



Cultivated Natural Fiber Crops in Iraq and their Uses: A Review

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ABSTRACT

Natural fibers or fibers derived from crop plants, which divided into different types according to their extraction place like seed, bast (stem), leaf fibers and fruit fibers. Fiber crops have many advantages that can be used in textile industries for making cloths, papers, towels, ropes and in other products such as in food, medicines, cosmetic, construction material, animal feed and blended with other by products for composite preparation. As well as, natural fibers are renewable, cheap, environmentally friendly, low weight, low cost, not toxic as compared to synthetic fibers, and produced in a wide scale worldwide. Therefore, the objective of this review is to determine the fiber crops which cultivated in Kurdistan Region and Iraq such as; cotton, flax, date palm, jute and kenaf. Nowadays, can say that cultivation these crops in Iraq are limited by the farmers. It is sowed just on research scope, which is due to absence of industries, environmental changes and may also due to the war in the region. Furthermore, for encouraging farmers for cultivating fiber crops, there should be companies and factories utilizing fiber crops in different scopes. Besides, researchers and scientists should work on developing natural fibers, which are known as ecofriendly fibers, based on the findings of this study.

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Keywords: Natural Fiber; Cotton; Kenaf; Flax; Jute; Renewable; Cheap; Ecofriendly.

1. Introduction

Natural fibers are of renewable materials that are abundant in nature and have benefits for example cheap, lightweight, renewability, biodegradability, and specific high characteristics^[1]. In addition, natural fibers are considered as plant fibers and include all forms of fiber from wood, grass, fruits, wild plants, aquatic plants, agricultural crops, palms, leaves, and seeds. The recognized fibers utilized for composite preparation include by-products such as banana, pineapple, sugarcane, rice, palm oil, coconut, kenaf, abaca, hemp, sugarcane, jute, sisal, bamboo and cotton^[2, 3].

^[4]reported that due to the growing environmental concerns and depletion of petroleum supplies has enhanced the relevance of natural fibers, motivating researchers and industry to adopt sustainable fibers rather than standard synthetic fibers. For making the composites lighter, natural fibers are utilized instead of synthetic fibers. Natural fibers have a lower density 1.2 - 1.6 g cm⁻³ than glass fiber 2.4 g cm⁻³, allowing for the creation of light weight composites. This makes commercial application of natural fiber-based composites in numerous industrial sectors to increase. As a result, natural fibers such as kenaf, jute, hemp, sisal, coir and

banana are widely employed in the manufacture of lightweight composites^[5, 6].

Therefore, the main objective of this review is to show natural fibers that well suited to Iraqi environmental conditions and their uses such as (Cotton, Flax, Jute, Kenaf and Date Palm).

2. Natural Fiber Crops

Plant fibers are classified into several types based on where they are extracted, such as; bast fibers, which come from the plant's phloem tissue and are represented by jute, kenaf, ramie, flax, and hemp. And may also fibers come from seed padding such as; coir, leaf fiber such as; pineapple, abaca, sisal, henequen, or other plant components. Plant biomass includes all plant fiber residues from forests, plantations/estates, and processing mills^[7, 8]reported that natural fibers provide the following benefits as compared to standard reinforcement like; kevlar, glass and carbon:

1. Friendly for the environment.
2. Completely bio-degradable.
3. Not toxic, and no health hazards (not causes irritation to the skin).
4. Handled easily.
5. During preparation and application, none abrasive.
6. Low weight and density.
7. Compostable.

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8. For rural and agricultural community, as a good source of income.
9. Good noise and heat isolation and have good thermal characteristics.
10. Continuous raw material supply, extensive and renewable.
11. Low cost and improved energy reclamation.
12. High stiffness and suitable specific strength characteristics.
13. Natural fibers are significantly less abrasive than glass fiber, which gives benefits in terms of processing and recycling technologies.

