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Traditional uses of wild and tended plants in maintaining ecosystem services in agricultural landscapes of the Eastern Cape Province in South Africa

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Abstract

Background: Many communities in developing countries rely on ecosystem services (ESs) associated with wild and cultivated plant species. Plant resources provide numerous ESs and goods that support human well-being and survival. The aim of this study was to identify and characterize wild and tended plant species, and also investigate how local communities in the Eastern Cape Province in South Africa perceive ESs associated with plant resources.

Methods: The study was conducted in six local municipalities in the Eastern Cape Province, between March 2016 and September 2021. Data on socio-economic characteristics of the participants, useful plants harvested from the wild and managed in home gardens were documented by means of questionnaires, observation and guided field walks with 196 participants. The ESs were identified using a free listing technique.

Results: A total of 163 plant species were recorded which provided 26 cultural, regulating and provisioning ESs. Provisioning ESs were the most cited with at least 25 plant species contributing towards generation of cash income, food, traditional and ethnoveterinary medicines. Important species recorded in this study with relative frequency of citation (RFC) values > 0.3 included *Alepidea amatymbica*, *Allium cepa*, *Aloe ferox*, *Artemisia afra*, *Brassica oleracea*, *Capsicum annuum*, *Cucurbita moschata*, *Hypoxis hemerocallidea*, *Opuntia ficus-indica*, *Spinacia oleracea*, *Vachellia karroo* and *Zea mays*.

Conclusion: Results of this study highlight the importance of plant resources to the well-being of local communities in the Eastern Cape within the context of provision of essential direct and indirect ESs such as food, medicinal products, construction materials, fodder, regulating, supporting and cultural services. The ESs are the basis for subsistence livelihoods in rural areas, particularly in developing countries such as South Africa. Therefore, such body of knowledge can be used as baseline data for provision of local support for natural resource management initiatives in the province and other areas of the country.

Keywords: Eastern Cape Province, Ecosystem services, Plant biodiversity, Traditional ecological knowledge, Useful plants

Background

A growing body of literature suggests that local communities in developing countries still continue to rely heavily on provisioning ecosystem services (ESs) derived from plants around their homesteads for their basic necessities

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[1–6]. Research by Bidak et al. [2] showed that plant resources provide direct ESs such as serving as sources of food, medicines, energy and shelter. There are also indirect social and economic ESs derived from plant resources. Ecosystem services are classified into four categories: provisioning ESs such as non-timber forest products, fibre, firewood, water, fish and natural medicines; regulating ESs such as pollination, natural hazards, water, air quality, runoff, disease and climate regulation; cultural services that provide recreational, aesthetic and spiritual benefits; and supporting ESs such as habitat for species, soil formation, photosynthesis and nutrient cycling [7]. Plant resources supply all three major categories of ESs, that is, provisioning, regulating and cultural services, including the supporting services that enable agricultural landscapes to be productive [8, 9]. Plant resources provide ESs that extend beyond the provision of food, medicines, energy, shelter and some of these ESs are indirect, unmanaged, underappreciated and undervalued. For example, research by Ladino et al. [10] showed that the plant group Bromeliads provide direct benefits to the human society, and they also form microecosystems in which accumulated water and nutrients support the communities of aquatic and terrestrial species. Previous research by Calvet-Mir et al. [8] and Camps-Calvet et al. [9] showed that plants grown and managed in home gardens are important for the provision of cultural ESs. The authors argued that plant resources managed in home gardens offer nature-based solutions to environmental problems, protection and restoration of agricultural landscapes, promotion of healthy lifestyles, social integration and environmental justice. Similarly, Barrios et al. [11] argued that tree-mediated ESs are recognized as key features of more sustainable agroecosystems but the strategic management of tree attributes for ES provision is poorly understood. For example, Barrios et al. [11] opined that managing trees for ESs requires understanding tree identities, their characteristics, uses and how to manage these trees in the provision of all four ESs categories in different socio-ecological contexts. Despite their importance and everyday use, comprehensive knowledge of the ecology and socio-economic value of ESs derived from plant resources is largely lacking, hindering the ability to monitor, regulate and manage them. Therefore, a clear understanding about the condition of provisioning, regulating, cultural and supporting services provided by plant resources is necessary and such information is derived from both the resource use patterns of the people who are most reliant on these services, as well as the utility of the plant resources exploited by local communities.

Mensah et al. [3] argued that ESs underpin human livelihoods around the world as the use of ESs is important for decision-making processes that target the social

expectations of local communities. However, a detailed understanding of the complex variation in the use and relative importance of ESs at the household level is required to fully understand how ESs affect livelihoods across different landscapes [12–15]. Other researchers are of the view that determination and identification of ESs is a prerequisite in order to estimate the relative importance of ESs in a community and ensuring their conservation and sustainable management [16–18]. Therefore, understanding the linkages between ESs and benefits for people is critical for safeguarding natural resources and particularly those important for groups that are most vulnerable to global change [19, 20]. However, the ability of ESs to inform decision-making has been limited by knowledge gaps about the links between ES supply and the delivery and distribution of benefits [20–25]. Despite growing interest in ESs provided by plant biodiversity in different landscapes [26–30], few studies have attempted to systematically describe and evaluate the ESs derived from wild and tended plant species. Current statistics show that most ESs research has focused on higher income countries [31] while growing body of literature shows that there is direct dependence on ESs in low-income countries [32, 33]. Therefore, the aim of this study was to assess ESs supplied by wild and tended plant species in the Eastern Cape Province in South Africa. The specific goals of this paper are: i. to identify and characterize the diversity of wild and tended plant species, and ii. to investigate how local communities in the Eastern Cape Province perceive ESs associated with plant resources.

Materials and methods

Study area

This study was conducted in six local municipalities in the Eastern Cape Province in South Africa, namely Elundini, Mbhashe, Mbizana, Ntabankulu and Raymond Mhlaba and Umzimvubu (Fig. 1). The Eastern Cape Province is the second largest province in the country covering 168 966 km² of land area [34]. It is regarded as a rural province and is predominantly inhabited by isiXhosa speaking people of Cape Nguni descent. The Eastern Cape Province includes two of the former homeland areas, namely Ciskei and Transkei out of the thirteen former racially-defined homelands or Bantustan areas of South Africa [35]. One of the Apartheid government's acts of segregation was the Bantu Authorities Act of 1951, which legalized the deportation of Black people into designated homelands. Black people were forcibly removed from urban areas and white farms to those areas demarcated as homelands. The Ciskei and Transkei are today characterized by landlessness, pervasive chronic poverty, low levels of education, economic activity, vulnerability,

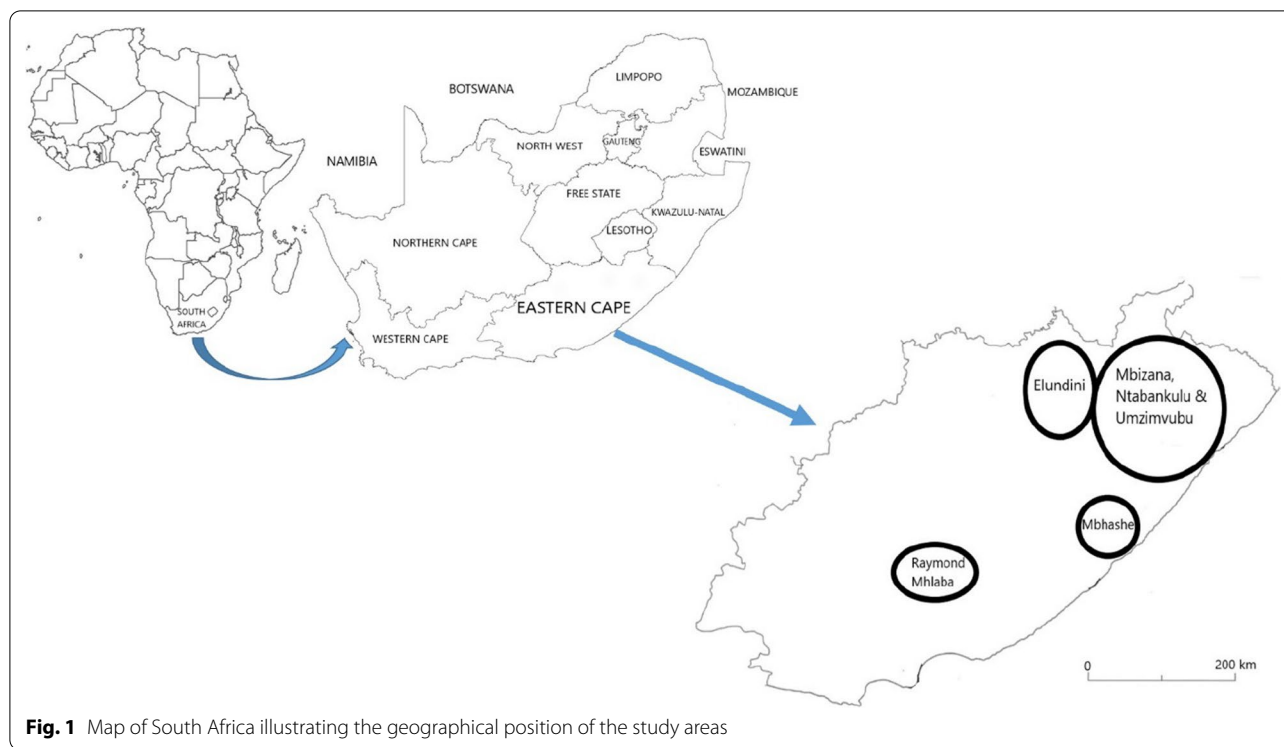


Fig. 1 Map of South Africa illustrating the geographical position of the study areas

lack of basic services, a dearth of employment opportunities and high levels of dependency on welfare [36, 37]. An estimated 72% of the population in the Eastern Cape Province live below the poverty line, which is more than the national average of 60% and this is attributed to the legacies of Apartheid, where the Eastern Cape provincial administration inherited the largely impoverished and corrupt former Ciskei and Transkei homelands [38]. Research by Westaway [37] revealed that the majority of households in the Eastern Cape Province spend most of their income on food and there is clear evidence of growing food insecurity as measured by the number of meals consumed and the quantity and variety of foods eaten. Most people in the province live in rural areas, the contribution of agriculture to local livelihoods is low in the entire province and has been in decline for several decades [39]. Research by Shackleton et al. [40] revealed that local people's livelihoods in the province are centred on grasslands and forests for fodder, wild foods, firewood, medicinal plants and fibre species for weaving.

