**ANXIETIES FOR LIGNOCELLULOSIC FIBERS; CDA PLANT AS A NEW FIBER SOURCE FOR ETHIOPIA: REVIEW**

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*Abstract: Fiber characterization is the furthermost imperative possessions to design a detailed determination of the material for its end use application. In this review,* *different literature were analyzed on natural fibers and documented through both technical application wise and traditional applications. The review was mainly focused on technical and scientific aspects regarding to plant fibers principally motivated on cyperus Dichrostachys A.Rich plant to investigate and analyze its applications as a new natural source for fiber extraction and utilization in composite and apparel requests.*

***Key Words****:* *Cyperus Dichrostachus A.Rich, Lignocellulosic fiber, Natural fiber, Non woody fiber,*

**Introduction**

At present, most manufacturing and industrial sectors are fascinated in evolving sustainable development and environmental friendly products [[1](#_ENREF_1), [2](#_ENREF_2)]. There is also a paradigm shift to sustainability in all aspects of fashion [[3](#_ENREF_3)], eco-friendly polymer composite manufacturing principles [[4](#_ENREF_4)], eco-friendly building materials production and utilization [[5](#_ENREF_5), [6](#_ENREF_6)], organic production systems. This scheme has been facilitated and motivated with the main consumable natural fibers like cotton[[7](#_ENREF_7)]. The main concern has been believed on maintaining the natural environment by following friendly production and manufacturing concepts that do not devour any dangerous provisions with no poisonous releases to the natural atmosphere at any circumstance. Consequently, the utilization of natural fibers in different applications especially in composite industries for reason that they are prospective choice resources for the composite engineering and manufacturing applications[[8](#_ENREF_8)]. These resources are also have a vital role in fiber-reinforced polymer composites, engineering applications [[9-11](#_ENREF_9)], structural applications[[12](#_ENREF_12)] particularly in rope making [[13](#_ENREF_13)], automotive applications like shock absorbers, windshields[[14](#_ENREF_14)], doors, ceilings [[15](#_ENREF_15), [16](#_ENREF_16)], reinforcement materials with polymer matrix for small-scale applications [[17](#_ENREF_17)]. These applications are dependent on natural fiber’s exceptional characteristics of flexibility, eco-friendly nature, low cost, renewability, and accessibility, less harmful effect to human beings, biodegradability, ease of extraction, fabrication and manufacturing, high strength to weight ratio with simple and harmless implementation process as compared with synthetic fibers.

In the Present scenario, perhaps, there have been many research works being put out recalling natural fibers as reinforcement in polymer matrices, home furnishings, and construction technology and even in apparel manufacturing applications. So far, it is still obligatory to search and characterize new natural fibers[[18-25](#_ENREF_18)] for multidisciplinary applications especially for reinforcements[[26](#_ENREF_26), [27](#_ENREF_27)], automotive engineering and packaging applications. Furthermore the world shall give emphasis for value addition on their current applications with different modification techniques. It has been obvious that numerous natural plants have been grown in different provinces of the world with fluctuating atmospheric conditions, grown in agricultural domains and after their lifetime, end up in landfills[[28](#_ENREF_28), [29](#_ENREF_29)]. Some other plants have grown wild and spread around forest areas like Cyprus Dichrostachys A.Rich(CDA) plants by their nature, some possess pharmaceutical properties, and others yield edible components [[13](#_ENREF_13)].

Starting from the 1980`s several natural fibers[[30](#_ENREF_30)] including coir[[31](#_ENREF_31), [32](#_ENREF_32)], sisal[[33-36](#_ENREF_33)] pineapple[[37-40](#_ENREF_37)], jute[[41-44](#_ENREF_41)], hemp[[45](#_ENREF_45), [46](#_ENREF_46)], palm[[47-49](#_ENREF_47)], banana[[50-53](#_ENREF_50)], and other fibers have been characterized and employed for many applications such as reinforcement in polymer matrix composites.

**Plant Fibers**

The utilization of natural fibers in different applications become more issue that is critical. There are varied applications of plant fibers in composite industries, engineering and manufacturing applications [[54-57](#_ENREF_54)], in fiber-reinforced polymer composites engineering applications [[9-11](#_ENREF_9)].

