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Full Length Research Paper

Survey of the ethnobotanical uses of *Ximenia americana* L. (*mumpeke*) among rural communities in South Angola

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An insight into the cosmetic and medicinal importance of *Ximenia americana* (*mumpeke*) in South Angola is provided. In the years 2009 and 2010 a field investigation was carried out in four rural communities, in order to gather information on traditional uses of this species. Sixty-eight informants were interviewed and 71% reported the use of *X. americana*. A total of 210 citations were recorded for 13 different uses: 9 medicinal (84 citations), 3 cosmetic (125) and 1 veterinary (1). The most relevant use resulted to be direct application of the oil extracted from seeds as a cosmetic for body and hair care and as a medicinal remedy to prevent varicose veins. Minor medicinal and veterinary uses of leaves were also recorded. Quantitative analyses showed that the use of *mumpeke* oil both as a cosmetic and as a medical remedy is widely and homogenously distributed within the communities (UE = 1). The category 'cosmetic uses' showed also the higher use diversity index (UD = 0.59). No statistically significant difference emerged in the number of uses cited by the informants grouped either for gender or for age. Yet, when comparing the distribution of citations with Hurlbert's PIE, women and >40 yrs informants showed a significantly higher use diversity. The distribution of knowledge among communities is also analyzed and discussed. Local traditional technique of oil extraction is described, based on direct observation in the investigated communities. *Mumpeke* oil is a potential economic resource for local communities and could provide important opportunities in increasing family income.

Key words: Angola, ethnobotany, ethnopharmacology, *Ximenia americana*, *mumpeke*, *mumpeke* oil, medicinal uses, cosmetic uses, quantitative analyses.

INTRODUCTION

Non wood forest products (NWFPs) are products of biological origin other than wood derived from forests andallied land uses (Belcher, 2003). NWFPs can be a significant part of local household economy which meets the community needs, at the same time assuring forest resources conservation. In recent years, international interest for natural products which can replace or at least be combined with synthetic products is considerably increasing, providing new opportunities for economic and social development in rural areas, especially in developing countries. Plants with medicinal and cosmetic properties can play an important role in this field Undoubtedly, cosmetic uses of oils extracted from seeds of different plant species are currently one of the fastest growing sectors in the global phytotherapic market. In Africa, several plants are known to produce seeds containing fats used in cosmetics and skin care products, as is the case of '*argan* oil' (extracted from *Argania spinosa*) in Morocco, '*marula* oil' (from *Sclerocarya birrea*) in Southern Africa, and '*shea* (or *karité*) butter' (from *Vitellaria paradoxa*) in Western Africa. Another significant example can be found in the use of '*mumpeke* oil' (from

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a) b)

Figure 1. *Ximenia americana*: a) a twig with leaves and fruit; b) dried fruits, kernels and seeds.

Ximenia americana) in different regions of tropical Africa.

Ximenia americana L. and its traditional uses

Ximenia americana L. (Olacaceae) - also known as 'wild plum', 'yellow plum' or 'sea lemon' - is a semi-scandent shrub or small tree with small elliptic leaves and whitish to yellowish-green flowers borne in small cymes. The fruit is a drupe, 20 to 30 mm long, oval-shaped, somehow resembling a yellowish plum or a small lemon (Figure 1). Immature fruits have a strong almond-like smell caused by cyanogenetic compounds, of which the most important has been identified as sambunigrine (Hutchinson and Dalziel, 1972). *X. americana* is currently widespread throughout tropical and subtropical countries in Central and Southern America, Africa, India and Southeast Asia to Australia, New Zealand, and Pacific islands. The native distribution area of the plant is controversial (Alpern, 2008). According to the Plants Database of the USDA Natural Resources Conservation Service (http:// plants.usda.gov/java), it is possibly a native of Florida, Puerto Rico and the Virgin Islands. The plant is mainly found in semi-arid scrubs and sandy open woodlands up to an altitude of 2000 m, with rainfall between 250 and 1330 mm. It grows on different soils, often poor and dry.

