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A comprehensive review on Kenaf seeds and leaves for medicine

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Abstract

Kenaf plant is a valuable industrial crop from Malvaceae family. It's considered as dual purpose crop, in which its best and core fibers used in paper, pulp industry and livestock feed. Recently, kenaf seeds and leaves used in medicine because of their beneficial chemical composition that include phenolic compounds, antioxidants, phytosterols, fatty acids, steroid, flavonoid and kaempferol which have many health benefits. Therefore, this review aims in determining possible medicinal uses of kenaf seeds and leaves. The oil of kenaf seeds were reported by several studies which used as anti-oxidant activity, anti-cancer activity, anti-ulcer, anti-inflammatory, anti-thrombotic activity and anti-hyper-cholesterolemic activity. As well as, kenaf leaves can be used as freshly or dried leaves as tea for treating blood, bilious, coughs, diabetes, throat problems and lowering blood pressure. Kenaf leave extract can also be used in cosmetic as lotion for skin as anti-aging, dryness of skin, pigmentation, skin whitening and hair damage. Kenaf seeds and leaves have other uses including biofuel, lubricants, edible oil, making breads, cakes, etc. There are few researches on kenaf leaves furthermore studies is required for examining kenaf leaves health impacts.

Keywords: Kenaf, seeds, leaves, medicinal, cosmetic, anti-oxidant

Introduction

Kenaf (*Hibiscus cannabinus* L.) is a seasonal herbaceous plant, which belongs to the family Malvaceae. Cultivated broadly in Asia and Africa, that mostly cultivates in tropical and temperate regions (Zhao *et al.*, 2014) [73]. Ramesh (2016) [56] who reported that in the United States agriculture department determined kenaf as a high potential crop for use as a source of fiber in pulp and paper industry. Ayadi *et al.* (2017) [9] defined kenaf as a substitute crop which might be a sustainable cellulose supply, and environmentally friendly and economically practical. Therefore, kenaf plant is sowed for its fiber, but its leaves and seeds that have been used in traditional medicine in Africa and India for a variety of diseases. As well as, kenaf is a major ligno-cellulosic feedstock for production of bioenergy. Chu *et al.* (2021) [18] who declared that derivatives of kenaf such as leaves and seeds were institute to exhibit high bio-active chemicals and prospective effect of skin whitening, indicating its potential for cosmetic submissions. Kenaf seeds and leaves might be situated as promising source of bio-active chemicals and phytonutrient. Since, a study conducted by Sim and Nyam (2019) [61] reported about the phrase "return to nature" have been widely employed in cosmetic industry, utilization of botanical extracts resulted in consumer acceptability. KLE (kenaf leaves extract) showed promising anti-oxidant and anti-tyrosinase capabilities, and it has the potential to be exploited as an added value to component in creation products for cosmetic. It's critical to produce safe and stable formulation incorporating KLE, since it includes a high concentration of polyphenol chemicals that have been shown to have skin whitening and anti-aging characteristics (Garbossa and Maia, 2016) [24]. In addition, (WHO) World health organization (2019) [69] reports according to one study approximately 80 % of the people in the world populations utilizes herbal plants to treat human illnesses. Ryu *et al.* (2017) [58] indicated that kenaf is an active plant biologically, were its seeds and leaves had extensive pharmacological submissions for example anti-oxidant and anti-inflammatory activities. Earlier, extracted cellulose from kenaf was used to produce AgNPs, the sucrose were utilized as a dropping agent and NPs showed strong anti-bacterial properties against *E. coli* (Reddy and Kim, 2016) [57]. Further, seeds of kenaf contain a putative major bioactive component known as kaempferol which has been used to treat cancer (Wang *et al.*, 2019; Imran *et al.*, 2019) [67, 31].

Bindhu and Umadevi (2013) [11] who indicated that this herb's leaves are beneficial in treating and preventing of scurvy, jaundice treatment, stomach stimulating and assisting its activity. Akinrotimi and Okocha (2018) [74] revealed kenaf seeds and leaves have plentiful of useful compounds such as fiber, fiber threads, oils, protein and allelopathic chemicals. On the other hand, a research revealed that presented ascorbic acid in leaves extract of kenaf have been utilized as reducing agent (Ayadi *et al.*, 2017) [9]. Significantly, because of kenaf huge biomass volume it might be a promising resource for future sustainable supply of energy, and its valuable phytol and phytocompounds from leaves must be recovered for medical uses. As well as, kenaf leave extract comprises various plant compounds, linolenic acid and phytol, that are Known to have many benefits for health (Saba *et al.*, 2015; Ryu *et al.*, 2017; Cordova and Alper, 2018) [59, 19]. Therefore, this review aimed to determine the medicinal benefits of seeds and leaves of kenaf plant.

