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Medicinal plants used in the management of chronic joint pains in Machakos and Makueni counties, Kenya

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ABSTRACT

Ethnopharmacological relevance: Traditional medicines play an important role in the management of chronically painful and debilitating joint conditions, particularly in the rural Africa. However, their potential use as sources of medicines has not been fully exploited. The present study was carried to find the medicinal plants traditionally used to manage chronic joint pains in Machakos and Makueni counties in Kenya.

Materials and methods: To obtain this ethnobotanical information, 30 consenting traditional herbal medical practitioners were interviewed exclusively on medicinal plant use in the management of chronic joint pains, in a pre-planned workshop.

Results and discussion: In this survey, a total of 37 plants belonging to 32 genera and 23 families were cited as being important for treatment of chronic joint pains. The most commonly cited plant species were *Pavetta crassipes* K. Schum, *Strychnos henningsii* Gilg., *Carissa spinarum* L., *Fagaropsis hildebrandtii* (Engl.) Milve-Redh. and *Zanthoxylum chalybeum* Engl. *Acacia mellifera* (Vahl) Benth., *Amaranthus albus* L., *Balanites glabra* Mildbr. & Schltr., *Grewia fallax* K. Schum., *Lactuca capensis*, *Launaea cornuta* (Oliv. & Hiern) O. Jeffrey, *Lippia kituiensis* Vatke, *Pappea capensis* Eckl. & Zeyh. and *Pennisetum glaucum* (L.) R. Br. are documented for the first time as being important in the management of chronic joint pains.

Conclusions: The findings of this study show that a variety of medicinal plants are used in the management of chronic joint pains and the main mode of administration is oral.

1. Introduction

Chronic joint pain can be caused by a multitude of factors, with osteoarthritis and rheumatoid arthritis being the most common conditions, particularly in individuals above the age of 55 years (Goldring and Goldring, 2006; Zhang, 2009). Osteoarthritis (OA) is a degenerative joint disease characterized by damage to the articular cartilage, changes in subchondral and marginal bone, synovitis and capsular thickening and it usually affects the weight bearing joints (Bendele, 2001; Schaller et al., 2005). Rheumatoid arthritis (RA) manifests as a systemic autoimmune disorder, with pain, inflammatory reaction and tissue damage in multiple joints (Wood, 2004). RA affects about 1% of the population and is more common in women than in men while osteoarthritis is a common problem affecting over 60% of all people by the age of 50 years (Alarcón, 1995; Wood, 2004; Lawrence et al., 2008). Like in most of the tropical African countries, no systematic studies on prevalence, spectra and pattern of chronic joint diseases has been carried out in Kenya, yet musculoskeletal disorders constitute the commonest cause of disability in adults in developing countries (Oyoo, 2004; Oyoo and Espinoza, 2006).

If in the case of osteoarthritis, lifestyle modification (such as weight loss and exercise) and analgesics are the mainstay of treatment. Acetaminophen/paracetamol is used first line and NSAIDs (non steroidal anti-inflammatory drugs) are only recommended as add on therapy if pain relief is not sufficient, due to the relative greater safety of acetaminophen. But, unfortunately the situation is much more difficult when one is speaking about rheumatoid arthritis, as this pathology can lead to complete destruction of the articulation, no satisfying treatment has been found. Over the years, there has been a variety of new therapeutic agents to manage it, but most of them have devastating side effects, some of which are life threatening (Wood, 2004; Setty and Sigal, 2005; Caporali et al., 2008). However, they are still in use, particularly by the terminally ill where safety versus severity of the condition is the main driving force towards their use (Mohan et al., 2001; Kroesen et al., 2003; Wood, 2004; Caporali et al., 2008).

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Though chronic joint pains present a serious continuing threat to human health with serious socio-economic impact particularly in long term retractable pain, high degree of suffering, irreversible joint deformities and functional impairments, only few studies have focused on traditional medicines used in their management (Wood, 2004). Furthermore, all these lead to both long term morbidity and early mortality. Like many other chronic illnesses, chronic joint pains are associated with a high usage of herbal medicines (Resch et al., 1997; Setty and Sigal, 2005). With a population of over 30 million, Kenya has slightly over 5000 doctors, 200 of whom are specialists in internal medicine, but very few specialise in joint diseases making the bulk of patients with these ailments to seek help from "whoever they go to" (Oyoo, 2004; Oyoo and Espinoza, 2006). This scenario further hastens the need for locally available, safe, and efficacious products to manage these chronically debilitating conditions. Owing to the fact that herbal medicines are accessible, affordable, culturally acceptable, socially sanctioned, and easy to prepare with little, a lot of people prefer them to the exorbitantly priced health care services (Calixto, 2000; Bodeker and Kronenberg, 2002). Moreover, herbal medicines are an important part of the culture and traditions of the African people (Nanyingi et al., 2008). In addition, they are a preserve of cultural heritage, ethnopharmacological base for drug discovery and biological diversity (Weldegerima, 2009). Furthermore, with changing lifestyles and customs, lack of proper documentation can easily lead to erosion of the traditional medicinal knowledge and resources, which threatens the sustainability of rural healthcare systems (Srithi et al., 2009).This study thus focused on medicinal plants used in the management of chronic joint pains in Machakos and Makueni counties in Kenya, a vast semi-arid region with scarce conventional health facilities. The dominant vegetation of this region is dry bush with shrubs and in the higher areas savannah with scattered trees (Ominde, 1968). The hills were once forested, but by the beginning of the colonial period most of the "desirable" agricultural land had been cleared, leaving patches and corridors of forest along ranges, rivers, ravines, and hilltops, as well as dry forest in large expanses of grazing land (Silberfein, 1989; Ojany and Ogendo, 1973). Several diseases are common in this remote region, and the people rely on the highly respected traditional medical practitioners, who prescribe cures for many of the diseases using herbs and roots, and sometimes charms and rituals (Bisiker et al., 2011; Wagate et al., 2009). The present study was therefore carried out to document the medicinal plants traditionally used in the management of chronic joint pains in the Machakos and Makueni counties, Kenya

