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# Knowledge and use value for Schlerocarya birrea and Cassia abbreviata in peri-urban and rural areas of Zimbabwe

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## *ABSTRACT*

*Sclerocarya birrea* (A.Rich.) Hochst and *Cassia abbreviata* (Oliv) are frequently harvested in Africa, yet little is known about harvesting implication. To fill this gap, we conducted surveys to assess perceptions of their uses, and how locality, gender, education, and age influence ecological knowledge, awareness of harvesting implications and willingness to conserve among rural and peri-urban populations and $\chi^2$ was used to test for associations. We used two-way ANOVA to compare tree density, diameter, height, and stump density, and one-way ANOVA for plant use values across study sites. No association observed between locality and species use; however, gender significantly affected the use of *S. birrea* ($P < 0.05$). Educational level influenced *S. birrea* usage but not *C. abbreviata*, and age had no influence ($P > 0.05$). Locality, gender, and education did not impact use values, while age did. Rural areas exhibited higher ecological knowledge and awareness of harvesting implications than peri-urban areas, while gender, educational level and age influenced ecological knowledge and awareness of harvesting implications, with males and tertiary education category more aware of harvesting implications. *C. abbreviata* had a higher tree density in rural areas, while *S. birrea* density was stable across locations. No significant differences in average height or stem diameter for either species. *S. birrea* exhibited higher stump density in peri-urban areas. This research highlights the need for further studies on the ecological impacts of harvesting these species, emphasising management challenges and the necessity for adaptable conservation strategies for *C. abbreviata*.

**Contribution/Originality:** This research on knowledge and utilization of *S. birrea* and *C. abbreviata* is original and first to exploring use values, plant part values, stump diameter distribution, tree stem and stump density most importantly in these sites. This study fills these gaps in existing literature.

## 1. INTRODUCTION

Numerous studies have indicated that plants are valuable to people in Africa and across the globe [1-4]. In the midst of challenges in dealing with diseases and ailments, plant medicines have emerged as alternatives; [2, 4]. Most plants are of pharmaceutical importance as plant scientists have adopted and have also discovered plant extracts that are used in traditional medicines and integrated them with scientific research to produce medicines [5, 6]. Most people living in rural areas are highly dependent on plant medicines, as they are conveniently available, affordable, and acceptable in these areas [7]. This study focuses mainly on *Sclerocarya birrea* (Marula), a savannah

tree belonging to the family *Anacardiaceae*, and *Cassia abbreviata* belonging to the family *Caesalphiniaceae*. *C. abbreviata* is commonly used in rural areas for traditional medicine [8]. World health organization (WHO) indicated that approximately 80% of the people in developing countries use these plants for medicine, among other uses [9]. *S. birrea* fruits can be eaten as raw fruits and are a source of food for livestock, such as goats and wildlife. These fruits are used to produce jam and fruit juice [10, 11]. Bark is used as a source of medicine for treating a variety of diseases, such as syphilis, leprosy, diabetes, and other diseases. The roots and leaves are useful in conditions such as menstrual problems, toothache, and ulcers [12]. Kernels are useful in the production of cooking oil or are eaten raw as snacks. Kernels have higher protein (28-31%) content and other minerals such as magnesium, phosphorus, iron, zinc, and copper [13]. Wood is useful for fencing, curving (furniture, spoons, and plates), and as fuel [13]. In Botswana and South Africa, *C. abbreviata* is ground into a powder and mixed with water to cleanse women who have miscarriages [14]. The decoction of the root is consumed to cure abdominal pain, dysentery fever, malaria, and other diseases [15, 16]. Maroyi [17] stated that the roots may also be crushed and mixed with hot water and drinks to treat constipation [17]. The bark can be used to treat stomach aches, whereas the roots, leaves, and bark can be mixed to treat stomach aches [18].

In Kenya, the decoction of *C. abbreviata* leaves has been used to treat malaria. Leaves are also used to treat skin rashes linked to HIV and AIDS [19, 20]. A decoction of the fruits may be administered to treat malaria [21] and when they are ground and heated, they may be used to wash infected eyes. Wood is used for firewood and timber production [18]. Studies have also shown that factors such as wealth status can affect the use of the Non-Timber Forest Products (NTFP). In a study by Shackleton, et al. [22] and Ngorima [23] poor people in Southern Africa harvest more than wealthier people. Gender is also listed as one of the factors that can affect the use of NTFP, as shown in a study by Mguni, et al. [24] who showed that both males and females are involved in harvesting *S. birrea* in Beitbridge district, although females are more involved [24].

The high demand for forest and woodland products has led to the overexploitation of forests, especially by local communities that are dependent on forests in communal areas [19] for subsistence and economic gain [25]. *C. abbreviata* is now very scarce in Africa, for example, in areas such as Matsa village, Limpopo province, South Africa, due to harvesting operations, which reduces the guarantee of sustainability; therefore, there is a need for alternatives to ensure the sustainability of these species by either domesticating the plants to safeguard them from extinction [26]. *C. abbreviata* is highly threatened in most areas and is in the third rank, with a score of 401 and a frequency of 10 of the top 10 significant medicinal trees in the Shimama region in Zambia [27]. There is a lack of security or law enforcement outside protected areas, as there are no officials from either the government or traditional leaders deployed to safeguard plants from destruction [10]. Moreover, the government lacks support for the regulation of the NTFP, while more support is given to the protection of state forests [24].

Most studies have explored the harvesting and utilisation of these plants, yet little information has been gathered on the implications for the environment. Therefore, the main objective of this study was to explore the variation in the utilisation, ecological knowledge, conservation efforts, and plant population densities of *S. birrea* and *C. abbreviata* in the peri-urban and rural areas of Zimbabwe.

The following research questions guided the data collection and analysis.

- Is there any variation in perceptions of the use of *C. abbreviata* and *S. birrea* between people in peri-urban and rural areas?
- Is there any association between gender, age, level of education, ecological knowledge and willingness to conserve the species in peri-urban and rural areas?
- Are communities aware of the implications of harvesting these plants in the environment?
- Are the local communities at the study sites willing to conserve these plants?
- Is there any variation in tree density, height, diameter, and stump density of C. *abbreviata and S. birrea* in peri-urban and rural areas?

## 2. METHODS

### *2.1. Study Site*

The study was conducted in Matopo district, Halale (rural area), and Hide-park, Bulawayo (peri-urban area). Halale is in the Matabeleland South province in Zimbabwe (Figure 1.). It is approximately 75km south of Bulawayo metropolitan province, and the communal area is part of the 25 wards of Matopo district, according to the Zimbabwean 2022 census. It borders Hove-river on its northern part, which divides the area from Natisa village. On the western side, it borders Njelele village. There are about 200 households in this village as confirmed by the authorities. Matopo district is found in agro-ecological region IV with an average rainfall of 400mm - 450mm. The temperature ranges around 26-28°C (Matopo district profile). The area has two distinct seasons, that is, the summer (November to March) and winter (April to October). The vegetation type is classified as a dry savannah characterised by sparse trees, shrubs and grassy understory. This dry savanna vegetation is adapted to the hot and dry climate and includes species such as *Vachellia nilotica*, *S.birrea*, *Colophospermum mopane* trees and various grasses. Clay and loam soils and granitic sand soils are the dominant soil types. Most parts of the region are dominated by granite rocks, inselbergs and castle kopjes [28]. Land use in this study area involves settlement, croplands and grazing land. Most of the agricultural activities are done at the irrigation farm, which has a very large perennial dam. This helps improve food security since there is low rainfall and relief factors affecting crop cultivation.

