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A review on: Impact of biomolecules of *Hibiscus cannabinus* seeds

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Abstract
Hibiscus cannabinus is a member of the Malvaceae family, which is well-known for its significance in horticulture and economy. One of the plant's most prized parts is the *Hibiscus cannabinus* seed. It has been utilized as a livestock feed and a cordage crop for a number of years. The possibility of generating food-based items from *Hibiscus cannabinus* seeds has not been completely utilized. Food products made from plants that are naturally healthful are gaining popularity. The future crop known as *Hibiscus cannabinus* seeds is rich in vital nutrients and a great source of phytocompounds could play appropriate roles in the creation of plant-based foods with additional value. The seed oils acquired through Sonication, Supercritical carbon dioxide fluid extraction (SFE), Maceration and Soxhlet extraction. The seed and its value-added ingredients are currently underutilized for their nutritional and functional qualities as a culinary ingredient or main component goods. This study focuses on the value-added components of *Hibiscus cannabinus* seed and its potential uses in food. The study focuses on providing a brief overview of the plant, its nutritional value, the makeup of its lipid and protein content, and its uses in cuisine. The review goes into great detail about the seed's bioactive ingredients, anti-inflammatory, anti-cancer, anti-thrombotic, antioxidants, and other properties as edible flour, as well as a source of protein and edible oil in the food chain. The study concludes with a consideration of additional potential uses of *Hibiscus cannabinus* seed in food.

Keywords: Anticancer, food application, antioxidants, kenaf seed, anti-thrombotic

Introduction
In close relation to cotton (*Gossypium hirsutum* L., Malvaceae) and okra (*Abelmoschus esculentus* L., Malvaceae), kenaf (*Hibiscus cannabinus* L., Malvaceae) is a warm-season annual fiber crop that can be successfully grown over much of the United States, especially in the southern states. As the commercial use of *Hibiscus cannabinus* continues to diversify from its historical role as a cordage crop (rope, twine, and sackcloth) to its various new applications including paper products, building materials, absorbents, and livestock feed, choices within the decision matrix will continue to increase and involve issues ranging from basic agricultural production methods to marketing of *Hibiscus cannabinus* products. These management decisions will require an understanding of the many different facets of *Hibiscus cannabinus* production as a fiber, feed, and seed crop [1].

Hibiscus cannabinus as a substitute crop that could be both economically and environmentally feasible and a sustainable source of cellulose. As a result, the plants are planted for their fiber, but their leaves and seeds are also utilized in traditional

treatment for a range of illnesses in India and Africa. Furthermore, one important ligno-cellulosic feedstock is in order to produce bioenergy. Stated that *Hibiscus cannabinus* derivatives, including leaves and seeds, were intended to possess a high concentration of bioactive compounds and the potential to whiten skin, suggesting its use in cosmetic contributions, the seeds and leaves have the potential to be a valuable source of phytonutrients and bioactive compounds. Since the term "return to nature" has been used extensively in the beauty industry, using botanical extracts has led to customer acceptability. *Hibiscus cannabinus* leaf extract, demonstrated encouraging anti-oxidant and anti-tyrosinase properties and additional value in cosmetic product production. It is essential to create a stable and safe formulation using the extract because of its high polyphenol content substances that have been demonstrated to have anti-aging and skin-whitening properties.

Furthermore, the World Health Organization (WHO) states that a survey indicates that 80% of people worldwide use herbal plants to cure medical conditions. Demonstrated that *Hibiscus cannabinus* is a physiologically active plant, were found to have significant pharmacological submissions in its seeds and leaves, such as anti-oxidant and anti aggressive actions. AgNPs (silver nanoparticles) were previously made using cellulose that had been isolated from *Hibiscus cannabinus*. A potential main bioactive component of *kenaf* (*Hibiscus cannabinus*) called as "kaempferol" has been employed in cancer treatments [2].