2. Materials and methods

2.1. Study area

The greater Machakos encompasses Machakos and Makueni counties, and stretches from latitudes 0°45′ south to 3°0′ south and longitudes 36°45′east to 38°30′ east, with a total population of about 1,678,189 inhabitants, spanning some 14,247 km^2 (Fig. 1). The headquarters of Machakos county is Machakos town, while that of Makueni county is Wote town. The two counties consist

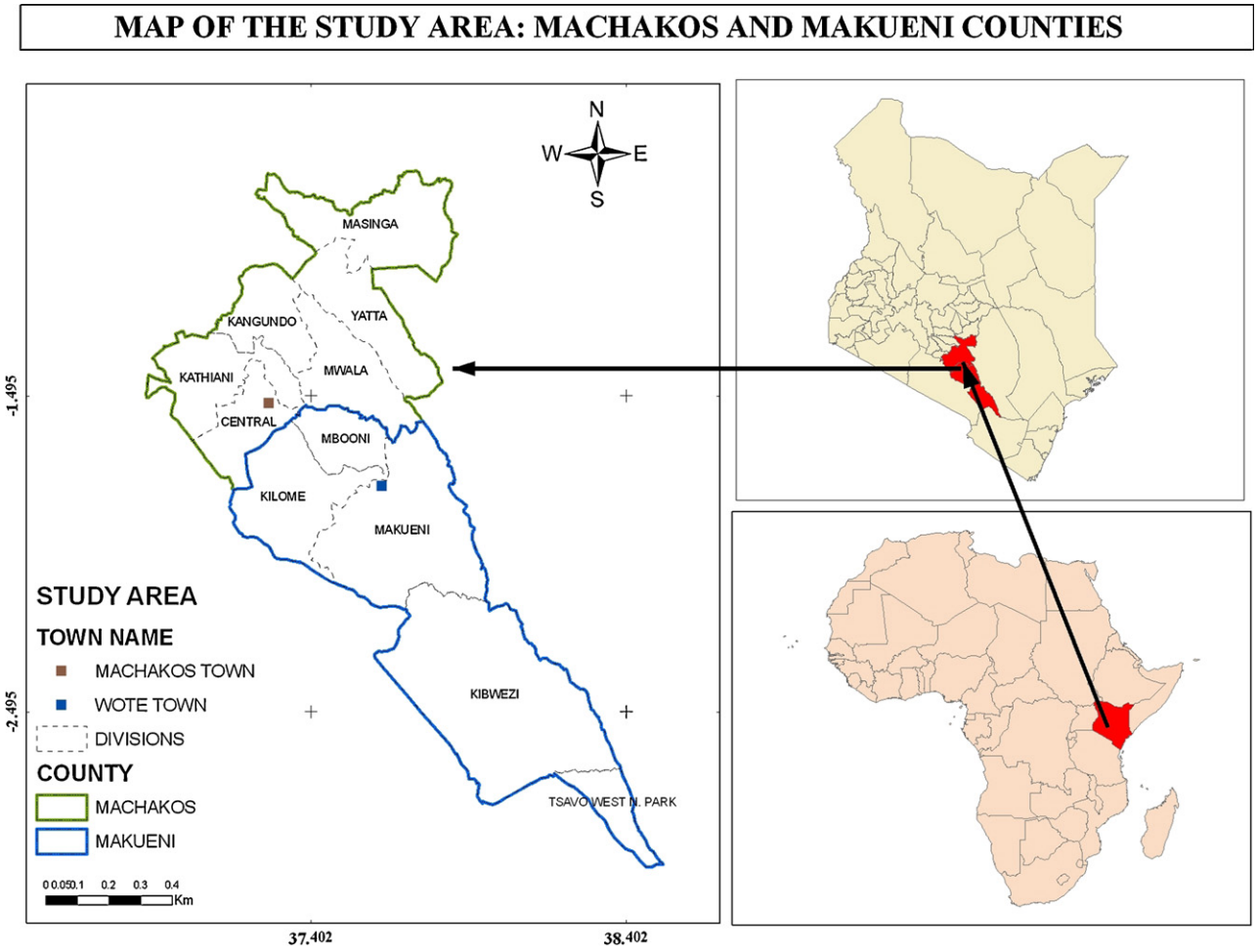

Fig. 1. Map of Kenya showing Machakos and Makueni counties.

of 11 divisions (6 and 5, respectively). The region neighbours Kajiado county (West), Taita Taveta (South), Kitui (East) and Nairobi (West) and Kiambu county (North).

The area has an ecologically distinct climate, with a bimodal rainfall distribution pattern namely: the long rains occurring in March/April while the short rains occur in November/December. The hilly parts of the region receive 800–1200 mm of rainfall per year. Temperature is fairly variable and ranges from 20.2 °C to 24.6 °C and averaging 22.1 °C. The area is characterized by vast plateaus and hills, with bush-land type vegetation. In this region, the Akamba people are the dominant ethnic group with a few Kikuyu and Maasai having settled in the area.

2.2. Data collection

Pilot field studies using rapid community participatory appraisal were conducted between March and May 2009, in which preliminary data was obtained regarding socio-economic and geographical aspects of the region, all of which culminated in an ethnobotanical workshop. The survey involved the use of participatory epidemiological approaches (interviews, questionnaires, focused group discussion and transect walks) involving local community and Traditional Herbal Medicine Practitioners (THMP). Thirty THMPs were selected to participate in the ethnobotanical workshop, based on location, age, sex, number of years in practice and experience in treating joint pains. Selection criteria of the workshop participants were exclusively consenting persons who had been living in the area for a period of not less than 10 years.

2.3. Interviews

A validated semi-structured questionnaire was used to obtain information on medicinal plant knowledge and utilization with special emphasis on chronic joint pains (osteoarthritis and rheumatoid arthritis). The interviews were recorded in specifically designed forms detailing interviewees' personal information, medicinal plant knowledge and utilization as well as the availability and status. In order to obtain sound unbiased information, an introductory seminar by key stakeholders and cultural officers preceded the administration of questionnaires. Leading questions, technical terms and jargons were avoided when asking the questions. All the questions addressed medicinal plant usage in the management of chronic joint pains. The participants were assured that their responses shall remain confidential and will only be used for research purposes. Each informant was interviewed *in camera*. The information obtained included names of plant(s) and part(s) used; method of preparation, dosage and means of administration, storage as well as plant status and habitat. Both formal and informal consents were obtained from the herbalists prior to in interviewing session.

