

Review Article

Nutritional and Therapeutic Potential of Soursop

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Soursop (*Annona muricata*) has been one of the most studied fruits in recent years, owing to its potential medicinal benefits, as evidenced by many studies. Soursop is a tropical and subtropical fruit having great versatility and is quite sensitive to drastic temperature fluctuations. Since soursop contains various phytochemicals, it can be used medicinally to treat a wide range of conditions, including diabetes (by inhibiting the enzymes α -glucosidase and α -amylase), tumor, cancer, oxidative stress, blood pressure, the induction of apoptosis in tumor cells as well as hemorrhagic disease and cholesterol lowering. Due to its significant nutritional profile and therapeutic potential, it can be utilized in the development of nutraceuticals and medicines. Its pulp, seed, and leaf extract are used as functional ingredients in different foods as value-added foods. This review article is intended to characterize fruit development patterns and examines potential maturity indicators in soursop. In addition, it also elaborates on the potential nutritional and active phytochemicals present in this magnificent gift of nature and their possible uses in the food and pharmaceutical industries.

1. Introduction

Fruits have long been an imperative part of the human diet. They are also regarded as dietary supplements and are universally recognized as vital to their well-being. Moreover, fruits are also high in moisture; carbohydrates; and organic, inorganic, and bioactive components [1, 2]. Herbal-based therapeutics have a key role in human well-being since prehistoric times. Plant phytochemicals have served a critical role in pharmacological advances in the past century. The interest of scientists in the biological activities of plants has been stimulated in recent years as a result of the significance of plant active components in agricultural and medical purposes [3, 4]. Soursop, also known as *Annona muricata*, has gained tremendous fame owing to its rich nutritional

profile [5, 6]. The term *Annona* means “annual harvest” in Latin. Root length, root development, wood, xylem, flowering behavior, fertilization, fruit development, and kernel type are all common characteristics in the genus [7]. *Annona muricata* popularly known as soursop or custard apple is a plant that belongs to the Annonaceae family. This plant thrives in hot environments throughout the USA, Europe, India, and Africa. The soursop fruit is bright green, spiny, spherical, sweet, sour, creamy, and delicious [8]. There are around 119 different species of this fruit found around the globe. Currently, seven species and one crossbreed of this fruit are globally cultivated for domestic purposes [9].

Before this fruit crop can be developed and exploited rationally, it is necessary to understand the high postharvest respiration rate of soursop requirements, fruit maturation,

and appropriate maturity indicators. It has little storage time, is subject to senescence, and cannot be used in any further processing operations [5]. This fruit is gaining interest owing to bioactive compounds possessing nutraceutical properties. The soursop pulp is a wonderful source of fiber and contains several intriguing compounds that may have health advantages if consumed in moderation. The polyphenols found in the soursop plants, for example, are natural chemicals with antioxidant activity that defend cells against free radical damage [10]. More than 200 different bioactive compounds have been found in this plant, the majority of which are alkaloids, phenols, and acetogenins [8].

Soursop phytochemicals have been used in herbal therapy for a long time. They can be used to treat medical conditions, such as bacterial or parasite infections, fever, hyperglycemia, hypertension, inflammation, anxiety, and cancer. Soursop extract has demonstrated antibacterial, anti-protozoan, anti-inflammatory, antioxidant, and antitumor properties in different scientific interventions [8]. The objective of this review article is to evaluate the soursop fruit development patterns and explore the possible maturity indicators. It also elaborates on the active phytochemicals present in this fruit and their possible therapeutic functions against different diseases.

2. Distributions

Soursop (*Annona muricata*) is classified into different categories such as sweet (sub-acid) and acidic (acid) in taste and spherical, elongated, or triangular in shape [11]. *Annona* species, commonly known as “custard apple,” is a member of the Annonaceae family that has been cultivated for its tasty fruits in many tropical regions around the world [12]. *Annona muricata* is also known by other names such as soursop, guanabana, paw-paw, graviola, and sirsak. Soursop seems to be native to the tropical regions of the United States. However, it expanded to other tropical and subtropical countries, such as India, Malaysia, and Nigeria. This fruit is a green heart-shaped with a diameter of 15 to 20 cm. When fully developed, their oval leaves have axillary buds that are 6 cm broad and 12 cm long [4]. The texture of the flesh varies from soft and moist to hard and dried [13].

