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"A REVIEW ON ROLE OF HERBS: NEW PERSPECTIVES AND POTENTIAL HEALTH BENEFITS OF *CITRULLUS LANATUS* & *CARICA PAPAYA*" SEEDS

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Abstract:
Citrullus lanatus (watermelon) seed and *Carica papaya* (papaya) seed are essential traditional crops with excellent nutritional properties. Traditional herb has played a significant role in global healthcare, providing a valuable repository of natural resources with diverse therapeutic properties. As part of our cultural heritage, papaya seeds and watermelon seeds have also emerged as sources of inspiration due to their potential health benefits. Watermelon seeds and Papaya seeds, often overlooked components of these popular fruits, are emerging as sources of numerous health benefits and versatile applications. This review explores the new perspectives and potential health benefits associated with papaya seed and watermelon seed extracts. These seeds, traditionally used for culinary purposes, have gained attention due to their rich nutrient content and bioactive compounds. Watermelon seeds, rich in protein, healthy fats, and essential minerals, are consumed as a nutritious snack and offer antioxidant protection against oxidative stress. The oil extracted from watermelon seeds is finding applications in skincare and hair care products, promoting healthy skin and hair. Papaya seeds, containing enzymes like papain and antioxidants, exhibit anti-parasitic properties and may aid digestion. They also possess anti-inflammatory potential, making them a promising candidate for managing inflammatory conditions. Additionally, papaya seed oil is utilized in cosmetics for its moisturizing and exfoliating properties. Both papaya and watermelon seeds show promise in reducing inflammation, which is a key factor in various chronic diseases. Their antioxidant content contributes to cellular health and protection against free radicals. These seeds provide an opportunity for developing functional foods, supplements, and skincare products with potential health benefits.

Keywords: Watermelon seed, Papaya seed, Health benefits, Phytochemicals, Herbal medicine, Biological Activity.

1. Introduction

The word "herb" is derived from the Latin ***Herba***, *which* means "Green crops/Grass/Green stalks" or, more literally, herbage. It is this meaning of herb that is used in Genesis, "the herb yielding seed[(75)] Herbs are different parts of plants like leaves, roots, stems, barks, seeds, bulbs, and flowers that are used for various purposes such as adding flavor to food, as ingredients in cooking, for medicinal uses, and even in making perfumes. [(51)] Herbs have a variety of uses including botanically, culinary, and

medicinally. Botanically, an herb is any seed-bearing plant that does not have a woody stem and dies down to the ground after flowering. [72]In culinary practices, they are employed as preservatives, flavor enhancers, colorants, and ingredient substitutions of salt and sugar. [30] In terms of medicine, herbs are crude drugs of vegetable origin that are used in the treatment of disease state, often of a chronic nature, or maintain a condition of improved health. [71]

Then, on April 7, 1948, in a radical departure from previous definitions, the World Health Organization (WHO) proposed a definition that aimed higher, linking health to well-being, in terms of "physical, mental, and social well-being",[86]and The writers of the Constitution were aware of the tendency of seeing health as a state dependent on the presence or absence of diseases: so they added to that definition that an individual if he is to be considered healthy, should not suffer from any disease, illness, injury. [17] Health can be influenced by a variety of factors, including genetics, lifestyle choices (such as diet, exercise, and substance use), environmental factors, access to healthcare, social and economic conditions, and more. [82] Achieving and maintaining good health involves taking proactive steps to promote well-being in all these areas. Striving for a balanced and holistic approach to health is essential for leading a fulfilling and enjoyable life. To maintain a healthy life people need nutrients. [60]

A nutrient is a substance that is essential for the growth, development, and maintenance of living organisms. Nutrients are the building blocks that organisms, including humans, require to carry out various physiological functions, such as energy production, metabolism, and cellular repair. These substances are obtained from the diet of an organism and play a crucial role in supporting its overall health and well-being. There are two main categories of nutrients: macronutrients and micronutrients. A balanced and varied diet is essential to ensure that an organism receives an adequate supply of all these nutrients. [23] Different organisms have different nutritional requirements based on factors such as age, sex, activity level, and overall health. Nutrient deficiencies or imbalances can lead to a range of health problems and disorders. Urbanization is causing people's lifestyles to change quickly, pushing them to prioritize healthier choices. [69] Today, individuals are more mindful of their diets, focusing on consuming nutritious foods. In this era of health-consciousness, foods packed with essential nutrients are extremely important. They fuel the body's growth, support overall development, and even work to ward off chronic illnesses. [46]

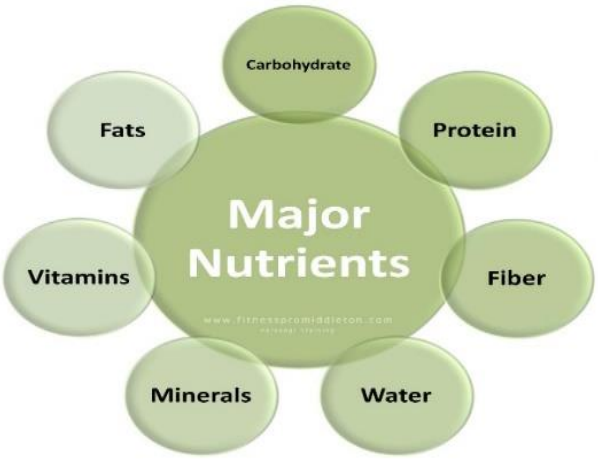

Figure 1: Major Nutrients

1.1. The important functions of nutrients include: [16]

- They are the main source of energy for the body.
- They aid in building and repairing body tissues.
- Increases the absorption of fat-soluble vitamins.
- They help make collagen, a vital protein.
- They give structure to blood vessels, bones, and ligaments.

They also help in maintaining the homeostasis of the body.
In modern times, diseases like cancer, heart issues, and diabetes are rising rapidly. Worldwide, two-thirds of annual deaths result from these non-communicable diseases. Additionally, the use of traditional crops has decreased over time, despite their remarkable medicinal qualities. Using processed and ready-to-eat foods like maize extrudates with added watermelon seed and papaya seeds can be a great way to include new ingredients that taste good and offer health benefits. Amid recent pandemics and ongoing outbreaks, the attention is now on uniting global endeavors to handle major health risks. This involves using different approaches for treatment, including natural products. [77]
Fruit seeds are usually thrown out as waste during processing or after human consumption. Over time, scientists have worked to understand the nutritional value of various fruit seeds. Currently, over 70 types of important and lesser-known fruits are cultivated in the area, including some promising exotic tropical fruits. Utilization of the seeds concurrently helps to deal with the waste disposal problem, which causes environmental pollution. Because of this, numerous fruit seeds have been studied to determine their potential uses in industries or as food, such as exploring them as new sources of oils. [76]

This review explains the characteristics and positive impacts on health that watermelon seed and papaya seed have. Additionally, this research emphasizes the different nutritious and active features of chia and quinoa seeds, and how they can enhance the value of food products to create a balanced and sustainable diet.