2.4. Sample collection and identification of medicinal plants used to treat joint pains

The medicinal plants that were reported by the herbalists as useful in the treatment of chronic joint pains were collected by a team comprising of a herbalist, the research team and a botanist. The plants were identified by a taxonomist and voucher specimens deposited at the University of Nairobi Herbarium, where each specimen was assigned a specific number. The information collected through both informal and formal discussions were normalized and summarized into meaningful units. Descriptive statistics such as frequencies and percentages were computed.

3. Results

The survey focused on plants used in the treatment of chronic joint pains. Thirty consented THMPs participated in the workshop (21 males and 9 females). Majority of the respondents were mature adults aged between 40 and 80 years (73%) and the greater majority of them had been in practice as herbalists for 10–20 years (37%). Some 37% of respondents had achieved primary school education, while the greater majority (53%) did not attend any formal school at all. In the study area, the most commonly treated chronic joint disorder is osteoarthritis. However, few cases of rheumatoid arthritis were also treated. The disease is commonly referred to as 'Mutambuko', in the Kamba language and its identified by nodular swellings in the fingers and feet (40%), joint stiffness in fingers and legs especially in the morning (70%), joint pain lasting for over one month (80%) and some other none specific symptoms. In general, most of the herbalists had at least seen a case of the disease, and that it is more prevalent in women than men are and the signs are usually symmetrical.

In the study, a total of 37 plants species in 32 genera and 23 families were mentioned as important in the treatment of chronic joint pains (Table 1), and even if a few of the herbalists were able to identify the two conditions using clinical manifestation, there was no difference in treatment between the two conditions, the same recipe were used, this is why they are presented together in Table 1. The most commonly cited plant species were Mukalati (*Pavetta crassipes* K. Schum, 37%), Muteta (*Strychnos henningsii* Gilg., 30%), Mukawa (*Carissa spinarum* L., 23%), Muvindavindi (*Fagaropsis hildebrandtii* (Engl.) Milve-Redh., 20%) and Mukenea (*Zanthoxylum chalybeum* Engl., 20%) (Table 1). The highest representative plant families were Fabaceae (7) and Asteraceae (4); followed by Verbenaceae, Rutaceae and Solanaceae (2 each). Morphologically, the plant parts most commonly used to treat chronic joint pains and rheumatoid arthritis were leaves (13.5%), root/stem bark (10.8%), followed by leaves/root, leaves/stem bark and stem (8.1% each). The medicinal plants are mainly used in dry form, but fleshy plants are also useful. The herbalists reported that the mature plants are preferred, and they are be harvested at any time of the year as long as they are available, and are usually collected when needed. Occasionally the plants that are scarce, particularly during the dry season, are collected when in abundance dried under the shade and stored until needed.

In addition, eight plant species are documented for the first time as being useful in the treatment of chronic joint pains, i.e. osteoarthritis and/or rheumatoid arthritis. These are *Acacia mellifera* (Vahl) Benth. (Fabaceae), Amaranthus *albus* L. (Amaranthaceae), *Balanites grabber* Mildbr. & Schltr. (Zygophyllaceae), *Grewia fallax* K. Schum. (Malvaceae), *Lactuca capensis* (Asteraceae), *Launaea cornuta* (Oliv. & Hiern) O. Jeffrey (Asteraceae), *Lippia kituiensis* Vatke (Verbenaceae), *Pappea capensis* Eckl. & Zeyh. (Sapindaceae) and *Pennisetum glaucum* (L.) R. Br. (Poaceae) (Table 2).

In the study area, diverse varieties of approaches were employed in the treatment of chronic joint pains. A large number of plants were reported as being utilized in the prescriptions and all herbalists used a combination of more than three medicinal plants in their prescriptions. The most commonly employed methods of preparation were by boiling, infusion, powder, and maceration of plant parts.

All the respondents reported using the oral route in administering their medicines. However, few THMPs additionally apply the medicinal preparation topically on the swollen and painful parts of the body. The oral dose of the herbal remedies varied among the THMPs but generally most of them reported administering one glass (about 200 ml), twice to thrice per day for two weeks or until patient recovers (Table 1). Some TMHPs advocate for mixing medicinal plant preparations with soup to improve responsiveness. The

Table 1
List of medicinal plants traditionally used in the management of chronic joint pains in Machakos and Makueni counties, Kenya.

