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A brief review of the remarkable nutritional value, phytochemical composition, and biological properties of *Annona squamosa* L.

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Abstract

Conventional uses for the fruit tree *Annona squamosa* L. date back a long way. *A. squamosa* is mostly found in tropical and subtropical climates, where it is an evergreen plant.The fruits of *A. squamosa* in fact widely utilised in the food processing industry to create chocolates, ice cream, drinks, and other culinary goods. *A. squamosa* has been associated with many ethno-medical uses, such as cardiac sedative, cool medicine, apophlegmatisant, tonic, and abortient. In an attempt to expand our understanding of *A. squamosa's* health benefits, this study summarises data on the plant's phytochemicals, traditional applications, and bioactivities based on a large body of research. Numerous investigations have revealed *A. squamosa's* anticancer, antiparasitic, antimalarial, hepatoprotective, antidiabetic, antihypertensive, and insecticidal,microbicidal, and molluscicide qualities. In phytochemistry research Regarding A. squamosa,the main constituents have been determined to be ananaceous alkaloids (ALKs), cyclopeptides (CPs), diterpenes (DITs), and acetogenins (ACGs). As the review article provides the most recent data on the nutritional profile, phytochemical biological activities and profile *A. squamosa* L. that promote health, as gathered from a variety of sources. The biological characteristics of *A.squamosa* leaves (ASLs), We covered the phytochemical and nutritional variety of ASLs in the current article. The health-promoting qualities and phytochemical profile of ASLs a review of the literature revealed that they hold the capacity to be put to use as ingredients in pharmaceutical and nutritious food products. To precisely ascertain the ASL extracts' implications on human health clinical trials are still required, despite a considerable body of data from studies conducted both in vivo and in vitro.Separate extraction of the phytochemical was done using 96% ethanol and distilled water. Numerous substances that are pharmacologically active were found, including alkaloids, phenols, flavonoids, cardiac glycosides, tannins, and sugars as well saponins discovered to exist in A. squamosa leaves. Nevertheless, this plant lacked phlobatannins and terpenoids. The antioxidant activity of the in vitro flavonoid as well phenolic content was also evaluated in this study. Using the Folin-Ciocalteau reagent, the

overall amount of polyphenols of the extract from ethanol of *A. squamosa* was calculated about the equivalent of gallic acid.

Keywords: *Annona squamosa*, health benefits, biological activity, nutritional value, phytochemicals

1. Introduction

Custard apple denotes from this family Annonaceae,the tropicana fruit tree *Annona squamosa* L. is indigenous to Bermuda, Brazil, India, Egypt, Peru, and South and Central America. In states like Tamil Nadu, Madhya Pradesh, Maharashtra, Assam, Uttar Pradesh, Bihar, and Chhattisgarh, among others. *A. squamosa* is extensively produced for its edible fruit(kumar et al., 2021). It is a tiny, three to eight-metre-tall semi-deciduous tree or shrub. For ages After *A. squamosa* was utilised in traditional medicine and development of different additional food products applications, including the usage of the fruit pulp as an addition or as a juice. According to recent studies, leftover plant parts from the main harvest materials, including husks, peels, seeds, leaves, and seed coats, are an abundant supply of nutrients and phytochemicals that can be applied to the development of new products, such as those for the the food and drug industries (Chiocchio et al., 2021). Fruit has the following nutritional values: 70.5% moisture, 23.5% carbohydrates, 1.6% protein, 4.4% fat, 0.9% mineral matter, 1.0% iron, 0.2% calcium, 0.4% phosphorus, and 100g of edible portion at 104 kcal (Gopalan et al., 2004). According to Sravanthi et al. (2014), the edible portion of a castor apple ranges from 37%–28% of the fruit's overall mass, while the sprouts account for between 23 and 40%.[16]. Fruit has a pH of 5.5, a TSS of 26.40 B, and 0.5% of tannins. After ripening, the fruits have a shelf life of two to three days.