Kenaf seeds

Taxonomy of Kenaf Seeds

Alexopoulou *et al.* (2013) [4] exposed that post pollination capsules of seeds are made, which are 1.3 – 1.9 cm wide and 1.9 – 2.5 cm long. The seed grows in five – lobed capsules. Every capsule has five segments, and a total of 20 – 26 seeds capsules⁻¹. Small hairy structures surround the seed capsules, which causes irritating for human skin. The grown type's capsules are typically indehiscent and persist intact for numerous weeks once accomplish its maturity. Under normal conditions of storage, the seed is viable for around eight months. Generally, kenaf plant seeds are similar. Nevertheless, there are some color and size differences. Kenaf seeds are around 4 mm wide and 6 mm long, which are wedge-shaped and have black color as showed in (Fig 1) (Salih, 2016) [60]. While, Islam (2019) [32] who told that kenaf seeds are triangular, sharp angles, ash gray with pointed pale yellowish warty patches. Brown hilum color and are relatively small.



Fig 1: Seeds of kenaf plant (Salih, 2016) [60]

Chemical Composition of Kenaf Seeds

Cheng *et al.* (2016) [12] indicated in a study there are various species in *Hibiscus* family that dispersed in diver's climate conditions containing bio-active substances such as (phenolics, antioxidants and phytosterols) with useful medicinal characteristics. The seeds contains high amount of antioxidant rich of oil, which earlier measured as a waste (Saba *et al.*, 2015) [59]. As well as, kenaf seeds comprise moisture 9.6 %, ash 6.4 %, oil 20.4, nitrogenous matter 21.4 % and crude fiber 12.9 %, whereas pressed dry cakes comprise ash 6.0 %, oil 6.0 %, protein 33.0 %, crude fiber 17.4 % and other substances 13.9 %. According to the same

study, the fatty oils divided to five acids including 19.1 % palmitic oil, 44.9 % linoleic acid, 28 % oleic acid, 0.5 % alpha-linolenic acid and 6 % stearic acid (Nyam *et al.*, 2009; Alexopoulou *et al.*, 2013) [51, 4]. Moreover, chemicals found in seeds of kenaf are Hexadecanoic acid 10.25 %, 9-octadecanoic acid 77.46 %, 2-hydroxy-1- (hydroxymethyl) ethyl ester 6.21 %, 9, 12-octadecadienoic acid and Linolenic acid 4.43 % (Adnan *et al.*, 2020) [2]. Kim *et al.* (2018) [39] who found that crude lipid content of kenaf seeds extending from 20.4 % to 24.8 % and crude protein 21.4 % to 30.5 %. Additionally, seed oil of kenaf comprises great amounts of mono-unsaturated fatty acids and poly-unsaturated fatty acids, tocopherol and phytosterols as bioactive compounds (Hue and Nyam, 2018) [61, 13]. As well as, kenaf seeds contain other substances including protein, fiber, ash, carbohydrates and fats their ratio differs from one variety to another as showed in (Table 1).

Table 1: The approximate conformation of several varieties of kenaf seed (Mariod *et al.*, 2010; Kim *et al.*, 2018; Ibrahim *et al.*, 2020) [39, 46, 30]

Composition %	Kenaf QP3	Kenaf V36	Kenaf KB6	Kenaf C14
Moisture	8.5	8.4	9.0	8.3
Crude protein ^A	30.5	29.8	21.9	27.5
Crude fat	24.8	22.6	24.7	22.1
Crude fiber	12.5	11.5	18.7	10.6
Ash	4.5	4.5	6.2	5.8
Total carbohydrate ^B	19.2	23.2	18.7	24.4