3. Production Technology

Despite its high respiration rate and ethylene generation, soursop has a high level of degradation. When the temperature is between 21 and 30°C, it thrives but it is quite sensitive to drastic temperature fluctuations, especially if the limit of 12°C is reached. Frost kills young trees in exposed areas with only a few degrees of frost exposure. Temperatures near freezing can cause temporary defoliation and fruiting interruptions [13]. Different factors can affect the quality of soursop such as climate conditions (temperature, humidity), premature harvesting, handling, storage conditions, and postharvest technologies [13].

As a result of the complicated pollination process in soursop, the fruit set is poor and the yield is low. For 6–15 weeks after pollination, soursop flowers remain dormant in the environment. The quiescent period lasts 6–15 weeks after the fruit has grown to about half its size. From post-anthesis quiescence through physiological maturity, soursop fruits have a life cycle of 100–150 days (14–21 weeks) [13].

As soon as it reaches full size and has a faint yellow-green tint, the soursop fruit is harvested. It will fall off the bud if it is left to soften on the tree, and ought to be handled with care as it is easy to bruise or puncture. Firm soursop fruits can be stored at room temperature for a few days. According to studies of the fruit's ripening process, the best period for eating soursop fruits in Hawaii is 5–6 days after harvest, when ethylene production is at its peak. According to research on the first harvest of 5-year-old trees, Hawaii had an average of 42.5 kg of fruits per tree [11]. Next year's yield was a little lower. In the third year, the average output per tree was 78 kg. At this rate, the annual crop would be 16 tons/ha. Since this crop has a restricted market, it is important to develop methods to postpone fruit ripening. Accordingly, chilling temperatures of 15°C extended the storage life of soursop without influencing the nutritive value of the fruit. In this respect, the majority of attempts have been undertaken to increase the shelf life of the soursop fruits after harvest. Fruit's quality depends on when it reaches physiological maturity. When fruit is harvested at an early stage, it will have a poor flavor. Correct handling, proper storage conditions, and diverse postharvest technologies are being developed to delay fruit ripening and minimize poor quality and postharvest losses. Refrigeration, emulsions, 1-methylcyclopropene (1-MCP), and waxes are among the technologies that can currently be used to preserve the quality of soursop [13].

4. Fermentation of Soursop

As the soursop fruit has a distinctive taste, aroma, and short shelf life, it has been used in different value-added products. Soursop wine and soursop vinegar are produced by alcoholic fermentation and acetous fermentation processes, respectively. Comparing the acceptability of soursop vinegar produced commercially with that of apple vinegar, it was found that soursop vinegar had higher overall acceptability than apple vinegar. As a result, it was hypothesized that soursop vinegar can have a competitive edge in the market. This has the potential to not only make the consumption of soursop more sustainable, but it also has the potential to reduce the amount of fruit that is wasted and to promote the use of soursop in other food products' applications [14].

Probiotic fermentation can increase the availability of phenolic compounds with highly promising antioxidant potential for human health benefits. Carotene, citric acid, gallic acid, catechin, pyrocatechol, vanillin, quercetin, protocatechuic acid, and propyl gallate are the most important compounds in probiotic fermentation. Therefore, this kind of fermentation can reduce the risk of diseases and exert a pharmacological effect [15].