This species is widely used in folk medicine of different countries to treat several human ailments. Data from some pharmacological studies seem to support some of these traditional medical uses. Fruits of *X. americana* are used in Burkina Faso as a remedy for constipation and as a natural source for astringent and tonic purposes (Meda et al., 2008). Bark or roots are used for healing skin diseases (ulcers or wounds) in Mali (Diallo et al., 2002; Grønhaug et al., 2008). In western tropical Africa, the roots have been used to treat 'sleeping sickness', in combination with those of *Annona chrysophylla* Boj (Burkill, 1997) and febrile headache (Okigbo et al., 2009). The roots have also been used in different African countries as an antiseptic to treat fever, edema, diarrhea, sexually transmitted diseases and as an antidote for poisons (Omer and Ali, 1998; Okigbo et al., 2009). A decoction of leafy twigs is given in Zimbabwe to heal febrile colds and cough and as a laxative (Okigbo et al., 2009); in Nigeria, the same preparation is used as a mouth wash and to relieve toothache (Dalziel, 1937). Leaves, barks, peeling and roots are used in different African countries for treating toothaches, mumps and conjunctivitis in frontal applications (Okigbo et al., 2009). Many studies report the use of an ointment prepared with minced leaves and applied on the skin to treat wounds, and also measles and rashes (Chinsembu and Hedimbi, 2010; Cheikhyoussef et al., 2011).

The presence of tannins and flavonoids (Ogunleye and Ibitoye, 2003) might support this action, due to their anti-inflammatory properties. Direct application of minced leaves or an infusion of bark or leaves are also used as an antidote in the case of snake and scorpion bites in different tropical countries (Teo, 1997; Feiberger and Vanderjagt, 1998). This use could be explained with the presence of chemical compounds such as alkaloids (Maikai et al., 2009), glycosides, phenols, tannins, saponins (Ogunleye and Ibitoye, 2003) and volatile oils (Mevy et al., 2006). Actually, most of these compounds

are not able to neutralize the venom itself, but can work as anesthetics, sedatives and anti-inflammatory, helping in relieving many ancillary symptoms or reactions (Okonogi et al., 1970).

Antimicrobial effects have been reported for water extracts of leaves, which could support the traditional use in treating infections and venereal diseases in Mali (Diallo et al., 2002) and malaria, ulcers and different kinds of skin infections in Nigeria (Ogunleye and Ibitoye, 2003).

Besides its medicinal uses, *X. americana* is traditionally used for different purposes. The use of the plant as a food source has been reported by some authors. In different Ethiopian regions, fresh fruit is consumed as such (Tilahun Teklehaymanot and Giday, 2010) or processed to make juice (Balemie and Kebebew, 2006); jams, jellies or alcoholic beverages are obtained from this fruit in Ethiopia and in different African countries (Watt and Breyer-Brandwijk, 1962). Actually, according to literature, edibility of *X. americana* fruit is controversial. The fruit is reported to be rich in vitamin C (Da Silva et al., 2008); however, other studies remarked the presence of polyphenolic and/or poisonous cyanogenetic compounds (Mora et al., 2009; Benoit and Santillana, 2000), suggesting that differences in taste and edibility of the fruit can be related with variations in its content of such chemical compounds. According to Chikamai et al. (2006), the pulp is edible, while the seed is toxic. Studies are not concordant even on the edibility of the oil extracted from seeds. Dalziel (1937) reports that the oil is used in Angola to prepare food, while in Southern India, a vegetable butter is obtained from the seeds boiled in water and is used in place of *ghee* (traditional clarified butter). According to Eromosele et al. (1994), the oil may be a good source of polyunsaturated fats for human nutrition; yet, Saeed and Bashier (2010) state that the high peroxide value beside the low saponification and iodine values make it not to be eatable.

Finally, in tropical Africa, the oil extracted from seeds is widely used as a cosmetic in skin and hair care, due to its emollient and nutritive properties (Hines and Eckman, 1993; Booth and Wickens, 1988; Vermaak et al., 2011). It is rubbed on the body to anoint and soften skin (Rovesti, 1979) and is applied to hair as a conditioner. Its beneficial effects may be related to the high content of lipids (64%) and fatty acids, namely ximenic acid (3.5 to 8.7%), having anti-inflammatory and vasodilator properties, and oleic acid (32.5 to 40.5%), which can improve tissue hydration and elasticity (Ligthelm et al., 1954).