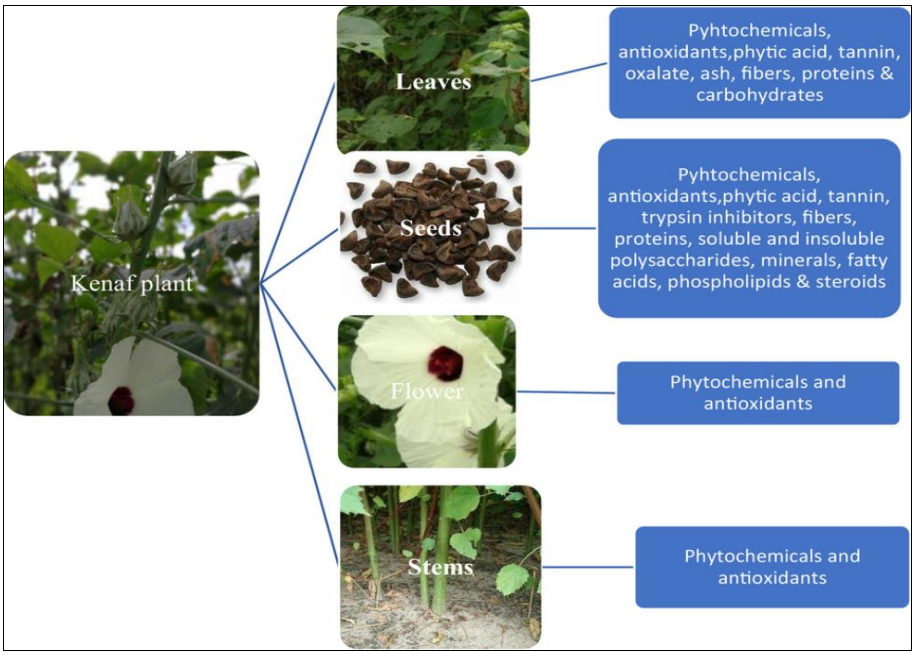


Fig 1: *Hibiscus cannabinus* plant

Plant profile

Synonyms: *Abelmoschus congener Walp., Abelmoschus verrucosus Walp., Furcaria cannabina Ulbr., Furcaria cavanillesii Kostel., Hibiscus malangensis Baker f. and Hibiscus vanderystii De Wild*, Bombay hemp, Deccan hemp, Indian hemp, Bimli, Bimli hemp, Kanaf, Java jute, Mesta, Ambari, and Stockroot.

Fig 2: Kenaf Plant Profile

Taxonomy and morphological characteristic

Kingdom	Plantae
Order	Malvales
Family	Malvaceae
Genus	Hibiscus
Species	*H. cannabinus*

Geographical Distribution: *Hibiscus cannabinus* was a warm-season annual fiber crop. It was native to Africa [Kenya, Tanzania, Uganda, Chad, Ethiopia, Somalia, Sudan, Angola, Malawi, Zambia, Botswana, Namibia, South Mozambique, Zimbabwe, Ghana, Mali, Nigeria, Senegal, Burundi, Cameroon, Central African Republic, Rwanda and Zaire], and has been commercially cultivated in Asia, such as Russia, China, India, Malaysia, Thailand, Iran, Iraq and many other countries

Hibiscus cannabinum is a member of the family Malvaceae. With over 400 species and a global distribution, the genus Hibiscus is split into six sections: Furcaria, Alyogen, Abelmoschus, Ketmia, Calyphyllia, and Azanza [3].

Physical discripton of seed

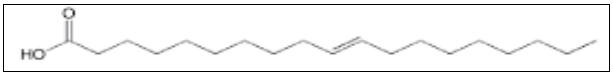
Following pollination, 1.9-2.5 cm length and 1.3-1.9 cm diameter seed capsules form. The seed grows into capsules with five lobules. There are five segments in each capsule, yielding a total of 20-26 seeds/capsule.

