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Socio-economic factors influencing *Afzelia africana* Sm. use value and traditional knowledge in Uganda: implications for sustainable management

Emmanuel Biara[1] · Anthony Egeru[1,2] · Sylvanus Mensah[2,3] · Jenipher Biira Salamula[4] · Mark Marvin Kadigo[4]

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Abstract

Afzelia africana Sm. is a highly valued multi-purpose and overexploited tree species in Africa. Ethnobotany of *A. africana* can guide its sustainable usage, yet there is limited information on such aspect for the species in Uganda. Here, we assessed use values of *A. africana* and users' traditional knowledge, and how they relate to plant parts and socio-economic factors including ethnicity, gender, education, age, marital status, profession, household size, income, land size and livestock ownership. Two hundred face-to-face semi-structured interviews were conducted. Use values were assessed based on plant part value (PPV) and use value per use category (UV_k), while users' traditional knowledge was compared using overall use value (OUV) and reported use value (RUV). All plant parts were used, with stem (PPV = 41.4%), seeds (19.6%) and leaves (19.3%) being the most important. Nine plant use categories were enumerated, with most dominant being material ($UV_k = 0.63$), followed by social (0.49) and fuel wood (0.41). Bark and root were mostly used for medicinal purpose, and branch and stem for fuelwood and material, respectively. Men and youngsters had higher OUV than females and older people, respectively. In particular, men frequently mentioned the use in agriculture, for fuelwood, environment and medicine, while women reported social use. Although socio-cultural group did not influence significantly OUV and RUV, multivariate analyses revealed differentiation in use category according to socio-cultural group. Land size also predisposed informants to report more uses for the species. Taking these significant socio-economic factors into account in participative forest management will facilitate *A. africana* sustainable use.

Keywords Ethnobotany · Socio-cultural group · Multi-purpose tree species · Gender · Traditional knowledge · Uganda

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✉ Sylvanus Mensah
sylvanus.m89@gmail.com

Extended author information available on the last page of the article

1 Introduction

Indigenous tree species play a vital role in animal and human nutrition and health; soil and environmental conservation and climate regulation (Byabashaija et al. 2004; Mannheimer and Curtis 2009; Buyinza et al. 2015). In sub-Saharan Africa that is grappling with the effects of climate change such as drought, flood and land slide, livelihoods of several communities are sustained by indigenous tree species that are resilient to such conditions owing to their morphological and physiological characteristics (Byabashaija et al. 2004). These tree species are extensively used in agroforestry by humans and animals. For instance, browsers such as camels depend on indigenous tree species as forage in dry land areas (Egeru et al. 2015; Salamula et al. 2017). Marius et al. (2017) argue that significant amounts of nutrients in indigenous tree species are deficient in other fodder resources during drought periods, making the former a good forage source for animals. Further, these tree species can develop deep rooting systems enabling the extraction of water and nutrients from deeper parts of the soil (Marius et al. 2017). Of great importance, these indigenous tree species also provide physical goods and services firewood, timber, medicinal resources, edible vegetable and wild fruits that are vital for humans livelihood (Bharucha and Pretty 2010; Dempewolf et al. 2014; Mensah et al. 2017). By doing so, they sustain livelihoods of close to 300 million people in the world, in the form of non-timber forest products to (Bharucha and Pretty 2010).

The importance of indigenous tree species for the well-being of communities and their livestock put them at a risk of depletion given their excessive exploitation and harvest (Gaisberger et al. 2017). *Afzelia africana* Sm. is one of such indigenous tree species under immense threat across its native range of distribution in Africa (Mensah et al. 2014; Assogbadjo et al. 2017), due to the high monetary returns from sale as logs in the international market (Ocungi and Owiny 2018; URN 2018). The URN (2018) report highlights that the species has attracted high trading in its logs and other products, owing to its beautiful orange brown wood that is on high demand in Africa, Europe, Asia and USA. The species equally plays a vital role in the livelihoods of communities and local climate regulation. It is a multi-purpose tree species used as forage for livestock during dry seasons when there is scarcity of grass (Mensah et al. 2016; Ouédraogo-Koné et al. 2006; Assogbadjo et al. 2017); herbal medicine where its organs are used to treat several ailments, namely diarrhoea, cough, mental illness and gastrointestinal disorders (Arbonnier 2004; Akinpelu et al. 2010; Delvaux et al. 2009; Ouédraogo-Koné et al. 2008); and for soap making (Egwujeh and Yusufu 2015). In Uganda, *A. africana* grows in wooded grassland and thrives in higher rainfall areas, though it can also be found on rocky ground or in gallery forests. The species is only found in Northern Uganda and in the West-Nile sub-region (URN 2018) of the country, in forests on Mt. Kei and the Otze Forest.