2. The role of herbs

2.1. *Citrullus lanatus* (watermelon) seed and Its Characteristics

2.1.1. Taxonomical classification: [12/15]

- Kingdom: Plantae
- Class: Equisetopsida
- Subclass: Dilleniidae
- Order: Cucurbitales
- Superorder: Violence
- Family: Cucurbitaceae
- Genus: Citrullus
- Species: *C. lanatus*

2.1.2. Vernacular names (Indian local name): [52]

- Sanskrit: Kharabuja, Kalingam
- Hindi: Tarbooz,
- Gujarati: Indark, Tarbooz
- English: Watermelon

2.1.3. Plant description:

Watermelon ***(Citrullus lanatus)*** a fruit crop, is a herbaceous creeping plant belonging to the family Cucurbitaceae. [71]This plant mostly spreads through seeds and grows well in warm regions. [47]Also it is widespread across the tropical and subtropical regions of the world. Some of the major watermelon-producing countries include China, Iran, India, Brazil, Egypt, Turkey, Africa and South East Asia. It requires a lot of sunshine and temperatures higher than 25°C (77°F) for its best growth. Watermelon thrives best in a drained fertile soil of fairly acidic nature. It can be grown along the coastal areas of Ghana, as well as in forested areas. [80]It is primarily consumed as fresh fruit because of its sweet taste and pleasant flavor. It is recognized for its low-calorie content, high nutritional value, and great thirst-quenching ability. The seeds are inside the tasty part of the fruit. The seeds are not big, about 4-6 centimeters long and flat. They can be different colors like white, tan, brown, black, red, green, or a mix of colors. [68]

Watermelon can be used as a fresh salad, dessert, snack, and for decorations. Drinks can also be made from the juice. Water retention of watermelon seed protein allows its use in breads and cakes and infants and weaning foods. Several watermelon varieties include sugar baby, golden midget, starlight, jubilee, and yellow baby. [44] Watermelon seeds are often discarded while the fruit is eaten. In this study, seeds of three varieties of watermelon (Charleston gray, Crimson sweet, and Black diamond) were analyzed for their proximate, minerals, phytochemicals, total phenols content, and antioxidant activity. [58] The seeds of brown-seeded melon are sometimes adulterated with the seeds of *Citrullus. moschata* by traders and sold as brown-seeded melon. [42]

(A) (B) (C) (D)

Figure 2: (A)Watermelon(B) Black (C) Wight (D) Brown Seed

Watermelon seeds are known to be highly nutritional; they are rich sources of protein, vitamin B, minerals (such as magnesium, potassium, phosphorous, sodium, iron, zinc, manganese, and copper), and fats. Phytochemicals such as carotenoids, lycopene, anthocyanins, phenols, and flavonoids. [15] The seeds of watermelons are known to have economic benefits, especially in countries where cultivation is on the increase. [5] The seeds are for instance used to prepare snacks, milled into flour, and used for sauces. Oil from the seeds is used in cooking and incorporated into the production of cosmetics. [27]

A watermelon seed is classified as a dicotyledon seed containing three basic components: (1) a seed coat, (2) an embryo, and (3) an endosperm. Each component plays a vital role in ensuring successful germination. The seed coat protects the inner parts of the seed from the outside environment, the embryo is a tiny plant that grows upwards, and the endosperm stores food to provide the necessary nutrients during germination. [53]

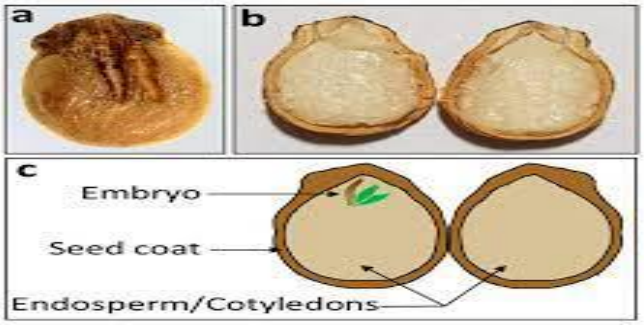

Figure 3: Basic components of a dicot seed (watermelon). (a) External view and (b) internal view of seed; (c) illustration of major parts of seed. [53]

2.1.4. Nutrients in watermelon seed (*Citrullus lanatus)*

Watermelon seed is known as a complete food due to its high nutritional value, i.e., proteins, carbohydrates, lipids, vitamins, and minerals. Each watermelon seed has a length of approximately 8.01 mm and a width of about 0.32 mm. When it comes to weight, 100 grams of watermelon seeds correspond to approximately 2000 seeds. [8] The approximate 100 grams of watermelon seeds provide 619 calories, while the pulp is more nutritious and has fewer calories. [5] It also contains roughly 6% sugar, which gives it its sweet taste. The composition of dried seed without shell per 100 g includes protein 28.3g, fat 47.4 g, water 5.1g, energy 2340kJ (557kcal), carbohydrate 15.3 g, Calcium 54 mg, Phosphorous 755 mg, iron 7.3 mg, thiamin 0.19 mg, riboflavin 0.15 mg, niacin 3.55 mg and folate 58 µg. seeds have a low moisture content (~4.9 g), which prevents their rapid degradation through biological contamination. [13]

It is a good source of vitamin C. They do contain small amounts of certain B vitamins, such as niacin (vitamin B3) and folate (Vitamin B9). Niacin is involved in various metabolic processes in the body and is essential for converting food into energy. It also helps maintain healthy skin, nerves, and digestion. Folate is crucial for DNA synthesis and cell growth. It's particularly important during pregnancy to support the development of the baby's neural tube. Folate also plays a role in the production of red blood cells. Understanding how seed characteristics like color, thickness, and biochemical composition relate to nutritional profiles could be valuable for breeding better watermelon varieties and creating more nutritious, value-added food products. [20/**18)**

Watermelon seeds are a good source of minerals, including magnesium, potassium, phosphorus, iron, and zinc. These minerals play various roles in maintaining overall health, from bone and muscle function to immune system support. Watermelon seeds provide dietary fiber, which supports digestive health and helps maintain regular bowel movements. On average, roasted watermelon seeds may contain approximately 5-6 grams of fiber per 100 grams. [53]

Watermelon seeds are relatively high in protein, typically containing around 35-40% protein by weight. Protein is essential for various bodily functions, including muscle development and repair. It contains albumin, globulin, prolamin, and glutelin. [49]Watermelon seeds provide dietary fiber, which supports digestive health and helps maintain regular bowel movements. [77] Watermelon seeds contain healthy fats, including monounsaturated and polyunsaturated fats. These fats are beneficial for heart health, brain function, and overall well-being. It's generally recognized that watermelon seeds can contain up to about 30-40% fat by weight. [32]

The high iodine values of these seed oils (135.39 ± 12.84 g I2/100 g oil) are linked to their richness in unsaturated fatty acids. This suggests that these oils are suitable for consumption and/or use as drying oils. There are numerous underexplored plant seeds with rich oil content, and watermelon seeds are seen as a valuable source of oil for use in food, pharmaceuticals, and cosmetics. The seed oils contained a significant amount of unsaturated fatty acids, making up around 82.32% of the total content. The primary ones were oleic (C18:1) and linoleic (C18:2) acids. [33] There are high concentrations of palmitic and stearic acids in these seeds, which are saturated fatty acids. Watermelon the biggest seed oil has the potential to provide antioxidant compounds like total phenols, α-tocopherol, and vitamin E. [54]

Amino acid compositions of the protein concentrate (g/100g) protein of *Citrillus vulgaris* seed.

