Journal of Food and Agriculture Research
Vol. 6, No. 1, 2026, pp. 15-30

URL: www.arfjournals.com
https://doi.org/10.47509/JFAR.2026.v06i01.02

Fibre Yielding Plant Species and Potential Applications

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Abstract: Documentation of fibre yielding plant species survey of Vijayapura district of Karnataka comprising 13 tehsil was conducted during March 2018 to March 2025. The study was initiated with an aim to identify fibre and cotton yielding plant species of Vijayapura district. Fibre and cotton are used for commercial purposes. There are about 40 species of angiosperms belonging to 35 genera and 15 families of fibre and cotton exude plant species were documented. This district belongs to arid region of Karnataka State and unexploited the natural fibre other than cotton fibre. Cotton is a commonly cultivated plant in regions so this survey is most significant in documentation and traditional uses of other plant species. The potential uses are described by various researchers and scientists to look at their future perspectives of these previous natural resources in upcoming generation and conservation.

Keywords: Fibre, cotton, plant species, vijayapura.

Received : 10 February 2026
Revised : 09 March 2026
Accepted : 16 March 2026
Published : 30 June 2026

TO CITE THIS ARTICLE:

Arati Laddimath & Ajayan K.V. 2026. Fibre Yielding Plant Species and Potential Applications. *Journal of Food and Agriculture Research*, 6: 1, pp. 15-30.

1. Introduction

A nation's economy is significantly influenced by its fibre crops. Cotton, jute, sunn hemp, and other fibrecrops are the main ones. Breeding cultivars with higher yields in terms of fibrequantity and quality is one of the main breeding strategies used in fibre crops. The fiber's composition, vegetative cycle duration, and resilience to different abiotic and biotic challenges are all regarded as significant factors in addition to the fiber's yield and quality. Anu *et al.*, (2022). Plant fibres, one of the oldest natural materials in human history, have been used for many purposes, e.g., hunting rope or yarn making, fishing, netting, climbing, carrying, and textile weaving (Kılınç *et* *al.*, , 2017). In the beginning history of plant fibre use, several wild species were the main sources of raw materials. After the emergence of agriculture, people started to cultivate fiber-yielding plants.

The plants that produce fibre are significant in terms of human usage. (Maiti, 1997; Maiti and Singh, 2006). It is challenging to determine how many known fiber-producing plants there are. Nonetheless, there are comparatively few fibres of commercial significance. Both developed and wild or natural environments are used to utilize fibres that are highly sought after worldwide. Cotton, a crop with a long history of use and greater industrial significance worldwide, is the most widely exploited species. In temperate and tropical regions, cannabis is widely grown. Because of its remarkable length, toughness, and durability, this species' fibre is important. Jute is the most widely used fibreafter cotton; however, from a textile value perspective, it is not as valuable as cotton or flax. The most studied species is the ramie.

Although a small portion is produced from the primary activity of procambium, the secondary activity of cambium in the secondary phloem contributes to the development of the stem's fibres. The core parenchyma continuously divides to produce the fibres of leaves. Aside from that, other scholars have extensively researched the emergence and evolution of various fibregroupings. (Kundu, 1954; Maiti,1979; Maiti,1995; and Maiti, 1997) have all undertaken in-depth research on the development of the fibre of the stem of jute (*Corchorus capsularis*), kenaf (*Hibiscus cannabinus* and *H. sabdariffa*), and sunnhemp (*Crotalaria juncea)*. Different plant species belonging to several families of angiosperms yield fibres and cotton. Cotton and fibres are the purest form of cellulose. The sclerenchyma cells are grouped into fibres. fibres are described as long cells with thick walls, correspondingly small cavities, and usually pointed ends. The wall of fibres consists of lining as well as cellulose. The fibres may occur singly or in small groups. The fibres may be found in any part of the plant—stems, leaves, roots, fruits, and seeds. Traditionally, fibres from plants have been used for a wide variety of purposes, including clothing, textiles, ropes, etc. This article gives insight into the importance of fiber-yielding plants in Vijayapura district and their local/traditional uses and other applications in scientific communities and industrial sectors.