Moreover, they are becoming common in structural applications[[12](#_ENREF_12)] especially in rope making [[13](#_ENREF_13)], and automotive applications like shock absorbers, windshields[[14](#_ENREF_14)], doors, ceilings[[15](#_ENREF_15), [16](#_ENREF_16)]. They are also vital sources for reinforcement materials with polymer matrix for small-scale applications [[17](#_ENREF_17)].

The varied application of plant fibers is the fact that they have exceptional characteristics of flexibility, eco-friendly nature, low cost, renewability, and accessibility, less harmful effect to human beings, bio degradability, ease of extraction, fabrication and manufacturing, high strength to weight ratio with simple and harmless implementation process as compared with synthetic fibers.

Moreover, natural resources have played foremost role in the economic activities with substantial sustainability to the growth of the world in progress through socio-economic development [[30](#_ENREF_30), [58-60](#_ENREF_58)]. The maximum utilization of such resources done with new developments and products in advance with preventing environmental pollution and generating employment opportunities followed by improvement of people’s living standards. One of the most abundant foundations of such resources has been lignocellulosic materials, have been utilized since 6000 BC available from many plant parts [[30](#_ENREF_30)].

**Classification of Plant Fibers**

In fact, natural plants are the chief sources of lingo-cellulosic fibers so that knowing the physical and chemical structure with classification of plants is vital in designing fiber processing and since these factors affect the final quality of the fiber. Different scholars classify these fibers as leaf, seed, fruit, stem, and bast based on their part from which they obtained (Fig 1).

On the other, hand Han at.el have classified, natural fibers into three general categories as wood, non-wood, and non-plant fibers. Non-wood fibers or agro-based fibers manufactured from special tissues of various mono- or dicotyledonous plants considered as grass, bast, leaf, or fruit fibers. Other non-wood fibers are grouped as “fiber plants,” plants with high-cellulose contents that are cultivated primarily for the primarily purpose of their fibers for instance jute, kenaf, flax, cotton and ramie[[61](#_ENREF_61)]

Various research works and literatures on lignocellulosic fibers revealed that lignocellulosic fibers have supreme potential power in automotive applications [[59](#_ENREF_59), [60](#_ENREF_60), [62](#_ENREF_62), [63](#_ENREF_63)].

They are renewable and cheap fibers in composite materials, particularly in the automotive industry and building sectors[[64](#_ENREF_64)], best solutions for ecological concerns[[65](#_ENREF_65)], fast approaching solutions for composite fundamental parts in land transportation [[66](#_ENREF_66)]. They can be processed with enhanced cultivation techniques, including genetic engineering[[30](#_ENREF_30), [67](#_ENREF_67)] and treatment methods to get uniform properties.

These facts showed that the utilization of lignocellulosic fibers can be described in two distinct developments; short term by synthesis and characterization of composites and craft work products based on the characteristics of fibers and as long time alternatives and substitutes for synthetic fibers[[68](#_ENREF_68)] in different applications[[69](#_ENREF_69)].

On the other hand, Rowell at.el and Kommula at.el described that most plant fibers have limiting factors of hydrophilic character caused for swelling of the fibers and affect the dimensional stability of the agro-fiber composites[[70](#_ENREF_70)]. They have possess variability in mechanical properties, poor resistance to high temperatures, variability of properties with plant age, part of the plant, and extraction method, weak bonding linkages to synthetic and other polymeric matrices [[71](#_ENREF_71)]. The cultivation and processing of natural plant fibers need care for the fact that they may consumes more water, synthetic fertilizers and pesticides, and may contribute for the emissions of greenhouse gases in some processing stages which are actual imperative environmental concerns. Yet these limitations can be manageable by applying systematically studied approaches as compared with synthetic fibers.

**Environmental contribution of plant fibers**

Natural plant fibers are more environmentally friendly than synthetic fibers. This is due to different reasons; one being their growth that ends-up with sequestration of CO2 from the atmosphere. The other reason is that they consume less energy of cultivation than the production of synthetic polymers and fibers. Additionally, their production from renewable resources contrasting to the production of synthetic fibers contributes to the depletion of natural resources.

