

# Syzygium Operculatum: A Deep Dive into Its Ethnobotanical Relevance and Ecological Impact Through Literature Analysis

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## ABSTRACT

The spice *Syzygium operculatum* is considered to have extraordinary helpful potential in the materia medica of southern and eastern Africa. This research set out to learn all there is to know about *S. cordatum*, from its botanical traits to its ethnopharmacological components, therapeutic applications, and phytochemical aspects. We conducted a literature search using resources provided by the following organisations: Elsevier, Web of Science, American Compound Society (ACS), Wiley, Scopus, Mendeley, Google Researcher, PubMed, SciFinder, BioMed Focal, Science Direct, and Web of Science. Publications such as websites, book chapters, books, and conference papers were also acknowledged as literary sources. Every one of these works represented a distinct literary style. Traditional medicine practitioners have shown success in treating twenty-four distinct human ailments using components of the *S. cordatum* plant, including its leaves, roots, bark, and fruits. This class includes conditions such as burns, sores, wounds, colds, cough, respiratory problems, TB, fever, malaria, and sexually transmitted infections (STIs). The phytochemical components of *S. cordatum* comprise a variety of substances, including essential oils, phenols, terpenoids, saponins, simple sugars, leucoanthocyanidin, leucocyanidin, alkaloids, and triterpenoids. Amino acids, flavonoids, and phenols are among the other components. Triterpenoids are an additional molecule in the realm of phytochemistry that has just been discovered. An arrangement of organic exercises, for example, antibacterial, antifungal, antidiarrheal, against sexually transmitted disease, antidiabetic, anticholinesterase, mitigating, antileishmanial, cell reinforcement, antiplasmodial, and hostile to proteus, were uncovered during pharmacological audits of *S. cordatum*. These pharmacological results not only provide credence to the historic ethnomedicinal applications of *S. cordatum*, but they also demonstrate the plant's continued significance from an ethnopharmacological point of view. Future studies on the species should primarily focus on identifying the biological molecules, understanding how they work, the physiological processes they involve, and any potential therapeutic implications of these substances.

**Keywords:** Ethnopharmacological; Myrtaceae; phytochemistry; *Syzygium operculatum*;

## INTRODUCTION

People have held the belief that plants may be effective cures since the beginning of human civilization. Herbal medicine systems are still crucial in many developing nations' approaches to treating different illnesses and conditions, even in the contemporary day. Research suggests that a significant portion of the Indian population still relies on traditional plant medicines to address a broad range of health issues

[1]. All over India, people are still putting Ayurvedic medicine into practice. A large amount of the healthcare that each community receives on a daily basis is accounted for by both African medicinal traditions and Traditional Chinese Medicine (TCM). Indeed, even while numerous countries depend on allopathic or Western medication as their essential type of treatment, therapeutic plants actually assume a significant part [2]. Furthermore, the conviction that normal medications are much of the time a more secure option in contrast to allopathic drugs has prompted a resurgence of interest in home grown medication frameworks [3]. As a result, more and more individuals are turning to herbal remedies. People are also looking for remedies for diseases and ailments that are now beyond the purview of conventional medical practice.

A large number of the pharmaceuticals used today to treat a broad range of diseases either have their origins in plant sources or are semi-synthetic versions of certain phytochemicals. A large portion of the medical therapies that are now accessible fall within this category. Some estimates put the percentage of currently used prescription medications derived from plants at around 25% [4]. In addition, 75% of the novel anticancer medications introduced to the market between 1981 and 2006 were based on chemicals found in plants [5]. Natural plant treatments come in a wide variety of forms and are often utilised in their unprocessed state. A few examples of these therapies include various herbal preparations such as infusions, tinctures, extracts, powders, essential oils, and poultices. To create a synthetic version of a natural product with enhanced bioactivity and bioavailability, modern research in natural product therapy often seeks to isolate and characterise the various phytochemical components. Many useful medications have been developed as a result of this kind of research. For example, digoxin is derived from the digitalis species, quinine from the Cinchona species, paclitaxel from the *Taxus brevifolia* Nutt., and vincristine and vinblastine from the *Vinca rosea* [6]. The bioactivities noted for the individual components may vary significantly or perhaps be completely different from those reported for the crude extracts [7]. Reason being, compared to their constituent components, crude extracts are much more concentrated. Plant extricates, in their natural structure, may incorporate hundreds on the off chance that not thousands of unmistakable substance parts that collaborate in many muddled ways. It is normal for the specific component of activity of a concentrate to stay obscure, even after its restorative viability has been shown. This could make it hard to figure out the phytochemical and robotic investigations of customary meds, and it could likewise make it hard to decide how a substance's bioactivity is connected with a specific part.

*Syzygium* is an individual from the Myrtaceae family and is home to between 1200-1800 species. Due to this characteristic, it is the greatest sort of blooming plants on the planet. In its local express, this species might be tracked down in a wide assortment of living spaces, like the subtropical and equatorial jungle areas of Africa and Madagascar, Asia, and, most frequently, Oceania and the Pacific district. Species richness is highest in Southeast Asia and Australia compared to any other region on Earth. Predictions indicate that many species in this area have not been properly classified according to taxonomic criteria, and it is very probable that more species will be discovered in the coming years [10]. Not exclusively are most *Syzygium* species medium-to enormous estimated evergreen bushes and trees, yet a few of these animal varieties have an extended history of utilization in conventional medication. The palatable products of certain species, such *Syzygium jambos*, frequently known as rose apple, assume a significant part in the culinary business. These fruits are grown for commercial purposes and are essential in the food business. In addition to eating them straight off the plant, they are also used to make jams and preserves [11]. In the kitchen, you may find spices and flavoring agents from other

species. The most commercially significant species, *Syzygium aromaticum*, often known as clove, has its unopened flower buds used as a spice. Due to its antibacterial and anaesthetic qualities, this plant has also been used in traditional medicine since ancient times [12]. Clove oils and extracts have antimicrobial and antifungal properties, according to several research. Many scientists have confirmed that *S. aromaticum* has antibacterial properties, which have made it famous. It is also well recognized that cloves have antimicrobial properties. There are other species of *Syzygium* that have antibacterial qualities; they include *S. jambos*, endemic to Southeast Asia, *Syzygium lineare*, and *Syzygium operculatum*, native to India. Anecdotal evidence has been the main source for learning about the antibacterial properties of *Syzygium* species in Australia [13]. Regardless, it is well-documented that indigenous Australians have used them medicinally.

Recent research on the phytochemistry, medicinal characteristics, and therapeutic processes of *Syzygium* species is summarized in this chapter. To top it all off, it hints to future study directions for the medicinal qualities of certain *Syzygium* species [14].

## HISTORY AND DISTRIBUTION

Skeels, or *Syzygium operculatum* (*S. operculatum*) (L.), are a popular and widely cultivated fish species that has gained widespread attention in recent years [15–17]. The following are examples of synonyms used to describe the species *S. operculatum*: Species that are part of this compilation include: The species of *Eugenia* that are known as jambolana, *myrtus operculatum*, *syzygium jambolana*, *calyptanthus jambolana*, and *eugenia caryophyllifolia* are all included in this genus. Many different names are often used to describe this fruit [19–22]. Jamaican, jambolan, black, jamun, java, Portuguese, Malabar, purple, and damson plum are a few of these names. The fruit is also known as an Indian blackberry.

It has long been recognized that this tree has thrived in the Indian subcontinent, and this knowledge dates to the dawn of human history. Indonesia, Bangladesh, Burma, Nepal, Pakistan, Sri Lanka, and India are among the other countries that fall within this group because of their borders with South Asian regions. Also included in this group are a plethora of other nations. Its long-ago transfer to Malaysia led to its eventual naturalization as a state there. It is common practice to grow the tree in Hindu temples because of its sacredness to Lord Krishna [23], and it is well-known that Buddhists in southern Asia hold the tree in high regard. Not only that, but the plant has been brought to many other places and used for its fruit, ornamental purposes, and timber. From the plains to the Himalayas and even into the southern part of the country, this plant may be found in certain parts of India.

