	√√√√√√ √√√√√	Whole plant Aerial parts	I, R, Af, B, F	Chih et al. (1996), Anon. (2001d), Taylor (2002)
Microglossa pyrifolia (Lam.) O. Kuntze	Enguu Inguu (Wanga)	Asteraceae	Climbing shrub	√√√	Whole plant-leaf-dust (used to make also suspension)	T, B	ITDG and IIRR (1996)
Chrysanthemum cinerariifolium (Trevir.) Vis.	Pyrethrum?	Asteraceae	Herb	√√√√√√	Flower/leaf/stem/aerial parts (used to make suspension/dust)	T, P, A, B, I	Cremlyn (1978)
Tagetes minuta L.	Nanjaka Nanzaka (Wanga)	Asteraceae	Herb/weed/forb	√√√√√√ √√√√√√ √√√√√√ √√√√√√	Leaf/flower (dust, suspension- acquoes and hanging bouquet)	T, P, A, B, I	Getahun (1976), Graham et al. (1980), Berger (1994), Vasudevan et al. (1997), Anon. (2001d)
						F	Vasudevan et al. (1997), Leung and Foster (2003)
						I	Kennewell (1990)
						Af	Jacobson (1990)
						P	Grainge and Ahmed (1988)

Scientific name	Local and/or indigenous name(s)	Family name	Growth habit or life form	Frequency of mention for use	Plant part(s) used (application form)	Plant uses	References
Solanecio mannii (Hook. F.) C.Jeffrey	Nandebe (Bukusu) Mwathathia (Kikuyu) Omukhupafula (Banyala)	Asteraceae	Shrub	√√√√√√ √√√√√√ √√√√	Whole plant	A, C	University of Nairobi herbarium
Markhamia lutea (Benth.) K. Schum.	Kumusiola	Bignoniaceae	Tree	√√√√√√	Leaf/stem	I	Anon. (2003c)
						B	Kayonga and Habiyaremye (1987), New Agriculturist (2003), Rahmatullah et al. (2010), Jawaid et al. (2011)
						C	UWMG (2003)
Stereospermum kunthianum Cham, Sandrine Petit.	Kumutomolo (1)	Bignoniaceae	Small tree	√√√√√√ √√√√√√ √√√√√√ √√√√√√ √√√√√√ √√√√√√√	Root/bark (used to make hanging bouquet/suspension)	B, F, C, I	Abbiw (1989), Onegi et al. (2002), Petit (2003), Ching et al. (2009a,b,c,d), Compaoré et al. (2011), Jawaid et al. (2011), http://www.worldagroforestrycentre.org/sea/products/afdbases/af/asp/SpeciesInfo.asp?SpID=1556
						B	Malerich and Trauner (2003), Rahmatullah et al. (2010)
Jacaranda mimosifolia D. Don	Chakaranda	Bignoniaceae	Tree	√√	Leaf/root/stem	C	Dos Santos and Miller (1997)
					Leaf/root/stem (water extract)	B	Rojas et al. (2006), Rahmatullah et al. (2010), Jawaid et al. (2011)
Piliostigma thonningii (*Schumach.*) *Milne-Redh.*	Kumulamalama	Caesalpiniaceae	Perennial tree/shrub	√√√√√√	Barks/leaf/root (used to make suspension)	T, B, C, F	Ogundaini (1999), Oni (2001), Anon. (2001b), Le Houérou (2003)
						F	Zemede and Mesfin (2001)
Senna siamea (Lam.) Irwin & Barneby.	Mbekoraisi or Kumuraisi	Caesalpiniaceae	Tree	√√√√	Root/stem/leaf (used to make suspension)	T, I, R	Adoyo et al. (1997), Mansingh and Williams (1998), Anon. (2001d)
Senna singueana (Del.) Lock.	Kumusilamosi	Caesalpiniaceae	Tree	√√√	Fruit/root/leaf/bark (used to make suspension)	B, T, I	Adoyo et al. (1997), Mansingh and Williams (1998)
Tamarindus indica L.	Kumukhua	Caesalpiniaceae	Medium to large tree reaching 30 m in height.	√√√√	Root/bark/leaf (used to make suspension)	I, B	Imbabi et al. (1992), El-Siddig et al. (1999), Rao et al. (1999), Gurumurthy and Sreenivasa (2000)
						B	Zemede and Mesfin (2001)
Senna didymobotrya (Fresn.) Irwin & Barneby	Kumupinupinu	Caesalpiniaceae	Tree	√√√√√√ √√√	Root/bark/leaf (used to make suspension)	T, B	Fernandes et al. (1985), Mansingh and Williams (1998), UWMG (2003)
Tylosema fassoglensis (*Kotschy ex. Schweinf.*) *Torre. & Hillc.*	Kumukayu	Caesalpiniaceae	Perennial herb/shrub	√	Whole plant	T, F	Anon. (2001b)
Gynandropsis gynandra (L.) Briq.	Chisaka (Bukusu) Tsisaka (Wanga) Ejobyo (Luganda) Akeyo (Luo) Esaka (Banyala)	Capparidaceae	Herb	√	Whole plant	A	Malonza et al. (1992), Dipeolu et al. (1992), Torto and Hassanali (1997), Lwande et al. (1999)
						B	UWMG (2003)
						T	Ndung'u et al. (1995, 1999)
Maytenus senegalensis (Lam.) Exell.	Kumwayakhafu	Celastraceae	Tree	√√	Fruit/leaf/stem/bark/root	B	El Tahir et al. (1998), El and Satti (1999), Hussein et al. (1999), Bhatt et al. (2001), Kumar (2003)

Scientific name	Local and/or indigenous name(s)	Family name	Growth habit or life form	Frequency of mention for use	Plant part(s) used (application form)	Plant uses	References