Family	Botanical name and voucher number	Kamba name	Part(s) used	Method of preparation and administration	Life form	Status	*N* (%)
Amaranthaceae	*Amaranthus albus* L. (SN 126)	Terere	Seeds, shoots, whole	Ground seeds or dried leave powder soaked in water for infusion, and is drunk as one glass 2–3 times daily, for 2 weeks or until recovery	Herb	Wild, cultivated	2 (6.7)
Apocynaceae	*Carissa spinarum* L. (SN 129)	Mukawa	Leaves, fruits, roots, stem bark	Boiled in water and concoction drunk, one glass 3 times daily, for 14 days or until patient recovers. Usually taken with soup. *Pavetta crassipes* leaves, *Strychnos henningsii* leaves and *Zanthoxylum chalybeum* leaves	Shrub	Wild	7 (23.3)
Asteraceae	*Lactuca capensis* Thunb. (SN 107)	Muuluki	Leaves	Boiled in water and drunk, one glass 2–3 times daily, for 14 days or until patient recovers	Shrub	Wild	1 (3.3)
Asteraceae	*Launaea cornuta* (Oliv. & Hiern) O. Jeffrey (SN 118)	Muthunga	Shoots, whole	Macerated in water and infusion drunk, one glass 2–3 times daily, for 2 weeks	Herb	Wild, weed	1 (3.3)
Asteraceae	*Schkuhria pinnata* (Lam.) Kuntze ex Thell. (SN 124)	Kalila/Kakumimi	Whole	Macerated in water and infusion drunk, one glass 2–3 times daily, for 2 weeks or until one recovers	Herb	Wild, weed	5 (16.7)
Asteraceae	*Tithonia diversifolia* (Hermsi.) A. Gray (SN 114)	Mulaa	Leaves, stem bark	Macerated in water and infusion drunk, one glass 2–3 times daily, for 2 weeks or until one recovers	Shrub	Wild	1 (3.3)
Capparaceae	*Boscia salicifolia* Oliv. (SN 130)	Mwenzenze	Leaves	Boiled in water and concoction drunk. One glass 2–3 times daily, for 14 days or until patient recovers. Sometimes taken with soup. Usually boiled with *Strychnos henningsii* leaves and *Carissa spinarum* root bark	Shrub	Wild	5 (16.7)
Combretaceae	*Terminalia brownii* Fresen. (SN 110)	Muuku	Roots, stem bark	Hot water extract taken orally, one glass 2–3 times daily, for 2 weeks	Tree	Wild	2 (6.7)
Euphorbiaceae	*Ricinus communis* L. (SN 125)	Mbaiki	Seeds	Boiled in water and decoction taken, one glass once daily, for 2 weeks. Usually taken with soup	Shrub	Cultivated, wild	2 (6.7)
Fabaceae	*Acacia mearnsii* De Wild. (SN 135)	Munyoonyoo	Roots, stem bark	Boiled in water and concoction taken orally, one glass 2 times daily, for 14 days or until patient recovers. Sometimes mixed with *Pavetta crassipes* leaves	Tree	Wild	1 (3.3)
Fabaceae	*Acacia mellifera* (Vahl) Benth. (SN 109)	Muthiia	Root, stem bark	Boiled in water and concoction taken orally, one glass 2 times daily, for 14 days or until patient recovers. *Pavetta crassipes* leaves	Shrub	Wild	3 (10)
Fabaceae	*Acacia nilotica* (L.) Willd. ex Delile (SN 112)	Musemei	Leaves, root, stem bark	Boiled in water and concoction taken orally with soup, one glass 2 times daily, for 14 days or until patient recovers. Sometimes boiled with *Pavetta crassipes* leaves	Tree	Wild	2 (6.7)
Fabaceae	*Acacia seyal* Del. (SN 116)	Musewa	Stem bark	Boiled in water and concoction taken orally, one glass 2–3 times daily, for 14 days or until patient recovers. Usually boiled together with *Strychnos henningsii* leaves and *Pavetta crassipes* leaves	Tree	Wild	1(3.3)

Table 1 (*Continued*)

Family	Botanical name and voucher number	Kamba name	Part(s) used	Method of preparation and administration	Life form	Status	*N* (%)
Fabaceae	*Cajanus cajan* (L.) millisp. (SN 121)	Musuu	Leaves, seeds	Seeds are Ground, soaked in water for infusion, and drunk. One cup taken 1–2 times daily, until recovery. Usually taken as porridge. Leaves macerated in hot water and taken as infusion	Herb	Cultivated	1 (3.3)
Fabaceae	*Cassia spectabilis* (DC.) Irwin & Barneby (SN 111)	Mukengeta/Itula	Leaves, stem bark	Macerated in hot water and taken as infusion, one glass 2–3 times daily, for 14 days or until patient recovers	Tree/shrub	Wild	1 (3.3)
Fabaceae	*Piliostigma thonningii* (Schum.) Milne-Redh. (SN 134)	Muti Mukuu (Mukuu)	Leaves, root, stem bark	Boiled in water and taken as infusion, one glass 2–3 times daily, for 14 days or until patient recovers	Tree	Wild	2 (6.7)
Lamiaceae	*Ocimum suave* Willd. (SN 115)	Mukandu	Leaves, roots,	Plant is cut into pieces or ground, macerated in hot water for infusion, and is drunk. One glass 2–3 times daily for 2 weeks	Herb	Wild, weed, cultivated	2 (6.7)
Lamiaceae	*Ajuga remota* Benth. (SN 122)	Katetema	Leaves, roots, whole	Plant is cut into pieces or ground, macerated in hot water for infusion, and is drunk. One glass 2–3 times daily for 2 weeks	Herb	Wild, cultivated	1 (3.3)
Lamiaceae	*Clerodendrum myricoides* spp. *myricoides* (Hochst.) R. Br. ex Vatke (SN 108)	Muvweia	Roots	Boiled in water and concoction taken orally, one glass 2–3 times daily, for 14 days or until patient recovers. Usually boiled together with *Strychnos henningsii* leaves and *Carissa spinarum* root bark	Shrub	Wild	2 (6.7)
Loganiaceae	*Strychnos henningsii* Gilg. (SN 128)	Muteta	Leaves, stem bark	Hot water extract taken orally, one glass taken 2–3 times daily for 14 days or until patient recovers. Usually taken with soup. Sometimes boiled together with *Pavetta crassipes* leaves, *Carissa spinarum* root bark and *Zanthoxylum chalybeum* leaves	Shrub	Wild, cultivated	9 (30)
Malvaceae	*Grewia fallax* K. Schum. (SN 151)	Ilawa	Leaves, stem bark	Boiled and taken as infusion, one glass 2–3 times daily for two weeks	Shrub	Wild	1 (3.3)
Moraceae	*Ficus sycomorus* L. (SN 133)	Mukuyu	Fruits, stem bark	Boiled in water and concoction taken orally, one glass 2–3 times daily, for 14 days or until patient recovers. Usually boiled together with *Strychnos henningsii* leaves and *Carissa spinarum* root bark	Tree	Wild	1 (3.3)
Oleaceae	*Olea europaea* L. (SN 136)	Mutamaiyu	Stem bark	Boiled in water and concoction taken orally with soup, one glass 2–3 times daily, for 14 days or until patient recovers. Usually boiled together with *Strychnos henningsii* leaves and *Carissa spinarum* root bark	Tree	Wild	1 (3.3)
Poaceae	*Pennisetum glaucum* (L.) R. Br. (SN 140)	Mwee	Seeds	Ground seeds soaked in water for infusion, and are drunk one glass 2–3 times daily, for 14 days or until patient recovers	Herb	Cultivated	2 (6.7)
Polygonaceae	*Rumex usambarensis* Dammer (SN 104)	Kyuvi	Leaves	Oral, 2 glasses taken twice daily for two weeks or until recovery	Herb	Wild, cultivated	5 (16.7)