Strategies of use and conservation of local resources are suggested to be elaborated in a collective and participatory manner, involving the local community at all stages (Albuquerque et al. 2008). Plant traditional knowledge and use patterns are support information that can be used in decision-making processes targeting the social expectations (Mensah et al. 2017; Cuni-Sanchez et al. 2016). The patterns of actual use of a target species provide insights into the most important and valued plant parts as well as user social categories or socio-economic factors to be considered in decision-making for biocultural conservation and strengthening traditional knowledge systems and for effective forest management (Beltrán-Rodríguez et al. 2014). Many case studies have shown how traditional knowledge can be used for sustainable management and conservation of natural resources (Albuquerque et al. 2008; Laleye et al. 2015; Honfo et al. 2015; Salako et al. 2018). For instance, a study by Salako et al. (2018) on traditional knowledge and cultural importance of *Borassus aethiopum* Mart. in Benin highlighted a need for capacity building for women in good practices of fruits and hypocotyls collection to avoid overutilization.

Several studies on human–environment interactions have shed light into the influence of various individual socio-cultural and demographic traits such as age, gender, formal educational level and ethnicity on plant traditional knowledge and use. For example, young people are expected to be less knowledgeable than adult and old people, given that accumulation of knowledge is a lifelong process, elderly people, compared to youngsters, would have more time to acquire knowledge (Hanazaki et al. 2013; Mensah et al. 2017). On the other hand, men and women may have distinct knowledge (Albuquerque et al. 2011), often related to the difference in societal roles they play in local livelihoods (Souto and Ticktin 2012; Salako et al. 2018). As also pointed out in recent studies, while men tend to place more importance on timber, women have a close relationship with the collection of forest resources (e.g. firewood, edible plants, edible fruits and medicinal plants) and often serve as the primary healthcare providers in their families, as part of domestic roles (Albuquerque et al. 2011; Torres-Avilez et al. 2016; Mensah et al. 2017). Other researchers have also showed the importance of socio-cultural groups or origin in the difference in knowledge and plant use (Fandohan et al. 2010; Salako et al. 2018; Souto and Ticktin 2012). For example, Fandohan et al. (2010) described significant differences for tamarind utilization among socio-cultural groups in Benin, with Fulani women showing positive attitude towards medicinal, cultural and material use categories, while Gourma women showed high saliency towards use in commerce. While it is expected that these primary socio-demographic factors (age, gender and ethnicity) will all influence the pattern of use of *A. africana* in Uganda, the insights could be further improved by testing the additional effects of other individual socio-economic factors such as education level, professional occupation, household size, household income, years of presence in the location and livestock ownership. For instance, in a study of use of plants in traditional treatment of diabetes in Republic of Benin, Laleye et al. (2015) found that professional occupation influenced informants' knowledge on plants. Similarly, wealth-related factors (e.g. income, land size, livestock ownership) have been shown to affect use of plants by changing the dependence on forest products and also by dictating how (depending on the tools they have at their disposal) forest products are extracted and processed (Takasaki et al. 2001).

In West Africa, few studies addressed traditional knowledge of *A. africana* (Houehanou et al. 2011; Balima et al. 2018) and reported ethnic differences and people's social background effect on diversity of use. According to these authors, *A. africana* is used as medicine, fodder and crafting by most communities. Its use as fuelwood has been mostly reported by women, while religious uses of these species were reported by old men from the Gourmantche ethnicity (Houehanou et al. 2011). On the other hand, Balima et al. (2018) further pointed out that the use of the species in medicine was the most diversified, with all plant parts involved in 10 medical prescriptions treating approximately 20 diseases.

In Uganda, there have been several studies on natural resources conservation and management, but very few addressed traditional ecological knowledge and the implications for sustainable use and management of woody plant species (Tabuti 2007; Okullo et al. 2004; Nyamukuru et al. 2015; Kyarikunda et al. 2017). There has been an increasing alert on the threat and conservation status of *A. africana*; however, there is lack of information on the use value and utilization patterns of the species in Uganda. Traditional knowledge and use associated with *A. africana* will fundamentally contribute to the development of conservation interventions for the species and also foster linkages between technical and local community conservation approaches. In this study, we assessed the use values and traditional knowledge of *A. africana*, and how they relate to the species plant parts and users' socio-economic factors including ethnicity, gender, education, age, marital status, profession, household size, income, land size and livestock ownership. The study was conducted in Yumbe, one of the northernmost districts in Uganda. First, we assessed *A. africana* plant parts used and use values by quantifying ethnobotanical indices such as the plant part value and the use value per use category. We explored the range of specific uses across all plant parts (seeds, leaves, branch, stem, bark, roots and whole plant). We further explored the relationship patterns between use category and plant parts. Second, to determine whether (and how) socio-economic aspects influenced traditional knowledge, we tested for (1) significant variation in overall use value among socio-cultural, age, gender and education level categories, and (2) significant effects of additional individual socio-economic factors on reported use value.