Maytenus heterophylla (Eckl. & Zehy) N. K. B. Robson.	Kumuwawa No. 1	Celastraceae	Tree	√	Fruit/leaf/stem/bark/root	F, B	Working Paper FGR/18E (2001)
Maytenus arbutifolius (Hochst. ex A. Rich.) R. Wilczek.	Kumuwawa No. 2	Celastraceae	Tree	√	Fruit/leaf/stem/bark/root	B, F	Getahun (1974)
Terminalia mollis Laws.	Kumukhonge	Combretaceae	Tree	√√√	Stem/root/bark	P, T, I	Berger (1994)
Combretum molle R. Br. ex G. Don.	Kumukimila	Combretaceae	Tree	√√√	Stem/root/bark	P, B, C, T, I	Berger (1994), Stockbauer (2003)
Combretum collinum Fresen.	Kumulaha	Combretaceae	Tree	√√√	Resin/root/bark/leaf	P, T	Berger (1994), Odda et al. (2008)
Combretum binderianum Kotschy.	Kumulaha	Combretaceae	Tree	√√√	Resin/root/bark/leaf	P, T	Berger (1994)
Combretum elgonense Exell.	Kumulaha kumukalukha	Combretaceae	Tree	√	Resin/root/bark/leaf	P, T	Berger (1994)
Vernonia amygdalina Del.	Kumululusia or Kumwirurusia	Compositae	Shrub or small tree	√√√√√√√	Whole plant	T, F, B, I	Getahun (1976), Toyang et al. (1995), Adoyo et al. (1997), Asfaw and Tadesse (2001)
Vernonia lasiopus O. Hoffm.	Namatuma	Compositae	Shrub	√√	Whole plant	T, F	Adoyo et al. (1997)
Vernonia grantii Oliv.	Endwasi	Compositae	Shrub	√√	Whole plant	T	Adoyo et al. (1997)
Tithonia diversifolia (Hemsl.) A. Gray	Kamang'ulie or Kamaua or Kiming'ulie	Compositae	Herb	√√√√	Whole plant/paste	I, P,T, B, F	Adoyo et al. (1997)
Ipomoea batatas (L.) Lam.	Kamabwoni (Chindabii Chekamabwoni)	Convolvulaceae	Herb	√√√	Leaf/stem/sap	B	Cevallos-Casals and Cisneros-Zevallos (2002)
Cuppressus lusitanica Mill.	Kumusayiprasi	Cupressaceae	Tree	√√√√√√	Leaf/stem/bark	C, I	Personal communication with herbalists
Juniperus procera Hochst. ex Endlicher.	Kumutarakwa (1)	Cupressaceae	Tropical African timber tree with fragrant wood	√√√√√	Leaf/root/bark	I, B	Getahun (1976), Anon. (2001d)
						I	Hines and Eckman (1993)
Euclea divinorum Hiern.	Kumuchanjaasi	Ebenaceae	Tree	√√√√√√√	Root/leaf/bark	B	Homer et al. (1990), Homer et al. (1992), Dagne et al. (1993), Hines and Eckman (1993), van Grinsven et al. (1999), Lukwa et al. (2001)
						C	Hines and Eckman (1993)
Euphorbia heterochroma Pax.	Kumutua (1)	Euphorbiaceae	Succulent shrub	√√√	Sap/stem (used to make suspension)	T	Kaaya et al. (1995)
						B	Watt and Breyer-Brandwijk (1962), Philippe and Sura Faucon (2003), Schmidt (2003b)
						A	ICIPE Annual Report (1998/99), Regassaa (2000)
Euphorbia tirucalli L.	Kumusongofwa	Euphorbiaceae	Perennial thornless cactus-like tree	√√√√√	Whole plant (used to make suspension)	I	Hines and Eckman (1993), Schmidt (2003b), Clevinger (2003)
						T	Kaaya et al. (1995), ICIPE Annual Report (1998/99), Regassaa (2000)
						B	Watt and Breyer-Brandwijk (1962), Getahun (1976), Duke (1983a), Hines and Eckman (1993), Bowen and Hollinger (2002)
						C	Hines and Eckman (1993)

Scientific name	Local and/or indigenous name(s)	Family name	Growth habit or life form	Frequency of mention for use	Plant part(s) used (application form)	Plant uses	References
Euphorbia candelabrum Kotschy.	Kumutua (2)	Euphorbiaceae	Tree	√√√	Leaf/stem/sap (used to make suspension)	T	Kaaya et al. (1995), Regassaa (2000)
						A	ICIPE Annual Report (1998/99)
						C	Hines and Eckman (1993)
						B	Watt and Breyer-Brandwijk (1962), Hines and Eckman (1993), Schmidt (2003b)
Margaritaria discoidea (Baill.) G.L.Webster	Erionoi (Teso) Atego (Luo) Kamenyabazi (Luganda) Muremampango (Runyankore)	Euphorbiaceae	Tree	√	Whole plant (used to make suspension while wood smoke repels mosquitoes and snakes)	I	ICIPE Annual Report (1998/99), Schmidt (2003b), Adedapo et al. (2009)
						T	Regassaa (2000)
						A	Kaaya et al. (1995)
						B	Irvine (1961), Watt and Breyer-Brandwijk (1962), UWMG (2003), Schmidt (2003b)
						C	Hines and Eckman (1993), Schmidt (2003b)
Bridelia scleroneura Mull. Ag.	Kumunyekerwe	Euphorbiaceae	Tree/shrub	√	Stem/root and or bark	I	Hines and Eckman (1993)
						B	Anon. (2001c), Schmidt (2003b), MTDP (2003)
						F	Persson (1986)
						C	Persson (1986)
						T	Kaaya et al. (1995), ICIPE Annual Report (1998/99), Regassaa (2000)