More importantly natural plant fibers are biodegradable at the end of their lifecycle for the fact that the main component of their fiber part, cellulose which can be degraded by microorganisms through enzymatic hydrolysis of cellulose into glucose[[69](#_ENREF_69)]. So searching and characterizing of new cellulosic fiber sources became an endless stream for fiber science intellectuals for their endless contribution for sustainable environmental protection and maximized resource utilization schemes.

**Extraction process of plant fibers**

Plant natural fibers been generally extracted with a simple and economical method known as retting process after which they are exposed to different chemical treatment approaches. Normally the make up the lignocellulosic fibers be consist of cellulose, hem-icellulose, and lignin.

Retting is widely used extraction methods of fibers from the plant parts. It is a process of controlled degradation of the plant to allow the fiber to be separated from the woody core and thereby improving the ease of extraction of the fibers through biological activity of microorganism, bacteria or fungi from the environment to degrade the pectic polysaccharides from the bonfiber tissue and, thereby, separate the fiber bundles.

The fiber separation and extraction process has a major impact on fibre yield and final fibre quality. It influences the structure, chemical composition and properties of the fibres. Most scholars divide retting procedures as biological, mechanical, chemical and physical fibre separation process.

Biological retting may be either natural or artificial retting. Natural retting comprises dew or field retting and cold water retting. Dew or field retting is commonly applied retting process with appropriate moisture and temperature ranges. Then, the crops should remain on the fields until the microorganisms have separated the fibres from the cortex and xylem then the stalk is dried and baled.

Moreover, Cold water retting by using anaerobic bacteria that breakdown the pectin of plant straw bundles submerged in huge water tanks, ponds, hamlets or rivers and vats. The process takes between 7 and 14 days and depends on the water type, temperature of the retting water and any bacterial inoculum. Even though the process produces high quality fibres, environmental pollution is high due to unacceptable organic fermentation waste waters.

Artificial retting involves warm-water or canal retting and produces homogeneous and clean fibres of high quality in 3–5 days. Plant bundles are soaked in warm water tanks. After sufficient retting, the bast fibres are separated from the woody parts. The sheaves or hurds are loosened and extracted from the raw fibres in a breaking or scotching process [[72](#_ENREF_72)].

Mechanical or green retting is much simpler and more cost-effective alternative to separate the bast fibre from the plant straw. The raw material for this procedure is either field dried or slightly retted plant straw. The bast fibers are separated from the woody part by mechanical means. Weather-dependent variations of fiber quality are eliminated. However, the produced green fibers are much coarser and less fine as compared to dew or water retted fibers [[72](#_ENREF_72)].

Physical retting includes ultrasound and steam explosion method. In ultrasound retting, the stems obtained after the harvest are broken and washed. Slightly crushed stems are immersed in hot water bath that contains small amounts of alkali and surfactants and then exposed to high-intense ultrasound. This continuous process separates the hurds from the fibre. The steam explosion method represents another suitable alternative to the traditional field-retting procedure. Under pressure and increased temperature, steam and additives penetrates the fibre interspaces of the bast fibre bundles. The subsequent sudden relaxation of the steam leads to an effective breaking up of the bast fibre composite, which results in an extensive decomposition into fine fibres [[47](#_ENREF_47), [73](#_ENREF_73)].

Chemical and surfactant retting [[74](#_ENREF_74)] is a retting process in which the fiber Plants submerged in heated tanks containing water solutions of sulphuric acid, chlorinated lime, sodium or potassium hydroxide and soda ash to dissolve the pectin component. The use of surface-active agents in retting allows the simple removal of unwanted non-cellulosic components adhering to the fibres by dispersion and emulsion-forming process.

