Botany, Ethnomedicine, Phytochemistry and Pharmacology of Musk Cucumber (*Sicana odorifera*) - A Review

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Review

Abstract

Background: *Sicana odorifera* is a fruit with a strong aroma that is native to Brazil and is extensively dispersed throughout Tropical America, because they have historically been used to treat a variety of illnesses like diabetes, high blood pressure, inflammation, itchiness, and more, have a name as "cassabanana", "sikana", or "musk cucumber".

Methods: Google Scholar, Web of Science, Sci-finder, PubMed, Elsevier, Wiley, China National Knowledge Infrastructure, Open Access Library, and SpringerLink were used to locate references about *Sicana odorifera* between 1963 and 2022. "The Plant List" (www.theplantlist.org) and "The World Flora Online" (www.worldfloraonline.org) gave the scientific plant names.

Results: Despite being regarded as Indigenous fruits, *Sicana odorifera* is significant for the creation of prospective sources of herbal remedies since the community consumes them. Catechins, depsidia and depsidones, coumarins, steroids and triterpenoids, flavonoids, glycosides, along with polysaccharides, saponins, tannins, and alkaloids have all been identified using phytochemistry screening. Recent studies have shown the pharmacological effects of *Sicana odorifera*, including its hypoglycemic, anti-depressants, and numerous traditional uses. Even though ethnomedical uses were an invaluable resource for pharmacology, several claims that certain plants might heal conditions like anemia, the symptoms of fever, diarrhea, or discomfort in the stomach fail to be validated by recent studies.

Conclusions: It is necessary to clarify the differences between ethnomedical applications and modern pharmacology and between phytochemistry screening and structural elucidation. This review shows that *Sicana odorifera* can be regarded as a promising source of phytomedicines whenever we look into their possible function.
Keywords: *Sicana odorifera*, Ethnomedicine, Phytochemistry, Pharmacology.

Background

One of the most significant families is the Cucurbitaceae family of plants used and marketed in the world, straddling the Old and New Worlds (Bisognin. 2002). According to Nuez et al. (2000), this family has the corresponding 118 genera and about 825 species, with a primarily tropical distribution, with nine genera and 30 cultivated species.

Cucurbitaceae is a botanical family of vines widely refined worldwide, instead of important social, economic, and cultural importance (Fapohunda 2018). Among the cucurbits used by man, there are species sophisticated due to the sensory and attractive quality of their fruits, and their phytotherapeutic character (Souza *et al.* 2012; Parada *et al.* 2000).

Sicana odorifera Naud is a cucurbit identified the same as "cassabanana", "sikana" or "musk cucumber". A *Sicana odorifera* is a slightly identified species of cucurbit, being a vine, whose length can reach more than 15 meters (Alves, J *et al.* 2021). It is a cylindrical fruit with soft skin, color ranging from reddish-purple to dark purple, about 15 cm in width and 35 cm long (Madeira., 2016). The pulp is ample and yellowish, with dark brown compressed seeds measuring around 1 cm (Brasil., 2015). Although it is widely distributed all over Tropical America, it is understood that this species is indigenous to Brazil, more particularly to the Recôncavo Baiano, and that it has widened all over the United States (Jesus *et al.* 2016; Kienteka *et al.* 2018).

Although it is found in the nation of the Caribbean nation, Costa Rica, the Dominican Republic, Nicaragua's population, El Salvador, Guatemala, Mexico, Honduras, the territory of Puerto Rico, Panama City, Venezuela, Colombia, Peru, and Bolivia, it is thought to be native to Brazil (Montano *et al.* 2007) (Fig. 1).

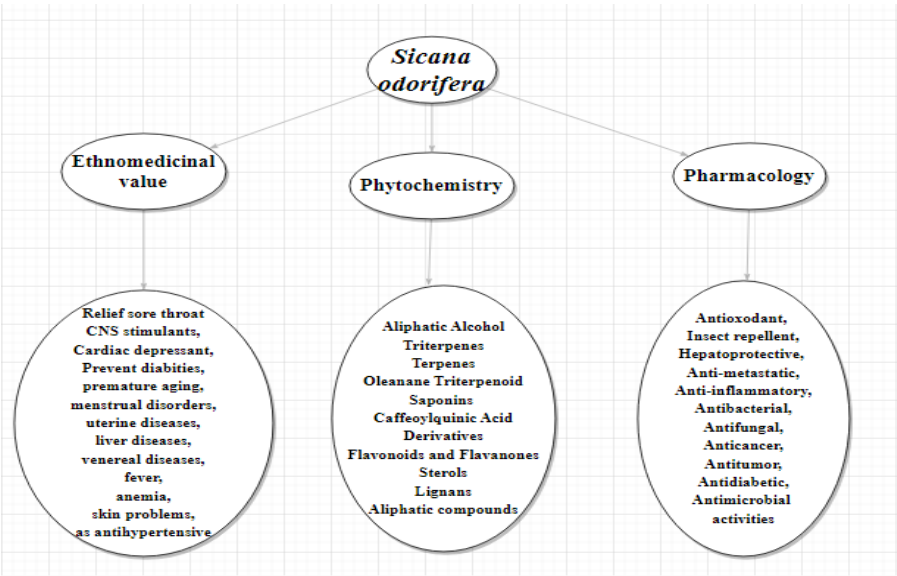


Figure 1. Uses of *Sicana odorifera*.

Among individuals used by man, some species originated and cultivated in different continents: in Africa, species of the genus *Citrullus* and the species *Cucumis anguria*; in Asia, *Cucumis sativus*, *Momordica charantia, Luffa cylindrica* it is *L. acutangula*; in the Americas, species of the genera *Cucurbita, Lagenaria* it is *sechium* and the species *Sicana odorifera* it *is Luffa operculata* (Souza *et al.* 2012).

There are numerous uses of raw red fruit in admired cultures, among which its use in cooking for arrangements such as conserve, jellies, juices, and sweets stands out. When juvenile, it can be addictive after cooking, and after maturation, it is enjoyed raw (Jaramillo *et al.* 2011; Kienteka *et al.* 2018). In addition, the fruit can be stored for up to six months behind harvesting, as long as it does not bear injuries (Priori *et al.* 2006).

Regarding the dietary characteristics of red cruá, some significant nutrients, for example, vitamins A, C, and E, and some B vitamins, in accumulation to minerals such as calcium, potassium, and phosphorus, have previously been recognized in the fruit and are important nutrients for human health (Filho *et al.* 2015).

The name "Coroa" or "Curua" is frequently used to refer to both the plant and its fruits (*Cucurbita odorifera*, Velloso, Flor. Flur). Its delicious aroma makes you want to consume them right away. The taste is syrupy and initially not unpleasant; however, it quickly makes me queasy and is intolerable to me. Fruits can be stored for four to five months without going bad; thus, I drive them before training in the hopes that they will arrive in good condition. *Sicana odorifera* has never been truly uncultivated in my experience; I have only ever seen it in farmland; therefore, I cannot be certain of its native place in Brazil (Lawson *et al.* 2010).

A vine is herbaceous and persistent. The fruit has a dense shell and is flat, shiny, cylindrical, orange-red, maroon, or black—the moist, light yellow to orange spongy tissue of the fruit. A dark-brown hoop surrounds the light-brown, elliptic seeds. Sikana is utilized as a mature fruit as well as a decorative and healing plant (Montano *et al.* 2007)—taste-tested seeds from various undeveloped and recycled sources. No phytoliths were present in the *Cucurbita* species, but leaves, peduncles, and tendrils produced a variety of siliceous substances, primarily from hair cells and hair bases that are characteristic of vegetative tissues (Piperno *et al.* 2000).

Conventional medicine continues to be very trendy since a huge part of the population has moreover no contact with or assets from Western medicine. Bacterial infections and irritation are between the ailments treated by conventional healers. While the World Health Organization has articulated high attention to conventional medicine, it is important to display scientifically that remedies working in folk medicine are certainly therapeutically dynamic (Munoz & Sauvain. 2002).

In accumulation to helping as food for man from ancient times to the present day, the fruits of several species are also used for animal nourishing and also as sources of oils, proteins, fibers, and raw material for the assemble of bottles, pipes, instruments music, masks and sponges used for private sanitation (Bisognin., 2002; Feijó. 2005).

Triterpenes and flavonols, which have been found in the skin and seeds, have been reported as secondary metabolites (Jaramillo *et al.* 2011; Nakano, Fujimoto, & Takaishi., 2004). A few chemical investigations have been done on this fruit. The free and glycosidically bound volatiles of *S. odorifera* fruit were taken into consideration because of its potent aroma (Parada *et al.* 2000). With 37 chemicals identified during GC and GC-MS psychoanalysis of the free explosive extract produced by liquid-liquid mining, 3-methyl-2-butanol, 3-hydroxy-2-butanone, ethyl 3-hydroxybutanoate, and (Z)-3-hexanol were determined to be the primary ingredients. The main components of glycosidically bound volatiles were identified as 4-hydroxybenzyl methyl ether, 4-hydroxybenzyl alcohol, and 2-phenylethanol. It's interesting to note that 4-hydroxybenzyl alcohol, among the principal volatiles produced by enzymatic hydrolysis of the glycosidic fraction, was identified as the precursor to [4-(-D-glucopyranosyloxy) benzyl] 2,3-dihydroxy-3methylbutanoate and 4-(-D-glucopyranosyloxy) benzyl alcohol. In a further investigation, the seeds of this fruit were used to isolate the two triterpenes cucurbita5, 23-diene-3,25-diol as well as D: C-friedo-oleana-7,9 (11)-diene3R,29-diol dibenzoate (karounidiol dibenzoate), as well as taxifolin and quercetin (Nakano *et al.* 2004).

Plant species from the *Cordillera blanca*, one of the high-altitude areas of Peru, have been considered in recent years for their antimicrobial, anti-cancer, and sore healing activities (Neto *et al.* 2002). Western researchers have just recently begun to study plants that may have antimicrobial properties, and several investigations have indicated that some of these plants may be bioactive (Perumal Samy & Ignacimuthu, 2000). Some of the plants that were affected have had their access to potentially aggressive chemicals shut off (Bussmann *et al.* 2011).

Plant polysaccharides found in cell walls have drawn an enormous amount of attention since they may be utilized in food processing to provide physiological characteristics to yield (Lopes da Silva & Rao, 2006) in addition to their nutritional assists that include antibiotics (Qian, 2014), cancer-preventing (Delphi & Sepehri, 2016), and immune-modulating actions (Amorim *et al.* 2016).

There is information on the use of *S. odorifera* in trendy medicine as antihypertensive, antihemorrhagic, healing of skin problems, anemia and gastroesophageal reflux, menstrual disorders, uterine diseases, worms, and indigestion. Given the above, this study meant to distinguish the secondary metabolites of notice pharmacology in extracts made from the fruit's, foliage, seeds, flesh, as well as skin, and an estimation of the fruit's antioxidant capacity (Tebaldi VMR *et al.* 2019).
This is the first review concerning the botany, ethnomedicine, phytochemistry, and pharmacology of Musk cucumber (*Sicana odorifera*). Furthermore, there is also a discussion of the existing research's limitations and prospects for the future.

Methods

Nomenclature

Except for one Cayaponia species found in the west of Africa as well as Madagascar, every 12 genera of the Cucurbitaceae are found only in the Modern World. They can be identified by their large, spiky, pastorate pollen grains. The refined species, *Sicana odorifera* Well.) Nauct. (cassabanana), and 5 Cucurbita species (pumpkins, squashes, and marrows), *C. pepo* L., *C. inixta* Pang., *C. maxima* Lam., *C. moschata* (Lam.) Poir. as well as *C. jicfolia* Bouchc (all but the last, annuals), can only recognized by (Jeffrey *et al.*1980).

Taxonomy and Classification

According to Kocyan et al. (2007) and Schaefer & Renner (2011), almost all of the cucumber family tend to be annual or perennial herbs, with 50% of the species being monoecious and 50% being dioecious. Most members of the Cucurbitaceae have unisexual blooms, as well as according to outgroup comparability, dioecy seems to represent the family's original condition (Zhang *et al.* 2006).

Habitat or Ecology

A new known species in a similar tribe as Cucurbiteae is *Sicana odorifera* (2n = 40). This large, perennial herb grows in tropical South America and has developed into a beautiful plant along with its non-bitter, ripe fruits, which look like squash (Janick and Paull, 2008; Schaefer and Renner., 2011).

S. odorifera is one species found in Paraguay. The peel's color differs among accessions, ranging from orange-red, maroon, or dark purple to completely jet black. The epicarp is stiff. Many round and oval-shaped seeds are present in the soft pulp (de Paula Filho *et al.* 2015).

The fruit known as cassabanana was cultivated in Neotropical forests, most likely in South America. One hemisphere of its phytoliths is noticeably conical in shape, and it frequently reaches its maximum point in an uneven location relative to the other. The barely smaller or roughly equivalent size as the other hemisphere is the cone-shaped hemisphere, which has subtle decorations on it. A *Sicana odorifera* phytolith turned to show the variations in hemisphere-to-hemisphere morphology and adornment. In addition to forming a cone, the left hemisphere differs from *Cucurbita* in terms of surface design (Piperno *et al.* 2000)

Morphological characteristics

It has a roughly cylindrical form, is 30 to 60 cm long, has a hard shell, and is purple, velvety, and sparkly. The oval, light brown seeds have a dark brown ring around them. The pulp can be consumed as cooling or sliced and utilized to make jams when it is fully ripe, and as a result, focusing on osmotic dehydration (OD) processes is an excellent substitute for its preservation and maintenance of its practical life (Diofanor Acevedo Correa *et al.* 2018).

The "cassabanana," "sikana," or "musk cucumber," *Sicana odorifera* (Cucurbitaceae), is a stem-climbing perennial vine that might grow toward a height of at least 15 m (Krings *et al.* 2003). On top of petioles 4–12 cm extended, rounded-cordate, and rounded kidney-shaped, as much as 30 cm broad, as well as commonly 3-lobed with serrated or curving edges, the leaves vary in terms of size and shape. Flowers are 5-lobbed, urn-shaped, white or yellow, and lone; the female bloom is superior to the male (Krings *et al.* 2003).

Cassabanana (*Sicana odorifera*) is a rapid-growing perennial herbaceous plant, requiring trellises for mountaineering. The vines favor growing up in fractional to full sun. Its vines mount trees of 15 m or greater with the aid of tendrils prepared using sticky disks, which may hold firmly onto the finest surface. The juvenile stems were enclosed with several tiny gland hairs resembling structures on them (Kellog *et al.* 2002).