Field investigation

In Angola, information on traditional uses of plants is generally very scarce, and this is the case also with *X. americana*, locally known as *mumpeke* (the plant name in *Mucubal* language): no detailed data are currently available on this subject, except for some information reported by Gossweiler (1950) and Bossard (1993) about the use of the oil extracted from seeds as a cosmetic and of other plant parts to treat dermatological and respiratory affections and dental caries. Alves (1951), cited in Bossard (1993), reported that the same oil is used to lubricate machinery and to treat leather. The aim of this study is to gather information on current ethnobotanical knowledge about this species and its traditional uses in Southern Angola. To achieve this goal, we carried out a field investigation in some selected communities.

MATERIALS AND METHODS

Study area

All the investigated communities lie in the municipality of Bibala province of Namibe (13° 21' S, 14°46' E), approximately 200 km NE from the provincial capital, Namibe (Figure 2). The climate is seasonal semi-arid, with an average annual temperature of 21.6°C and an average rainfall of 300 to 600 mm. It is characterized by the presence of two seasons: a rainy hot season from January to March and a dry, long winter lasting nine months. In the area, altitude ranges from 700 to 1000 m. Soils are defined as paraferralitic of medium or coarse texture (Diniz, 1998).

Vegetation is mostly composed of woodlands (*mata de mutuate*), with *Colophospermum mopane* (Kirk ex Benth.) Kirk ex J. Léonard (*mutuate*) as the dominant species alone or in association with *Adansonia digitata* L. (*imbondeiro*). Local communities lived mainly on livestock breeding and charcoal production. Livestock is considered by people as their main survival means and income source and is also regarded as a wealth symbol. Farming is hard in these communities, due to the uncertainty of rainfall. In this socio-economic setting, harvesting of NWFPs can play an important role, supplying significant dietary supplement as well as other valuable products, such as medicinal remedies and raw material for the production of different goods, which can be used within the community or sold in local or even wider markets.

Sampling, data collection and analyses

This study was carried out in years 2009 and 2010, during both rainy (March to May) and dry seasons (July to September). Data on the traditional uses of *mumpeke* were collected through interviews in four villages (Figure 2): Assunçao, Garganta, Munhengo (all located along the road leading from Bibala to EN 208 Namibe-Lubango), and Rio d'Areia (located along the road leading to the municipality of Lola) (Table 1). These communities were selected on the ground of the ease of access and also of the willingness of *sobas* (community leaders) to take part in the survey. Information on traditional uses of *X. americana* in the studied villages was gathered through semi-structured interviews with adult residents, randomly selected on the ground of each house location. A total of 68 informants were interviewed in the four communities (Table 1). Before carrying out the interviews, informants were briefed about the aims of the study, and only those who gave their express informed consent were subsequently interviewed. In the first part of the interview, personal information was gathered (that is, name, age, level of education, etc.). In the second part, information on local uses of *mumpeke* was collected. Each informant was asked to answer the following questions:

1. Do you currently use *mumpeke*?
2. If yes, for what purpose?
3. Which plant parts do you make use of?
4. How is the plant prepared/administrated/applied for each use?