There are several ways to preserve custard apples, including spray drying, foam drying, freeze drying, and tray drying (Quek et al., 2007).Custard apple agriculture in Chhattisgarh occupies around 7.990 thousand hectares and yields 39.73 metric tons of fruit year at a productivity of 497.25 q/ha.The Kanker district is distinguished by its inherent custard apple biodiversity, with wild landraces spread across around 7,20,000 hectares, yielding a 35.60 MT yearly production and a yield of 494.45 q/ha.The *A.squamosa L.,* sometimes known as the custard apple a member among the 'Annonaceae' family as well as the subject of much global interest due to its nutritional and therapeutic qualities. Its chromosomal count is 2n = 14. Both the Ayurvedic and Yunani medical systems place great therapeutic significance on the young leaves, roots, fruits, and seeds of the custard apple.

Custard apples, which are rich in vitamin C and antioxidants, which support a stronger immune system and fight a variety of illnesses. Its ingestion is linked to the treatment of many illnesses and disorders, including as skin problems, heart problems, bone health, and blood pressure maintenance.The custard apple is also well-known for its ability to effectively heal gum disease, boils, and ulcers.The bark helps relieve gum discomfort and toothaches, while the leaves are said to have anti-cancer qualities.The Custard Apple can endure gloomy weather and drought **.** Its color ranges from pale green to blue-green, and certain kinds have a deep pink blush. It usually has a bloom. Among them are *A.squamosa, A.cherimola, and A.reticulate.*To prepare medicine, the leaves and seeds are utilized. The Annona squamosa type is also widely used in conventional medicine to treat a range that of illnesses. The plant's leaves have been applied as an antihelmintic, pesticide, and wound healer. Dried and unripe fruits have antidysentery properties. Almost 400 active substances have been found in *A. squamosa* (Mondal et al. 2018). Recent studies on the the phytochemical and pharmaceutical activity of plant seeds possess revealed that cyclopeptides and annonaceous acetogenins are the main active chemical components of plant seeds (Ma et al., 2017; Dai et al., 2021). Anonaceous acetogenins are a class of polyketides that

are mainly found in seeds and contain *hydroxyls*, *tetrahydropyrans*, *tetrahydrofurans*, *ketones*, and epoxides are examples of oxygenated functional groups. potent antimicrobial, anti-inflammatory, anti-ovulatory, antithyroidal, and other qualities have been demonstrated for them (Poyer et al. 2022). In vivo Research has indicated that the effectiveness of its seed extracts in treating malignancies of the pancreas, liver, prostate, cervix, and other organs (Chen et al. 2011 and Fareed and Ali, 2022). The *A. squamosa* seed extract are primarily responsible for the biological activities displayed by it (Ben-Othman et al. 2020 and Ahmed et al. 2021). Anonaceous acetogenins isolated from custard apple seeds have interesting antitumor/anticancer potential (Chen et al. 2011 and Imadi et al. 2018). These substances demonstrated cytotoxicity against different cancer cell types.

Custard apples contain a variety of phenol-oriented substances, such as proanthocyanidins, and 18 distinct phenolic compounds, mostly alkaloids or flavonoids, according to phytochemical research. *Annona squamosa* leaves (ASLs) possess a multitude of pharmacological properties and biological activities, such as hepatoprotective, antiviral, antidiabetic, antioxidant, and antibacterial properties (Kumari et al. 2022). Consequently, ASLs may be considered valuable.

2. Nutritional value

The tropical lowland shrub *Annona squamosa* exhibits promising pharmacological properties for the treatment of diabetes, cancer, thyroid-related ailments, and cardiac ailments (Table 1). ASLs contain significant concentrations of several minerals, including vitamins A, C (ascorbic acid), B9 (folic acid), B1 (thiamine), B2 (riboflavin), B3 (niacin), and E as well as elements like Iron (Fe), calcium (Ca), magnesium (Mg), sodium (Na), copper (Cu), phosphorus (P), potassium (K), zinc (Zn) and silver (Se).The maintenance of robust bones and teeth, muscle tightness and ease, blood clotting, control of blood pressure, health of the immune system, neuronal function,energy metabolism, as well as the activities of multiple enzymes are just a few of the processes that these minerals support, making them essential for the upkeep of a healthy human body (Akram et al. 2020).