The leaves, which are three-lobed with saw-like margins extremely concave at the bottom, are gray, smoothed kidney-shaped, and 30 cm broad. The leaf petioles are 4-12 cm elongated. Its five-lobed and urn-shaped flowers born lonely in the axil of the leaf are also white or yellow. The male flowers are 2 cm elongated, while, the female flowers are about 5 cm long. The species is thought to have originated in Brazil, although it now spreads across tropical America. Each of *S. odorifera's* juvenile aerial parts is heavily embedded in 'explosive' glandular trichomes. The capitated, uniseriate trichomes can reach up to 0.2 mm (often 0.1-0.15 mm), as well as have a two-celled head with a larger, secretion-filled cell and a succeeding, small, and papillate cell on the apex. Although the apical cell is often curved, it might have a triangular drawing in certain types of trichomes on tendrils. The papillate cell immediately enters the secretory cell once the beginning methodology is used, suggesting that it is a step in the method of the secretory cell's fast ejection of its contents.

The head often breaks from the stalk during extensive discharge of the secretions (post-secretory stage); heads sometimes get incorporated into the assets gathered along arthropod legs. Contrarily, the trichome stalk gradually loses turgor over time, possibly even lengthening, before eventually degenerating. The stalks may act as natural barriers that allow the leaf to take cover. Unexploded "explosive" trichomes and the majority of extruded trichome stalks are discarded from the surface as the leaves mature.

Additionally, to the 'explosive' trichomes, a subsequent form of capitate glandular trichomes can be seen, yet it is less frequent. These trichomes are smaller and are typically 0.09–0.12 mm tall. They have a four-celled secretory head and a uniseriate, two–five cell stalk. *Oleander aphids* (*Aphis nerii*) were found on the leaves of *Sicana odorifera* to better understand the process by which the "explosive" trichomes defend themselves against herbivores (see also Kellogg, Taylor & Krings. 2002).

Fruits of cassabanana, which are prominent and well-known for their melon-like sugary, and attractive pungent strong odor, are extended and cylindrical and appear just as an overrun cucumber with very hard skin. The conspicuous fruit is 30-60 cm elongated, 7-11.25 cm broad, maroon, orange-red, and a dark purple with violet undertones or entirely black with almost cylindrical, ellipsoid, or occasionally somewhat bent in shape. On ripening, they turn into silky, flat with solid, orange-yellow or yellow, hard, cantaloupe-like with 2 cm broad succulent flesh. The fruit pulp with a plump core present in the central cavity is squashy.

The cavity is crammed with seeds, which are elliptical shaped, 16 mm elongated, 6 mm broad, and light-brown bound with a dark-brown band. In opening, the seeds are there in rows that are closely spaced and cover the entire fruit (Rana and Brar. 2017).

Table 1. Vernacular names of *Sicana odorifera*.

Place/Country	**Name**	**Reference**
Brazil	*Cruatina, melo caboclo, cura, coróa, curua, curuba,* or *melo mac,*	Lawson *et al.* 2015
Mexico	*melocotonero, calabaza melón, pérsico* or *alberchigo*	Rana and Brar. (2017)
Costa Rica	*calabaza de chila*	Rana and Brar. (2017)
Nicaragua	*Cojombro*	Rana and Brar. (2017)
Bolivia	*Pavi*	Rana and Brar. (2017)
Panama	*Chila*	Rana and Brar. (2017)
Peru	*padea, olerero, secana* or *upe*	Rana and Brar. (2017)
Colombia	*pepino melocoton, curuba,* or *calabaza de Paraguay*	Rana and Brar. (2017)
Venezuela	*cajú cajuba, cajua, cagua, calabaza de Guinea*	Rana and Brar. (2017)
Puerto Rico	*pepino, pepino angolo* or *pepino socato*	Rana and Brar. (2017)
Cuba	*Cohombro*	Rana and Brar. (2017)
El-Salvador and Guatemala	*Melocotón*	Rana and Brar. (2017)

Ethnomedicine

Traditional medicine continues to be extremely admired because a huge part of the population has moreover no access to or possessions from Western medicine. Bacterial infections and irritation are surrounded by ailments treated by conventional healers. Because the World Health Organization has uttered elevated interest in traditional medicine, it is significant to reveal systematically that remedies engaged in folk medicine are certainly therapeutically vigorous (Munoz & Sauvain., 2002).

The fruits exposed the occurrence of saponins, evidenced by the configuration of constant foam for more than 30 minutes. This metabolite has been worn as a pharmaceutical adjuvant in formulations, as vigorous components in herbal medicine, and as unrefined material for the amalgamation of steroids (Costa NC *et al.* 2017).

Plants with probable antibacterial action have been newly approached regarding the consideration of Western researchers, as well as several investigations have found that some are bioactive (Perumal Samy & Ignacimuthu., 2000). A few of the tested plants were successfully isolated from possibly strong chemicals (Bussmann *et al.* 2011).

Like in other South American nations, the Paraguayan people have been consuming natural fruits like kurugua since pre-Columbian times. The indigenous people employed the fruit in entire or in portions for a variety of uses. Although the seeds are effectively used to cure liver problems, the pulp of the plant is utilized to prepare beverages and pastries. It has been established that promoting its use will help to grow the crop and improve food security.

Individual initiatives to sustainably produce kurugua were prompted by the crop's potential loss as a conventional crop. The goal was to preserve the crop near home, with a cheap production cost for personal use or neighboring markets. The atropurpurea (the dark one) type is the most widely grown and commercialized. Each plant's harvesting volume is determined by several variables, including the kind of vine utilized, the quality of the soil when to sow the seed, the variety and caliber of the seed, and the local soil conditions.

Under equivalent soil conditions, the production volume may exceed 112 fruits of identical weight when the crop is produced by treetops and branches. Even though they may be preserved more easily compared to various fruits, fruits that are harvested carelessly sometimes end up wasted because they are harvested too late or are far from marketplaces. They can be kept for up to three months if stored in dry areas and under ideal postharvest circumstances. Kurugua is not yet extensively grown, but its unique color and scent make it a viable raw material for flavor and colorants in the food industry (Jaramillo *et al.* 2011). Ketineka *et al.* (2018) have emphasized the possibility of *S. odorifera* fruit peels as a unique source of antioxidant chemicals, including flavonols as well as anthocyanins.

The increasing interest in organic food additives has led to studies on fruits and vegetables as potential sources of antioxidants (Albuquerque *et al.* 2020, Domínguez *et al.* 2020, Ghada *et al.* 2020, Ochoa *et al.* 2020). Furthermore, the majority of them exhibit potential uses as food industry dyes, making them intriguing options as natural supplements. Ultrasound-assisted extraction (UAE) constitutes one of the most extensively researched extraction techniques (Albuquerque *et al.* 2020; Kumar *et al.* 2021) and is thought to be one of the most effective at extracting the target molecule (Farooq *et al.* 2020).

The consumption of this fruit's inedible components, such as its peel, for medicinal purposes, is not well-established in science, although its widespread utilization as a repellant, fresh food, perfume for clothing, and infusion of its seeds. According to current studies on the chemical composition of *S. odorifera* epicarp, the hydroalcoholic extract has a substantial amount of tocopherols, organic acids, and various other phenolic compounds, as well as strong antiseptic, antioxidant, antibacterial, as well as antifungal properties (Albuquerque *et al.* 2021).

These findings help close an understanding gap about its essential application. The purpose of this work is to give information on the extraction of a class of highly valuable bioactive molecules that have potential uses in the food and pharmaceutical industries. These uses could include new ingredients in functional foods that can substitute essential components like artificial coloring or alternative treatments in pharmaceutical products used in disease management or prevention.

Blanca, one of the elevated-height areas of Peru, has been considered in recent years for their antimicrobial, anti-tumor, and wound-healing actions (Neto *et al.* 2002). Nevertheless, even though the core of remedial traditions in Northern Peru is situated in the Trujillo/Chiclayo coastal area, no studies have been undertaken in this region so far.

In Puerto Rico, the fleshy tissue of its mature fruits is trampled and let to softly agitate overnight at room temperature while soaked in water with extra sugar. The fermented invention is drunk down with its fleshy tissue to get a reprieve from sore throat. At the same time, it is also supposed that a tiring necklace of its seeds around the neck is also extremely advantageous for sore throat. The leaves of *cassabanana* are engaged in the treatment of venereal infections and uterine bleeding. In Brazil, the mixture equipped from its seeds is also taken as a purgative, emmenagogue, febrifuge, and vermifuge. A remedy made from its leaves and petals and prepared in Yucatan (2 g in 180 ml water) is recognized as an emmenagogue, bowel movements, as well as vermifuge.

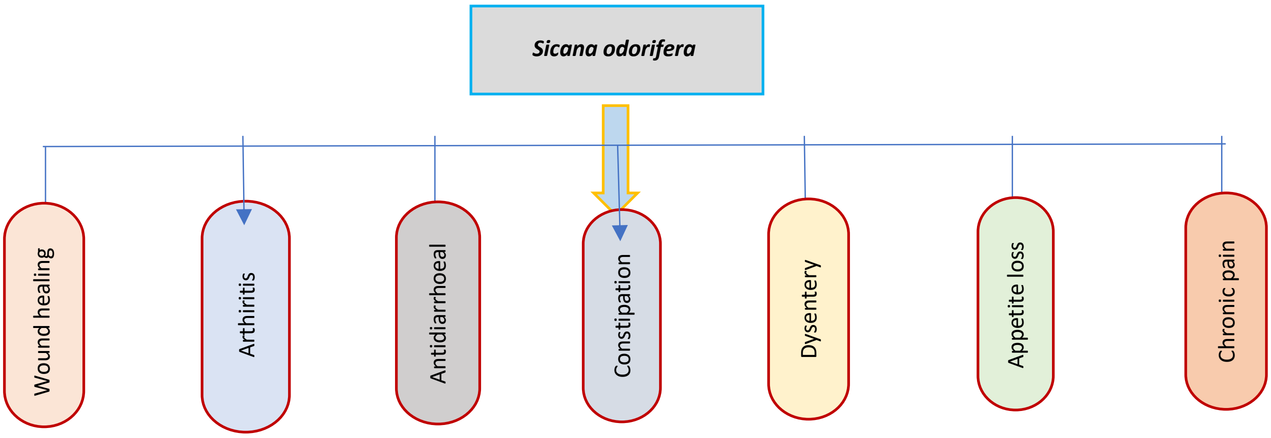


Figure 2. Traditional uses of *Sicana odorifera*.

The seeds and flowers of *cassabanana* capitulate a definite quantity of hydrocyanic acid so it is sensible not to create too much burly decoction from seeds and flowers. People consider that keeping its ripe fruits more or less in the house, particularly in muslin clothes repels moths, particularly in the rainy season because of its long-lasting burly smell. Placing its fruits on church altars in holy weeks is measured hopefully by the people of the Christian community. A lot of people favor employing its long-lasting mature fruits as air fresheners in kitchens and lavatories due to their long-lasting delightful and pleasing smell (Rana and Brar. 2017).

The first instance of visibly ill sikana plants was observed in the State of Rio de Janeiro in 2006. Witches' broom growths, extensive stunting, and yellowing resembling phytoplasma disease were signs of infected plants. This study's objective was to determine a phytoplasma that may be the cause of the Sikana Wiches' Broom Syndrome in Brazil (MONTANO H. G. 2006). Its most conventional type of use is as a pest repellent (Nakano *et al.* 2004) as well as a medication for hepatic conditions, anxiety, a painful throat, uterine bleeding, as well as venereal illnesses (Morton *et al.* 2004).

This fruit has been used in Brazil for different purposes such as decoration and trendy medicine, in which it is employed to treat several ailments and symptoms, being underutilized and of slighter monetary appearance, although with substantial characteristics (Araújo *et al.* 2016).

There is information on the use of *S. odorifera* in trendy medicine as antihypertensive, antihemorrhagic, healing of skin tribulations, anemia and gastroesophageal reflux, menstrual disorders, uterine diseases, worms, and stomachache (Lima JF *et al.* 2010).

It has been gaining a lot of consideration in recent decades due to its antitumor, immunostimulant, anticomplement, anti-inflammatory, anticoagulant, antiviral, hypoglycemic, and hypocholesterolemic stroke (Simões CMO *et al.* 2010).

It also has hypocholesterolemic distinctiveness, anti-inflammatory and antiviral action, and an enhancement in dieresis (Costa NC *et al.* 2017). Although fruits possess essential components for individual nutrition, including mineral deposits, vitamins, phenolic compounds, and nutritional fibers, their research is important (Rufino *et al.* 2010).

Regarding nutritional fibers, these are composite carbohydrates derived from plants that the human intestine is unable to digest. They are necessary for the proper functioning of the digestive system, moreover, are additionally connected to the prevention of numerous ailments, such as tumors, diabetes, as well as coronary heart disease (McDougall, Morrison, Stewart, & Hillman., 1996).

Tannins can be ascribed a variety of actions such as antidiarrheal and antibacterial, antimicrobial, and antifungal, are hemostatic and can supply as an antidote in cases of intoxication, in accumulation to serving in the therapeutic process of wounds, burns, and irritation (Monteiro JM *et al.* 2005).

Table 2. Ethnomedicinal uses of *Sicana odorifera*.