**Cyperaecae family fibers: Cyperus pangorei fiber**

**Pangorei fiber** has been a newly identified natural plant fiber that was belonged to the Cyperaceae family, with large genus with around 710 species present all over the world. The plant has grown well in and around slow-moving water streams up to 0.5m deep, such as rivers, canals, and ponds. It has been utilized for weaving of table mats, window curtains, and other textiles. Even the world-famous super fine silk mat has been made from pangorei fibers. Pangorei fibers have been extracted by water retting techniques. First it has been immersed in a water tank for at least 30 days (Figure 2) for retting process and then fibers have been separated from the wet stem for extraction followed by detail washing and drying at ambient conditions[[75](#_ENREF_75)]. The fibers have good physical properties of length 142mm, diameter 0.255mm and aspect ratio 556.8 with chemical compositions of α-Cellulose (45.66%) Hemicellulose (33.67%) and Lignin (20.60%). It has also found that the Maximum stress of (75 MPa), Young's modulus (6.8 GPa) and Elongation at break (2.8 %) tensile properties make it feasible for utilizing the fibers as reinforcement for composites.[[76](#_ENREF_76)]

**Properties of plant fibers**

**Physical properties**

The physical and chemical properties of plant fibers are dependent on different factors mainly on geography, soil, weather and method of processing (Table 1).

Microscopic studies such as optical microscopy, scanning electron microscopy (SEM), transmission electron microscopy (TEM) and atomic force microscopy (AFM) can be used to study the morphology of fiber surface and can predict the extent of mechanical bonding at the interface. AFM is a useful technique to determine the surface roughness of fibers. The morphological characterization of the fibers was conducted through an optical microscope and scanning electron microscope. The degree of Crystallinity of the fibers was calculated from X-ray diffract grams. It was found that fiber consists of different types of regularly arranged cells, with a large lacuna at the **Chemical properties**

The objectives of chemical analysis are to determining the content of lignin, cellulose and hemi-cellulose, fibers (Table 2). A novel study contact-resonance force microscopy (CR-FM) in nano-scale characterization of natural fibers using was innovated by Sandeep et al [[77](#_ENREF_77)]. This method has utilized to evaluate the cell wall layers of natural fibers for studying the elastic properties of cell walls.

**Potentials for study and characterize CDA plant fibers**

Ethiopia has many of plants for the fact that the country has unique topography suitable for biodiversity among African countries, having a huge area of forest and woodland. The country is also lucky geographically in possessing exceptional climate conditions and fertile soil intended for the cultivation of a range of plant species.

On this regard Cyperus species plants have great importance in advancing the socio-economic developments in different countries including *Cyperus papyrus* in paper manufacturing and writing material [[78](#_ENREF_78), [79](#_ENREF_79)] *Cyperus tegetum* in mat manufacturing[[80](#_ENREF_80)], and handicraft products[[81](#_ENREF_81)] *Cyperus esculentus* for medicinal value in diabetic patients [[82](#_ENREF_82)] composite reinforcements, structural applications in rope making, basketry and craftworks in house hold industries [[83](#_ENREF_83)].

These plant fibers are categorized under Non-wood fibers, but they have remarkable variations in chemical and physical properties as compared to woody fibers [[84](#_ENREF_84)]. Yet they are massive and susceptible to organic weakening during storage. There have been numerous literatures revealing that multiple Cyperus plant fibers have been extracted and characterized for different applications.

*Ayandi at.el* and Benazir.at.el have extract and characterize natural lingo-cellulosic fiber from Cyperus pangoreiplant. They have concluded that Cyperus pangorei fibers have suitable surface topography, stiffness, fiber texture, and higher thermal stability, high slenderness and runkell ratio with good tear resistance, high elongation and tenacity make them appropriate alternatives for composite reinforcements in polymer matrices applications, epoxy hybrid composites, and mat and silk mat industries [[75](#_ENREF_75), [85-87](#_ENREF_85)].