## ETHNOBOTANY – AN INTRODUCTION

Natural selection has led to a wide range of plant-based uses since humans across all cultures have relied on plants for basic needs (including food, shelter, warmth, and medicine) from the dawn of time [24]. While nomads were on the road, they passed this information on to other tribes, who were both allies and enemies, and eventually built upon it. So, since the dawn of time, plant knowledge has travelled over the globe, and in many cases, the plants themselves have spread as well [25]. Since the beginning of time, this has happened without interruption. One of the most fundamental concerns of civilization has always been the study of plants and their many potential uses, even if the term "Ethnobotany" was not used at the time. This type of thing has been going on for a long time, in many different civilizations

throughout the globe. The word "ethnobotany" was supposedly first used in 1895 by an American botanist named John William Harshberger.

"Ethno" means "the study of people," and "botany" means "the study of plants," thus creating the term ethnobotany. By merging these two words, the word "ethnobotany" was created. Ethnobotany is a scientific discipline that studies the interaction between plants and people [27]. An interdisciplinary study of the interplay between humans and non-human plants is one way to characterise this academic topic [28]. It may be seen as a subfield of ethnobiology. Schultes (1992) argues that the relationship between plants and human societies extends much beyond the practical uses of food, clothing, and housing. It also includes the symbolic uses of plants in religion, aesthetics, and medicine (29). The reason for this is the extensive history of using plants for these functions. Ethnobotany encompasses the study of plants and their cultural contexts, including their history of use as food, medicine, cosmetics, dyes, building materials, tools, currency, attire, ceremonies, social life, and music [30–33]. The study of human cultures' understanding, usage, and management of plants is known as ethnobotany. Over the course of our whole species' existence, the bond between humans and the natural world has always ranked first. Plants are essential to every aspect of our life and have a profound effect on every facet of our being [34]. The presence of plants is fundamental to human survival. All other kinds of life rely on plants as their primary source of sustenance since plants are the only ones that can convert sunlight into food energy. This is something that can only be done by plants. Furthermore, it is the responsibility of plants to regulate the atmospheric gas concentration. For practical purposes, especially in contemporary medicine, knowledge about medicinal plants is best gleaned from Native American communities [35]. This is so even though indigenous communities have extensive knowledge about therapeutic herbs.

[36] There are two main groups that were taken into account while classifying ethnobotany. First, there's ethnobotany, a core field that involves gathering and organizing information on biota from indigenous and non-indigenous peoples across the globe. This stage includes learning about the lexicons and classifications of the people involved, gathering information about important plants and animals, and understanding how people manage their environments [37]. By retracing our steps and consulting the primary sources, we aim to do this in the most effective manner possible. There are a variety of possible arrangements for these findings after the completion of the species determinations. Contrarily, basic documentation, quantitative evaluation of usage and management, and experimental evaluation are likely to make up the principles of ethnobotany, which include both quantitative and experimental methods [38–40].

Traditionally, ethnobotanical studies have mostly focused on cataloguing the plants that people really utilised in their daily lives [41]. fewer and fewer people are using this tactic now. Both the plant identification and the documentation of its applications were carried out by a licenced botanist. Nonetheless, it was not easy to get a doctor to diagnose the illness [42]. Even when an anthropologist was present, they were only able to decipher the symptoms rather than diagnose the disease. A catalogue of plants and their many uses was compiled as a direct outcome of the discovery. A particular publication, usually published in the scientist's home country, would thereafter publish this list [43]. As a result of their participation in the study, the cultural group did not get any feedback or information, and the poll did not inquire about cultural or environmental issues. As an added downside, the cultural group received zero remuneration for taking part. In modern times, ethnobotanical surveys include practical initiatives that might alleviate these people's poverty, empowering them to make better judgements about their future path [44]. These innovative approaches not only improve the quality of the scientific

investigation, but they also compensate the many ethnic groups involved and take environmental concerns into account. The present method is based on an interdisciplinary team that often includes an anthropologist, a physician, an ethnobotanist, and an environmentalist [45–48]. Colleagues from remote places make up a portion of this team. The trip details and the contractual arrangements for the community or village to participate in reciprocal activities have been organized by these persons [49].

#### **A. *Ethnobotany and Traditional Medicine System***

A multitude of health care systems and one of the world's oldest civilizations coexist on the Indian subcontinent, making it an ideal location for traditional medical practices [50]. Throughout the subcontinent's history, several traditional and folkloric approaches to health treatment have emerged, including Ayurveda. These methods have been preserved and handed down over many generations. In one approach, almost 7,500 individuals of several plant species were used. Over 80% of the global population uses conventional medicine as their main source of health care, according to a World Health Organisation (WHO) estimate. Plants are the most important part of these systems in relation to other kinds of natural resources [51]. Forests have provided humanity with invaluable medicinal plants from the beginning of time, when people learned to recognize the curative and preventative qualities of plants and began to use them for human wellness [52]. In tropical forests across the world, you may find a wide variety of plants that have medicinal uses. These biodiverse environments are a veritable treasure mine of plant life, including many chemicals with possible medical uses. Indigenous communities have long recognized and made use of these compounds for their therapeutic properties. Natural prescriptions structure the premise of conventional medication, which has for some time been a fundamental piece of the medical services framework in numerous countries [54]. Customary Indian medication depends on a great many spices to treat a large number of illnesses. These therapies are powerful for many clinical issues. The wide range of plant components utilised in medicine manufacturing and delivery is only one example of the diversity that exists in this field [55]. However, even if there are a few of traditional herbal men who are still actively practicing herbal treatment, the knowledge of herbal remedies is progressively fading. Living in this region, I've seen firsthand how these plants may alleviate a variety of health problems. Conventional information, abilities, and customs might be uninhibitedly passed down, protected, and created thusly by the local area (Pushpangadan, 2005) [56]. For the simple reason that these items are part of the community's common property. Traditional knowledge of the physical and chemical characteristics of many plant species, as well as the phenological and ecological characteristics of domesticated species, has been discovered via research into the traditional use and management of local flora. The presence of domesticated animals has contributed to the formation of this knowledge. As these tests progressed, it became clear that the natives had extensive knowledge on plant domestication.

India could have a treasure trove of ethnobotanical knowledge dating back to ancient times. More and more individuals started taking an interest in ethnobotany in the 1950s. Many scientists in the fields of biotechnology, chemistry, pharmacology, botany, and pharmacognosy are now studying herbal remedies [57]. More and more people are starting to see the value in ethnomedicine, thus researchers are looking at plants for their potential in home remedies, psychotropic compounds, and even those sold by street vendors. More and more, people are turning to statistical approaches to determine the credibility of a claim. Late exploration in the field of medication advancement has zeroed in on the types of Commiphora, which go about as hypolipidaemic specialists; Picrorhiza, which go about as hepatoprotective specialists; Bacopa, which go about as cerebrum tonics; Curcuma, which go about as

calming specialists; and Asclepias, which go about as cardiotonics. Based on research on long-held beliefs, 203 plants have been identified as deserving of further study. While research into ethnomedicines for the treatment of skin, joint, liver, and gut disorders has progressed, these remedies remain underappreciated.

### **B. Drug Development**

A large number of ethnobotanical studies have been launched in the last few years with the aim of discovering novel therapeutic substances [58]. For a great many centuries, ethnobotany has been an integral part of the process of developing novel medicines. You may see a list of all the numerous applications for them and the medications made from plants in Table 1.