Firm fruits contain a lot of starch, but when it softens, it contains a lot more sugar. Glucose and fructose make up the majority of sugars (80–90%). It has a high calorific value (300–450 kJ per 100 g) that is about twice as high as apple, orange, and peach.Custard apples are a great a supply of protective agents,especially vitamin C, which boost immunity and help ward against illness. It is high in potassium, vitamin A, vitamin C, antioxidants, and dietary fibre. It also contains minimal fat content, vitamin B6, calcium, and copper. It's a fantastic source of iron as well. It can give you sustained energy, has a high calorific value, and the edible part has about 3.1% fibre.

Antioxidants in the fruit, notably Vitamin C, aid in the body's defence against free radicals. These are also high in magnesium and potassium, which guard against high blood pressure and cardiac problems. This fruit's benefit of that is actually in simple to digest even when advanced ages. The sweet fruits' potassium content activates and eliminates lethargies. It also aids in preventing muscular wasting. Additionally, it contains Vitamin A, which treats indigestion and maintains the condition of your skin, hair, and eyes. The fruit's high magnesium content helps to maintain our body's water balance, which aids in eliminating toxins from the joints and minimises rheumatism and arthritis's symptoms
(Nair and Agrawal 2017).

3. Physico-chemical Properties of Fruit

The Custard apple has disappeared considered the the fruit of the impoverished man since it sells for in fact more than a number of other fruits due to its high sugar content, high nutritional value, short shelf life, and several medicinal uses. compared two varieties of custard apple *(A. squamosa)*fruit in terms measurements of the mass, acidity, specific gravity, and amount of sugars—reducing and non-reducing in the berries. It was also found that the berries containing seeds were bigger and contained more sugar.

Evaluated variations in Annona squamosa fruit size at intervals of 20 August to 18 November, as well as the characteristics both physical and chemical makeup of fully ripe The fruit's level of ascorbic acid was 1.10 mg/100 g, and it was stated that with In custard apples, 240 g of each fertiliser per plant specific gravity, total sugar content, fruit count per tree and seed count per fruit were considerably greater and The peel weight had been reduced. The diameter notably increased at both fertilizer rates. percentages of DM, TSS, vitamin C, and decreasing sugar relative to the group under control.

Research on the maturing process of fruit in cherimoya revealed a respiratory climacteric linked to a high rate of ethylene generation. The activities of Enzyme that forms ethylene (EFE) and ACC-synthase, that were extremely minimal in the newly harvested fruits, nevertheless climbed fast during the subsequent day and reached the third's maximum, were the source of the rise in ethylene production. Additionally, there was very little Iaminocyclopropane-I-carboxylic acid (ACC) in its conjugated state throughout the climacteric. After harvesting, there was a rise in rinse browning, but this did not correspond with a drop in chlorophyll since the level of chlorophyll did not change over the post-harvest period. The degree of browning showed a strong correlation with the Hunter L Worth. The creation of ethylene, the breakdown of starch, the hardness loss, and the acceleration of total sugar all occur at the same time Cultivars Barbadose Seedling and Washington-97, which are ten-year-old Annona squamosa trees grown at Hessaraghatta Experimental Station (Karnataka, India), were observed for their fruit growth and development fifteen-day intervals between blooming and physiological maturity (two to five days after harvest maturity) and harvest maturity (120+ days after flowering).

Berries have climacteric respiration and a double sigmoid growth curve. Changes in the fruit's dimensions and weight, the ratio of pulp to peel, the amount of dry matter accumulated, the total solid solids (TSS), carbohydrates, fructose, citric acid, sucrose, and glucose the amount of Mineral and vitamin contents were all recorded.The edible pulp's appearance of a golden color and the sugar-acid ratio seemed to be trustworthy indicators. Custard apple harvest criterion.