Hyde-park is in the peri-urban area of Bulawayo, Zimbabwe (1274m elevation -20.9106 S: -28.5081°East (Maplanda.com). The region is found in Agro-ecological region IV, with an average rainfall of 400mm - 450mm FAO 1999. This area experiences a hot, semi-arid (steppe) climate. The temperatures in this region range around 27°C (weatherclimate.com), and this area is not that suitable for crop production, although most people undergo crop production as confirmed during the survey. The area has two distinct seasons: the summer, from November to March and winter, which ranges from April to October. This community has about 120 households as confirmed by the secretary and the community leadership, and it shares the same national assembly constituency as Pumula North Surbub in Bulawayo. It is dominated by Indigenous hardwoods such as *Coleophospermum mopane*, which are confined in loom soils, and some Acacia species such as the *Vachelia karoo*. There are also other trees dominating the area, including *Dichrostachys cinerea*, *Azanza garckeana*, *S.birrea*, *Grewia* species, *Kirkia accuminata*, and other trees. Land uses in this study area are settlement, croplands, grazing and woodland. There is less crop production due to rocky terrain and very low rainfall. The major agricultural activity is animal husbandry, as they keep cattle, sheep, goats, chickens, donkeys and other domestic livestock.

### *2.2. Study Area Map*

Figure 1A and 1B the study area map for Halale (Rural) and Hydepark (Peri-urban).

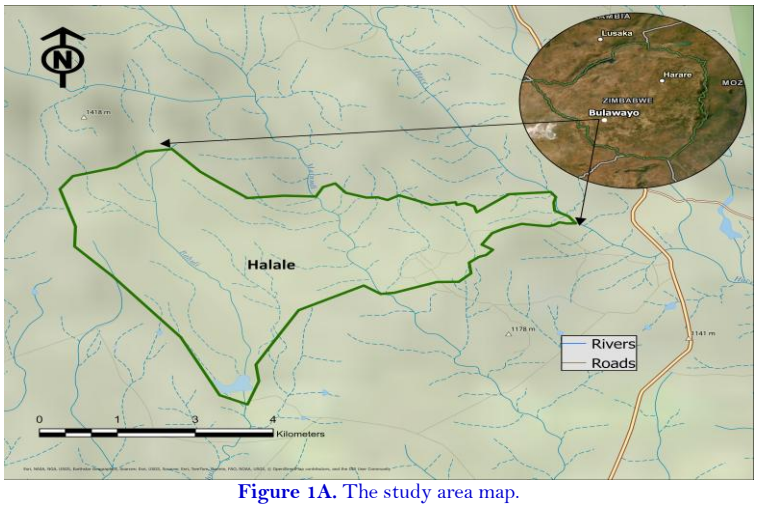



**Figure 1A.** The study area map.

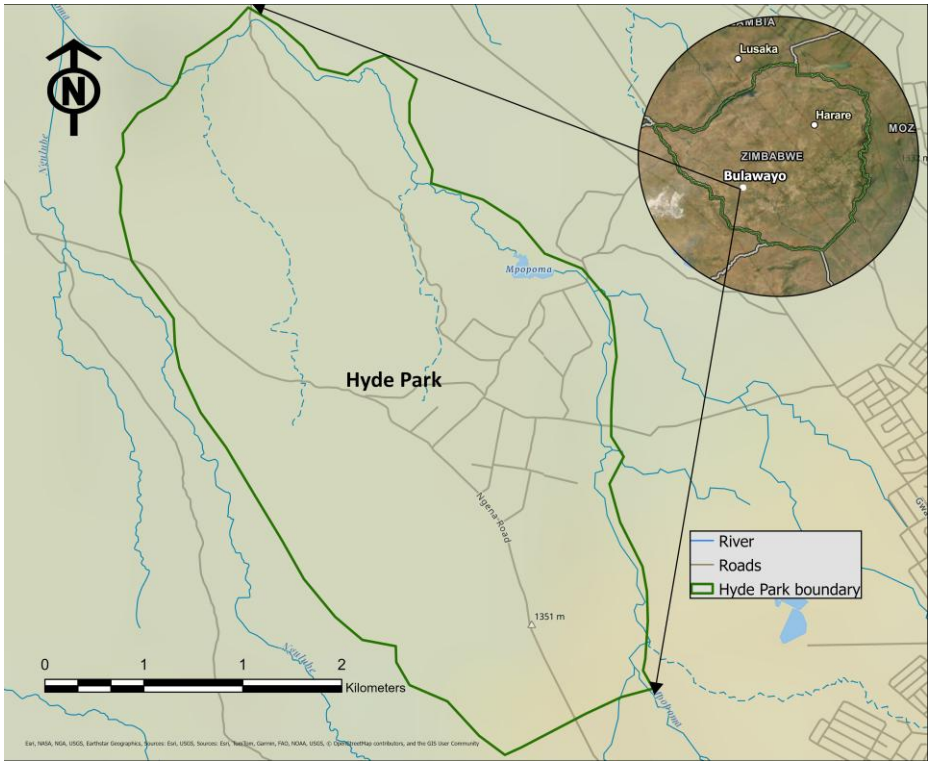



**Figure 1B.** The study area map.

### *2.3. Study Species*

*Sclerocarya birrea* (Marula) is a savannah tree belonging to the family Anacardiaceae. It is deciduous and dioecious as the male and female flowers are from different trees [29]. It is a medium-sized tree reaching heights of between 7m and 17 m with a rough bark and leaves that are imparipinnate, spirally arranged, crowded towards the ends of the branches and has 3-7 pairs of opposite to sub-opposite leaflets [30]. The flowering is said to be starting from September up to November and produces fruits of a diameter of 3cm [30]. It exists at altitudes varying from sea level to 1800m and in areas of an annual rainfall range of 200–1500 mm. *S. birrea* is said to be widely spread in semiarid savanna ecosystems, especially in Sub-Saharan Africa and offers a wide range of benefits to local communities [13]. The plant is well adapted to drought-prone areas, and people in the region benefit from the plant products. *S.birrea* also occurs in a wide range of soil types, although they prefer mostly well-drained soil in regions receiving rainfall between 200mm and 1500mm. However, this tree is said to be very sensitive to frost [13].

On the other hand, there is the *C. abbreviata*, which is in this study, which is under the family Caesalpiniaceae and is known for its pharmacological properties [31]. It is a shrub tree which grows to a height of up to 10m. It has compound leaves of up to 5 to 12 pairs, and the pods are dark brown in colour and cylindrical in shape. This plant is widely spread in Africa and occurs at low to medium altitudes between 220m and 1520m in open bushveld, woodland or wooded grasslands along rivers, hillsides and frequently on termite mounds [31]. These plants grow in clusters and grow in multiple clusters [31].

### *2.4. Sampling Design*

#### *2.4.1. Questionnaire Administration*

Simple random sampling was used to conduct the survey and to administer questionnaires in both study sites. Households were randomly selected in both study areas to respond to the questionnaire. The researchers tried to balance the number of females and males as well as the youth and old. The questionnaire was designed in a way to capture data on the social status of respondents, uses of the two selected plant species, their perceptions on the

sustainability of their harvesting methods, conservation approaches, willingness to conserve and problems faced to conserve and to have access to these plants. One hundred and five households were interviewed 33% in the peri-urban area) and 65 households in a rural community (33% in the rural area). The researchers translated the questionnaire into the local language for ease of communication.

### *2.4.2. Tree and Stump Density*

Twenty transects measuring 200m by 100m were used to count the number of trees measured in height and diameter at breast height (1.3m). The number of stumps within transects was also counted, and stumps were identified using re-sprouts. A calibrated stick of 2.5m was used to estimate tree height in both study areas. A tap measure was used to measure circumference at breast height. All the *C.abbreviata* and *S.birrea* were counted in all transects. Transects were set with respect to where the locals indicated they harvest these plants.