Fig 3: *Kenaf* Seeds

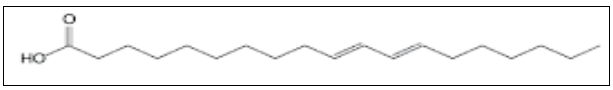
After reaching maturity, the capsules of the cultivated kinds typically do not break apart and stay whole for a few weeks. After pollination, the seeds need to mature in frost-free environments for 60-90 days. It takes about 45 days for seeds to mature. The seed continues to be viable for roughly eight months in typical storage circumstances. *Hibiscus cannabinus* seeds have a brown tint around 4 mm in width and 6 mm in length (35,000-40,000 seeds per kg)

Chemical composition

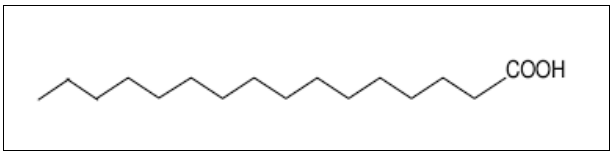
Hibiscus cannabinus seeds have a moisture content of 9.6%, ash content of 6.4%, fatty oils of 20.4%, nitrogenous matter of 21.4%, saccharifriable matter of 16.7%, crude fiber of 12.9%, and other matter of 13.9%, according to their chemical makeup. According to the same study, the fatty oils correlate to the following five acids: stearic acid (6%), palmitic oil (19.1%), oleic acid (28%), linoleic acid (44.9%), and alpha-linolenic acid 0.5%.



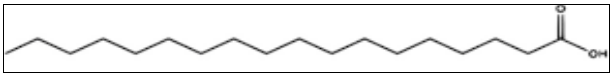
Palmetic acid



Oleic acid



Linolic acid



Steric acid

Nutritional functions of kenaf seed [5-13]

The following summarizes the nutritional roles and advantages of *Hibiscus cannabinus* seeds:

1. **Rich in essential fatty acid:** Omega-3 and omega-6 fatty acids, in particular, are abundant in kenaf seeds, making them a good source of important fatty acids. These fats are essential for lowering inflammation, preserving heart health, and promoting brain function.
2. **High in Protein:** Protein is necessary for the synthesis of enzymes, the mending of muscles, and the general growth and upkeep of bodily tissues. Kenaf seeds contain a sizable amount of protein.
   Minerals: *Hibiscus cannabinus* seeds are rich in a variety of minerals. That includes: Phosphorus, potassium, magnesium, and calcium are among the elements that are essential for healthy bones, nerve function, and electrolyte balance.
3. **Vitamins:** Red blood cell production and energy metabolism depend on B vitamins.
   Antioxidant vitamin E aids in preventing cell damage.
   Dietary Fiber: They include dietary fiber, which supports healthy digestion, lowers blood sugar, and may help with feelings of fullness.
4. **Antioxidants:** The antioxidant qualities of the seeds assist the body fight oxidative stress and may lower the risk of chronic illnesses.
5. **Phytochemicals:** While specific phytochemicals in the seeds are less well-studied than in more popular seeds like flax or chia, they may contain advantageous plant substances that can improve general health.

Hibiscus cannabinus seeds are a significant natural ingredient for making functional foods, and they serve a variety of nutritional purposes. A good supply of fat, proteins, and dietary fibers are *Hibiscus cannabinus* seeds. High antioxidant activity and anticancer properties have been suggested for the oil. The oil has also been suggested for use as a new source of functional edible oil.

According to several studies, *Hibiscus cannabinus* seed-derived products, such as *Kenaf* (*Hibiscus cannabinus*)seed flour (KSF), defatted *kenaf* seed meal (DKSM), and *kenaf* seed protein concentrates (KSPC), are valuable and have health-promoting properties. Given that *kenaf* seed contains alpha-linolenic acid, an essential omega-3 fatty acid with anti-inflammatory and antithrombotic properties as well as chemo-preventive activity, it appears to have excellent potential as a source of functional edible oil.