3. Cultivated Natural Fiber Crops in Iraq

Therefore, the common sources of natural fibers in Iraq and Kurdistan which is extracted from the plants are supplied from few sources such as; cotton, flax, date palm, jute and kenaf fibers. Unfortunately, could say that political issues and war beside of the climate change caused to serious problems to the farmers by shutting the factories and industries in some regions of Iraq and Kurdistan, which was directly and indirectly relationships to use these fibers above. Then, it causes to reduce cultivation and production by the farmers. In the fact, these problems not just faced to the natural fiber manufacture factories but also to all industries and factories which relative to agriculture sectors. There more, [9]stated in an investigation it is not enough to have a large amount of output; it is also vital to know how to achieve it. That is, how to cut manufacturing/production costs while remaining ecologically conscious. As it well known, global climate change is one of the most pressing concerns that must be addressed in order to protect and rejuvenate the environment on a worldwide scale. Forest conservation is important because the loss of each tree means an increase in atmospheric CO₂, which causes climate pollution as observed regionally. Hence, the best approach to achieve this goal is to encourage farmers for cultivating natural fibers, particularly cotton, kenaf, hemp and jute. After that, the obvious objective for developing global law requiring companies and industries to utilize these natural fibers as alternative renewable materials. Researchers and scientists should work on developing this type of natural fibers, which are known as ecofriendly fibers, based on the findings of this present study.

3.1 Cotton

[10]Informed that cotton (*Gossypium hirsutum* L.) is a crop that belongs to the Malvaceae family, and generally one of the major important agricultural crops and fiber crops in particular. Cotton grows as herbaceous or perennial shrub crop, but it is treated like other annual crops. In addition, the cultivation of cotton crop is found in warm regions that are not less than 12 °C and not more than 40 °C and the optimum degree is 32 °C, generally its cultivation is consistent with the increase in monthly temperature rates during the third weeks of March until mid of April. It is suitable for germination in most countries of the world, including Iraq particularly in summer. However, cotton industry was found in the central and southern of Iraq, because of its natural capabilities including climatic factors.[11]cultivated three varieties of cotton (Lachata, Stoneville 213 and Coker 310) for determining a suitable date for cotton sowing in Erbil, Kurdistan

Governorate. Under the agro-climatic conditions of Erbil, Kurdistan, was determined that sowing on March 28 is the most optimal sowed time for these types. In addition, the findings of this recent study, some varieties will grow better in different states of Kurdistan, particularly in cold conditions. So, the sowing dates had substantial effect on seed cotton production, indicating that sowing dates are a more essential element that should be considered in agricultural processes. Besides, [12, 13]recommended to use different varieties that can tolerate adverse environmental conditions especially Lachata variety as showed significance effect for most used growth and yield parameters in their experiments, and well suited to Iraqi environmental condition and well suited to its soil composition especially in Kurdistan region. Different stages of cotton plant, which was cultivated in Iraq-Kurdistan region showed in the (Figure 1)[14].

In modern systems of cropping the height of plants is (1 – 2) m, whereas its higher in traditional varieties. The leaves are large and lobed with (3 to 5 or seldom 7) lobes, the capsules hold the seeds which is called the boll every seed is surrounded by two types of fibers. These fibers are the most intriguing component of the plant, and the seeds are removed by a ginning procedure. The initial or first ginning contains the longer fibers called staple, which is separated and twisted together for making yarn to form threads and weaves into high quality fabrics. There more, linters are the shorter fibers obtained from second ginning, and those are woven into lower quality fabrics. Several investigations are continuing to cross breed several desirable features from wild cotton species into the main commercial species, for example drought tolerant, diseases and insect resistance. Naturally the fibers of cotton are white, brown, green in color and often mixing of them. Cotton plant is the major fiber producer in industrial scale, and yields (55 %) of the fiber used in the textile industry. In addition, the seeds of this plant contain around (20 %) oil that is regarded as the world's largest oil seed after soybean. After oil extraction the resulted meal is considered as one of the main feeds for animals, and contains around (48 %) protein[15].



Figure 1: Cotton plant at different stages; flowering, boll formation and maturity stages[14].

3.1.1 Uses of Cotton Crop

3.1.1.1 Fiber Uses

Fibers of cotton nature's most common polymer are the purest form of cellulose; approximately (90 %) of cotton fiber is cellulose. All plant fibers contains cellulose but in a different

amount, cellulose in cotton fibers also has the most crystalline, orientated and fibrous of highest molecular weight in all plant fibers^[16]. High strength has renewed the use of cotton; therefore, it may be utilized in a range of ways by men^[17]. Cotton is important in the industries of weaving, spinning and napkins^[10]. On the other hand, ^[18]revealed that cotton plant lints spun and then woven into textiles, such as velvet, chambray, velour, flannel, jersey and corduroy. 60 % of the world's net production of cotton is used for clothing, while the remainder is used for industrial and household furniture. T-shirts, denim trousers, socks, towels, underwear and bedding are the most known cotton products (Figure 2). Fibers are also utilized in the production of tentages, tires, ropes, fish networks and book ties. Its fiber is utilized in many domestic fabrics, for example blanket, rugs, tampons, diapers, face masks and window covering etc. As well as, fine fiber has been utilized in manufacture of papers, art papers, stationary items, document folders degrees and currency. Removal of dirt, plenty of waste, inert matter and fine fibers amongst cleaning techniques get fine cotton for creating quality papers. Theoretically, both long and small staples with fibers are more robust since they withstand misuse easier. Despite this