### *2.5. Data Analysis*

R studio version 4.2.0 was used for all data analysis. $\chi^2$ tests were used to test for associations between locality, age, gender, level of education with uses, ecological knowledge, awareness of harvesting implications, and willingness to conserve between rural and peri-urban areas. Two-way ANOVA was used to compare the density of tree species, diameter, height and stump density between the two study areas. Plant Part Value (PPV) were calculated using the Formula where PPV is the plant part value, $RU_p$ is the number of reported uses of the plant, and $RU_w$ is the number of reported uses of the whole plant. The use Value for each informant was calculated using the Medeiros, et al. [32] formula $UV_{is}$ =, where $U_{is}$ = the number of uses quoted in each interview by informant I, $n_{is}$ = the number of quotations for the species given by the informant.

The Use Value for each category was calculated using the Medeiros, et al. [32]) formula, where $\sum U_c$= sum of all the use citations of the category, either gender, education or age, $n_c$ = total number of individuals in the category. Overall Use Value (OUV) was obtained using the Medeiros, et al. [32] formula, $OUV = \sum^{U} V_k$, OUVs were calculated as the sum of all use-values per category for each respondent following. One-way ANOVA was used to compare Use values across all categories.

**Table 1.** Demographics of respondents in each study site.

| Variable | Rural n=65 | Peri-urban n=40 |
|---|---|---|
| Gender | | |
| Males | 26 | 17 |
| Females | 39 | 23 |
| Age group | | |
| Young | 19 | 13 |
| Middle age | 29 | 20 |
| Adults | 17 | 7 |
| Level of education | | |
| Primary | 16 | 5 |
| Secondary | 43 | 31 |
| Tertiary | 6 | 4 |

### *2.6. Demographics*

105 respondents were interviewed, with more females than males (Table 1). The table of demographics also showed the representation of the three age categories (Youths, middle age, and Adults) in each study site. Across the site, a representation of the respondents' levels of education was recorded.

**Table 2**. *S. birrea* and *C. abbreviate* Plant part value.

| Plant part | Plant part value (%) | |
|---|---|---|
| | ***S.birrea*** | ***C.abbreviata*** |
| Barks | 33.2 | 35 |
| Fruits | 26.8 | 30 |
| Nuts | 28.2 | Null |
| Stem | 11.8 | Null |
| Roots | Null | 35 |

## 3. RESULTS

### *3.1. Plant Part Value*

The plant parts used for *S.birrea* are the bark (33.2%), nuts (28.2%), fruits (26.8%), and stems (11.8%). *C.abbreviata* plant parts used are bark (35 %), roots (35%), and fruits (30%) as shown in Table 2.

**Table 3**. Effect of locality, age category, gender, and education on overall use-values for *S.birrea* and *C. abbreviate.* aa, aaa p>0.05: ab p<0.05: a ab a p<0.05.

| Variable | ***S birrea*** | | | ***C abbreviata*** | | |
|---|---|---|---|---|---|---|
| | **Average OUV** | **SE** | **PV** | **Average OUV** | **SE** | **PV** |
| Locality | | | | | | |
| Rural | 0.377 [a] | 0.316 | NA | 0.854 [a] | 0.082 | NA |
| Peri-urban | 0.363 [a] | 0.260 | | 0.725 [a] | 0.396 | |
| Gender | | | | | | |
| Males | 0.453 [a] | 0.359 | NA | 0.826 [a] | 0.303 | NA |
| Females | 0.315 [a] | 0.229 | | 0.758 [a] | 0.369 | |
| Age group | | | | | | |
| Young | 0.266 [b] | 0.249 | * | 0.735 [b] | 0.399 | * |
| Middle age | 0.388 [ab] | 0.349 | | 0.735 [ab] | 0.350 | |
| Adults | 0.479 [a] | 0.136 | | 0.940 [a] | 0.136 | |
| Level of education | | | | | | |
| Primary | 0.381 [a] | 0.209 | NA | 0.929 [a] | 0.361 | NA |
| Secondary | 0.328 [a] | 0.312 | | 0.754 [a] | 0.318 | |
| Tertiary | 0.750 [a] | 0.312 | | 0.700 [a] | 0.415 | |

**Note:** Values within a column followed by a different superscript differ significantly (Tukey's HSD; $p < 0.05$).

### *3.2. Plant Use Value*

*S.birrea* is used for food, personal, furniture, and medicine while *C.abbreviata* is only used for lights and medicine. Medicine has higher average use values for both species. These use values were calculated in different categories such as age, gender, level of education, and locality. The overall use values are shown in Table 3.

Results show that for both species, plant use values are the same between peri-urban and rural areas. The results also show that use values are the same for both species in the gender and level of education category. However, there is a significant difference observed in the age category in both species.

There is a significant difference observed between the young and the adults while middle-aged people use values do not differ from the young and the adults use values as shown in Table 3.

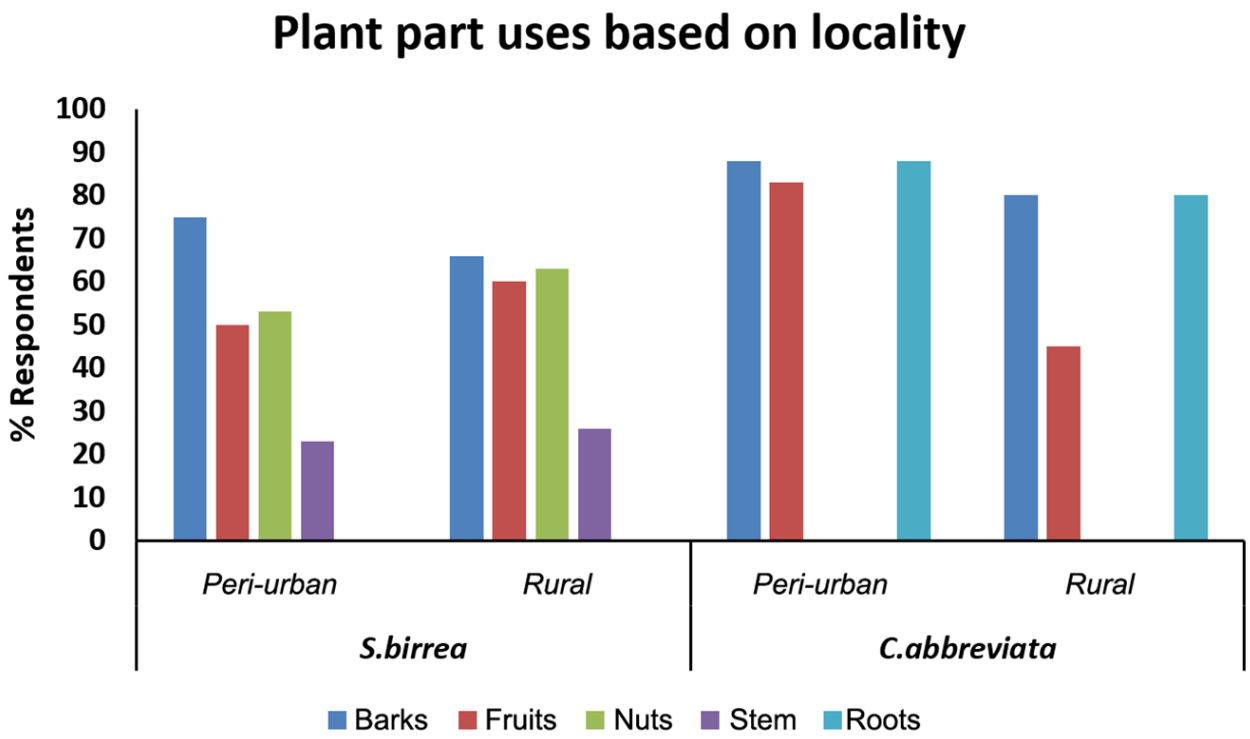



**Figure 2.** *S.birrea* and *C.abbreviata* plant part uses in peri-urban and rural areas based on locality.

### *3.3. Plant Part Uses*

#### *3.3.1. Influence of Locality on Plant Part uses of S. Birrea and C. Abbreviata*

Results show that the most used plant parts in peri-urban and rural areas are the bark followed by nuts, fruits, and lastly stems of *S.birrea* while the bark, roots, and fruits are mostly used parts of *C.abbreviata* as shown in Figure 2. No leaves were used in both areas. Locality does not influence the use of *S.birrea* and *C.abbreviata* in peri-urban and rural areas ($\chi 2 = 2.0605$, df=3, p-value=0,5599; and $\chi 2 = 5.8377$, df = 2, p-value = 0.05399) respectively.