The six local municipalities are in the Savanna Biome [41] dominated by grassland, succulent thicket and *Acacia* thornveld, and species such as *Aloe aborescens* Mill., *Aloe ferox* Mill., *Diospyros dichrophylla* (Grand.) De Winter, *Eragrostis curvula* (Schrad.) Nees, *Euphorbia* spp., *Melinis nerviglumis* (Franch.) Zizka, *Olea europaea* L. ssp. *africana* (Mill.) P. S. Green and *Vachellia karroo* (Hayne) Banfi & Glasso. The altitude of the study area

is between 0 and 1860 m above sea level, characterized by summer rainfall and dry frosty winters with approximately 500–1069 mm per year [42, 43]. Mean maximum and minimum monthly temperatures are 38 °C in summer and 4 °C in winter, respectively [42–44]. The Eastern Cape Province is characterized by a variety of land uses ranging from commercially oriented rangeland stock farming to small-scale vegetable and crop production [42]. Other economic activities in the province include tourism, forestry and wool production [43]. Major crops cultivated in the study area include beetroot (*Beta vulgaris* L.), cabbage (*Brassica oleracea* L.), carrots (*Daucus carota* L.), maize (*Zea mays* L.), potatoes (*Solanum tuberosum* L.) and spinach (*Spinacia oleracea* L.). The majority of the inhabitants (at least 87%) in the study sites are traditional isiXhosa speaking people who are highly dependent on natural resources for their livelihoods [45].

Data collection

This study is part of a wider research on utilization of plant resources and other non-timber forest products in the Eastern Cape Province [46–52]. Therefore, sampling occurred during one week field excursions conducted between March 2016 and September 2021. Sampling was carried out in six Local Municipalities (Fig. 1). Standardized plant sampling procedures were used to collect specimens [53, 54] involving transect walks in home gardens, farms and the surrounding landscapes. Interview

discussions were conducted in the local language, isiXhosa and were translated into English with the help of an interpreter. During the interviews, we documented information on names of plant species, uses, plant parts used and preparation of useful plants. The ESs were identified using a free listing technique [10, 55], whereby interviewees were asked to list benefits and contributions of plant species to human well-being. The stated benefits were matched with the four major categories in the established ES classifications which included provisioning ESs (timber and firewood, edible plants, edible fruits and medicinal plants), regulating ESs (benefits from natural and ecological processes, e.g. pest control, pollination), supporting ES (healthy soil) and cultural ESs (tourism and recreation) [7, 56]. These categories were expanded or modified based on information obtained during fieldwork, focus group discussions and field observations. Plant species were identified in the field and the taxon names conform to those of Germishuizen et al. [57] and the Plants of the World Online [58]. Unknown plant species were collected, pressed, oven-dried and identified by taxonomists at the Giffen Herbarium (UFH) at the University of Fort Hare and Schonland Herbarium (GRA) at Rhodes University, Grahamstown, South Africa.

Ethnobotanical data were gathered from 196 purposively sampled participants using snowball sampling technique [59–61]. The participants were requested to sign University of Fort Hare (MAR011) informed consent form and researchers also adhered to the ethical guidelines of the International Society of Ethnobiology (www.ethnobiology.net). The majority of these participants (55.6%) were males and their age ranged from 18 to 84 years. More than half of the participants (57.7%) were above 50 years, while 34.2% were below 40 years of age. About half of the sample (46.4%) were single, 23.5% were married, 16.8% and 13.3% were widowed and divorced, respectively. Close to half of the sample (44.4%) were educated up to primary level, while 21.9% of the sample were educated up to secondary level, 17.9% and 15.8% of the sample had attained tertiary education or no formal education, respectively. About half of the participants (48.5%) were unemployed, surviving on government social grants and remittances.

Data analysis

The data collected were entered in Microsoft Excel 2016 file and this data were used to determine frequencies and other descriptive statistical patterns. Interview responses from participants were coded and sorted into themes, paying particular attention to inconsistencies and unique statements. The relative frequency of citation (RFC) of reported plant species was determined using the following equation:

$$RFC = FC/N(0 < RFC < 1)$$

This index shows the local importance of each species and is given by the frequency of citation (FC) that is the number of informants mentioning the use of species divided by the total number of informants participating in the study [62, 63]

Results and discussion

Floristic composition

A total of 163 plant species were recorded in the Eastern Cape Province (Table 1), with herbs, shrubs and trees having the most species. Pteridophytes and gymnosperms were represented by a single species each, that is, *Cheilanthes hirta* Sw. (family Sinopteridaceae) and *Podocarpus latifolius* (Thunb.) R.Br. ex Mirb. (family Podocarpaceae), respectively. A large number of the plant species (67.5%, $n=110$) recorded in this study are from 16 families (Table 2). The other 29 families had less representation, between one and two species each. Plant families with the highest number of species were: Asteraceae (16 species), Poaceae (14), Fabaceae (10 species), Solanaceae (nine species), Amaryllidaceae (eight species), Asphodelaceae (seven species), Apiaceae (six species), Amaranthaceae, Asparagaceae, Cactaceae, Myrtaceae and Rosaceae (five species each), Apocynaceae, Lamiaceae and Myrtaceae (four species each) and Salicaceae (three species) (Table 2). Bennett [64] categorized seven of these plant families, that is, Apiaceae, Fabaceae, Lamiaceae, Malvaceae, Myrtaceae, Poaceae and Solanaceae as vital for human existence. Bennett [64] also argued that diets of most cultures around the world rely substantially on species of Fabaceae and Poaceae families, and the world's three most important cultivated plants, that is, *Oryza sativa* L. (rice), *Triticum aestivum* L. (wheat) and *Zea mays* L. (maize) are grasses and belong to the Poaceae family. Similarly, Hammer and Khoshbakht [65] argued that Asteraceae, Fabaceae and Poaceae are among the most important families in the world as these families have high numbers of domesticated and semi-domesticated species. Among the recorded genera, those species belonging to *Acacia* Martius, *Aloe* L., *Asparagus* Tourn. ex L., *Bulbine* Wolf, *Helichrysum* Mill., *Opuntia* Mill., *Prunus* L., *Solanum* L. and *Tulbaghia* L. with three species each were the dominant taxa. From the 163 plant species recorded, 96 (58.9%) were indigenous to South Africa while 67 species (41.1%) were exotic (Table 1). Similar results were obtained by Akinnifesi et al. [66] who recorded 40.0% exotic plant species in home gardens of São Luis in Brazil arguing that such exotic species ensures biodiversity and genetic diversity. Other researchers argue that exotic species introduced purposefully offer economic and intrinsic benefits when used