Bridelia micrantha Hochst. Baill.	Kumulondamwombe or Kumukhulang'wa	Euphorbiaceae	Small tree/herb	√√√√√√ √√√√	Leaf/root/bark (used to make suspension)	I	Hines and Eckman (1993), Anon. (2001d)
						T	Kaaya et al. (1995), ICIPE Annual Report (1998/99), Regassaa (2000)
						F	Tredgold (1990), Hines and Eckman (1993), Asfaw and Tadesse (2001)
						B	Rulangaranga (1989), Hines and Eckman (1993), Abo and Ashidi (1999), Izelle (2002), Green et al. (2011)
						C	Hines and Eckman (1993)
						S	Tredgold (1990)
Erythrococca bongensis Pax.	Lupiriapiria	Euphorbiaceae	Tree	√√	Stem/root/leaf	B	Kayonga and Habiyaremye (1987), Maundu et al. (2001), Schmidt (2003b)
						T	Regassaa (2000), Kaaya et al. (1995), ICIPE Annual Report (1998/99)
						F	Anon. (1968)
Neoboutonia melleri (Müll. Arg.) Prain	Kumulongo	Euphorbiaceae	Tree/shrub	√√√√	Stem/root (used to make suspension)	B	Schmidt (2003b)
						T	Kaaya et al. (1995), ICIPE Annual Report (1998/99), Regassaa (2000)
Macaranga kilimandscharica Pax.	Kaptebema (Sebei) Kumulongo	Euphorbiaceae	Tree Tree/shrub	√√√√√	Stem/root (used to make suspension)	B	Dewees (1995), Maundu et al. (2001)
						T	Kaaya et al. (1995), ICIPE Annual Report (1998/99), Regassaa (2000), Schmidt (2003b)
						C	Dewees (1995)

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Croton sylvaticus Hoschst. ex Krauss	Kumuchwichwi	Euphorbiaceae	Tree	√	Seed	T	Kaaya et al. (1995), ICIPE Annual Report (1998/99), Regassaa (2000)
						B	Watt and Breyer-Brandwijk (1962), Mwangi et al. (1998), Schmidt (2003b)
Croton macrostachyus Hochst. ex Delile	Kumuchwichwi or Kumutotoa or Kumukunusia or Kumutoboso (Saboti)	Euphorbiaceae	Tree	√√	Leaf/bark/root (suspension)	I	Fernandes et al. (1985), Stockbauer (2003)
						F	Fernandes et al. (1985)
						B	Getahun (1976), Fernandes et al. (1985), Toyang et al. (1995)
						T	Kaaya et al. (1995), ICIPE Annual Report (1998/99), Regassaa (2000)
						C	Fernandes et al. (1985), Hines and Eckman (1993)
Croton megalocarpus Hutch.	Kumukunusia kumukeni or Kumutotoa kumukeni	Euphorbiaceae	Tree	√√	Leaf/bark/root (used to make suspension)	T	Kaaya et al. (1995), ICIPE Annual Report (1998/99), Regassaa (2000)
						C	Fernandes et al. (1985), Hines and Eckman (1993)
						B	Harjula (1980), Politz and Lekeleley (1988), Minja (1989), Gachathi (1989), ICRAF (1992), Hines and Eckman (1993), Kokwaro (1993), Minja (1994), Masinde (1996), ITDG and IIRR (1996), Schmidt (2003b)
						F	Hines and Eckman (1993)
						C	Hines and Eckman (1993)
						T	Kaaya et al. (1995), ICIPE Annual Report (1998/99), Regassaa (2000)
Ricinus communis L.	Kumuroborobo or Kumubono	Euphorbiaceae	Tree/shrub	√√√√	Seed/stem/root (used to make suspension)	A	van Rijn and Tanigoshi (1999), Mitchell and Ahmad (2006)
						B	Getahun (1976), Duke and Wain (1981), Core (1981), Fernandes et al. (1985), Toyang et al. (1995), UWMG (2003), Schmidt (2003b)
						I	Mahgoub and Ahmed (1996)
Hymenocardia acida *Tul.*	Nangoso	Euphorbiaceae	Mostly found in savanna as woody plant/small shrubs/tree	√	Bark/leaf (used to make decoction)	P	Fernandes et al. (1985)
						T	Kaaya et al. (1995), ICIPE Annual Report (1998/99), Regassaa (2000)
						B	Irvine (1961), Marin (1999), Schmidt (2003b)
Drypetes gerrardii Hutch.	Kumwilima	Euphorbiaceae	Tree	√√	Leaf/root (used to make decoction)	T	Kaaya et al. (1995), ICIPE Annual Report (1998/99), Regassaa (2000)
						B	Schmidt (2003b)
Flueggea virosa (Roxb. ex Willd.) Royle	Lubwili	Euphorbiaceae	Shrub	√√	Whole plant (used to make decoction)	T	Kaaya et al. (1995), ICIPE Annual Report (1998/99), Regassaa (2000)
						I	Anon. (2003a), Lister (2003)

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Sapium ellipticum Hochst. ex Krauss Pax	Kumuchaso	Euphorbiaceae	Tree	√√√	Root/bark (used to make decoction)	T	Kaaya et al. (1995), ICIPE Annual Report (1998/99), Regassaa (2000)
						F (Fuits)	Asfaw and Tadesse (2001)
						B	Samuelsson et al. (1992), Schmidt (2003b)
						B	Schmidt (2003b)