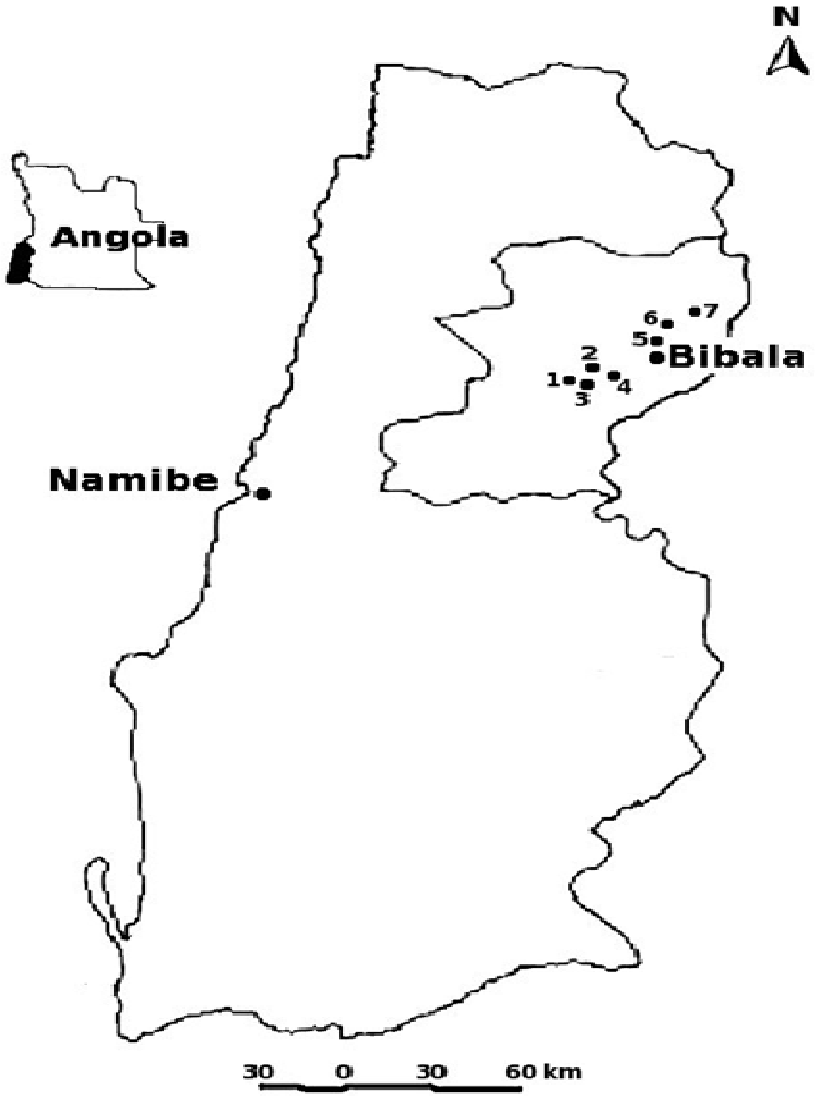

Figure 2. Map of the study area. Province of Namibe, municipality of Bibala and location of the investigated communities. 1: Munhengo; 2: Haukulu; 3: Assunçao; 4: Garganta; 5: China; 6: Rio d'Areia; 7: Takutaku.

Informants were asked only about current personal uses of *mumpeke*, as it has already been pointed out (Byg and Balslev, 2001) that correlation is not always strict between knowledge (that is, what the informants tell the researchers) and use (that is, uses that are actually practiced).

We also asked the informants about their perceptions on possible changes in the plant abundance in *mata* (woods) surrounding the villages. Interviews were carried out in their local dialect in the presence of an interpreter (native of the same area); the recorded information was simultaneously translated by the interpreter into Portuguese and written out in this language in the researchers' notebook. In a following stage of the study, direct observations were made in order to record local traditional technique of oil extraction. Seven independent observations were carried out in the following five villages: Assunçao, Haukulu, Munhengo, China, and Takutaku, all lying in the same area (Figure 2). More precisely, the last two communities are situated along the road leading to the municipality of Lola. In the village of Assunçao, the whole extraction process was digitally recorded, with the express permission of the community.

Data analyses

Different uses reported by the informants (detailed uses) were grouped into the following general categories of use: medicinal, cosmetic, veterinary. All the collected data were entered into a spreadsheet (Microsoft Excel 2003 for Windows). Here, each row represents an elementary record and is intended as a citation, that is, a single use reported by a single informant (Signorini et al., 2009).

In performing subsequent quantitative analyses, we considered distinct citations those that differ from each other in at least one of the following data: informant, and use (detailed use). Citations differing in minor aspects - such as plant part used, methods of preparation and administration - were combined into a single

Table 1. The four studied communities' synthetic data.

	Geographical coordinates	Number of families (approx.)	Number of interviews	Number of informants reporting the use of *Ximenia americana*
Assunçao	14°52'03.2"S 13°06'002"E	100	32	22
Garganta	14°50'21.8"S 13°12'25.6"E	60	15	11
Munhengo	14°50'41.1"S 13°02'14.8"E	50	14	12
Rio d'Areia	14°48'23.2" S 13°24'03.5" E	40	7	3
Total		250	68	48

citation (Signorini et al., 2009). In data processing, informants were grouped into classes by gender and age (40 years old or younger; older than 40 years), as suggested by de Freitas Lins Neto et al. (2009).