2. Material and Methods

A fibre and cotton yielding plant species survey was conducted from March 2018 to March 2025 in Vijayapura district. For this, frequent field trips were conducted. Data and information recorded in the standard questionnaire. Prior Informed Consent (PIC). Collected data and information include scientific name, family, vernacular name, source, and mode of use. Fiber- and cotton-yielding plant species were photographed in the field. Plant specimens were identified by consulting with experts and by referring to three volumes of the Flora of the Presidency of Madras (Gamble and Fischer, 1967). The voucher specimens were stored at the herbarium center, and cotton was preserved at the museum, Department of Postgraduate Studies and Research in Botany, Karnataka State Akkamahadevi Women's University, Vijayapura.

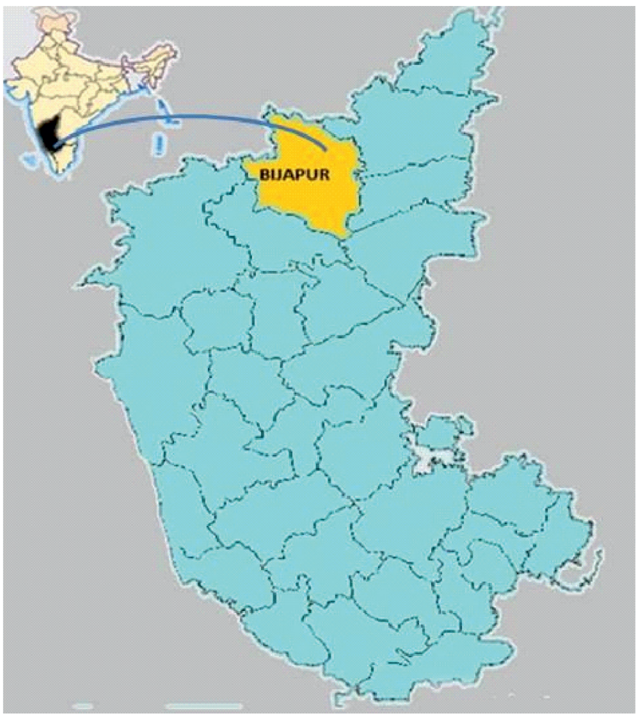

Figure 1: Study area

The Vijayapura district consists of a dry and arid tract of the Deccan plateau. The summertime temperature is 42°C, while the wintertime temperature is 15°C. The average maximum temperature in May is 40°C. The plain Deccan plateau in Vijayapura district is between 365 and 610 meters above sea level. This area slopes from west to east. The slope determines how the Doni, Krishna, Bheema, and their tributaries flow. The district of Vijayapura is 10,541 square kilometers in size. Vijayapura, Muddebihaal, Sindagi, Basavanbagevaadi, Indi, Talikote, Devara Hipparagi, Chadachan, Tikota, Babaleshwar, Kolhar, and Nidagundi are the thirteen talukas that make up the Vijayapura district. The Bheema River forms Almel's northern boundary, while the Krishna River forms its southern boundary (Fig. 1).

The district consists of the dry and arid tract of the Deccan Plateau. The climate of this region is arid, tropical, and steppe-type. The soil of the Vijayapura district area is rich in the content of basalt rock, magnetite, magnesium, aluminum, and iron oxide. The Vijayapura district receives normal rainfall of 578.0 mm, and the vegetation of this region is mainly dry and deciduous and may be broadly classified as vegetation on plains. The natural vegetation near the Alamatti Dam area is dry and hot, having rich flora. Many local people with their traditional knowledge collect and utilize these plants.