Figure 2: The products made from cotton fiber and seeds.
<https://www.shutterstock.com/search/cotton-products>.

growing synthetic fabric prices and recent cotton price rises, textile sector in China has managed to recover^[19].

3.1.1.2 Seed Uses

^[20]exposed cotton comprises seeds, which contains more than the half of cotton. One ton of cotton seed may contribute to 1/3 of seed coat, while over (20 %) oil can be produced, and half of that seed can even be utilized as ruminant feed following pressing. Seeds of cotton satisfies world's demand for protein of half a billion humans and billions of ruminants. Most common uses of cotton seeds are oil for food and feeding livestock and animals. The seeds of cotton are pressed or crashed so as to produce cotton seed oil for several purposes, from home to industry. During processing the cotton seeds, washing is done as a first stage, even until medicinal or industrial substances like gossypol are extracted. Cotton seed may be prepared as food, since it is a rich energy source. The production of numerous industrial products

such as; margarine, soap, emulsifier, medicine, cosmetic, rubber, candles, water proofing, etc. may also be done using seed oil (Figure 2). Oil from cotton seeds has a high quality, which is cholesterol free and have large quantities of antioxidants (vitamin E) and polyunsaturated fats that increases the chickens, rabbits shelf life amongst others^[18]. As well as, ^[10]showed that the oil extracted from cotton seeds are made up of glycerides of palmitic acid, oleic acid and some other unsaturated fatty acids such as linoleic acid, it constitutes 56 % in the weight which is used in the products like candles and soap making.

3.2 Flax

Flax (*Linum usitatissimum* L.) is an annual or perennial crop, belongs to the family Linaceae. Flax is an upright plant that grows to a height of (100 – 125) cm. It have a thin stem and leaves that are green, narrow, alternating, and lanceolate. It has white, purple, blue, pink, or red blooms with 5 petals and a spherical, dry capsule that contains roughly 10 seeds as can be seen in (Figure 3). It is one of the industrial and a trade crop that plays essential role in regional strategy throughout both local manufacturing and exportation. The seeds of flax as well provide excellent sources of protein, fiber and have high antioxidant activity^[21, 11]. ^[22]informed that flax is a dual-purpose crop, which can be sown for oil extraction from flaxseeds and fiber from its stem.

^[23]testified that the market value increased for linseeds, due to its health benefits of Al-Bughrbee crop type. Although, these industrial and food crops are important, its cultivation in Iraq is still faces certain challenges which restricts growth and their production, for example failed to establish seeding dates to allow the plant to develop and mature before onset of high temperatures, which might lead to a reduction in seed production owing to an increase in warmness throughout the periods of pollination and fruiting. As well as, the ratio and composition of fatty acids in seeds (green) is affected. In Iraq the planted areas with flax are very narrow almost only on the research scope. Thus, it's essential to enlarge cultivation of flax crop and increasing the yield per unit area by following some agricultural practices, like sowing date and the application of fertilizer especially micronutrients such as zinc^[24]. ^[11]investigated in a study for the first time at Grdarasha field that belongs to the college of Agricultural Engineering Sciences – Erbil, studied impact of using different rates of charcoal and potassium on flax growth and yield. Hence charcoal never been used as a fertilizer for flax or any other crop in Kurdistan (Figure 3). So, the results presented that several growth and yield parameters for example height of plant, technical length of stem, total fresh and dry stem yield were improved by using charcoal and potassium. As well as, ^[25]sowed flax plant for indicating effect of different levels of phosphorus and iron, as a result percentage of oil yield, protein, and concentration of Fe were increased with the application of phosphorus and iron. In another study conducted in Erbil governorate at Grdarasha field for determining the impact of row spacing and plant spacing on flax plant. Thus, the results expressed that 30 cm of row spacing increased plant height, stem diameter, number of primary branches/plant, number of capsules/plant, seed yield and oil content to (77.2 cm, 2.78 mm, 6.4, 39.1, 2.107 t/ha and 22.8 %) respectively. While, plant

spacing of (4 and 6) cm had highest yield of seeds and oil percentage 1.981 t/ha and 22.4 %, respectively^[26].