Table 1: Essential amino acids [53]

Sr.no	Amino acid	Concentration (g/100 g protein)
1	Lysine	4.11
2	Methionine	1.76
3	Threonine	3.61
4	Isoleucine	3.61
5	Leucine	5.66
6	Phenylalanine	5.26
7	Valine	4.41
8	Tryptophan	1.10
9	Histidine	2.06
10	Cysteine	2.33

Table 2: Non-essential amino acids [53]

Sr.no	Amino acid	Concentration (g/100 g protein)
1	Arginine	15.20
2	Serine	5.62
3	Tyrosine	3.22
4	Alanine	5.10
5	Aspartic acid	9.33
6	Glutamic acid	22.20
7	Glycine	7.30
8	Asparagine	7.11
9	Proline	2.68
10	Glutamine	3.60

Table 3: Proximate contents of watermelon seed [7]

Sr.no	Parameters	Values
1	Moisture	6.4%
2	Fat	47.1%
3	Protein	68.4%
4	Fiber	1.2%
5	Ash	2.6%
6	Carbohydrate	25.1%

Table 4: Watermelon seed minerals [44]

Sr.no	Mineral	mg/Kg
1	Calcium	0.68
2	Manganese	0.14
3	Cobalt	0.03
4	Copper	0.86
5	Iron	1.87
6	Sodium	10.5
7	Potassium	53
8	Magnesium	28
9	zinc	0.94

Table 5: Vitamin composition of the watermelon seeds [82]

Sr.no	Vitamin	Amount (mg kg^{-1})
1	Vitamin A	69.128±0.57
2	Vitamin B_1	00.967±0.00
3	Vitamin B_2	00.796±0.12
4	Vitamin B_3	00.915±0.05
5	Vitamin B_6	00.053±0.00
6	Vitamin B_9	01.843±0.05
7	Vitamin B_{12}	01.092±0.01
8	Vitamin C	19.450±0.49
9	Vitamin D	08.760±0.71
10	Vitamin E	03.533±0.01
11	Vitamin K	01.437±0.06

2.1.5. Bioactive Compounds/ Phytoconstituents in Watermelon Seed

Watermelon seed is well known for its high nutritional content. It also possesses medicinal health benefits against different chronic diseases such as diabetes. These health benefits are due to certain phytochemicals that make watermelon seed superior to other grains in providing human health and wellness. Phenolic compounds present anticancer, anti-inflammatory, antiviral, and antioxidant

effects. Eight phenolic acids were identified from watermelon seeds: syringic acid, caffeic acid, sinapic acid, ferulic acid, vanillic acid, p-coumaric acid, gallic acid, and 4- hydroxybenzoic acid. [3]Phenolic compounds, often referred to as bioactive compounds, are secondary plant metabolites. They are prevalent throughout the plant kingdom and can be found in various plant parts, both edible and non-edible, including pulp, seeds, leaves, bark, and roots. [41]They range from simple molecules to highly complex ones and can exist in free form or attached to sugars (glycosides) and/or proteins. There are over 8,000 known chemical structures of phenolic compounds, originating from the shikimic acid and phenylpropanoid pathways. [26]Among the three varieties, Crimson Sweet exhibited the highest antioxidant activity and had a substantial phenolic content. This difference in activity is likely because of variations in the presence of phenolic compounds in the different extracts, as phenols are well-known for their potent antioxidant properties compared to other phytochemicals. [71/54]

Considering the nutritional and chemical composition of these seeds, they may be useful in the treatment of various pathologies, such as bronchitis, diabetes, nephritis, asthma, sinusitis, syphilis, and psychiatric diseases, among others. Therefore, its nutritional and pharmacological potential must be evaluated, emphasizing the biological properties and health benefits. [8] Watermelon is a vital part of human nutrition, eaten fresh, packaged, in frozen juices, and pulps. Its high water content and low calories drive up consumption and production. Fruit pulp holds valuable bioactive compounds, notably citrulline and lycopene. [38]

Citrulline is an antioxidant that helps combat atherosclerosis and enhances blood vessel relaxation. It's converted to arginine in the body, which then produces nitric oxide (NO), a key molecule in vasodilation. [48]

Lycopene, the compound responsible for the red color of watermelon, is recognized for its antioxidant properties. Consuming it has been linked to the prevention of cancer and degenerative diseases. Lycopene, a carotenoid in watermelon, has high antioxidant power because of its unique acyclic structure with two unconjugated double bonds. This structure makes it effective in neutralizing singlet oxygen, and acting as a potent antioxidant. Lycopene content in watermelon is 40% higher than in tomatoes, and unlike tomatoes, it doesn't require heat treatment to become bioavailable. [3/85]

Watermelon fruit pulp contains vitamins and bioactive compounds. The notable ones include phenolic acids, lignans, coumarins, and stilbenes. These compounds are typically found throughout different parts of the plant species, including both the pulp and seeds, with potential variations in quantities. [24]

Table 6: Phytoconstituents of *Citrullus lanatus* [7]

Part	Constituents
Seeds	Lycopene, Beta-carotene, Xanthophylls, Phenolics, Vitamin C Protein-globulin, Albumin, Glutelin. Flavonoids, Thiamine, Riboflavin, Polyphenolic compounds Terpene, Steroid, Flvonoid.Glycoprotein-vicilin 2-dodecyclobutanon, 2-tetradcylcyclobutanon, Cellulose radicals Crude protein, carbohydrates, Amino acids- arginine, isoleucine, leucine.Mineral composition- Na, Ca, Mg
Seed oil	Total lipid content- oils- Polyunsaturated fatty acids- oleic, linoleic fatty acid The high amount of higher fat acids- palmitic acid, stearic acid, linoleic acid. A higher amount is linoleic acid. Poor in linolenic acid Saturated fatty acid. Unsaturated fatty acid- tocotrienols

Biologically active compounds like tocopherols, phospholipids, and sterols are present in Watermelon seed oil in large amounts which has a beneficial effect on humans. The study examined the fatty acid composition and physiochemical characteristics of melon seeds after analyzing their lipid content. The percentages of these components varied based on the geographic region of seed origin and their specific types. Various researchers have documented significant quantities of phenolic acids, flavonoids, terpenoids, alkaloids, steroids, carotenoids, and saponins within watermelon seeds. Rutin and quercetin were also described. [1]

Various researchers have documented significant quantities of phenolic acids, flavonoids, terpenoids, alkaloids, steroids, carotenoids, and saponins within watermelon seeds. Spinasterol is the primary phytosterol in watermelon seeds, making up approximately 57.7% of its composition. It's a natural food ingredient, like argan oil, used in the traditional 'Amazigh diet,' supplying around 25% of the total dietary fat intake for indigenous consumers, a type of phytosterol, differs from cholesterol due to (i) an extra ethyl group and a double bond in the aliphatic side chain and (ii) the position of the double bond in the tetracyclic ring system. [81/10]It plays a significant role in lowering plasma LDL-cholesterol levels. Research has indicated that α-spinasterol has diverse physiological effects, including modulation of mitochondrial activity, and gene expression of nuclear receptors, and it also exhibits anti-tumor, antioxidant, and anti-inflammatory activities. [29]

Watermelon seeds contain significant amounts of saponins, alkaloids, and terpenoids (cucurbitacins) as their major compounds. Pectin, while not a secondary metabolite, is also found in seeds and functions at the intestinal level by regulating carbohydrate and cholesterol absorption and supporting beneficial gut bacteria as a prebiotic agent. [74]