The following synthetic indexes were calculated to estimate the relative importance of different uses and the distribution of knowledge:

1. Use diversity value (UD) and use equitability value (UE) (Byg and Baslev, 2001), which measure the importance of each use (UD) and the degree of homogeneity of knowledge concerning that use (UE), respectively.
2. Consensus values of use type (CTU) (Monteiro et al., 2006).

Hurlbert's Probability of Interspecific Encounter (PIE) diversity index (Hurlbert, 1971), calculated through EcoSim software (Gotelli and Entsminger, 2005). This index evaluates the probability of finding different uses in two samples chosen at random and was used to estimate the diversity of knowledge among informants and among communities. Hurlbert's PIE diversity index was chosen because - unlike other diversity indexes such as Shannon index - it remains unbiased even with small sample sizes and its independence from the abundance of data makes it an ideal estimator of knowledge evenness in the context of our study. This index was originally developed as a measure of ecological diversity, but in recent times, it has also been used in ethnobotanic studies to compare the distribution of knowledge on medicinal plants within and among communities (Merétika et al., 2010; Bruschi et al., 2011). Differences are considered statistically significant if PIE value of a certain sample falls outside the 95% confidence interval of the randomly-generated PIE for the second sample (Gotelli and Entsminger, 2005).

Kruskall-Wallis test was used to confirm the existence of differences among groups, and the means were compared two by two using Mann-Whitney test.

RESULTS AND DISCUSSION

Traditional uses

Two hundred and ten citations were recorded for 13 different detailed uses: 84 citations for 9 medicinal uses, 125 citations for 3 cosmetic uses, and 1 citation for 1 veterinary use (Table 2).

Information gathered through field investigation showed that in the studied area, the most important local traditional uses of *Ximenia americana* concern the oil extracted from seeds. *Mumpeke* oil is widely used by people, mostly as a cosmetic for skin and hair care. Women use to apply it with a gentle massage to moisturize and soften their skin, to improve its tone and elasticity and to prevent stretch marks. The same oil is used as a hair conditioner. It is also applied on the body as a medical remedy to relieve joint and muscular pain, abdominal pain and to prevent varicose veins. This last action could be related with the content of flavonoids, which are known to possess antithrombotic and vasoprotective properties (Ogunleye and Ibitoye, 2003). The oil is produced in all the studied communities, and besides being personally used by the villagers, it is also sold at local markets at a price of 300 to 1200 *kuanza* per liter (3 to 12 Euros approximately). Due to its wide use, its actual and potential trade value and its availability, this oil can be regarded as one of the most important NWFPs locally available. Other plant parts are used in the investigated communities to prepare medical remedies.

Leaves are minced and crushed to obtain an ointment, which is rubbed over the body to treat measles and rashes and to heal wounds and burns. Entire or chopped leaves prepared as an infusion, decoction, and ointment or macerated in water are administered or directly applied to the body to treat snake and scorpion bites. It is believed that an application of chopped leaves on the affected body part can slow down the poison circulation in the bloodstream until the struck person is able to receive definitive medical care. Minor medical uses have been reported for leaf sap (ear pain) and for crushed and infused leaves (diarrhea, cough) (Table 2). According to the examined ethnobotanical literature

Table 2. Local uses of *Ximenia americana* in four rural communities of Bibala (Angola) and distribution of knowledge. UD = Use diversity value; UE = use equitability value; CTU = consensus value of use types.

Category of use	Detailed use	Used part	Way of preparation	Way of administration	Number of informants citing the use	UD	UE	CTU
Cosmetic	As a hair conditioner	Seeds	Oil	Direct application	42	0.20	1	3.23
	To improve skin tone and elasticity				42	0.20	1	3.23
	To prevent stretch marks				41	0.19	0.97	3.15
All cosmetic uses						0.59	1	9.61
Medicinal	To prevent varicose veins	Seeds	Oil	Direct application, massage	42	0.20	1	3.23
	To soothe joint and muscular pain				7	0.03	0.16	0.53
	To relieve abdominal pain				6	0.02	0.14	0.46
	As an astringent to heal diarrhea	Leaves	Infuse made with chopped leaves	oral	1	0.004	0.02	0.08
	As an antidote in case of snakes and scorpions bites		Infuse, decoction, macerated in water or ointment, all made with chopped leaves	Oral; direct application	5	0.02	0.12	0.38
	To alleviate ear pain		sap	Direct application	1	0.004	0.02	0.08
	To relieve cough		Infuse made with chopped leaves	Oral	3	0.01	0.07	0.23
	To heal wounds and burns		Ointment made with chopped leaves	Topical	5	0.02	0.12	0.38
	To heal measles and rash		Ointment made with chopped leaves mixed with ash	Topical	14	0.07	0.33	1.08
All medicinal uses						0.40	0.68	6.46
Veterinary	To treat cows for respiratory troubles	Leaves	Chopped fresh leaves	Oral	1	0.005	0.02	0.08

(as explained in the foregoing), only the use of oil in preventing varicose veins had not been previously reported.