Evaluated the fruits of *Annona squamosa*, a custard apple, that were gathered at the schedule after 2 or 5 days, store at 25–33 degrees Celsius and 85–90% relative humidity. It was established how much vitamin C, total acids, and soluble solids were present in the preserved fruits. The ideal time to harvest fruit for immediate eating, according to the results, was when the fruit's soluble solids concentration was between 15% and 20%. If not, harvesting need to happen two to three days sooner, once the fruit now contains around 10% soluble solids in it.

In 2000, physico-chemical analyses were carried out on four-year-old grafted custard apple (Annona reticulata) trees in West Bengal, India. The cultivars studied were Washington, Jargham Local, Iceland Gem, Atemoya, Balanagar, and Chance Seedling. Fruit dimensions: 300 g in weight, 8.3 cm in length, 9.0 cm in diameter, 35 seeds per fruit, and October as the earliest maturity date were all greatest for Balanagar and the amount of consisting of 11.8% reducing sugar, 4.7% non-reducing sugar, 16.7% total sugar, 54.4 mg/100 g pulp of ascorbic acid, and total soluble solids (27.0 º Brix). The maximum acidity (0.32%) as well as quantity of berries without seeds per berry (48) were found in Atemoya and Chance Seedling, respectively said that

they have discovered custard apple (Annona squamosa L.) varieties with excellent yields that had good quality and long shelf lives.

4. Phytochemical profile

Aside based on its roots, stem, and leaves, which especially noteworthy since they have therapeutic as well as nutritional worth, *Annona squamosa* is widely planted in India for its fruits (Fig. 1.). Additionally, the ASL essential oil exhibits outstanding antiparasitic and antimalarial action (Meira et al. 2015). Numerous investigations have been made to learn more about the chemical make-up of ASL essential oil (ASLEO). Through the hydrodistillation process, shade-dried leaves taken from the lower Himalayas produced 0.13% essential oil. There were discovered 43 components in all, accounting for Eighty-six percent of the oil produced from ASLs.In gas studies of ASLEO GC-flame ionisation detection (GC-FID) and gas chromatography-mass spectrometry (GC-MS) are two methods that can be used.

sesquiterpenoids (oxygenated sesquiterpenes, 21.8%, and sesquiterpene hydrocarbons, 63.4%) dominated, followed by monoterpenes (oxygenated monoterpenes, 1.4%, and monoterpene hydrocarbons, 2.0%) (Verma et al. 2016). The two most common elements that make up ASLEO found in the southern region of India are - Along with caryophyllene (14.1%) and cedrene (23.3%) whereas - Germacrene D (21.3%) and caryophyllene (23%) are more common in northern India (Garg and Gupta 2005).

Researchers looked into bioactive compounds in several extracts in ASL demonstrated pharmaceutical and biological properties, including as antidiabetic, antioxidant, antibacterial, antiviral, antiobesity, antidiarrheal, and anticancer activity (Thakkar et al. 2011 and Nguyen et al. 2020). The general categories for the phytochemical profile of ASLs consist of fatty acids, amino acids, anthocyanins, quinones, steroids, phenols, alkaloids, saponins, tannins, glycosides, and sesquiterpenes.(Kumar et al. 2019). The total number of phenolic compounds (TPCs), which also comprise tannins, flavonoids, alkaloids, phenols, and saponins make up the majority of these. Polyphenolic compounds have been shown in epidemiological studies to be beneficial in preventing a variety of persistent illnesses, as diabetes, cancer, and heart disease, and neurological problems. Polyphenolic compounds regulate several physiological and biological processes, such as mechanisms of signal transmission, cellular redox potential,enzyme activity, and cell proliferation, to prevent chronic illnesses (Luca et al. 2020).