						T	Kaaya et al. (1995), ICIPE Annual Report (1998/99), Regassaa (2000)
Phyllanthus ovalifolius Forssk.	Kumusekese	Euphorbiaceae	Shrub	√√	Aerial parts	T	Kaaya et al. (1995), ICIPE Annual Report (1998/99), Regassaa (2000)
						B	Schmidt (2003b)
Phyllanthus muellerianus (Kuntze) Exell.	Kumutikaa	Euphorbiaceae	Tree	√√	Leaf	T	Kaaya et al. (1995), ICIPE Annual Report (1998/99), Regassaa (2000)
						B	Schmidt (2003b), Agyare et al. (2011)
Clutia richardiana Moll.Arg.	Nabilikhe or Luyebeye or Lulako	Euphorbiaceae	Shrub	√	Aerial parts (used to make concoction)	T	Kaaya et al. (1995), ICIPE Annual Report (1998/99), Regassaa (2000)
						B	Muhammad et al. (1999), Schmidt (2003b), Abourashed et al. (2003)
Clutia abyssinica Jaub. & Spach	Nabilikhe or Luyebeye or Lulako	Euphorbiaceae	Shrub	√	Aerial parts	T	Kaaya et al. (1995), ICIPE Annual Report (1998/99), Regassaa (2000)
						B	Duke (2002), Schmidt (2003b)
Clutia mollis Pax.	Nabilikhe or Luyebeye or Lulako	Euphorbiaceae	Shrub	√	Barks/leaves (used to make concoction)	T	Kaaya et al. (1995), ICIPE Annual Report (1998/99), Regassaa (2000)
						B	Schmidt (2003b)
Manihot esculenta Crantz.	Kumwoko	Euphorbiaceae	Perennial woody shrub	√√√	Root/bark/stem (used to make concoction)	B	Schmidt (2003b)
						T	Kaaya et al. (1995), ICIPE Annual Report (1998/99), Regassaa (2000)
Acalypha racemosa Wall. ex Baill.	–	Euphorbiaceae	Shrub	√√	Root/bark/stem (used to make concoction)	B	Schmidt (2003b)
						T	Kaaya et al. (1995), ICIPE Annual Report (1998/99), Regassaa (2000)
						B	Schmidt (2003b)
Dolichos kilimandscharicus Harms ex Taub.	Nandwasi	Fabaceae	Herb/shrub	√√√√	Root/stem/leaf (used to make concoction)	B, P	University of Nairobi Heerbarium Library/records on voucher specimen.
					Powdered root	P	Golob et al. (1999)
Garcinia buchananii Bak.	Kumukhomeli	Guttiferae	Tree	√√√√√√ √√	Twig/bark/root/fruit (used to make suspension)	Ps, B	Smith (1969), Duke-Elder and MacFaul (1972), Schmidt (2003c)
Psorospermum febrifugum Spach.	Nangoso (2)	Guttiferae	Tree	√	Fruit/bark/stem/leaf	B	Aubréville (1936), Dalziel (1937), Irvine (1961), Cassady et al. (1990), Schmidt (2003c)
Harungana madagascariensis Lam. ex Poir.	Namalasile	Guttiferae	Tree	√	Leaf/bark/stem	B	Woodland (1997), Irvine (1961), Schmidt (2003c), The World Bank Group (2003), Erah et al. (2003)
Dovyalis macrocalyx (Oliv.) Warb.	Kumusongolamunwa/ Busongolomunwa (fruit)	Flacourtiaceae	A spiny shrub	√	Whole plant (adecoction made from the crushed leaves)	F	Maundu et al. (1999)
						B	Chifundera (1998)
Tinnea aethiopica Hook. f.	Lubilikhe	Lamiaceae	Shrub	√√√	Leaf	T	Jembere et al. (1995)
Plectranthus barbatus Andr.	Ling'ulie or Kamang'ulie	Lamiaceae	Shrub	√	Leaf	T	Jembere et al. (1995)
Plectranthus lactiflorus (Vatke) ined.	–	Lamiaceae	Shrub	√	Aerial parts	T	Jembere et al. (1995)

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Leonotis nepetifolia (L.) R. Br.	Susuni	Lamiaceae	Shrub	√	Aerial parts	T	Jembere et al. (1995)
Hoslundia opposita Vahl.	Bifwofwo	Lamiaceae	Herb	√√√	Root/barks	T	Jembere et al. (1995)
Ocimum kilimandscharicum Baker ex Gürke	Bifwofwo	Lamiaceae	Herb	√√	Leaf	TC	Jembere et al. (1995)
Leucas calostachys Oliv.	Nasusi	Lamiaceae	Herb	√	–	T	Jembere et al. (1995)
Strychnos innocua Del.	Kumulende	Loganiaceae	Tree	√√√√√√	Powder of tried leaf/seed (storage pests-weevils)	P, F (fodder)	Assefa and Williamson (2001)
						B	Hines and Eckman (1993)
						Ps	Stedman et al. (1942), Volfová and Patočka (2003)
Strychnos spinosa Lam.	Kumukhubwe	Loganiaceae	Tree	√	Leaf/bark/fruit	C, F	Wehmeyer (1966), Fox and Norwood-Young (1982), Taylor (1986), Saka and Msonthi (1994), Phillipson (1995), Mizrahi et al. (2002), Kristensen and Lykke (2003)
Hibiscus calyphyllus Cav.	Kumwarakumba	Malvaceae	Shrub	√	Leaf/stem/aerial parts/root	F, N	Puckhaber et al. (2002)
Ekebergia capensis Sparm.	Kumusilisisi (1)	Meliaceae	Evergreen or semi-deciduous, medium-sized to large tree.	√√√	Root/bark/fruit/flower/leaf/stem	T, B, C, F	World Agroforestry Centre (2003a)