Plant part	Ethnomedicinal use	Reference
Bark	Have been recognized for having antitumor, analgesic, and antipyretic properties	Tebaldi *et al.* 2019
Bark	Used as a refreshment, antipyretic, uterine bleeding and sexually transmitted infections (stis)	Tebaldi *et al.* 2019
Bark	Have been recognized for having antioxidant, and antiviral properties	Tebaldi *et al.* 2019
Flesh	Soaked in water with extra sugar and used to relieve sore throat	Rana and Brar. (2017)
Flowers	Make the mixture and use as laxatives, emmenagogue, and vermifuge	Rana and Brar. (2017)
Flowers	Used as an antiflatulent, also combating dyspepsia and pain-causing spasms	Rana and Brar. (2017)
Fruit	Used as ornamentation and popular medicine	Araújo *et al.* 2016
Fruit	Used as hypno-analgesic, cardiac depressant, central nervous system (CNS) stimulant, myorelaxant, sympathomimetic	Araújo *et al.* 2016
Fruit	Used to treat coronary heart disease and diabetes, antioxidant has hypocholesterolemic characteristics	Araújo *et al.* 2016
Fruit	Used to treat a variety of symptoms and illnesses	Araújo *et al.* 2016
Fruit	Protects the body and prevents premature aging	Araújo *et al.* 2016
Fruit	Has anti-inflammatory and antiviral activity and an increase in dieresis	Araújo *et al.* 2016
Fruit	Used as anticholinergic, amebicide, emetic, antihypertensive, antimalarial, antitumor, and antitussive properties	Araújo *et al.* 2016
Fruit	Used to prevent premature aging	Araújo *et al.* 2016
Fruit Peel	Used as a medication for treating liver disorders	Albuquerque *et al.* 2021
Fruit Peel	Used to treat fever and uterine haemorrhaging venereal infections	Albuquerque *et al.* 2021
Fruit Peel	Used as an insect repellent	Albuquerque *et al.* 2021
Fruit Peel	Used for the treatment of throat discomfort	Albuquerque *et al.* 2021
Fruit Pulp	Used in soups, preserves, sliced and peeled like melon	Simões *et al.* 2010
Fruit Pulp	As they irritate the bronchial mucosa and increase the volume of secretion, helping with expectoration	Simões *et al.* 2010
Fruit Pulp	They act as secretolytics	Simões *et al.* 2010
Fruit Pulp	Have antitumor, immunostimulant, anti-complement, and anti-inflammatory properties	Simões *et al.* 2010
Fruit Pulp	In accumulation to being used in the preparation of juices, compotes, jellies	Simões *et al.* 2010
Fruit Pulp	As anticoagulant, antiviral, hypoglycemic, and hypocholesterolemic action	Simões *et al.* 2010
Leaves	Used in treating uterine hemorrhages	Rana and Brar. (2017)
Leaves	Used in treating venereal diseases and many others	Rana and Brar. (2017)
Seeds	Beneficial in sore throat	Rana and Brar. (2017)
Seeds	Used as diuretics, myorelaxant, sympathomimetic, and antiviral among many others	Rana and Brar. (2017)
Seeds	Used as antitussive, hypnoanalgesic, cardiac depressant,	Rana and Brar. (2017)
Seeds	Used as central nervous system (CNS) stimulant	Rana and Brar. (2017)
Seeds	Used as an anticholinergic, amebicide, emetic, antihypertensive, antimalarial, antitumor	Rana and Brar. (2017)
Seeds	Seed infusion is taken as a febrifuge	Montano *et al.* 2007
Seeds	Used as a febrifuge, vermifuge, purgative and emmenagogue, anticonstipant	Rana and Brar. (2017)
The whole plant, flesh	Used for Jealousy, Charm	Bussmann *et al.* 2011
Whole plant	Having antioxidant, antiviral, antitumor, analgesic, and antipyretic properties	Tebaldi *et al.* 2019
Whole plant	Used for menstrual disorders, uterine diseases, worms, and heartburn	Lima *et al.* 2010
Whole plant	Used as an antinode and has antioxidant, anti-proliferative, antibacterial, and antifungal activities	Albuquerque *et al.* 2021

Whole plant	Used for making jam or other preserves	Rana and Brar. (2017)
Whole plant	Cooked in the veggie form and also used in stews and soups	Rana and Brar. (2017)
Whole plant	Witches' broom growths, generalized stunting, and yellowing suggestive of phytoplasma disease were among the sick plants	Montano *et al.* 2007
Whole plant	As an antihypertensive, antihemorrhagic, treatment of skin problems	Lima *et al.* 2010
Whole plant	Used to treat anemia and gastroesophageal reflux	Lima *et al.* 2010

Phytochemistry

The family of cucurbits is distinguished biochemically because cucurbitacins are present as well as additional triterpenoids found in fruits or vegetative parts, as well as via the prevalence of released amino acids, seed oils, as well as protein stores in the seeds. The cucurbitacins, which are oxygenated tetracyclic triterpenes, are the vinegar-like philosophy of the Cucurbitaceae. Eight of the liberated amino acids from the seeds have been discovered, and a significant number of various ninhydrin-positive substances have been reported (Jeffrey *et al.* 1980).

On this fruit, there's not much knowledge about chemical studies. The volatiles in unbound and glycosidically bound *S. odorifera* fruit have been taken into consideration because of their potent aroma (Parada *et al.* 2000).

To identify the 37 compounds, present in the free volatile extract resulting from liquid-liquid extraction, GC and GC-MS have been used. Of these, 3-methyl-2-butanol, 3-hydroxy-2-butanone, ethyl 3-hydroxybutanoate, as well as (Z)-3-hexanol have been determined to be the primary ingredients. The main components of glycosidically bound volatiles were identified as 4-hydroxybenzyl methyl ether, 4-hydroxybenzyl alcohol, as well as 2-phenylethanol. It's interesting to note that 4-(-D-glucopyranosyloxy) benzyl alcohol and [4-(-D-glucopyranosyloxy)benzyl]2,3-dihydroxy-3methylbutanoate were shown to be antecedents of 4-hydroxybenzyl alcohol, among the principal volatiles produced via glycosidic fraction hydrolysis by enzymatic means. Following research isolated taxifolin, quercetin, and the two triterpenes cucurbita5,23-diene-3,25-diol as well as D: C-friedo-oleana-7,9(11)-diene3R,29-diol dibenzoate (karounidiol dibenzoate) from the seeds of this fruit (Nakano *et al.* 2004).

There are few studies associated with the fruit, though it has been reported that the unrefined red fruit has a variety of nutrients, including carotenoids, vitamin C, vitamin E, and vitamin A, rich in potassium, copper, iron, and zinc. A portion of 105 g provides about 70 kcal with elevated protein concentrations (Paula *et al.* 2015).

Free and glycoconjugate aromatic compounds implicated in aroma formation were secluded and characterized from fruit squash (Maximiliano *et al.* 2019).

(Jaramillo *et al.* 2011) also account for the existence of flavonoids and anthocyanins with antioxidant action in the fruit peel. In the chemical composition of the fruit *S. odorifera*, 37 volatile compounds were recognized in the pulp, 22 of which are accountable for the fruit's aroma4. In the seeds, triterpene substances, flavones, and quercetin were evidenced (Jaramillo *et al.* 2011).

Determination of total phenolic compounds, anthocyanins, and antioxidant capacity

The raw red fruit showed interesting values of phenolic compounds. For comparison purposes with a fruit of the same botanical family, Tamer et al. (2010) found 476.6 mg/100 g of pulp of phenolic compounds in *Cucurbita moschata* L, lower levels than those found in red cruá. Phenolic compounds are varied groups of secondary metabolism products of plants and have high antioxidant capacity (Dias *et al.* 2015). According to Kuskoski et al. (2006) and Melo et al. (2008), the antioxidant capacity is mainly caused by phenolic chemicals in fruits, accounting for more than 90% of the total antioxidant capacity of fruits. According to Brandão et al. (2011), the ripening process reduces the number of phenolic compounds in fruits; therefore, it is believed that immature raw red fruits present higher amounts than those found in the present work.

Employing the Folin-Ciocalteu method (Gressier *et al.* 2000), the total amount of phenol was assessed, and the findings were represented in gallic acid equivalents (GAE, mg/100 g of fresh mass) utilizing a standard curve of gallic acid (0.05 to 1.2 mg/mL). All analyses were carried out in triplicate.

Torres et al. (2002) were modified to get peel extracts for determining the phenolic components in fruit peels. One gram of the sample was diluted in fifty milliliters of a 70% hydroalcoholic solution. The mixture was then filtered under vacuum after being homogenized in a magnetic stirrer at 25 °C for 1 hour. Using the Folin-Ciocalteu test developed by Quettier-Deleu et al. (2000), the peel's overall phenolic content remained assessed. Employing a standard curve of gallic acid (0.05 to 1.2 mg/mL), according to the data, gallic acid equivalents were obtained (GAE, mg/100 g of fresh mass).

Anthocyanins are substances with several functions. These phenolic substances confer color and perform important biological activities, such as antioxidant, anti-inflammatory, antimicrobial, and even neuroprotective functions (Khoo *et al.* 2017).

The anthocyanin content in the skin of the raw red fruit found in the current investigation, there lower than the anthocyanin content of the other fruits, such as blackberry (Morus), which has 201 mg/100 g; of the blueberry (*Vaccinium myrtillus*), with 243.8 mg/100 g, and jabuticaba (*Plinia cauliflora*), which has about 48 mg/100 g. These mentioned fruits are recognized for containing a high concentration of anthocyanins (Rigolon, 2017).

In accordance with Fuleki and Francis' methods, an extraction solution consisting of 95% ethanol was treated to pH 1.0 with 1.5 M HCl (85:15 v/v) and employed to extract anthocyanin pigments. A UV spectrophotometer with a wavelength of 520 nm was used to take the reading. Every analysis was done in triplicate (Paulo *et al.* 2019).

Melo et al. (2008) classified the %SRL of extracts from the pulp of several fruits, including several species of the Cucurbitaceae family, as follows: low, when below 50%; moderate, when between 50% and 70%, and high, when above 70%. Considering the classification proposed by the authors, the raw red fruit exhibited a high percentage of free radical scavenging (78.13%). The pulp of the raw red fruit showed a high antioxidant capacity (1,957.58 µM eq. trolox/g) when compared to the anti-oxidant capacity of other fruits, being the instance, for example, of the results found by Gonçalves (2008), who analyzed camu-camu fruit extract (*Myrciaria Dubai*), which is already well established as a fruit with high antioxidant activity (1,439 µM eq. trolox/g); abiu (*Pouteria caimito*) (69 µM eq. trolox/g); tamarind (*Tamarindus indica*) (21 µM eq. trolox/g), among other results. Genovese et al. (2008) and Hoffmann-Ribani et al. (2009) found, in strawberry (*Fragaria* × pineapple), 1221 µM eq. trolox/g. All these works used the same method of analysis as the present work. Therefore, the antioxidant power of raw red fruit can be considered high.

Determination of total carotenoids

For the analysis of total carotenoids in the fruit pulp, extracts rich in carotenoids were initially prepared with each part of the fruit. To obtain the extracts, approximately 0.5 g of samples previously ground directly into a beaker (50 mL) were weighed. The pigment was extracted from the sample with acetone (10 mL) and celite (1 g) using a porcelain mortar and pestle, and using a funnel over a sintered glass plate, the specimens were filtered until the residue was devoid of color (four extractions). Within a funnel that separates approximately 50 mL of petroleum ether, the total carotenoid extract (obtained via the extraction) was added, followed by the careful addition of distilled water (approximately 300 mL).

After phase separation, the aqueous phase, consisting of water and acetone, was discarded. When all of the extract was transformed into petroleum ether, the process was resumed. To thoroughly eliminate the acetone, the ether phase was then rinsed five times utilizing distilled water. After discarding water from the last wash, the ether extract is collected in a volumetric flask (50 mL) passing it through a glass funnel containing a small portion of anhydrous sodium sulfate (2 g) to remove any residual water collected within a measuring flask. After turning up the volume, read absorbance at a length of 450 nm in a UV-visible spectrophotometer (Rodriguez-Amaya, 2001).

Determination of vitamin C

A vitamin C (ascorbic acid) measurement was carried out using the approach described by Instituto Adolfo Lutz (2008), in which, through titration with potassium iodate, the spent volume of reagent can be calculated. Then, the product corresponding to the volume of reagent used was multiplied by the ascorbic acid factor, which is 0.8806, and subtracted from the weight of the samples.

Vitamin E

The fruits were extracted using a remedy of hexane: ethyl acetate (85:15, v/v), comprising 0.05% butylated hydroxytoluene as well as anhydrous sodium sulfate. The eight homologs of vitamin E (-, -, tocopherols, and tocotrienols) were then examined. The experiment was carried out via the chromatographic procedures suggested by (Pinheiro-Sant'Ana *et al.* 2011) which consists of the HPLC system, fluorescence detector (290 nm for excitation along with 330 nm for emission), LiChrosorb column (Si60 Phenomenex 250 mm × 4 mm, 5 µm) fitted with a guard column (Phenomenex Si100, 4 mm×3 mm), a mobile phase: hexane: isopropanol: glacial acetic acid (98.9: 0.6: 0.5, v/v/v); as well as flow rate of the mobile phase: 1.0 mL min−1.

Physical-chemical characterization

The physicochemical characterization of the fruit in nature can be verified as well as its representativeness percentage in the Recommended Daily Intake (RDI) for an adult individual with a simulated energy demand of 2,000 kcal and having a food plan composed of 65% carbohydrates, 20% lipids and 15% of proteins. Moreover, with a demand of 25 g of dietary fiber per day.

A high moisture content was observed, similar to the levels found in fruits of *Citrullus lanatus* (92.3%) and *Cucumis melo* (93.3%), both from the Cucumber family (Morais *et al.* 2017). The moisture content of fruits is related to their perishability (Coutinho & Cantillano. 2007).

The present study found a considerable protein percentage in the fruit pulp, with 100 g corresponding to approximately 6.6% of the daily protein needs of an adult individual. It should be considered the fact that it is a food of vegetable origin, which naturally exhibits reduced amounts of this important macronutrient, which enhances the information about the fruit's protein content studied here. The total protein content of the raw red fruit is higher than that found in fruits of the same family, such as *Citrullus lanatus* (0.9%), *Cucumis melo* (0.7%), and *Cucumis sativus* (0.9%) (State University of Campinas. 2011).

Regarding fibers, the present study found a content similar to that found in papaya (*Carica papaya* L.), which was 1.8% (Morais *et al.* 2017). The interest in dietary fiber is due to its many positive health effects, such as intestinal regulation and the reduction of glucose and serum lipid levels (Mineiro, 2014).

The soluble solids/titratable acidity ratio of the redraw fruit pulp was 133.33, showing that the fruit was picked ripe. Soluble solids are related to the acceptance of the foodstuff, due to their relationship with its sweetness (Silva *et al.* 2002).

Regarding the pH, the value found (6.00) indicates that the pulp is slightly acidic, similar to the values found by other authors.

The state of maturation of the fruit at different stages, or even the environmental conditions of the place where the fruit is harvested, can influence its physicochemical characteristics (Nascimento *et al.* 2014).

Identification and quantification

Tocopherols and tocotrienols (vitamin E standards) have been bought from Calbiochem, EMD Biosciences, Inc. (USA). We bought L-ascorbic acid from Sigma-Aldrich in Germany. By using open-column chromatography, standards of -carotene and -carotene have been extracted from concentrated carrot extracts, while -cryptoxanthin and lycopene have been extracted from papaya (*Carica papaya* L.) and tomato (*Solanum lycopersicum* L.) extracts, correspondingly. Thereby correlating the peak retention periods acquired for the standards and samples within identical circumstances, it was possible to identify the chemicals.

Additionally, equivalents to vitamin E were discovered utilizing co-chromatography, and carotenoids and ascorbic acid were recognized by contrasting the absorption spectra of the interest peaks in the samples and standards utilizing the DAD. Applying analytical curves as well as regression equations created by the triplicate injection of six distinct standard solution concentrations, the chemicals detected in the fruit of the genus *Sicana* were measured. Peak regions and the amounts of each administered substance were correlated linearly (Galdino *et al.* 2015).