2 Materials and methods

2.1 Study area

The study was conducted in the Yumbe district, located between the latitude 3° 30′ 0″ N and the longitude 31° 19′ 60″ E, in the West-Nile sub-region of Northern Uganda. Yumbe district was purposively selected because of the occurrence of *A. africana*, and the availability of anecdotal evidence of high incidences of harvesting of the species. Kerwa sub-county was the target sample area in the district as shown in Fig. 1. The population size of Kerwa sub-county is approximately 41,308 persons (Yumbe District Local Government 2013). Socio-cultural groups in the area include Aringa, Kakwa, Kuku, Lugbara, Luo, Madi, Muganda and Liwolo. Yumbe district has a bimodal rainfall pattern where the wet season occurs between March and May and then August and October, whereas the dry seasons occur in June and December to early March (Yumbe District Local Government, 2013). Most areas in Yumbe are used for farming, with forests and woodlands covering only 17.1 per cent of the total area (Yumbe District Local Government 2013). Agriculture is the dominant economic activity in the district employing 72% of the population. However, most of the agricultural activity is subsistence in nature (Yumbe District Local Government 2013). The agricultural activities in the district include crop farming, fish farming and livestock husbandry. Savannah is the predominant vegetation in the district (Otim et al. 2017). The vegetation is *Butyrospermum-Hyparrhenia* savannah and characterized by tree species, namely *Isoberlinia doka, Daniellia oliveri* and *A. africana.* There is massive deforestation in the district, especially on privately owned land, where over 80% of the district's tree resources exist (Yumbe District Local Government 2013).

2.2 Sampling and data collection

We determined the number of respondents to be included in the study using the following formula (Yamane 1967).

$$n = \frac{N}{\left(1 + N \times e^2\right)} \tag{1}$$

where n is the sample size, *N* is the population size of Kerwa sub-county, which is 41,308 persons, and e is the level of precision, which is 0.07 at a 95% confidence. A sample size of

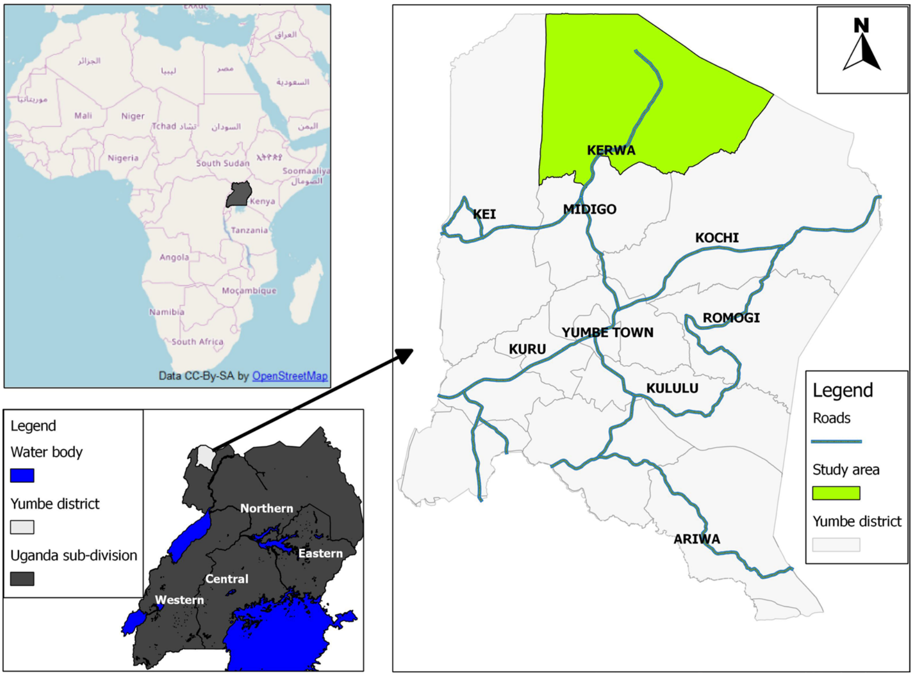

Fig. 1 Location of the study area in the Yumbe district in Uganda

203 individuals was obtained when applying Eq. (1); however, a total of 200 respondents were interviewed while observing an equal number of individuals per gender category. A stratified random sampling technique was used to select respondents in the study area. The target sample was initially stratified at the two levels of gender (male and female), and within the gender categories the population was further stratified based on age (females below and above 35 years/males below and above 35 years; Online Resource 1). We initially used two gender and age categories (below and above 35 years) to simplify the stratification.

A semi-structured questionnaire was utilized to collect information on the use of *A. africana*. The questionnaire was designed to record information on respondents' demographic and socio-economic factors including gender, age, socio-cultural group, main occupation, education background, household size, income, land size and livestock ownership.