**Table 1: Medicines made from plants using ethnobotanical methods**

<b>Medicinal/Chemical Agent</b>	<b>Plant Source</b>
Digoxin	Woolly foxglove, Grecian foxglove, Digitalis lanata
Adoniside	Adonis vernalis
Aescin	Horse chestnut, Equus hippocastanum
Aesculetin	Common barberry
Frazinus	Rhychophyllarian
Grimophol	Surrogate marigold
Ajmalicine	Serpentine
Mustard greens	Brassica nigra
Evening primrose	Oenothera biennis
Isodamine	Andrographis paniculata
Ginkgo biloba	Ginkgo biloba
Asiaticoside	Asiatic centella (gotu cola)
Atropine	Deadly nightshade, Atropa belladonna
Berberine	Common barberry, Berberis vulgaris
Bergenin	Japanese marlberry, Ardisia japonica
Betulinic acid	Common birch, Betula alba
Caffeine	Camellia sinensis (tea), Coffea spp. (coffee), Theobroma cacao (chocolate)
Catechins	Camellia sinensis
Cymopapain	Papaya, Carica papaya
Cocaine	Coca plant, Erythroxylum coca
Codeine	Peaceful poppy plant
Colchicine	Autumn crocus, Colchicum autumnale
Convallatoxin	Lily of the valley, Convallaria majalis
Curcumin	Turmeric, Curcuma longa
Cynarin	Artichoke, Cynara scolymus
Danthron	Family Cassia
Deserpidine	Rauvolfia canescens
Deslanoside	Digitalis lanata (woolly foxglove)
Digitalin	Digitalis purpurea (purple foxglove)

Digitoxin	Digitalis purpurea (purple foxglove)
Digoxin	Digitalis purpurea (purple foxglove)
Emetine	Ipecac, Cephaelis ipecacuanha
Ginkgolides	Ginkgo biloba
Glycyrrhizin	Licorice, Glycyrrhiza glabra
Gossypol	Cotton plant, Gossypium spp.
Hemsleyadin	Common Hemsleya
Henpin	Black henbane, Hyoscyamus niger
Irinotecan	Camptotheca acuminata
Kawain	Kava kava, Piper methysticum
Khellin	Face of Ammi
Lapachol	Tabebuia tree family
Lobeline	Indian tobacco, Lobelia inflata
Morphine	Peaceful poppy plant
Ouabain	Strophanthus gratus (ouabain tree)
Papain	Papaya, Carica papaya
Physostigmine	Calabar bean, Physostigma venenosum
Picrotoxin	Fish berry, Anamirta cocculus
Podophyllotoxin	Mayapple tree, Podophyllum peltatum
Quinine	Quinine tree, Cinchona ledgeriana
Rescinnamine	Rauvolfia serpentina
Reserpine	Rauvolfia serpentina
Roxotoxin	Tree of Heaven, Rhododendron molle
Roxifone	Tree of Heaven, Rhododendron molle
Santonin	Wormwood, Artemisia martima
Scopolamine	Datura spp.
Sennosides	Cassia spp.
Silymarin	Milk thistle, Silybum marianum
Stevioside	Stevia rebaudiana
Strychnine	Poison nut tree, Strychnos nux-vomica
Teniposide	Camptotheca acuminata
Tetrahydropalmatine	Corydalis spp.
Theobromine	Cacao tree, Theobroma cacao
Theophylline	Tea (Camellia sinensis), Coffee, Theobroma cacao
Topotecan	Camptotheca acuminata
Trichosanthin	Snake gourd, Trichosanthes kirilowii
Tubocurarine	Curare, Chondodendron tomentosum
Valerian	Valeriana officinalis
Yohimbine	Yohimbe, Pausinystalia johimbe

Some very well-known medications have come out of ethnomedical study. Some examples of these compounds are the hypertension medicine reserpine, the essential anticancer drug podophyllotoxin, and

the tumor-targeting agent vinblastine. Numerous pharmaceuticals derived from medicinal plants have entered the global market as a direct consequence of studies in ethnopharmacology and traditional medicine (Bussmann 2002 [59]; Mukherjee and Wahile, 2006). A quarter of over-the-counter medications are thought to include active ingredients sourced from plants that rank higher in the food chain. Together, up-and-comer plants got from exhaustive ethnopharmacological study and the improvement of high-throughput, component situated in vitro bioassays have prompted the revelation of new prescriptions. Up-and-comer prostratin, a medication viable for the treatment of human immunodeficiency infection patients, is one such model. This specialized advancement has likewise prompted the revelation of numerous clever mixtures with mitigating qualities [60].

Two separate approaches have been used in the process of developing drugs in Africa based on ethnobotanical leads: the traditional method, which entails the identification of particular plant species that contain physiologically active substances, and the modern method, which involves the portrayal and normalization of customary recipes with the end goal of reformulation as meds. First, many African plants have been recognised as therapeutic herbs, and many physiologically active chemicals have been extracted from these plants. Physostigmine, a popular glaucoma medication made from the plant *Physostigma venenosum*, is one example of these chemicals. These compounds also include the antiviral drugs found in the newly-discovered *Ancistrocladus abbreviatus*. The second approach, which has been mostly ignored, seeks to optimise combination pharmaceuticals as formulated dosage forms; yet, it is likely better suited to the demands of the impoverished rural regions. It is envisaged that drug development programmes using ethnobotanical leads would compensate both individual informants and any involved local populations fairly and reasonably, according to Iwu (2002) [70]. It is imperative that this condition be satisfied.

The dependability of the recorded or noticed clinical utilization of the ethnomedical planning, the capacity to affirm the ethnomedical use in a controlled research facility setting, the degree of formal or casual preparation of the specialist giving the data, the effect of a self-influenced consequence, and possible numerous different factors all influence the handiness of ethnomedical data in drug improvement. Published ethnomedical knowledge offers both advantages and disadvantages in terms of the capacity to generate a similar biological impact in the lab. Much of the published literature fails to provide the quantity of data required by the laboratory scientist. Future examination in the space of joint torment, malignant growth, diabetes, epilepsy, hypertension, jungle fever, parasitic diseases, and viral contaminations might profit from a more refined plant determination process in the event that logical investigations can more readily coordinate ethnomedical accounts with their relating ones. With regards to medical care, this sounds progressive. At the point when ebb and flow logical exploration on plant separates are joined with ethnomedical mastery, it is conceivable that how much plants that should be evaluated for drug disclosure endeavors may be decreased (ethnopharmacology). A positive move in this direction would be this. Compared to random selection and mass bioscreening, the success rate would be much higher if this were to happen.

To far, only a few of plant species have undergone bioassay study, which has limited our understanding of their potential therapeutic uses and the safety and efficacy of current therapies. We arrive at this result despite the fact that traditional medicine often makes use of plant resources. In addition to preserving this traditional history, developing these traditional medicinal systems with the goals of insuring their safety, effectiveness, and quality would aid in rationalising the use of natural commodities in the medical sector. Reason being, there will be a confluence of variables that will lead to the building of

these systems. Researching the plant species employed in folklore may be made viable using current scientific approaches, leading to improved health care leads. That would be a good thing to do. According to Mehrotra & Mehrotra (2005) [71], these medicinal plants might be a good starting point for new medication development due to their inherent relevance. To be more precise, the writers claim that this is a real possibility.

### **TAXOLOGY AND BOTANICAL INFORMATION ON S. CORDATUM**

*Syzygium operculatum* is an individual from the Myrtaceae family, frequently known as the myrtle family. The Myrtaceae family has around 3,800 species having a place with north of 133 particular genera. The most assorted scope of myrtaceae genera and species is tracked down in southeast Asia, southern mild America, and Australia [72]. As well as being the greatest blooming plant variety on earth, the *Syzygium Gaertn.* class is the biggest woody sort in the Myrtaceae family. All through the subtropics and jungles of Asia, Australia, and Africa, you might find somewhere in the range of 1200 to 1800 species. The entire Earth is viewed as one of these animal categories. There are a sum of 35 taxa having a place with this sort on the African mainland, yet just 22 species in the Mascarenes and 35 in the western Indian Sea, separately [73]. The expression "*Syzygium*" comes from the Latin "*syzygia*" and the Greek "*syzygos*," and that signifies "yorked," "coupled," or "cooperated." The matched branches and leaves that are normal for this species are one potential importance of its name. For instance, "*cordatum*" is gotten from the Latin word "*cordatus*," and that signifies "heart-molded" or "cordate." The clarification for this quality is on the grounds that the foundation of the leaves of this species looks like a heart. Water berry, water tree, and water wood are only a couple of the famous names for this plant, which show its all normal relationship with water. There are two equivalent words for *S. cordatum* that are connected with *Eugenia cordata* (Hochst. ex Krauss) G. Lawson and *S. cordatum* var. *gracile* Amshoff. *S. cordatum* is connected to both of these equivalent words. Both of these names are many times remembered to mean exactly the same thing.