On the same scenario, there is a huge potential for study and characterize a new lignocellulosic fiber from (Cyperus Dichrostachus A. Rich) plant. Currently the plant has been grown commercially and may perhaps be of interest for handcrafting, packaging and traditional equipments [[88-91](#_ENREF_88)]. The plant is just a tough plant, traditionally used for the weaving of huts, mats, and baskets in Ethiopia and different countries in Africa [[2](#_ENREF_2), [92](#_ENREF_92)]. It has a decorative nature used to weave baskets, sleeping and sitting mats, rolled twines, more traditionally cereal and crop basket, food basket (lemat, mesob), crop and powder filter (wonfit), crop basket(letteb, kuna), and covering materials like home apparatus (pots, cooking devices (dist and wochit). As yet, apart from traditional craftworks, there are no research works done for this plant regarding to characterization and modification of its intrinsic properties. So adaptation of this fiber into valuable goods is the anxiety of the fiber researchers with technologies employed to transform them into beneficial products that are grounded in the physical, mechanical, and chemical characteristics of the fibers. Most of these distinctive features are determined throughout the progress of the plant and successive fiber drawing out or extraction stages.

The plant has been found non-wood *pernial plant having a hardy, tall sedge grass-like* clumps and green stems topped with horizontal, flattened leaves that radiate out like the spines of a sunshade from their guidelines. The plant has distinctive green leaves and brownish flowers above its bracts in late summer. It has an attractive nature that growed in stream or other damp places, wetlands, water edges, swamp gardens and the cleaning of grey water. It has many rhizomes covered a huge area rapidly, and thinned out from time to time with its culms have over 2 meters height, and 10 to 250 clusters, and flat, leaf-like bracts.

Further more, the CDA plant has long and triangular stems especially in maturity stages; grow from rhizomes and small-branched greenish flowering spikes appeard above the leaf-like bracts. It has also true leaves at the base of the plant, reduced to sheaths to fasten the stem as shown in figure 12. The CDA plant has similar morphological characteristics with various Cyperaceae family plants like Cyperus Alternifolius, Cyperus longus, Cyperus textilis, Cyperus cyperus, and Cyprus papyrus.

CDA plant has been found with long, soft, scaly and perennial rhizomes, spread up to 15–65 cm, triangular, and smooth leaves, 0.5–1.5 cm leaf blade width flat, reddish brown sheaths, 6–14-flowered spikes. Most of the time, it can grow from Jun through November in wet grasslands on mountain slopes, water margins with average 1100 m or within 1800–2600 m above sea-level.

**Distribution and habitat for CDA plants**

*CDA plant* is found in the different parts of Africa, where it grows along riverbanks and streams, in pools, dams or marshes, in wet gorges and even in coastal wetlands and saltyriver mouths. Many African countries gave different names for the plant due to the presence of similar or related plants in the province that are difficult to differentiate from each other.

*Cyperus Dichrostachus A. Rich plant* is found in the different part of Africa specially in congo, of Ethiopia, Rwanda, Kenya, and Tanzania (Figure 4 and Figure 5). In Ethiopia, the plant is found almost in all regions especially in the northern part, south Gondar zone [[89](#_ENREF_89)], and around the Blue Nile River[[90](#_ENREF_90)]. The plant has grown with maize gardens, around river basins, forests and even anywhere in high lands and semi-arid regions of the country.

**Products and Uses of CDA plant in Ethiopia**

The Giramta (CDA) plant has previously initiated in the Ethiopian high lands by the different societies. The wild and cultivated CDA plants have been utilized for packaging purposes mainly in raw consumption, and making basketry, as well as the production of handcraft products, grass extract, ropes, filter nets, and baskets. It also finds uses as tough traditionally weaving huts, and floor mats. *CDA* has a unique lovability that is ideal for use in the decorative and customhouse industry [[73](#_ENREF_73), [80](#_ENREF_19)].

Giramita baskets have played a major role in different culture and society perceived as functional, decorative, and blessed items throughout the history of the country. It can be used to make wonderful custom products as a module of fruit, utilized for packing lunches in rural areas called *agil-gil* baskets woven from Giramta stem and straw, covered with leather and embroidered with metal and beadworks (Fig 7). There is a strong belief in the benefits of Giramta as a cultural proud for that it is an alternative decor in weddings and ceremonies with *Mesob (Fig 6).*  *Mesob* baskets have been used as tables the ceremonies for which *Injera* and *wots* were placed on the wide, flat top of the *mesob* by which diners sit around the table and share a meal.