Ekebergia rueppeliana (Fresen.) A. Rich.	Kumusilisisi (2)	Meliaceae	Evergreen or semi-deciduous tree	√√√	Root/bark/fruit/flowers	T, C, F, B	World Agroforestry Centre (2003b)
Turraea holstii Gürke	Nawili	Meliaceae	Tree	√√	Whole plant	B	Mulholland et al. (1998), Rajab et al. (1998)
						T	Lindsay and Kaufman (1988), Cabral et al. (1996), Mansingh and Williams (1998), Ndumu et al. (1999), Abdel-Shafy and Zayed (2002), Borges et al. (2003)
Turraea robusta Gürke	Nabili	Meliaceae	Small tree	√√√√	Whole plant	T, B	Rajab et al. (1988), Bentley et al. (1992), Rajab et al. (1998), Gathirwa et al. (2008)
Azadirachta indica A. Juss.	Kumwarubaine (2)	Meliaceae	Tree	√√√√√√ √√√√√√ √√√√√√ √√	Stem/bark/fruit/leaf/root (suspension/dusting/rubbing bolus/paste)	I	ITDG and IIRR (1996), ICIPE Annual Report (1998/99), Mansingh and Williams (1998), Mulla and Su (1999), Ndumu et al. (1999), Anon. (2001d), Abdel-Shafy and Zayed (2002), Singh (2002)
						A	Lindsay and Kaufman (1988), Williams (1993), ITDG and IIRR (1996), ICIPE Annual Report (1998/99), Ndumu et al. (1999), Wilson and Mansingh (2002), Blair and Mansingh (2002), Abdel-Shafy and Zayed (2002), Mansingh and Williams (2002)

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						T	Lindsay and Kaufman (1988), Cabral et al. (1996), Mansingh and Williams (1998), Borges et al. (2003)
						P	Isman et al. (1996), Brechelt (2002), Singh (2002)
						B	UWMG (2003), Thapa and Pathak (2002)
						Af	Vellaikumar (1997), ICIPE Annual Report (1998/99)
Melia azedarach L.	Kumwarubaine (1)	Meliaceae	Tree	✓✓✓✓✓✓ ✓✓✓✓✓✓ ✓✓✓✓✓✓ ✓✓	Stem/bark/fruit leaf/root (used to make suspension/dusting/rubbing)	T	Williams (1993), Ndumu et al. (1999), Anon. (2001d), Abdel-Shafy and Zayed (2002)
						A	Lindsay and Kaufman (1988), Cabral et al. (1996), Mansingh and Williams (1998), Borges et al. (2003)
						P	Stoll (1988), Neupane (1992), Berger (1994), Kroschel (1996), Batcher (2000)
						Af	Chen et al. (1996), Nardo et al. (1997), Vellaikumar (1997)
						B	Andrei et al. (1990), Zakir et al. (1991), Villamil et al. (1995), HerbWeb (2000)
						I	Al-Sharook et al. (1991), Arias et al. (1992), Isman et al. (1996), Cabral et al. (1996), Nardo et al. (1997), Valladares et al. (1997), Adoyo et al. (1997), Schmidt et al. (1998), Singh (2002)
Acacia macrothyrsa Harms.	Kumukholondo	Mimosaceae	Shrub/tree	✓✓✓	Root/leaf/bark (used to make hanging bouquet/suspension)	B, C, T, F	Marin (1999), Le Houérou (2003)
Albizia coriaria Welw. ex Oliv.	Kumupeli (Bukusu) Ober (Luo)	Mimosaceae	Perennial tree	✓✓✓✓✓✓ ✓✓✓	Stem/root/bark/leaf	T, B	Kokwaro (1993), ITDG and IIRR (1996), Schmidt (2003d)
Albizia grandibracteata Taub.	Kumufunjamwe/ Kumulongo/ Kumunianyuni	Mimosaceae	Perennial tree	✓	Bark/leaf	T, N	–
Entada abyssinica A.Rich.	Kumusembe	Mimosaceae	Perennial tree	✓✓	Root/bud/leaf/ Bark (used to make suspension)	T, C, F, B	Hines and Eckman (1993), Toyang et al. (1995), Freiburghaus et al. (1998), Duke (2002)
Acacia sieberiana DC.	Kumulemba	Mimosaceae	Perennial Tree	✓✓✓✓	Root	F, C, B, T	Anon. (2001a)
Acacia nilotica (L.) Bel.	Kumulemba	Mimosaceae	Tree	✓✓✓✓	Bark/root	B, I, F	Duke (1983b), Anon. (2001d)
						B, P	Heine and Heine (1988), Heine and König (1988), Timberlake (1987)
Ficus sycomorus L.	Kumukhuyu	Moraceae	Tree	✓✓✓✓✓✓ ✓✓✓	Leaf/fruit/bark/latex	T, B, F, C	Puyvelde (van) et al. (1985), Hines and Eckman (1993), Regassaa (2000)
Ficus vasta Forssk.	Kumutoto kumutotoa	Moraceae	Tree	✓✓✓✓	Root/fruit/bud/latex (used to make suspension)	T, F, C	Puyvelde (van) et al. (1985), Regassaa (2000)
Ficus amadiensis De Wild.	Kumutoto kumukobianyuni	Moraceae	Tree	✓✓	Root/fruit/bark/latex	T, C	Puyvelde (van) et al. (1985), Regassaa (2000)
Ficus thonningii Blume.	Kumutoto kumusecha	Moraceae	Tree	✓	Root/fruit/bark/latex	T, F, B, C	Puyvelde (van) et al. (1985), Hines and Eckman (1993), Regassaa (2000), Stockbauer (2003)
Ficus glumosa Del.	Kumusilisisi	Moraceae	Tree	✓	Root/fruit/bark/latex	–	–
Ficus sur Forssk.	Kumukhuyu nandere	Moraceae	Tree	✓✓	Root/fruit/bark/latex (used to make suspension)	T, F, C	Puyvelde (van) et al. (1985), Regassaa (2000)