5. Nutritional Composition

The soursop fruits are made up of 4% core, 8% seeds, 20% peel, and 67% edible pulp by weight. Their pulp is rich in protein; carbohydrate; water; nonreducing sugar; and vitamins B₁, B₂, and C [16]. Several physicochemical characteristics were refractive indices of 1.356 for the pulp and 1.335 for the seeds, pH values of 4.56 for the pulp and 8.34 for the seeds, and soluble solid contents of 151Brix for the pulp and 1.51Brix for the seeds. The second most copious component of the soursop pulp next to water are the sugars, which constitute about 70% of the total solids. The reducing sugars, glucose, and fructose were 93.6% of the total sugar content. Using gas-liquid chromatography, fructose, D-glucose, and sucrose contents of the soursop pulp were 1.80, 2.27, and 6.57%, respectively, to make a total sugar content of 10.48%. The soursop fruit contains 12% sugar (mostly glucose and some fructose), pectin, calcium chloride, sodium, potassium, and citrate [12].

The fiber content of the soursop pulp was reported as 0.78 and 0.95%. The alcohol-insoluble solids were mainly pectin, which in ripe fruit is 0.91% on a fresh weight basis. The fraction decreases from 12.0 to 4.0% on a dry weight basis from climacteric-to-climacteric phases. The wet weight of the soursop pulp has been reported to be 0.055 gN/100 g. 91% of this amount was contributed by the acid and free amino acids. 11 free amino acids were identified by paper chromatography and four other unknown ninhydrin-positive components were detected. Proline and γ -aminobutyric acid were the most copious free amino acids. Other amino acids identified were serine, aspartic acid, glutamic acid, glycine, citrulline, alanine, cysteine, lysine, and arginine [17]. A study of the preharvest deterioration of soursop and its effect on nutrient composition was performed in Ibadan, southwestern Nigeria. Four fungal pathogens including *Botryodiplodia theobromae*, *Fusarium* sp., *Rhizopus stolonifer*, and *Aspergillus niger* were found to be linked with the preharvest deteriorating soursop. Nutrient analysis shows that the freshly harvested noninfected soursop fruits have 14.88–14.91% carbohydrates, 0.89–0.90% ash, 1.20–1.24% crude protein, 19.15–19.35% dry matter, 78.49–78.68% moisture content, 0.63–0.65% sodium, and 1.39–1.41% potassium at five tested sites. Comparable values have also been documented. An estimated 39% reduction in the carbohydrate contents has been observed in the freshly harvested fruits. This was probably due to the degradative activities of the pathogens leading to a decrease in the quality of the fruit. The contaminated fruits had about 20 and 11% loss in crude protein and dry matter, respectively. However, the ash and moisture contents of the infected fruits were higher than those of the noninfected ones [18].

The soursop fruit has a distinct aroma and flavor [19]. It is a unique fruit with delightful fragrant and creamy pulp. The fruit is rich in vitamins, minerals, and dietary fiber [20]. The fruit's edible pulp makes up around 66% of the total weight and has a pleasant aroma and flavor. This is rich in vitamins and minerals. Polyphenols are categorized into groups based on their chemical structure with main examples including phenolic acids and flavonoids (Table 1)

[22]. Methanol extract phytochemical investigation revealed the presence of alkaloid and flavonoid. Meanwhile, ethyl acetate extract included tannin, saponin, and phenolic compounds, and hexane contained tannin and phenolic compounds [17].

Virgen-Cecena et al. [23] added the soursop pulp to yogurt and frozen desserts to improve its functional and nutritional characteristics. The research concluded that these value-added food products include dietary fiber, ascorbic acid, and polyphenols, all of which have high antioxidant activity. Sonication technology was used to extract phytochemicals from soursop and added to yogurt and frozen dessert, which was a quick, safe, and low-cost method of extracting phytochemicals from soursop-based foods [23].