Figure 3: Photograph of flax plantation, (Thorshansity 72, “Poland cultivar). Gardarasha Field, College of Agriculture, Salahaddin University – Erbil^[11].

3.2.1 Uses of Flax

3.2.1.1 Fiber Uses

Flax fiber has little flexibility and is resistant to moisture, mildew and heat. It has a cellulose content of 8 to 9 % and renowned for its strength and durability since it is stronger than cotton, wool or rayon^[27]. The precious fiber known as ‘Linen’ is extracted from the bark of its stem and has traditionally been consumed for bed sheets, table linen and underclothing^[28].^[29] reported that flax fiber primarily utilized for textile such as clothes and paper. ^[30] stated that due to the hydrophilic properties of flax, which absorbs and retains moisture better than other materials and can be recommended for dressing of wounds. Besides the medicinal benefit the mechanical property of moisture through none woven mats of flax fiber in comparison to traditional dressing can be beneficial when utilized as the diffusion testing method. Flax produces two types of long and short strands. Long line fiber is used to make high linen value products, whereas short staple fiber is a byproduct of long line fiber and is utilized to make lower value items like; mats, covers and sleeping pads. Flax fiber strings are sufficient to design sewing threads, catch and shoe strings. In Asia, cloth is also used to make the best quality hankies, window decorations, bedding, curtains, pad and covers, towels, other enlivening products and materials for suits and traditional clothes. Likewise, it may also be used to assemble composites such as particleboard^[31, 32]. Figure 4 shows the products that made from flax fiber and seed oil, and can be used in different ways.



Figure 4: Products from flax fiber and seed oil. <https://thethirty.whowhatwear.com/ground-flaxseed-benefits/slide19>.

3.2.1.2 Seed Uses

^[21] informed that oil content in flax seeds are between (33 – 47)%. In some parts of the country, its also utilized as edible oil. Cakes of flax seed make excellent manure and are widely utilized as animal and poultry feed across the country. The flax plant as a whole has a high economic importance. Flaxseed has been taken for generations due to its pleasant flavor and nutritional value. As individuals have grown more cared about their healths, the demand for flax in food and drinks, functional foods, and nutritional supplements has increased considerably in recent years. Flaxseed typically comprises 28 % dietary fiber, 42.66 % fat, 21 % protein, 6 % carbohydrates and 4 % ash. In addition, flax seed meal has a specific mix of amino acids in the protein, which results in a glossy, healthy coat for the animals; as a result, breeders of horses across the United States employ flaxseed meal. ^[33] stated that polyunsaturated fatty acid triglycerides account for up to 90 % of the total oil content in flaxseed. Flaxseed oils high linolenic acid content gives drying properties, which are beneficial for paint manufacturing, linoleum flooring coverings and varnishes. On the other hand, flaxseed is regarded as a possible functional food component since it offers several health advantages and nutritional value. Consuming flaxseed or meals of flaxseed or its cake has been proven to inhibit proliferation and nuclear transformation of epithelial cells in mammary glands, and diets containing these nutrients are related with lower growth of cancer. Also, as a dietary supplements used to reduce constipation and the risks associated with heart disease, diabetes, cholesterol, cancer, and other disorders^[34]. Furthermore, ^[35] informed that flaxseed contains more than 10 % soluble dietary fibers, and consuming enough dietary fiber can lower plasma triglyceride, low density lipo-protein (LDL) cholesterol, and plasma cholesterol in rats, as well as attenuate atherosclerosis, nowadays flaxseed available as seeds, powder, tablets and oil, due to which^[36] informed that flaxseed is as a food plant it provides beneficial lipids, fibers and antioxidants. It has been proposed that the high content of α -linolenic acid (ALA) in oil of flaxseed aids the prevention of skin dryness.^[37, 38] considered that flaxseed water soluble gum can be consumed in the diet to help in weight reduction or regulation, as well as to regulate or lower blood cholesterol. It has been proposed that 10 ml of flaxseed oil be consumed daily, or that a lotion made of flaxseed oil and essential oils are applied^[39].