Table 1 Diversity and use categories of plant species in the Eastern Cape Province

| Species name and voucher number | Family | Vernacular name | Growth form | Parts used | Uses | RFC |
|-----------------------------------------------------------------------------------------------|----------------|------------------------------------------------|-------------|-----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| * <i>Acacia baileyana</i> F. Mueli; AM1421 | Fabaceae | Iwatlisi | Tree | Stems | Construction timber | 0.03 |
| * <i>Acacia dealbata</i> Link; AM1422 | Fabaceae | Idywabasi | Tree | Stems | Construction timber | 0.04 |
| * <i>Acacia mearnsii</i> De Wild.; AM1424 | Fabaceae | Idywabasi | Tree | Bark, leaves, stems and twigs | Construction timber, firewood, fodder, windbreak and sold as herbal medicine (diarrhoea) | 0.07 |
| <i>Acofanthera oblongifolia</i> (Hochst) Codd; AM1451 | Apocynaceae | Intlungunye and inxinebe | Tree | Leaves | Sold as herbal medicine (ethnoveterinary medicine (EVM), headache and snakebite) | 0.09 |
| <i>Agapanthus africanus</i> Hoffmanns; AM1432 | Amaryllidaceae | Isicakathi | Herb | Leaves and whole plant | Ornamental and herbal medicine (antiseptic, rash and stomach problems) | 0.05 |
| * <i>Agave americana</i> L.; AM1452 | Asparagaceae | Ikhامanga | Shrub | Leaf sap and whole plant | Fibre, live fence, ornamental and herbal medicine (high blood pressure) | 0.06 |
| <i>Alepiidea amatymbica</i> Eckl. & Zeyh.; AM1494 | Apiaceae | Iqwili | Herb | Roots | Sold as herbal medicine (abdominal pains, fever, pimples and wounds) | 0.33 |
| <i>Alepiidea serrata</i> Eckl. & Zeyh.; AM1505 | Apiaceae | Ubulawa | Herb | Roots | Herbal medicine (cough) | 0.01 |
| * <i>Allium cepa</i> L.; AM1507 | Amaryllidaceae | Itswele | Herb | Bulb | Edible tubers and bartered with neighbours or sold in local markets | 0.41 |
| * <i>Allium sativum</i> L.; AM1508 | Amaryllidaceae | Ivimbampunzi | Herb | Bulb | Edible tubers and herbal medicine (cough) | 0.12 |
| <i>Aloe arborescens</i> Mill.; AM1493 | Asphodelaceae | Ikhala and ingcelwane | Shrub | Leaf gel and leaves | Herbal medicine (EVM; constipation, dry skin, inflammation, stomach problems and wounds) | 0.12 |
| <i>Aloe ferox</i> Mill.; AM1409 | Asphodelaceae | Ikhala and umhlaba | Shrub | Leaf gel, leaves, stems and whole plant | Firewood, live fence, animal enclosure and sold as herbal medicine (EVM, boils, dry skin, immune booster, stomachache, tuberculosis(TB) and wounds); leaf gel harvested and marketed | 0.38 |
| <i>Aloe greatheadii</i> Schönland var. <i>dawyana</i> . (Schönland) Glen & D.S. Hardy; AM1559 | Asphodelaceae | Inkala | Herb | Leaf gel and leaves | Herbal medicine (burns, sores and wounds) | 0.01 |
| <i>Aloiampelos ciliaris</i> (Haw.) Klopffer & Gideon F.Sm. var. <i>ciliaris</i> ; AM1506 | Asphodelaceae | Intelezi | Shrub | Leaf gel and leaves | Herbal medicine (wounds) | 0.01 |
| * <i>Amaranthus hybridus</i> L.; AM1515 | Amaranthaceae | Nomdlomboyi, umfino, umtyutyu and unomdlomboyi | Herb | Leaves | Leafy vegetable | 0.04 |
| <i>Amaranthus spinosus</i> L.; AM1560 | Amaranthaceae | Utyuthu | Herb | Leaves | Leafy vegetable | 0.06 |
| <i>Artemisia afra</i> Jacq. ex Willd.; AM1516 | Asteraceae | Umhloniyane | Shrub | Leaves and roots | Herbal medicine (cough, diabetes, loss of appetite and TB) | 0.32 |
| * <i>Arundo donax</i> L.; AM1561 | Poaceae | Intsasela | Grass | Whole plant | Thatching grass and erosion control | 0.01 |

Table 1 (continued)

| Species name and voucher number | Family | Vernacular name | Growth form | Parts used | Uses | RFC |
|--------------------------------------------------------------------------|----------------|-------------------------------------------------|-------------|-------------------------------|------------------------------------------------------------------------------------------------------------------------------|------|
| <i>Asparagus africanus</i> L.; AM1495 | Asparagaceae | Ubulawu, ubumhlope, umathunga and umthunzi | Climber | Leaves and roots | Sold as herbal medicine (sexually transmitted infections (STIs), to speed up labour and wounds) | 0.14 |
| <i>Asparagus asparagoides</i> (L.) Druce; AM1433 | Asparagaceae | Imvane and isicakathi | Climber | Roots | Herbal medicine (STIs) | 0.01 |
| <i>Asparagus larinicus</i> Burch.; AM1562 | Asparagaceae | Inqatha | Shrub | Roots | Herbal medicine (EVM, inflammation, TB and wounds) | 0.01 |
| * <i>Avena fatua</i> L.; AM1563 | Poaceae | Ihabile | Grass | Whole plant | Fodder | 0.01 |
| * <i>Bambusa balcooa</i> Roxb. ex Roxb.; AM1564 | Poaceae | Ingcongolo | Grass | Whole plant | Thatching grass | 0.01 |
| * <i>Beta vulgaris</i> L.; AM1489 | Amaranthaceae | Bhetruithi | Herb | Leaves and tuber | Edible tubers and leaves, and bartered with neighbours or sold in local markets | 0.11 |
| * <i>Bidens pilosa</i> L.; AM1536 | Asteraceae | Umhlabangubo, umhlabangulo, ucadolo and uqadolo | Herb | Leaves | Leafy vegetable and herbal medicine (TB) | 0.04 |
| <i>Boophone disticha</i> (L. f.) Herb.; AM1496 | Amaryllidaceae | Incwadi and ishwadi | Herb | Bulb | Sold as herbal medicine (EVM, boils and circumcision wounds) | 0.13 |
| <i>Bowiea volubilis</i> Harv. ex Hook. f. ssp. <i>volubilis</i> ; AM1490 | Asparagaceae | Umaqana, umagaqana and umagaqana | Herb | Bulb | Sold as herbal medicine (headache, inflammations and impotence) | 0.13 |
| * <i>Brassica oleracea</i> L.; AM1535 | Brassicaceae | Ikhaphetshu | Herb | Leaves | Leafy vegetable and bartered with neighbours or sold in local markets | 0.64 |
| * <i>Brassica</i> spp.; AM1534 | Brassicaceae | – | Herb | Leaves | Leafy vegetable and bartered with neighbours or sold in local markets | 0.03 |
| * <i>Bromus catharticus</i> Vahl; AM1565 | Poaceae | Irhasi | Grass | Whole plant | Fodder | 0.01 |
| <i>Bruguiera gymnorrhiza</i> (L.) Lam.; AM1533 | Rhizophoraceae | Isiqungati | Tree | Stems | Construction timber | 0.04 |
| <i>Bulbine abyssinica</i> A. Rich.; AM1492 | Asphodelaceae | Intelezi and uyakayakana | Herb | Leaves and roots | Sold as herbal medicine (EVM, diarrhoea and menstrual problems) | 0.05 |
| <i>Bulbine frutescens</i> (L.) Willd.; AM1532 | Asphodelaceae | Ibhucu | Herb | Leaf sap | Herbal medicine (EVM, diabetes, ringworm and wounds) | 0.09 |
| <i>Bulbine latifolia</i> (L. f.) Roem. & Schult.; AM1531 | Asphodelaceae | Ibhucu and incelwane | Herb | Roots | Sold as herbal medicine (EVM, diarrhoea and speed up labour) | 0.15 |
| * <i>Caesalpinia decapetala</i> (Roth) Alson; AM1566 | Fabaceae | Bobo | Shrub | Fruits, stems and whole plant | Edible fruits, firewood, animal enclosure and live fence | 0.02 |
| * <i>Cannabis sativa</i> L.; AM1567 | Cannabaceae | Intsanga, somntsangu and umya | Shrub | Leaves | Smoked for pleasure and sold as herbal medicine (EVM, diabetes, epilepsy, headache, labour pains and respiratory infections) | 0.02 |

Table 1 (continued)