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Syzygium guineense (Willd.) DC. ssp. *guineense*	Kumusitole kumusecha	Mrytaceae	Tree	√	Bark/root/fruit	C, F, B	Hines and Eckman (1993)
Syzygium cordatum Hochst.ex C.Krauss.	Kumusemwa	Mrytaceae	Medium-large tree.	√	Stem/root/bark/fruit	F	Trade Winds Fruit (2003)
Syzygium cumini L.	Kumusemwa	Mrytaceae	Medium-large tree.	√	Stem/root/bark/fruit	F	Trade Winds Fruit (2003)
Maesa lanceolata Forssk.	Namaru	Myrsinaceae	Tree	√√	–	T, B	Getahun (1976)
Lophira alata Banks ex Gaertn.	Oteng (Luo)	Ochnaceae	Tree	√	Whole plant	B	Anon. (1977)
Ximenia americana L.	Kumutuli	Olacaceae	Woody shrub or small tree	√√√	Leaf/bark/root/fruit	P, B, C, F	Hines and Eckman (1993)
						B	Anon. (2003b)
Olea capensis L.	Kumutamaywa	Oleaceae	Tree	√	Leaf/bark/fruit	F, C	Hines and Eckman (1993), Mutangah (1996)
						B	Hines and Eckman (1993), Stockbauer (2003)
Olea europaea (L.) ssp. *africana* (Mill.) P. Green.	Kumunyubuti	Oleaceae	Woody perennial tree	√	Bark/stem/leaf	C	Palgrave (1988), Hines and Eckman (1993)
						F	Hines and Eckman (1993)
						B	Botanical South Africa (2003), Viable Herbal Solutions (2003)
Sesbania sesban (L.) Merrill.	Chisubasubi (1)	Papilionaceae	Tree	√√√	Leaf/stem (used to make suspension)	T	Matzigkeit (1990)
Kotschya africana Endl.var. *bequaertii* (De Wild) Verdc.	Chisubasubi (2)	Papilionaceae	Tree	√	Various parts of the plant	T	Matzigkeit (1990)
Sesbania macrantha Welw. ex Phillips and Hutch.	Chisubasubi (3)	Papilionaceae	Tree	√√√	Leaf/stem (used to make suspension)	T	Matzigkeit (1990)
***Indigofera emarginella* Steud. ex A. Rich.**	Lusisakwe	Papilionaceae	Shrub	√√√	Root/stem	T	Matzigkeit (1990)
Erythrina abyssinica Lam. ex DC.	Kumurukuru or Kumurembe	Papilionaceae	Perennial shrub/tree	√√	Leaf/bark (used to make hanging bouquet/ dusting/fumigation)	T	Matzigkeit (1990), Mansingh and Williams (1998)
						B	Rulangaranga (1989), Hines and Eckman (1993), ITDG and IIRR (1996)
						C	Rulangaranga (1989), Hines and Eckman (1993)
Tephrosia vogelii Hook F.	Kumufila or Esumu	Papilionaceae	Shrub	√√√√√√ √√√√√√ √√√√√√√	Leaf/stem/fruit/bud/bark/ seed/root (whole plant)	A, T	Lemmens and Fryer (1917), Cremlyn (1978), Matzigkeit (1990), Toyang et al. (1995), Kambewa et al. (1997)
						I	Kambewa et al. (1997)
						Af	Niang (1987), Bertram (1988)
						B	Niang (1987), Getahun (1976)
						P	Matzigkeit (1990), Cremlyn (1978)
Rhynchosia resinosa (A. Rich.) Baker	Kumusiuli	Papilionaceae	Tree	√	Leaf/stem/root/bark	T, B	Matzigkeit (1990), William (1999)
Macuna poggei Taub.var. *pesa* (De Wild) Verdc.	Kumuchuli or Kumusiuli	Papilionaceae	Perennial climbing herb or shrub	√	Bark/root	T	Matzigkeit (1990)
Mucuna poggei Taubert var. *poggei* (De Wild) Verdc.	Kumuchuli or Kumusiuli	Papilionaceae	Perennial climbing herb or shrub	√	Aerial parts	T	Matzigkeit (1990)

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Mondia whytei (Hook f.) Skeels	Kumukombela	Periplocaceae	Herb	✓	Root/stem?	B	Okwemba (2002)
Pittosporum viridiflorum Sims.	Nambaa (1)	Pittosporaceae	Shrub	✓✓	Stem bark/root/leaf	F, B	Coetzee et al. (1999), Berger et al. (2002), Seo (2002)
Sorghum bicolor (L.) Moench.	Kamayemba (Bukusus) Amabele (Wanga) Ammabelee (Banyala)	Poaceae	Grass	✓	Whole plant (particularly grains, leaf and stem)	I, F, B	Grieve (1931), Watt and Breyer-Brandwijk (1962), Duke and Wain (1981), Morton (1981), Perry (1980), Duke (1983c), Anon. (2001d)
Saccarhum officinarum L.	Kimiba (Bukusu) Emikhonye (Wanga)	Poaceae	Grass	✓	Leaf/stem/juice	F	–
Zea mays L.	Kamayindi (Bukusu) Amatumwa (Wanga)	Poaceae	Grass	✓✓✓	Leaf/stem	B	Lukwa et al. (2001), Ramos-Escudero et al. (2011)
Podocarpus falcatus (Thunb.) R.Br. ex Mirb.	Kumutarakwa (2)	Podocarpaceae	Shrub	✓	Leaf/root/bark	I	Stockbauer (2003)
Podocarpus latifolius (Thunb.) R.Br. ex Mirb.	Kumutarakwa (3)	Podocarpaceae	Tree	✓✓	Stem/root/leaf	C	Stockbauer (2003)
Securidaca longipedunculata Fres.	Kumunyakasia Kumuyanjabakeni	Polygalaceae	Tree	✓✓	Whole plant	I, C, B, F, Ps	Rukangira (2001), Jayasekara et al. (2002)