Free and Glycosidically Bound Volatiles

The free and bound volatile compounds recognized in the previously noted extracts through HRGC and HRGC-MS analyses, the retention metrics encountered through experimentation for every compound and the ones acquired for genuine allusion chemicals or those indicated in the chemical literary works, as thoroughly as the concentration of all scent compound determined on the foundation of the standard included as well as the odor explanation of every GC separated volatile.

The 37 chemicals (94.8% of the total extract) are free volatiles, with the main constituents comprising 3-methyl-2-butanol, 3-hydroxy-2-butanone, ethyl 3-hydroxybutanoate, as well as (Z)-3-hexanol. In the melon de olor free volatiles profile, aliphatic alcohols (61.1%) dominated, with hydroxyl ketones (14.6%), aliphatic acids (7.5%), hydroxy-esters (4.8%), terpenes (2.7%), aromatic compounds (2.6%), aldehydes (1.5%), and unknown chemicals (5.2%) following closely behind. In contrast to melon (*Cucumis melo*), melon de colors near relative, and another member of the Cucurbitaceae family, melon has a very distinct free volatile profile. Sulfur compounds make up a larger portion of the volatiles in the melon fruit than they do in other tropical fruits including banana, mango, papaya, passion fruit, and guava. The scent spectrum for melon de olor, on the other hand, is distinct and is documented here.

At the initial time, the 22 aglycones produced by enzymatic hydrolysis in melon de olor fruit were recognized as binding fragrance components. One hydroxy ketone (0.4%), one sulfur compound (0.3%), one unidentified compound (0.3%), and aliphatic acids (5.0%) made up the majority of the recognized glycosidically bound compounds (87.3%). These were then followed by hydroxy-esters (3.9%), aliphatic alcohols (2.8%), and one hydroxy ketone (0.4%). The 4-hydroxy benzyl alcohol, 4-hydroxy benzyl methyl ether, benzyl alcohol, as well as 2-phenyl ethanol comprise the composition of bound volatiles (Parada *et al.* 2000).

Physicochemical Characteristics

According to (Coronel *et al.* 2020), morphological research was conducted on entire fruits lacking any prior treatment. Following the AOAC Methods (Horwitz *et al.* 2000), the pH (technique N 920.152), tithable acidity (technique N 925.53), as well as soluble solids (technique N 932.14) remained assessed. Both an analytical balance (KERN ADB, Baligen, Germany) and a potentiometer (BOECO, MBT-700 type, Berlin, Germany) were utilized.

Proximal Composition

Official AOAC methodologies were used to identify the proximal composition of the endocarp as well as the seed of the examined fruits: moisture (method number 950.06), ash (method number 923.03), dietary fiber (method number 991.42), total lipids (method number 970.51), as well as total nitrogen (method number 920.152), utilizing the conversion factor 6.25 from nitrogen to proteins. The Clegg anthrone technique was used to calculate the amounts of soluble sugars and overall carbs without any prior acid hydrolysis, correspondingly. The outcomes were given in grams per 100 grams of fresh sample (Caballero *et al.* 2021).

The investigated types of *S.odorifera* have similar-looking flat oval seeds that are brown in hue. Kurugua seeds have a centesimal composition that is mostly composed of lipids (more than 34%), dietary fiber (greater than 34%), as well as proteins (greater than 17%) in dried seeds (Mereles *et al.* 2021).

Total Phenol Content

The amount of total phenols in the fruit's endocarp and epicarp was quantified. The extracts have been created using an 80:20 methanol and water mixture, as instructed by IICA (Daz *et al.* 2018). The approach that Singleton and Rossi outline was used to determine total phenols spectrophotometrically utilizing the Folin-Ciocalteu reagent, with the blue-colored complex being quantified at 765 nm (UV-1800, Shimadzu, Kyoto, Japan). The calibration curve for gallic acid (10–160 g/mL) was applied. The outcomes were given as mg of gallic acid equivalents (GAE) for every 100 g of fresh sample.

Content of β-Carotene

IICA was employed to extract total carotenoids using the Procisur method previously explained. With certain adjustments, HPLC-PDA was used to measure the amount of –carotene (Daz *et al.* 2018). The chromatographic method employed was a C18 column (Phenomenex Inc., Torrance, CA, USA) with the following specifications: 250 cm, 4.6 mm, 5 m, 100, maintained at 30 C, FM, methanol, acetonitrile, and triethylamine (900:100:1) isocratic. 20 L of injection volume, 1.5 mL/min of flow. PDA SPD-M20A detector (Shimadzu, Kyoto, Japan), 450 nm. 0.3–3 g/mL of -carotene in HPLC-grade acetone was utilized as a calibration curve.

Obtaining ethanolic extracts from the leaves, seeds, and bark of the fruit

The plant material was fragmented into small pieces and then dried for 72 hours in a 40°C oven. Then, grinding was carried out until a fine powder was obtained and used in the preparation of ethanolic extracts. The extracts were obtained from 50 g of the powder of each of the parts used and added to 500 mL of ethyl alcohol at 80% concentration. After that, they spent 60 minutes in an 80°C water bath. The resulting material was then vacuum-filtered in a Büchner funnel utilizing high-quality filter paper that had a grammage of 80 g/m2 and was 12.5 cm in diameter. Three times the extraction technique was carried out. The residues were taken to the rotary evaporator at a temperature of 40°C for approximately 5 hours until all alcohol was removed from the samples (Cardoso *et al.* 2001).

Phytochemical prospecting of the constituents of *S. odorifera*

Phytochemical screening was performed using standardized qualitative assays for the detection of the following compounds: reducing sugars, polysaccharides, proteins as well as amino acids, tannins, catechins, flavonoids, cardiac glycosides, steroids, triterpenoids, depsides, and depsidones, coumarins, saponins, as well as alkaloids (Simões *et al.* 2010).

Confirmation of the presence of the investigated phytochemical compounds in the ethanolic and aqueous extracts was verified through the following observations: saponins by the formation of abundant and stable foam for more than 30 minutes; catechins, with the appearance of red color; steroids and triterpenoids with the appearance of a succession of colors, from evane scent blue followed by persistent green by extraction with chloroform, acetic anhydride and sulfuric acid; coumarins by the development of blue fluorescence in the exposed part of the blot on filter paper under ultraviolet light; alkaloids, with the appearance of reddish orange precipitate for Bouchardat's reagent and white for Mayer's reagent; reducing sugars by the formation of a brick red precipitate; depsides and depsidones by the development of a green, gray or blue color; cardiac glycosides due to the appearance of an intense purple color; polysaccharides by the emergence of blue coloration; proteins and amino acids by the appearance of a persistent violet color; tannins due to color change or precipitate formation; and finally flavonoids due to a pink hue showing up in the precipitation.

Secondary metabolites

Secondary metabolites established in the extracts of *S. odorifera* are sugars reducers, Catechins, depsidia and depsidones, Coumarins, steroids and triterpenoids, flavonoids, Glycosides, cardiac C, protein molecules, amino acids, the saponins tannins, alkaloid compounds, as well as polysaccharides, (RB), (RM).

Along with the investigated compounds, a larger number of secondary metabolite categories occurred within the pulp and skin of the fruit along with a lesser amount in the leaves.

The occurrence of reducing sugars was confirmed in the leaves and pulp of the fruits. Monosaccharides are also identified as reducing sugars (RA), since in their chemical structure they have an aldehyde or ketone group that remains free in an aqueous solution and are competent in reducing bromine (Br). Consequently, monosaccharides are capable of oxidizing in the existence of oxidizing agents in alkaline solutions. The fruits of cucurbits are affluent in water, with sugar being an imperative quality feature in melon, watermelon, and some pumpkin species, and are also affluent in carotenes (provitamin A), an antioxidant that protects the body and prevents early aging, particularly when the fruits are orange and yellow-fleshed (Caniço *et al.* 2005).

The test for depsides and depsidones showed an optimistic result merely for the bark extracts. Depsides and depsidones are phenolic substances obtained from acetyl-CoA. This pathway is accountable for producing hydroxybenzoic acid which, when forming esters of two or more subunits, originates depsides, the precursors for the configuration of depsidones (Carrazoni *et al.* 2003).

The fruit pulp extract showed an optimistic response to the existence of steroids and triterpenoids. According to Simões and Spintzer. (2010), triterpenoids are biosynthetic foodstuffs generated from isoprene units. Steroids are produced from triterpenes through decarboxylations, along with their major bioactivities the anti-inflammatory and analgesic activity.

Phenolic compounds are compounds resulting from the secondary metabolism of plants and their antioxidant capability is associated with their oxidation-reduction properties. These may be essential in enticing and scavenging free radicals, chelating reactive oxygen molecules, or breaking down peroxides. They signify the major phytochemicals accountable for the antioxidant capability of fruits (Kuskoski *et al.* 2006).

Newly isolated constituent

The calculated value of cucurbita-5,23-diene-3h,25-diol for $C_{30}H_{50}O_2$ is 442.3811. The structure was determined using spectrum data from 1H-1H COSY, HMQC, as well as HMBC NMR spectra as well as the contrast of the NMR data to that of cucurbita-5,24-diene-3h-ol (boeticol), a closely related cucurbitane. D: C-friedo-oleana-7,9(11)-diene-3a,29-diol dibenzoate (also known as karounidiol dibenzoate) (0.01%), as well as (+)-taxifolin (0.007%) and quercetin (0.004%), have been obtained in accumulation (Nakano *et al.* 2004).

Aliphatic alcohols

Aliphatic alcohols (61.1%) made up the majority of the chemicals, as well as the free volatile profile differed from those of the melon (*Cucumis melo*), a distant family member of the Cucurbitaceae, suggesting that a fragrance continuity of kurugua may be unique (Parada *et al.* 2000). A monosaccharide symphony of raw polysaccharide percentage has been defined in the pulp of the red diversity. Pectin, which has largely galactans as side chains, makes up the watery fractions. Galactose makes up the citric acid fraction, and xyloglucans, xylans, and mannans may make up the hemicellulosic fractions (Kienteka *et al.* 2018).

Although the fruits have been processed fresh for seasonal expenditures, the peel as well as seeds are substantial by-products, and it appears that phenolic chemicals are responsible for their antioxidant potential (Nakano *et al.* 2004).

Triterpenes

Triterpenes, for example, karounidiol dibenzoate and Cucurbita5,23-diene-3h,25-diol; flavones; taxifolin; as well as quercetin have been secluded from the seeds (Contreras-Calderón *et al.* 2011), however, several types of anthocyanins, for an instance cyanidin, peonidin, as well as pelargonidin glycosides, and quercetin and kaempferol glycosides have been identified in this fruit's epicarp (Jaramillo *et al.* 2011).

Compared with various fruits, pulp from Colombian red peel extracts *S. odorifera* cultivars have shown minimal in vitro antioxidant activity (Nakano *et al.* 2004).

As a substitute, flavonoids found in the seeds as well as epicarp are recognized for having strong antioxidant properties and are possibly beneficial in the development of novel food items (Albuquerque *et al.* 2021).

Ethanol

Because it can be utilized in food processing and is classified as GRAS (generally documented as safe), ethanol was chosen for this study (Lao *et al.* 2018). Furthermore, Dominguez et al. (2020) suggested that this solvent may be regarded as ecological.

Higher L-S and higher ethanol concentrations were examined utilizing the Box-Behnken design following the screening design. The pH usually ranged from 3.5 to 6. Up until the greatest value of concentration, beyond which has an unfavorable outcome, a high TMA concentration can be achieved by increasing the concentration of alcohol. According to Kumar et al. (2021), plant tissue dehydration may occur at exceptionally high concentrations (near the pure solvent), which justifies the low concentration of TMA produced utilizing a pure solvent. Several writers who used other basic materials have had personal experience with this (Domínguez *et al.* 2020).

Since the difference in concentration between the solvent and the peel acts as the impetus for the mass transfer approach and changes to an increased mass transfer rate, a liquid-solid ratio also has a favorable impact on the extraction of anthocyanins (Cacace *et al.* 2003).

Glycosidically-bound volatile compounds produced via carbohydrate metabolism

Despite the mature stage, the concentrated amount of fully volatile glycosidically bound chemicals formed by carbohydrate oxidation unrestricted by enzymatic hydrolysis was considerably (P5/0.05) higher in the pulp as opposed to the skin. When contrast to the adult green and ripe stage, the concentrated amount of entire glycosidically-bound volatile chemicals in the skin at the half-ripe phase was significantly (P5/0.05) higher. As the squash ripened, they became better. Four chemicals were established in the pulp, whereas six ketones were instituted in the skin (Herianus J.D. *et al.* 2002).

Terpenes

The amount of terpenes in the skin was considerably (P5/0.05) elevated at the partially mature phase as opposed to every other maturity phase, while the amount of the whole terpenes in the flesh enhanced significantly (P5/0.05) as maturing developed to the ripe stage. As the fruit ripened to the mature stage, the concentrated amount of total terpenes in the flesh increased considerably (P5/0.05). Regardless of the fruit's state of development, the number of terpenes that were established in the skin was much greater than those that were established in the pulp in terms of both figure and quantity. Oxygenated terpenes made over 75% of the total amount of known terpenes unrestricted by enzymatic hydrolysis. Geraniol was the terpene that is most frequently detected in skin, accompanied by trans-chrysanthemal, p-mentha-1,5,8-triene, as well as mentha-1,5,8-triene. P-cymen-8-ol, cis-1,2,3,6,7,7ahexahydro-7a-methyl-3aH-inden-3a-ol, and geraniol were the three most abundant terpenes in the pulp (Herianus J.D. *et al.* 2002).

Oleanane Triterpenoid Saponins

Plants are rich in triterpenoid saponins, which have many biological effects, including antiviral, antioxidants, and antifungal medications, as well as anti-cancer properties (Jia *et al.* 2017).

A novel 30-noroleanane triterpenoid saponin called 3,20(29)-diene-28-oic acid was discovered in 2012. Three well-known triterpenoid saponins (2-4) and 3-O-D-glucuronopyranosyl-28-O-D-glucopyranoside (1) were also sequestered (Kim *et al.* 2012).

Gypsogenin3-O-D-glucuronopyranoside (3), 30-norhederagenin3-O-Dglucuronopyranosyl-28-O-D-glucopyranoside (2), or gypsogenin3-O-D-glucuronopyranosyl-28-O-D-glucopyranoside (4) have been recognized as the renowned chemicals. Compounds 1-4's ability to scavenge peroxynitrite (ONOO), as well as 1,1-diphenyl-2-picrylhydrazyl (DPPH) radicals, has been used to evaluate their antioxidant activity. All four substances were found to have high scavenging potencies for both naturally occurring peroxynitrite as well as peroxynitrite formed by morpholinosydnonimine (SIN-1) (IC50 range: 1 to 21.9 M). It should be noted that compound 2 showed the minimum IC50 values (1 M) for both naturally occurring ONOO as well as ONOO created via SIN-1, although showing no discernible DPPH radical scavenging action (Shan *et al.* 2015).