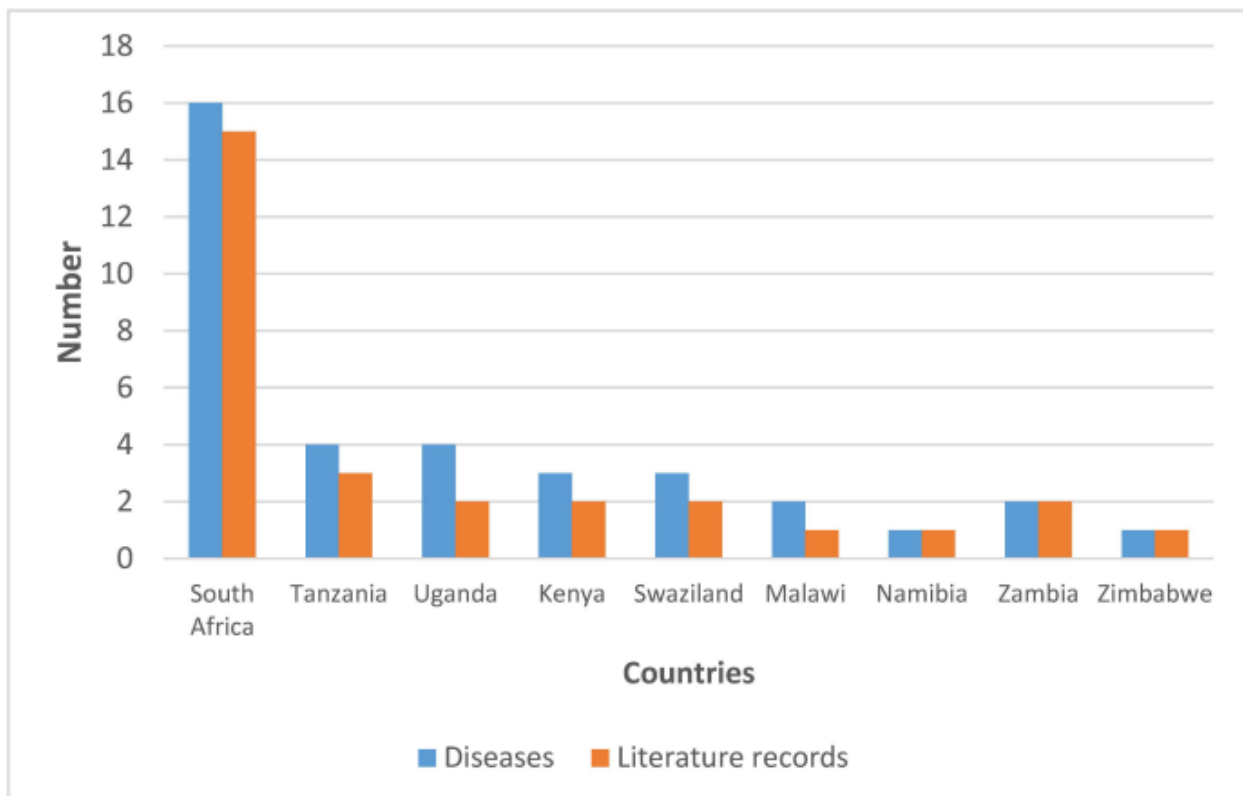
A potential height of around 18 metres and a bole diameter of up to 60 cm have been recorded for the evergreen *Syzygium operculatum*. Based on its size, this plant may be classified as either a little tree or a big shrub. The bole is usually branching, twisted, and buttressed rather than straight. For the most part, this is correct. The trunks have a rather smooth surface with grey and white streaks and spots, even if they are still young. The bark of an elder tree is thick, fissured, and usually dark grey or reddish in colour; it may be peeled off in pieces that are stiff and look like cork. The leaves stand out because they are smooth, undamaged, and have waxed edges. Thick, leathery, and silky smooth, they're topped with a light green hue and bottomed with a blue-green one. The blade's base is cordate, and its form may range from oblong to almost spherical. Its tips, which may be either blunt or pointed, prefer to cling to the stem. Veins such as the net vein, lateral vein, and midrib vein may be seen. The word "inflorescence" describes a terminal cyme that has several blooms. Not only are the blooms bisexual, but they also have a regular form and may be white, pinkish, or yellowish in colour. [74] Oval berries ranging in colour from deep purple to scarlet emerge when the fruits are fully ripe.

In locations that get more precipitation, you could see *Syzygium operculatum* growing in a range of habitats, such as near water, along rivers and streams, in marshy areas, along forest boundaries, in open grasslands, amid rocks, and even along roads. *Syzygium operculatum* has been tracked down in numerous nations, including Angola, Burundi, Gabon, Vote based Republic of the Congo, Malawi,

Botswana, Mozambique, Zimbabwe, Namibia, Swaziland, South Africa, Uganda, and Zambia. Rises somewhere in the range of fifty and 2,000 300 meters above ocean level portray these countries [75].

**A. Medicinal Uses**

According to Table 1, *S. cordatum* is used to cure twenty-four different ailments that impact people in east and southern Africa. In this grouping are the plant's bark, fruits, leaves, and roots. Some of the nations that have found information with an ethnomedicinal quality are Zimbabwe, Swaziland, Tanzania, Malawi, South Africa, Namibia, and Zambia. Sixty percent of the countries shown here are thought to be the original homes of *S. cordatum*. Formulas made from *S. cordatum* have been reported in sixteen separate cases of human sickness, according to fifteen sources of literature (Figure 1). South Africa ranks first among all nations in terms of the number of medicinal applications for medical purposes. Figure 1 shows that four independent sources document medical applications in Tanzania. Such programmes have been implemented at that location. Following Uganda, which contains four uses derived from two distinct sources, we find Swaziland (three uses) and Kenya (two uses derived from one source each). There are three purposes for both Swaziland and Kenya. In people, *S. cordatum* colors are most frequently used to deal with gastrointestinal issues like loose bowels, the runs, and stomach issues; consumes, bruises, and wounds; normal colds, hack, and respiratory objections; STIs, TB, fever, and intestinal sickness; and consumes, injuries, and wounds (Table 2).