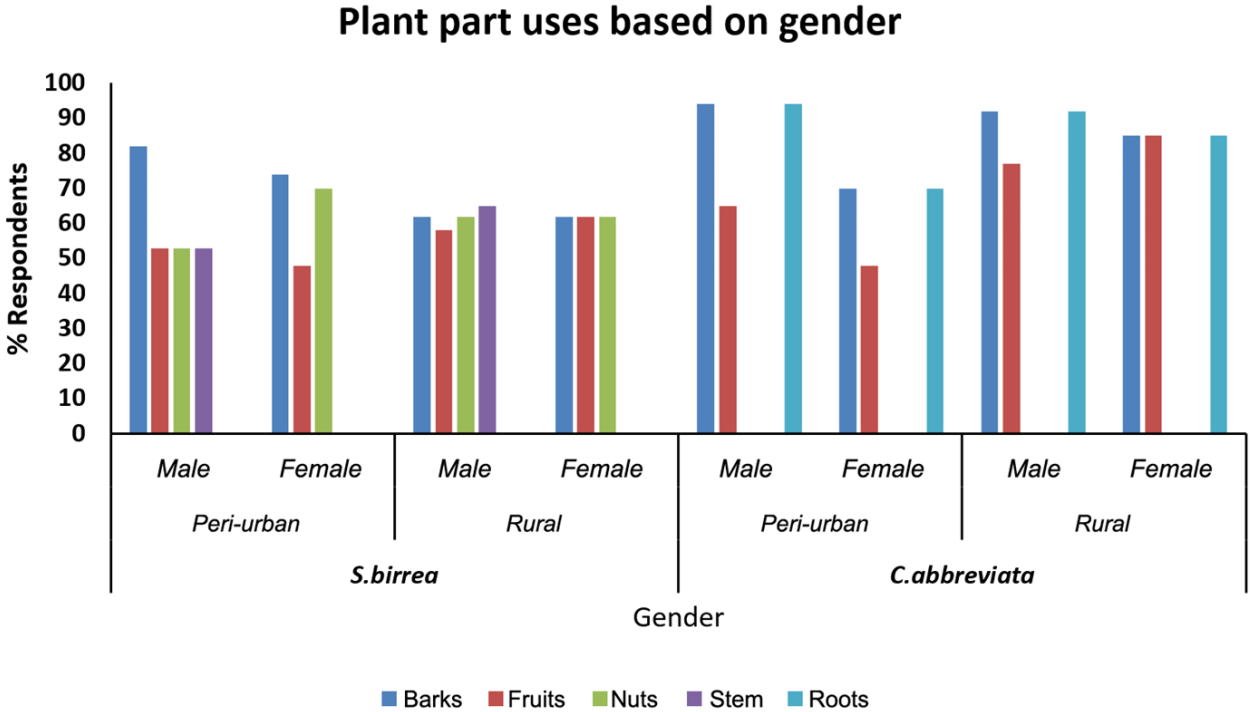



**Figure 3.** *S.birrea* and *C.abbreviata* plant parts used in peri-urban and rural areas based on gender.

### *3.3.2. Influence of Gender on Plant Part uses of S. Birrea and C. Abbreviata*

Results indicate that gender does not influence use of *S. birrea* plant parts in rural areas and peri-urban areas ($\chi2$ = 57.685, df = 3, p-value = 1.835e-12; $\chi2$ = 51.117, d f = 3, p-value = 4.619e-11), respectively and *C. abbreviata* plant part uses in rural and peri-urban areas (X-squared = 0.87909, df = 2, p-value = 0.6443; $\chi2$= 0.0014449, df = 2, p-value = 0.9993) respectively.

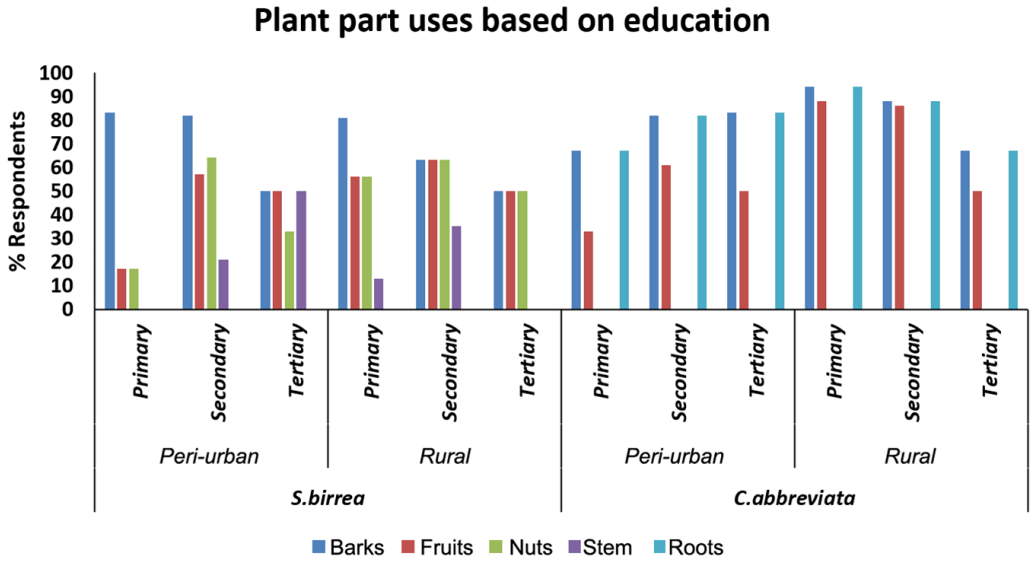



**Figure 4.** *S.birrea* and *C. abbreviata* plant part use based on level of education.

### *3.3.3. Influence of Level of Education on Plant Part uses of S. Birrea* and *C. Abbreviata*

Results show that there is an association between *S.birrea* plant part uses and level of education in peri-urban areas and rural areas ($\chi2$= 94.309, df = 6, p-value < 2.2e-16; $\chi2$= 35.071, df = 6, p-value = 4.175e-06) respectively as shown in Figure 4.2.3.1. For *C.abbreviata* there is no association between the level of education and plant part use in peri-urban and rural areas ($\chi2$ = 2.9187, df = 4, p-value = 0.5715; $\chi2$= 1.7668, df = 4, p-value = 0.7785) respectively.