3. Result and Discussion

Natural fibres, which are an environmentally friendly substitute for synthetic polymers, can be found in agro waste residues. Global output of natural fibres is rising in tandem with the growing demand for items made from natural fibres. Natural fibres are not only environmentally friendly but also lightweight, renewable, and have superior mechanical and absorption qualities (Dunne *et al.,* 2016). These can also be recycled and biodegraded. Natural fibres that are being used and investigated by industries include hemp, jute, sisal, kenaf, cotton, flax, ramie, and banana fibres. Compared to other fibres, banana fiber, which is isolated from pseudostems, has superior fineness and spinnability. The majority of the biomass waste that remains after fruit is harvested is banana pseudo-stem, which can serve as a substitute supply for the fiber-based sectors (Yan *et al.,* 2016).

Fiber-yielding plant species are those cultivated or harvested primarily for the fibres they produce, which are used in making textiles, ropes, mats, paper, brushes, and other materials. These fibres can be obtained from different parts of the plant, such as the bast (stem), leaves, seeds, or fruit (Fig. 2). There are 40 species of angiosperms belonging to 35 genera and 15 families of fibre and cotton exuding plant species that were documented during the survey period. Apocynaceae has nine species, followed by Fabaceae with two, Arecaceae with two, Asteraceae with six, Poaceae with six, Malvaceae with five, Areaeae, Cyperaceae, Fabaceae, Asperigaceae, and Menispermaceae with two each, and Musacae, Acanthaceae, Vitaceae, and Verbinaceae with one each (Fig. 3).

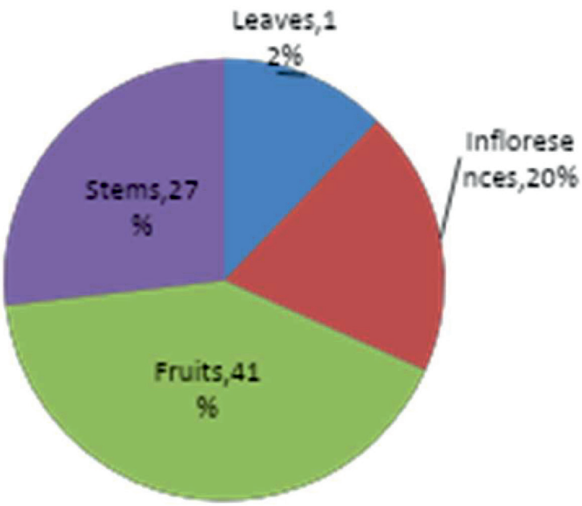

Figure 2: Percentage of fibre yielding parts of plant species

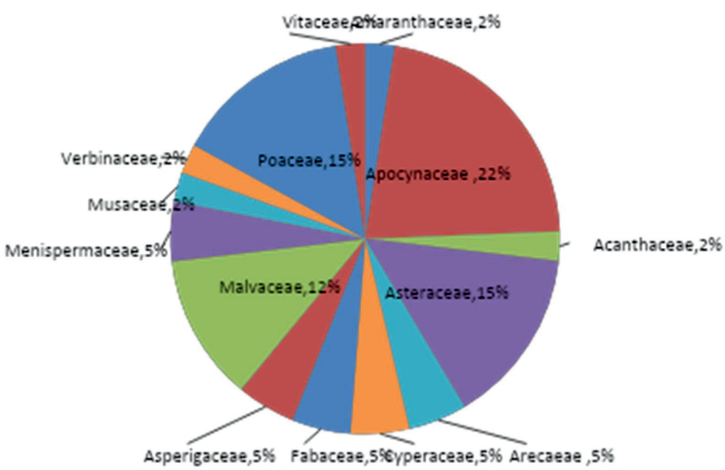

Figure 3: Distribution status of Families in fibre yielding plants

Different plant parts were used to treat different ailments. Among stems were used 41%, followed by stem 27%, and inflorescence 20% and leaves 12% in decreasing order. Data obtained from the survey is compiled in Table 1. All plant species scientific name, family, vernacular name, and mode of administration are provided. "Fibre yielding plants of Rajasthan" (Singh and Singh,1982) have been published. In Vijayapuraa, among the documented plant species 22% covered by Apocynaceae and other species contributions are noted in Fig.3. Among the plant parts production in terms of plant parts, fruits (43%) contribute in fibre production compared to other parts of the plant.