Quantitative analyses performed on the collected data (Table 2) showed that the general category 'cosmetic uses' got the highest values of equitability (UE = 1), indicating that the use of *mumpeke* oil for body and hair care is widely and homogenously distributed among the informants. The same is true for the single detailed medicinal use, ‘seeds oil to prevent varicose veins' (UE = 1), with all the other uses recorded having only a secondary importance for the communities. The same pattern was observed in the consensus value for general categories of use (CTU), with 'cosmetic uses' considered as a whole getting the greatest relevance (9.61). The category ‘cosmetic uses’ also showed the highest use diversity index

(UD = 0.59), followed by that of 'medicinal uses' (UD = 0.40).

Seeds resulted to be the most cited plant part (183 citations), but exclusively for oil extraction. The only other plant parts mentioned by the informants were leaves (27 citations). No use has been reported for bark, roots or other plant parts, even if they are known to provide many traditional medical remedies in different parts of Africa (as seen in the study's introduction), including Angola (Bossard, 1993). In a study on medicinal plants carried out in Mali (Grønhaug et al., 2008), the most used plant part resulted to be the root, followed by the leaves. However, it must be noted that the use of oil extracted from seeds was not reported by these authors.

No alimentary use was cited by the informants; all of them reported instead that the fruit is not consumed because of its bitter and sour taste. This is confirmed by one of us (Valeria Urso) who personally tasted the fruit, and it is also in accordance with the study of Alves (1951) cited in Bossard (1993) who reported that the fruit is very acidic and palate-irritating. The use of fruit and even of seed oil as a food source in other African countries could be possibly due to the differences in contents of some bitter and/or sour chemical compounds (such as polyphenols and cyanogenetic compounds) in different local ecotypes (as explained in the study's introduction as well). Analyses are currently in progress to determine the chemical characteristics of fruits and seeds collected in the investigated area.

With regard to their perception of possible current changes in local abundance of *mumpeke*, all the informants answered that no decline had been perceived by them. On the contrary, they appeared to consider this natural resource not only as very abundant, but also as virtually inexhaustible.

Distribution of knowledge among informants and communities

As stated in the foregoing, a total of 68 participants were interviewed. Of these participants, 48 (71% of the informants) reported that they used to collect *X. americana*, and that they know at least one of its uses and ways of preparation. Informants using the plant were mostly women (71%) and their age ranged from 25 to 80 years, with a mean value of 46.4 ± 13.3 years (women 46.7 ± 13.8 years; men 46.1 ± 12.5 years). Most of them (82%) are illiterate and only 12 informants have attended the first grade of education. Our results indicate that knowledge on local uses of *X. americana* is widespread among the four communities, and both genders and all age groups are involved in using this plant. On average, each informant knows 4.37 ± 1.28 different uses, belonging to 1.90 ± 0.31 use categories; none of the informants knows all the 13 cited uses, and there are also differences in the total number of uses quoted by each informant (1 to 7). Data were performed in order to pick out possible relations between local knowledge on traditional uses of *X. americana* and informants, gender and age. The association between gender and/or age and number of traditional uses is well documented in ethnobotanical literature. Several studies show that differences in plant uses are often related to sex-specific divisions of labor (Hanazaki et al., 2000) and that women tend to be the main holders of traditions linked to domestic life, where most plant resources, especially food and medicinal plants are managed (Voeks and Leony, 2004; Quinlan and Quinlan, 2007; Voeks, 2007). As for age, it has been reported in different studies that older people are more knowledgeable than their younger counterparts about local resources (Begossi et al., 2002; Case et al., 2005).