Zizyphus abyssinica Hochst. ex A. Rich.	Kumukomboti (1)/Kumwikalangwe	Rhamnaceae	Tree	✓✓✓	Root/bark	F	Hentgen (1985)
Zizyphus mucronata Willd.	Kumukomboti (2)/Kumwikalangwe/Tirokwo (Pokot)	Rhamnaceae	Tree	✓✓✓	Root/bark	F	Hentgen (1985)
Prunus africana (Hook.f.) Kalkman.	Kumuturu/Kumwilima	Rosaceae	Tree	✓✓✓	Bark/leaf/root	P, I, B	Cunningham and Mbenkum (1993), Schippmann (2001), World Agroforestry Centre (2003b), USDA, ARS, National Genetic Resources Program (2004)
Gardenia ternifolia Schumach. & Thonn.	Siuna	Rubiaceae	Shrub	✓✓✓✓✓✓ ✓✓✓✓✓✓✓	Root/fruit	F	Asfaw and Tadesse (2001)
						C, I	Fernandes et al. (1985)
Pavetta oliveriana Hiern.	Kumukokhakokhe	Rubiaceae	Tree/shrub	✓	Root/leaf	–	N
Pavetta crassipes K. Schum.	Kumusindusianjofu/ Kumupepenambusi kumukhasi	Rubiaceae	Tree	✓✓	Root/leaf	F, B	Sanon et al. (2003).
Teclea nobilis Del.	Kumutare	Rutaceae	Tree	✓	Root/stem/bark/leaf	C, B	Hines and Eckman (1993), Marin (1999)
Paullinia pinnata L.	Kumukoyakoye kumulaasi	Sapindaceae	Lianas	✓	The root and root bark are applied for rubefacient purposes.	B, F	Killip and Smith (1935), Fanshawe (1948, 1953), Watt and Breyer-Brandwijk (1962), Abourashad et al. (1999), van Andel (2000), Onge (2002), Duke and Bogenschutz (2003)
Harrisonia abyssinica Oliv.	Sibondwe	Simaroubaceae	Tree	✓✓	Leaf/root/bark/stem	B	Bally (1937), Watt and Breyer-Brandwijk (1962), Johns et al. (1990), Kokwaro (1993), Fabry et al. (1996)
Withania somnifera (L.) Dunal	Nambaa (2)	Solanaceae	A perennial herb	✓✓	Stem/root/leaf	B	Pande (1999), Singh and Kumar (1998), Scartezzini and Speroni (2000), McIntyre (2002), Chopra et al. (2004), Van Der Hooft et al. (2005), Cooley et al. (2009), Mirjalili et al. (2009), Ven Murthy et al. (2010), Ahmad et al. (2010)

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Nicotiana tabacum L.	Eraba	Solanaceae	Herb	√√√√√	Leaf/stem-dust (used to make suspension smoke and hanging bouquet)	P, A, I, B, C	Cremlyn (1978), Stoll (1988), Matzigkeit (1990), Juliette de Ba Levy (1991), Dipeolu and Ndungu (1991), Berger (1994), Mwangi (1996), ITDG and IIRR (1996), Adoyo et al. (1997), Mansingh and Williams (1998), Adewusi and Afolayan (2010)
Capsicum annum L.	Pilipili 1	Solanaceae	Shrub	√√√√√√ √√√√√√ √√√√√√ √√√√√√√	Fruit/leaf/stem (suspension, dust, smoking and hanging bouquet)	P, I, T, B, F	Stoll (1988), Berger (1994), Adoyo et al. (1997), Mansingh and Williams (1998), Regassaa (2000)
Capsicum frutescens L.	Pilipili 2	Solanaceae	Shrub	√√√√√√ √√√√√√ √√√√√√ √√√√√√√	Fruit/leaf/stem (suspension, dust, smoking and hanging bouquet)	P, I, T, B, F	Stoll (1988), Berger (1994), Adoyo et al. (1997), Mansingh and Williams (1998), Regassaa (2000)
Solanum incanum L.	Chindurandura	Solanaceae	Shrub	√√√√√	Root, fruit-juice (suspension)	B, C, F	Hines and Eckman (1993), Lukwa et al. (2001), Jawaid et al. (2011), Adewusi and Afolayan (2010)
Physalis peruviana L.	Embunwe Emiilwa (Wanga)	Solanaceae	Herb	√√	Stem/root/fruit/leaf (heated leaves are applied as poultices on inflammations and leaf infusion as an enema to relieve abdominal ailments in children).	F, B, C	Morton (1987), Barbadine (2003), Wu et al. (2005), Wu et al. (2006), Franco et al. (2007), Arun and Asha (2007), Pardo et al. (2008), Pinto et al. (2009), Lan et al. (2009), Wu et al. (2009), Kolar and Malbeck (2009), Yen et al. (2010)
Grewia trichocarpa Hochst. ex A. *Rich.*	Kumusitati or Lusitati	Tiliaceae	Tree	√	Root	F, B	Brink (2009)
Grewia bicolor A. Juss.	Kumusitati or Lusitati	Tiliaceae	Tree	√	Root/bark	B	http://www.pbs.org/wnet/africa/explore/sahel/sahel_vegetation_lo.html (retrieved 19.08.004), Orwa et al. (2009)
Steganotaenia araliaceae Hochst.	Kumutomolo (1) or Kumupepenambusi kumusecha	Umbelliferae	Tree	√	Leaf/stem/bark	B, P	Rukangira (2003)
Clerodendrum myricoides (Hochst.) R. Br. & Vatke.	Nangoso (3)	Verbenaceae	Tree	√√√	Leaf, juice, roots	B, P, I, A	Baerts and Lehmann (1991), Kasonia et al. (1991)