Each respondent was asked to disclose ethnobotanical information regarding the use of *A. africana*, including all the plant parts used as well as specific use for each part harvested. In particular, for each respondent, information on preferred plant part (e.g. bark, leaves, stem, seeds and roots) and local uses (e.g. food, games, timber and medicine) was collected. Specific uses reported by informants were a priori classified according to the use categories, which include fuelwood, implement, material, environment, food, medicinal, social, agriculture and ornamental (Fandohan et al. 2010; Honfo et al. 2015).

2.3 Data analysis

The following ethnobotanical indices were considered: the reported use value—RUV (Gomez-Beloz 2002), the plant part value—PPV (Gomez-Beloz 2002), the use value per use category—UV_k (Philips and Gentry 1993) and the overall use value for all categories—OUV (Philips and Gentry 1993).

RUV is the total number of uses reported by an informant (Gomez-Beloz 2002). PPV was defined as the ratio of the total number of uses reported by all informants for each plant part ($RU_{plant\ part}$) to the total number of reported uses (RU) reported for the tree species.

$$\mathrm{PPV} = \frac{\mathrm{RU}_{\text{plant part}}}{\mathrm{RU}} \times 100 \quad (2)$$

UV_k was computed for each use category (k) as the ratio of the sum of citations (S_{ijk}) by the informant (i) to the specific uses (j) in the category (k) to the total number (N) of informants.

$$\mathrm{UV}_k = \frac{\sum_{J=1}^{n_k} \sum_{i=1}^{n} S_{ijk}}{N} \quad (3)$$

In Eq. (3), n_k is the total number of specific uses in the category (k).

OUV was defined as the sum of use value per use category (UV_k) of all categories of use (Philips and Gentry 1993).

$$\mathrm{OUV} = \sum \mathrm{UV}_K \quad (4)$$

2.3.1 *Assessing A. africana* plant parts used and use values

To assess *A. africana* plant parts used and use values, PPV and UV_k are calculated using Eqs. (2) and (3). PPV and UV_k are suitable for identifying the most used *A. africana* plant parts and assessing the importance of each use category, respectively.

To explore the relationship patterns between use category and plant parts, a correspondence analysis (CA) was performed on the matrix of frequency of citation of use category and plant parts using the FactoMineR and factoextra package in R Statistical software (version 3.5.2). The matrix consisted of the absolute frequencies (obtained from cross-tabulation procedure) of use category and plant parts. The factor scores for the plant parts and uses categories were used to represent their association graphically.

2.3.2 Assessing the relationships between socio-economic variables and use of *A. africana*

To determine whether (and how) socio-economic aspects influenced traditional knowledge, we used three response variables that were computed at different levels: OUV, UV_k (group level) and RUV (individual level). Using Eq. (4), we computed OUV for main socio-economic variables (socio-cultural group, gender, age and education categories) to determine how overall use (i.e. for all use categories) varied among socio-cultural groups, gender, age categories and levels of education. Among the eight socio-cultural groups surveyed, the most represented (> 20 individuals) were considered individually and the less represented [Liwolo (1), Madi (3), Luo (1), Muganda (1)] were grouped as others. Four levels of education were considered: no formal education, primary education, secondary education and tertiary education. Data of OUV were normally distributed after logarithmic transformation, and one-way analyses of variance (ANOVA) were used to test significance of differences among socio-cultural groups, gender, education levels and age categories.

Next, we computed UV_k for socio-cultural groups and for socio-cultural groups across gender, separately. We performed two principal component analyses (PCAs) to assess the patterns of variability of use category and association with (1) socio-cultural groups and (2) socio-cultural groups across gender.

At individual informant level, we used RUV to test for significant effects of additional individual socio-economic factors on users' traditional knowledge. The utility in using RUV here is that additional important individual socio-economic variables such as marital status, professional occupation, household size, household income and years of presence in the location could be directly tested without prior categorization as previously done for ANOVA. RUV was analysed as count variable (number of citations) and modelled using Poisson distribution (Zuur et al. 2009). Count data are often over-dispersed. Over-dispersion in RUV was tested using the qcc package (Scrucca 2004) in the R statistical software. The significance test has a p value of 0.357, indicating little evidence of over-dispersion. The simple Poisson regression was therefore used to test the effects of socio-economic and demographic variables on RUV. Due to the high number of variables, we used the step AIC function in the MASS package to perform a stepwise model selection (forward, backward or stepwise) based on the exact AIC criterion (Kabacoff 2015).

3 Results

3.1 *Afzelia africana* plant parts and use categories

Afzelia africana plant parts used were stem, leaves, roots, bark and seeds. The stems, seeds and leaves were the most used plant parts, with, respectively, 41.4%, 19.6% and 19.3%, while the bark was the least used plant part (Fig. 2). The whole tree (6.6%) was also of use. A total of nine use categories were recorded including material, social, fuel wood, medicine, implement, ornamental, food, agriculture and environment (Table 1). The use for material was the most extensive ($UV_k = 0.63$), followed by social (0.49) and fuel wood (0.41). The use for food (0.1%), agricultural (0.1%) and environmental (0.1%) purposes was the least mentioned (Table 1).