Additionally, *Acanthopanax senticosus* fruit containing this triterpenoid saponin was isolated, and it demonstrated pancreatic lipase inhibiting action (Li *et al.* 2007).

Caffeoylquinic Acid Derivatives

In addition to coffee beans, many plants have been found to contain derivatives of caffeineoylquinic acid (CQA), which have many biological effects such as antioxidants, antibacterial, anticancer, as well as antihistaminic characteristics (Miyamae *et al.* 2011).

In 2005, Chung *et al*. extracted and clarified the composition of tungtungmadic acid (3-caffeoyl-4-dihydrocaffeoyl quinic acid,22), a novel natural chlorogenic acid derivative (Chung *et al.* 2005). The plant material was gathered in Busan, on Korea's southern coast. With IC50 values of 5.1 and 9.3 M, correspondingly, tungtungmadic acid demonstrated a powerful antioxidant effect in the current investigation's DPPH free radical scavenging as well as iron-induced liver microsomal lipid peroxidation inhibition experiments. Compound 22 has also been shown in studies to protect plasmid DNA in opposition to strand breakage brought on by hydroxyl radicals. Several additional investigations into compound 22's biological effects were done as its discovery. For example, compound 22 has additionally been found to safeguard against tert-butyl hydroperoxide (t-BHP) and carbon tetrachloride (CC14)-induced hepatic fibrosis (Hwang *et al.* 2009).

Furthermore, this substance has anti-inflammatory qualities (Han *et al.* 2010), hinders tumor cell attack, and shields elevated-glucose-induced lipid formation in human HepG2 cells (Hwang *et al.* 2010). Fascinatingly, the amount of compound 22 has not been mentioned in other publications.

Flavonoids and Flavanones

Additionally, flavonoids and flavonoid glycosides were extracted. 20-hydroxy-6,7-methylenedioxyisoflavone (36), ()-(2S)-20-hydroxy-6,7-methylenedioxyflavanone (37), as well as 20,7-dihydroxy-6-methoxyisoflavone (38), were isolated from a methanol extract in 1982 by Arakawa et al. (Kim *et al.* 2021). The plants used in the current research were from the Japanese island of Hokkaido's lake Lake Notoro, a coastal lagoon.

According to Shimoda et al. (2011), a cherry blossom resulting component (39) served as a strong inhibitor of advanced glycation end-product generation (AGEs) and AGE-induced fibroblast death. As an antioxidative mediator, such quercetin was sequestered from the leaves of *Corchorus olitorius* or the fruit peel of *Sicana odorifera* (Jaramillo *et al.* 2011). Compounds 40–42 have been shown to have a broad range of biological actions, such as anti-inflammatory, cardiovascular, and diabetes prevention, as well as anticancer activity (Anand *et al.* 2016).

Sterols

Sterols are essential for each of the eukaryotes and are a part of the enormous isoprenoid family of chemicals (Kim *et al.* 2021). There have been five sterols isolated: ergosterol (60), stigmasterol (59), -sitosterol (58), and cerevisterol (62).

Compounds 58 and 59 were isolated and identified in 2004 by Lee et al. Mokpo, which is located on Korea's southwest coast, provided the plant samples for this study. According to compound 58's anti-cancer, anti-inflammation, hypocholesterolemic, immunomodulatory, antioxidants, neuroprotective, and antidiabetic activities (Saeidnia *et al.* 2014), these properties are also present in compound 58. In addition, this substance is enveloped by the principal phytosterols found in the human diet, in addition to campesterol and stigmasterol. Additionally, compound 59 has anti-inflammatory, cytotoxic, anticancer, anti-hypercholesterolemic, antioxidants, hypoglycemic, as well as antitumor properties (Kaur *et al.* 2011).

This substance was initially isolated from the poisonous native tropical plant *Physostigma venenosum*, although it has now been found in more medicinal plants like *Croton sublyratus*, *Ficus hirta*, *Eclipta alba*, *Eclipta prostrate*, and *Parkia speciosa* (Kim *et al.* 2008).

Lignans

According to Saleem et al. (2005), lignans are widely spread across the plant world and have major pharmacological effects, such as anti-inflammatory, anticancer, immune-suppressive cardioprotective, antioxidants, as well as antiviral actions.

Syringaresinol 4-O-D-glucopyranoside (63), erythro-1-(4-O-D-glucopyranosyl-3,5-dimethoxyphenyl)-2 syringaresinoxyl-propane-1,3-diol (64), as well as longifloroside B (65) were all separated and identified in 2011, according to Wang et al. Compound 63 has been demonstrated to have numerous powerful biological processes, such as DPPH radical scavenging activity (Jung *et al.* 2004), antiestrogenic action against MCF-7 cells (Luecha *et al.* 2009), and antitumor properties adjacent to the A549 cancer cell line. However, the biological functions of compounds 64 and 65 have not yet been explained (Wei *et al.* 2015).

Compound 63 was discovered in the leaves of the *Fatsia japonica* plant, the Thai medicinal plant *Capparis flavicans*, as well as the stem bark of *Albizzia julibrissin* (Jung *et al.* 2004; Luecha *et al.* 2009). In HepG2 cells and C2C12 myotubes, this substance has also been demonstrated to alter the metabolism of glucose and lipids (Wang *et al.* 2017).

Current in-vitro tests examining the compound's antiphotoaging characteristics helped to prove its cosmeceutical potential (Oh *et al.* 2020). Accordingly, this substance was also found in Formosan *Zanthoxylum simulans*, *Wikstroemia indica* roots, and *Sasa borealis* entire plant extracts (Yang *et al.* 2002; Wang *et al.* 2005; Jeong *et al.* 2007). Additionally, the Asian medicinal plant *Millettia pulchra's* torto side A (67) showed a moderate NQO1-inducing effect (Wang *et al.* 2016).

Aliphatic Compounds

Stearic acid (69), -linolenic acid (70), (3Z,6Z,9Z)-tricosa-3,6,9-triene (71), linoleic acid (72), hexadecanoic acid (73), 1-octadecanol (74), and 1-octacosanol (75) are the seven aliphatic chemicals that have been isolated (Wang *et al.* 2013).

Saturated fatty acids are found in compounds 69 and 73, omega-6 polyunsaturated fatty acids are found in compounds 70 and 72, polyunsaturated linear hydrocarbons are found in compounds 71, and aliphatic alcohols are found in compounds 74 and 75. Compounds 69 to 72 were isolated by Wang et al. (2013), who then looked into their antioxidants and antiproliferative effects on HepG2 and A549 cells. It's interesting to note that none of these substances—aside from compound 72—displayed a robust antioxidant effect. Instead, compound 72 strongly blocked the proliferation of both HepG2 and A549 cells (EC50 values: 65.35 1.22 M and 83.23 3.26 M, correspondingly). Compound 72, a vital omega-6 fatty acid, has been employed to treat arthritis such as rheumatoid, eczema, premenstrual syndrome (PMS), and neuropathy from diabetes because it possesses anti-inflammatory properties (Kapoor *et al.* 2006).

Others

Together with the oleanane triterpenoid saponins, caffeoylquinic acid derivatives, flavonoids, sterols, lignans, and aliphatic chemicals previously described. In this investigation, compounds 76–78 demonstrated notable DPPH, superoxide, and hydroxyl radical scavenging activity. Compounds 76–78 show a wide range of additional potent bioactivities in addition to their antioxidant action. Compound 76 has been discovered to have antiseptic, anti-diabetic, anti-cancer, anti-ulcer, anti-aging properties, antifibrotic, antiviral, and anti-inflammatory actions (Kakkar *et al.* 2014).

Protocatechuic acid, also known as catechol benzoic acid, is typically found in veggies and grains like onion, brown rice, plums, or bran (Kakkar *et al.* 2014). Compound 77 also has an inhibitory impact on thrombosis and atherosclerosis in addition to having cholesterol-lowering, antibacterial, anti-inflammatory, and cancer-preventing properties as well (Ou *et al.* 2004).

That phenolic acid is prevalent in plants and often forms an ester bond with polysaccharides like bamboo, lettuce, and sugar beet. Compound 78 has been shown to possess antioxidant, cancer-fighting, antihepatocarcinoma, antiviral, anti-inflammatory, anti-atherosclerotic, immunostimulatory, cardioprotective, antiproliferative, hepatoprotective, and antiseptic actions (Monteiro *et al.* 2019). The precursor of caffeine, caffeineic acid (78), is created by a variety of plants, such as olive, coffee, fruit, and potato plants (Monteiro *et al.* 2019).

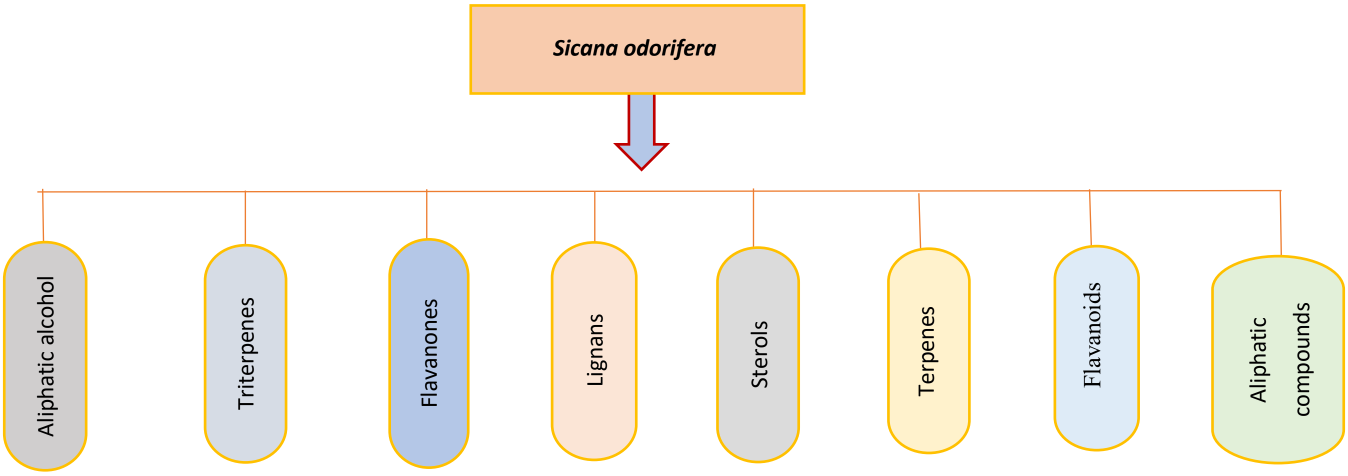
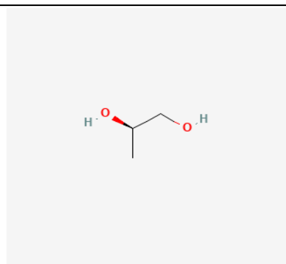
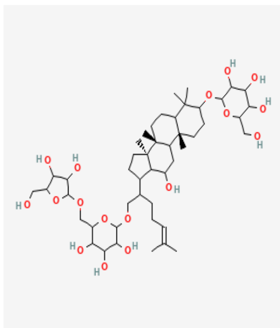
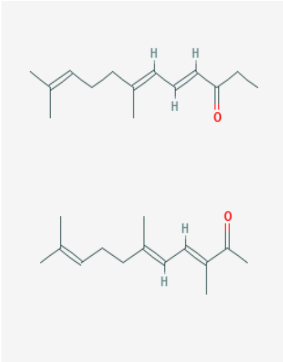
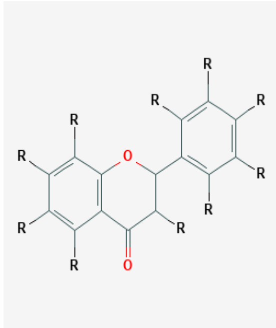
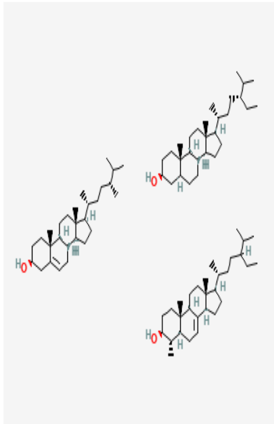
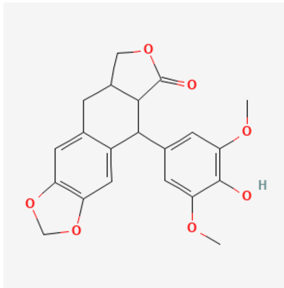
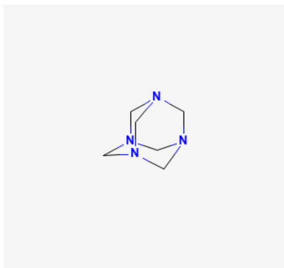


Fig 3. Phytochemistry of *Sicana odorifera*.

Table 3. List of different phytochemicals reported in *Sicana odorifera*.