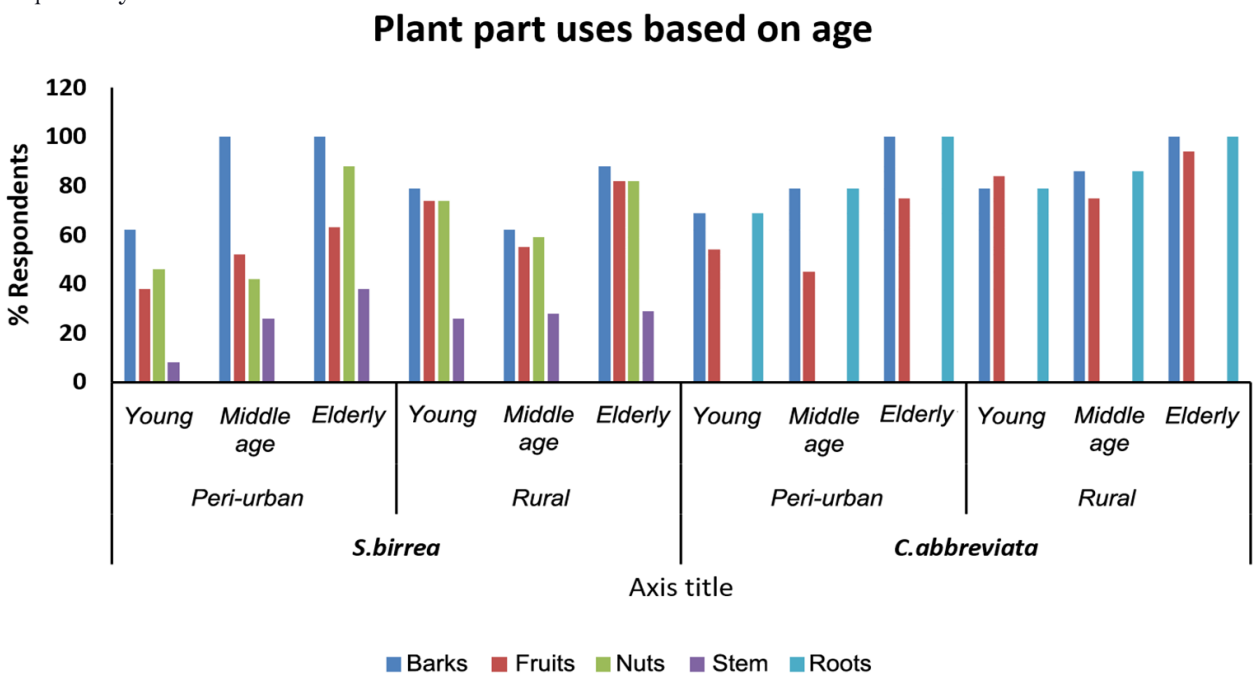



**Figure 5.** *S. birrea* and *C. abbreviata* plant use between different age classes.

### 3.3.4. Influence of Level of Age on Plant Part uses of *S. Birrea* and *C. Abbreviata*

The results show that there is no association between age and *S. birrea* plant parts used in rural and peri-urban areas ($\chi2$ = 1.8447, df = 6, p-value = 0.9334; $\chi2$ = 59.055, df = 6, p-value = 7. 002e-11) respectively. There is no association between age and plant part used for *C. abbreviata* in rural areas and peri-urban areas ($\chi2$ = 1.0805, df = 4, p-value = 0.8974; $\chi2$= 2.2332, df = 4, p-value = 0 .6929) respectively.

**Table 4.** Effect of locality on ecological knowledge, awareness of harvesting implication, and willingness to conserve.

| Variable | Level | Peri-urban | Rural | $\chi2$ | P-value |
|---|---|---|---|---|---|
| Ecological knowledge | Knowledgeable | 83 | 90 | 6.666 | 0.009 |
| | Not knowledgeable | 17 | 10 | | |
| Awareness on harvesting implication | Aware | 68 | 79 | 4.849 | 0.028 |
| | Not aware | 32 | 31 | | |
| Willingness to conserve | Willing | 73 | 78 | 0.433 | 0.511 |
| | Not willing | 27 | 22 | | |

### 3.4. Effect of Locality on Ecological Knowledge, Awareness of Harvesting Implication, and Willingness to Conserve

$\chi2$ results indicated that people in rural areas have higher ecological knowledge, more aware of the harvesting implications, than people in peri-urban areas ($\chi2$ = 6.6659, df = 1, p-value = 0.009827; $\chi2$= 4.8486, df = 1, p-value = 0.02767), respectively, while the willingness to conserve both species is the same between peri-urban and rural ($\chi2$ = 0.43249, df = 1, p-value = 0.5108).

**Table 5.** Effect of gender, level of education, and age on ecological knowledge, willingness to conserve, and awareness of harvesting implications in Peri-urban and rural area.

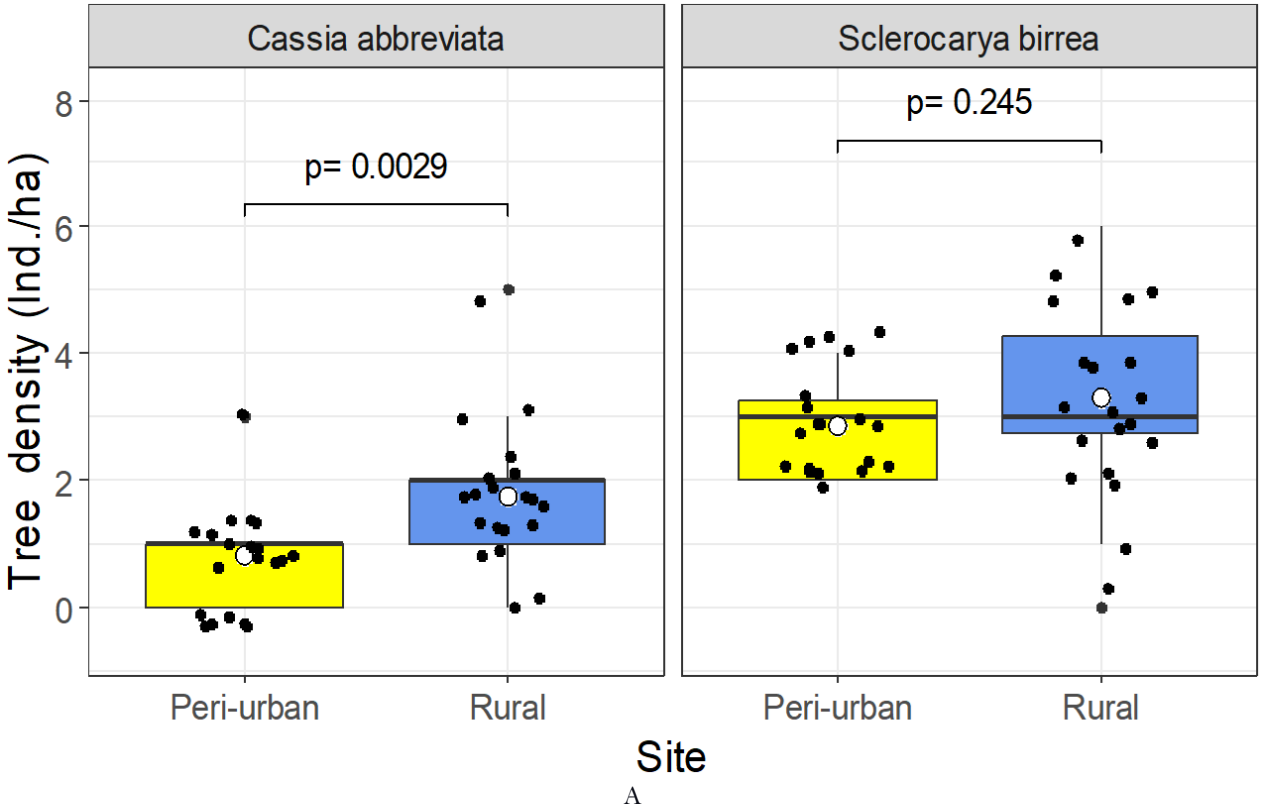
| Variable | Level | Peri-urban | | Rural | |
|---|---|---|---|---|---|
| | | $\chi2$ | P-value | $\chi$ 2 | P-value |
| Ecological knowledge | Male | 0 | 1 | 0.023 | 0.880 |
| | Female | | | | |
| | Primary | 8.089 | 0.01752 | 18.607 | 9.11E-05 |
| | Secondary | | | | |
| | Tertiary | | | | |
| | Young | 45.161 | <1.561E-1 | 11.105 | 0.003877 |
| | Middle age | | | | |
| | Adults | | | | |
| Awareness of harvesting implication | Male | 8.7101 | 0.003165 | 4.500 | 0.03389 |
| | Female | | | | |
| | Primary | 71.642 | 2.77E-16 | 34.154 | <3.833E-08 |
| | Secondary | | | | |
| | Tertiary | | | | |
| | Young | 34.837 | <2.724E-08 | 28.195 | 7.54E-07 |
| | Middle age | | | | |
| | Adults | | | | |
| Willingness to conserve | Male | 22.571 | <2.026E-06 | 1.775 | 0.183 |
| | Female | | | | |
| | Primary | 64.578 | <9.485E-15 | 30.758 | 2.09E-17 |
| | Secondary | | | | |
| | Tertiary | | | | |
| | Young | 74.154 | <2.2E-16 | 49.322 | 1.95E-11 |
| | Middle age | | | | |
| | Adults | | | | |