Table 1 (*Continued*)

Family	Botanical name and voucher number	Kamba name	Part(s) used	Method of preparation and administration	Life form	Status	*N* (%)
Rhamnaceae	*Scutia myrtina* (Burm. f.) Kurz (SN 137)	Osanangururi	Stem bark	Boiled in water and concoction taken orally, one glass 2–3 times daily, for 14 days or until patient recovers. Usually boiled together with *Strychnos henningsii* leaves and *Carissa spinarum* root bark	Tree	Wild	1 (3.3)
Rubiaceae	*Pavetta crassipes* K. Schum (SN 103)	Mukalati	Leaves	Hot water extract taken oral, one glass is taken 3 times daily for 14 days or until patient recovers. Usually boiled together with *Strychnos henningsii* leaves, *Carissa spinarum* root bark and *Zanthoxylum chalybeum* leaves	Herb	Wild, cultivated	11 (36.7)
Rutaceae	*Fagaropsis hildebrandtii* (Engl.) Milne-Redh. (SN 113)	Muvindavindi	Leaves, roots, shoots	Boiled in water and concoction taken orally, one glass 2–3 times daily, for 14 days or until patient recovers. Usually boiled together with *Strychnos henningsii* leaves and *Carissa spinarum* root bark	Shrub	Wild, cultivated	6 (20)
Rutaceae	*Zanthoxylum chalybeum* Engl. (SN 131)	Mukenea	Leaves, roots	Boiled in water and concoction taken orally, one glass 2–3 times daily, for 14 days or until patient recovers. Usually boiled together with *Strychnos henningsii* leaves and *Carissa spinarum* root bark. Sometimes taken with soup	Shrub	Wild, cultivated	6 (20)
Salvadoraceae	*Salvadora persica* L. (SN 138)	Mukayau	Roots, stem bark	Boiled and taken as infusion, one glass daily for two weeks. Sometimes taken with soup	Shrub	Wild	2 (6.7)
Sapindaceae	*Pappea capensis* Eckl. & Zeyh. (SN 149)	Muvaa	Roots, stem bark	Boiled and taken as infusion, one glass daily for two weeks	Tree/shrub	Wild	2 (6.7)
Solanaceae	*Solanum incanum* L. (SN 119)	Mukondu	Roots	Boiled and taken as infusion, one glass 2–3 times daily for two weeks or until one recovers.	Shrub	Wild	1 (3.3)
Solanaceae	*Withania somnifera* (L.) Dunal (SN 120)	Mwianzo	Leaves, roots, stem bark	Boiled and taken as infusion, one glass 2–3 times daily for two weeks	Shrub	Wild	1 (3.3)
Verbenaceae	*Lantana camara* L. (SN 139)	Mutavasi/Mushomoro	Leaves	Macerated in hot water and taken as infusion, one glass 2–3 times daily, for 14 days or until patient recovers	Shrub	Wild	1 (3.3)
Verbenaceae	*Lippia kituiensis* Vatke (SN 141)	Muthiti wa Nthi	Roots	Boiled in water and drunk as infusion, one glass every other day, for two weeks	Shrub	Wild	1 (3.3)
Xanthorrhoeaceae	*Aloe secundiflora* Engl. (SN 123)	Kiluma	Leaves, roots	Fleshy young stem juice is applied on painful area 3–4 times a day to reduce pain and to promote rapid healing of injured tissues. Aloe gel macerated in hot water and taken orally. 1 glass 2 times daily for 2 weeks	Herb	Wild, cultivated	4 (13.3)
Zygophyllaceae	*Balanites glaber* Mildbr. & Schltr.(SN 173)	Olongoswa	Roots	Boiled in water and concoction taken orally, one glass 2–3 times daily, for 14 days or until patient recovers. Usually boiled together with *Strychnos henningsii* leaves and *Carissa spinarum* root bark	Tree	Wild	1 (3.3)

N; represents the number of herbalists mentioning the use of the species for treating chronic joint pains.

Table 2
Plant species collected from Machakos and Makueni counties based on traditional knowledge on their use in pain management, and cross-reference in published literature on ethnopharmacological use.