Fibers of *Agave americana* L. Originally used for decoration, it was later used to extract bast fibres for use in textiles. Mexico essentially controlled the production of sisal fibres until the turn of the 20th century, as the leaves of the Agave sisalana plant are used to make sisal fibres (Townsend and Sette, 2015). According to Karus *et al.,*(2000), the majority of sisal fibres used in Europe today are imported from South Africa, South America, and Asia, and they cost between €0.56 and €0.74/kg. *Blepharis integrifolia* (L.f.) E.Mey. and Drege ex Schinz is a plant species belonging to the family Acanthaceae, commonly found in arid and semi-arid regions, especially in parts of Africa and the Indian subcontinent. While it is better known for its ecological and medicinal significance, its fibres are gaining attention for traditional and sustainable applications. It is mainly used for local communities for making ropes, strings, and fishing nets. Twisted or woven into mats and simple baskets, research is exploring its use in eco-friendly materials (with resin/ plastics).

There are a vast amount of fibres in the Phoenix sylvestris L. leaf sheath that are currently thrown. The properties of *P. sylvestris* leaf sheath fibre were examined comprehensively in order to use it in composite industries Gangadharan *et al.,* (2025).The *Sansevieria ehrenbergii* fibre has a tensile strength range of 50–585 MPa, whereas most similar natural fibres have tensile strengths between 170 and 900 MPa, with flax having a tensile strength of 45 MPa and pineapple having a tensile strength of 1627 MPa. *S. ehrenbergii* fibres have an elongation range of 2.8 to 21.7, which is likewise about the same as that of other natural fibres. The fibres of S. ehrenbergii were comparable in strength to those of *S. trifasciata*, *S. cylindrica*, and *S.*

Table 1: Fibre and Cotton yielding plant species of Vijayapura district

Sl. No.	*Name of the plants*	*Family*	*Source*	*Fibre*
1	*Agave americana* L.	Asparigaceae	Leaves	Jute
2	*Blepharis inetegrifolia* (L.f.) E.Mey. and Drege ex Schinz	Acanthaceae	Leaves	Cotton
3	*Phoenix sylvestris* (L.)	Arecaceae	Leaves	Cotton
4	*Senecio crassissimus* Humbert	Asteracea	Leaves	Jute
5	*Sensevieria zeylanica* (L.) Willd.	Asparagaceae	Leaves	Cotton
6	*Aerva javanica* (Burm.f.)Juss.ex Schult.	Amaranthaceae	Inflorescence	Cotton
7	*Emilia sonchifolia* (L.) DC	Asteraceae	Inflorescence	Cotton
8	*Erigeron bonariensis* L.	Asteraceae	Inflorescence	Cotton
9	*Imperata cylindrica* L.	Poaceae	Inflorescence	Cotton
10	*Launaea nudicaulis* (L.)Hook. F.	Asteracaeae	Inflorescence	
11	*Pennisetum setaceum* (Forssk.) Chiov.	Poaceae	Inflorescence	Cotton
12	*Polypogon monospeliensis* (L.)Desf.	Poaceae	Inflorescence	Cotton
13	*Saccharum spontaneum* L.	Poaceae	Inflorescence	Cotton
14	*Alstonia scholaris* (L.)R.Br.	Apocynaceae	Fruit	Cotton
15	*Calotropis gigantea* (L.)R. Br. In Aiton.,Hort	Fabaceae	Fruit	Cotton
16	*Calotropis procera* Aiton) W.T.Aiton	Fabaceae	Fruit	Cotton
17	*Ceiba pentandra* (L.) Gaertn.	Malvaceae	Fruit	Cotton
18	*Cocos nucifera* L.	Arecaeae	Fruit	Jute
19	*Cryptostegia grandiflora* (Roxb.)R.Br.	Apocynaceae	Fruit	Cotton
20	*Gossypium hirsutum* L.	Malvaceae	Fruit	Cotton
21	*Gymnema sylvestre* B. Br.	Apocynaceae	Fruit	Cotton
22	*Launaea pinnatifida* Cass.	Asteraceae	Fruit	Cotton
23	*Launaea procumbence* (Roxb.)	Asteracaea	Fruit	Cotton
24	*Nerium indicum* Mill. Gard. Dict. Ed	Apocynaceae	Fruit	Cotton
25	*Pentatropis capensis* (L.f)Bullock	Apocynaceaea	Fruit	Cotton
26	*Pergularia daemia* (Forssk.)Chiov,	Apocynaceae	Fruit	Cotton
27	*Wattakaka volubilis* (L.f.) Stapf.	Apocynaceaea	Fruit	Cotton
28	*Wrightia tinctiria* (Roxb.)R. Br.	Apocyanaceae	Fruit	Cotton
29	*Zea mays* L.	Poaceae	Fruit	Jute
30	*Bambusa vulgaris* Schrad.	Poaceae	Stem	Jute
31	*Cocculus hirsutus* (L.)W. Theob.	Menispermaceae	Stem	Jute
32	*Corchorus capsularis* L.	Malvaceae	Stem	Jute
33	*Corchorus trilocularis* L.	Malvaceae	Stem	Jute
34	*Cyperus alternifolius* L.	Cyperaceae	Stem	Jute
35	*Cyperus rotundus* L.	Cyperaceae	Stem	Jute
36	*Hibiscus sabdariffa* L.	Malvaceae	Stem	Cotton
37	*Musa paradiasiaca* L.	Musaceae	Stem	Jute
38	*Tinospora cordifolia* (Willd.)Hook.F and Thoms.	Menispermaceae	Stem	Jute
39	*Vitex negundo* L.	Verbenaceae	Stem	Jute
40	*Cissus quadrangularis* L.	Vitaceae	Stem	Jute