^A Crude protein = N (%) × 6.25

^B By differences

Medicinal Uses of Kenaf Seeds

Kenaf plant produces seeds as a by-product, which yields kenaf seed oil with little toxicity such as triacylglycerol 99.81% contributing the most, free fatty acids, mono-acylglycerol and di-acylglycerol. The kenaf seed oil profile of fatty acid made up from linoleic acid (omega-6) and oleic acid (omega-9), which related to the capability for lowering cholesterol. In addition, owed to the occurrence of bio-active constituents, oil of kenaf seeds has considerable health advantages and pharmacological activities such as anti-oxidant, anti-cancer activity, anti-ulcer, anti-inflammatory, anti-thrombotic activity and anti-hypercholesterolemia activity. Kenaf seed oil has been nano-encapsulated and micro-encapsulated to increase its bio-accessibility and bio-availability in the gastrointestinal system (Ramadan, 2019; Chew and Nyam, 2019) [55, 61]. Cheong *et al.* (2018) [13] who conveyed about the impact of kenaf seed oil for anti-hypercholesterolemia, oil of knead seed in water nano-emulsion and emulsified mixes lacking the oil on the profile of serum lipid, histological research, and liver oxidative status in the rats was studied. Results demonstrated that all of the samples treatment had lowering cholesterol capabilities, as measured via decreased total blood cholesterol, LDL-C, and levels of lipid peroxidation in rats who taked treatment against the group who did not get treatments and the normal control group. There more, Abd Ghafar *et al.* (2013) [11]; Wong *et al.* (2014) [68] who conducted studies that have been taken to assess the cytotoxic effect of kenaf seed oil against several human cancer cell lines, including ovarian cancer, cervical cancer, colon cancer, breast cancer, lung cancer and leukemia cancer cell lines. All of the data suggest that kenaf seed oil might be used as a natural cytotoxic agent, which has a substantial cytotoxic impact on human cell line of colon cancer, trailed by breast, lung, and cervical cancer. As well as,

the high phenolic content of kenaf seed extract and oil was found to be responsible for cancer cell apoptosis. Thus, the cytotoxic effect of kenaf seed oil is attributed to its linoleic acid, high phyto-sterol and phenolic content. As a result, the discoveries supported the use of kenaf seed oil as a natural anti-cancer agent.

On the other hand, Nyam *et al.* (2016) [49]; Chong *et al.* (2018) [75] in their research determined kenaf seed oil in water Nano emulsion's potential to scavenge radicals free in the body of human and reduce the risk of developing peptic ulcer illness. Phenolic chemicals have been shown to limit nitric oxide activity, which enhances pathological and physiological responses for example chronic irritation (Joseph *et al.*, 2009; Kim *et al.*, 2014) [76, 38]. Phenolic chemicals have anti-thrombotic effect via inhibiting platelet aggregation and platelet-leukocyte interaction. Flavonoids can lower thromboxane (A2) levels in blood and inhibits activities of lipoxxygenase, cyclooxygenase reducing platelet aggregation and anti-hypercholesterolemia. Anti-inflammatory, antioxidant, and blood dilution nutrient helps minimize thrombosis risks (Cheng *et al.*, 2016) [12]. Alexopoulou *et al.* (2013) [4] also told that kenaf seed oil had several health benefits, which helps in cholesterol and blood pressure controlling. In addition, floral juice and seeds are utilized for treating biliousness and bruising (Ryu *et al.*, 2017) [58]. Son *et al.* (2019) [64] explained that the presence of rich phenyl propanoid chemicals in the Kenaf plant reveals these therapeutic effects.