3.3 Date Palm

Date palm (*Phoenix dactylifera* L.) which belong Arecaceae family is one of most ancient, widely known cultivated fruit trees and is originated from Babylon, Iraq since 4000 B.C, the palms were revered for their power and grandeur throughout this time. People depended significantly on this tree to produce food and wood for manufacturing elements, baskets and furnishings^[40, 41]. ^[42] informed that Iraq has been the largest date palm producer in the world for several years, although several influences negatively impacted both the natural genetic diversity and productivity of the crop. Iraqi officials also scientists are nevertheless making attempts to offset the significant harm that the palm products industry has suffered in the previous 30 years.^[41] conveyed that Iraq is the earliest historical date palm domestication center. While, the country possessed around 32 million date palms in the mid of twentieth century, and this figure

has plummeted to below 12 million by 2000. As a result, the government implemented many projects targeted at raising the number of trees to 40 million in the following ten years (Figure 5).



Figure 5: Najaf date palm station established in 2008^[41].

3.3.1 Date Palm Uses

^[43]concluded that dates are grown primarily for their fruit, which may be eaten fresh, dried, or manufactured. There were about 100 million of palms tree in the globe. Only in Saudi are 15 thousand tons of palm leaves utilized for preparing garbage. In various regions of the world, the leaves of the date palm trees are used to make mats, baskets and ropes. Inappropriately, a great portion of date palm's non-food products end up in landfills with no specified use. It has been obviously demonstrated that every portion of the palm trees have the enormous ability that can be utilized in a range of purposes like manufacturing papers, energy generation, immersion of toxic and heavy metals, as well as soil fertilization by paying attention to the date palm features. ^[44]reported that all portions of the date palm produce economically valuable products. The trunk prepares timber, the leaves midribs provides materials for furniture and crates, the leaf lets provides materials for basketry, fuel by leaf bases, rope and fuel by fruit stalks, cordage by the fiber and packing materials and seeds are occasionally ground and consumed for stock feed (Figure 6). In addition, the fruit is used for making syrup, vinegar, alcohol, and powerful liquor. Also the sap used as a beverage either fermented or fresh, however because the extraction procedure damages the palm, only trees with small fruit are utilized for sap. The delicate terminal bud of date palm is eaten as a salad after it has been chopped down. Theremore, various products for example Medium Density Board (MDF), Laminated Strand Lumber (LSL), Parallel Strand Lumber (PSL) and etc. where produced from raw materials of wood^[45]. The hunt for alternatives to wood products is prompted by environmental concerns about raw wood availability^[46]. A long from many years, wastes of agriculture and leftovers for example; bagasse and wheat straws are employed^[47]. ^[48, 49]stated that date palm is another replacement resource that has previously been given a large quantity of agricultural residues, so MDF made from date palm pruning waste is being researched. The research revealed the MDF made from those elements outperformed the constraint that EN and ASTM standards advised assessing mechanical qualities. ^[41]presented different types of date palm seeds that eaten as a fruit, Produced in Iraq (Figure 7).



Figure 6: Date palm fiber and its uses^[100].



Figure 7: Variations in fruit morphology of common cultivars of date palm in Iraq^[41].

3.4 Jute

Jute which belong Tiliaceae family, and is one of the fiber crops with long fiber that found in its stem, and it comes in the second grade after cotton fibers in importance^[50]. ^[51]who investigated in

a study on jute plant in Iraq, which can be sowed as a summer crop and may be sown all the year from March until September except cold months. Indo-Burma and south china were known to be the origin of white jute (*Corchorus capsularis* L.). However, its sown in Iraq, Iran, Bhutan, Bangladesh, Nepal, India, Sri Lanka, Pakistan, Thailand, Myanmar, Vietnam, Taiwan, Malaysia and Indonesia, in Africa (Sudan and Egypt), Philippines and Brazil. [52] described that jute is a fast-growing annual plant. It attains a height of (2.5 – 3) m in 4 - 6 months in hot and humid climates. The majority of the jute is collected when roughly half of the plants are in pod because good quality jute fiber bundles produced at this stage of growth. The retting procedure separates the fiber bundles from the woody stem (Figure 8). Jute is the most common bast fiber, followed by flax and hemp fibers, and its high lignin content separates it from hemp and flax fiber. Jute was identified as golden fiber and it is an essential cash crop. There are two major species of jute; tossa jute (*Corchorus olitorius*), and white jute (*Corchorus capsularis*)^[53, 54].



Figure 8: Jute plant^[54].