Hibiscus cannabinus oil may be used in cooking due to its relatively high oil composition, similar to that of cottonseed oil, and significant amounts of phospholipids and phytosterols; additionally, the seeds may be used for feed and food. In order to produce wholesome and nutrient-dense diets, scientists have expressed interest in separating the bioactive ingredients (phytosterol) of *Hibiscus cannabinus* seed oil. It has been observed that the phenolic and flavonoid chemicals found in the seed may suppress the angiotensin I-converting enzyme as well as the peroxidation of lipids.

Application of kenaf seed

1. **Oil Production**: Oil from *Hibiscus cannabinus* seeds is used to make a variety of commercial items as well as for cooking. The oil contains a sizable amount of unsaturated fatty acids, which are good for our health.
2. **Animal Feed:** High-protein animal feed can be made from the seeds and leftover meal from the oil extraction process. Because of this, it is a useful resource in agriculture, particularly for feeding livestock.
3. **Biodiesel:** Biodiesel is a renewable energy source that may be made from the oil derived from kenaf seeds. As the globe looks for new environmentally friendly energy sources, interest in this field is expanding.
4. **Industrial Applications:** *Hibiscus cannabinus* seed oil is used to make paints, varnishes, and lubricants, among industrial goods
5. **Enhancement of Soil:** After oil is extracted, *Hibiscus cannabinus* seed meal can be applied as an organic fertilizer or soil conditioner. It can strengthen the structure of the soil and enrich it with nutrients.
6. **Supplemental Nutrition:** Due to their high protein and essential fatty acid content as well as other nutrients, seeds can be used in health foods or supplements.

Medicinal activities of Kenaf seed[14-31]

1. **Anti-cancer activity:** (Ghafar, S.A.A.; *et al*., 2012) The oil extracted from *Hibiscus cannabinus* seeds using supercritical carbon dioxide fluid extraction at 600 bars and 40°C showed significant cytotoxicity against HT29 human colorectal cancer cell line. The presence of antioxidant substances including vitamin E, β-sitosterol,

and alpha-linolenic acid in the seed oil may have a significant role in the observed chemopreventive potential. This resulted in apoptosis, which is characterized by the blebbing of the plasma membrane and reduces the number of viable cells of HT29. This process is preferred over necrosis because apoptosis is a planned cell death that does not cause an inflammatory reaction [14].