The anti-irritation efficacy of kenaf seed extract, kenaf seed oil, seed oil of roselle and their seed extracts in male Sprague dawley rats utilizing histamine prompted paw edema, carrageenan paw edema, and arachidonic acid paw edema. Treatment with oil of kenaf seeds (500 mg/kg) resulted in (19.9–36.4%) inhibition of induced histamine paw edema after 5 hours from injection (4.1–57.5%) inhibition of induced carrageenan paw edema after 5 hours of injection, (3.5–32.5%) inhibition of induced arachidonic acid paw edema 5 hour after injection. The therapy of indo-methacin (5 mg/kg), anti-irritation medication, as well as, exhibited an inhibitory of 4.0–56.7% with average 36.7% in 3 of the generated paw edema within 5 hours of injection. As a result, kenaf seed oil inhibited the inflammatory reaction in rats with generated paw edema (Nyam *et al.*, 2015) [50]. Kai *et al.* (2015) [34] studied the antihypercholesterolemic influence of kenaf seed models (spray dried MKSO, kenaf seed oil, extract of kenaf seed, and defatted meal of kenaf seed and compared them to a commercial hypocholesterolemic drug on serum lipid profiles and malondialdehyde (MDA) levels in male Sprague dawley rats. For 32 days, these kenaf samples were fed as normal nutrition or a diet of hyper-cholesterol emic (including of cholesterol into the food). The rats' total blood cholesterol, LDL-C, and level of MDA were greater in hypercholesterolemia diet group than in normal control diet group. The resulted effect demonstrated that the samples of kenaf seed had an antihypercholesterolemic influence in the following orders kenaf seed extract and oil, DKSM, MKSO, as measured with a substantial reduction in blood triglycerides, cholesterol, and levels of MDA. Serum of MDA levels are used to investigate peroxidation of lipids in the body, which is produced by oxygen responsive types. The simvastatin had no effect on the levels of MDA of rats who taked therapy. Dian-Nashiela *et al.* (2015) [21] reported that linoleic acid, tocopherol, phenolic and sterol found in kenaf seed oil are thought to be crucial in cholesterol-lowering effects. Phenolic have antioxidant properties that help free

radicals scavenge in the body and minimize oxidative stress, lowering the chance of developing hyper-cholesterolemia. Then this research discovered that extract of kenaf seed, which is abundant in phenolic, had greatest antihypercholesterolemic impact. As a result, it established a substantial link between oxidative stress and hypercholesterolemia. Furthermore, phyto-sterol aids in the reduction of triglycerides in the body, the rise of high density lipo-protein, and the prevention of dietary cholesterol absorption. In ulcer-induced rats, Nyam *et al.* (2016) [49] evaluated the antiulcer efficacy of roselle and kenaf seed oil. Treatment with oil of kenaf seeds (500 mg/kg) provided 54.5% protection in induced ethanol ulcer mice's, 75.0% protection in induced indomethacin ulcer mice's, and 60.4% protection in cold restraint induced stress ulcer mice's, compared to omeprazole, that provided 35.9, 48.0, and 95.3% protection in 3 ulcer induced models above mentioned. In this research, ethanol was found being capable of inducing gastric ulcers by disrupting the protective barrier of the stomach mucosa and promoting microvascular alterations after only a few minutes of application. Mucus secretion in the stomach mucosa is critical for gastric lesion protection. Flavonoids in the oil of kenaf seeds are known for promoting mucus, prostaglandin and bi-carbonate production in order for strengthening the gastric mucosa and inhibiting free radicals in order to avoid stomach ulcers and lesion.

Kenaf Leaves

Taxonomy of Kenaf Leaves

Salih (2016) [60]; Islam (2019) [32]; Sreenivas *et al.* (2020) [65] who claimed that on the main stalk (stem) and along branches, kenaf plant produces simple leaves with serrated edge. The location of these leaves on the stalk and branches alternates from side to side, and are 10 to 15 cm long. Kenaf plants produce two types of leaves: split and entire (Fig 2) (A and B). The leaf form is influenced by plant variety and age. The leaf also affected by environmental factors.

Appearance and color is two essential quality markers for both fresh and processed foods. It may stimulate consumption by conveying the sense of pleasant look; otherwise it may discourage consumption by alerting the substance is rotting. When fresh kenaf leaves were compared to one another, the color of the FKL was found to be impacted by the stages of maturity. In other words, as plant grows, color of the FKL got lighter, greener, and yellow. At 150 DAS, FKL had highest lightness, greenness, and yellowness. The increase in greenness and yellowness of plant leaves at ripeness is mostly because of an increase in content of chlorophyll, anthocyanin and xanthine in leaves as plant grows (Arias *et al.*, 2000; Zhang *et al.*, 2009) [8, 72].