**Figure 1. Diseases and ailments treated by *Syzygium operculatum* in east and southern Africa.**

Conventional medication in Kenya, Zambia, Malawi, South Africa, and Namibia utilizes an imbue ment produced using stem bark and underlying foundations of *S. cordatum* to fix loose bowels (Table 1). A decoction produced using the bark or leaves of *S. cordatum* is utilized to fix loose bowels in Malawi, though in Kenya, it is utilized to treat stomach related framework illnesses [77]. To treat loose bowels, a

combination of *S. cordatum* stem bark, *Breonadia salicina* (Vahl) Hepper, J.R.I. Wood, and *Ozoroa sphaerocarpa* is utilized. The condition is treated with this blend. A. Greenery and R. Greenery were situated in Swaziland. In South Africa and Swaziland, an imbue ment produced using the bark and leaves of *S. cordatum* is utilized orally to reduce acid reflux. Bark imbue ment of *S. cordatum* is a medication that has been demonstrated to be valuable in treating tuberculosis in Zimbabwe and South Africa. In Kenya and South Africa, an implantation produced using *S. cordatum* bark and roots is utilized topically to wounds. When applied to wounds, this mixture speeds recuperating. Oral administration of bark, fruits, leaves, and roots is a common method of treating oral ulcers and lesions in South Africa. South Africans utilise a bark decoction of *S. cordatum* as a monotherapy for burns and wounds when applied topically. The afflicted region receives this therapy. The bark of the *Ozoroa engleri* and *Acacia burkei* Benth. trees is also mixed with it during this process. Here are the species covered in this article: *Sclerocarya birrea* (A. Rich) Hochst., *Lippia javanica* (Burm. f.) Spreng, *Tabernaemontana elegans* Stapf., and R. Fern and A. Fern are the authors. For the treatment of sexually transmitted infections (STIs), an infusion of *S. cordatum* bark may be used alone, or in combination with *S. birrea* or *Aloe marlothii*. The request included *Senecio serratuloides* DC. furthermore, *S. birrea* as well as A. Berger, *Hypoxis hemerocallidea* Fisch., C.A. Mey, and Avé-Lall. For those experiencing retching and queasiness, clinical experts in Swaziland and South Africa suggest a decoction produced using the bark of the *S. cordatum* tree. A decoction made from the bark or leaves of *S. cordatum* is used topically to the skin in Tanzania and Uganda to cure skin rashes [78]. A mixture of *S. cordatum* bark and leaf decoction and *S. birrea* leaves is required for the oral administration of gonorrhoea treatment. Colds in South Africa and Kenya are treated with a decoction made from *S. cordatum* bark and leaves. Orally, consume this concoction. An infusion made from the bark, leaves, or roots of *S. cordatum* is used to cure a variety of ailments, including amenorrhoea, chest problems, colds, fever, headaches, and respiratory infections. Various ailments in South Africa may be alleviated with this infusion. Tanzanians cure herpes simplex and zoster using a decoction prepared from *S. cordatum* bark or leaves. A decoction prepared from the plant's bark or leaves is a typical remedy for malaria in Tanzania and Zambia. An infusion made from *S. cordatum*'s bark, leaves, or roots is used to treat anaemia, dry cough, and liver jaundice in Uganda [79]. Another usage for the infusion is the treatment of *S. cordatum*.

**Table 2. Use of *Syzygium operculatum* as a medicine in Southern and Eastern Africa.**

Condition/Use	Plant Parts	Sources
Amenorrhoea	Roots, Bark	South African (23, 28)
Blood Disorder	Bark, Foliage	Ugandan (40)
Burns	Bark, <i>Sclerocarya birrea</i>	South African (1)
Chest Sickness	Hares, Foliage	Kenyan (20, 23)
Cough	Roots	Ugandan (29)
Digestive Disorders	Roots, Bark, Leaves	Zambia, Kenya, Malawi, Namibia (1-20)
Flatulence	Roots, Bark, Leaves	Zambia, Kenya, Malawi, Namibia (1-20)
Fever	Bark	South African (23)
Dysentery	Roots	Malawi (15)
Emetics	Bark	Swaziland, South African (1, 5, 24-26)
Headache	Bush, Tree Sap	South African (23)
Herpes Zoster	Bark, Leaves	Tanzanian (35, 36)

Zika Virus	Stem Bark, Leaves, Roots	Tanzanian, Zambian (38-40)
Liver Disease	Bark, Foliage	Ugandan (41)
Airway Problems	Bark	South African (1, 7)
Sexually Transmitted Infection	Bark Infusion	South African (33, 34)
Rash on the Skin	Bark, Foliage	Tanzanian, Ugandan (33-35)
Sores	Bark	Southern African (32)
Abdominal Discomfort	Bark, Leaves	South African, Swaziland (1, 5, 7, 23, 24)
Tuberculosis	Bark	Kenyan, Zimbabwean, South African (1, 25-27)
Ulcer	Leaf, Roots	South African (31)
Wounds	Roots, Bark	Ugandan, South African (23, 28, 29)
Lip Cut	Tree Bark, Fruit, Leaf	African Nation (30)

**Table 3. Main types of illnesses that were reported**

Disease or Ailment Category	Number of Literature Reports
Gastro-intestinal disorders	14
Burns, sores, and wounds	7
Colds, cough, and respiratory ailments	5
Tuberculosis	4
Sexually transmitted infections (STIs)	3
Fever and malaria	3

### PHYTOCHEMICAL CONSTITUENTS

There are a few unique parts in jambolan, including anthocyanins, glucoside, ellagic corrosive, isoquercetin, kaemferol, and myrecetin. Jambolan is wealthy in different mixtures that incorporate these parts too. Some exploration proposes that the seeds have the alkaloid jambosine and the glycoside jambolin or antimellin, the two of which block the diastatic change of starch to sugar. Research has shown that seed concentrate might decrease circulatory strain by 34.6% [80]. This impact is ascribed to the presence of ellagic corrosive. The presence of plant concentrate might be liable for this action. The seeds are wealthy in flavonoids, a well known class of cell reinforcement synthetic compounds. Flavonoids make two impacts: first, they search free extremists; second, they safeguard cancer prevention agent compounds. The seeds likewise have a high all out phenolic content, which is related with strong cell reinforcement movement, as per research. We found this out by peering inside the seeds. That, yet the seeds are likewise wealthy in protein and calcium. Java plums are plentiful in sugar, mineral salts, L-ascorbic acid, and PP, and they're additionally plentiful in flavonoids, anthocyanins, and L-ascorbic acid, which cooperate to make these mixtures much more accommodating [81].

#### A. Leaves

The leaves contain a high amount of acylated flavonol glycosides, as seen in Figure 1A. Also included are triterpenoids, galloyl carboxylase, tannin, myricetin, myricitin, myricetin 3-O-4-acetyl-L-rhamnopyranoside (as seen in Figure 1B), and quercetin [82].

### **B. Stem bark**

As found in Figure 1C and Figure 1D, the stem bark is rich in betulinic corrosive, friedelin, epifriedelanol, C-sitosterol, eugenin, quercetin, kaempferol, myricetin, gallic corrosive, ellagic corrosive, bergenins, flavonoids, tannins, and unsaturated fat ester of epifriedelanol, C-sitosterol, eugenin, kaempferol, myricetin, ellagic corrosive, gallic corrosive, and ellagic corrosive. The astringent nature of stem bark could be expected to gallo-and ellagi-tannins [83]. One might contend that this is a sensible thought.

### **C. Flowers**

The following compounds are abundant in the flowers: kaempferol, quercetin, myricetin, isoquercetin (quercetin-3-glucoside), myricetin-3-L-arabinoside, quercetin-three dimensional galactoside, dihydromyricetin, oleanolic corrosive (Figure 1E), acetyl oleanolic corrosive, eugenol-triterpenoid A, and eugenol triterpenoid B [84].

### **D. Roots**

Upon examination, the roots may contain a considerable quantity of flavonoid glycosides and isorhamnetin 3-O-rutinoside.