3.4.1 Uses of Jute

3.4.1.1 Fiber Uses

Various types of fibers with different characteristics may be utilized for strengthen concrete, jute fibers are one of them. Utilization of fiber improves the characteristics of concrete such as increasing tensile strength and toughness, decreasing shrinkage and cracking by maintaining the micro cracks and improving the durability because of the permeability^[55]. Jute was used for packing for example gunny bags, carpet backing, twill, twine, wool pack, mats, hessian, rug, canvas, cover of walls, handicrafts and furnishing different fabric types and nature (Figure 9). It has been utilized nowadays for packaging as a common raw material, the fiber made from jute is highly absorptive due to which is utilized in surgical dressings. In diverse regions in the globe, home and farms equipment like clothing, hand-crafted garments, wall hanging were utilized before being employed as a commercial product, etc. from jute papers can be made as well ^[56, 57]. A new technology has developed for a large-scale consuming jute as a raw material in the manufacturing of high-value added, low-cost intermediary or end products, like home textiles, composites, geo-textiles of jute, paper pulp, chemical products, handicrafts, technical textiles, accessories for fashion, and other high value added items have

been produced. As well as, the woody center core of 'jute stick' that remains after removing the bast is used as a rural construction material, for fences, thatch, charcoal and fuel production. It is also capable of being converted into paper, board, and derivatives of cellulose^[58].



Figure 9: Jute fiber applications.

<https://agricultureandfarming.wordpress.com/2021/10/10/cultivation-of-jute-in-bangladesh-increasing-golden-fiber/>.

3.4.1.2 Leaf Uses

Corchorus olitorius leaves and tops are consumed as a vegetable in Malaysia, Indonesia, and the Philippines. Jute is mostly grown and utilized for this purpose in Africa and Middle East, rather than for its fiber. The leaves of *C. capsularis* are used to poultice ulcers, and in decoction, they are utilized to cure diarrhea, phthisis, coughs, and as a tonic for children. *C. capsularis* leaves are used for curing headache in the Philippines^[58].^[59-61] identified that leaves are widely recognized for their emollient, tonic, diuretic, and purifying properties. Jute leaf is often consumed for making a sticky sauce which is served with the main meals and as a tea (Figure 10). The leaves of jute contains high amount of proteins, iron, β -carotene, folic acid, calcium, B vitamins, amino acids, and vital substances. In addition, the leaves of jute are employed in herbal pharmacopoeia to treat malaria. Jutes are high in (A, C, E) vitamins, iron and calcium^[62].



Figure 10: Jute leaves products.

<https://www.teapasar.com/products/jute-tea-pure/>,

<https://tribuneonlineng.com/eight-amazing-health-benefits-of-ewedu-jute-you-probably-didnt-know/>.

3.5 Kenaf

^[63]reported that kenaf (*Hibiscus cannabinus* L.), which belongs to the family Malvaceae. In Malaysia considered as an industrial crop, it sown in other countries of the world for certain purposes. Kenaf is considered as one of the most important planted fiber crops, that can be utilized as natural fibers worldwide next to cotton this is why it's wide spread in ancient Africa. Kenaf can be employed to manufacture excellent paper quality, cordage of lesser grade paper, ropes, packing, canvas, fishing nets and carpet backing. As well as, for industrial uses such as headliners, door panel and interior vehicle elements. In addition, in animal bedding the interior section of the plant (core) can be employed^[64].

Giving kenaf high adaptability to all soil kinds, so it has the ability to be sowed in trouble soils that have a characteristically low efficiency, and also in the soils which are poor in water-holding capacity and availability of nutrients^[65]. According to the results were found by ^[66]Kurdistan environment is conceivable for growing kenaf plant, during their researching seeds of ten kenaf cultivars were planted for the first time in Kurdistan in the summer season 2017 as can be seen in (Figure 11). Also, they believed that economic and ecologic characteristics of kenaf plant, that encourage researchers and farmers for cultivating this plant, and then using their fibers in wide range of applications. Kenaf crop in order to be produced in a large scale as a commercial crop, several scientific evidences must be known about its production for example nitrogen fertilizer recommendation and plant population^[67, 68].