2. **Anti-bacterial activity:** (Adnan, M.; *et al*., 2020) *Hibiscus cannabinus* seed extracts acquired using ethyl acetate, ethanol and water also successfully expressed their antibacterial properties against both Gram-positive (Bacillus cereus and Bacillus subtilis) and Gram-negative bacteria (Escherichia coli). An outstanding inhibitory performance was observed using the ethyl acetate extract of *Hibiscus cannabinus* seed against E. coli with a zone of inhibition of 15 mm, followed by B. cereus and B. subtilis at 13 mm and 12 mm, respectively. The high concentration of phenols and flavonoids in the seed extract may be the reason for its effectiveness against the bacteria. This enables the extract to impair cellular function or destabilize bacterial membranes, hence exhibiting a wider range of antibacterial action. Furthermore, the seed peptides, which are made by fermenting *Lactobacillus casei*, showed a minimum bactericidal concentration (MBC) of 11-22 µg/mL, as well as an exceptionally high antibacterial activity of 94-98% *against B. subtilis, Listeria monocytogenes, Staphylococcus aureus, Salmonella typhimurium, E. coli*, and *Vibrio parahaemolyticus* [15].
3. **Anti fungal and phytotoxic properties:** (Arulrajah, B.; *et al*., 2021) *Lactobacillus pentosus* assisted in the fermentation process to create *Hibiscus cannabinus* seed peptides, which shown antifungal efficacy against *Fusarium sp.* and *Aspergillus niger*. The peptide composition of the mixture of cell-free *Hibiscus cannabinus* seed peptides was successful in reaching a minimum inhibitory concentration (MIC) and minimum fungicidal concentration (MFC) for *Fusarium sp*. of 0.18 mg/mL and 0.7 mg/mL, respectively. According to the study, the seed peptide may seriously impair the integrity of the fungal membrane by rupturing the lipid bilayer of the fungal membrane, as evidenced by the rise in the leakage of its protein and nucleic acid, which eventually causes cell death. The *Hibiscus cannabinus* seed peptides that are made by fermentation with *L. casei* also have a comparable action. High antifungal activity against *Aspergillus flavus, A niger*, and range of 97-99% was noted for the efficacy of *Fusarium sp*. The MIC and MFC examined fungi had recorded concentrations of 43 g/mL and 86 g/mL, respectively. As a result, *Hibiscus cannabinus* seed is an additional effective antifungal that is extensively used in many industries [16].
4. **Anti thrombotic properties:** (Hanumegowda, S.; *et al*., 2022) *Hibiscus cannabinus* can also be used to treat problems related to the cardiovascular system. Thrombotic diseases can be stopped in their tracks by using protein extract of kenaf seed (PEKS) obtained using ammonium sulphate precipitation, because it has the ability to act as an antiplatelet and anticoagulant. Using 30 grams of PEKS demonstrated a 56% suppression of platelet aggregation with an IC50 of 13.05 g and 34% with an IC50 of 22.0 g for platelet-induced adenosine diphosphate (ADP) and epinephrine causes aggregation respectively. Additionally, PEKS demonstrated an anticoagulant effect by delaying the duration of mouse *in vivo* bleeding and lengthening the clotting times of platelet-rich and platelet-poor plasma. Additionally, the study found that this happened because PEKS primarily targets the intrinsic mechanism of blood coagulation, interfering with it.
Solely the activated partial thromboplastin time's clotting time [17].
5. **Anti hypercholesterolemia properties:** (Kai,N.S.; *et al.* 2015) Furthermore, it was demonstrated that *Hibiscus cannabinus* seed exhibited anti-hypercholesterolemic characteristics and observed that serum total cholesterol (TC, 1.59-1.86 mmol/L) and malondialdehyde (MDA, 0.06-0.08 mol/L) levels were lower in hypercholesterolemic rats on a high-fat diet treated with Kenaf (*Hibiscus cannabinus*) seed extract (KSE), kenaf seed oil (KSO), defatted kenaf seed meal (DKSM), and microencapsulated kenaf seed oil (MKSO) than in the control group (2.29 mmol/L TC, 0.14 mol/L MDA) [18].