6. Compositional Characteristics of the Soursop Seeds

The seeds of the soursop fruit are rich in oil and protein and small intoxicants (cyanide, phytate, and tannins) and therefore might be harnessed in human and animal nutrition. The seeds contain 22% pale-yellow oil and 21% protein. The oil is bland in taste and contains an acid value of 0.93, a saponification value of 227.48, an iodine value of 111.07, and an acetyl value of 66.77. The oil consists of 28.07% saturated and 71.93% unsaturated fatty acids. The seeds yield a yellowish-brown 70% unsaturated oil which consists of 12–33% linoleic, 41–58% oleic, 16% palmitic, and 5% stearic with traces of myristic acid. If some potentially hazardous components can be eliminated, this oil might have economic value as an edible oil. The seed contains a higher content of magnesium and zinc than the pulp; moreover, the pulp has a higher content of potassium and calcium than the peel or seeds. The seeds also have 0.2% water-soluble ash, 0.79% titratable acidity, and 17.0 mg calcium in every 100 g [24, 25].

7. Therapeutic Potential of Soursop

The phytoconstituents and bioactive compounds of *Annona muricata* L. (medicinal herb) were examined and it was revealed that they possess medicinal properties. The soursop leaf was identified to be useful in inhibiting the cancer cells by inducing apoptosis, improving immune response, decreasing glucose concentration in blood, reducing depression, stimulating digestion, and dilating blood vessels [18]. The soursop fruit bioactive components along with their therapeutic potential are presented in Table 2.

7.1. Anticarcinogenic Effect. The annonaceous acetogenins found in the soursop leaf showed strong inhibitory effects against human cancers such as airways, breast, small intestine, liver, and renal cancers. Medicinal herbs can be a beneficial or complementary addition to standard cancer treatments. The soursop leaves are used in traditional medicine to treat a variety of ailments. They have increased flavonoid concentration compared to the roots and stalks [34].

TABLE 1: Nutritional value of the soursop fruit.

Nutritional components	Amounts	References	
Antioxidant components (mg/100 g)	Total phenolic compounds	449.47	
	Total flavonoid compound	1.97	[21]
	Total anthocyanin contents	0.15	
Organic acids (mg/100 g)	Lactic acid	15.56	
	Acetic acid	1.66	[21]
	Citric acid	1.43	
	Oxalic acid	0.02	
Sugar content (mg/100 g)	Glucose	0.41	
	Fructose	0.62	[21]
	Sucrose	1.86	
Physiochemical properties (%)	Moisture	67.45	
	pH	3.87	
	Protein	3.59	
	Fat	0.8	[1]
	Crude fiber	2.36	
	Ash	1.98	
	Soluble fiber	5.4	
	Thiamine	0.11	
	Riboflavin	0.05	
	Niacin	1.28	
	Nutritional profile (mg/100 g)	Ascorbic acid	29.6
Tryptophan		11	
Methionine		7	
Lysine		60 g	

Annonaceous acetogenins present in this fruit have shown significant antitumor properties. In the leaves of *A. muricata*, 34 acetogenins have been isolated. Acetogenins have been shown to have higher toxicity in tumorous cells than in normal ones. Many plant antioxidants, including quercetins, flavonoids, and flavones (2-phenyl-4H-1benzopyran-4-one), have been found to have chemopreventive effects, reducing the occurrence of many types of cancers, especially in the intestinal epithelium. Natural polyphenols, such as flavones, flavonols, isoflavones, catechins, and anthocyanins were demonstrated to possibly prevent cancer, with respect to the research and implications of these chemicals on human health [26].

Daddiouaissa et al. [35] studied human breast cancer cells (MCF-7); they used an ionic liquid extract of soursop extract (IL-GFE) and observed the cytokinetic behavior of the cells. Additionally, the distribution of the cell cycle and the mechanism of apoptosis of IL-GFE action on MCF-7 cancer cells were determined. They concluded that the growth of tumor cells can be reduced by using ionic liquid extract of soursop [35].

7.2. Antihemorrhagic Effect/Anticoagulant Properties. Hemorrhoids are a prevalent disorder in humans, usually occurring in the rectum, while external hemorrhoids form under the skin around the anus. Although it is difficult to determine the exact prevalence of hemorrhoids since so many people with the disorder are reluctant to admit it, it is more common among those aged 45–65 [36, 37].