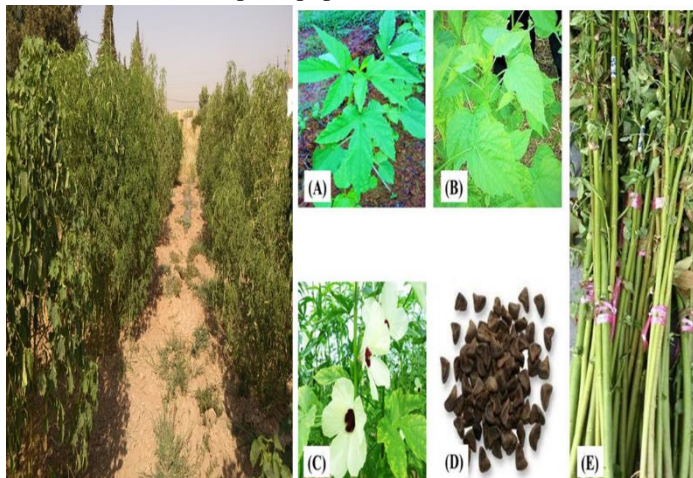


Figure 11: kenaf plants, (A, B) leaves, (C) flower, (D) seeds and (E) kenaf stems, which sowed in Grdarasha Field, College of Agricultural Engineering Sciences, Salahaddin University – Erbil^[3,66].

3.5.1 Kenaf Uses

3.5.1.1 Fiber Uses

Kenaf fiber is typically used for producing cordage and paper pulp, but it is also an important ligno-cellulosic feedstock for bioenergy production^[69]. Because of kenaf long fibers (bast), which originate from outer fibrous bark, it is more favorable in the bio-composite industry. Compared to any other fiber crops in the successful manufacturing business, the plants have a larger

variety of adaptability to temperatures, soils and locations, and are rich cellulose sources. Kenaf exposes a virtuous sources of high and enhanced quality cordage fiber that can be processed into a wide range of items such as particle boards, fiber-reinforced plastics, pulp and paper, chemical absorbents, and others. In building materials for example breadth, boards of different densities, fire and insect resistance, textiles, and adsorbents^[70- 72]. ^[73]stated that thermoplastic hybrids composites with natural fibers reinforcing have long been employed in automobile sector due to their light weight potential and high eco-balance (Figure 12). On the other hand, ^[74]indicated that the kenaf core has the potential to be as a fiber for industries of pulp and paper, potentially replacing wood and several natural fibers as raw materials. When kenaf was combined with cotton to make fabric and yarn. Also, ^[71]reported that Samsung and LG are testing kenaf powder as an alternative material for mobile phone and laptop covers. ^[75]testified that paper produced from kenaf is whiter, stronger, lasting longer, more resistant to yellowing and have greater ink adhesion than paper produced from wood.



Figure 10: Kenaf fiber bio-composites^[101,73].

3.5.1.2 Medicine

^[76]defined that kenaf as a valuable medicinal plant yields various bioactive substances for example phytosterols, phenolic, antioxidant, antitumor, anti-inflammatory, anti-proliferative activities, antihypertensive and cardio-protective that have been investigated pharmacologically. ^[77, 78]stated that as a byproduct, the kenaf plant produces seeds, which give kenaf seed oil with low toxicities, including triacylglycerol 99.81 %, free fatty acids, mono-acylglycerol, and di-acylglycerol. Fatty acids produced from kenaf seed oil is composed of oleic and linoleic acid, that have the potential for decreasing blood cholesterol. Furthermore, because of existing of bioactive molecules seed oil of kenaf has significant benefits for health such as anti-cancer, antioxidant, anti-inflammatory, antithrombotic, anti-hypercholesterolemic and antiulcer. In other studies, that conducted to examine the cytotoxic impact of kenaf seed oil against various cancers that infects human such as colon cancer, breast cancer, lung cancer,

cervical cancer, leukemia and ovarian cancer. Kenaf seed extracts and oil were discovered to have a significant phenolic content, which was found to be responsible for death of cancer cells. Thus, kenaf seed oil's cytotoxic action is linked to its high phytosterol, linoleic, and phenolic content [79, 76].