Twenty-eight specific uses were reported across these use categories. Boat making, building, building poles, logs, bridge making, drums, furniture and timber were cited as specific uses for material (Table 1). Shade, games and clothing were cited as specific uses within the social use category, whereas fuel wood category included firewood and charcoal. For the least cited use categories, food, oil and seasoning were specific uses within food use category; fodder and manure were specific uses within the agriculture use category and seedling was specific use within environment use category (Table 1). Informants reported that the species seedlings are conserved on farms to support local conservation of the environment.

The results of the correspondence analysis showed significant association between plant parts and use category ($\chi^2 = 733$; $p < 0.001$). The first axis retained most information on leaves, branch and stem (48.3%), while the second axis accounted for information on roots, seeds, bark and the whole tree (28.6%). The outputs revealed that bark and

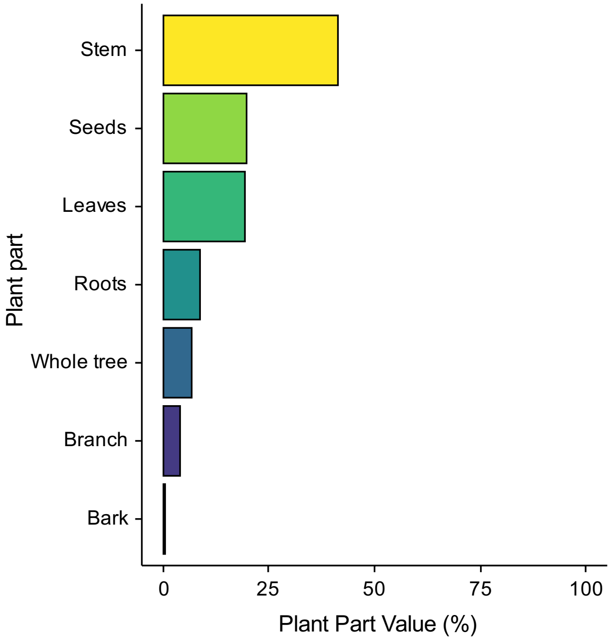

Fig. 2 Plant part value (PPV, %) of *Afzelia africana*

roots were mainly used for medicinal purpose (Fig. 3), branch and stem were mainly used for fuelwood and material purposes, respectively, leaves were mainly used for ornamental and agriculture purposes, seeds were mainly used for social purposes and whole tree was majorly used for environment purposes.

3.2 Relationships between socio-economic variables and use of *A. africana*

Results of the analyses of variance testing the differences in overall use value (OUV) among socio-cultural group, gender, and age and education categories revealed no significant difference between socio-cultural groups categories and education levels ($p > 0.05$) (Table 2). However, there were significant differences for gender and age categories. More specifically, men and youngsters had significantly higher OUV than females and older people, respectively ($p < 0.05$; Table 2).

Two principal axes were retained (PCA1 with 45.3% and PCA2 with 32.3%; Table 3). The factor plots of principal component analysis showed the distribution of socio-cultural groups and how they used *A. africana* (Fig. 4). The results indicated that the socio-cultural groups in the Yumbe district utilize *A. africana* differently. Particularly, *kakwa* socio-cultural group could be associated with the use of the species for fuelwood and medicine; *aringa* socio-cultural group (for agriculture and ornamental); and *lugbara* socio-cultural group (for food and environment) (Fig. 4). Across different socio-cultural groups, there were also similarities in use of the species among males and among females (Online Resource 3); for example, men (Kakwa and Aringa males) mainly used the species for agriculture (as fodder and green manure), for fuelwood (firewood and charcoal), environment and medicine, while women mostly used it for social purposes (game, clothing) (Online Resource 3).

Table 1 Use category, use value per use category, specific use and parts of *Afzelia africana*

Use category	UV_k	Specific uses	Plant parts
Material	0.633	Boat making, building, building poles, logs, bridges making, drums, furniture, timber	Branch, stem
Social	0.494	Shade, games (using seeds), clothing (using ropes around the waist to hang the leaves)	Leaves, seeds, whole tree
Fuel wood	0.405	Charcoal, firewood	Stem, branch, bark
Medicinal use	0.329	Medicine	Bark, leaves, seeds, roots
Implement	0.127	Cleaning pots, gun handles, knife handles, making mats, seed cones used for scooping food, soap making, trapping fish and rats	Seed, stem, roots, leaves
Ornamental	0.101	Decoration for traditional dance	Leaves
Food	0.076	Food, oil, seasoning	Seed, leaves
Agriculture	0.063	Fodder, manure	Leaves
Environment	0.051	Seedlings	Seed