It is made from a wide and colorful basket styles with a conical top place on top of a hollow, tapering base. Crafts persons have used combined coil weaving with flat strand weaving techniques to create Giramta grass fiber mats, bags, and screens (Fig 8). Flat reed baskets have been used for inspecting and drying grains in almost everywhere in Ethiopian farmers and used as containers, tools, and decorations (7) [[93](#_ENREF_93)].

Moreover, Giramta grasses have been used in basket making and use is common throughout the country, often realize serviceable, decorative, and symbolic. Women were responsible to weave the brightly colored, Giramta grass baskets and important containers from their young age through the continuous coiling technique using colored transverse fibers that create geometric designs. Especially, young women are expected to produce a set of baskets as a grant for their marriage. In past times, women would spend at least a few hours each day weaving baskets. However, with the pressures of education, more women have turned to professional basket makers to fulfill their wedding gift requirements [[73](#_ENREF_73), [74](#_ENREF_12), [80](#_ENREF_19)].

In most parts of the country, there is a custom of making a hut as a workshop and makes the basket that the women will take to their new home after mirage. At the time of their wedding all the items they made are displayed to their in-laws and wedding guests. After the wedding (fig 9), all the baskets are moved to their new home and demonstrated on the walls as decoration for which every basket has a specific place on the household wall culture. So that baskets have been hung on the walls of the house's public sitting area and can be read by guests to tell them about the woman's life and family [[93](#_ENREF_93), [94](#_ENREF_94)].

More importantly functional baskets including bread baskets, grass mesh (sieve), and *qimba or Kuna*(grain container for measuring grains) have been used and sold in the marketplaces yet they were slow in production and now being replaced with imported plastics and varnish products.

**Basket Making Techniques in Ethiopia from CDA**

Most handicrafts workers in the country have used chemically dyed Giramta grasses and have able to create brightly colored baskets and decorative products with the help of knives and borers to trim the grassy fibers and rounded tapestry needles for the manufacturing of coiled-ended baskets [[74](#_ENREF_12), [80](#_ENREF_19)].

On the other hand coiling techniques including sewing a standing horizontal foundation with vertical stitches have been utilized by *Giramita* grass fiber skilled workers and bind a bundle of grass pieces into a long roll by wrapping with a single piece of grass around the roll. The stitches on a coiled basket can be decorative, functional, or both with different colored grasses to create a decorative patterns as shown in figure 10 [[93](#_ENREF_93)].

Ethiopian farmers harvest the Giramta grasses from their gardens or in forests, dried them followed by splitting, opening, and peeling them into strips that can be used for weaving in coordination with other grass fibers in the coil technique , then woven together with a simple plaiting technique for passing strips of the fiber over and under each other at a fixed angle to produce a checked pattern (fig 11)[[95](#_ENREF_95)].

Even though there are high trends in using and utilizing of CDA plants for different applications in different literatures, no one has tried to extract and characterize this plant for fibrous applications especially for textile application and composite manufacturing applications. Therefore, the thesis work intends to study and characterize CDA plant fibers for different applications as reinforcement for composite manufacturing, basketry, carpet making and in textiles based on the intended characteristics.

Our country is at an early stage in the utilization of natural fibers. Natural fiber extraction and characterization has to be the basement for growth and enhancement of the textile and related sectors that extensively affect life of the whole society in the growing fashionable world; priority for new fiber like Cyperaecae family CDA fibers has to be paid great attention for enhancing domestic culture, keeping traditional and tribal decoration knowledge as fashion in basketry, packaging and textile sectors in carpeting, blanket manufacturing, matt designing and composite manufacturing in the countryside.

Over the last two and more decades, the world has experienced rapid changes and socioeconomic transformations and radical changes that exaggerated and caused severe impact especially synthetic fiber industries on the natural environment that may cause global warming, pollution, and destruction of world ecosystem. Beyond this these changes in synthetic and non-natural fiber manufacturing schemes, affect social-cultural structure of the world initiated to decreased farm revenues of natural fibers and their production, value addition and modification, changing in the farmland values and high rates of unemployment in developing countries especially Ethiopia, may be the most important event to bulk migration of the productive forces and make lack of interest in cultivation and utilization of natural fibers in rural areas.