### *3.5. Effect of Gender, Level of Education, and Age on Ecological Knowledge, Willingness to Conserve, And Awareness of Harvesting Implication in Peri-Urban and Rural Area*

Generally, the level of ecological knowledge is the same($p>0.05$) for males and females in peri-urban areas while there is no association in rural areas. Level of education has a significant influence($p<0.05$) on the ecological knowledge in both study sites as most of the people who reached tertiary education have higher ecological knowledge. Age also significantly influences ($p<0.05$) ecological knowledge in both study sites with the majority across all age groups having higher ecological knowledge as shown in Table 5.

There is a significant association($p<0.05$) between gender and awareness of harvesting implications in peri-urban areas, with males and females, while in rural areas there is no association between gender and awareness of harvesting implications. There is an association($p<0.05$) between the level of education and awareness of harvesting implications in both study sites. Those with primary and tertiary education were more aware of the harvesting implications in both study sites. Those with secondary education are more aware of the harvesting implications. Age also significantly influences($p<0.05$) the awareness of harvesting implications in both study sites with most of the elderly and the young age more aware of the harvesting implications as shown in Table 5.

The results also show that gender has no influence($p>0.05$) on willingness to conserve in rural areas while in peri-urban areas gender influences the willingness to conserve with most of the males willing to conserve, compared to females. The level of education also influences($p<0.05$) the willingness to conserve in both study sites. Everyone within tertiary education was more willing, followed by primary and secondary education. Age significantly influences($p<0.05$) willingness to conserve in both rural and peri-urban areas. In both areas, the young (18-30) and the elderly (>60) generation are more willing to conserve than the middle-aged (31-60) as shown in Table 5.

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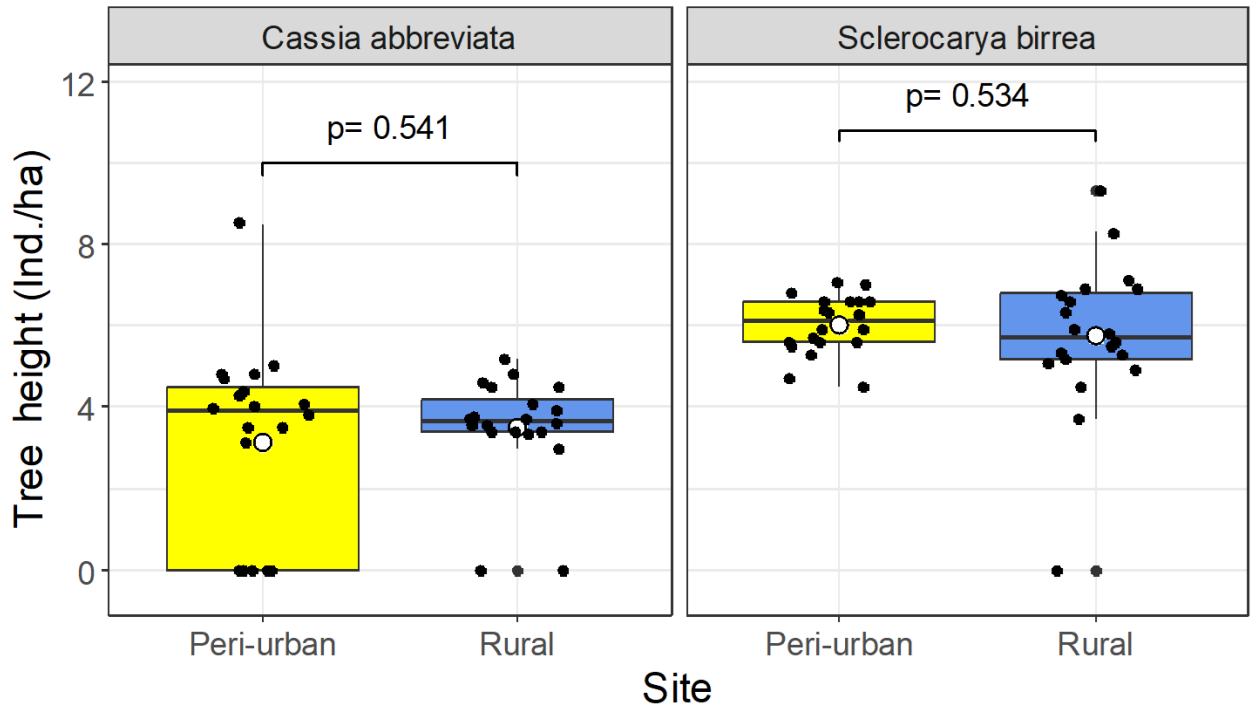
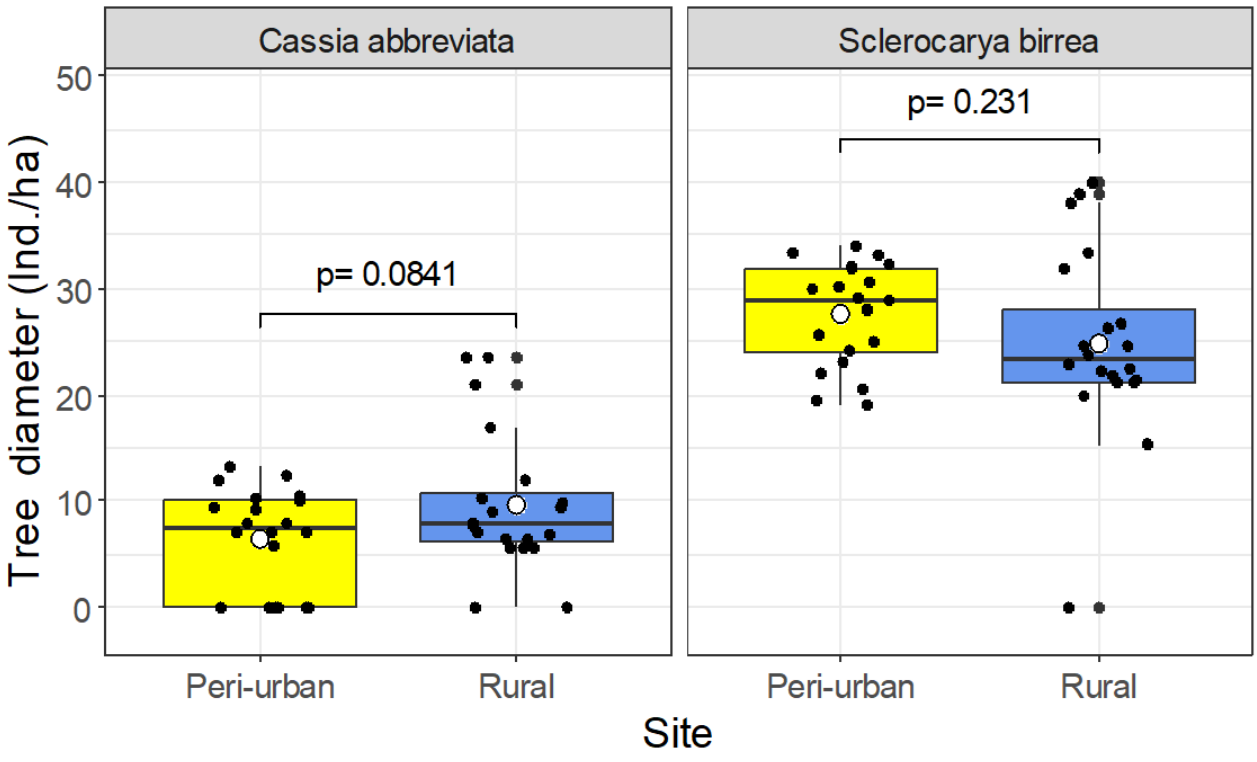