Plants rich in phenolic compounds such as flavonoids, tannins, stilbenoids, catechins, lignins, and phenolic acids can help with autoimmune illnesses, inflammatory bowel disease, and hemorrhoids. Flavonoids and phenolic

compounds have been proven in several studies to boost the antioxidant potential of natural substances. The phytochemical acetogenins, alkaloids, and megastigmanes and phenolic compounds such as quercetin and gallic acid present in *A. muricata* are thought to have antioxidant and anti-inflammatory properties. As soursop leaf extract has anti-inflammatory properties, it can be used against hemorrhage [27]. The aqueous extract of the soursop leaf has a natural combination of bioactive components with a biogenesis (new blood vessel formation from a preexisting vessel) function [38].

7.3. Antidiabetic Effect. Hyperglycemia is a change related to insulin secretion problems, insulin sensitivity issues, or both. In the treatment of diabetes, lowering hyperglycemia is a key therapeutic strategy. However, inhibiting key enzymes (α amylase and α glucosidase) responsible for the starch breakdown and glucose assimilation would provide a nutraceutical option for disease management. The activity of the enzymes α amylase and α glucosidase does take a significant impact on blood glucose levels—blocking these enzymes may reduce the glucose levels in the blood after eating considerably (Figure 1). In this figure, rats were treated with methanol extracts of soursop for 28 days after which pancreatic and blood tissue samples were collected for α -amylase assay. In vitro inhibitory properties of methanol, ethyl acetate, and dichloromethane extracts from various parts of the plant on α -amylase and α -glucosidase activities were performed using standard procedures. The mode and mechanism of interactions between the enzymes and extracts (isolated acetogenin) were determined. This study showed that the soursop fruit pulp can hinder α -amylase and

TABLE 2: Bioactive components along with their therapeutic potential.

Therapeutic attributes	Bioactive components	Function	Reference
Anticarcinogenic effect	Annonaceous acetogenins (polyphenols) Flavonoids Quercetins	Chemopreventive properties lower the incidence of cancer	[26]
	Flavone (2-phenyl-4h-1benzopyran-4-one) Acetogenins Alkaloids		
Anticoagulant properties	Megastigmanes Phenolics Quercetins Gallic acid	Improve immune response Prevent inflammation Antihemorrhagic effect	[27]
	Total phenol flavonoid Antioxidant enzymes (superoxide dismutase (SOD), catalase, and nitrite oxide)		
	Caffeic acids Procyanidins B ₂ Catechins Quercetins Kaempferols Flavonoids		
Antidiabetic effect	Tannins Alkaloids	Inhibitory effects on α -amylase and α -glucosidase. Prevent the accumulation of glucose in the blood.	[28, 29]
	Essential oils Alkaloids Coumarins Tannins		
Anticholesterol properties	Flavonoids Carbohydrates Phenols Terpenoids Saponins	Control fatty acid catalyze activity and lower LDL, TGs, as well as VLDL Reduce blood cholesterol.	[30] [31]
	Extracted with n-butanol		
Antioxidant properties	Flavonoids	Free radical scavenge activity.	[32]
	Carbohydrates Phenols Terpenoids Saponins		
Antihypertension and hyperuricemia properties Induce apoptosis in cancer patients	Flavonoids	Reduce the production of new uric acid and keep the blood pressure under control.	[33]
	Flavonoids	Potent inducer of apoptosis	[26]

α -glucosidase activity and decreased fat deposition in the blood [39].

Different studies have shown that the activity of α -amylase and α -glucosidase has a substantial impact on blood sugar levels and that inhibiting these enzymes can considerably minimize blood sugar levels after eating a meal [40]. The seed coat of the soursop fruit with the greatest total phenol and flavonoid content would have inhibitory effects on α -amylase and α -glucosidase. Plant nutrients' suppressive effect on α -amylase and α -glucosidase was due to their phenolic components. Furthermore, the finding that soursop extracts inhibited α -glucosidase more than α -amylase substantially is therapeutically important. Phenolic-rich extract from the soursop plants reduced α -glucosidase activity more than α -amylase activity [28]. Further research indicates that soursop seed oil also has the potential to reduce type 1 diabetes [41].