5. Pharmacological Components

Custard apple seeds have gained attention recently as a possible component for the creation of supplemental meals due to their substantial phytochemical and nutraceutical properties composition. On the other hand, the bioactive chemicals from the custard apple seeds are integrated to produce by-products that have unique pharmacological qualities. The antibacterial, antidiabetic, anti-inflammatory, anticancer, antitumor, antioxidant, hepatoprotective, antiproliferative, antihelminthic, and antilarval effects of A. squamosa, or custard apple seed, have been the subject of substantial research. (Fig. 2). The important pharmacological properties/activities are well discussed in the following Sections **5.1**-**5.7**

5.1 Anticancer activity

The anticancer effectiveness among acetogenins derived apple seed oil was made from custard evaluated both in vitro and in vivo in opposition to human tumour cell lines. The seed oil of A. squamosa yielded two main acetogenins that were identified: bullatacin (256.18 mg/g) and 12, 15-cis-squamostatin-A (47.98 mg/g).which were found and measured by means of HPLC, or high-performance liquid chromatography. Seed oil has strong anticancer properties, especially when it comes to Hep G2 cells MCF-7 (IC50: 0.25 mg/mL) and (IC50: 0.36 mg/mL) cells grown

in vitro (Chen et al., 2012).Strong cytotoxic and antiproliferative effects were seen when leaf extract was used to treat MCF-7 and MDA-MB-231 breast cancer cell lines. The extracts showed a prolonged stimulation of apoptosis and a reduction in wound closure. Silver nanoparticles (As-Ag NPs) were synthesised from ASL extract and subsequently tested for anticancer effects using the HeLa (cervical carcinoma) cell line (Ruddaraju et al. 2019). According to the findings, these As-Ag NPs had a potent apoptotic effect on HeLa cancer cells. This might be brought on by atypical protein signalling and the creation among ROS, which would lead to oxidative stress, which would then trigger cell death and apoptosis (AshaRani et al. 2009).

5.2 Antidiabetic activity

In an experiment, rats with diabetes induced by alloxan (BW = 150 mg/kg body weight) were given the *A. squamosa* seed extract in both ethanol and methanol to investigate how it influenced the animals' blood glucose levels. *A. squamosa*'s ethanolic and methanolic seed extracts each revealed considerable dose-dependent antihyperglycemic action, with 43.96% and 45.99%, respectively. According to the findings, the ethanolic extract had lower hyperglycemic activity than the reference drug (glibenclamide). Active anti-diabetic substances include saponins, flavonoids, acetogenins, phenolic compounds, and alkaloids. The seed extract containing methanol and ethanol of apples may have its antidiabetic properties because it contains several of the above-mentioned antihyperglycemic compounds.(Sangala et al. 2011). An essential enzyme in our digestive tract, porcine pancreatic α-amylase (PPA) catalyzes the conversion of maltose to glucose in the small intestine after eating starch.

When this dietary starch is broken down, glucose levels rise quickly, which causes postprandial hyperglycemia (PPHG) to rise. Additionally, a significant factor in the management of diabetes is the correlation between increased glucose levels and malfunctioning of the small intestine's hypothalamic-pituitary-adrenal (HPA) axis (Eichler et al., 1984). Therefore, one of the most important aspects of treating diabetes would be to delay the degradation of starch by inhibiting the α-amylase enzyme. To do this, α-amylase inhibition was used to assess the antidiabetic efficacy various genotypes of custard apples using methanolic leaf extract.The most activity that was recorded was K-2 (43.64%), followed by Lok-1 (43.20%), K-1 (42.62%), and Aml-6 (41.89%).Aml-11 (2.41%), Aml-12 (3.07%), and Aml-4 (6.73%) are three of the thirty genotypes all showed antidiabetic efficacy, with a mean activity of 23.81%.

5.3 Antioxidant activity

Research was done on the protective agent effects verbal plant leaf water-based extract administration to plasma insulin, lipid peroxidation in the liver and kidney, glucose, haemoglobin, glycosylated haemoglobin, antioxidant enzymes, and diabetic rats caused by streptozotocin (STZ).After receiving an water-based extract orally 30 days at a time, diabetic rats showed important reductions within blood sugar, lipid, as well as lipid peroxidation. However, there were increases in plasma insulin levels as well as the actions of antioxidant enzymes like catalase, superoxide dismutase, reduced glutathione, and glutathione peroxidase.