						B, P	Staner and Boutique (1937), Watt and Breyer-Brandwijk (1962), Glover et al. (1966), Lemordant (1971), Van Puyvelde et al. (1977), Lindsay and Hepper (1978), Harjula (1980), Gelfand et al. (1985), Kayonga and Habiyaremye (1987), Heine and Heine (1988), Baerts and Lehmann (1989), Gachathi (1989), Polygenis-Bigendako (1990), Kokwaro (1993), Tadesse (1994)
Rotheca myricoides (Hochst.) Steane & Mabb.	Nangoso (1)	Verbenaceae	Shrub	√√	Whole plant	B, T, B	http://members.lycos.co.uk/ethiopianplants/shinasha.html, Getahun (1976), Kebenei et al. (2004)
Lantana camara L.	Mukhekhe (Bukusu) Lantana (Wanga)	Verbenaceae	Herb/shrub	√√	Whole plant (pour on or steaming)	B, F, C, I	Adebayo et al. (1999)
Lippia grandifolia Hochst. ex A. Rich. var. longipedunculata Moldenke	Lukumakuma	Verbenaceae	Herb	√√√√√√	Root/leaf/stem	T[l]	Kunle et al. (2003), Mwangi et al. (1989, 1991a,b, 1994, 1995), Koumaglou et al. (1996a,b), Garneau et al. (1995), Mwangi et al. (1998)

Scientific name	Local and/or indigenous name(s)	Family name	Growth habit or life form	Frequency of mention for use	Plant part(s) used (application form)	Plant uses	References
Vitex doniana Sweet	Kumufutu or Kumufututu	Verbenaceae	Tree	√√√√	Bark/root/leaf/fruit (used to make smoke and hanging bouquet)	I, B, F, C	FAO (1983), RSCU (1992), Hines and Eckman (1993), Olusola et al. (1997), Rukangira (2001), Ky (2008)
Vitex fischeri Gürke	Kumufutumbwe	Verbenaceae	Tree	√√√√√√√	Whole plant (used to make smoke and hanging bouquet)	I, F, B	Thijssen (2008)
Cyphostemma adenocaule (Steud. ex A. Rich.) Desc.	Kumukoyakoye	Vitaceae	Lianas	√	Whole plant	B	Adamantidis (1956), Polygenis-Bigendako (1990), Kokwaro (1993)
Cyphostemma heterotrichum (Gilg & R.E. Fr.) Desc. ex Wild & R.B. Dru.	Libombwe	Vitaceae	Lianas	√	Whole plant	B	N
Rhoicissus tridentata (L.f.) Wild & R.B. Drumm.	Kumukoyakoye	Vitaceae	Lianas	√√√√√√ √√√√√√√	Root or tuberous rootstock (lignotuber)	F, C, B	Kayonga and Habiyaremye (1987), Cunningham (1990, 1995), Maundu et al. (2001), Michael (2003), Brookes and Katsoulis (2006), Gruber and O'Brien (2010)
Rhoicissus revoilii Planch.	Kumukoyakoye	Vitaceae	Climber	√√√√	Whole plant	B	ITDG and IIRR (1996)
Cyphostemma orondo (Gilg & M.Brandt) Desc.	Kumukoyakoye	Vitaceae	Lianas	√	Whole plant	–	N
Other anti-tick ethnoagents (claimed by the Bukusu community to work best in mixed forms as agents to control and manage livestock ticks)							
	Bar soap (toxic?)						
	Fish (odours) (repellent?)						
	Cattle urine + sisal (toxic and repellent?)						
	Kerosene (toxic and repellent?)						
	Magadi soda (toxic)						Dipeolu and Ndungu (1991)
	Grease (toxic and repellent?)						
	Ash (toxic and repellent?)						
	Feeding animals on natural salty soils locally called "*silongo*" (repellent/toxic?)						Dipeolu and Ndungu (1991)
	Cattle cowdung (repellent)						Sika (1996), Wanzala et al. (2004)

√, refers to a mention of a plant for its use in tick control and/or control of other livestock pests; A, plants that were found in literature to demonstrate acaricidal activities/compounds; B, plants that were found in literature to have bioactive and toxic compounds other than pesticidal/acaricidal/insecticidal constituents; P, plants that were found in literature to demonstrate pesticidal activities/compounds other than insecticidal constituents; I, plants found in literature to be resistant to attack by insects or found to demonstrate insecticidal activities/compounds; T, taxonomic affinity to plant species (at genus and family levels) known to possess bioactive, insecticidal, acaricidal activities/compounds; N, no leading bioactive, insecticidal and or acaricidal information from literature; F, human food plants, unless otherwise stated; Af, plants with antifeedant activities against insects; C, Plants with cultural implication and applications; –, information not available for documentation; S, sericulture – the cultivation of silk worms for the production of natural silk fiber; Ps, poisonous plants; ?, no consistent information obtained on the plants from field responses and different literature sources.

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