Fatty acids analysis through GC-MS (gas-liquid chromatography-mass spectroscopy) of WMSs revealed a range of fatty acids including linoleic acid, stearic acid, palmitic acid, and oleic acid is predominantly present in seeds identified prevailing fatty acids in WMSs oils with percent composition and reported palmitic acid (3.80%), carbonic acid (1.30%), oleic acid (17.84%), linoleic acid (13.77%), propanediol acid (3.74%), delta-tocopherol (5.16%) and dioctyl esters (0.98%). Watermelon seeds are rich in protein (15-50%), including albumin, globulin, prolamin, and glutelin. Studying seed characteristics like coat color, hardness, and biochemical composition (lignin, cellulose, and hemicellulose) can help develop nutritionally improved watermelon genotypes and valuable food products**. [9/65/25]**

2.1.6. Pharmacological/ Biological Activity

Bioactive compounds are elements found in food that influence physiological or cellular activities in humans or animals when consumed**.** They include flavonoids, anthocyanins, tannins, betalains, carotenoids, plant sterols, and glucosinolates offer antioxidant, anti-inflammatory, and anti-carcinogenic benefits. They can protect against diseases and metabolic disorders**.** These positive effects make them suitable for creating new functional foods with potential protective and preservative properties. Watermelon, considered food, also serves as a medicinal plant in African and Asian cultures because of its abundance of bioactive compounds with significant biological activities. [13]

Among the various biological activities, watermelon has been attributed with anti-diabetic, hypoglycemic, hypolipidemic, hypocholesterolemic, diuretic, anti-urolithiatic, and anthelmintic properties seed extracts have demonstrated antimicrobial properties, making them potential candidates for use in pharmaceutical formulations against certain harmful microorganisms. [46]

Studies have indicated antibacterial activity in watermelon seed extracts against *Escherichia coli*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Enterococcus faecalis*, and *Bacillus subtilis*. The ethanol extract from *Citrullus lanatus* seeds demonstrated notable analgesic and anti-inflammatory effects over 3 to 24 hours, possibly attributed to cucurbitacins, which are believed to inhibit COX 2 (Cyclooxygenase 2). The ethyl acetate extract from *Citrullus lanatus* seeds exhibits activity against certain bacteria and fungi linked to respiratory, gastrointestinal, and urinary tract infections. [59]

Table 7: Different pharmacological activities of *Citrullus lanatus* seeds. [80]

Sr.no	Pharmacological Activity	Effects
1	Anti-inflammatory	Cox2 inhibition
2	Antimicrobial	Activity against S. aureus (Staphylococcus aureus), E. coli (Escherichia coli), B. stubtilis (Bacillus subtilis) and P.aeruginosa (Pseudomonas aeruginosa).
3	Sexual enhancement	Increases serum testosterone and luteinizing hormone

4	Weight loss and hematological benefits	Reduction of weight in Wistar rats; treatment of anemia; depressing effects on platelet activity and leucocyte function
5	Anti-hepatotoxicactivity	Seed extract inhibited the elevations of hepatic enzymes in serum, and ameliorated the histopathological changes induced by CCl4 in mice
6	Anti-diabetic	Methanolic seed extract caused a reduction in blood glucose concentrations in rats
7	Antiulcer and gastroprotective	Gastric ulcer inhibition in rats
8	Cardiovascular benefits	Reduced body weight gain, decreased plasma cholesterol concentrations, improved homeostasis of pro- and anti-inflammatory cytokines, and attenuated development of atherosclerosis in hypercholesterolemic mice

Anti-diabetic activity

In a study with ICR mice, watermelon's anti-diabetic potential was tested. Mice were fed diets with 10% watermelon flesh powder (WM-P) or 1% watermelon rind ethanol extracts (WM-E). After 4 weeks, diabetes was induced in the mice using streptozotocin. The findings demonstrated that WM-E supplementation notably reduced blood glucose levels and increased serum insulin levels. Moreover, the histological analysis indicated that watermelon protected pancreatic cells, implying a potential diabetes management benefit. (32)

Anti-inflammatory activity

Citrullus lanatus seed oil (CLSO) displayed anti-inflammatory activity in a rat model of carrageenan-induced paw edema. The effectiveness of the oil was compared at doses of 50 mg/kg and 100 mg/kg with the standard anti-inflammatory drug diclofenac (10 mg/kg). The results revealed that both doses of CLSO and diclofenac significantly reduced the swelling and inflammation in the rat's paw induced by carrageenan, indicating the potential anti-inflammatory properties of CLSO. (52)

Anti -Cancer Activity

Watermelons, like other fruits and vegetables, can lower cancer risk due to their antioxidants. Lycopene, found in watermelons, may reduce prostate cancer cell growth. Eating vitamin-A-rich fruits can also protect against lung and oral cavity cancers, as per the National Cancer Institute. (59)

Antioxidant activity

The study assessed the antioxidant activity of *Citrullus lanatus* using chloroform, ethyl acetate, and methanol extracts. The DPPH method was employed to measure antioxidant activity. The highest antioxidant potential was observed in the methanolic extract of *Citrullus lanatus* (MECL) seeds. (46)

Hepatoprotective activity

Citrullus lanatus seed oil demonstrated hepatoprotective effects against liver damage induced by CCl4 in rats. The doses of 125 mg/kg and 250 mg/kg resulted in a significant decrease in blood serum ALT, AST, and ALP levels when compared to the negative control group. Furthermore, histopathological examination of liver tissue confirmed the hepatoprotective properties of Citrullus lanatus seed oil. (5)

Antimicrobial activity

Various parts of *Citrullus lanatus* (watermelon) were tested for their antimicrobial properties. Extracts from leaves, stems, fruits, and seeds, using chloroform, hexane, and ethyl alcohol, exhibited antibacterial effects against Escherichia coli, Staphylococcus aureus, Pseudomonas aeruginosa, Bacillus subtilis, and Proteus vulgaris. These extracts also demonstrated antifungal activity against Aspergillus niger and Candida albicans. Additionally, a *Citrullus lanatus* seed extract, obtained through cold maceration, showed potential antibacterial action against Staphylococcus species and Pseudomonas aeruginosa. (52)

Anti-ulcerogenic activity

Citrullus lanatus (watermelon) has demonstrated anti-ulcerogenic properties. When a methanolic extract of its seeds was administered orally to rats in two different ulcer models (pyloric ligation and water immersion stress), it significantly reduced the ulcer index. Additionally, in the pyloric ligation model, it also lowered gastric volume, free acidity, and total acidity. These protective effects are attributed to the presence of triterpenoids and phenolic compounds in the methanolic extract, which have anti-secretory and proton pump inhibitory activities. [66]

Cardioprotective activity

In a study involving male albino rats, it was noted that when the rats were fed a modified diet containing Citrullus vulgaris (watermelon) seeds, there were significant reductions in serum triglyceride (TG) and VLDL-C (Very Low-Density Lipoprotein Cholesterol) levels ($p < 0.05$ for both) compared to a control group fed with a regular diet. Additionally, the treated group exhibited decreased levels of serum total cholesterol, LDL (Low-Density Lipoprotein), and AI (Atherogenic Index), while there was an increase in HDL (High-Density Lipoprotein) levels. These changes in lipid profiles suggest potential positive effects of Citrullus vulgaris seed consumption on cardiovascular health. [45]

2.2. *Carica papaya* (papaya) seed and Its Characteristics

2.2.1. Taxonomical classification: [1]

- Kingdom: Plantae
- Sub-Kingdom: Tracheobionta
- Class: Magnoliopsida
- Subclass: Dilleniidae
- Division: Magnoliophyta
- Superdivision: Spermatophyta
- Phylum: Steptophyta
- Order: Brassicales
- Family: Caricaceae
- Genus: Carica
- Species: *Carica papaya* L.