The aqueous extract of the soursop leaf is used to reduce glucose uptake in the intestine and enhance resistance to glucose load [42]. When a hyperglycemic patient uses *A. muricata* extracts, antioxidant enzymes like superoxide nitrite oxide, catalase, and dismutase (SOD) may be restored

while lowering blood glucose levels. Lipid peroxidation can be decreased by inhibiting malondialdehyde and transamination. Soursop has also been shown to have a protective effect against liver lipid peroxidation when consumed [43]. Probiotic fermentation of soursop fruit residue has bioaccessibility of phenolic compounds and its invitro study showed the inhibition activity of α -amylase, thus helping to prevent the diabetes [44].

7.4. Effect on Lowering Cholesterol. High levels of LDL cholesterol (LDL-c) are a characteristic of the hereditary illness familial hypercholesterolemia (FH), which can progress to coronary heart disease prematurely (CHD) [45]. Fruit pulps containing phytochemicals with a pleasant fragrance, such as *Annona muricata*, may have positive metabolic benefits, particularly on lipid status. *Annona muricata* is very rich in essential oils, with alkaloids among the chemical components identified in the plant. Fatty acid synthase (FAS) is a multienzyme protein that catalyzes the production of fatty acids. Its real task is to catalyze the conversion of acetyl-CoA and malonyl-CoA into palmitate (saturated fatty acid) in the

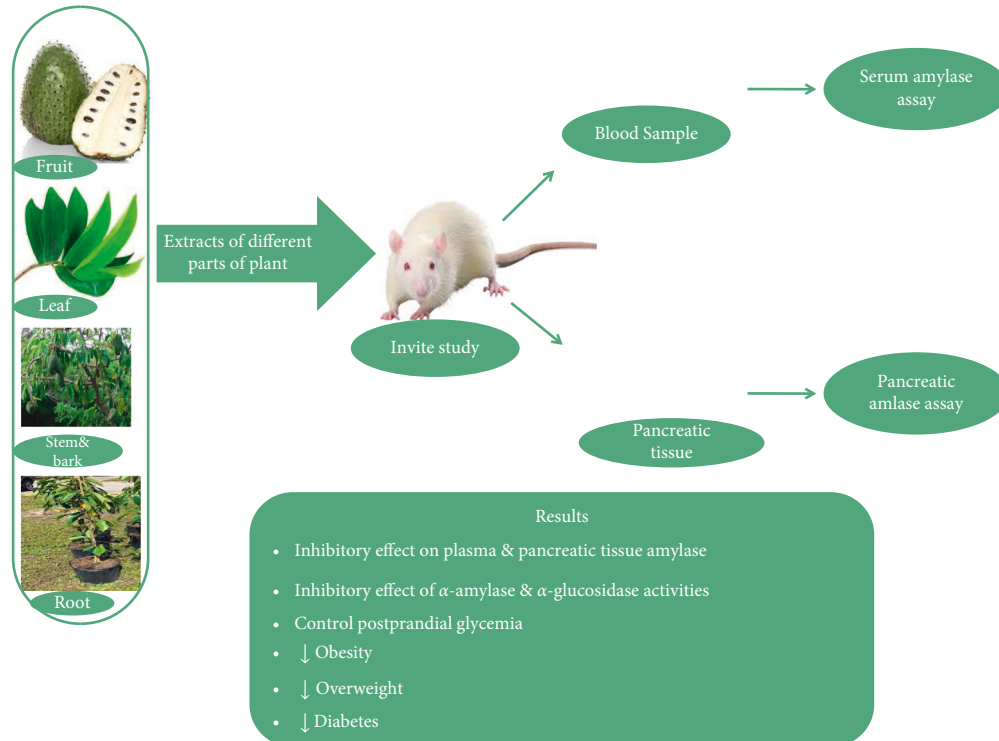


FIGURE 1: The antidiabetic activity of soursop [39].

presence of NADPH. In humans, this enzyme is essential for de novo synthesis. FAS catalyzes all of the chemical steps in the conversion of acetyl-CoA and malonyl-CoA to palmitate and other long-chain fatty acids using its seven active sites. Soursop bioactive components affect basal lipid profile and plasma FAS activity which decrease plasma low-density lipoprotein (LDL), triglycerides (TGs), and very low-density lipoprotein (VLDL) cholesterol [30].