In our study, comparing the number of uses cited by informants grouped for gender and age we found that in the investigated communities, women actually know more uses of *X. americana* compared to men, but surprisingly younger interviewees know more uses than older ones (Table 3). The differences are very small and according to Mann-Whithney test, they are not statistically significant (gender as grouping variable: $Z = 1.0$; $p > 0.05$; age as grouping variable: $Z = 0.76$; $p > 0.05$); nevertheless, the relation between local traditional knowledge and informants age pointed out in several ethnobotanical investigations, seems not to be confirmed by our data.

Yet, when comparing the distribution of citations with Hurlbert's PIE, significant differences come out, as women and >40 yrs informants show a higher use diversity (Table 3). PIE measures species' evenness, and the observed differences in Hurlbert's values are possibly related to a reduction in the number of rare or occasional uses, that is, those that were recorded only once in the survey or were restricted to a single informant. This means that in the two groups of women and older people, a lot of uses are largely shared by the informants (e.g., cosmetic uses in women group).

Further quantitative analyses on data concerning the knowledge on uses of *mumpeke* and its relation to Informants, gender and/or age were not performed, considering the relatively small number of informants, the different sizes of informants groups (men/women; younger/older) and the small differences in the number of uses reported by the informants.

When analyzing the distribution of knowledge among communities, significant differences concerning Hurlbert's PIE could be observed (Table 4). As expected, informants living in Rio d'Areia - that is, the smallest investigated community - know a lower number of uses; however, the mean number of uses per informant was higher in this village than in the other communities (Table 4). Lower abundance of rare uses cited in this community increased equitability, raising PIE index (Table 4). On the other hand, higher abundance of rare uses could explain the lower diversity value observed in Munhengo community. As the four studied communities are very similar to one another in their main features (history,

Table 3. Comparison of uses cited by the informants according to gender and age for 48 interviews performed in four communities in Bibala.

	Men	Women	≤40	>40
Number of informants reporting the use of *Ximenia americana*	14	34	17	31
Number of citations	55	155	79	131
Number of uses cited	11	12	11	10
Mean number of uses per informant (± standard deviation)	3.93 (1.63)	4.55 (1.07)	4.65 (0.99)	4.23 (1.40)
Hurlbert's PIE (confidence intervals)	0.839 (0.833-0.844)	0.849* (0.836-0.857)	0.814 (0.804-0.820)	0.844* (0.831-0.853)

*= significant differences for comparisons within each group.

Table 4. Quantitative data concerning the distribution of knowledge on *X. americana* in four rural communities of Bibala (Angola).

	Assunçao	Garganta	Munhengo	Rio d'Areia
Number of informants reporting the use of *Ximenia americana*	22	11	12	3
Number of citations	94	50	51	15
Number of uses cited	12	9	9	6
Mean number of uses per informant (± standard deviation)	4.27 (1.38)	4.54 (1.50)	4.25 (1.05)	5.0 (0.0)
Hurlbert's PIE (confidence intervals)	0.852 (0.841-0.859)	0.852 (0.838-0.858)	0.8206 (0.813-0.833)*	0.876 (0.856-0.886)*

*= significant differences for comparisons among communities.

ethnical group, socio-economic characteristics and remoteness from markets), we are unable to find a plausible explanation for the observed pattern. We can only conjecture that, while some major uses such as cosmetic are widely known and practiced, minor ones can vary substantially even in such a small geographical area. Other studies carried out by us in the same area currently in progress show that traditional knowledge about the use of medicinal plants is particularly high within the Rio d'Areia community (unpublished data).

Techniques of oil extraction

Direct observations of oil extraction process were carried out in five communities in the studied area. An original video (six minutes) showing the main phases of extraction was recorded by us in the village of Assunçao, and is available at the URL http://eprints.unifi.it/archive/00002228/.