2.2.2. Vernacular names (Indian local name): [1]

- Sanskrit: Madhukarkati
- Hindi: Papita, Papaya
- Gujrati: Papaya
- English : Papaya,Papaw,Pawpaw

2.2.3. Plant discription:

The papaya, *Carica papaya* Linn is commonly known for its food and nutritional values throughout the world. [4] It belongs to a small family Caricaceae having four genera in the world. The genus *Carica* L. is represented by four species in India, of which *Carica papaya* L. is the most widely cultivated and the best-known species. [28] Papaya (*Carica papaya*) is a tropical fruit with high nutritional and medicinal value. It originated in South Mexico and Costa Rica and is native to southern Mexico and neighboring Central America. It is commercially grown in various regions including Florida, Hawaii, Eastern British Africa, South Africa, Sri Lanka, India, Canary Islands, Malaysia, and Australia. [43] Papaya is now cultivated in tropical and subtropical countries worldwide. [84] It is growing both commercially and in a home garden. The seeds are numerous, small, black, round, and covered with gelatinous aril. [4]

Different parts of *Carica papaya* (leaves, barks, roots, latex, fruit, flowers, and seeds) are used in folk medication to treat a broad range of diseases. [52] Papaya is a powerhouse of nutrients and is available throughout the year. It is a rich source of three powerful antioxidants, vitamin C, vitamin A, and vitamin E. Minerals, magnesium and potassium, vitamin B, pantothenic acid, folate, and fiber. [48] Along with all of this, it also has papain, a digestive enzyme that is useful in treating the root causes of trauma, allergies, and sports injuries. [64] Studies have also shown the presence of proteolytic enzymes (chymopapain & papain) with antiviral, antifungal, and antibacterial properties. [29] Papaya is rich in the enzyme papain which is effective against cancer. Papain breaks down the fibrin cancer cell wall and protein into amino acid form. [36]

The papaya seed contains fatty acids, crude protein, crude fiber, papaya oil, carpaine, caricin, glucotropaeolin, benzyl glucosinolates, benzyl Isothiocyanate, benzyl thiourea, hentriacontane, ß-sitosterol, caressing and an enzyme myrosin. Both the seeds and pulp of *Carica papaya* contain benzyl glucosinolate, which can be converted into benzyl isothiocyanate by the enzyme myrosinase. Benzyl isothiocyanate, found in abundance in the seeds of unripe fruits, is a sulfur-containing compound known for its strong bactericidal and insecticidal properties. These substances play a crucial role in the plant's natural defense mechanisms. [36/84]

The use of *Carica papaya* in folk medicine is made possible by the phytochemicals present in the plant, which include tannins, steroids, terpenoids, saponins, phenols, flavonoids, ferric reducing antioxidant properties (FRAP), pro-anthocyanidins, alkaloids, anthraquinones, and cardiac glycosides. [78] Papaya seeds constitute a 15%–20% mass of fruit that represents a considerable amount of papaya fruit waste in processing units. Papaya seeds have the potential to produce 30%–34% oil with nutritional and functional properties highly similar to olive oil. [61]Papaya seeds are small, round, black-colored, encased in a gelatinous coat in the inner cavity of the fruit have a strong flavor similar to black pepper and small amounts of it are beneficial for overall health. [4/66]

(A) (B) (C) (D)

Figure 4: *Carica papaya*: (A) Papaya tree; (B) Leaf (C) Ripe fruit (D) Seed

Papaya trees can be male, female, or hermaphrodite. Female tree fruits are round, while hermaphrodite tree fruits are elongated in shape. [25] Papaya seeds that are discarded as waste have some major health benefits. Papaya seeds can be used to treat roundworms (Ascaris lumbricoides) infections, indigestion, diarrhea, skin ailments, and colds and they can also be used as a source of fatty acids. [62] It is effective for combating constipation and other digestive problems. [61] Chewing the seeds of ripe pawpaw fruit also helps to clear nasal congestion. [14] The papaya seed extract is used for the treatment of bleeding piles as well as liver and spleen enlargement. They are also useful in controlling hypertension and hypercholesterolemia. Papaya seeds offer health benefits due to bioactive compounds like polyphenolics, carotenoids, alkaloids, terpenoids, and tannins, which provide antimicrobial properties. [62]

Papaya seed extracts have demonstrated antibacterial activity against various types of bacteria, including both gram-positive and gram-negative strains. Same bacteria like *Staphylococcus aureus*, *Bacillus cereus, Escherichia coli, Pseudomonas aeruginosa*, and *Shigella flexneri*. [31]The seeds,

irrespective of their fruit maturity stages have bacteriostatic activity on gram-positive and negative organisms which could be useful in treating chronic skin ulcers. [4] Different parts of the Carica papaya plant have anti-inflammatory effects. Papaya seed extract reduces NO radicals by 69.4% in vitro and stabilizes red blood cell membranes by 22.7% at 150 µg/mL concentration. BITC (benzyl isothiocyanate) in papaya seeds has a wide range of applications, including vascular relaxation and inhibiting cancer cell growth. [61] The seed is a good source of oil (25.6%) that may be useful for medicinal, biofuel, and industrial purposes. Oleic, palmitic, linoleic, and stearic acids were the most abundant fatty acids found in the papaya seed oil. [66]

Utilizing papaya seeds to create new products is a promising option. It can add value to a by-product, offer novel ingredients for the food industry, and help reduce the disposal of agro-industrial waste. This approach has the potential to be economically and environmentally beneficial. [39]The functional properties found in papaya seeds, such as enzymes like papain, could potentially be explored for their use as growth promoters, antimicrobial and antiparasitic factors, and immunomodulatory and anti-inflammatory agents for poultry. [70] Papaya seed is known that most bioactive compounds degrade over time, with exposure to heat, extreme pH, light, oxygen, or food processing, losing their activity. [40]

Papaya seeds are typically found embedded in the fruit. In the immature stage of fruit development, they are whitish in coloration. However, as the fruit matures and reaches full maturation, the seeds tend to become darker in color, often taking on a dark brown or blackish hue. [8]This color change is a natural indicator of the seed's readiness for planting or consumption. Papaya seeds are spherical with a protective outer layer called the sarcotesta, which covers the seed coat and an inner endosperm. The seed pericarp contains protein, while the endosperm contains both oil and protein. Papaya seeds are particularly abundant in amino acids, especially within the sarcotesta. [31]