| Species name and voucher number | Family | Vernacular name | Growth form | Parts used | Uses | RFC |
|--------------------------------------------------------|-----------------|----------------------------------------------|-------------|------------------------|--------------------------------------------------------------------------------------------------|------|
| <i>Capparis tomentosa</i> Lam.; AM1410 | Capparaceae | Imfishlo, intshihlo, intsihlo and umpasimani | Tree | Roots | Herbal medicine (pneumonia, snake-bite and sore throat) | 0.06 |
| * <i>Capsicum annuum</i> L.; AM1447 | Solanaceae | Itshilisi | Herb | Fruits | Edible fruits, herbal medicine (fever) and bartered with neighbours or sold in local markets | 0.35 |
| <i>Carissa bispinosa</i> (L.) Desf. ex Brenan; AM 448 | Apocynaceae | Beta-urntumzi | Shrub | Fruits | Edible fruits | 0.04 |
| <i>Carapobrotus edulis</i> (L.) L. Bolus; AM1449 | Aizoaceae | Igcukuma | Shrub | Leaves | Herbal medicine (ringworm, sore throat, TB and wounds) | 0.08 |
| <i>Catha edulis</i> (Vahl) Endl.; AM1568 | Celastraceae | Iqwaka, iqwaka and umhlwazi | Tree | Leaves | Leafy vegetable | 0.01 |
| * <i>Catharanthus roseus</i> (L.) G. Don; AM1450 | Apocynaceae | Isihlungu | Herb | Leaves and whole plant | Ornamental and herbal medicine (cancer and diabetes) | 0.09 |
| <i>Cenchrus ciliaris</i> L.; AM1569 | Poaceae | Phungela | Grass | Whole plant | Fodder | 0.01 |
| <i>Centella asiatica</i> (L.) Urb.; AM1570 | Aiaceae | Udingu | Climber | Leaves | Herbal medicine (skin diseases (acne) and wound) | 0.02 |
| <i>Centella coriacea</i> Nannf.; AM1453 | Apiaceae | Unongotyozana | Herb | Leaves | Leafy vegetable and herbal medicine (EVM, STIs, TB and wounds) | 0.10 |
| * <i>Cereus jamacaru</i> DC.; AM1571 | Cactaceae | Unoroshe | Shrub | Stems | Fodder | 0.01 |
| * <i>Chenopodium album</i> L.; AM1454 | Amaranthaceae | Iphunga | Herb | Leaves | Leafy vegetable | 0.11 |
| <i>Cheilanthes hirta</i> Sw.; AM1455 | Sinopteridaceae | Ifense | Peridophyte | Leaves | Herbal medicine (wounds) | 0.01 |
| * <i>Citrus limon</i> (L.) Burm. f.; AM1530 | Rutaceae | Lamuni | Tree | Fruits and leaves | Edible fruits, herbal medicine (skin rash) and bartered with neighbours or sold in local markets | 0.19 |
| * <i>Citrus sinensis</i> (L.) Osbeck; AM1529 | Rutaceae | Iorenji | Tree | Fruits | Edible fruits and bartered with neighbours or sold in local markets | 0.20 |
| <i>Clivia miniata</i> Regel; AM1434 | Amaryllidaceae | Umayime | Herb | Leaves | Herbal medicine (stomach problems) | 0.04 |
| <i>Colocasia antiquorum</i> Schott; AM1572 | Araceae | Idumbe | Herb | Tubers | Edible tubers | 0.01 |
| <i>Combretum erythrophyllum</i> (Burch.) Sond.; AM1528 | Combretaceae | Umdubu | Tree | Leaves | Fodder | 0.02 |
| <i>Convolvulus sagittatus</i> Thumb; AM1497 | Convolvulaceae | Uboqo | Herb | Roots | Herbal medicine (headache) | 0.01 |
| * <i>Cucurbita maxima</i> Duchesne; AM1517 | Cucurbitaceae | Ithanga | Climber | Fruits | Edible fruits and bartered with neighbours or sold in local markets | 0.24 |
| * <i>Cucurbita moschata</i> Duchesne ex Poir.; AM1498 | Cucurbitaceae | Ithanga | Climber | Fruits | Edible fruits and bartered with neighbours or sold in local markets | 0.30 |
| <i>Cussonia paniculata</i> Eckl. & Zeyh.; AM1518 | Araliaceae | Umsenge | Tree | Bark and leaves | Herbal medicine (immune booster and skin diseases) | 0.06 |

Table 1 (continued)

| Species name and voucher number | Family | Vernacular name | Growth form | Parts used | Uses | RFC |
|-----------------------------------------------------------------------------|---------------|------------------------------------------|-------------|--------------------------|-------------------------------------------------------------------------------------------|------|
| <i>Cussonia spicata</i> Thunb.; AM1488 | Araliaceae | Umgezisa | Tree | Leaves | Sold as herbal medicine (EVM, immune booster and stomach problems) | 0.07 |
| <i>Cymbopogon nardus</i> (L.) Rendle; AM1426 | Poaceae | Umqungu | Grass | Whole plant | Thatching grass | 0.01 |
| * <i>Cynodon dactylon</i> (L.) Pers.; AM1509 | Poaceae | Uqaqqa | Grass | Leaves | Fodder | 0.04 |
| * <i>Datura stramonium</i> L.; AM1510 | Solanaceae | Umhlavuthwa, umvumbangwe and uvumbangwe, | Herb | Leaves and stems | Firewood, fodder and herbal medicine (asthma, boils and wounds) | 0.07 |
| * <i>Daucus carota</i> L.; AM1487 | Apiaceae | Kharothi | Herb | Taproots | Edible taproot and bartered with neighbours or sold in local markets | 0.27 |
| <i>Dicerothamnus rhinocerotis</i> (L.f.) Koekemoer; AM1573 | Asteraceae | Umlingatho | Herb | Leaves and roots | Herbal medicine (stomach problems and fumigant) | 0.01 |
| <i>Dicoma capensis</i> Less; AM1574 | Asteraceae | Ucelezi | Herb | Leaves | Herbal medicine (respiratory infections) | 0.02 |
| <i>Digitaria eriantha</i> Steud.; AM1575 | Poaceae | Ulozana | Grass | Whole plant | Fodder | 0.01 |
| <i>Diospyros lycioides</i> Desf.; AM1427 | Ebenaceae | Umbhongisa | Shrub | Fruits, leaves and stems | Edible fruits, firewood and fodder | 0.02 |
| <i>Dovyalis caffra</i> (Hook. f. & Harv.) Hook. f.; AM1486 | Salicaceae | Incagolo | Shrub | Fruits | Edible fruits | 0.04 |
| <i>Dovyalis rhamnooides</i> (Burch. ex DC.) Burch. ex Harv. & Sond.; AM1576 | Salicaceae | Umkhamswinqi | Shrub | Fruits | Edible fruits | 0.04 |
| <i>Elegia tectorum</i> (L.f.) Moline and H.P. Linder; AM1577 | Restionaceae | – | Herb | Whole plant | Construction material and thatching | 0.01 |
| <i>Elephantorrhiza elephantina</i> (Burch.) Skeels; AM1425 | Fabaceae | Intolwane | Shrub | Rhizomes | Sold as herbal medicine (EVM, high blood pressure, haemorrhoids, rashes and purify blood) | 0.17 |
| * <i>Eucalyptus camaldulensis</i> Dehnh.; AM1485 | Myrtaceae | – | Tree | Stems and leaves | Construction timber, firewood, wind-break and herbal medicine (cough and TB) | 0.05 |
| * <i>Eucalyptus grandis</i> W. Hill ex Maiden; AM1519 | Myrtaceae | – | Tree | Stems | Construction timber, firewood and windbreak | 0.03 |
| <i>Euphorbia ingens</i> E. Mey. ex Boiss; AM1520 | Euphorbiaceae | Intsema | Shrub | LateX | Herbal medicine (cancer and skin rash) | 0.04 |
| * <i>Ficus carica</i> L.; AM1484 | Moraceae | ikwiwane | Tree | Fruits | Edible fruits | 0.05 |
| * <i>Foeniculum vulgare</i> Mill.; AM1578 | Apiaceae | Imboziso | Herb | Leaves | Culinary herb and herbal medicine (stomach problems) | 0.01 |
| <i>Grewia occidentalis</i> L.f.; AM1526 | Malvaceae | Umgaqambo | Shrub | Fruits and roots | Edible fruits and herbal medicine (EVM and wounds) | 0.01 |

Table 1 (continued)

| Species name and voucher number | Family | Vernacular name | Growth form | Parts used | Uses | RFC |
|--------------------------------------------------------------------|----------------|------------------------------------------------------|-------------|------------------|------------------------------------------------------------------------------------------------------------------------|------|
| <i>Gunnera perpensa</i> L.; AM1525 | Gunneraceae | Iphuzi, iphuzi lomlambo and uxobo | Herb | Rhizomes | Sold as herbal medicine (EVM, cancer, constipation, induce or augment labour, inflammation, menstrual pain and wounds) | 0.18 |
| <i>Harpophyllum caffrum</i> Bernh.; AM1483 | Anacardiaceae | Umgwenya, umgwenye, umgwenyehangul and umgwenyobomvu | Tree | Bark and fruits | Edible fruits and herbal medicine (rash and wounds) | 0.12 |
| * <i>Harrisia balansae</i> (K. Schum.) N.P. Taylor & Zappi; AM1579 | Cactaceae | Ukatyi | Shrub | Fruits | Edible fruits | 0.01 |
| <i>Helichrysum gymnocomum</i> DC.; AM1458 | Asteraceae | Icholachola | Herb | Whole plant | Herbal medicine (colds and cough) | 0.06 |
| <i>Helichrysum nudifolium</i> (L.) Less.; AM1457 | Asteraceae | Icholocholo and insicwe | Herb | Leaves | Spiritual and herbal medicine (cough, diabetes, menstrual problems and circumcision wounds) | 0.09 |
| <i>Helichrysum odoratissimum</i> (L.) Sweet; AM1456 | Asteraceae | Iphepho | Shrub | Whole plant | Spiritual and sold as herbal medicine (colds, diabetes, headache, wounds, fumigant and insect repellent) | 0.12 |
| <i>Helichrysum pedunculatum</i> Hilliard & B.L. Burt; AM1580 | Asteraceae | Iphepho | Shrub | Whole plant | Spiritual and circumcision wounds | 0.03 |
| <i>Hermannia depressa</i> N.E.Br.; AM1435 | Malvaceae | Phate eangaka | Shrub | Leaves | Herbal medicine (colds and cough) | 0.04 |
| <i>Hyparthenia hirta</i> (L.) Stapf; AM1482 | Poaceae | Umggele | Grass | Whole plant | Thatching grass | 0.04 |
| <i>Hypoxis argentea</i> Harv. ex Baker; AM1499 | Hypoxidaceae | Inongwe, isinana and ixalanxa | Herb | Bulb | Herbal medicine (EVM, cancer, ring-worm and TB) | 0.06 |
| <i>Hypoxis hemerocallidea</i> Fisch. Mey. & Ave-Lall.; AM1524 | Hypoxidaceae | Inongwe | Herb | Bulb | Sold as herbal medicine (cancer, diabetes, high blood pressure, immune booster and pimples) | 0.33 |
| <i>Ilex mitis</i> (L.) Radlk.; AM1480 | Aquifoliaceae | Isidumo, umduma, unduduma and unduma | Tree | Bark | Sold as herbal medicine (sore throat and stomach problems) | 0.08 |
| * <i>Pomoea batatas</i> (L.) Lam.; AM1428 | Convolvulaceae | Bhatata | Climber | Tubers | Edible tubers and bartered with neighbours or sold in local markets | 0.21 |
| * <i>Lactuca sativa</i> L.; AM1471 | Asteraceae | Ilethasi | Herb | Leaves | Leafy vegetable and bartered with neighbours or sold in local markets | 0.14 |
| <i>Lasiosiphon capitatus</i> (Lam.) Burt Davy; AM1527 | Thymelaeaceae | Isidikili | Shrub | Roots | Herbal medicine (ringworm and wounds) | 0.04 |
| <i>Leonotis leonurus</i> (L.) R. Br.; AM1523 | Lamiaceae | Imvovo, Umfinafincane and utywala bengcungcu | Shrub | Leaves | Herbal medicine (EVM, colds, cough, diarrhoea and snakebite) | 0.09 |
| <i>Lippia javanica</i> (Burm. f.) Spreng.; AM1479 | Verbanaceae | Inzinziniba | Shrub | Leaves and roots | Herbal medicine (chicken pox, colds, cough and wounds) | 0.12 |
| <i>Lobelia flaccida</i> (C. Presl) A. DC.; AM1522 | Campanulaceae | Itshilizi and ubulawu | Herb | Leaves | Herbal medicine (abdominal pain) | 0.02 |