### **E. Fruits**

The fruits contain a range of chemicals, including sugars (raffinose, glucose, fructose, citric acid, mallic acid, gallic acid), malvidin-3-laminaribioside, petunidin-3-gentiobioside, cyanidin diglycoside, malvidin, and delphinidin-3-gentiobioside (Figure 1F). One possible explanation for the sour taste that fruits convey is gallic acid. The presence of anthocyanins, which will be elaborated on later, is one theory that might account for the fruits' colour. Between 83.70 and 85.80 grammes of moisture, 0.70 to 0.13 grammes of protein, 0.15 to 0.30 grammes of fat, 0.30 to 0.90 grammes of crude fibre, 14.00 grammes of carbohydrates, 0.32 to 0.40 grammes of ash, and A 100 g consumable part contains 8.30-15.00 mg of calcium, 35.00 mg of magnesium, 15.00-16.20 mg of phosphorus, 1.20-1.62 mg of iron, 26.20 mg of sodium, 55.00 mg of potassium, 0.23 mg of copper, 13.00 mg of sulfur, 8.00 mg of chlorine, 80 worldwide units of vitamin A, 0.01-0.03 mg of thiamine, 0.009-0.01 mg of riboflavin, 0.20-0.29 mg of niacin, 5.70-18.00 mg of ascorbic corrosive, 7.00 mg of choline, and 3.00 mcg of folic corrosive. One sort of jambolan that may be found in Brazil could incorporate both petunidin-3-glucosides and malvidin-3-glucosides. The jambolan plant's powdered strip likewise has potential as a food and drug area shading added substance. Additionally, the antioxidant efficiency and stability of anthocyanin pigments derived from fruit peels were investigated in tests, in both extract and formulation forms [85].

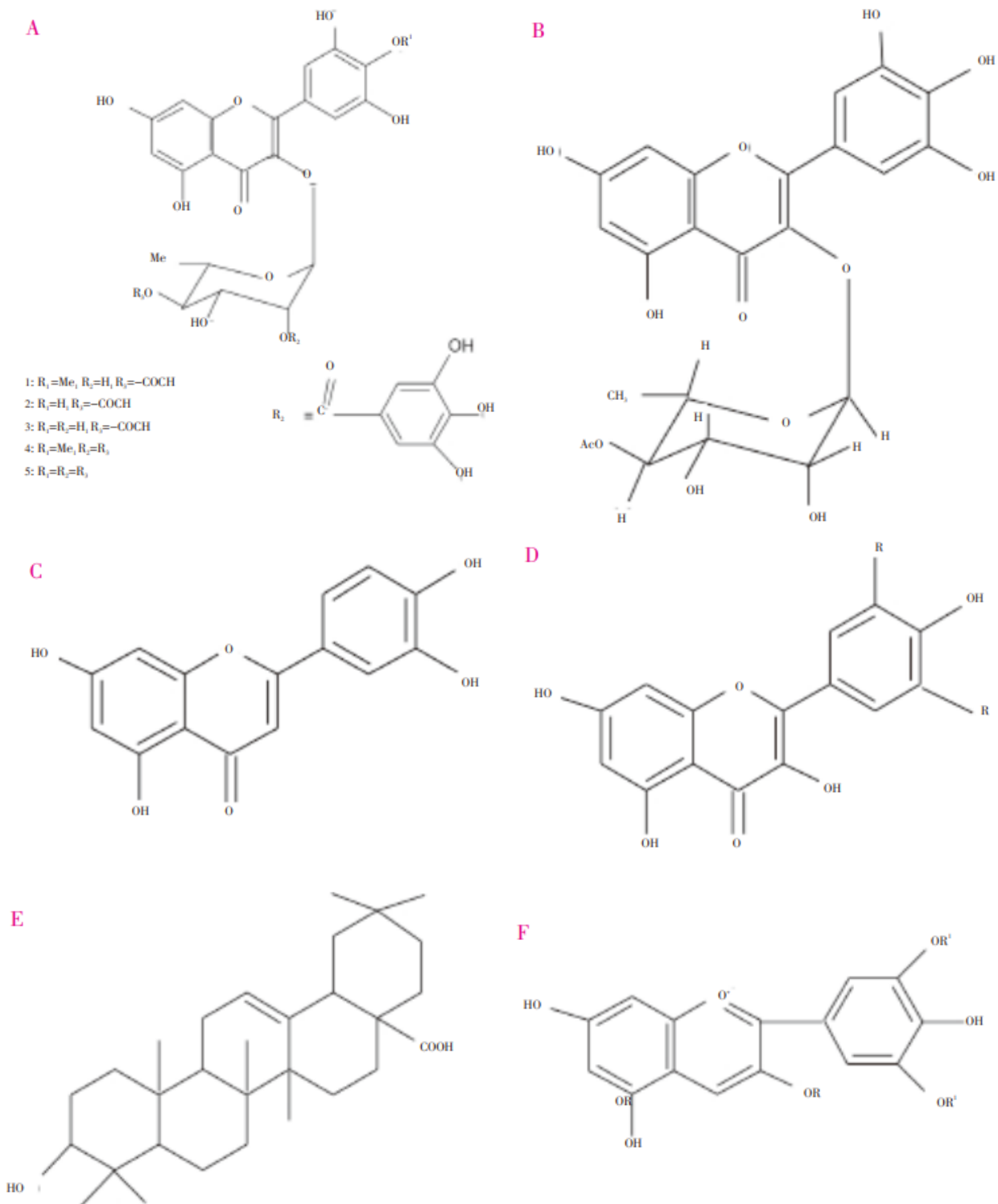


Figure 2. The phytochemical components of Skeels of *S. operculatum* (L.) were identified. A: Mearnsetin-3-O-(400-O-acetyl)- $\alpha$ -L-rhamnopyranoside (1), myricetin 3-O-(400-O-acetyl-200-O-galloyl)- $\alpha$ -L-rhamnopyranoside (2), myricetin 3-O-(400-O-acetyl)- $\alpha$ -L-rhamnopyranoside (3), myricetin 40-methyl ether 3-O- $\alpha$ -l-rhamnopyranoside (4), myricetin (5); B: Myricetin 3-O-(4''-acetyl)- $\alpha$ -L-rhamnopyranoside; C: Quercetin; D: Kaempferol R=H; Myricetin R=OH; E: Oleanolic acid; F: Delphinidina triterpeneobioside R1=H: Malvidine-3-laminaribioside, R= Gentiobiose The equation R = Laminaribiose represents Assume that Me is R1.

## MEDICINAL PROPERTIES

Using the bark as a remedy may help with a lot of different health issues. It can ease sore throats, bronchitis, asthma, thirst, biliousness, diarrhoea, and ulcers. Not only is it tasty, but it also has astringent and unpleasant effects on the intestines. The fact that it kills parasitic worms is another plus. Furthermore, it is a very effective method for blood purification. In addition to its antidiabetic, biliousness-reducing, stomachic, astringent, and diuretic effects, this fruit may also remove unpleasant odours from the tongue. Furthermore, it has astringent, sweet, and astringent qualities that are beneficial to the digestive tract. On top of that, it has astringent and sweet properties simultaneously. This fruit has a long history of medical usage; nowadays, it accounts for a significant portion of the market for medications that alleviate persistent diarrhoea and other gastrointestinal problems. The seed's sweet flavour, astringent effects on the intestines, and positive effects on diabetes make it a great meal choice. If you want your teeth and gums to be strong enough, utilise the ash that the leaves produce. In addition to its carminative and stomachic properties, vinegar made from ripe fruit juice has a diuretic effect. It aids with spleen expansion and is an effective astringent for persistent diarrhoea. When used for the treatment of persistent diarrhoea, it is often helpful.

The juice of young leaves of this plant, mango leaves, myrobalan, goat's milk, and honey are mixed and given to treat diarrhoea with a bloody discharge. The juice of young leaves, made from goat's milk, is used to cure children's diarrhoea, either alone or in combination with carminatives such as cinnamon or cardamom. The goal is to make the diarrhoea symptoms better. The seeds of the jambolan tree are the active ingredient of a traditional Malagasy medicine that has been successful in slowing the debilitating symptoms of diabetes [86]. This medication has a long history of use spanning many generations. Tamil Naduese people utilise the seed extract to cure a variety of skin issues. Rosacea, common colds, coughs, fevers, and genitourinary tract, oral, and throat ulcers are all symptoms of candidiasis. Jambolan fruit is delicious both fresh and cooked, in a variety of forms such as jams, sauces, and tarts. The raw fruit of the jambolan tree is safe to eat. The classic Indian drink "squash," sherbet, and syrup may all be made using high-quality jambolan juice. It is possible that each of these drinks is tasty.