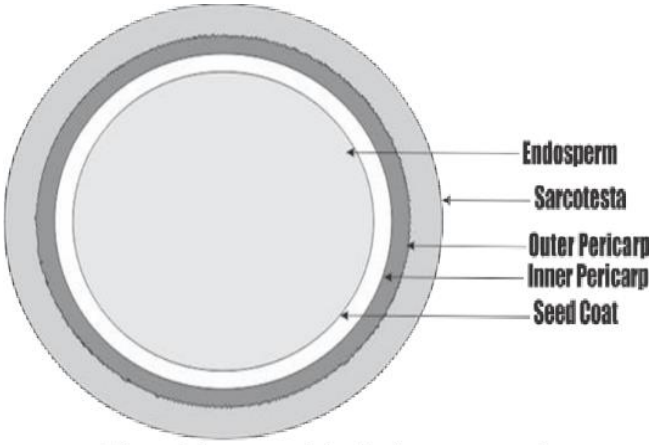

Figure 5- Structure of the *Carica papaya* seed [31]

Medicinal uses of papaya seed are as a carminative, anti-fertility agent in males, counter-irritant, as a paste in the treatment of ringworm, psoriasis, emmenagogue, vermifuge, liver cirrhosis, and abortifacient. Seed juice is used for bleeding piles, enlarged liver, and pectoral properties. Seed paste is used as anthelmintic, stimulation of menstruation, or abortion. [24]

2.2.4. Nutrients in papaya seed (*Carica papaya*)

Papaya seeds contain various nutrients, although they are typically consumed in small quantities. [66] Papaya seeds contain proteins, fiber, fatty acids, papaya oil, carpaine, vitamins, minerals, and an enzyme Papain. [63] Papaya leaves and seeds, rich in nutrients, are used to enhance the nutritional value of products like flour and tea. Papaya seeds contain minerals like magnesium, potassium, calcium, copper, and zinc, as well as phenolic compounds such as benzyl isothiocyanate, glucosinolates, tocopherols (alpha and delta), beta-cryptoxanthin, beta-carotene, and carotenoids. [78] The oil's characteristics are an iodine value of 65.5%, a saponification value of 155.5%, and an un-

saponifiable value of 1.37%. [31] High-quality oleic oils can be extracted from papaya seeds. This is followed by palmitic acid (13.5%) and stearic acid (4.5%). It was also reported that papaya oil is a good source of monounsaturated fatty acids and saturated fatty acids. [57]

Papaya seeds contain proteins, which are essential for various bodily functions, including tissue repair, enzyme production, and immune system support. However, before considering their use in food applications, it is recommended to conduct toxicological studies to ensure their safety for consumption. A protein composition of 28.55% was estimated in flour produced from the seeds. [31] Variations in papaya seed composition are likely due to different varieties, ripening stages, and climates. [4]Papaya seeds have the potential to yield approximately 30–34% oil content, depending on factors like variety, seed size, and shape. [73]Their high oil content makes them economically appealing for industrial use, comparable to other oilseed crops like corn (3.1–5.7% oil content) and soybean (18–20% oil content). This attractiveness arises due to the substantial oil output per seed, opening doors for various applications and economic viability. [57]Papaya seeds contain vitamins such as vitamin A, vitamin E, and vitamin K. These vitamins play roles in maintaining healthy skin, vision, and blood clotting. Papaya seeds contain enzymes like papain, which is also found in the papaya fruit. Papain is known for its digestive benefits and is used as a meat tenderizer. It has been reported that the nutritive value of cooked food is lower in comparison to uncooked food. [11]The composition of both unripe and ripe papaya seeds was analyzed for various nutritional components. This included measuring their moisture content, ash content (inorganic residue after burning), protein content, fiber content, and lipid (fat) content. Papaya seeds also contain dietary fiber, which is important for digestive health and can help regulate bowel movements. [2/57]

Table 8: Amino acid profiles of papaya seed [70]

Sr.no	Amino acids	Papaya seed (g/100 g protein)
1	Lysine	4.21
2	Histidine	2.21
3	Arginine	6.44
4	Phenylalanine	3.38
5	Methionine	1.30
6	Threonine	2.85
7	Leucine	7.78
8	Isoleucine	3.09
9	Valine	2.25
10	Aspartic acid	7.05
11	Glutamic acid	12.4
12	Serine	3.01
13	Proline	2.13
14	Glycine	4.46
15	Alanine	3.32
16	Cystine	1.14
17	Tyrosine	2.06

Table 9: Nutritional Composition of papaya seeds per 100g. [61]

Sr.no	Component	Values
1	Energy	374.47 kcal
2	Crude fiber	21.96g%
3	Carbohydrate	31.94g%
4	Crude fat	26.36g%
5	Crude protein	2.33g%
6	Moisture content	10.5%
7	Ash content	6.91%

Table 10: Mineral Elemental Composition of *Carica papaya* seed [31]

Sr.no	Minerals Element	Composition (mg/100g) of seed
1	Calcium(Ca)	1821
2	Magnesium(Mg)	28.7
3	Potassium(K)	32.89
4	Sodium(Na)	12.59
5	Phosphorous(P)	1156.0

Table 11: Vitamin composition of the papaya seed [34]

Sr.no	Vitamin	Sun-dried samples	Oven-dried samples
1	Vitamin A (IU/Kg)	2266±1.41	1897±2.83
2	Vitamin B1 (mg/100g)	1.57±0.01	1.39±0.01
3	Vitamin B2 (mg/100g)	0.75±0.01	0.81±0.02
4	Vitamin B3 (mg/100g)	3.88±0.01	3.90±0.01
5	Vitamin B6 (mg/100g)	1.88±0.01	1.49±0.01
6	Vitamin B12 (mg/100g)	0.76±0.01	0.77±0.01
7	Vitamin C (mg/100g)	7.51±0.03	7.84±0.03

Table 12: Fatty acid profiles of C. papaya seed oil [38]

Sr.no	Fatty acid	Nutritional value (%)
1	Lauric acid	0.01–0.40
2	Myristic acid	0.04–0.49
3	Palmitic acid	13.90–19.70
4	Palmitoleic	0.08–1.77
5	Margaric acid	0.10–0.13
6	Stearic acid	4.20–6.68
7	Oleic acid	70.84–79.10
8	Linoleic acid	0.04–6.06
9	Linolenic acid	0.17–0.90
10	Arachidic acid	0.38–1.10
11	Gadoleic acid	0.51

2.2.5. Bioactive Compounds/ Phytoconstituents in Papaya Seed

Carica papaya Linn. Commonly known as papaya, is a valuable plant with diverse applications in the field of medicine. These plant parts are rich in bioactive compounds and have been traditionally used to treat a wide range of health conditions. Papaya is known for its potential therapeutic properties and is used as a natural remedy in different cultures for its health benefits. [22] These compounds include flavonoids, tannins, reducing sugars, alkaloids, phenols, saponins, and terpenoids. These constituents contribute to the potential medicinal properties of papaya seeds and may have various health benefits. [69]

Table 13: Phytoconstituents of *Carica papaya* [2/37/24/38/22/64]

Seed	Benzyl Isothiocyanate, Carpaine, Benzyl isothiocyanate, Benzyl glucosinolate, Glucotropacolin, Benzyl thiourea, Hentriacontane, β-sitosterol, Caricin, Tocopherols (α and δ), β-Cryptoxanthin and β-Carotene, Lycopene. Flavonoids, Tannins, Alkaloids, Phenols, Saponins, and Terpenoids, Anthraquinones, Phlobatannins, Carotenoids. Enzymes like Papain, Myrosin.
Seed oil	Carotenoids, Flavonoids, Alkaloids, Terpenoids, Saponins, Tannins.