Table 1 (continued)

| Species name and voucher number | Family | Vernacular name | Growth form | Parts used | Uses | RFC |
|----------------------------------------------------------------------------------------------------|----------------|----------------------------------------------------------|-------------|-------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|------|
| * <i>Jycopersicon esculentum</i> Mill.; AM1521 | Solanaceae | Tumata | Climber | Fruits | Edible fruits and bartered with neighbours or sold in local markets | 0.22 |
| * <i>Malus domestica</i> Borkh.; AM1481 | Rosaceae | Apile | Tree | Fruits | Edible fruits | 0.10 |
| <i>Malva parviflora</i> L.; AM1482 | Malvaceae | Ujongelana and unomolwana | Shrub | Leaves | Herbal medicine (wounds) | 0.01 |
| <i>Mentha longifolia</i> (L.) Huds.; AM1483 | Lamiaceae | Inxina | Herb | Leaves | Culinary herb and herbal medicine (wounds) | 0.05 |
| <i>Miscanthus capensis</i> (Nees) Andersson; AM1478 | Poaceae | Idobo | Grass | Leaves and roots | Thatching grass and herbal medicine (wounds) | 0.04 |
| * <i>Musa X paradisiaca</i> L.; AM1503 | Musaceae | – | Tree | Fruits | Edible fruits sold in local markets | 0.13 |
| * <i>Nicotiana glauca</i> Graham; AM1502 | Solanaceae | Icubamfene | Shrub | Leaves | Herbal medicine (headache) | 0.05 |
| <i>Nidorella ivifolia</i> (L.) J.C.Manning & Goldblatt; AM1581 | Asteraceae | Isavu | Shrub | Leaves | Herbal medicine (diabetes) | 0.03 |
| * <i>Opuntia engelmannii</i> Salm-Dyck ex Engelm.; AM1582 | Cactaceae | Unochwane | Shrub | Stems | Fodder | 0.02 |
| * <i>Opuntia ficus-indica</i> (L.) Mill.; AM1501 | Cactaceae | Itolofya | Tree | Fruits, stems and whole plant | Edible fruits and bartered with neighbours or sold in local markets, fodder, live fence, animal enclosure, ornamental and herbal medicine (wounds) | 0.34 |
| * <i>Opuntia monacantha</i> Haw.; AM1583 | Cactaceae | Tolofya | Shrub | Fruits | Edible fruits | 0.01 |
| <i>Pentstemon prunelloides</i> (Klotzsch ex Eckl. & Zeyh.) Walp. ssp. <i>prunelloides</i> ; AM1411 | Rubiaceae | Cimamilo, icimamilo, icishamilo, irubuxa and isicimamilo | Herb | Roots | Herbal medicine (wounds) | 0.04 |
| * <i>Persea americana</i> Mill.; AM1459 | Lauraceae | – | Tree | Fruits and seed paste | Edible fruits and herbal medicine (ringworm) | 0.12 |
| * <i>Phaseolus vulgaris</i> L.; AM1460 | Fabaceae | Mbotyi | Herb | Fruits and seeds | Edible fruits and seeds | 0.20 |
| <i>Phoenix reclinata</i> Jacq.; AM1469 | Arecaceae | Idama and isundu | Tree | Leaves and whole plant | Crafts and ornamental | 0.04 |
| <i>Phragmites australis</i> (Cav.) Steud.; AM1500 | Poaceae | Ingcongolo | Grass | Leaves and stems | Thatching grass, building walls and animal enclosure | 0.04 |
| * <i>Physalis angulata</i> L.; AM1470 | Solanaceae | Iyoli | Herb | Leaves | Herbal medicine (burns) | 0.05 |
| * <i>Phytolacca dioica</i> L.; AM1584 | Phytolaccaceae | Umvumvu | Tree | Leaves and whole plant | Ornamental, fodder and shade | 0.01 |
| * <i>Pinus halepensis</i> Mill.; AM1585 | Pinaceae | Ipayina | Tree | Whole plant | Firewood, ornamental and windbreak | 0.01 |
| * <i>Pisum sativum</i> L.; AM1461 | Fabaceae | Erityisi | Herb | Fruits | Edible fruits sold in local markets | 0.16 |
| <i>Pittosporum viridiflorum</i> Sims.; AM1420 | Pittosporaceae | Umgqengqwe and umkhwenkwe | Shrub | Bark and roots | Herbal medicine (EVM, abdominal pain, cancer and fever) | 0.12 |
| <i>Plectranthus ambiguus</i> (Bolus) Codd; AM1429 | Lamiaceae | Irhajojo | Herb | Leaves | Herbal medicine (EVM, colds and cough) | 0.06 |

Table 1 (continued)

| Species name and voucher number | Family | Vernacular name | Growth form | Parts used | Uses | RFC |
|-----------------------------------------------------------------|----------------|----------------------------------------------------------------------|-------------|--------------------------|------------------------------------------------------------------------------------------------------|------|
| <i>Podocarpus latifolius</i> (Thunb.) R. Br. ex Mirb.; AM1511 | Podocarpaceae | Umcheya | Tree | Leaves | Herbal medicine (EVM and wounds) | 0.01 |
| * <i>Pontederia crassipes</i> Mart.; AM1586 | Pontederiaceae | Inyibiba | Herb | Whole plant | Ornamental and erosion control | 0.12 |
| * <i>Pontederia cordata</i> L. var. <i>ovalis</i> Solms; AM1587 | Pontederiaceae | Ingcongolo | Herb | Whole plant | Ornamental and erosion control | 0.01 |
| <i>Portulaca oleracea</i> L.; AM1588 | Portulacaceae | Igwanisha | Shrub | Leaves and stems | Leafy vegetable | 0.01 |
| <i>Portulacaifra</i> Jacq; AM1589 | Didiereaceae | Igqwanitsha, igwanisha, igwanishe, umfayisele and wehlatshi | Shrub | Leaves and stems | Leafy vegetable | 0.01 |
| <i>Prunus africana</i> Hook.; AM1467 | Rosaceae | Inyazangoma, itywina-elikhul, umdumizulu, umkhakhashe and umkhakhazi | Tree | Bark and leaves | Herbal medicine (cough, eye problems and TB) | 0.04 |
| * <i>Prunus armeniaca</i> L.; AM1415 | Rosaceae | - | Tree | Fruits | Edible fruits | 0.12 |
| * <i>Prunus persica</i> (L.) Batsch; AM1512 | Rosaceae | Ipesika | Tree | Fruits, leaves and stems | Edible fruits, firewood and herbal medicine (eye problems) | 0.13 |
| * <i>Psidium guajava</i> L.; AM1513 | Myrtaceae | Gwava | Shrub | Fruits, leaves and stems | Edible fruits and bartered with neighbours or sold in local markets, and herbal medicine (diarrhoea) | 0.18 |
| * <i>Punica granatum</i> L.; AM1591 | Lythraceae | Rhanati | Tree | Fruits, leaves and stems | Edible fruits, firewood and fodder | 0.01 |
| <i>Rhoicissus digitata</i> (L.f.) Gilg & Brandt; AM1468 | Vitaceae | Uchithibhunga | Climber | Roots | Herbal medicine (headache and high blood pressure) | 0.07 |
| * <i>Ricinus communis</i> L.; AM1466 | Euphorbiaceae | Umhluksa and umkakuva | Tree | Leaves | Herbal medicine (stomachache) | 0.05 |
| * <i>Rubus fruticosus</i> L.; AM1590 | Rosaceae | Qunube | Shrub | Fruits | Edible fruits and wine production | 0.01 |
| <i>Rumex lanceolatus</i> Thunb.; AM1592 | Polygonaceae | Idololenkonyane and idolonyana | Shrub | Roots | Herbal medicine (EVM, back pain and rheumatism) | 0.01 |
| * <i>Salix babylonica</i> L.; AM1593 | Salicaceae | Umngcunube | Tree | Whole plant | Ornamental | 0.01 |
| <i>Salvia scabra</i> L. f.; AM1416 | Lamiaceae | Isicakathi | Herb | Leaves | Herbal medicine (EVM and tonic) | 0.01 |
| <i>Schottia latifolia</i> Jacq; AM1418 | Fabaceae | Umaphipha and umgxam | Tree | Bark and stems | Construction timber and herbal medicine (EVM and diarrhoea) | 0.04 |
| <i>Senecio speciosus</i> Willd.; AM1419 | Asteraceae | Idambiso | Herb | Leaves | Herbal medicine (inflammations and wounds) | 0.05 |
| <i>Senegalia caffra</i> (Thunb.) P.J.H. Hurter & Mabb; AM1504 | Fabaceae | Umnyamanzi and umthole | Tree | Stems | Construction timber | 0.04 |
| <i>Sida rhombifolia</i> L.; AM1465 | Malvaceae | Umdizawethafa | Shrub | Leaves | Herbal medicine (wounds) | 0.01 |
| <i>Solanum aculeastrum</i> Dun.; AM1417 | Solanaceae | Umthuma | Shrub | Fruits | Edible fruits and herbal medicine (boils, cancer, dysentery and impotence) | 0.05 |
| * <i>Solanum nigrum</i> L.; AM1430 | Solanaceae | Umsobo and umsobosobo | Herb | Fruits and leaves | Edible fruits and herbal medicine (ringworm and wounds) | 0.07 |