List of compounds	Name	Molecular formula	Molecular weight	Structure	Reference
Aliphatic alcohol	Pectin, which has largely galactans as side chains, makes up the watery fractions. Galactose dominates the citric acid fraction, while xyloglucans, xylans, and mannans may make up the hemicellulosic fractions	$C_3H_8O_2$	76.09 g/mol		Kienteka *et al.* 2018
Triterpenes	Several anthocyanins, including cyanidin, peonidin, as well as pelargonidin glycosides, as well as quercetin, and kaempferol glycosides, were found within the fruit's epicarp, but none of the triterpenes, that is karounidiol dibenzoate as well as Cucurbita5,23-diene-3h,25-diol, flavones, taxifolin, and quercetin	$C_{47}H_{80}O_{17}$	917.1g/mol		Jaramillo *et al.* 2011

Terpenes	Geraniol was the first terpene to be produced by the enzymes b-glucosidase and hemicellulase in the skin, accompanied by p-mentha-1,5,8-triene as well as trans-chrysanthemal. In the pulp, p-cymen-8-ol was the most abundant terpene, accompanied by cis-1,2,3,6,7,7ahexahydro -7a-methyl-3a	$C_{28}H_{44}O_2$	412.6g/mol		Herianus J.D. *et al.* 2002
Oleanane Triterpenoid Saponins	3-hydroxy-23-oxo-30-norleana12,20(29)-diene-28-oic acid 30-norleanane triterpenoid saponin 30-norhederagenin was identified as 3-O-D-glucuronopyranosyl-28-O-D-glucopyranoside, an established chemical.3-O-β-DGypsogenin3-O-D-glucuronopyranoside, glucuronopyranosyl-28-O-D-glucopyranoside, 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical, as well as peroxynitrite (ONOO) is the entire examples of compounds	$C_{41}H_{64}O_{14}$			Li *et al.* 2007
Caffeoylquinic Acid Derivatives	Tert-butyl hydroperoxide (t-BHP), a natural derivative of chlorogenic acid known as tungtungmadic acid (3-caffeoyl-4-dihydro caffeoyl quinic acid, 22), caused hepatotoxicity	$C_{16}H_{18}O_9$			Hwang *et al.* 2009

Flavonoids and Flavanones	The 20-hydroxy6,7-methylenedioxyisoflavone, (−)-(2S)-20-hydroxy-6,7-methylenedioxyflavanone, and 20,7-dihydroxy-6-methoxyisoflavone from a methanol extract	$C_{27}H_{32}O_{14}$			Kim *et al.* 2021
Sterols	In sterols, the human diet contains campesterol, stigmasterol, ergosterol, -daucosterol, as well as cerevisterol in addition to phytosterols	$C_{87}H_{152}O_{3}$	1246.1g/mol		Saeidnia *et al.* 2014
Lignans	lignan compounds erythro-1-(4-O-D-glucopyranosyl-3,5-dimethoxyphenyl)-2 syringaresinoxyl-propane-1,3-diol, as well as longifloroside B include syringaresinol 4-O-D-glucopyranoside	$C_{22}H_{22}O_{8}$	414.4g/mol		Wei *et al.* 2015
Aliphatic compounds	saturated fatty acids, omega-6 polyunsaturated fatty acids, polyunsaturated fatty acids, -linolenic acid, (3Z,6Z,9Z)-tricosa-3,6,9-triene, as well as linoleic acid, hexadecanoic acid, as well as 1-octadecanol linear hydrocarbon, and aliphatic alcohols	$C_{6}H_{12}N_{4}$	140.19g/mol		Wang *et al.* 2013

Pharmacology

This fruit has been used in Brazil for diverse purposes such as ornamentation and trendy medicine, in which it is used to treat diverse symptoms and illnesses, being underutilized and of less important cost-effective manifestation, but with considerable characteristics (Araújo *et al.* 2016). There are in order of the use of *S. odorifera* in trendy medicine as antihypertensive, antihemorrhagic, management of skin tribulations, anemia and gastroesophageal reflux, menstrual disorders, uterine diseases, worms, and indigestion (Lima JF *et al.* 2010).

The bark and leaves of the fruit can be used as a stimulant, antipyretic, uterine hemorrhage, and sexually transmitted infections (STIs). With the tea of the leaves and flowers, it can be used as an antiflatulent, also skirmishing heartburn and pain-causing spasms. The mixture of seeds is used in Brazil to function as a febrifuge, emmenagogue, vermifuge as well as anticonstipant, on the other hand, consideration should be rewarded to the amount to be ingested, as the seeds and flowers may hold hydrocyanic acid. The pulp of the fruit can be eaten equally green and ripe like vegetables and used in soups, conserved, sliced, and peeled like melon, in accumulation to being used in the preparation of juices, compotes, jellies, and numerous other options (Rodriguez-Amaya *et al.* 2001).

In vegetables, they are established in the form of starch, fiber, gum, mucilage, and pectin. It has been gaining a lot of concentration in recent decades due to its antitumor, immunostimulant, anti-complement, anti-provocative, anticoagulant, antiviral, hypoglycemic, and hypocholesterolemic action (Simões *et al.* 2010),

The fruits exposed the occurrence of saponins, evidenced by the development of constant foam for more than 30 minutes. This metabolite has been used as a pharmaceutical adjuvant in formulations, vigorous components in herbal medicines, and as unrefined material for the amalgamation of steroids. It also has hypocholesterolemic distinctiveness, anti-inflammatory and antiviral action, and enhances dieresis (Costa NC *et al.* 2017).

Tannins can be recognized for different actions such as antidiarrheal and antibacterial, antimicrobial, and antifungal, are hemostatic and can supply as a remedy in cases of intoxication, in addition to serving in the therapeutic process of wounds, burns, and irritation (Monteiro *et al.* 2005).

Alkaloids have a huge structural variety and this gives them a broad variety of biological proceedings, such as anticholinergic, amebicide, emetic, antihypertensive, antimalarial, antitumor, antitussive, hypnoanalgesic, cardiac depressant, central nervous system (CNS) tonic, diuretics, myorelaxant, sympathomimetic, antiviral along with several others (Saints *et al.* 2016). Alkaloids, due to their huge structural variety, have an elevated number of pharmacological measures, a lot of them helpful for treatment, such as antimalarial (quinine), anticolchium (Colchia), antitumor (vinblastine and vincristine), emetic (emetine) and cough narcotic (codeine and narceine) (Tebaldi *et al.* 2019).

Carotenoids have antioxidant ability due to their capacity to appropriate reactive oxygen molecules and react with free radicals. This capability has been associated with the anticipation of a variety of diseases (Kobori *et al.* 2010).

According to Teixeira *et al.,* 2008 anthocyanins are substances classified as phenolic, accountable for the pigmentation of plants, and execute different remedial functions in the human body, such as antioxidants and anti-inflammation functions. Given the above, this research's goal is to differentiate the secondary metabolites of concern pharmacology in extraction made from seeds, leaves, squash, and peel of the fruit, as well as to estimate the antioxidant capability of the fruit (Tebaldi *et al.* 2019).

Antioxidant Activity

The antioxidant possibility of extracts from the flesh, seeds, as well as peel of *S. odorifera* was assessed by Contreras-Calderón et al. (2011) and contrasted to that of 23 more exotic fruits. By FRAP and ABTS experiments, *S. odorifera* extracts demonstrated lower levels of antioxidants than other fruits.

The antioxidant activity of the unrefined red fruit (1957.58 µM Eq. to Trolox/g), when compared to fruits recognized to be affluent or deprived in antioxidant action, such as the consequences reported by Gonçalves36 for the subsequent fruits: camu-camu, which is previously well recognized as a fruit with elevated antioxidant activity (1439 µM Eq. to Trolox/g), abiu (69 µM Eq. to Trolox/g), tamarind (21 µM Eq. to Trolox/g), among other outcomes. Previously Ribeiro37, reports 1,221 µM Eq. to Trolox/g of antioxidant activity in strawberries. The antioxidant used to evaluate both studies was DPPH, therefore confirming the antioxidant authority of red cruá (Tebaldi *et al.* 2019).

To determine the extent of each fruit's in vitro antioxidant effect, the anthocyanin-rich extracts were submitted to ABTS and DPPH assays. The final dimensions of this reaction are likely to be determined by several analytical methods, including measurement at a constant time peak (antioxidant capacity in micromole of radical despoiled per micromole of antioxidant) or measurements of the reaction's rate (antioxidant prospective in micromole of radical despoiled per minute) (Rohn *et al.* 2005).

The TPC concentration, monomeric anthocyanins, as well as vitamin C, were thought to have an antioxidant effect as a result of the radical ABTS's hesitation, as well as the aggregation of these compounds to their full antioxidant potential (Caballero *et al.* 2021).

According to Albuquerque et al. (2002), the phytochemical outline of the flesh can serve as a foundation of antioxidant chemicals. Anthocyanins and flavonols among antioxidant effects were recently identified in peels (Jaramillo *et al.* 2011).

According to Halliwell (2011) and Valko et al. (2007), free radicals inflict widespread injury to living things along with a major cause of aging, cancer, osteoarthritis, and neurological illnesses. In the past, various diseases have been treated using phytocompounds and nanoformulations (Sathishkumar, Gu, Zhan, Palvannan, & Yusoff, 2018). PFSs have demonstrated exceptional anti-oxidant capacity and can restrain illnesses brought on by oxidative smash-up. Numerous research teams have thoroughly investigated the anti-oxidant efficiency of FPSs in vitro settings (Ge *et al.* 2009; Li *et al.* 2018; Marzouk, Chaouch, Hafsa, LeCerf, & Majdou, 2017; Qin, Liu, Lv, & Wang, 2019; Tu *et al.* 2016).

Significant anti-oxidant activities have been found in the PSs secluded from lychee pulp as well as pericarp (Huang and al., 2016, 2017; Kong *et al.* 2010; Yang *et al.* 2006). Along with superoxide radical-scavenging efficacy, ferrous ion chelating capacity, as well as 2,2diphenyl-1-picrylhydrazyl (DPPH) scavenging activity, the PS fractions isolated from longan seeds as well as pericarp demonstrated possible antioxidant prospective (Viet *et al.* 2016; Yang, Zhao *et al.* 2008; Yang, Zhao, Prasad, Jiang, & Jiang, 2010).

Two PS fractions (MSP-I and MSP-II) from mango seeds were characterized by Chen, Luo, et al. (2012), and Chen Tang et al. (2012). They demonstrated that MSP-I had a greater anti-oxidant impact than MSP-II owing to MW distinctions. Additionally, an improved antioxidant effect in vitro has been demonstrated by banana peel PSs (Can, 2009). Corresponding to this, at low concentrations, three PS fractions from pineapple peel (PAPs 1-3) demonstrated robust DPPH radical-scavenging ability (Wang *et al.* 2015). According to Zhang et al. (2012), pineapple peel-derived heteropolysaccharides have the highest superoxide and hydroxyl reluctance, as well as the ability to conceal DPPH radicals and reducing agents.

Water soluble PS fractions (PGJ, PGPGP90, as well as P90) isolated from guava were found by Zhang et al. (2016) and Kamara Zaman, Abdul, Nik Hasan, Ahmad, and Ayob (2017) to have major DPPH scavenging behavior as well as to reduce lipid peroxidation. Wang, Shu, et al. (2014), Wang, Zhang, et al. (2014), Chen, You, et al. (2016), Chen, Zhang, Fu, Liu, et al. (2016), Chen, Zhang, Fu, You et al. (2016), Chen, Jin et al. (2016), and Peng et al. (2019) examined the anti-oxidant actions of water-soluble as well as sulfated derivative PSs from tangerine peel and citrus fruits. According to Yang et al. (2013), the PSs from apple peel as well as meat displayed strong anti-oxidant properties. The original water-soluble PSs (DFPWSP-1) from dragon fruit peel was extracted with the aid of ultrasound, and the process revealed distinct DPPH radical, superoxide anion, and hydroxyl radical-scavenging behavior (Qian *et al.* 2018).

It has been demonstrated by Zhai, Zhu, Zhang et al. (2018) and Zhai, Zhu, Li et al. (2018) that PSs made from pomegranate peel (PPP) gain antioxidants. Although numerous in vitro research have supported the anti-oxidant functions of FPSs, less has occurred in vivo investigations that call for further investigation.

Insect repellent Activity

It has been claimed that the *S. odorifera* seeds contain fragrant characteristics that work as an insect repellant. Triterpenes and flavonoids were isolated from them, along with karounidiol dibenzoate, cucurbita-5,23-diene-3h,25-diol, taxifolin, as well as quercetin (Nakano *et al.* 2004).

Both the fruit's alluring aroma and the vibrant color of the peel have been described (Kienteka *et al.* 2018). Although research on the makeup of the seeds as well as the biological activities of its constituent parts continues to lacking, the pungent spectrum of the pulp is distinctive as well and the compounds accountable for the flavor have been documented (94.8% free volatile; with 61.1% as aliphatic alcohols) (Parada *et al.* 2000).

Hepatoprotective Activity

Among the properties is a liver model smash-up generated by acetaminophen (APAP), a medicine extensively utilized as an antiseptic as well as a painkiller, that large doses can trigger necrosis as well as insufficiency acute hepatica. There are many models for estimating the hepatoprotective effects of natural products (Abdel-Azeem *et al.* 2013).

Despite advancements in current pharmacology, one of the biggest causes of death is still liver disease worldwide, as well as there is nonetheless a significant need for efficient and secure hepatoprotective medicines (Zhang *et al.* 2018).

N-acetyl-p-benzoquinone imine (NAPQI), which can combine with glutathione (GSH) to create oxidative stress that may cause the mitochondrial signal pathway as well as trigger cell fusion, is the primary catalyst for APAP's hepatotoxicity (Hinson *et al.* 2010).

Contrarily, scientific evidence supporting the multiple positive health benefits of omega-3 PUFA for humans has promoted its use. Its supply is insufficient and focuses mostly on the eating of fatty fish or bluefish as well as dietary supplements made from fish oils or microalgae, which prevents the Western population from consuming more of these fatty acids. In various Latin American nations, the early manufacturing of ALA-rich vegetable oils is a creative and narrative replacement to enhance the usage and production of -3 fatty acids, namely from its metabolic parent, ALA (Pipoyan *et al.* 2021).

According to recent research on the chemical makeup of *S. odorifera* epicarp, the hydroalcoholic extracts have elevated levels of antiseptic, antioxidants, disinfectant, as well as antifungal properties along with a high concentration of anthocyanins, as well as phenolic compounds, organic acids, as well as tocopherols (Albuquerque *et al.* 2021).

We investigated the effect of an extract from *S.odorifera* seeds on hepatotoxicity brought on by acetaminophen. The serum levels of alkaline phosphatase, total proteins, as well as albumin were not significantly affected by the oral administration of the methanolic extracts of *S. odorifera* seeds among the various treatments. In the current study, it was shown that serum albumin, total proteins, as well as alkaline phosphatase values were not significantly impacted by the administration of acetaminophen, silymarin, along with the various doses (10, 100, 300, and 500 mg/kg) of the methanolic extract of *S. odorifera* seeds (EMSo). As opposed to that, the effect of the extract's oral administration on the serum levels of glutamicpyruvic transaminase as well as glutamic-oxaloacetic transaminase in male mice with hepatic injury brought on by acetaminophen (Caballero *et al.* 2021).

Anti-metastatic Activity

In addition to the importance of Galatians for plants, these compounds' pharmacological impacts have also been researched. In cancer cells, galactans have been found to exhibit anti-metastatic effects. Galactan-rich molecules have been shown to work with the overexpressed galectin-3 protein in cancer cells to prevent metastasis (Leclere, Cutsem, Van, & Michiels, 2013). An acetylated galactan imitative was shown to have anti-pancreatic cancer activity (Gu, Huang, Chen, Wu, & Ding, 2018). In this sense, the pulp of *S. odorifera* represents a cutting-edge galactan source with therapeutic potential.