Papaya seeds contain compounds called glucosinolates, which can break down into various biologically active substances, including isothiocyanates like benzyl isothiocyanate. Also, Papaya seeds may contain carotenoids like beta-carotene and beta-cryptoxanthin, which are antioxidants and

are important for eye health. [22] Consuming foods rich in tocopherols is associated with several health benefits. These include reduced risk of heart disease, protection against certain cancers, and support for eye health. [67] Tocopherols are often referred to as vitamin E, and they are a part of the broader vitamin E family. Vitamin E is a fat-soluble vitamin, and it is essential for various bodily functions, including immune system support and skin health. [23]

Flavonoids are antioxidants found in papaya seeds that can help protect cells from oxidative damage and may have various health benefits. Flavonoids are antioxidants found in papaya seeds that can help protect cells from oxidative damage and may have various health benefits. Benzyl Isothiocyanate are naturally occurring compound in plants that may have positive effects on human health. Some studies suggest that isothiocyanates, including BITC, may have anti-cancer properties by inhibiting the growth of cancer cells and promoting their self-destruction (apoptosis). [11/78]

Papaya seeds contain an enzyme known as "papain." Papain is a proteolytic enzyme, which means it can break down proteins into smaller peptides or amino acids. Papain has been explored for its potential medical applications, including in wound care and as an anti-inflammatory agent. Some studies suggest it may aid in wound healing and reduce inflammation. [28]

Table 14: Some medicinal uses of the Papaya plant as mentioned in ancient Ayurvedic literature (35)

Part	Medicinal uses
Seed	Carminative, Emmengogue, Vermifuge, Abortifacient, Counter irritant, As part of the treatment of ringworm and Psoriasis, Anti–fertility agent in males.
Seed juice	Bleeding piles and enlarged liver and spleen.
Seed paste	Anthelmintic, Stimulation of menstruation or abortion.

2.2.6. Pharmacological/ Biological Activity

The available literature on Carica papaya, commonly known as papaya, has revealed a wide range of significant biological activities in both in-vivo and in-vitro models. These activities include anti-inflammatory, anti-cancer, anti-protozoal, anti-microbial, anti-oxidant, anti-diabetic, anti-fungal, anti-hyperlipidemic, anti-thrombocytopenic, anti-viral, anti-gout, anti-hypertensive, analgesic, and hepato-protective effects. Papaya appears to have diverse potential health benefits based on these findings.

Antioxidant activity

This study focused on evaluating the antioxidant properties of water extract derived from Carica papaya (papaya) seeds when exposed to hydrogen peroxide (H2O2)-induced oxidative stress in human skin Detroit 550 fibroblasts. The findings of the study are noteworthy: The papaya seed water extract was proven to be non-toxic and exhibited potent free radical scavenging capabilities, offering protection to Detroit 550 fibroblasts subjected to H2O2-induced oxidative stress. [55] Importantly, the study revealed several key points:(1)The most significant protective effect was achieved when the extract was administered simultaneously with 1 mmol/L H2O2.(2)The extract, when present during oxidative stress, did not lead to an increase in catalase activity, which is typically associated with breaking down hydrogen peroxide. (3)It prevented the release of cytochrome C and the loss of inner mitochondrial transmembrane potential, indicative of its ability to safeguard against mitochondrial damage during oxidative stress. (4)The papaya seed water extract was found to be more effective at countering oxidative damage than vitamin C, a well-known antioxidant. (5)Purified subfractions of the seed water extract displayed the same antioxidant effect as the whole extract. [2/24]

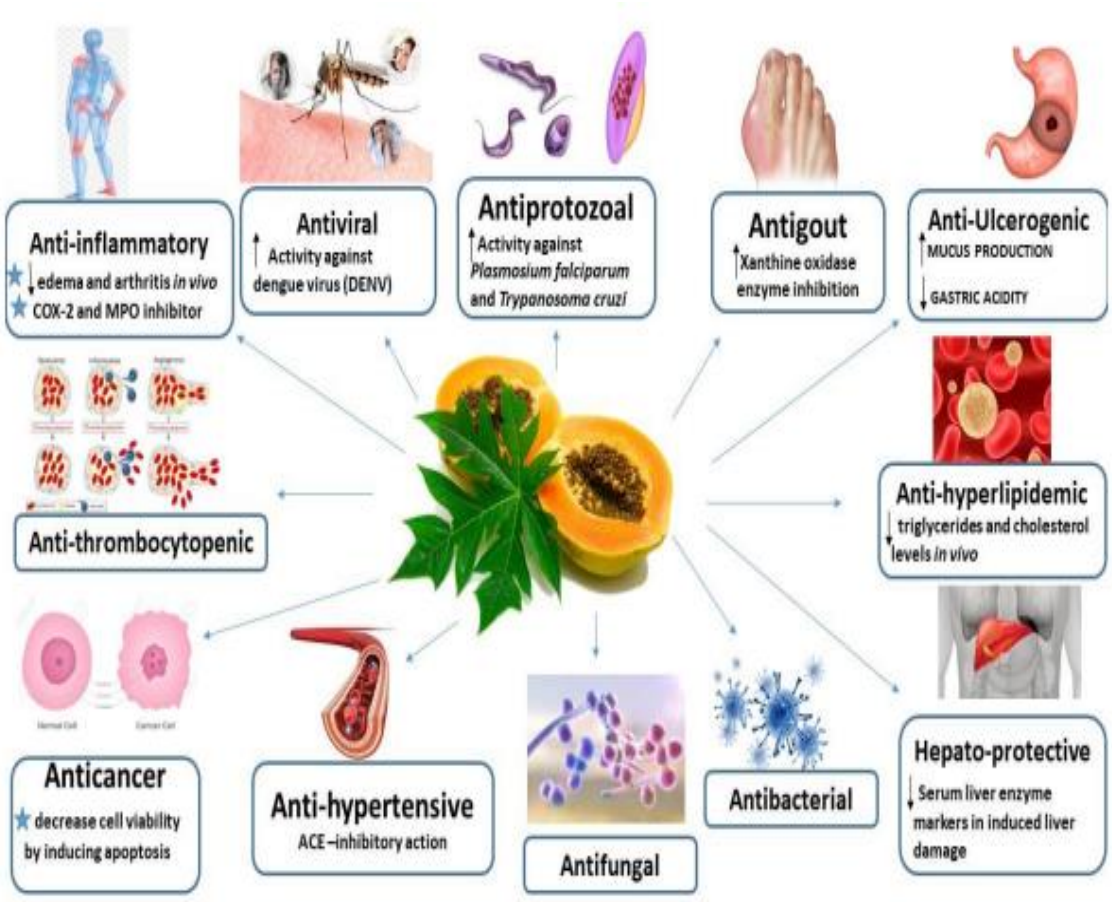

Figure 6 -Major reported biological activities of *Carica papaya* seed [(2)]

Anti-amoebic activity

The study found that a cold macerated aqueous extract of matured papaya seeds, specifically at a concentration of 100 µ/mL, exhibited significant anti-amoebic activity against *Entamoeba histolytica*. This suggests that the extract from mature papaya seeds has the potential to be effective in combating this parasitic infection caused by *Entamoeba histolytica.* [(24)]