Soursop leaf extract contains flavonoids, tannins, and alkaloid active substances which can reduce blood cholesterol. To decrease cholesterol levels, people take three to five doses of soursop leaf extracts daily, which are boiled in two to three glasses of water until just a half to one glass of water remains. Ethanol extract of 96% of soursop leaves at concentrations can reduce total plasma cholesterol [31].

7.5. Antioxidant Properties. Free radicals produced in excess through metabolic functions and different external stimuli could be reduced by plant products, which are high in a range of functionally active chemicals with antioxidant potential. Excessive levels of free radicals induced oxidative stress, that could cause tissue, DNA, protein, and lipid damage, necessitating the consumption of dietary antioxidant substances that aid the body in neutralizing these free radicals [46]. Flavonoids and tannins are phenolic chemicals, their availability in soursop extracts may be vital for the reported free radical scavenging actions [47]. The leaves of soursop contain therapeutic active substances (e.g., alkaloids, coumarins, tannins, flavonoids, carbohydrates, phenols, terpenoids, and saponins that have antioxidant activity [32].

A study found that the ethanol extract of the soursop plant contains alkaloid, saponin, terpenoid, flavonoid, coumarin, lactone, anthraquinone, phenol, and phytosterol phytochemicals (acetogenins). These phytochemicals are powerful enzyme inhibitors primarily in the membranes of tumor cells. Antioxidant action is linked to their capacity to reduce reactive oxygen species, for example singlet molecular oxygen and peroxy radicals functioning as deactivators of excited molecules and chain breakers, respectively. This study reports that ethanol extract of this plant has phytochemicals with secondary metabolites that have moderate antioxidant activity [48].

In a study, researchers used standard biochemical procedures to evaluate the antioxidant properties of soursop. The results showed that the hydroxyl-free radical scavenging capacities of the leaf and stem bark petroleum ether fractions were higher. When compared to the other parts of the plant, the leaf and fruit pulp of soursop have a high antioxidant capacity. This is due to the abundance of phytochemicals and other phytoconstituents such as phenols, flavonoids, alkaloids, and essential lipids. As a result of these findings, it was concluded that there exists a possible correlation between the ethnomedicinal properties of soursop and its antioxidant potentials [49]. Another study in vivo indicated that soursop fruit juice 2.22 ml/kg body weight for 56 days can have a significant improvement in the antioxidant potential [50].

7.6. Effect on the Blood Pressure Level. Blood pressure may be defined as the pressure of circulating blood against the walls of blood vessels. When an individual has increased blood pressure (BP), the individual's arteries are under more