Table 1 (continued)

| Species name and voucher number | Family | Vernacular name | Growth form | Parts used | Uses | RFC |
|--------------------------------------------------------------|----------------|------------------------------------------------------|-------------|------------------------|----------------------------------------------------------------------------------------------------------------------------------|------|
| * <i>Solanum tuberosum</i> L.; AM1444 | Solanaceae | Amazambane | Herb | Tubers | Edible tubers and bartered with neighbours or sold in local markets | 0.29 |
| * <i>Sonchus asper</i> (L.) Hill; AM1445 | Asteraceae | Irwabe | Herb | Leaves | Leafy vegetable | 0.04 |
| * <i>Sonchus oleraceus</i> L.; AM1446 | Asteraceae | Ihlababa | Herb | Leaves | Leafy vegetable | 0.05 |
| * <i>Spinacia oleracea</i> L.; AM1412 | Amaranthaceae | Imifuno | Herb | Leaves | Leafy vegetable and bartered with neighbours or sold in local markets | 0.54 |
| <i>Sporobolus africanus</i> (Poir.) Robyns & Tournay; AM1431 | Poaceae | Umtshiki | Grass | Whole plant | Thatching grass | 0.04 |
| <i>Sporobolus fimbriatus</i> (Trin.) Nees; AM1436 | Poaceae | Umgigwi | Grass | Whole plant | Thatching grass | 0.03 |
| <i>Syzgium cordatum</i> Hochst. ex C. Krauss; AM1443 | Myrtaceae | Umswi | Tree | Bark | Herbal medicine (inflammation and pimples) | 0.06 |
| * <i>Syzgium paniculatum</i> Gaertn.; AM1594 | Myrtaceae | Iharinati | Tree | Fruits | Edible fruits | 0.01 |
| * <i>Tagetes minuta</i> L.; AM1595 | Asteraceae | Nnkayo | Herb | Whole plant | Herbal medicine (anthelmintic, insect repellent and stomach problems) | 0.02 |
| * <i>Taraxacum officinale</i> Weber; AM1463 | Asteraceae | Ikhokhoyi | Herb | Leaves | Leafy vegetable | 0.05 |
| <i>Tecoma capensis</i> (Thunb.) Lindl.; AM1596 | Bignoniaceae | Umsilingi | Tree | Leaves | Herbal medicine (inflammation and pain) | 0.01 |
| * <i>Toxicodendron succedaneum</i> (L.) Kuntze; AM1597 | Anacardiaceae | Gantriya | Tree | Leaves | Herbal medicine (wounds) | 0.01 |
| <i>Trichilia ermetica</i> Vahl; AM1437 | Meliaceae | Isibara and umkhulu | Tree | Leaves | Herbal medicine (wounds) | 0.04 |
| <i>Tulbaghia acutiloba</i> Harv.; AM1462 | Amaryllidaceae | Isivumbampunzi | Herb | Leaves | Herbal medicine (colic) | 0.04 |
| <i>Tulbaghia alliacea</i> L. f.; AM1442 | Amaryllidaceae | Umwelala | Herb | Bulb | Herbal medicine (boils and wounds) | 0.06 |
| <i>Tulbaghia violacea</i> Harv.; AM1464 | Amaryllidaceae | Utswelane | Herb | Bulb | Herbal medicine (cancer and TB) | 0.07 |
| <i>Typha capensis</i> (Rohrb.) N. E. Br.; AM1438 | Typhaceae | Ingcongolo and umkhanzi | Herb | Leaves and rhizomes | Construction material, crafts, green mature, water purification and herbal medicine (dysentery and STI) | 0.07 |
| <i>Vachellia karroo</i> (Hayne) Banfi & Glasco; AM1423 | Fabaceae | Umnga, umnga-mpunzi and umunga | Tree | Bark, leaves and stems | Construction timber, firewood, fodder and sold as herbal medicine (EVM, boils, diarrhoea, haemorrhage, ring-worm, thrush and TB) | 0.35 |
| * <i>Vitis vinifera</i> L.; AM1440 | Vitaceae | Umdiliya | Climber | Fruits | Edible fruits sold in local markets | 0.06 |
| <i>Withania somnifera</i> (L.) Dunal; AM1414 | Solanaceae | Ubuvuma | Shrub | Leaves and roots | Herbal medicine (inflammations, TB and wounds) | 0.04 |
| * <i>Xanthium spinosum</i> L.; AM1598 | Asteraceae | Itshungu | Herb | Roots | Herbal medicine (wounds) | 0.03 |
| <i>Xysmalobium undulatum</i> (L.) W.T. Aiton; AM1442 | Apocynaceae | Ishongwane, itshongwe, iyeza elimhlophe and nwachaba | Herb | Roots | Herbal medicine (STIs) | 0.05 |

Table 1 (continued)

| Species name and voucher number | Family | Vernacular name | Growth form | Parts used | Uses | RFC |
|-----------------------------------------------------|------------|-----------------|-------------|------------|-------------------------------------------------------------------------------|------|
| <i>Zantedeschia aethiopica</i> (L.) Spreng.; AM1537 | Araceae | Inyiba | Herb | Leaves | Sold as herbal medicine (wounds) | 0.04 |
| * <i>Zea mays</i> L.; AM1441 | Poaceae | umbone | Grass | Fruits | Edible seeds and fruits and bartered with neighbours or sold in local markets | 0.57 |
| <i>Ziziphus mucronata</i> Willd.; AM1413 | Rhamnaceae | Umphafa | Tree | Leaves | Herbal medicine (EVM, chest pains, cough, dysentery and TB) | 0.11 |

Species marked with an asterisk (*) are exotic to South Africa

Table 2 Plant families of utilized plant species with the largest number of species (with at least 3 species)

| Family | Number of species | % |
|----------------|-------------------|-----|
| Asteraceae | 16 | 9.8 |
| Poaceae | 14 | 8.6 |
| Fabaceae | 10 | 6.1 |
| Solanaceae | 9 | 5.5 |
| Amaryllidaceae | 8 | 4.9 |
| Asphodelaceae | 7 | 4.3 |
| Apiaceae | 6 | 3.4 |
| Amaranthaceae | 5 | 3.1 |
| Asparagaceae | 5 | 3.1 |
| Cactaceae | 5 | 3.1 |
| Myrtaceae | 5 | 3.1 |
| Rosaceae | 5 | 3.1 |
| Apocynaceae | 4 | 2.5 |
| Malvaceae | 4 | 2.5 |
| Lamiaceae | 4 | 2.5 |
| Salicaceae | 3 | 1.8 |