B

**Figure 6.** Comparison of tree density(Ind./ha) (Fig 6A) and height distribution(Ind./ha) (Fig 6B) for *C. abbreviate* and *S. birrea* in peri-urban and rural areas.

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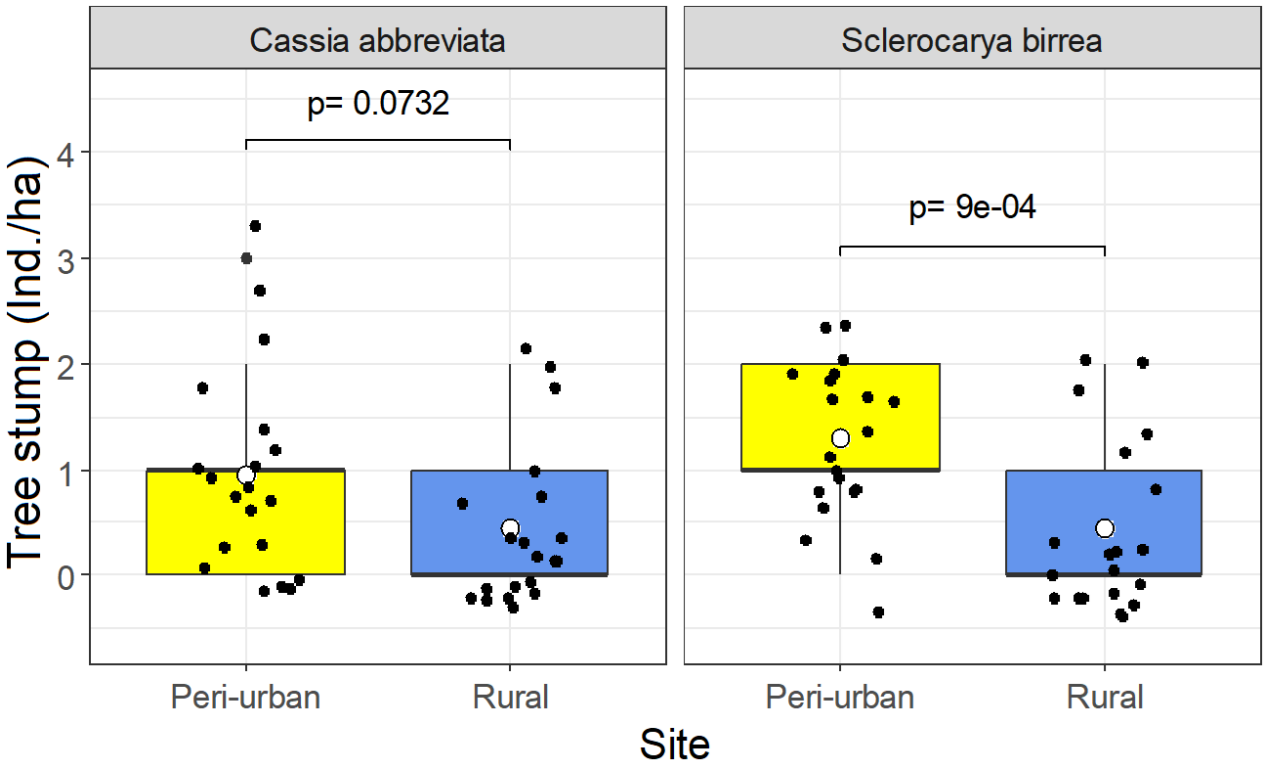


B

**Figure 7.** Comparison of tree diameter (Ind./ha) (Fig 7A) and tree stump density(Ind./ha) (Fig 7B) for *C. abbreviata* and *S. birrea* in peri-urban and rural areas.

### *3.6. Tree Density, Height, Diameter, and Stump Density of S.Birrea and C. Abbreviata in the 2 Study Sites*

There is a significantly higher tree density for *C.abbreviata* in rural areas compared to peri-urban areas while tree density was the same for *S.birrea* in rural areas and peri-urban areas (Figure 6A). Height and diameter are the same *for C.abbreviata* and *S.birrea* in rural and peri-urban areas (Figure 6B, Figure 7A) respectively($p>0.05$). The stump density of *C.abbreviata* is the same in rural areas and peri-urban areas ($p>0.05$) while the stump density of *S.birrea.* is higher in peri-urban areas ($p<0.05$) than rural areas as shown in Figure 7B.

## 4. DISCUSSION

According to the study's findings, there was no association between the utilisation of *S. birrea* and *C. abbreviata* in peri-urban and rural areas. This clearly indicates that plant products contribute to livelihoods in areas of food security, medicine, and others, as proven by studies by Sinthumule and Mzamani [11] and Suleiman, et al. [33]. In both study areas, no one used roots and leaves for *S birrea*, although some studies have indicated that leaves and roots are useful for treating ulcers, tooth pain, and conditions such as menstrual problems [12]. There was no use of *C. abbreviata* stems and leaves in peri-urban and rural areas, although in Kenya, leaves are used for treating malaria and even for treatment of skin rashes and other conditions related to HIV and AIDS [20]. Gender and educational level significantly influenced the utilisation of *S. birrea*, whereas no association was observed for *C. abbreviata.*

Although there are no studies conducted on the PPV and PUV for *S. birrea* and *C. abbreviata*, the findings in this study indicate that the bark had a higher PPV for both species, implying that the bark is the most used plant part. Therefore, there is a need for sustainable harvesting of the bark, such as controlled strip barking regulatory measures to protect phloem vessels for nutrient transactions. Although the bark has a higher PPV, other plant parts have a higher PPV, such as stems, fruits, and roots. Harvesting the roots is said to be more destructive (PROTA4U), which calls for conversation. Roots play a crucial role in osmosis, enhancement of the plant, and soil protection, and if their harvesting is unchecked, there is a higher chance of exposing these species to extinction.