Botanical name and family	Biological activity/chemical constituents	Ethnomedicinal uses
Acacia mearnsii (Fabaceae)	Bark rich in proanthocyanidins; strong antioxidant and anti-tumour activity (Huang et al., 2010; Shen et al., 2010)	Used in management of HIV (Lamorde et al., 2010). Used treat abortion related illnesses in animals in central Kenya (Njoroge and Busman, 2006)
Acacia mellifera (Fabaceae)	In vitro cytotoxic Lupane triterpenoids (Mutai et al., 2007)	Root decoction used in stomach ailments, malaria, and general infections (Kokwaro, 1993; Maundu et al., 2005)
Acacia nilotica (Fabaceae)	In vitro antiplasmodial activity; terpenoids and tannins (El-Tahir et al., 1999). In vivo anti-inflammatory, antipyretic activity (Dafallah and Al-Mustafa, 1999). Trypanocidal activity (Freiburghaus et al., 1996)	Used in the treatment of Gonorrhoea, chest pains, coughs, stomach aches, fevers and gonorrhoea (Kokwaro, 1993; Maundu et al., 2005)
Acacia seyal(Fabaceae)	No previous reports	Root decoction used in general illnesses (Kokwaro, 1993) and breast pain (Lulekal et al., 2008)
Ajuga remota (Lamiaceae)	In vitro antimalarial and antiplasmodial activity; ajugarin-1 and ergosterol-5, 8-endoperoxide (Kuria et al., 2001; Muregi et al., 2007). In vivo anti-inflammatory, analgesic (Debella et al., 2003; Makonnen et al., 2003), antioxidant (Matu and Staden, 2003) and antipyretic activity (Debella et al., 2005). Antifungal activity (Kariba, 2001)	Leave infusion taken for fever, t e, high blood pressure in Eastern Africa (Kokwaro, 1993). Concoction of leaves taken against malaria (Njoroge and Busman, 2006)
Aloe secundiflora (Xanthorrhoeaceae)	Antimalarial activity (Oketch-rabah et al., 1999; Nguta et al., 2010). Leave exudates contains phenolic compounds, mainly anthrones (aloenin, aloenin B, isobarbaloin, barbaloin and other aloin derivatives), chromones and phenylpyrones (Rebecca et al., 2003)	Used for rheumatism, malaria, headache, pneumonia and chest pains in Kenya (Kokwaro, 1993; Maundu et al., 2005)
Amaranthus albus (Amaranthaceae)	No previous reports	Roots used to treat stomachache (Maundu et al., 2005)
Balanites glaber (Zygophyllaceae)	No previous reports	Used in treating various ailments (Kiringe and Okello, 2004). Reported to cause abortion in goats (Kiptot, 2007)
Boscia salicifolia (Capparaceae)	Aqueous extract posses antihelmintic activity (Waterman et al., 2010); leaves contain flavanol glycosides (Pauli and Sequin, 1996). Antiplasmodial and antimalarial activity (Gathirwa et al., 2007, 2008; Kazembe and Nkomo, 2010); flavanol glycosides (Walter and Séquin, 1990)	Used as a dewormer (Gathirwa et al., 2007, 2008) and decoction used to treat headache, fevers, stomach ache and other painful conditions (Kokwaro, 1993)
Cajanus cajan (Fabaceae)	Leaf extract shows antioxidant activity; cajaninstilbene acid (3-hydroxy-4-prenylmethoxystilbene-2-carboxylic acid), pinostrobin, vitexin and orientin (Wu et al., 2009, 2011). Anti-cancer activities of Cajanol, a root extract (Luo et al., 2010)	Used in the treatment of diabetes (Espósito-Avella et al., 1991)
Carissa spinarum (Apocynaceae)	Antioxidant (Rao et al., 2005) and anti-viral activity studied (Tolo et al., 2006). Identified bioactive components include sitosterol, lupeol and urosolic acid (Rao et al., 2005). Antipyretic activity (Hegde and Joshi, 2010). Aqueous ethanolic extract demonstrated anticonvulsant activity (Ya'u et al., 2008)	Decoction of root and stem used in rheumatism, arthritis, inflammatory conditions and fevers (Maundu et al., 2005; Hegde and Joshi, 2010). Has purgative, anticancer and wound healing effects; snake repellant activity (Maundu et al., 2005). Root powder sprinkled onto burning charcoal and inhaled to treat 'evil eye' (bad omen) (Teklehaymanot and Giday, 2007). Reportedly used to treat many different ailments
Cassia spectabilis (Apocynaceae)	Antifungal, antioxidant, and antibacterial activity (Sangetha et al., 2009; Torey et al., 2010). Leaves contain piperidine alkaloids, (−)-3-*O*-acetylspectaline, (−)-7-hydroxyspectaline, iso-6-spectaline and (−)-spectaline (Viegas et al., 2004)	Used for the treatment of flu and cold, as a laxative and purgative (Lawal et al., 2010; Torey et al., 2010)
Clerodendrum myricoides spp. *myricoides* (Verbenaceae)	Anti-malarial, anti-inflammatory, antipyretic and antioxidant activity (Muregi et al., 2007). Steroids, terpenes and flavanoids (Shrivastava and Patel, 2007)	Root decoction (usually boiled with soup) for treatment of chest pains, arthritis, rheumatism, sore throat, malaria, and fevers (Kokwaro, 1993; Njoroge and Busman, 2006). Root decoction used to treat GIT, Lumbago, Venereal Diseases (Nanyingi et al., 2008)
Fagaropsis hildebrandtii (Rutaceae)	Benzophenanthridine alkaloids and limonoids (Boustie et al., 1995)	Leaves and root bark decoction used to treat malaria, arthritis and chest pains in east Africa (Maundu et al., 2005; Njoroge and Busman, 2006). Leave decoction used to treat morning sickness and infertility (Musila et al., 2004)
Ficus sycomorus (Moraceae)	Anti-inflammatory and anticancer activity (Lansky et al., 2008). Inhibition of smooth and skeletal muscle contraction; gallic tannins, saponins, reducing sugars, alkaloids and flavone aglycones (Sandabe et al., 2006)	Sap used for toothache and powdered bark infusion for dysentery (Maundu et al., 2005)
Grewia fallax (Malvaceae)	No previous reports	Roots used for treating chest pains (Kokwaro, 1993). Used as antivenin for snakebites (Owuor and Kisangau, 2006).
Lactuca capensis (Asteraceae)	No previous reports	Root decoction given to patients with syphilis and gonorrhoea (Kokwaro, 1993)
Lantana camara (Verbenaceae)	Antimicrobial activity (Badakhshan et al., 2009). Neurotoxic to animals (Bevilacqua et al., 2010)	Decoction used to treat fever, headache, wounds, and chest pains (Kokwaro, 1993)
Launaea cornuta (Asteraceae)	No previous reports	Root decoction used to treat typhoid (Kokwaro, 1993)
Lippia kituiensis (Verbenaceae)	No previous reports	Infusion of leaves used to treat fever (Kokwaro, 1993)
Ocimum suave (Lamiaceae)	In vivo antipyretic activity (Makonnen et al., 2003)	Leave infusion used to treat stomachache, crackling feet, and rheumatism (Kokwaro, 1993; Maundu et al., 2005)

Table 2 (*Continued*)