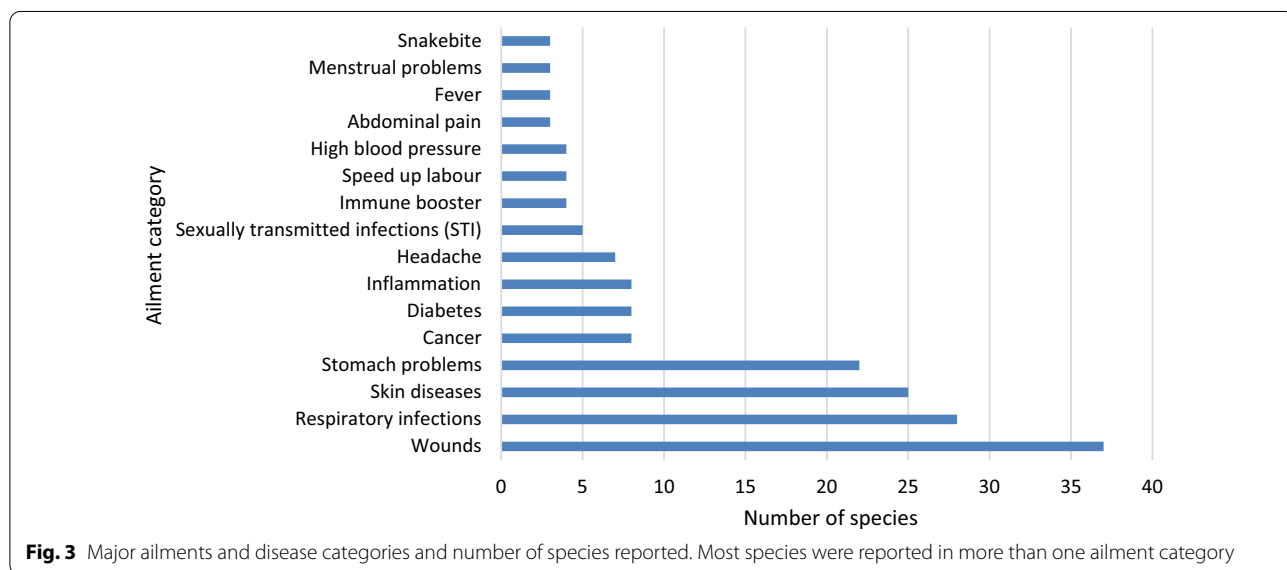
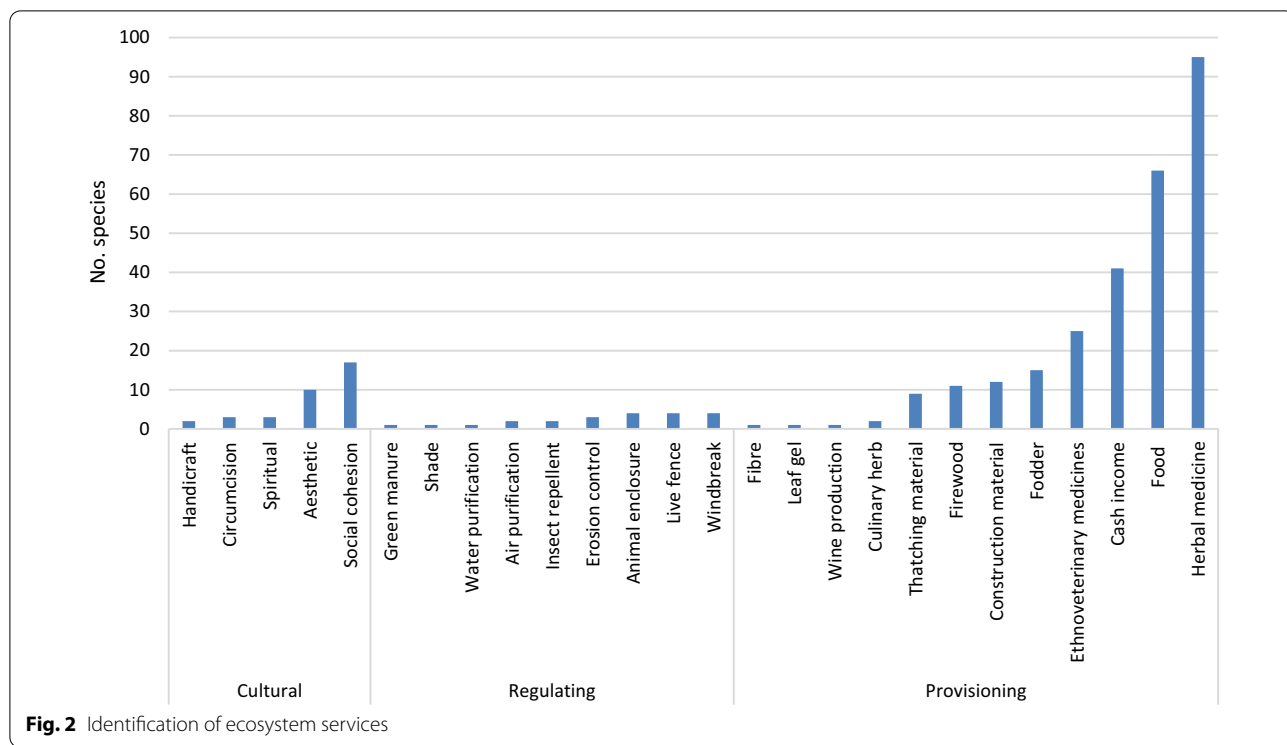
as food plants [67–69], fuel [67, 70–72], herbal medicines [73–75], ornamental [76–78] and shelter [67, 79, 80]. Similarly, Kahane et al. [81] and Caballero-Serrano et al. [82] argued that indigenous and traditional plant species are usually less attractive to farmers and some commercial exotic species are preferred as these species are easier to grow and more marketable than indigenous and traditional food plants. Evaluation of plant diversity in home gardens of Kerala in India revealed that exotic plants constituted 51.0% of the recorded species [83].

Ecosystem services identification

A total of five cultural services (aesthetic, circumcision ritual, handicrafts, spiritual, social cohesion and integration), nine regulating services (air purification, animal enclosure, erosion control, green manure, insect control, live fencing, shading, windbreak and water purification) and 12 provisioning services (cash income, construction materials, culinary herbs, ethnoveterinary medicines, fibre, firewood, fodder, food, herbal medicines, leaf gel, thatching materials and wine production) were identified through interviews and observations made during field work (Fig. 2). Traditional male circumcision is an important cultural ritual practiced by the Xhosa people in the Eastern Cape Province. Male circumcision is carried out for cultural reasons, as an initiation ritual and a rite of passage or transition from boyhood to manhood [84–86]. The foreskin is cut off without anaesthesia and the wound is not stitched but bound in traditional medicines to help in the healing process [84–86]. The majority of

species recorded in this study provided provisioning services such as herbal medicines (95 species, 58.3%), food (67 species, 41.1%), source of income (41 species, 25.2%), ethnoveterinary medicines (25 species, 15.3%), fodder (15 species, 9.2%), construction materials (12 species, 7.4%), firewood (11 species, 6.7%) and thatching materials (9 species, 5.5%) (Fig. 2). The cultural and regulating services were characterized by lower number of plant species than provisioning services. This result is consistent with previous studies that identified provision of food, medicinal products, construction materials, firewood, fibre and fodder as the most important ESs provided by wild and cultivated plant species [87–90]. Research by Landreth and Saito [91] showed that ESs derived from plant resources are diverse and subject to environmental, economic and cultural livelihood needs. Other researchers argued that food provisioning is particularly important in rural areas of subsistence economies as this ES is important for the well-being of households [92–94]. Similarly, a study by Mensah et al. [3] carried out in the Greater Letaba Municipality in the Mopani District of the Limpopo Province in South Africa revealed the dominance of the provisioning ESs such as edible plants, firewood and timber.

A total of 30 medical conditions were treated using remedies prepared from medicinal plants (Table 1). Wounds, respiratory infections, skin diseases, stomach problems, cancer, diabetes, inflammation, headache and sexually transmitted infections (STI) were treated with the highest number of medicinal plant species (Fig. 3). Research by Ghuman et al. [95] showed that medicinal plants are widely used in South Africa for treating wounds, eczema, ringworm, sores, boils, pimples and infected wounds. Similarly, research by Louw et al. [96] showed that monocotyledonous geophytes and bulbous plants indigenous to South Africa are characterized by valuable pharmacological properties such as the analgesic, anticancer, antimutagenic, immune stimulating, anti-infective, antimalarial, cardiovascular and respiratory system effects. Results of this study showed that the value of medicinal plants in terms of number of species traded in the Eastern Cape Province is significant as 45.9% of the traded species were medicinal species in comparison with 54.1% food plants that were bartered with neighbours or sold in local markets (Table 1). Interviews with participants showed that the value of medicinal plants is not only for primary healthcare, but financial, cultural identity and livelihood security. Moreover, previous research by Van Wyk et al. [97] showed that medicinal plants are an important aspect of the daily lives of many people and an important part of the South African cultural heritage.