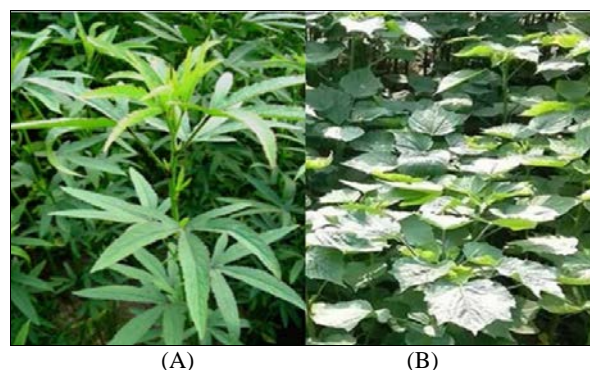


Fig 2: Varieties of kenaf leaves (A) Devided, and (B) Complete (Islam, 2019) [32]

Chemical Composition of Kenaf Leaves

The leaves of kenaf are high in bio-active compounds including catechin hydrate, caffeic acid, kaempferol and chlorogenic acid (Kho *et al.* 2019; Sim and Nyam, 2019; Haw *et al.*, 2020). Leaves of kenaf contains alkaloid 0.28%, saponin 0.15%, tannin 0.003%, glycoside 0.10%, steroid 0.002%, flavonoid 20 mg/100 g and carotenoid 569.55 mg/100 g (Omenna and Ojo, 2018) [52]. There more, Adnan *et al.* (2020) [2] indicated that seeds have the greatest phenolic and flavonoid levels as compared to the leaves. Water extract

has greatest total phenol concentration for both kenaf seeds (754.6 3.14 mg/100 g dry extract) and leaves (418.7 3.47 mg/100 g dry extract). The highest flavonoid concentration likewise found in water extract (425.33 4.39 and 299.17 3.43 mg/100 g dry extracts) extracts of kenaf seeds and leaves. Other liquid seed extracts of ethyl acetate, followed by ethanol extract and n-Hexane extract, as well as leave extracts of ethanol extract, followed by ethyl acetate and n-Hexane extract, was shown to be significant for total phenolic content and total flavonoid content (Fig 3).

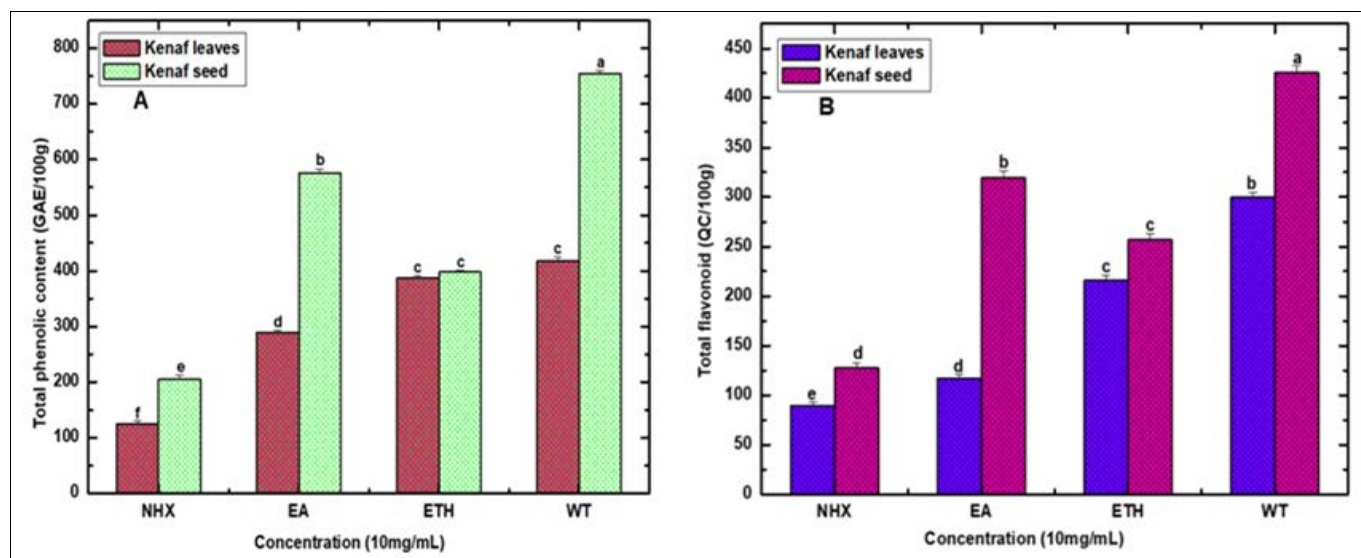


Fig 1: 5 Total phenolic (A) and flavonoid (B) content of various solvent extracts (NHX, EA, ETH, and WT) of Kenaf leaves and seed. Values are expressed as mean \pm SD (n = 3). Values marked by different letters in each column are significantly different by t-test (p < 0.05). GAE = Gallic acid equivalent, QC = Quercetin equivalent, NHX = n-Hexane extract, EA = Ethyl acetate extract, ETH = Ethanol extract, and WT = Water extract 5