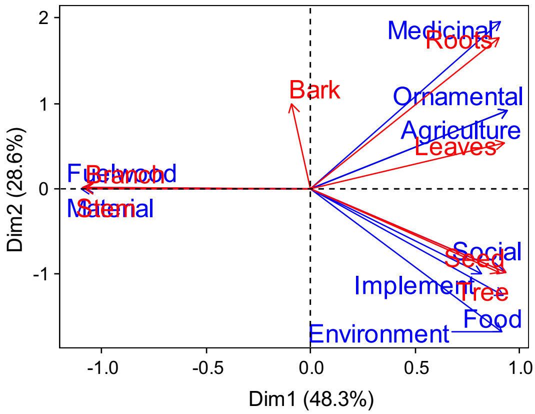

Fig. 3 Asymmetric correspondence analysis plot showing the distribution patterns and association of plant parts and use category

Table 2 Results of the analyses of variance testing for differences in overall use value (OUV) among socio-cultural group, gender, and age and education categories

	Level	OUV	SE	*F*	*p*
Socio-cultural groups	Aringa	2.769	0.352	0.81	0.520
	Kakwa	2.062	0.451		
	Kuku	2.241	0.164		
	Lugbara	2.105	0.373		
	Others	2.166	0.600		
Gender	Female	2.097	0.205	4.30	0.040
	Male	2.453	0.163		
Education	No formal education	1.902	0.217	2.01	0.115
	Primary	2.253	0.170		
	Secondary	2.785	0.357		
	Tertiary	3.166	0.945		
Age	< 30	2.666	0.251	2.72	0.046
	30–40	2.459	0.228		
	40–60	1.756	0.187		
	> 60	1.583	0.287		

Results of the Poisson model testing the effects of socio-economic and demographic variables on the reported use value are presented in Table 4. Only three variables were retained in the final fitted model after stepwise elimination of non-significant variables: age, land size and livestock ownership. The effect of age was shown by a significant decrease in the reported use value as age increases. This indicates that younger people reported more uses for the species than the elders, as also revealed in the ANOVA. Land size had significant and positive effect on reported use value, suggesting that the bigger the size of informants' lands, the more knowledgeable they are in using *A. africana*. Similarly to land size, livestock ownership was positively associated with the reported used value (Table 4).

Table 3 Correlation between principal components and use category

Factors	Dim.1	Dim.2
Percentage of variance	45.30	32.31
Cumulative percentage of variance	45.30	77.61
Use category		
Fuelwood	– 0.62	0.10
Implement	0.95	– 0.26
Material	0.82	0.55
Environment	0.77	– 0.55
Food	0.36	– 0.84
Medicinal	– 0.97	0.01
Social	0.32	0.05
Agriculture	0.56	0.73
Ornamental	0.16	0.98

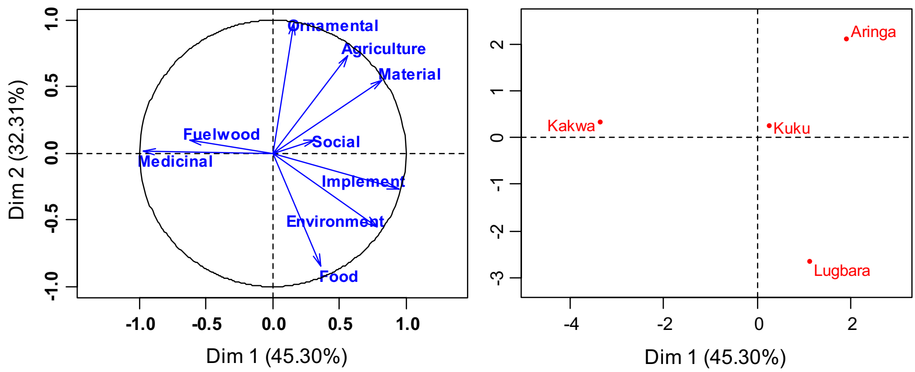

Fig. 4 Plot of principal component analysis showing the distribution patterns of socio-cultural groups according to the principal axes. Ma: male; Fe: female; Ar: aringa; Lu: lugbara; Ku: kuku; Ka: kakwa

4 Discussion

4.1 *Afzelia africana* plant parts used and use values in Uganda

We found that all *A. africana* plant parts were used in Uganda; this makes the species overexploited. We also noted that stems, seeds and leaves were the most used plant parts. The observed high use of stems could be attributed to the lack of law enforcement and the high cost of *A. africana* logs that are traded locally in Uganda and further exported to the Asian countries (Ocungi and Owiny 2018). The communities in the study area also used *A. africana* as a material for making boats, bridges, drums and furniture besides the well-known exploitation for timber that is sold expensively within Uganda and exported to Asian countries. Previous studies (Amusa 2010; Atanasso et al. 2019) have observed that *A. africana* wood is hard, characterized by remarkable stability with less susceptibility to variations in humidity, small shrinkage rates during drying and good natural durability. Because of these attributes, the wood can be used in permanent humid conditions or localities where wood-attacking insects are abundant.