Anti-Inflammatory Activity

The technique of LPS-induced nitric oxide (NO) invention by mouse macrophages RAW 264.7, which was formerly established by Corrêa et al. (2015), helped determine the anti-inflammatory actions of the extract obtained from *S. odorifera* epicarp. A positive control was dexamethasone (50 M). The concentrations needed to reduce NO generation by 50% (EC50 values ((g/mL)) were steadfast in articulating the outcomes.

Numerous investigations have confirmed that FPSs have anti-inflammatory consequences. In LPS-treated RAW 264.7 macrophages, blackberry wine PSs were found to reduce the creation of cytokines that cause inflammation (TNF- and IL-1), as well as NO. The two PS fractions secluded as well as purified from strawberry and mulberry fruit juice demonstrated probable anti-inflammatory effects through cytokine production, specifically, the production of tumor necrosis factor, that lowers pro-inflammatory cytokine concentrations like interleukin (IL)-1 and IL-6 as well as increases production of the anti-inflammatory cytokine IL-10. These findings indicate that strawberry and mulberry altered Bak and Bcl-2 levels in the cells and prevented LPS-stimulated macrophages from undergoing apoptotic cell death (Liu & Lin, 2012; 2014). These studies have unequivocally established that FPSs have potent anti-inflammatory properties.

Anti-Proliferative Activity and Hepatotoxicity

By employing 4 human tumor cell lines (MCF-7, breast adenocarcinoma; NCI-H460, non-undersized cell lung cancer; HeLa, cervical carcinoma; as well as HepG2, hepatocellular carcinoma), obtained from Leibniz-Institut DSMZ, the anti-proliferative properties of the hydroethanolic extracts were examined via the Sulforodamine B (SRB) method. Regarding the evaluation of hepatotoxicity, the extracts were examined on normal pig liver cells (PLP2) taken from a nearby butcher. The tests were done in triplicate, and the extract concentration that could stop 50% of cell growth (GI50 values (g/mL)) was identified using the Corrêa et al. (2015) technique.

Antibacterial Activity

Inhibitory action of hydroethanolic extract organized from *S. odorifera* epicarp was experienced regarding three Gram-positive bacterial strains: *Staphylococcus aureus* (ATCC 6538), *Bacillus cereus* (food isolate), as well as *Listeria monocytogenes* (NCTC 7973), with three Gram-negative strains: *Escherichia coli* (ATCC35210), *Salmonella typhimurium* (ATCC13311), as well as *Enterobacter cloacae* (ATCC 35030). According to Sokovic et al. (2010), the smallest inhibitory, as well as bactericidal concentrations (MICs and MBCs, respectively), were determined using a microdilution test in 96-well microtiter plates.

Through a colorimetric viability test determined by a decrease in an INT color (p-iodonitrotetrazolium violet (Sigma, St. Louis, MO, USA)), the MIC principles—which denote a major requirement of bacterial growth in the existence of the experienced sample—were established. After reinoculating the well's contents (which included medium, extract, and bacterial inoculum, totaling 10 L), demonstrated that the clean medium had no bacterial growth., even more incubating at 37 °C for 24 h, MBC principles were ascertained. The MBCs, which exhibited 99.5% obliteration of the studied bacteria, were the smallest amounts that indicated no bacterial growth. Two commercial food preservatives—potassium metabisulfite (E224) as well as sodium benzoate (E211)—were employed as effective safeguards.

Antifungal Activity

Concerning antifungal activity, *Aspergillus fumigates* (ATCC1022), *Aspergillus versicolor* (ATCC 11730), *Aspergillus niger* (ATCC 6275), *Penicillium funiculosum* (ATCC 36839), *Penicillium verrucosum* var. *cyclopium* (food segregate), as well as *Trichoderma viride* (IAM 5061) were used to check the hydroethanolic extract of *S. odorifera*. The tested organisms were acquired from the National Institute of the Republic of Serbia, the University of Belgrade's Mycological Laboratory, the Department of Plant Physiology, and the Institute for Biological Research "Sinia Stankovic." According to Sokovic's and Van Griensven's prior descriptions, the test was conducted (Sokovic *et al.* 2006).

Using sterilized 0.85% saline that contained 0.1% Tween 80 (v/v), the test's fungal spores were removed from the surface of agar plates containing the tested fungal strains. As a result, their concentration was acclimated to a concentration of roughly 1.0 105 in a final volume of 100 L per well using disinfected saline. To ensure their authenticity and absence of infectiousness, fungal inocula were advanced on malt agar plates at 25°C for 72 hours before to the experiment. The following procedure was used to conduct the antifungal test: tested extract was added to a broth of bright malt extract, along with suitable amounts of fungal inocula.

Immunomodulatory activities

The immune system protects against harmful intruders and has both innate and adaptive resistance (Iwasaki & Medzhitov, 2010; Mohan *et al.* 2018; Song *et al.* 2019). FPSs can initiate several immune system-establishing signaling pathways and can overtly or ultimately cooperate with the immune system. FPSs have been shown in numerous studies to have efficient immunomodulatory effects together in vivo as well as in vitro. According to studies, desiccated lychee pulp PSs can increase macrophage phagocytosis, natural killer (NK) cell cytotoxicity, as well as spleen lymphocyte production (Huang *et al.* 2014; Jing *et al.* 2014).

According to Yi et al. (2011), the water-soluble PSs from longan pulp have a propensity to initiate downstream signal transduction in murine macrophages, the proliferation of T and B lymphocytes, along with the cytotoxicity of NK cells next to YAC-1 lymphoma cells. *Citrus medica* (CMSPW90-M1) and *Citrus unshiu* peel (CPE-II) polysaccharide fractions also promoted the generation of mouse splenocytes, neural red phagocytosis, as well as IL-6 and nitric oxide (NO) in RAW264.7 cells (Peng *et al.* 2019; Shin *et al.* 2018).

In sarcoma S180 tumor-bearing mice, the tumoricidal impact of pomelo peel PSs considerably increased the proliferative capability of splenic lymphocytes as well as the homicidal action of NK cells. These findings suggest that pomelo peel PSs functioned as effective immunomodulatory and anti-tumor mediators (Yu *et al.* 2018).

The three polysaccharide fractions (BWPs, BWPFs, and BWPFp) from blackberry wine also considerably reduced NO action along with the manufacture of pro-inflammatory cytokines (TNF- and IL-1), according to research by Caillot et al. (2018) in LPS-treated RAW264. 7 macrophages. By encouraging the emission of cytokines (TNF- and IL-6), a narrative polysaccharide division (FCPW80-2) from *Ficus carica* also enhanced immunological activities, and NO generation significantly increased the development of macrophages (Du *et al.* 2018).

Current research has revealed that *Ficus carica* polysaccharides encourage T cell proliferation and dendritic cell maturation (Tian *et al.* 2014). Additionally, in immunosuppressed animals, *Schisandra chinensis* polysaccharide (SCP-IIa) promoted the pinocytic activity of peritoneal macrophages (Chen, Tang, *et al.* 2012).

Anti-diabetic or hypoglycaemic activities

By 2030, 439 million individuals will have diabetes mellitus (DM), an extreme metabolic illness that affects 2.8% of the world's population (Shaw, Sicree, & Zimmet, 2010). Between 1990 and 2016, there was an increase in the number of DM patients in India, from 26 to 65 million (Tandon *et al.* 2018).

The use of artificial chemicals that promote serious adverse impacts as well as are linked to organ damage or breakdown in chronic DM patients is a habit of DM. Unconventional, fictitious, and predicted anti-diabetic medications are required to treat DM to tackle this issue. FPSs were recently shown to have favorable effects on lowering blood sugar. According to Huang et al. (2017), PSs from lychee fruit enhanced rats with diabetes' ability to absorb glucose.

In rats with oxidative diabetes, Gao et al. (2015) found that an oily water-soluble PS from *Opuntia dillenii* fruit may significantly lower blood glucose levels and increase body weight. According to Chen et al. (2018), the PSs from mulberry fruits established major anti-diabetic achievement.

In addition, the Chinese *Lycium barbarum* PSs reduced the hepatic mRNA expression in diabetic rats caused by a high-fat diet and streptozotocin (HFD-STZ) (Zhao, Jin, Chen, & Han, 2015). It has been proven that FPSs can function as plausible, nontraditional, as well as narrative treatments for diabetes.

Anti-cancer activities

Modern studies have shown that FPSs exhibit major anti-cancer action in equal vitro and in vivo. Apple PSs have been shown by Li et al. (2012), Zhang, Li et al. (2013), and Zhang, Tang et al. (2013) to exhibit anti-cancer activity near colorectal cancer cells. The anti-cancer action of pomegranate peel PSs was also better when matched with human osteosarcoma cancer cells (Li, Zhang, & Wang, 2014). Additionally, PSs from *Lycium barbarum* were found to arrest the G0 and G1 stages of the cell cycle in human liver cancer cells (SMMC7721) by Zhang et al. (2013).

Anti-tumor activities

Fruit pulp, pericarp, peel, and seed polysaccharides have demonstrated potent anti-tumor properties. The following pathways are thought to be involved in how polysaccharides have anti-cancer activities (Ji *et al.* 2017; Meng, Liang, & Luo, 2016; Ren, Perera, & Hemar, 2012; Sun *et al.* 2019). They exhibit anti-tumor activity by suggesting tumor apoptosis, limiting tumor metastasis, as well as inhabitation of angiogenesis. These three steps are **(1)** anticipation of oncogenesis via oral administration of FPSs (cancer-preventing action); **(2)** formation of the immune reaction next to tumors; and **(3)** expression of anti-tumor activity (Ji *et al.* 2017).

Numerous studies have demonstrated that immunological regulation or engrossing the tumor cell cycle are two crucial strategies by which FPSs might inhibit the growth of tumors. One pure PS component from longan meat (LP1), for instance, displayed stronger anti-tumor activity near the SKOV3 and HO8910 tumor cells (Meng *et al.* 2014). Along with lung cancer A549 cell lines, the PSs isolated from longan seeds showed major anti-tumor properties (Wang, Shu, *et al.* 2014; Wang, Zhang, *et al.* 2014).

According to Wang et al. (2015), two PS fractions from pineapple pulp (PAP1 and PAP2) showed renowned inhibitory effectiveness adjacent to breast carcinoma cells. This suggests that these PSs can be used as effective food components to delay breast cancer. According to Zhao et al. (2017), acetic PSs from *Citrus aurantifolia* peels had an antiproliferative impact on liver cancer H22 cells. Growth inhibition was caused by the stimulation of apoptosis, cell cycle arrest, increased tumor levels in filtering CD8+ T lymphocytes, and stimulation of apoptosis-linked protein expression in H22 cells in vivo. Human oral cancer KB, pancreatic carcinoma BXCP-3, as well as gastric carcinoma SGC-7901 cell proliferation, was inhibited in vitro by the removal of polysaccharide (CAFP) from *Camptotheca acuminata* with the aid of ultrasound and microwave technology (Sun *et al.* 2019).

According to Sun et al. (2017), the PSs from apple peel pomace cause human liver cancer cells to undergo apoptosis. Lewis lung cancer development in mice was significantly suppressed by polysaccharides removed from fruit juice (Hirazumi &

Furusawa, 1999). The BLU87 human bladder cancer cells were propagated in vitro using the polysaccharide LBPF5 from dried *Lycium barbarum* fruit (Ke *et al.* 2011).

According to Xu, Liao et al. (2016), PSs from *Borojoa sorbilis* fruit had a major anti-tumor effect when matched with liver cancer as well as lung cancer cells in vitro. These investigations show that FPSs suppress direct tumor growth by a variety of mechanisms, such as cell cycle arrest, activation of apoptosis, resistance to metastasis, as well as immunomodulatory effect, in addition to activating T cells and immunological function.

Anti-glycation activities

To stabilize ketoamines, reducing sugars as well as amino groups go through a chemical reaction known as glycation, which is crucial for the development of extremely higher-level glycation outcomes (Ahmed, 2005). According to Kostolanska, Jakus, and Barak. (2009), tissue-advanced glycation end products and enlarged glycation play significant roles in diabetic complications. Very few investigations have been done to confirm FPSs' anti-glycation ability. Kiwi (Zhu, Zhang, *et al.* 2019), longan (Yang, Zhao, *et al.* 2009), dates (Marzouk *et al.* 2017), black currant (Xu, Liu, *et al.* 2016), and other FPSs have been reported to acquire PSs that can neutralize free radicals produced by glycation and its finished goods from the organization. Consequently, further, highly developed research is necessary to define the anti-glycation properties of these PSs.

Hepatoprotective effects

Using rat models of paracetamol-induced liver damage, the hepatoprotective effects of dehydrated polysaccharides from guava fruit were examined. The aspartate aminotransferase as well as alanine aminotransferase levels in the paracetamol group were found to be noticeably raised, but they returned after receiving dosages of 200 and 400 mg/kg BW of guava fruit polysaccharide (Alias *et al.* 2015).

According to Yang et al. (2013), oral treatment of apple peel polysaccharides at doses of 250 and 500 mg/kg prohibited the liver injury brought on by CCl_4 (0.5mL/kg) in mice. Additionally, widely recognized from the histological evaluation, these doses of apple peel polysaccharides safeguard the liver from CCl_4-induced effects on the covering of the liver cells. As a result, FPSs can be used to gauge conceivable supplemental foods for the defense of the liver against drug-related compensation.

Anti-microbial activities

The usefulness of FPSs near microorganisms has been demonstrated in numerous investigations. According to Lipipun, Nantawanit, and Pongsamart. (2002), the polysaccharides gel-purified from durian fruit hulls had a MIC of 0.64 mg/ml and were inhibitory to 2 bacterial strains (*Staphylococcus aureus* plus *Escherichia coli*) but not to 2 fungal strains (*Candida albicans* plus *Saccharomyces cerevisiae*). With a minimum dose of 6.25 mg/ml, *Bryonia lacinosa* PSs were intentionally designed to have an antibacterial effect against *E. coli* (Singh, Malviya, Tripathi, & Naraian, 2009).

Other activities

FPSs have also been found to have additional biological effects, including those that are anti-complementary (Choi & Shin, 2011; Chun *et al.* 2002), anti-coagulant (Román *et al.* 2017), anti-corpulence (Choi *et al.* 2016), as well as anti-aging (Hui *et al.* 2019).