Anti-ulcerogenic activity

The methanolic extract of Carica papaya seeds exhibited strong gastroprotective properties in rat models with gastric ulcers induced by ethanol and indomethacin, as well as in a model of chronic ulcers induced by acetic acid. A dosage of 500 mg/kg was particularly effective in significantly reducing gastric lesions. Furthermore, this extract demonstrated a systemic effect by increasing mucus production and reducing gastric acidity. [(2)]

Antidiabetic activity

Studies on laboratory animals have demonstrated that Carica papaya seed extracts possess anti-diabetic effects. In particular, the aqueous seed extract of Carica papaya Linn has shown hypoglycemic and hypolipidemic activities in Wistar rats. These effects were observed to significantly lower fasting blood glucose (FBS), serum triglyceride (TG), total cholesterol (TC), low-density lipoprotein cholesterol (LDL-c), and very low-density lipoprotein cholesterol (VLDL-c) in a dose-dependent manner. Additionally, acute oral toxicity testing indicated that the seed extract is safe for consumption. Phytochemical analyses of the extracts revealed the presence of various bioactive compounds, including alkaloids, flavonoids, saponins, tannins, anthraquinones, anthocyanosides, and reducing sugars. [(43)]

Anthelmintic activity

Using dried papaya seeds as an elixir with honey is a traditional remedy that some people believe can help with human intestinal parasites. These seeds contain a compound called benzyl isothiocyanate (BITC), which is considered the primary anthelmintic, a substance that can combat parasites, found in the seeds. While this remedy is often claimed to have few adverse effects and a notable impact on intestinal parasites, it's important to note that scientific evidence supporting its effectiveness and safety is limited and inconclusive. If you suspect a parasitic infection, it is advisable to consult a healthcare professional for proper diagnosis and evidence-based treatment options. (1)

Anticancer activity

Papaya seed extract showed anticancer activity against acute promyelocytic leukemia cells (HL-60 cells) with an IC50 of 20 µg/mL, while papaya pulp extract had no effect even at a higher concentration of 100 µg/mL. However, the statement suggesting that papaya seeds can be effective in inhibiting prostate cancer cells and serving as a nutraceutical for preventing and treating prostate cancer is not supported by the provided information. Further research is needed to explore papaya seed extract's potential effects on prostate cancer specifically. (69)

Antimicrobial activity

Papaya seeds, regardless of fruit maturity, have bacteriostatic properties against both gram-positive and gram-negative organisms, making them potentially useful for treating chronic skin ulcers. Ethyl acetate extracts from papaya seeds exhibit promising antimicrobial activity due to their secondary metabolites. These extracts effectively inhibit Proteus mirabilis and Vancomycin-resistant enterococci, suggesting potential applications in treating urinary tract infections and sepsis caused by these bacteria.

Additionally, papaya seed extracts may have therapeutic potential for treating candidiasis. Further research is needed to validate these findings for clinical use. (69)

Anti-inflammatory activity

A study evaluated the anti-inflammatory effects of papaya seed extract using rats with carrageenan-induced paw edema. The study involved three groups: a control group receiving gum acacia suspension, a test group receiving papaya seed extract at 400 mg/Kg, and a standard drug group receiving Diclofenac at 10 mg/Kg, all administered orally. The results showed that the aqueous extract of papaya seeds exhibited significant anti-inflammatory effects in acute, sub-acute, and chronic inflammatory models in albino rats. Additionally, a separate study on rats, using aspirin as a positive comparative control, indicated that papaya seed extract displayed dose and time-dependent inhibition of edema. (78)

Immunomodulation

A study investigated the immunomodulatory potential of crude papaya seed extract and its bioactive fractions in vitro using lymphocyte proliferation assays and complement-mediated hemolytic assays. The results of the study revealed that both the crude papaya seed extract and two bioactive fractions significantly enhanced the responsiveness of lymphocytes to phytohemagglutinin. (79)

This enhancement of lymphocyte responsiveness to phytohemagglutinin suggests that *Carica papaya* seed extract contains compounds that promote the growth of lymphocytes, indicating immune-stimulatory properties. In summary, the findings of this study provide evidence for the immune-stimulatory effects of papaya seed extract. (41)

Anti-bacterial activity

The antibacterial activity of both aqueous and 70% methanolic extracts of papaya seeds was investigated using an agar well diffusion assay. These extracts were applied to agar plates after swab inoculation with various bacterial strains, including Staphylococcus aureus and gram-negative

bacteria such as Pseudomonas aeruginosa, E. coli, and Salmonella typhi. The results of the study showed that both the aqueous and methanol extracts from papaya seeds were effective in inhibiting the growth of these bacterial pathogens. In another study, it was revealed that the ethanol extract of C. papaya seeds exhibited antimicrobial activity against Salmonella choleraesuis and Staphylococcus aureus. These findings highlight the potential antimicrobial properties of papaya seed extracts, suggesting their usefulness in combating bacterial infections. (41)

Digestive Aid

Papain, the enzyme found in papaya seeds, has been widely used as a digestive aid. It can help break down proteins in the digestive system, potentially aiding in the digestion of food and relieving digestive discomfort. (43)

Antiparasitic Activity

Papaya seeds contain an enzyme called papain, which has demonstrated antiparasitic properties. Papain has been used to treat certain intestinal parasites like roundworms and tapeworms. It is believed to disrupt the parasites' protective outer layers, making them more vulnerable to the body's immune response. (1/78)

3. Conclusion

The role of herbs in promoting health and well-being continues to evolve as we discover new perspectives and potential benefits associated with lesser-known sources like watermelon seeds and papaya seeds. These often-overlooked seeds have shown promise in various aspects of health and nutrition, providing us with valuable additions to our understanding of herbal remedies.

Watermelon seeds, once discarded as waste, have emerged as a nutritional powerhouse. Their rich profile of essential nutrients, including plant-based protein, vitamins, and minerals, positions them as a valuable addition to a balanced diet. The presence of amino acids and antioxidants further highlights their potential to support heart health, digestive well-being, weight management, and oxidative stress management.

Papaya seeds, on the other hand, have long been appreciated for their digestive properties, owing to the enzyme papain. Beyond this, they demonstrate potential as natural antiparasitic agents, liver detoxifiers, and sources of antioxidants. These properties make them a compelling choice for those seeking holistic approaches to health.

While the emerging perspectives and potential health benefits of watermelon seeds and papaya seeds are promising, it's important to maintain a critical approach. Further research is necessary to establish precise dosages, mechanisms of action, and long-term effects. Additionally, individual responses may vary, and caution should be exercised, particularly by those with underlying health conditions or medication regimens.

Incorporating watermelon seeds and papaya seeds into one's diet can be a flavourful and nutritious endeavor. However, consultation with healthcare professionals or nutritionists is advised to ensure alignment with personal health goals and needs.

As we continue to learn more about herbs and natural remedies, it is crucial to embrace this newfound knowledge while still respecting traditional practices. Watermelon and papaya seeds are examples of how ancient wisdom and modern scientific inquiry can work together. This highlights the significance of using evidence-based approaches to make informed decisions when pursuing holistic well-being.

In summary, the role of herbs in health and wellness is a dynamic field that continues to reveal nature's bountiful offerings. Watermelon seeds and papaya seeds are just two examples of the wealth of potential resources available to support health naturally. By blending tradition with scientific rigor, we can unlock the full potential of these treasures while advancing holistic and evidence-based approaches to health.

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