zeylanica when compared to other Sansevieria species. Nevertheless, it is said that the *S. ehrenbergii* fibreis more robust than the *S. roxburghiana* fiber. According to Wantahe and Bigambo, (2023), the Sansevieria species under study also exhibited similar length, diameter, elongation, and linear density characteristics. Experiments have demonstrated that *Aerva javanica* fibreis less dense than traditional fibres, weighs less, and has a lot of promise for use in the production of environmentally friendly composites (Ahmed *et al.,* 2019).Kassim *et al.,* (2016), their study provided an understanding that *Imperata cylindrica* fibre represents a highly potential alternative resource for pulp and paper-based manufacturing. It gives an insight of this underutilized non-wood resource (cogon grass), for various application possibilities in paper-based industries as well as in other sectors such as biofuel and agriculture. Injection molding has not yet been tested in composites reinforced with *P. setaceum* fibres. The chemical analysis of P. setaceum fibres both before and after they were treated with silane, acetic acid, and alkaline treatments—all of which have demonstrated promising outcomes for improving the interfacial adhesion of matrix and other plant fibres—represents another innovation (Cabrera-García *et al.,* 2023).

Due to its rapid growth and year-round availability, *S. spontaneum* appears to be a promising nonwood fibrous plant for use as a cellulosic raw material for small-scale industries and as a supplement to raw materials for large paper industries in tropical nations like India, which have dense populations and limited land resources (Tyagi and Dutt,2007). The viability of *Calotropis gigantea* fibreas a substitute raw material for artificial fibrein lightweight composites has been examined (Ashori and Bahreini, 2009). The density of *C. gigantea* bark fibreis 0.56 g/cm^3, and its chemical composition is given as follows. Hemicellulose (76%), alpha cellulose (57%), lignin (18%), and ash (2.5%) are the constituents of *C. gigantea* fiber. Later, Sisti et al., (2017) described the classification of the retting technique used to separate bast fibres from plants, as well as the methods of fibre extraction.