Medicinal Uses of Kenaf Leaves

In some regions of the world, the leaves are used as a vegetable, and they have an erythrocyte protecting action against drug induced oxidative stress (Alnadif *et al.*, 2017) [5]. Quispe *et al.* (2012) [54]; Chong and Nyam (2021) [18] who found that when dried kenaf leaves powder was added to various foods, calcium and fiber levels were founded being enhanced but flavor remained the same. Consumption of tea has risen in last years and has become a global trend, since its inclusion in the human food delivers strong antioxidant components with high health characteristics that supports human body processes. Dian-Nashiela *et al.* (2015) [21] who concluded that tea is a well-known product in the health care industry since it is simple to make, easy to consume, and most significantly inexpensive. The extract of kenaf leaves made by Sim and Nyam (2019) [61] it has been claimed that it might be used as potential natural antioxidant source, antibacterial, and anti-tyrosinase constituents in the food, cosmetic, and pharmaceutical industries. Personal care products, such as skin and hair care products are pharmaceutical preparations with therapeutic characteristics that protect against degenerative disorders. They are becoming increasingly popular in current formulations as a result of customer worries about the safety of synthetic constituents (Emerald *et al.*, 2016) [23]. Kaul *et al.* (2018) [36] demanded that natural produces for cosmetic has quantifiable therapeutic efficiency on skin, as the medications and formulations has evolved from skin, body to hair and are used to treat a variety of ailments such as damage of hair, photo aging, wrinkles, dryness of skin, un-even tone of skin, pigmentation, etc. As well as, kenaf leaves can be used in traditional medicines for

treating blood, bilious, coughs, diabetes, and throat problems. There more, leaves of kenaf has been related to anodynes, aperitifs, anti-oxidant, anti-inflammatory and aphrodisiac properties (Jin *et al.*, 2013; Sim and Nyam, 2019) [33, 61]. Aside from that, Omenna and Ojo, (2018) [52] described that the occurrence of tannins, alkaloids and saponin in kenaf leaves has been linked to antibacterial action. Flavonoids and carotenoids can serve as antioxidants, preventing inflammation and viral activity by inhibiting free radical chain reactions. Many studies have been conducted on kenaf plants, particularly their leaves, and several positive results have been shown on the medicinal potential of the leaves in antioxidant properties, for example hepato-protective influence and anti-hyperlipidemia impact. However, addition of kenaf leaves into bread for improving nutritional level was rarely conducted, and no studies on the antioxidant characteristics of the fortified bread have been conducted (Agbor *et al.*, 2005) [3]. Besides, Lim *et al.* (2020) [44] found that the high antioxidant contents and low fat content of kenaf leaves powder are critical in the present functional diet industry addressing chronic disease prevention induced by unhealthy life style and nutrition. The addition of kenaf leave to bread increased total dietary fiber when compared to commercial white breads. This can aid in the reduction of cholesterol and constipation. The addition of 4% kenaf leaves powder had the best overall sensory acceptability. Kenaf leaves tea utilization has risen in last years and has been a worldwide trend as its addition to human food provides high anti-oxidant components, which have great health promoting characteristics towards the human body (Quispe *et al.*, 2012) [54]. Dian-Nashiela *et al.* (2015) [21] investigated that because

of the evidence that the kenaf leaves tea has an attractive odor, refreshing flavor, and contributes to favorable health benefits on our bodies, it is the world's second most popular beverage after water. People have recently sought for suitable herbal products as a result of technological advancements and time constraints. Kenaf leave is utilized in Ayurvedic medicine for treating bilious, blood, dia-betes, coughs, and throat diseases. Consequently, kenaf is used in traditional medicine to cure a variety of conditions; such as, in Africa, a

paste of leaves and stems is utilized to treat Guinea worm diseases and anemia. (Monti, 2013; Jin *et al.*, 2013; Omenna and Ojo, 2018) [52, 47]. Furthermore, 29 phenolic compound were found in leaves of Everglades 41 and Tainung 2 types of kenaf. The most common byproducts are chlorogenic acid, quercetin and kaempferol. These chemicals have antioxidant, vaso-protective, anti-carcinogenic, anti-diabetic, anti-inflammatory, anti-platelet properties and neurodegenerative.