Table 4 Results of Poisson generalized linear model testing the effects of socio-economic and demographic variables on the reported use value

	Deviance (DF)	AIC	*F* value	Pr(> *F*)
Overall significance of the model				
<none>	141.56	536.93		
Age	153.45 (1)	548.6	12.93	< 0.001
Land size	145.69 (1)	540.73	4.49	0.036
Livestock ownership	145.36 (1)	538.73	4.14	0.043
Pseudo *R* Square	12.14%			
	Estimate	Std. error	*z* value	Pr(> |*z*|)
Specific effects of retained variables				
(Intercept)	0.910	0.221	4.124	< 0.001
Age	− 0.014	0.004	− 3.343	< 0.001
Land size	0.019	0.008	2.154	0.030
Livestock ownership: yes	0.332	0.177	1.871	0.061

The particular interest in the stem is more prejudicial for conservation of the species, as compared with the high use of seeds and leaves, which is attributable to the ease of harvesting of areal plant parts. However, harvesting leaves and seeds (fruits) and also bark might affect the reproductive performance of the species (Nacoulma et al. 2016).

The species further provides a range of socio-cultural benefits including provision of shade for community meetings and for social gatherings; seeds (harvested) for playing board games; and leaves used as decoration during traditional dances and as clothing. These uses were observed in West Africa (Orwa et al. 2009; Amusa 2010), with a particular preference by hunters (Bonou et al. 2009), as they wait for wildlife and in particular because wildlife tends to rest under its shade. Additionally, the communities noted that the species was a good fuel wood source derived from branches, stems and the bark. A study by Duruaku et al. (2016) ranked *A. africana* as the most desired species for wood production. However, in Burkina Faso, the use of *A. africana* for fuel wood is forbidden within some socio-cultural groups owing to the attached spiritual value (Kristensen and Balslev 2003). These authors reported that the species has been rejected as firewood by some informants belonging to the Gourounsi socio-cultural group. In Benin, a similar traditional knowledge has been reported, as the use of the species as fuelwood is not accepted by Gourmantche socio-cultural people, due to its mystical character (Houehanou et al. 2011). Communities in the north-western Uganda relied on *A. africana* for medicinal value, in particular the stem, roots and bark which were extremely used. This use could be attributed to the fact that *A. africana* has been observed to exhibit antimicrobial, anti-inflammatory, antimalarial, analgesis and trypanocida activities, and it can be used to treat ailments such as oedemas, intercostal neuralgias, convulsions, staturo-ponderal backwardness (Akinpelu et al. 2010) and also believed to cure mental illness (Ibrahim et al. 2007). This pattern of reliance on indigenous plants for medicine has been attributed to limited availability of western medicine and/or a high cost of medicine (Laleye et al. 2015), which conditions prevailed in the study area.

4.2 Relationship between socio-economic variables and use of *A. africana*

Earlier studies on *A. africana* in West Africa (Houehanou et al. 2011; Balima et al. 2018) indicated that differences and diversity of use were closely associated with people's cultural background. Although we found no significant influence of socio-cultural groups on OUV and RUV, PCA revealed that the socio-cultural groups used the species differently. The results from ANOVA, Poisson regression and PCA collectively showed that age, gender and socio-cultural groups are determinant variables of traditional knowledge and use value of plant species. Contrary to the expectation, age effect was shown by higher OUV and use reports among young people than older. This could, however, be due to the fact that younger individuals are more energetic and more desirous for wealth and hence would utilize the species more. Past studies (Wezel and Haigis 2000; Pare et al. 2010; Laleye et al. 2015) reported a link between the age and knowledge and use of the plant. Older individuals may be more knowledgeable about the species since local knowledge of plants tends to accumulate with time and with continued interaction with the natural environment (Honfo et al. 2015; Ayantunde et al. 2008). However, they may not be actively involved in the harvesting or exploitation of the plants because of allocation of social duties in the communities among gender groups (Sop et al. 2012).

We also found that men had higher OUV than females and that uses in agriculture, for fuelwood, environment and medicine were frequently mentioned by men, whereas social use was mentioned by women (Online Resource 3). According to Guimbo et al. (2011) and Mathez-Stiefel and Vandebroek (2012), gender directly influences the way people interact and use plants. Gender-specific use and knowledge of the forest may be linked to life form, taxa, parts of trees used, methods of forest-product processing, and ecological processes (Elias et al. 2017). Further, difference in the use of *A. africana* among the men and women of the same socio-cultural group could perhaps be linked to the predetermined social construction where men are perceived as those involved in "productive" activities and women only in the "reproductive" activities. Social and cultural contexts determine the roles suitable for women and men and encourage them to develop different activities that may vary over time and differ by region (Lunelli et al. 2016). Howard (2003) highlighted that women are usually in charge of home affairs including caring for children and other family members. Because of this, they will be more interested in utilization aspects such as food, medicinal purposes, firewood and implement. On the other hand, men tend to focus on income-generating activities (Lunelli et al. 2016). In this regard to men, uses such as material and fuelwood that can generate income tend to be more appealing. These results, however, differed with other studies that concluded that gender is not a determinant of plant use (Belem et al. 2007; De Caluwé et al. 2009; Sop et al. 2012).