According to Ashori and Bahreini,(2009), the fibres from its bark and seeds have sufficient potential to either replace or enhance other fibrous raw materials as reinforcing agents. They can also be utilized to create composites reinforced with natural fibres (Babu *et al.,* 2014). As a result, *Calotropis procera* and *C. gigantea* fibres have a lot of promise for use in industry and can be used as a substitute fibre source. Because of its exceptional qualities, kapok fiber—which is produced by the fruit of the *Ceiba pentandra* tree—is increasingly recognized by scientists as a material that is superior to cotton and other plant fibres. Itsideal fibrelength is from 5 to 20 mm, and its ideal wall thickness is between 0.5 and 2 mm (Sangalang, 2021). Natural fibres can be added to polymers to improve the mechanical properties of composites, which may have a wide range of uses (Ning *et al.,*2020). A unidirectional fibre orientation along the fibre direction has the highest stiffness and strength, whereas a bidirectional fibre orientation in all directions has these characteristics. Coir fiber, often known as coconut fibre (Cocos nucifera L.), is a ligno-cellulosic, agro-renewable fiber. Traditional household ropes, mats, brushes, scrubbers, and mattress filler are all made from the fiber. The mesocarp tissue, or husk, of the coconut fruit is the source of coconut fiber, a multipurpose natural fiber. About 30% of the fruit, which weighs between 1 and 2 kg, is husk. 20–30% of the husk is made up of fibreof various lengths. According to EST RAMHOT TEAM, (2017), around 431.5 thousand tonnes of coconut fibres are extracted each year worldwide. This amounts to 15% of the entire amount of potential extractable fibres that is now released as a byproduct of the nut's oil extraction process (Wang and Huang, 2009).

According to Texier, (1993), cotton is the world's most significant crop for fiber. According to Anonymous, (2005), it supplies raw materials to 2622 oil-expelling machines, 503 textile mills, 8.1 million spindles, and 1263 ginning units. Since the nation's independence, cotton has been vital to employment, industrial growth, agriculture, financial stability, and economic sustainability. It is Pakistan's most advantageous cash crop and fibre source, bringing in a healthy amount of foreign exchange for the nation (Ahmed *et al.,* 2009). Most of the ligno-cellulosic agricultural byproducts have a cellulose content of about 40-45%, but the cellulose content of the *Pergularia daemia* fibres is a little bit on the higher side but much lower than that of cotton, and the lignin content is very high in *P. daemia* fiber, which is responsible for the stiffness and brittle nature of the fibre (Karthik and Murugan, 2013).Corn (*Zea mays* L.), also known as maize, is the potential candidate for plastic matrix and reinforcement. Corns are mainly processed to obtain cornstarch, a source for saccharide components, which can be used for bioplastic matrix (Brodin *et al.*, 2017). The lignocellulosic fibre by-products, such as corn cobs, corn husks, corn stalks, and corn stover, can then be used as a reinforcement material. For every grain production of corn, wastes such as corn cobs, corn stalks, and corn husks account for 40% of the production (Miranda *et al.*, 2018).

Bamboo fibre that has been mechanically extracted has an average length of 22.8 mm and a diameter of 150 µm, with a range of 5 mm to 5 cm. Lengths less than 12.5 mm are not used in the production of yarn. Usually, these fibres are found in bundles of ten to twenty separate fibres. It is difficult to transform them into yarn and fabric because of their small length. As a result, they are frequently used as technical fibres in nonwoven manufacturing. Long lengths and predetermined diameters of regenerated bamboo fibre can be achieved through chemical processing. The surface of bamboo fibres is rough, and their cross-section is circular with a tiny round lumen. Bamboo fibres are composed of 36–41% cellulose, 22–26% lignin, and 16–21% pectin (Sadrmanesh and Chen, 2019; Malekzadeh *et al.*,2021). A continuous strand of fibres makes up bamboo yarn. Loops of bamboo yarn are interlocked to create knitted bamboo fabric, an elastic and flexible material frequently used to make breathable and comfortable apparel. The herbaceous annual plant known as jute (*Corchorus capsularis*), which belongs to the Tiliaceae family, is primarily farmed in Southeast Asian nations. According to Akhtaruzzaman and Shafi, (1995), jute fibreis derived from the bast, or outside part of the stem, and is a good source of various pulp grades. Previous published research has described the properties of this fiber, including its behavior during pulping and the concentration of its main organic constituents, including lignin and carbs (Akhtaruzzaman and Shafi 1995 ; Islam and Sarkanen, 1993 ; Jahan, *et al.*, 2008).