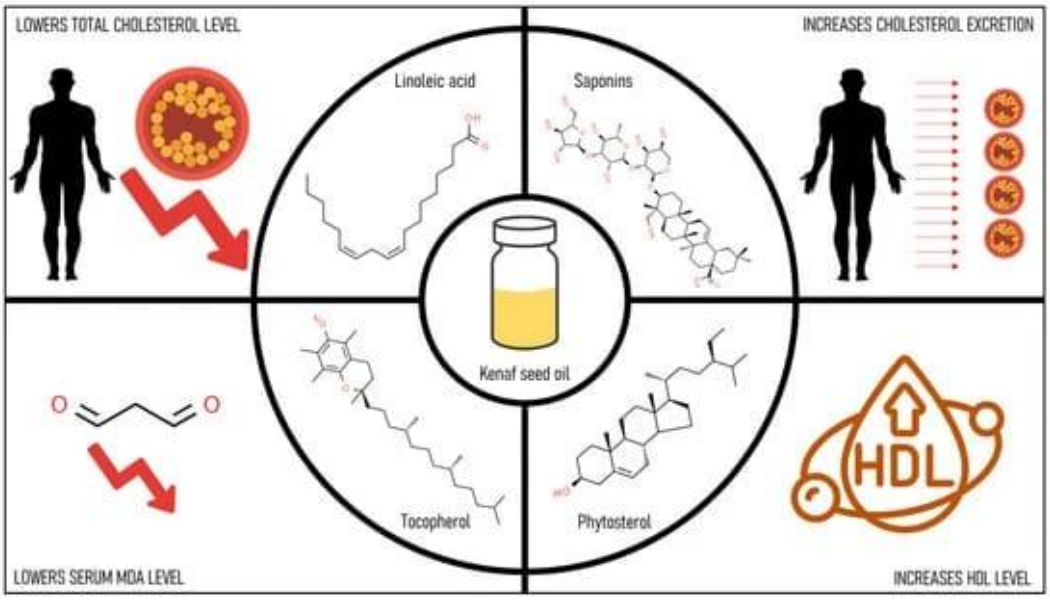


Fig 4: Graphical illustration of *Hibiscus cannabinus* seed oil mechanism in addressing hypercholesterolemia conditions.

Anti hyperpegmentation, skin whitening and anti aging properties: (Sim, Y.Y.; *et al*. 2022) It's interesting to note that *Hibiscus cannabinus* seed has anti-hyperpigmentation properties as well—a crucial attribute for the cosmetics and beauty sectors. The emergence of black spots, darker tones, and discoloration are symptoms of a skin disease known as skin hyperpigmentation, which has been identified as one of the most prevalent skin conditions. It is brought on by an overabundance of melanin, a pigment that darkens skin, which is created by a physiological process called melanogenesis that is controlled by the enzyme tyrosinase. Normal human epidermal melanocytes (NHEM) were treated. Using a lotion composed of *Hibiscus cannabinus* seed oil and kenaf leaf extract at a non-cytotoxic dose of 0.5 mg/Ml [19].

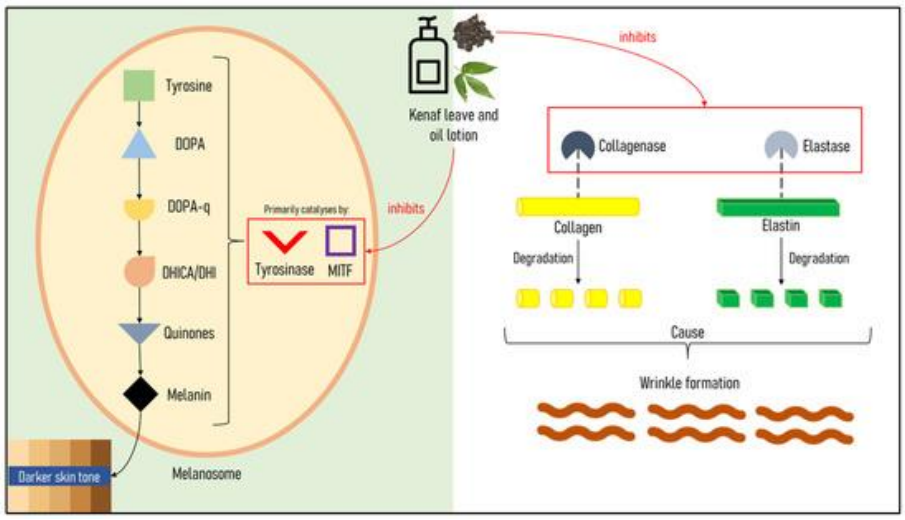


Fig 5: Graphical illustration of *Hibiscus cannabinus* leave and oil-based lotion mechanism in addressing hyperpigmentation and ageing. DOPA: dihydroxyphenylalanine, DOPA-q: DOPA quinone, DHICA: 5, 6-dihydroxyindole-2-carboxylic acid, DHI: 5, 6- dihydroxyindole, MITF: microphthalmia associated transcription factor. 5, 6-dihydroxyindole-2-carboxylic acid, DHI: 5, 6- dihydroxyindole, MITF: microphthalmia-associated transcription factor

Anti oxidant properties: (Adnan, M.; *et al*., 2020) Additionally, the *Hibiscus cannabinus* seed extract has antioxidant properties since it demonstrated a strong scavenging ability, particularly in a water extract in the DPPH-free radical assay (73%). and the assay for hydroxyl (H2O2)-free radicals (67%). It can scavenge quite a bit of material reliant because *Hibiscus cannabinus* seed water extract shown a higher capacity than other extraction solvents including hexane (28% DPPH), ethanol (52% DPPH), and ethyl acetate (54% DPPH) [20].