The number of species used for regulating services ranged from one to four species. Species such as *Aloe ferox* Mill., *Caesalpinia decapetala* (Roth) Alson, *Opuntia ficus-indica* (L.) Mill. and *Phragmites australis* (Cav.) Steud. were used to reinforce animal and/or livestock enclosures. *Agave americana* L., *Aloe ferox* (Fig. 4), *Caesalpinia decapetala* and *Opuntia ficus-indica* were used as live fence, while *Acacia mearnsii* De Wild., *Eucalyptus*

camaldulensis Dehnh., *Eucalyptus grandis* W. Hill ex Maiden and *Pinus halepensis* Mill. were used as wind-break (Table 1). Plant species used for cultural services included *Helichrysum* species, that is, *H. nudifolium* (L.) Less., *H. odoratissimum* (L.) Sweet and *H. pedunculatum* Hilliard & B.L. Burt. These three *Helichrysum* species were used as incense to invoke the goodwill of the ancestors and/or used during ceremonial events. *Boophone*

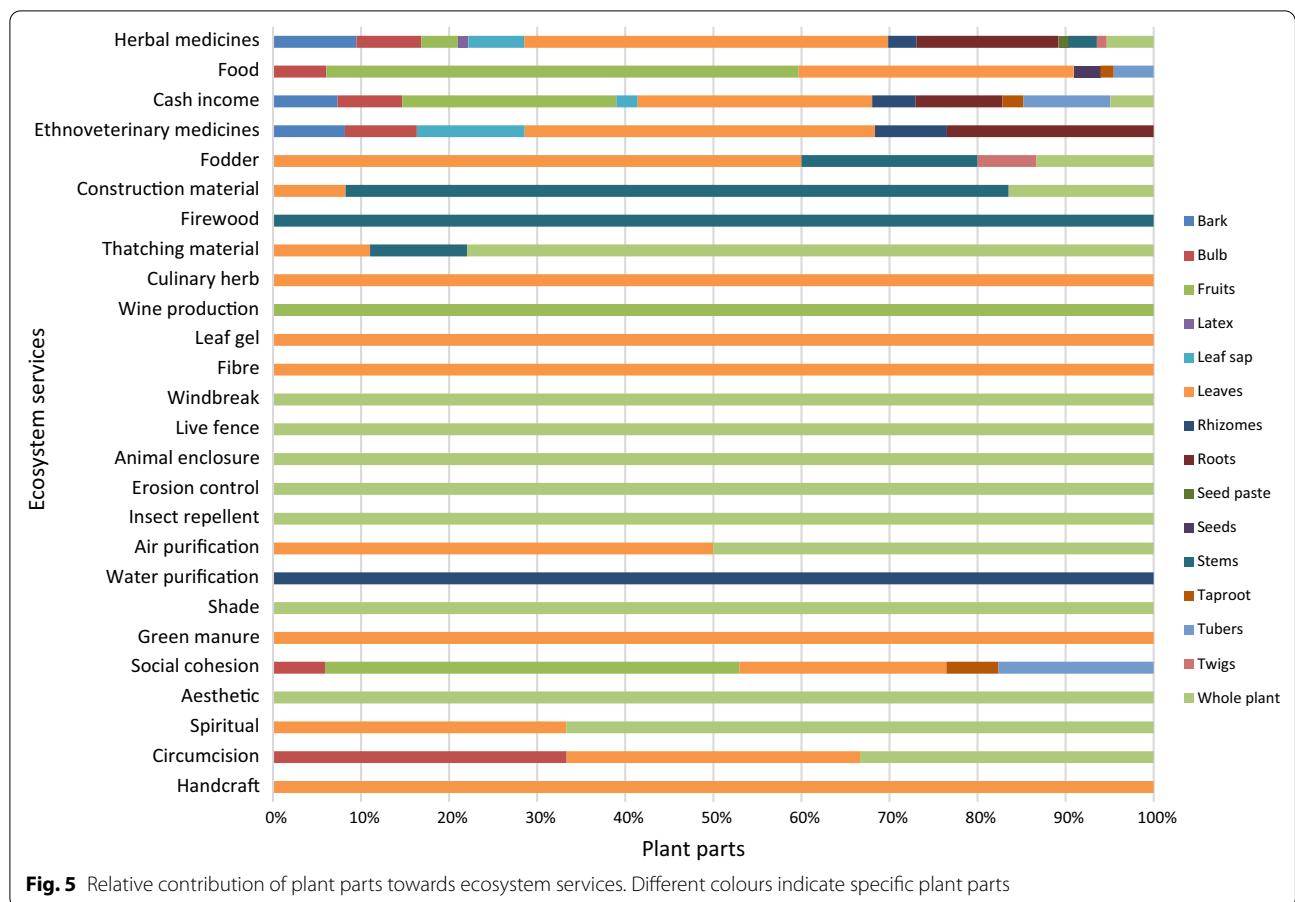


Fig. 4 Some plant species recorded in the Eastern Cape. **A** Live fence of *Agave americana* and *Aloe ferox*, **B** Harvested *Aloe ferox*, **C** Harvested leaves of *Aloe ferox*, **D** Intercropping of *Amaranthus hybridus*, *Brassica* spp. and *Cucurbita moschata* and **E** *Vachellia karroo* (photos: Alfred Maroyi)

disticha (L. f.) Herb., *Helichrysum nudifolium* and *Helichrysum pedunculatum* were used against circumcision wounds (Table 1). Previous research by Calvet-Mir et al. [8] revealed that cultural services are less developed in the literature on ESs although this category plays a central role in explaining the societal value of plant species to several communities around the world. Plant species characterized by edible fruits, seeds, taproot, tubers and those used as leafy vegetables were bartered with neighbours or sold in local markets, reinforcing social cohesion and integration. It was observed that plants sold in large quantities in local markets were species in high demand such as medicinal plants, fruits and leafy vegetables. *Agapanthus africanus* Hoffmanns, *Agave americana*, *Catharanthus roseus* (L.) G. Don, *Opuntia ficus-indica*, *Phoenix reclinata* Jacq., *Phytolacca dioica* L., *Pinus halepensis*, *Pontederia crassipes* Mart., *Pontederia cordata* L. var. *ovalis* Solms and *Salix babylonica* L. were

grown or maintained around homesteads as ornamental or for their aesthetic value (Table 1). A similar trend was reported by Ndayizeye et al. [98] where the Twa hunters, gatherers and farmers of Burundi sold forest products such as medicinal plants, ethnoveterinary medicines, fodder, ornamental plants and wild vegetables. Therefore, wild plant species deserve special attention due to their possible role as off-farm sources of income, particularly for communities in remote and marginalized areas with limited sources of livelihoods.

Figure 5 shows different plant parts utilized to provide various ESs. Whole or entire plants were associated with aesthetic plants, air purification, animal enclosures, erosion control, insect repellent, live fence, shading and wind-break (Fig. 5). Tree stems were used as firewood and water purification, while leaves were used as sources of culinary herbs, fibre, green manure, handcraft and leaf gel. Several



plant parts were used as sources of herbal and ethnoveterinary medicines, food plants and cash income. However, harvesting of bark, bulbs, rhizomes, roots, stems and whole or entire plants, particularly herbaceous plants for medicinal purposes is not sustainable as such strategies threaten the survival of the same species used as food or to treat or manage human ailments or animal diseases.

Important species recorded in this study with RFC values > 0.3 included *Alepidea amatymbica* Eckl. & Zeyh., *Allium cepa* L., *Aloe ferox*, *Artemisia afra* Jacq. ex Willd., *Brassica oleracea* L., *Capsicum annuum* L., *Cucurbita moschata* Duchesne ex Poir., *Hypoxis hemerocallidea* Fisch. Mey. & Ave-Lall., *Opuntia ficus-indica*, *Spinacia oleracea* L., *Vachellia karroo* (Hayne) Banfi & Glasso and *Zea mays* L. *Allium cepa* (onion), *Brassica oleracea* (cabbage), *Capsicum annuum* (pepper), *Cucurbita moschata* (butternut), *Spinacia oleracea* (spinach) and *Zea mays* (maize) were widely grown as food crops assisting in the provision of necessary nutrients and food security. *Alepidea amatymbica* and *Hypoxis hemerocallidea* are categorized as threatened in South Africa [99] due to over-collection as traditional medicines [46]. Other plant species that were recorded in this study that are categorized as threatened in

South Africa include *Boophone disticha* (L. f.) Herb., *Bowiea volubilis* Harv. ex Hook. f. ssp. *volubilis*, *Clivia miniata* Regel, *Gunnera perpensa* L., *Ilex mitis* (L.) Radlk. and *Prunus africana* [88]. It is well recognized that medicinal plants primarily valued for their medicinal properties are intensively harvested and some of them tend to be the most threatened by over-exploitation.

Conclusion

Results of this study indicate that local communities in the Eastern Cape Province in South Africa derive ESs such as traditional medicines, food, raw materials, cultural and regulating benefits from plant species collected from the wild as well as cultivated species. This study showed that provisioning services were perceived as the most important ES in comparison with regulating and cultural services. These results highlight the importance of plant resources to the well-being of local communities in the context of provision of essential direct and indirect ESs such as food, medicinal products, construction materials, fodder, regulating, supporting and cultural services. The ESs are the basis for subsistence livelihoods

in rural areas, particularly in developing countries such as South Africa. Therefore, understanding the ESs that can be derived from wild and cultivated plant species is important, as well as the implications of utilization of such natural resources in the context of rural livelihoods and well-being. These ESs place plant resources in a web formed by linkages with different ESs services derived from agricultural landscapes. Therefore, these research findings contribute to the wider body of knowledge on ESs derived from plant species, expanding the understanding of the uses and values of plant resources, the livelihood benefits derived by local communities from plant species, and how these benefits influence local support for natural resource management initiatives in the province and other areas of the country.

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Authors' contributions

Author conceived the study and wrote the manuscript

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Availability of data and materials

Raw data is contained in questionnaire forms and cannot be shared in this form.

Declarations

Ethics approval and consent to participate

This study was approved by the University of Fort Hare's Research Ethics Committee (UREC) on 25 February 2014, and ethics clearance code is MAR011. Before conducting interviews, all participants signed the prior informed consent form.

Consent for publication

This manuscript does not contain any individual person's data, and therefore, no further consent is required for publication.

Competing interests

The author declares that he has no conflict of interest.

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