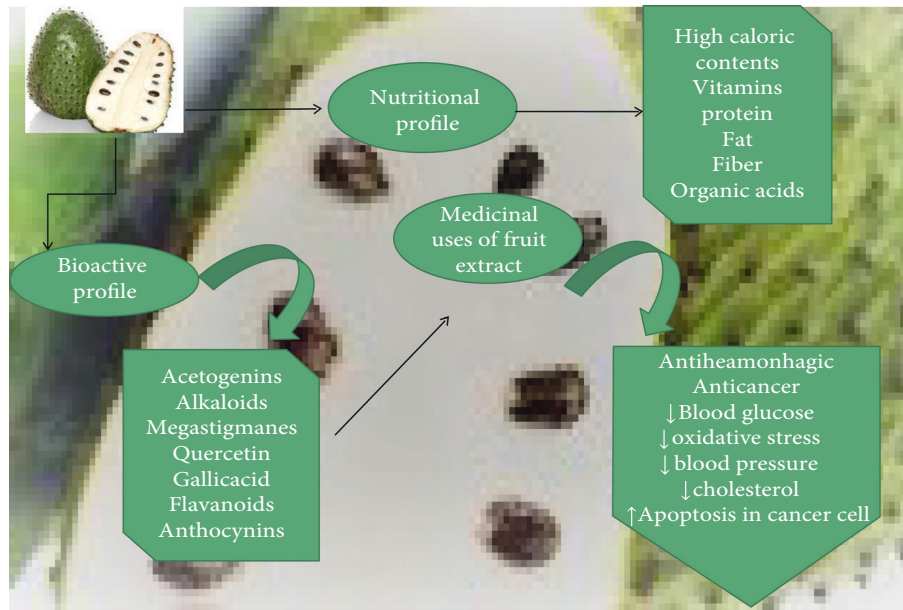


FIGURE 2: The nutritional and medicinal potential of soursop.

pressure than they should be. Hypertension is a term that describes elevated blood pressure. There are over 80 million adults over the age of 20 who are affected by high blood pressure, making up one-third of all mature persons in the United States. Many of these people are completely unaware of their elevated blood pressure issues. It is risky to ignore increased blood pressure treatment. High blood pressure raises the chances of congestive heart failure, stroke, peripheral arterial diseases, or kidney diseases [51].

The soursop fruit carries the phenolic compounds and alkaloids which can lower BP and control the uric acid production in hyperuricemia patients [52]. Different studies have proved that after a 12-week therapy period, using soursop fruit supplements can reduce blood pressure and serum uric acid levels. In hyperuricemia patients, a dosage of 250 and 500 mg/kg body weight of soursop leaf extract with n-butanol prevented additional uric acid production and regulated blood pressure [33].

7.7. Apoptosis-Inducing Properties. Apoptosis is a type of planned cell death that is triggered by an internal program. Proteolytic enzymes are activated by cells which should kill during the apoptosis process. Apoptosis plays a role in suppressing the progression of liver disease, either through the intrinsic or extrinsic pathway, as well as disorders of the mitochondria [53, 54]. This is a crucial physiological function that is necessary for tissue homeostatic processes and normal cell maintenance [53]. Apoptosis delay is a characteristic of cancer and is agnostic to the origin or kind of cancer; therefore, addressing it is helpful for many forms of cancer [55]. *A. muricata* has therefore been suggested as a possible nutritional supplement for the creation of apoptotic medicines. The flavonoids in this fruit have been shown to be a more potent inducer of apoptosis than the well-known anticancer agent camptothecin. It has been suggested that *A. muricata*

could serve as a natural product source for the development of drugs that induce apoptosis in cancer patients. Flavone activity has been linked to changes in mRNA levels of cell cycle, apoptosis-related genes, and nuclear transcription factors. Furthermore, flavone induced apoptosis with great specificity and inhibited proliferation has been depicted exclusively in altered colonocytes [26]. Figure 2 summarizes the nutritional and medicinal potential of soursop.

8. Conclusion

Global interest in soursop has increased significantly in recent years due to its nutritional, functional, and therapeutic properties. Because of its excellent pulp extraction, various aromatic components, and notably rich viscosity, several studies have indicated that soursop can serve as a good raw material for the processing of various functional and value-added food products. The leaves, seeds, and residue of soursop contain a wide range of pharmacologically active compounds, including alkaloids, coumarins, tannins, flavonoids, phenols, terpenoids, and saponins. Owing to its pleasant odor and flavor, soursop is among the most suitable fruits in terms of economic potential and commercialization. In a nutshell, the soursop fruit and its components may be used in the food and pharmaceutical industries to develop a range of functional and high-value food products as well as medicines.

Data Availability

The data that support the findings of this study can be obtained from the corresponding author upon request.

Ethical Approval

This article does not contain any studies with human participants or animals performed by any of the authors.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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