The current research examines how aqueous extract supplementation helps experimental diabetic rats maintain their blood glucose levels, improve plasma insulin levels, regulate their lipid metabolism, and protect them from diabetic problems caused by lipid peroxidation and antioxidant systems. Because they include free radicals, the phenolic chemicals found in plant extract, such as polyphenols, flavonoids, tannins and terpenes, shown a strong antioxidant action.(Rahman and Moon, 2007).

5.4 Antimicrobial activity

Because they have strong preventative properties, plant-based antimicrobials are considered safe, effective, and affordable alternatives to synthetic antimicrobials with more noticeable negative effects. Though *Annona squamosa* is a fruit plant used for commercial purposes due to its creamy, succulent flesh; it is also said to have powerful pharmacological qualities, such as antibacterial action due due to the existence of various metabolites that are secondary, including Alkaloids, oils, saponins, phenols, glycosides, phytosterols, and flavonoids (Cosentino et al. 1999). Many studies have revealed that *Annona squamosa* leaf extracts are highly antifungal and antibacterial qualities. Significant antibacterial activity was shown by An active acetogenin component is called annotemoyin extracted from leaf extract in chloroform, and by specific flavonoid substances that were isolated from an aqueous leaf extract of the plant.

5.5 Anti-inflammatory activity

Inflammatory illnesses such as multiple sclerosis, inflammation of the intestine, rheumatoid arthritis, and chronic asthma can be brought on by elements that interfere with anti-inflammatory mediators, either internal or exogenous. For example, *A. squamosa* seed extract
lowers the lipopolysaccharide (LPS)-stimulated macrophage J774A.1 cell line's TNF- and IL-6 levels.It has been demonstrated that the extraction of two cyclic cyclopeptides from the from the custard apple seeds, which were generated simultaneously, exhibit anti-inflammatory properties by inhibiting the synthesis of IL-6 and TNF (Dellai et al. 2010).

5.6 Hepatoprotective Activity

Stress, sedentary lifestyles, and poor eating habits can all contribute to an imbalance in the body's synthesis and metabolization of fat, which is the main cause of fatty liver disease (FLD), also known as hepatosteatosis. Furthermore, it is known that some drugs, such as paracetamol, damage hepatocytes. A high fat diet and drug damage cause oxidative stress in hepatocytes, which encourages hepatosteatosis even more. The business and other healthcare professionals are currently very concerned about liver damage caused by drugs. Consequently, compounds with hepatoprotective properties may be lipid peroxidation inhibitors, antioxidants, or scavengers of free radicals. ASLs have a high level of antioxidant activity. ASLs have been found to contain flavonoids, glycosides, saponins, alkaloids, and phenolic chemicals (Rajeshkumar et al. 2015). *A. squamosa* seed extract has been shown to have a concentration-dependent hepatoprotective effect by lowering levels of Total bilirubin (0.71-1.47 mg/dL), SGOT (51.22-87.37 U/L), SGPT (38.21-96.22 U/L), and ALP (98.28-159.25 U/L)in a study. According to the study's findings, *A. squamosa* seeds can be utilised to prevent liver damage (Mehta and Paliwal 2017). Fig 2. represents the various health benefits of *A. squamosa.*

5.7 Other activity

As previously indicated, *A. squamosa* seeds also display a number of additional pharmacological properties. Since the dawn of time, Traditional medicine has made use of *A.Squamosa* to exfoliate skin and get rid of lice. Custard apple seeds include biologically active compounds like acetogenins, alkaloids, polyphenols, and cyclohexapeptides. In recent years, researchers have looked at the pharmacological effects of specific acetogenins, including their capacity to heal wounds, ability to repel insects like lice and mosquitoes, and antioxidant and anticancer qualities. When tested on earthworms, the *A. squamosa* seed extract also demonstrates antihelminthic qualities. Additionally, it exhibits antihelminthic qualities against sheep and goat nematodes. Additionally, when compared *to A. muricata*, the ethanolic *A.squamosa* seed extract suppresses the expansion of larvae in Spodoptera litura. The findings of all the aforementioned investigations demonstrate *A. squamosa*'s pharmacological significance, demonstrating its pharmacological worth (Kumar et al. 2021).