So the need of natural resources for socio-economic development followed by regeneration and value addition of natural fibers along with the necessity for modification of their cost-effective utilization has to be done to meet requests for the changes in today's scenario. In this sense, modification and characterization of new fibers has to be an encouraging engineering science and one of the main segments of economy that national and local governments, higher institutions and agricultural sectors work in harmonization to support and promote as a one head one tongue. This scheme may be the way for regeneration of the rural livelihood intrinsic culture and support domestic manufacturing and engineering of craft works specifically craft works in basketry, household handicrafts, traditional decorations, and increase the cultural value of craft materials.

The development of household fiber industry has been shadowed by the changes on fiber demands and their performance keep an eye on by western industrialization. Yet fiber manufacturing and utilization in rural areas willpower the potentials for alternative, different and more dependable manufacturing familiarities sustaining the needs of the skilled and highly demanded fiber production monitored by effective product development. Besides, there is a demand for specialty fiber and recreational product developments in the countryside that support traditional and national cultures.

One motivation for this study is the fact that during the last few decades the growth of synthetic fiber industry and exploration of domestic culture and knowledge has been affected. From different countries like Kenya[[96](#_ENREF_96), [97](#_ENREF_97)], Traditional house industry development, concentrated in natural fiber manufacturing, has proven that natural fibers can bring enormous benefits to the economy, society, and environment. But in our country, realizations of such activities have been left behind from development strategies rather raw resources have been utilized as it is and/or leftover there on the natural environment without any economic role. The other interesting motivation for this research is that ease of accessibility of CDA plant in the country and easy of cultivating, harvesting and utilizing with effective cost of handling and extracting possibilities with sustainable and environmental controllable principles.

The main effort of this review was a rural area of Ethiopia, especially the Amhara Region in South Gondar[[90](#_ENREF_90)], the North-Eastern part around the Blue Nile River basin[[89](#_ENREF_89)]. Even if natural fiber manufacturing and characterization practice is in its early period in the region, this review work has provided with a unique opportunity for the investigation of CDA fibers for different applications in composite reinforcements and craft works.

**Conclusion**

The contemporary situation of the textile fibers has been on a great deal for specific applications and eco-friendly to the air. Changes have been taken place due to the need of improved properties in the natural fibers and their end applications. Exponential growth of the textile industry, which has been primarily, runs on textile fibers will bringing about a revolution as they have started replacing the synthetic fibers will make the bright future due to the various Research & Development activities worldwide on the modification and new findings. The main trust in natural fibers applied to textiles, clothing has been to improve the properties and performance of existing materials, and develop new textiles and composite materials with novel functions; greatly increase the use of fibers in different options, and and open up new opportunities for fibers as a new source for apparel and engineering applications. Overall, this review has offered with great potential for the future and could radically change consumer perception of what constitutes a “standard” natural fiber for its intended end use applications. It has presented with CDA plants as a new natural source and its viability towards composite manufacturing and traditional applications,

The review was hence explored for the purpose and exploration of the nature of CDA plant, the extent to which CDA grass contributes to the economy of the producers, the demand for CDA in the local market and description of the physical nature of the plant in detail.

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Table 1: Physical properties of some plant fibers

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Fiber | Strength (MPa) | Modulus (GPa) | Strain (E) (%) | Density(kg/m3 |
| Cyperus pangorei | 196±56 | 11.6±26 | 1.69 | 1.102 |
| Bagasse | 20–290 | 19.7–27.1 | 1460 | 1.2 |
| Banana | 54–789 | 3.4–32 | 2–7 | 1.3-1.4 |
| Flax | 345–1500 | 27.6–80 | 1.2-3.2 | 1.4-1.5 |
| Sisal | 400-700 | 9-38 | 2-14 | 1.3-1.5 |
| Jute | 93–773 | 55 | 1.5–1.8 | 1.3 |