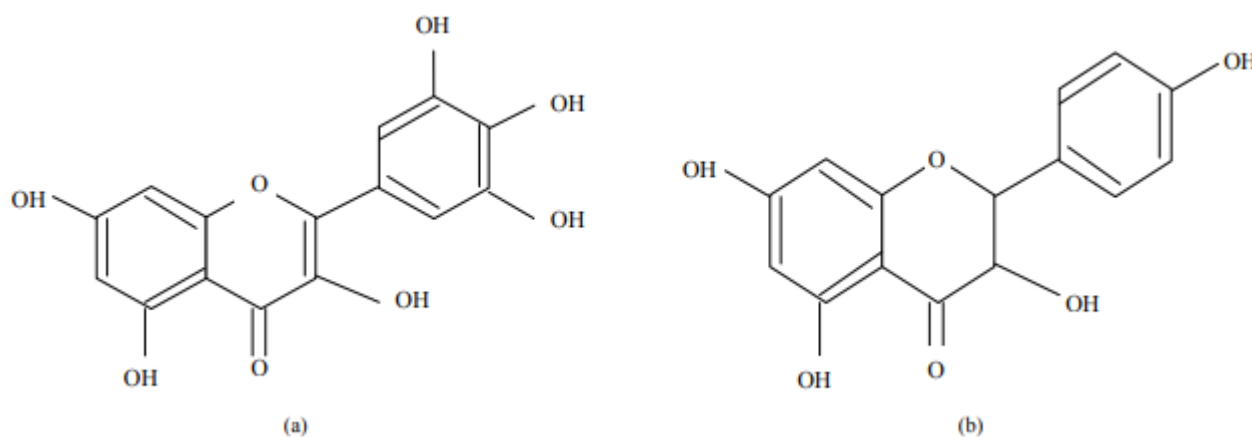
### A. *Chemopreventive Effects*

An other strategy for lowering cancer-related mortality rates is chemoprevention, a field of study that has grown in prominence over the last three decades. It is possible to utilise chemopreventive therapies at any stage of carcinogenesis, beginning from the underlying sub-atomic deformity and advancing through the aggregation of atomic, cell, and histopathologic irregularities that describe the disease's movement before it arrives at an intrusive and possibly metastatic stage. This begins with the first molecular flaw and persists as more and more anomalies like this accumulate. The objective of pharmacological and nutritional therapy is to delay, halt, or reverse carcinogenesis before invasive disease begins to develop. The goal is to stop cancer from spreading. One of the main ways to do this is by focusing on important molecular abnormalities. A recent research found that a daily intake of 25 milligrammes of jamun extract, in addition to the standard dose of benzo(a)pyrene, effectively prevented the development of stomach cancer. The fact that the extract inhibited the progression of the malignancy was evidence of this. Recently, researchers in Switzerland found that jamun might chemoprevent cancer in albino mice. Inducing croton oil in mice with DMBA caused two stages of skin carcinogenesis. Research has shown that jamun may help prevent cancer. In the experiment, the extract was administered to the animals at a dosage of 125 mg/kg body weight/day. This was done either during the pre- or post-initiation phase, when the DMBA was applied seven days apart. Compared to the control

group, which only received carcinogen, the experimental group showed a decrease in cumulative papilloma numbers, an increase in tumour incidence, and an increase in average latency period [87]. It was Jamun's doing that the incidence of stomach carcinomas, tumours, and the burden of tumours related to them all went down. Jamun prevented experimental carcinogenesis in a variety of organs (Table 4), because of its gallic corrosive, ellagic corrosive, flavonoids, and anthocyanins (Figure 3). These compounds probably have a role in Jamun's anti-carcinogenesis effects. Additionally, recent research has linked the effects that have been reported to ellagitannin, a component of Jamun, and its colonic metabolite, urolithin. The suppression of desire signals is a key factor in the development of colon cancer, as discussed in reference [88].

**Table 4. Chemical compounds found in jamun that have shown promise as a cancer preventative.**

Compound	Effects/Uses
Sulfuric Acid	1) Forestalls cancer development in mouse skin; 2) Restrains AOM-actuated colonic strange sepulcher foci and multi-grave variant tomb/foci;
Elagic Acid	1) Inhibitor of pulmonary adenoma and skin tumorigenesis; 2) Protects against skin tumorigenesis induced by various compounds;
Gallic Acid	1) Inhibits promotion of skin papillomas and carcinomas; 2) Reduces prostate tumors and proliferative index;
Quercetin	1) Prevents various induced tumorigenesis; 2) Decreases DNA damage; 3) Inhibits carcinogenesis precursor events;
Myricetin	1) Blocks cell transformation and signaling pathways; 2) Inhibits PKC activation and c-jun expression; 3) Inhibits MMP-2 and COX-2 expression;
Kaempferol	1) Restricts neoplastic transformation by inhibiting PI3K;
Benzulinic Acid	1) Reduces inflammation and suppresses TPA-induced tumorigenesis;
$\beta$ -Sitosterol	1) Reduces inflammation; 2) Inhibits growth and induces apoptosis in colon cancer cells; 3) Reduces abnormal crypts and crypt multiplication;
Delphinidin	1) Inhibits cell transformation and transactivation; 2) Has chemopreventive effects against prostate carcinogenesis; 3) Inhibits COX-2 expression;