Botanical name and family	Biological activity/chemical constituents	Ethnomedicinal uses
Olea europaea (Oleaceae)	In vitro antioxidant activity (Benavente-García et al., 2000)	Bark infusion drunk to treat tapeworms (Kokwaro, 1993)
Pappea capensis (Sapindaceae)	No previous reports	Bark decoction taken with soup to treat stomach problems and diarrhoea (Kokwaro, 1993; Maundu et al., 2005)
Pavetta crassipes (Rubiaceae)	Alkaloids with in vitro antiplasmodial activity (Sanon et al., 2003b). Smooth muscle relaxant activity (Amos et al., 1998), hypotensive activity (Amos et al., 2003) and anticonvulsant activity (Amos et al., 2004)	Leave decoction used to treat painful body conditions in Africa (Maundu et al., 2005; Abubakar et al., 2007); leaves used to treat malaria (Sanon et al., 2003a, b). Leaves used to treat mental illnesses and convulsions (Amos et al., 2004)
Pennisetum glaucum (Poaceae)	High oxalate concentration (Libert and Franceschi, 1987)	Grain flour reported to good for diarrhoea (Maundu et al., 2005)
Piliostigma thonningii	In vivo anti-inflammatory and antibacterial activity; C-methylflavonols (Ibewuike et al., 1997; Olakunle, 2011). Antibacterial activity; antihelmintic activity (Akinpelu and Obuotor, 2000)	Leaves chewed to cure stomach pains in East Africa (Kokwaro, 1993). Root and leaf infusion drunk for cough and chest problems (Maundu et al., 2005)
Ricinus communis (Euphorbiaceae)	Seeds have in vivo antinociceptive effects (Okwuasaba et al., 1991). Ricin from seed oil can be toxic (Audi et al., 2005)	Root decoction taken to treat stomach problems and stimulate appetite. Seeds crushed and taken in stomachache in Kenya (Kokwaro, 1993)
Rumex usambarensis (Polygonaceae)	Leave extract has some antifungal activity (Kisangau et al., 2009)	Concoction taken in peptic ulcers and diarrhoea (Boer et al., 2005). Leaves used for coughs, stomach pains and decoction of whole plant used to treat small pox as a bath (Kokwaro, 1993; Schlage et al., 2000)
Salvadora persica (Salvadoraceae)	Antibacterial activity; alkaloid salvadorine (Almas and Al-Bagieh, 1999)	Root decoction used to cure abdominal pains, chest diseases, wounds and young stems used as toothbrush (Kokwaro, 1993)
Schkuhria pinnata (Asteraceae)	Antibacterial, anti-inflammatory activities (Luseba et al., 2007). Isolated compounds include sesquiterpene lactones, heliangolides, germacranolide, schkuhripinnatolide C and pectolarigenin (Pacciaroni et al., 1995)	Plant used in treating joint, chest and abdominal pains (Kokwaro, 1993); abortifacient and contraceptive (Van Wyk and Gericke, 2000)
Scutia myrtina (Rhamnaceae)	Antiproliferative and anti-malarial activity; anthraquinones (Hou et al., 2000)	Root decoction used as a dewormer (Kokwaro, 1993)
Solanum incanum (Solanaceae)	Anticancer activity; glycoalkaloid solamargine (Kuo et al., 2000)	Unripe fruits used to treat pains associated with teething in children. Leaves taken for stomachache (Maundu et al., 2005)
Strychnos henningsii (Loganiaceae)	Antioxidant activity (Oyedemi et al., 2010); holstiine, splendoline, 23-hydroxyspermostrychnine, 19-epi-23-hydroxyspermostrychnine, retuline, henningsiine, and other alkaloids (Massiot et al., 1991)	Decoctions from roots and leaves used to treat chest pains in Kenya (Kokwaro, 1993). Treatment of inflammatory joint diseases and rheumatism (Tits et al., 1991)
Terminalia brownii (Combretaceae)	In vitro antimicrobial activity of root and stem extracts (Mbwambo et al., 2007)	The stems and branches fumigants are used to treat rheumatic and back pains. Phloem fibres used to treat yellow fever (Kokwaro, 1993) in Kenya
Tithonia diversifolia (Asteraceae)	In vitro anti-inflammatory and analgesic activity (Owoyele et al., 2004). Anti-tumour activity (Huang et al., 2011). Anti-malarial activity (Muganga et al., 2010). Hepato-renal toxicity (Elufioye et al., 2009)	Used in painful conditions in Nigeria (Owoyele et al., 2004)
Withania somnifera (Solanaceae)	Antiproliferative activity; withanolides-steroidal derivatives (Jayaprakasam et al., 2003). Immunomodulatory and anti-inflammatory effects (Scartezzini and Speroni, 2000; Rasool and Varalakshm, 2006)	Root decoction used to treat toothache, stomach pains, inflammations and gonorrhoea in Kenya. Heated leaves are applied to various parts of the body as pain killers (Kokwaro, 1993; Jayaprakasam et al., 2003; Rasool and Varalakshm, 2006)
Zanthoxylum chalybeum (Rutaceae)	Different parts show anti-inflammatory and antibacterial activity (Matu and Staden, 2003); antiplasmodial activity (Gessler et al., 1994), quinoline alkaloids and protoberberines (Kato et al., 1996)	Leaves, bark or root decoction used for chest pains, colds, respiratory diseases, malaria and fevers (Gessler et al., 1994; Maundu et al., 2005; Nguta et al., 2010). Bark infusion (with that of *Terminalia brownii*) applied to wounds) and fresh shoots and seeds used as toothbrush and air fresheners (Johns et al., 1990; Maundu et al., 2005)

medicinal preparations are generally prepared just before use, but if need be, storage does not exceed 5 days. Powders on the other hand last as long as needed, but were always kept in dry environment and away from direct sunlight. There were no side effects reported by the traditional healers upon use of their herbal remedies. The herbalists further claimed that their herbal remedies cure chronic joint pains, usually within a period of two to four weeks, and eliminate or alleviate symptoms of rheumatoid arthritis in a similar period for as long as one continually takes the medicine as prescribed.

Analysis of the species habitat revealed that shrubs, herbs and trees are the main important sources of herbal remedies for the treatment of chronic joint pains in the area (14 and 10, respectively). Most of the plants mentioned occur naturally in the wild (35/37), while three (3) are exclusively cultivated. However, with increasing disappearance of these plants in the wild, some THMPs reported cultivating some of the medicinal plants (11/30). Moreover, some of the plants are endangered or of unknown status (*Ficus sycomorus* and *Fagaropsis hildebrandtii*).