Uncontrolled harvesting can affect the plant's regeneration since these plants normally regenerate naturally through seeds. Therefore, this calls for sustainable harvesting practices to ensure effective conservation. While locality, gender and level of education do not affect average OUV, age was found to significantly affect plant use values significantly. The similarity in average OUV for both species in both study sites implies that they have similar needs and priorities and access to resources. Significant difference observed in the age category implies that the young and the adults have different priorities and traditional knowledge. Observations on the middle age group demonstrate that this age category may be a transactional phase, where individuals adopt use patterns from either the young or adult groups.

To the best of the researchers' knowledge, this is the first study to investigate ecological knowledge, awareness of harvesting implications, and willingness to conserve *S.birrea* and *C.abbreviata*. However, findings highlighted the fact that rural areas exhibit higher ecological knowledge levels compared to peri-urban areas, as witnessed in this study. This highlights the Indigenous Knowledge System (IKS) gaps between peri-urban areas and rural areas. It emerged from the study that gender does not influence ecological knowledge in peri-urban areas, while in rural areas, gender significantly influences ecological knowledge levels, with males more knowledgeable and educational levels, and age significantly influences ecological knowledge levels with notable differences between peri-urban and rural demographics. The knowledge gap between different age groups is attributed to poor knowledge distribution among different age groups, as the more knowledgeable adults tend to hide some knowledge they have. Education is deemed to spearhead ecological knowledge as those with tertiary education exhibited higher ecological knowledge, pointing to the role of school curricula such as environmental sciences. This shows that a review of the school curriculum can help boost ecological knowledge in these lower levels by integrating the subject with other non-science subjects.

It was also found that rural people demonstrated a greater awareness of the harvesting implications compared to the peri-urban people. This might be because of the issue of deficiency of laws that help in the regulation of the use of *S.birrea* tree, for example, and the laws that are used are borrowed from just the environmental laws whose measures are confusing [34, 35]. Modernisation in most areas has led to the abandonment of the traditional livelihood systems. As such, there is a need to review laws on harvesting and overexploitation since the current laws and regulations of the Forest Produce Act are focused on the "use of" and "trade on". The same Act does not clarify who should harvest and for what purpose. There is also a lack of support for the regulation of the NTFP by the government, while more support is given to the protection of State forests [24]. Gender, educational level, and age influence awareness levels, with different patterns found in rural and peri-urban settings.

In peri-urban areas, gender significantly influenced awareness as males were shown to be more aware of the harvesting implications than females, while in rural areas, gender did not influence the awareness of harvesting implications. Levels of education and age were found to significantly influence the awareness levels in peri-urban areas and rural areas, as those with primary and tertiary education are more aware in peri-urban areas, while in rural areas, those with secondary education are more aware of the harvesting implications. The elderly demonstrated to be aware of the harvesting implications in both peri-urban and rural settings. The awareness gaps posed by differences in age, gender and different educational levels demonstrate a threat to the success of conservation. For conservation to be a success story, there is a need to reduce the cutting down of these species by increasing awareness of the importance of trees, especially in the hydrological cycle [35]. In other words, strengthening traditional leadership helps bridge the gap in the management of NTFP as people normally respond to the laws passed to the traditional system [24].

Although willingness to conserve is generally high across peri-urban and rural areas (Table 4), differences are noted in gender, educational levels and age categories (Table 5). This is contrary to the awareness of harvesting implications, which is higher in rural areas than in peri-urban areas (Table 4). This shows that although the peri-urban people have lower awareness levels of the harvesting implications, they are more willing to conserve. In rural

areas, gender has no significant impact on conservation willingness. However, in peri-urban areas, men are more willing to conserve than women (Table 5). This aligns with a study indicating that socio-economic roles and gender egalitarian attitudes significantly influence environmental concern and conservation behavior [36]. Educational level was consistently influential across both peri-urban and rural areas, with individuals possessing tertiary education showing a higher willingness to conserve. This is supported by findings that higher education levels correlate with increased environmental awareness and proactive conservation attitudes [37, 38]. Age also plays a significant role, with elderly individuals more willing to conserve than middle-aged groups. This is consistent with studies showing that older individuals tend to have a greater appreciation for the long-term of different communities. Gender-sensitive approaches and culturally relevant education initiatives can enhance inclusive participation in conservation efforts, particularly by increasing awareness and involvement among women in peri-urban areas [36]. Environmental education can also promote a positive attitude towards environmental protection by providing awareness and understanding its significance [39]. There is also a need to incorporate communities in conservation and give power to traditional leaders to implement measures for harvesting operations, such as in Malawi [40].

Lastly, it was observed that the ground in rural settings tends to have a higher tree density for *C. abbreviata* compared to peri-urban areas, although the stump density is the same. The study's design did not allow the researchers to collect data on strip barking. As such, the researchers propose that strip barking caused a difference in tree density, as some studies prove that strip barking affects plant population density, such as the pepper bark tree [41]. Studies indicate that stripped surfaces are very prone to water loss, [42] and the researchers propose that this might have enhanced the death of some trees, leading to the variation in tree density. The trunk tends to dry and decay and, hence, affects translocation processes [43]. Interestingly, the number of stumps recorded was significant, although the respondents indicated that they do not use the stems for *C. abbreviata*. This signals bias if research only relies on personal responses without observations. People responded no use for *C. abbreviata*, although stumps were recorded due to fear of prosecution since harvesting of medicinal plants is an offence in many traditions, although in *S. birrea*, cutting is permitted on male plants [40, 44]. Population density for *S. birrea* is the same for peri-urban areas and rural areas, although the stump density is the same. This shows that the harvesting of *S. birrea* promotes regeneration. However, diameter and height distribution are currently the same in peri-urban and rural areas, which shows that harvesting operations currently have no influence on the height and diameter for *C. abbreviata* and *S. birrea*. This, therefore, calls for further assessment in subsequent years.

## 5. CONCLUSIONS

In view of the findings presented it can be concluded that locality does not significantly influence the utilisation of *S. birrea* and *C. abbreviata*, although socio-demographic factors such as gender and education level significantly influence the utilisation patterns, particularly for S. *birrea* where all these factors significantly influenced plant part usage. It is a different case when it comes to ecological knowledge. Results indicate that locality affects ecological knowledge as rural people demonstrate higher ecological knowledge levels compared to peri-urban areas. This is attributed to IKS differences between the two sites. Gender, education level, and age play significant roles in shaping ecological knowledge, with implications for conservation efforts and sustainable resource management. Gender significantly influenced ecological knowledge levels, particularly in rural areas, as the females exhibited a higher ecological knowledge. The same applies to awareness of harvesting implications as rural communities exhibit greater awareness of the environmental implications of harvesting practices compared to peri-urban communities, with gender, educational levels, and age influencing awareness levels. This signals the importance of targeted education and outreach programmes that can promote awareness levels. However, willingness to conserve both species is high across peri-urban and rural areas as gender, educational level, and age disparities exist, emphasising the need for inclusive conservation strategies that address diverse community needs and preferences.

Finally, from the researchers' observations, it can be concluded that rural areas have higher tree density for *C. abbreviata* than peri-urban areas. No significant difference in density was observed for *S. birrea*. This clearly indicates potential management challenges and the need for adaptive conservation approaches that can address conservation challenges for *C. abbreviata*.

**List of Abbreviations**

| | |
|---|---|
| PPV | Plant Part Value |
| PUV | Plant Use Value |
| NTFP | Non-Timber Forest Products |
| OUV | Overall Use Value |
| UV | Use value |
| GPS | Global Positioning System |
| IKS | Indigenous Knowledge System |
| HIV | Human Immuno-deficiency virus |
| AIDS | Acquired immune deficiency syndrome |
| FAO | Food and Agriculture Organisation |
| WHO | World Health Organisation |

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**Transparency:** The authors state that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.
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