The leaves are utilized like vegetable in several countries around the world, and they have an erythrocyte protective activities against drug-induced oxidative stress^[80]. When dried leaves powder of kenaf was added to a variety of meals, the calcium and fiber in it were shown to be increased but the flavor remained the same. Consumption of tea has increased in recent years and has become a global trend, owing to the fact that its inclusion in the diet of human that provides powerful antioxidant components with high properties of health that supports human body functions^[81, 82].^[83] claimed that tea is a well known commodity in the health care industry due to its ease of preparation, ease of consumption, and, most importantly, low cost. ^[84] prepared the extract of kenaf leaves and showed that it can be consumed as important source of natural antibacterial, antityrosinase and anti-oxidant compounds in diet, pharmaceutical and cosmetic industry. ^[85] reported that personal care products, such as skin and hair care are pharmacological preparations that have beneficial properties which protects against degenerative illnesses. As a consequence of client concerns regarding the safety of synthetic ingredients, they are becoming more common in current formulations. Ayurvedic medicine uses leaves of kenaf for treating bilious, blood, diabetes, coughs, and throat illnesses, for example in Africa, a paste made from the leaf and stem is used to treat Guinea worm sickness and anemia^[86- 88]. Several investigations have found that the oil of kenaf seeds has anti-cancer, anti-oxidant, anti-inflammatory, anti-ulcer, anti-hypercholesterolemic and anti-thrombotic, impacts. Also, kenaf leaf extract can be used in cosmetics as a skin whitening, skin dryness, skin lotion for anti-aging, pigmentation and hair damage^[89].

3.5.1.3 Food

Seed flour of kenaf used in food industry to make breads, cakes and noodles, etc. Besides, oil of kenaf seeds as a vegetable oil has similar compositions to the oil of cotton seed that considered to as edible oil. The oil of kenaf seed does not have odor and translucent yellow in color, and turned to reddish brown color with a little odor when heated similar to soybean. Because of its high concentration of beneficial elements such as fatty acids, phospholipids, phenolic, phytosterols, and tocopherols, it is safe to consume^[90- 92]. Creamy white color milk can be extracted from seeds of kenaf, which are similar in appearance and texture to milk of soybean. Kenaf seed test is unfavorable and categorized with thin and have earthy flavor. In addition, seeds of kenaf are very nutritious, thus it must be accomplished in improving none conventional plant based alternative milk and other food uses. Hence, it has white creamy color resembling to that of soybean milk. Figure (13) below shows step by step the extraction of milk from kenaf seeds^[93]. Increasing the nutritional content of kenaf leaves benefits not only animals but also human purposes such as food, cosmetics, and medicines^[94].

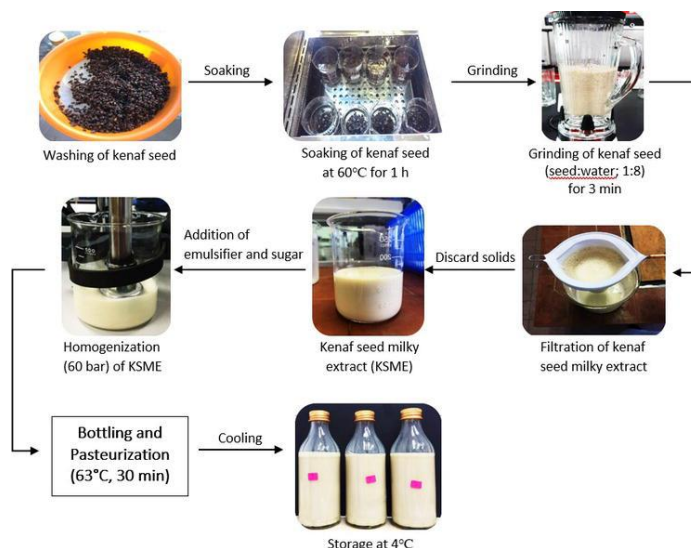


Figure 11: Steps of milk extraction from kenaf seeds^[93].

3.5.1.4 Feed

^[95, 96] described that as a functional constituent kenaf used as animal feed. Due to their nutritional levels, such as protein, fats, minerals and carbohydrates, appear to be extremely excellent, with good palatability and digestibility. Therefore, it is recommended being an appropriate supplementary protein for animal feed. In addition, forage crude protein is one of the most essential factors in quality of forage, and high crude protein content is considered a positive attribute for production of forage since it includes amino acids that are beneficial to animal development and production of milk. There are, few studies on the cultivation, development, and usage of kenaf as a feed for livestock^[97- 99].

Conclusion

During this review about natural fiber crops numerous advantages were found in their stem, leaves and seeds which are utilized as; fiber, composites, food, feed, medicine and cosmetics. Fiber crops are well suited to the most of environments and soils especially Iraq and Kurdistan conditions. Cotton, jute, date palm and flax which were sowed for many years ago in Iraq, recently kenaf is also sowing, but only in research scope. Generally, sowing these plant fibers dramatically dropped, which is due to none availability of factors and industries in the region. Unfortunately, with having these benefits of plant fibers currently it is cultivation for investigation only.

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Conflict of interests

None

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