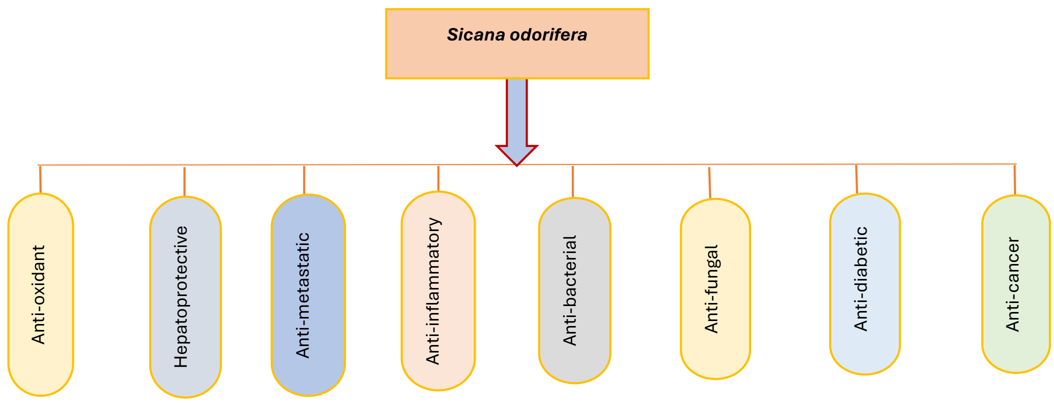


Figure 3. Phytochemistry of *Sicana oderifera.*

Table 4. Pharmacological activities of *Sicana odorifera*.

Bioactivities	Sources	Bioactive constituents	References
Antioxidant activities	camu-camu, abiu, tamarind, strawberry, lychee pulp and pericarp, longan seeds, mango seed, banana peel, pineapple peel, guava, tangerine peel and citrus fruits, apple peel, dragon fruit peel, pomegranate peel	Each of the fruit's anthocyanin-rich extracts was tested using the ABTS as well as DPPH methods, monomeric anthocyanins, vitamin C, phytocompounds and nanoformulations, Superoxide radical-scavenging capability, chelating ferrous ions capacity, including anti-oxidant activity against 2,2-diphenyl-1-picrylhydrazyl (DPPH)	Mohan *et al.* 2020
Insect repellent activities	Both the fruit's pleasant aroma and the brilliant peel color have been noted as significant characteristics	Triterpenes and flavonoids, such as quercetin, taxifolin, karounidiol dibenzoate, and Cucurbita-5,23-diene-3h,25-diol, have been identified	Kienteka *et al.* 2018
Hepatoprotective activities	of fatty fish or bluefish as well as nutritional supplements made from microalgae or fish oils, vegetable oils affluent in ALA	Tocopherols, high concentrations of anthocyanins along with other phenolic compounds, organic acids, and the cytochrome P450's production of N-acetyl-p-benzoquinone imine (NAPQI), that may interact with glutathione (GSH) to generate oxidative stress, are all factors in the process	Albuquerque *et al.* 2021
Anti-metastatic activities	galactan-rich molecules	Galectin-3 protein, a galactan derivative that has been acetylated	Gu, Huang, Chen, Wu, & Ding, 2018
Anti-inflammatory activities	Strawberry and mulberry fruit juice is separated and filtered to create blackberry wine	Synthesis of cytokines that promote inflammation (TNF- and IL-1), as well as NO in LPS-treated RAW 264.7 macrophages, were assessed using Dexamethasone (50 M) as a positive control.	Liu & Lin, 2012; 2014
Anti-proliferative activities	obtained from a local abattoir	There were four human tumor cell lines employed in the sulforhodamine B (SRB) assay: HeLa, cervical carcinoma; NCI-H460, lung cancer that is not tiny cell; as well as MCF-7, hepatocellular carcinoma	Corrêa *et al.* 2015
Antibacterial activities	Epicarps from *S. odorifera* were produced as a hydroethanolic extract	Potassium metabisulfite (E224) with sodium benzoate (E211)	Sokovic´ *et al.* 2010
Antifungal activities	*Aspergillus fumigates* (ATCC1022), *Aspergillus versicolor* (ATCC 11730), *Aspergillus niger* (ATCC 6275), *Penicillium funiculosum* (ATCC	E211 and E224, two commercial food preservatives, served as positive controls	Sokovic *et al.* 2006

	36839), *Penicillium verrucosum* var. *cyclopium* (food isolate), as well as *Trichoderma viride* (IAM 5061) were used to test the hydroethanolic extract of *S. odorifera* epicarp		
Immunomodulatory activities	lychee pulp, longan pulp, *Citrus unshiu peel (CPE-II) and Citrus medica (CMSPW90-M1),* pomelo peels, blackberry wine, *Ficus carica, Schisandra chinensis*	cytokine interferon- (IFN-), murine macrophages, T- and B-lymphocyte proliferation, cytotoxicity of NK cells against YAC-1 lymphoma cells, neural red phagocytosis, as well as generation of IL-6 and nitric oxide (NO) in RAW264.7 cells are all factors.	Yu *et al.* 2018
Anti-diabetic activities	lychee fruit improved glucose tolerance, mulberry fruits showed considerable anti-diabetic effects, and *Lycium barbarum* PSs lowered the hepatic mRNA expression in high-fat diets. *Opuntia dillenii* fruit may significantly lower blood sugar levels.	FPSs can function as possible, substitute, as well as innovative diabetes treatment options in streptozotocin (HFD-STZ)-induced diabetic rats	Chen *et al.* 2018
Anti-cancer activities	Apple PSs had anti-cancer properties, while pomegranate peel PSs had stronger anti-cancer properties, as did *Lycium barbarum*	Cell cycle stages G0 and G1 within human liver cancer cells (SMMC7721)	Zhang *et al.* 2013
Anti-tumor activities	Fruit pulp, pericarp, peel, and even seed polysaccharides have demonstrated potent anti-tumor properties, longan pulp, peels of *Citrus aurantifolia, Camptotheca acuminate,* apple peel, *Lycium barbarum,* pineapple pulp (PAP1 and PAP2), *Borojoa sorbilis* fruit	SKOV3 and HO8910 tumor cells, using oral cancer KB, pancreatic carcinoma BXCP-3, gastric carcinoma SGC-7901, and human bladder carcinoma BLU87 cell proliferation are all caused by CD8+ T lymphocytes and apoptosis-related protein activation in H22 cells in vivo.	Sun *et al.* 2019
Anti-glycation activities	FPSs for example, longan, dates, kiwi, and black Currant	ketamine is stabilized by decreasing sugars and amino groups, which alterations cause the development of advanced glycation end-products	Zhang *et al.* 2019
Hepatoprotective activities	guava fruit polysaccharides, apple peel polysaccharides,	Aspartate aminotransferase as well as alanine aminotransferase levels were significantly greater in the group of paracetamols	Alias *et al.* 2015
Anti-microbial activities	hulls of durian fruit	Two bacterial strains (*Staphylococcus aureus* and *Escherichia coli*) showed clear inhibitory effects, while *Saccharomyces cerevisiae* and *Candida albicans* showed no inhibitory effects	Naraian *et al.* 2009

Toxicology

Numerous hazardous tests have been recorded as of late. The dosages could also affect whether *Sicana odorifera* crude extracts have adverse consequences. Although the inclusion of cytotoxicity, genotoxicity, as well as clinical trial assessment outcomes allow for a more thorough assessment of *Sicana odorifera's* safety, the current findings serve as a good starting point for further toxicology investigations.

Despite advancements in modern pharmacology, liver illness remains among the most prevalent reasons for death worldwide, as well as a critical need for efficient and secure hepatoprotective medicines (Xu *et al.* 2018). Cytochrome P450 metabolism of APAP results in N-acetyl-p-benzoquinone imine (NAPQI), when combined with glutathione (GSH) can lead to oxidative stress and disrupt cells by activating the mitochondrial signal pathway (Hinson *et al.* 2010).

On the other hand, the consumption of -3 PUFA has been encouraged by the strong data showing the numerous positive health implications of -3 PUFA for humans. The availability is constrained and concentrated mostly on eating fatty fish and blue fish as well as dietary supplements made from fish oils or microalgae, which prevents the Western population from consuming more of these fatty acids. An original and creative solution to raise the intake and manufacture of -3 fatty acids, notably from its metabolic ancestor, ALA, is the beginning of industrial manufacturing of vegetable oils that contain ALA in various nations of Latin America (Pipoyan *et al.* 2021).

In line with the current pattern of developing more environmentally friendly alternative methods as well as the growing enthusiasm for the long-term cultivation of biologically active compounds, plant remains with the help of *S. odorifera* seeds provide the possibility to discover their characteristics and offer a fundamental application to commercialized fruits (Fierascu *et al.* 2020). There were no fatalities or indications suggestive of acute toxicity when the methanolic extract of *S. odorifera* seeds was provided at approximately a dose of 2000 mg/kg taken continuously, demonstrating its safety.

Future perspectives

Although earlier research on *Sicana odorifera* produced excellent results, there are still several issues that need to be resolved. The following criticisms are directed at these issues.

As we all know, even if *Sicana odorifera's* high medical worth is served, it is not reasonable to gain them by harming their hosts. As a result, we may create a model of the ideal growing environment for *Sicana odorifera* and then plant their seeds there to produce seeds quickly. In the future, perhaps artificial cultivation will produce more *Sicana odorifera*.

To date, only 40 components' chemical structures have been clarified in terms of phytochemistry, which is far from enough to fully utilize *Sicana odorifera*. Further research is required to determine whether phytochemicals such as reducing sugars, polysaccharides, proteins and amino acids, tannins, catechins, flavonoids, cardiac glycosides, steroids as well as triterpenoids, depsides and depsidones, coumarins, saponins, as well as alkaloids which are glycosides' major secondary metabolites in *Sicana odorifera*. Notably, given that secondary metabolites are thought to be responsible for pharmacological effects; To identify possible bioactive components, we are capable of isolating crude extracts and fractions with significant biological activities with precision. This justifies *Sicana odorifera's* prospective scientific applications in the future.

Sicana odorifera's traditional usage is still unknown in some areas, despite its recognized medical properties. We have not yet demonstrated why using and processing *Sicana odorifera* is more rational, thus further research is needed to clarify this. Additionally, there are still some unsubstantiated reports regarding the medication for arthritic conditions fever, itch, anemia, diarrhea, as well as other conditions. Considering that ethnomedicinal use offers beneficial suggestions for continued investigation, the documents' existence also shows clear viability among substantial growth prospective. These findings indicate that some traditional usage has drawbacks, hence a complete scientific examination should be offered. The traditional uses of *Sicana odorifera* have been supported by current research, although there are still many areas that require improvement.

First off, there aren't many bioactive substances that can exert pharmacological effects on particular diseases that have been identified from crude extracts and fractions. Therefore, it is crucial to discover more bioactive substances and identify the substances that are responsible for the related bioactivities to further the development of novel, potential drugs in the prospect.

Second, the significance of bioactive extracts in various assays has not been fully elucidated by current research, and their fundamental mechanics exposed intended for treating pertinent disorders are unclear. As a result, more information is required to clarify the signaling pathways and probable action targets for a particular bioactivity.

Third, the development of contemporary integration of pharmacological and traditional applications is revealing the study direction. Conventional usage, on the one hand, can serve as an invaluable resource for the most recent study, on the other hand, the latter can confirm and back up the former to increase the scientific nature of its applications.

Fourth, *Sicana odorifera* has not yet undergone a thorough safety assessment. Although earlier toxicity experiments indicated that *Sicana odorifera* bioactive extracts were safe at a variety of concentrations, the results were evaluated primarily based on aging and physiological parameters within multiple in vivo models. To adequately evaluate the safety of *Sicana odorifera,* future testing will need to include cytotoxicity, genotoxicity, and clinical trial testing. Finally, despite the advancements in *Sicana odorifera* study, there are still notable imbalances.

Conclusion

Sicana odorifera Naud is a cucurbit identified the same as "cassabanana", "sikana" or "musk cucumber". It's a cylinder-shaped fruit with delicate skin that belongs to a hardly recognized species of cucurbit. Although it is commonly farmed and dispersed throughout Tropical America, some species originated on other continents.

The vine is herbaceous and persistent. Fruit has a hard shell and is flat, shiny, cylindrical, orange-red, maroon, or black. Its Cucurbita species were sampled for their seeds, which lacked phytoliths but did contain a variety of siliceous structures made primarily of hair cells and hair bases in the form of leaves, peduncles, and tendrils.

The use of conventional medicine is still highly popular. The diseases that are treated by conventional healers are surrounded by bacterial infections and discomfort. Uterine hemorrhages and venereal disorders are treated with cassabanana leaves. It is permitted for use as an emmenagogue, laxative, and vermifuge. It is used as a pest deterrent as well as a medication to treat agitation, uterine hemorrhages, liver disorders, sore throats, and sexual infections.

Sugar reducers, Catechins, Depsidia and Depsidones, Coumarins, Steroids and Triterpenoids, Flavonoids, Glycosides, Cardiac C, Saponins, tannins, alkaloid compounds, proteins and amino acids, polysaccharides, (RB), (RM) are among the secondary metabolites found in *S. odorifera* extracts. Since they possess an aldehyde or ketone group in their chemical structure that is capable of reducing bromine (Br) and remains free in aqueous solution, monosaccharides are also known as reducing sugars (RA).

The application of *S. odorifera* in modern medicine for the treatment of worms, indigestion, anemia, gastric reflux, hypertension, and hemorrhagic illnesses. Due to its anticancer, immunostimulant, anti-complement, anti-provocative, anticoagulant, antiviral, hypoglycemic, and hypocholesterolemic effects, it has been receiving a lot of attention lately.
We stressed that although these findings may open up treatment windows for neurological and diabetes diseases, additional research studies are still required. They did this by referring to prior studies on the botany, ethnomedicinal applications, phytochemistry, and pharmacology of *Sicana odorifera*. In conclusion, we made the point that *Sicana odorifera* are becoming more widely acknowledged as viable sources of phytomedicine with comprehensive pharmacological capabilities, necessitating additional research into their potential medical benefits rather than simply dismissing them as pests.

Declarations

List of abbreviations: Osmotic Dehydration (OD), Diode Array Detector (DAD), High-resolution gas chromatography (HRGC), Gas chromatography (GC), Association of Official Analytical Chemists (AOAC), Inter-American Institute for Cooperation on Agriculture (IICA*),* Reducing sugars (RA), Heteronuclear multiple-quantum correlation (HMQC), Nuclear Magnetic Resonance (NMR), Trimethylamine (TMA), 2,2-Diphenyl-1-picrylhydrazyl (DPPH), Diabetes mellitus (DM).
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Conflict of Interest: The authors declare that they have no conflict of interest.
Availability of data and materials: The data included in this review are collected from the literature available online.

Authors' contributions: **HS** collected, organized, and wrote the manuscript. **KM** conceived the idea and guided me through the whole review. **SAMN** helped in data curation and revisions. **AH** and **SA** helped in the collection of data and in formatting the manuscript.

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