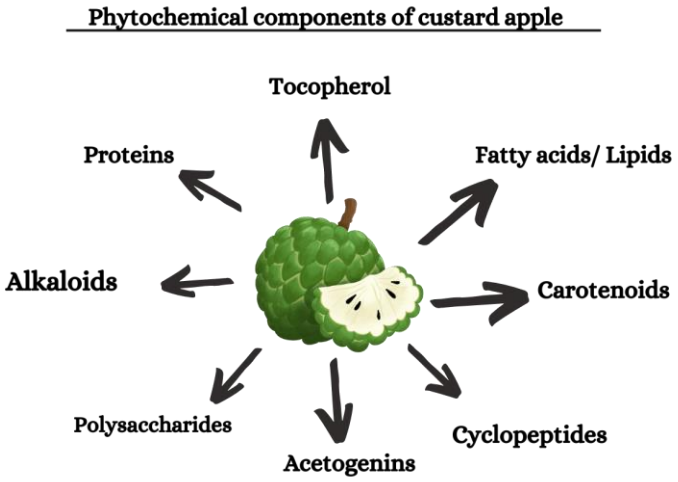

Fig. 1. Phytochemical properties of custard apple

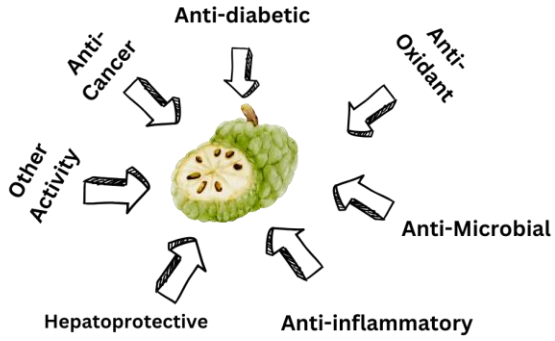

Fig. 2. Biological properties of custard apple powder

Table 1. Nutritional profile of *A. squamosa*

Nutrition	Amount
Water	180gm
Protein	5.6gm
Ash	1.6gm
Total Calories	233
Calories from Fat	6.5

Calories from Protein	18
Calories from Carbohydrates	225
Total Fat	720gm
Omega-6 Fatty acids	90gm
Total Carbohydrates	49gm

6. Conclusion

Custard apple has become more well-known due to the current rise in studies and research on the benefits to health and bioactivities of different plant parts, such as the fruits, leaves, bark, and seeds. A. squamosa has been used in food preparation since between 50 and 80 percent of the fruit is edible used worldwide in traditional medication and most likely being abused in the food industry. Custard apples have noteworthy phytochemical, biological, pharmaceutical, and nutraceutical activity because of the abundance of flavonoids, phenolic substances, metabolites, and other active substances. ASLs provide a number of advantages as a naturally occurring fruit ingredient, nutrient-rich food ingredient, and naturally occurring medicinal plant that is used globally to treat a range of acute and chronic ailments. Experiments conducted in vitro and in vivo revealed that A. squamosa seed extracts were useful in a variety of biological activities including anticancer, antibacterial, antifungal, hepatoprotective, antidiabetic, anticancer, and antifertility properties. A few research has focused with relation to the phytochemical profile of *A. squamosa* as well as the molecular underpinnings of its many biological activities.Further pharmacological study is needed to determine the crop's potential as a dietary supplement and nutraceutical.

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Statements and Declarations

Conflict of interests

The authors declared that they have no conflict of interest with respect to this work.

Credit author statement

Praveen Verma: Conceptualization, Md Shakeeb Alam: Writing-original draft preparation, Suman Bodh: writing-review and editing, Abdul Waheed Wani& Sanjeev Kumar: writing-review and editing. All the authors read and approved the manuscript.

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