According to the literature, *Hibiscus sabdariffa's* resources from the stem and its use have not gotten much attention because of a lack of knowledge about its characteristics. The bast *fibre of H. sabdariffa* has a larger commercial potential and is closely related to jute and kenaf. According to reports, it is one of the crucial bast fibres (Rathinavelu *et al.*,2023). Overall, their study provides new information about the potential use of *Tinospora cordifolia* fibres as reinforcement in composite materials. Further work is needed to investigate the mechanical properties of these fibres and to determine their potential for use in practical applications. However, the results of this study provide a promising foundation for future research in this area and suggest that *T. cordifolia* fibres have the potential to be a valuable new resource for the composite materials industry. Surface topological analysis was used (Arunprasath *et al.*,2025) and their researchers to find surface imperfections that enhance fibre bonding. The tensile strength of the 50 mm fibre utilized for testing was roughly 322.9 ± 39.62 MPa. These results validated the superior mechanical and thermal characteristics of *Vitex negundo* plant stem fibres, making them a viable option for lightweight composite applications.

A retrofit is necessary due to health and environmental concerns regarding the carcinogenic nature of artificial fibre in polymer composites. An environmentally benign natural cellulosic fibre extract from the stem of the *Cissus quadrangularis* plant has been thoroughly studied and is thought to be a good substitute for dangerous synthetic fibres. To determine the

Figure 4: A- *Ceiba pentandra;* **B-** *Calotropis procera;* **C-** *Launaea procumbence* **D-** *Cryptostegia grandiflora;* **E-** *Gossypium hirsutum ;* **F-** *Gymnema sylvestre*

Figure 5: A- *Imperata cylindrica;* **B-** *Pennisetum setaceum;* **C-** *Pergularia daemia* **D-** *Polypogon monospeliensis* ; **E-** *Emilia sonchifolia* ; **F-** *Wattakaka volubilis*

certainty of employing them as reinforcement fiber, anatomical study, chemical analysis, physical analysis, FTIR, XRD, SEM analysis, and thermogravimetric analysis were conducted. Because of its low weight and high cellulose content (82.73%) and low wax concentration (0.18%), it has a high specific strength and good bonding qualities when used to make composites. Electron microscopy reveals the flaky honeycomb outer surface, which contributes to the high modulus in Cissus quadrangularis stem fiber. A thermogravimetric study guarantees thermal stability up to 270°C, which is within the temperature range for the polymerization process (Indran and Raj, 2015). There are few plant species; their fibre uses are not yet to be exploited due to lack of research gaps in these fields. Many of them are used as dietary fibres, not for commercial purposes. The surveyed plant species are given in tabular form in the Vijayapura district, Karnataka State.

Figure 6: A- *Nerium indicum;* **B-** *Erigeron bonariensis ;* **C-** *Pergularia daemia*

4. Conclusion

Angiosperm species, including scientific names, families, and habits, were identified in 40 species during a survey carried out in the Vijayapura area between 2018 and 2025. The study intends to impart traditional knowledge and make recommendations for further research into new sources of cotton and fibre in the desert region. In an effort to lessen the textile industry's environmental impact, new fibre and cotton substitutes are appearing quickly. Sustainable plant-based fibres and recycled materials are anticipated to become more prevalent in upcoming textile advancements, even if many still have issues with scalability or performance. A common natural material, cotton is increasingly being criticized for its high water consumption, usage of pesticides, and negative environmental effects. Global interest in creating sustainable fibre substitutes that are as functional and environmentally friendly as cotton, or better, is growing as a result. The development of sustainable fibres is revolutionizing the textile sector. The trend toward low-impact, biodegradable, and circular materials is quickening, even though conventional cotton is still widely used.

Acknowledgment

We acknowledge the Vice-Chancellor and Registrar of Karnataka State Akkamahadevi Women's University, Vijayapura, for providing permission for the survey and laboratory facility.

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