Table2: Chemical properties of stem and grass fibers

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Cellulose (%) | Hemicellulose (%) | Lignin (%) | Moisture (%) | Wax (%) | Ash (%) |
| C.pangorei | 68.5 | ND | 17.88 | 9.19 | 0.17 | 3.56 |
| Grass | 25–40 | 25–50 | 10–30 | 13 | 25.8 |  |
| Jute | 59-71 | 12-20 | 12-13 |  | 0.5 | 0.7 |
| Banana | 60-65 | 6-8 | 5-10 | ND | ND | 1.2 |
| Sisal | 60-67 | 9.9-15 | 8-12 |  |  | 0.14-2 |
| Kenaf | 31-72 | 20.3-21.5 | 8-19 |  | <1 |  |
| Bagasse | 25-45 | 28-32 | 15-25 | - | - | - |
| s.bagass | 32-44 | 27-32 | 25-28 | - | - | 1.1 |
| Straw | 76 | 15 | 1 | - | - | - |
| S. straw | 32-35 | 24-27 | 15-21 | - | - | - |
| Nappier grass | 47.12 | 31.27 | 21.63 | - | - | - |
| Borassus | 53.40 | 29.6 | 17 | - | - | - |
| Bamboo | 33–45 | 30 | 20–25 | - | - | - |

Figure 1: Classification of plant fibers based on the position of fibers

|  |  |  |
| --- | --- | --- |
| [[75](#_ENREF_75)] | [[85](#_ENREF_85)] | [[87](#_ENREF_87)] |
| Figure 2: Extraction mechanisms of Cyperus pangorei plant by different scholars | | |

 

Figure 3: Napier grass clump, stems, and extracted fiber strands *[*[*76*](#_ENREF_76)*,* [*98*](#_ENREF_98)*]*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *D:\my files\2012\research\papers for litrature\papers for litrature\distribution over africa.jpg* | | | | | | | | |  | | | | | | | |
| Source:-African plant database system  Figure 4: Distribution CDA plant in Africa | | | | | | | | | | | | | | | | |
| D:\my files\2012\research\papers for litrature\papers for litrature\african distribution.JPG | | | | | | | | | | | | | | | | |
|  | | Congo | Ethiopia | Rwanda | Kenya | | Tanzania | Burundi | | Cameroon | | S.africa | Mad. askar | Others | | |
| Figure 5: Occurrence and distribution rate in Africa | | | | | | | | | | | | | | | | |
| D:\my files\2012\research\papers for litrature\papers for litrature\3eb66d57626352da905d707dfcd15620.jpgD:\my files\2012\research\papers for litrature\papers for litrature\mesob.jpg  Figure 6: Ethiopian indigenous mesob products[[94](#_ENREF_94)] | | | | | D:\my files\2012\research\papers for litrature\papers for litrature\hand bag.jpg  Figure 7: Giramta hand bag products | | | | | D:\my files\2012\research\papers for litrature\papers for litrature\wonfit.jpg  Figure 8: Giramta sieve for grain filter | | | | |
| D:\2012\2nd PG classes\thesis\research and its progress\cyperus species fibers\aksum-ethiopia-january-13-baskets-600w-1044722830.jpgD:\2012\2nd PG classes\thesis\research and its progress\cyperus species fibers\aksum-ethiopia-january-13-ethiopian-600w-1044094657.jpg  Figure 9:Interesting mesob baskets in the market of Axum | | | | | | | | | | D:\2012\2nd PG classes\thesis\research and its progress\cyperus species fibers\WOVEN-AFRICAN-BOWL-BASKET-20190215215649.jpggrain dishes | | | | |
| D:\2012\2nd PG classes\thesis\research and its progress\cyperus species fibers\Types-of-basketry-1024x246 (1).jpg  Figure 10: Different basketry production techniques | | | | | | | | | | | | | |
| D:\my files\2012\research\papers for litrature\papers for litrature\header-basketry.jpgD:\2012\2nd PG classes\thesis\research and its progress\cyperus species fibers\IMG_4161-1024x423.jpgD:\my files\2012\research\papers for litrature\papers for litrature\header-basketry.jpg  Figure 11: Basket making trends and techniques from Giramta grass with awls | | | | | | | | | | | | | |



Figure 12: CDA plant