Apart from age and gender, the use of *A. africana* varied by socio-cultural group. A similar trend was reported in Burkina Faso where utilization of *A. africana* varied according to socio-cultural groups (Balima et al. 2018). In particular, we found that *kakwa* socio-cultural group could be associated with the use of the species for fuelwood and medicine; *aringa* socio-cultural group (for agriculture and ornamental); and *lugbara* socio-cultural group (for food and environment). The differences in use of *A. africana* by socio-cultural groups could be attributed to differences in cultural practices, taboos, rituals and norms surrounding *A. africana*. Interestingly, there were similarities in use of *A. africana* by women across different socio-cultural groups and by men different socio-cultural groups (Online Resource 3). Across socio-cultural groups, uses in agriculture, for fuelwood, environment and medicine were frequently mentioned by men, whereas social use was mentioned by women. This result suggests that gender category might be a stronger social factor of differentiation of use of plants. The similarities in the use of *A. africana* among women of different socio-cultural groups could be linked to social interaction beyond their house, e.g. in market, gardens, water collection points and hospitals where they share information on the use of *A. africana.* These interactions at these common places can potentially contribute to the similar use of the species among women, as also reported for traders of medicinal plants from different phytodistrict regions in Benin (Laleye et al. 2015). The similarities in use of *A. africana* among men of different socio-cultural groups could be determined by the prevailing economic situation in the study area. Across socio-cultural groups, uses in agriculture, for fuelwood, environment and medicine were frequently mentioned by men, whereas social use was mentioned by women, suggesting a dominance of men over women in the utilization of *A. africana*. Such a dominance might be a result of gender roles, norms and taboos that limit women's access to certain forest areas, concerns for women's safety and socially determined household duties that require women's presence near home (Howard and Nabanoga 2007). Men also have better access to plant knowledge through the social division of labour (Sop et al. 2012).

5 Conclusion and implications for sustainability

The present study showed the multiple uses that communities in north-western Uganda make from *A. africana*. Overall, it points to a great deal of local knowledge of the plant and plant parts and its uses and applications; it also reveals how the species meets various demands, being exploited for material, social purposes, fuel wood and medicinal purposes; further, it reveals the important role that *A. africana* plays in the social–cultural life of these rural communities. The findings collectively support the ideas that age, gender and socio-cultural groups are determinant variables of traditional knowledge and use value of plant species. In addition, land size also predisposed informants to report more uses for the species. These findings are important for conservation of the species by establishing management strategies based on local demand and use. In essence, actions that encourage conservation of the species and its sustainable use should be put in place, taking into account the patterns of use as well as the determinant socio-economic factors. First, the stem being the most used part, it is necessary that the ban on exploitation and uncontrolled harvesting of the species be reinstated and improved to control the high rate of exploitation. Second, we recommend that local people be trained in good practices of collection of other plant parts such as leaves, seeds, bark and branches to avoid overharvesting which will affect the reproductive performance of the species. Third, the findings revealed that *kakwa* socio-cultural group being associated with the use of the species for fuelwood and medicine is more involved in collection and use of most plant parts (stem, branch, bark, leaves, seeds, roots; see Table 1) than other socio-cultural groups; as such, they should be approached and involved in participatory conservation actions. In particular, they should be sensitized to (1) identify suitable lands for community forests and (2) either plant alternative trees or establish woodlots to provide similar benefits to reduce exploitation of the species. Fourth, participative actions should also involve (young people, men and landowners), local decision-makers to increase the awareness on importance of the species and develop win–win scenarios for its sustainable use and for the benefits of future generations.

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Compliance with ethical standards

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Affiliations

Emmanuel Biara[1] · Anthony Egeru[1,2] · Sylvanus Mensah[2,3] · Jenipher Biira Salamula[4] · Mark Marvin Kadigo[4]

1 School of Forestry, Environmental and Geographical Science, Makerere University, Kampala, Uganda

2 Regional Universities Forum for Capacity Building in Agriculture, Makerere University, Kampala, Uganda

3 Laboratoire de Biomathématiques et d'Estimation Forestières, Faculté des Sciences Agronomiques, Université d'Abomey-Calavi, Cotonou, Benin

4 Institute of Development Policy (IOB), University of Antwerp, Antwerp, Belgium