Table 1: Kenaf leaf extract lotion and kenaf seed oil lotion properties (control) (Sim and Nyam, 2021b) 63.

Parameters	KLEL	KSOL (Control)
Appearance	Light milky	Light milky
Odor	Pleasant	Pleasant
Homogeneity	Homogeneous and smooth	Homogeneous and smooth
Physical stability	Stable with no phase separation	Stable with no phase separation
PH	5.43	5.02
Viscosity	2176.30	2177.00
Spread ability (cm)	3.13	2.90
Color		
L*	87.68	82.32
a*	-2.24	-1.87
b*	15.54	11.34
ΔE	6.82	-

Sim and Nyam (2021b) [63] conducted an experiment on kenaf leave extract for making a lotion for skin whitening. Different concentrations of kenaf seed oil used with kenaf leave extract, and as showed in (Table 2) the lotion base containing kenaf leave extract had a light milky color, pleasant odor, and no phase of separation was detected. The lotion of kenaf leave had a greater value of PH as compared to control, this indicates that cosmetic formulations applied with kenaf leave extract may cause in an increase in PH value. The pH reading of the samples was all within the skin pH ranges and was thus safe for the skin. There were no significant variations in viscosity or spread ability between KLEL and control, indicating that adding KLE to the emulsions had no effect on viscosity or spread ability. As well as, the lotion color influenced by the color of natural green kenaf leaves. The lotion of kenaf leave extract made from 15% of kenaf seed oil

and 0.1% w/w KLE has highest physical and microbiological stabilities and no poisonousness on humans. Yazan *et al.* (2011) [70] indicated that kenaf has traditionally been used to heal injuries, bilious disorders, fever, and puerperium. Table 3 shows the bactericidal activity of Kenaf leaf and extracts of seed. The disc diffusion method was used to test Gram positive (*Bacillus cereus*, *Staphylococcus aureus* and *Bacillus subtilis*) and Gram negative (*Escherichia coli*, *Salmonella Typhi*, and *Pseudomonas aeruginosa*) bacteria. Kenaf seed extracts were shown to be highly efficient against both Gram-positive and Gram-negative bacteria. Antibacterial activity was found in ethyl acetate, ethanol, and water extracts against *B. cereus*, *E. coli* and *B. subtilis* pathogens. The most notable inhibitory impact was reported against *E. coli* bacteria, with a zone of inhibition of 15.2 mm for ethyl acetate extract.

Table 2: Antibacterial effect of several solvent extract of kenaf leaves and seed (Adnan *et al.*, 2020) [2].

Bacterial Strain	Zone of inhibition (mm)					
	Gram Negative		Gram Positive			
	Name of Bacteria		<i>Bacillus cereus</i>		<i>Bacillus subtilis</i>	
Concentration (50 mg/mL)	Leaves	Seed	Leaves	Seed	Leaves	Seed
NHX	-	-	-	-	-	-
EA	-	15.2	-	12.8	-	11.6
ETH	9.8	13.1	-	11.2	-	10.1
WT	11.3	13.7	9.7	12.5	-	9.3
Standard Ampicillin 25 ug/mL)	29.4	27.9	26.4	28.4	30.1	28.4

The values are shown as the mean inhibition zone (mm) SD of three repetitions, with-denoting no activity, NHX denoting n-Hexane extract, EA denoting Ethyl acetate extract, and WT denoting Water extract

In case the leaf extracts, zone of inhibition obtained for ETH and WT was the best powerful of all extracts. These findings suggest that the Kenaf plant has a wide anti-pathogenic impact. Furthermore, neither the leaves nor the seed extracts of NHX inhibited the growth of any microorganisms. However, neither the leaf nor the seed extracts showed any efficacy against Gram-positive or Gram-negative pathogens. There was no activity noticed in the case of the negative (control) 5% (DMSO), indicating that the (5% DMSO) had no

influence on the extracts activity (Adnan *et al.*, 2020) [2].