Traditional method of processing *mumpeke* seeds for oil extraction observed in the investigated area followed the same basic steps already described by Von Maydell (1986) for *shea* butter (*Vitellaria paradoxa* C. F. Gaertn.) production in Sahel, with a few differences. Fruits are gathered during the rainy season (January to March); they are not de-pulped, but are dried for two to three days directly under the sun. This facilitates dehydration of seeds and prevents fungi growth and related decomposition processes. Drying also causes inactivation of enzymes responsible for building up fatty acids. Following this procedure, kernels can be stored up to one year without spoiling problems. For oil extraction, kernels are crushed and ground between two stones (Figure 3). As it has been observed also for *shea* butter, drying facilitates the hulling process, necessary to remove the kernel covering the seed. The paste coming out from grinding is toasted in a pot (time: 6.15 min ± 0.75; temperature: 117.8°C ± 7.42) (Figure 4) and then crushed and kneaded a second time to obtain an oily pulp. Water is added and the obtained batter is churned and heated (time: 60.2 min ± 0.35; temperature: 94.5°C ± 0.68) in order to separate oil from the waste liquid. Oil is then collected by hand, removing the fat from the surface of the cooled liquid, and dripping it into another pan (Figure 5). Production process is completed by boiling the oil (time: 16.5 min ± 3.53; temperature: 96.7°C ± 1.15) and finally pouring it into a bottle for conservation. The color of *mumpeke* oil can vary between brownish-yellow and dark brown, depending on temperatures reached during different phases of the extraction process. The whole traditional, labor-intensive process of *mumpeke* oil production is a task performed only by women, as it has already been observed also for processing other oleaginous species (Von Maydell, 1986). It is women who harvest and store fruits, process kernels to produce oil

Figure 3. Woman grinding kernels of *X. americana.*

Figure 4. Woman toasting kernels of *X. americana.*

Figure 5. Separation of oil from the waste liquid (see text for details).

and sell oil or kernels in local markets. From our direct observations, it turned out that to produce one liter of oil, 6 kg ± 0.58 of kernels and the work of one person for about four hours - let alone the time requested for fruit harvesting - are needed. This low efficiency of the extraction process is quite comparable with that found for other species such as *Baillonella toxisperma* (Vermeulen and Doucet, 2004) or *Moringa oleifera* (Mohammed et al., 2003) when processed with traditional methods.

Conclusions

The results of our field investigation shed light on traditional uses of *Ximenia americana* in Southern Angola and attest that in the investigated communities, this plant is very important for local communities' livelihood, due to its highly prized cosmetic and medicinal properties and could also be a valuable economic resource. From our study, it came out that the most relevant product traditionally obtained from the plant is the oil extracted from seeds, widely used to soften and add elasticity to the skin and as a hair conditioner, whereas other uses are of minor or even marginal importance. The oil is personally used by most villagers in local communities, but it can also be regarded as a product of economic interest for local and regional trade which could provide an important opportunity of increasing the household income, in such a way contributing to poverty alleviation. However, traditional extraction technique is time consuming and physically hard, and it requires resources such as water and firewood that are barely available in the area. Moreover, it is a highly inefficient process in terms of the amount of extracted oil. In other countries and for different oleaginous plants, suitable technologies have been introduced in order to add efficiency and value to oil extraction process, improving both the quantity and quality of oil and reducing physical effort and time needed. For example, Dagomba women in Ghana were among the first to start mechanizing *shea* butter production, obtaining a significant increase in labor productivity over traditional methods of extraction (Swetman et al., 1997). Improving the extraction process can also provide women with a possible independent income and status and contribute to their empowerment, as it occurred in the *marula* (*Sclerocarya birrea*) trade in Namibia (Shackleton et al., 2002). Even in the case of *mumpeke* oil in Southern Angola, the whole process of fruit harvesting, oil extraction and products marketing could be improved by recourse to suitable tools and

machinery: for example, simple machines could ease and speed up the two time-consuming processes of shelling and grinding. In addition, the oil cooking process could be shortened, in order to reduce the chance of altering the organoleptic characteristics of the final product affecting its cosmetic and medical properties; cold extraction procedures could also be tried out.

By the conservation point of view, harvesting *mumpeke* fruits actually do not seem to threaten the species survival, as it resulted also from the interviews; *X. americana* is widespread in the area and all the informants stated that at the present time, the tree population is definitely not declining. It must be stressed that, unlike other plant parts, fruits or seeds of annually fruiting plants (as is the case of *X. americana*) have a high potential for sustainable harvesting (Stockdale, 2005). On the other hand, no informant reported the use of other plant parts such as roots, which can be highly detrimental to the health of trees (Cunningham, 2001). Nevertheless, in order to diminish pressure on wild populations, domestication and local cultivation in fields of this plant could also be promoted.

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