Anti hypertensive properties: (Zaharuddin, N.D.; *et al*., 2020) Furthermore, it has been demonstrated that protein hydrolysates made from kenaf seeds via enzymatic hydrolysis exhibit antihypertensive properties in both vitro and *in vivo* settings. This is significant because high blood pressure, or hypertension, is linked to kidney, heart, and brain disorders and is regarded as a chronic medical issue. ACE activity utilizing a protein hydrolysate from kenaf seeds produced by papain. ACE is in charge of turning the vasoconstrictor angiotensin I into the vasoconstrictor angiotensin II while deactivating the vasodilator bradykinin, which ultimately raises blood pressure, causing hypertension. Rats with spontaneously generated hypertension also showed signs of an antihypertensive impact. Systolic blood pressure was lowered by 46 mmHg after using papain-generated protein hydrolysate as a treatment. This reduction was equivalent to that of captopril, a prescription medication that lowers blood pressure by 50 mmHg [21].

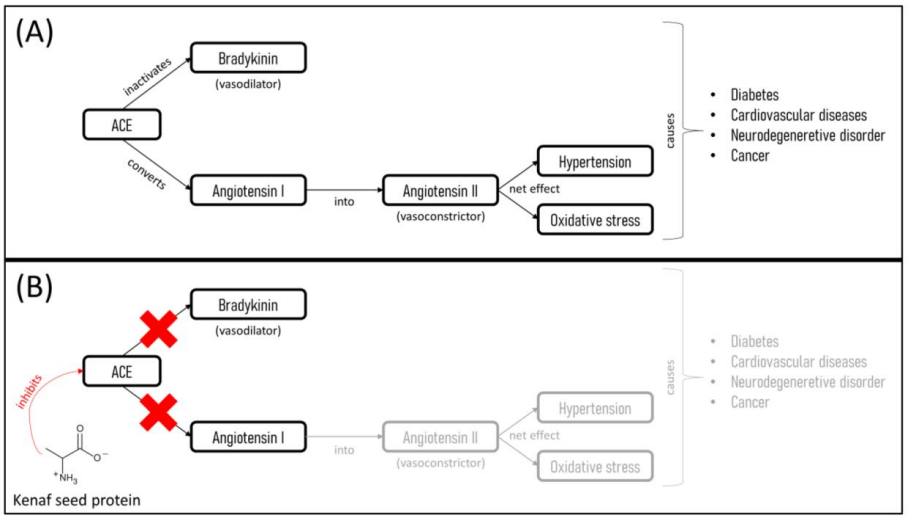


Fig 6: Graphical illustration of *Hibiscus cannabinus* seed protein mechanism in addressing hypertensive conditions. (A) Without kenaf seed protein. (B) With kenaf seed protein. ACE: Angiotensin converting enzyme I

Conclusion

These components' present in *Hibiscus cannabinus* allow a wide variety of product types available for purchase and ongoing use. With time and as a result of studies, the application of *Hibiscus cannabinus'* original use as a crop for cordage had given way to other uses like to various novel uses, including paper goods, absorbents, construction supplies and feed for animals. Food substitutes with diversity, practical uses, and nutritional advantages appeal to both food producers and consumers. This review has covered several applications for the seed, including *Hibiscus cannabinus* using seed as a meat alternative, edible oil, flour, and antioxidant and antibacterial agents based on its dietary composition profile as well as practical attributes. There are fantastic chances for scientists and the food industry to use this organic seed as a useful component in food items and to provide a substitute, nutrient-dense, high-protein plant-based meals for customer. The present review examined the chemical composition, and toxicological consequences of *Hibiscus cannabinus*, which is considered a potential herbal medication due to its safety and efficiency.

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