4. Discussion

The study identified 37 plants distributed in 32 genera and 23 families used in the treatment of chronic joint pains in Machakos and Makueni Counties. Most of these plants are known to be used in the treatment of various painful and inflammatory conditions as well (for example *Acacia* spp., *Aloe secundiflora*, *Carissa spinarum, Clerodendrum myricoides*, *Piliostigma thonningii*, *Strychnos henningsii*, *Terminalia brownie*, *Withania somnifera* and *Zanthoxylum chalybeum*) (Table 2). In addition, isolation of bioactive phytoconstituents has been successfully done in some like *Acacia* spp., *Ajuga remota*, *Aloe secundiflora*, *Carissa* spp., *Clerodendrum myricoides*, *Ficus sycomorus*, *Pavetta crassipes*, *Schkuhria pinnata*, *Strychnos henningsii, Withania somnifera* and *Zanthoxylum chalybeum*) (Table 2).

This is in agreement with their reported ethnomedicinal uses in other places (Stepp and Moerman, 2001; Namse et al., 2009). However, 8 plant species are documented for the first time as being useful in the management of chronic joint pain. This could perhaps be due to the geological characteristics of the study area, particularly with the frequent episodes of drought, making the plants to synthesis chemical that enhance their survival in this harsh environment.

It is interesting to note that *Pavetta crassipes* K. Schum, which was the most cited species, has not been reported to posses' analgesic, antioxidant or anti-inflammatory activity. Additionally, *Rumex usambarensis* (Dammer) has not been investigated on its pain alleviating properties though reported to be used in traditional medicine (Kisangau et al., 2009) (Table 2). On the hand, *Strychnos henningsii* Gilg., *Carissa spinarum* L. and *Zanthoxylum chalybeum* Engl. have been reported by various investigators as possessing significant pain alleviating activities on different tests (Massiot et al., 1991; Tits et al., 1991; Matu and Staden, 2003; Rao et al., 2005; Oyedemi et al., 2010) (Table 2). It would therefore be worth to explore the analgesic and anti-arthritic properties of some of these plant species, particularly *Pavetta crassipes* K. Schum, *Fagaropsis hildebrandtii* (Engl.) Milne-Redh. and *Rumex usambarensis* (Dammer). In addition some of these plants used in this community have been reported in in vitro and in vivo studies to posse's anti-inflammatory and anti oxidant effects, namely *Acacia nilotica* (Dafallah and Al-Mustafa, 1999), *Ajuga remota* (Makonnen et al., 2003).

Majority of the THMPs interviewed use either flesh or dried leaves suggesting a higher concentration of the active agents on this part of the plant. This may arise from the fact that leaves act as reservoirs for photosynthates or exudates that are thought to contain toxins for plant protection and survival which consequently, find medicinal value in human health (Balick and Cox, 1996). Roots were the second most frequently used plant part and this usually but not always involves uprooting the whole plant. This is unsustainable method of harvesting that pose danger to the conservation status of some of these rare indigenous plant species. To mitigate these, the herbalist harvest some roots on one side, and leave the plant to rejuvenate more roots before harvesting again. This is particularly so with *Fagaropsis hildebrandtii* (Engl.) Milve-Redh., which is now increasingly being cultivated by the THMPs in the study area, fearing its disappearance from their ecosystem.

Unlike in most studies where herbal remedies for the treatment of inflammatory diseases are mainly applied topically (Namse et al., 2009), the respondents in this study reportedly administer their prescriptions for chronic join pains exclusively via the oral route. However, few of the THMPs additionally prescribe topical treatments, by applying it on the aching parts of the body. The duration of treatments was generally long, usually lasting for at least two weeks or until recovery, perhaps due to the chronic nature of chronic joint pains and rheumatoid arthritis (Bendele, 2001; Goldring and Goldring, 2006).

Medicinal plant preparations for treating join pains and rheumatoid arthritis usually entail a complex combination of different plants, plant parts, and methods of preparation (Lee, 2000; Laupattarakase et al., 2003; Chrubasik et al., 2007; Park et al., 2007). Combined plant extracts offer a more wide range of biological effects, which are attributable to additive and synergistic effects, and indeed this may be the future direction in the development of efficacious, safe, and cost effective phytopharmacotherapeutics world over (Park et al., 2007). Several herbal-based traditional medicines are commercially available patented phytopharmaceutical products (Darshan and Doreswamy, 2004). However, a major challenge to the use of traditional phyto remedies is lack of proper standardization, safety measures, quality control, as well as adulteration with conventional medicines (WHO, 1998, 2003; Bodeker and Kronenberg, 2002; Harnischfeger, 2005). It is thus recommended that all phytochemical substances be scientifically validated for their claimed efficacy, safety and toxicity (WHO, 1998, 2003).

5. Conclusion

The present study has shown that the people in the Machakos and Makueni counties in Eastern province of Kenya have a very good know how on medicinal plants and herbal remedies for management of chronic joint pains (osteoarthritis and rheumatoid arthritis). Moreover, eight plants are reported for the first time as being important in the treatment of these chronic joint pains. In addition, some of plants mentioned have been found to posses' anti-inflammatory, anti-nociceptive and anti oxidant properties, both in in vitro and in vivo studies. The herbal remedies are made from a diverse array of combinations of different plants and parts, perhaps indicating the synergistic advantage of phytopharmacotherapeutics, as opposed to use of a single plant part, particularly while dealing with conditions of multifactorial causative factors. The THMPs in the study also expressed the need for concerted efforts in environmental conservation to cub the rapid disappearance of important plant species, which would otherwise lead to the disappearance of potentially useful new medicines. Machakos and Makueni counties are regions where traditional medicines are the main form of treatment and part of culture. In addition, in this region acceptability and reliability of herbal remedies is very high, particularly while dealing with chronic illnesses. It is therefore important that such important information on traditionally used medicinal plants is documented and appropriately preserved to avoid erosion of our cultural heritage as well as to form a bases for scientific validation of their claimed efficacy and safety, with a view to developing better remedies for such chronically painful debilitating joint conditions. Furthermore, conservational measures need to be addressed accordingly as the region is facing vast environmental degradation which threatens to wipe out its rich fauna and flora, as being a low socio-economic class, the inhabitants are less likely to afford any other form of treatment other than that of medicinal plants, as well as to avoid erosion of this prestigious cultural heritage.

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