Other Uses of Kenaf Seeds and Leaves

Flour of kenaf seeds has been utilized in industry of food for making cakes, bread, noodles and other meals (Zwawi *et al.*, 2014) [77]. Whitten leaves of kenaf are eaten within ten days of seeding, due to their high protein approximately 34%, and are tasty. Kenaf leave dishes are popular in Haiti and may be found in the salad, soups, cooked like spinach, or added to rice. They can also be utilized in bakery (Saba *et al.*, 2015; Ayadi *et al.*, 2017) [9, 59]. Sim and Nyam (2021a) [62] demonstrated its adaptability as a useful element in food and animal nutrition. Aminah *et al.* (2006) [7]; Cross (2012) [20]; Mohd *et al.* (2014) [78]; Kipriotis *et al.* (2015) [41] claimed that

the kenaf leaves nutrient composition like carbohydrate, protein, minerals and fats appeared to be excellent with good digestibility and palatability. As well as, Noori *et al.* (2016) [48] mentioned that one of the most significant factors in forage quality is crude protein; and high crude protein is regarded as a good attribute for forage production since it provides amino acids that are essential for animal growth and production of milk.

Oil of kenaf seeds can be utilized in several purposes such as biofuel, lubricant and cosmetic (El Bassam, 2010) [22]. Furthermore, because of the high oil contents of kenaf seeds, it has been proposed that it can be utilized to manufacture edible oil. In addition, oil of kenaf seed is a vegetable oil with a related composition to cotton seed oil that has been advocated as viable edible oil. Kenaf seed oil is odorless and transparent its color is yellow, similar to soybean oil, and when heated, it turns reddish brown with little odor. It is safe to eat because of its high concentration of useful ingredients for example phospholipids, fatty acids, phenolic compound, phytosterol, and tocopherol (Kim and Kwak, 2015; Cheong *et al.*, 2016) [40, 14]. Kenaf seeds milk extract might be hastened

to make curd using coagulants such as calcium sulphates, gluconodelta lactone, magnesium chloride, aluminum potassium salt, citric acid and acetic acid to produce a solid block of varying firmness similar to peanut tofu, and kenaf seed tempeh may be made by cooking and fermenting it with *Rhizopus oligosporus*. On the basis of its nutritional functional and profile qualities, was examined a little prospective uses of kenaf seed, such as kenaf seed as a source of edible flour, edible oil, meat alternative, antioxidant, and antibacterial agents (Malav *et al.*, 2015; Guo *et al.*, 2018; Vital *et al.*, 2018; Giwa *et al.*, 2019) [45, 26, 66]. There more, Karim *et al.* (2020) [30] investigated that extracted milk from kenaf seeds, which is similar in texture and appearance to soybean milk and has creamy white color. Unfavorable milk of kenaf seeds taste is characterized to be thin with an earthy flavor. It has the look and feel of soymilk and is creamy white in hue. Kenaf seed milk has a protein level of 1.93-2.48 percent and a fat content of 2.10-2.60 percent, which is equivalent to almond milk in terms of protein and fat content as showed in (Table 4).

Table 3: The approximate compositions of kenaf seed milk (seed variety V36) and a range of commercially available plant-based milk replacements (Chich-owska *et al.*, 2002; Alozie *et al.*, 2015; Haytowitz *et al.*, 2018; Kundu *et al.*, 2018; Karim *et al.*, 2020) [30, 16, 6, 28, 43]

Compositions	Kenaf seed milk	Soymilk	Almond milk	Hemp milk
Moisture %	91.04	88.12-91.00	72.00-93.40	91.60
Protein %	1.93-2.48	3.82-3.98	1.90-2.50	0.83-4.00
Fat %	2.10-2.60	3.10-4.30	3.20-3.60	1.25-3.00
Carbohydrate %	1.82	4.64-4.92	4.30-4.70	2.50-20.00
Ash %	3.11	0.84-0.81	0.09-3.04	0.47

Conclusion

According to researcher results from several studies on kenaf plant seeds and leaves that can be used for medicine, it contains a lot of useful chemical ingredients that human can benefit.

Before kenaf seeds considered as a waste product, but recently the oil extracted from kenaf seeds utilized by human as anti-cancer, anti-inflammatory and had cholesterol lowering capacity. On the other hand, kenaf leaves can be used as anti-oxidant, anti-bacterial, lowering blood pressure and in cosmetic for skin care. Besides, kenaf leaves and seeds used in many food applications as food additives.

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