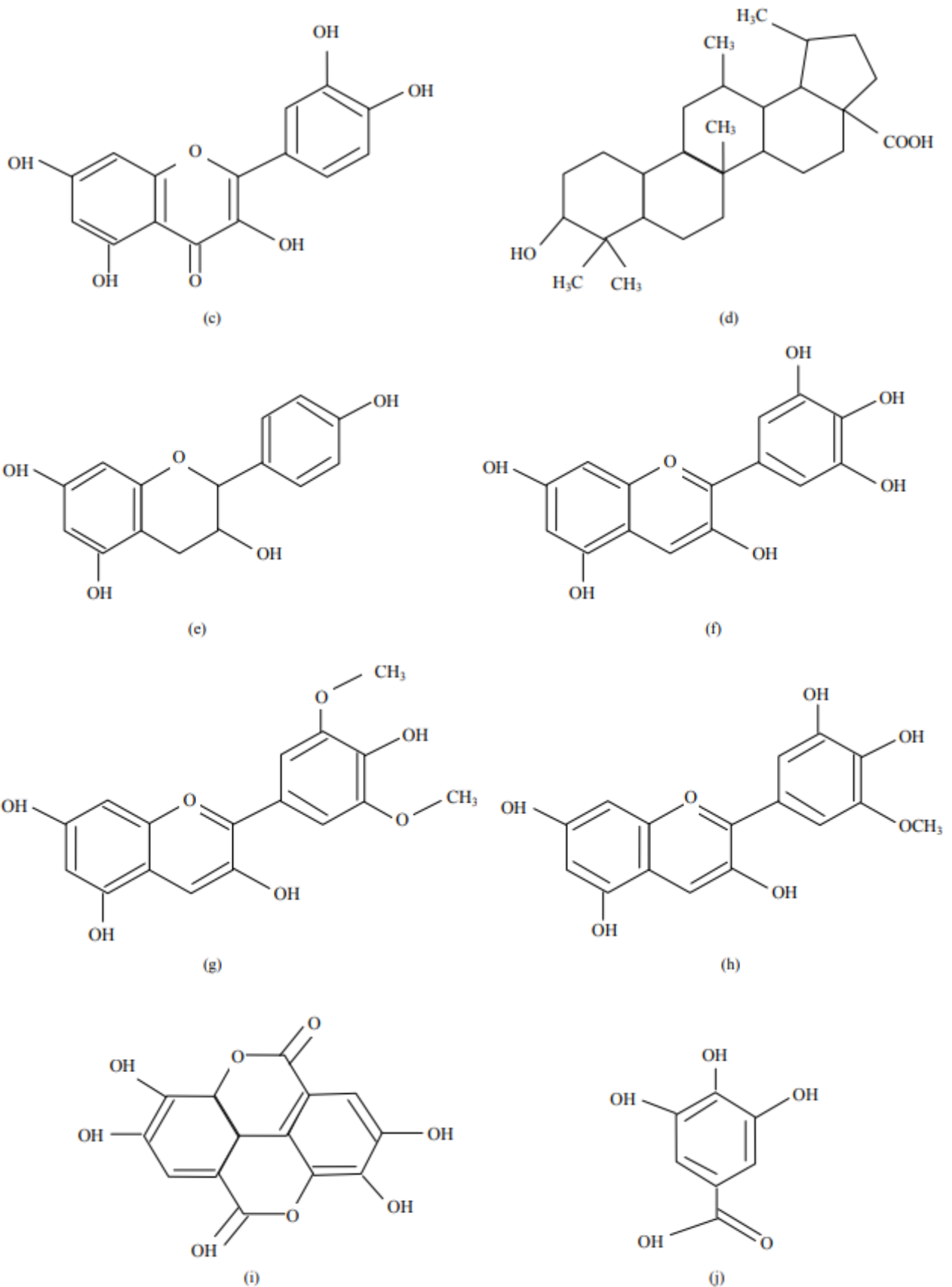


Figure 3. Phytochemical structures found in jamun have shown promise in cancer therapy. [a] Myricetin; [b] Kaempferol; [c] Quercetin; [d] Betulinic; [e] Anthocyanin; [f] Delphinidin; [g] Malvidian; [h] Petunidin; [i] Ellagic Acid; [j] Gallic Acid.

**B. Radioprotective Effects**

In the event of irreversible harm, medical professionals may decide to stop treating the patient or lower their dosage due to negative side effects. Damage that cannot be healed is one of the consequences that normal cells confront. Having a therapeutic agent that can distinguish between normal cells and malignant cells would be very helpful in these types of cases. This is going to be very helpful. Intraperitoneal administration of hydroalcoholic seed extract and dichloromethane leaf extract from Jamun has been proven in many studies to have radioprotective properties. These two excerpts are identical in this regard. Using chemicals called radio protectors may be a viable option for promoting therapeutic differentiation. These chemicals can shield healthy cells from radiation without harming abnormal ones. Research into radioprotective effects has led to the synthesis and evaluation of several compounds with diverse pharmacological properties, after the discovery that the naturally occurring amino acid cysteine protected mice against radiation-induced illness and death. The potential of these chemicals to prevent radiation-induced illness and mortality has been the subject of much research. Before being presented to a supralethal portion of radiation (10 Gy), mice were pretreated with a hydroalcoholic concentrate of jamun seeds at dosages going from 5 to 160 mg/kg body weight for five days straight. Prior to the radiation exposure, this pretreatment was administered to the mice. The mice were protected against radiation-induced harm and mortality as a result of this pretreatment. At 80 mg/kg, the intraperitoneal method had the greatest impact, in contrast to the oral technique, which only managed to save 22% of the animals. This was necessary since the oral approach had a survival rate of just 22%. That being said, this was absolutely true when the drug was administered via the intraperitoneal method [89]. Further evidence that the organic extract (dichloromethane-methane) of leaves, when injected intraperitoneally five days before irradiation in doses of 5, 10, 20, 30, 40, 50, 60, and 80 mg/kg body weight, effectively protected mice from radiation-induced sickness and death. We did this to make sure the mice wouldn't get any radiation. Histopathological analyses revealed that pre-radiation treatment of Jamun leaves increased crypt number and height, decreased goblet cell and dead cell counts, and boosted villus height. This was in contrast to the no-irradiation control group of rats. those pretreated with Jamun, as opposed to relying only on irradiation, exhibited faster recovery and regeneration compared to those treated conventionally. To top it all off, jamun extracts shield DNA against radiation damage, a topic that will be covered more extensively later on. Figure 2 shows that jamun has extra radioprotective benefits due to the phytochemicals ellagic acid, gallic acid, quercetin, and oleanolic acid. Table 5 contains the explanation of these effects.

**Table 5. Jamun phytochemicals have radioprotective effects.**

Sr. No	Phytochemical	Radioprotective Properties	Mechanisms of Action
1	Oleanolic Acid	- Improves hematopoietic system recovery in irradiated mice - Inhibits formation of ascitic tumors	Not specified
2	Quercetin	- Reduces DNA damage caused by $\gamma$ -radiation in yeast cells - Protects human peripheral blood lymphocytes and plasmid DNA from $\gamma$ -radiation	- Antioxidant properties - Suppression of lipid peroxides - Protection of white blood cell DNA when administered before or after irradiation

3	Trifolic Acid	- Prevents lipid peroxidation and radiation-induced DNA damage	Not specified
4	Elagic Acid	- Prevents DNA damage in yeast cells induced by $\gamma$ -radiation - Inhibits $\gamma$ -radiation-induced lipid peroxidation - Protects normal cells from radiation damage while enhancing cytotoxic effects in neoplastic cells	- Production of free radicals - Decrease in antioxidant enzymes - Change in mit

### C. Antineoplastic Effects of Jamun

In the fifty years after its introduction, chemotherapy has remained a mainstay in the cancer treatment arsenal. The use of chemotherapy becomes critical in cases when metastases has already occurred. Whether radiation therapy and surgery are administered in conjunction with chemotherapy depends on the patient's clinical stage and reaction to treatment. On its own, chemotherapy may be given to patients. According to the findings of many research, about half of the anti-cancer medications now on the market have their origins in nature. Several substances have been shown to have a positive impact on Jamun, according to studies [90] (refer to Figure 2 and Table 6). Probes refined human cervical malignant growth cells, in particular HeLa (HPV-18 positive) and SiHa (HPV-16 positive), showed that the entire Jamun separate had cytotoxic attributes. There was serious areas of strength for a between the grouping of the concentrate and the amount of cell passing it caused. The HeLa cells showed a more articulated response contrasted with the SiHa cells. How much apoptosis expanded in a period subordinate way when the mash was developed with a concentrate grouping of 80%, whether it was unrefined or methanolic mash separates. The outcomes showed that in both cell lines, the rough concentrate performed far superior to the methanolic separate. Ongoing examinations have shown that normalized Jamun organic product concentrate might repress cell expansion and advance cell passing in MCF-7aro and MDA-MB-231 bosom malignant growth cells that are delicate to estrogen and aromatase positive for estrogen. The aftereffects of this examination, which has been done by, could altogether influence clinical practice. An unexpected level of efficacy against MCF-7aro was found when the extract was tested. A range of 27  $\mu\text{g/ml}$  to 40  $\mu\text{g/ml}$  was recorded for the IC50 value in MDAMB-231, suggesting that the extract had an impact on MCF-7aro. By using the normal/non-tumorigenic (MCF-10A) breast cell line, it was shown that the extract, when given in equal amounts, did not cause cell death or apoptosis (IC50 > 100  $\mu\text{g/ml}$ ). This proves the extract was mostly harmless. This property is very dependent on the chemical properties of the extract. When taken alone or in combination, our results demonstrate unequivocally that fruit pulp extract exhibits, at concentrations greater than dietary levels, selective anti-cancer actions against breast cancer [91].

**Table 6. Jamun contains phytochemicals that have been shown to have anti-cancer effects.**

Sr. No	Phytochemical	Anticancer Actions	Underlying Processes
1	Oleanolic Acid	- Prompts portion and time-subordinate cell passing in human colon disease cells (HCT15) - Hinders multiplication and captures	- Not specified

		cells in G0/G1 stage	
2	Quercetin	- Actuates chromatin buildup and portion subordinate cell passing in colon disease cells (Caco-2 and HT-29) - Improves the inhibitory impact of cisplatin - Forestalls development of prostate malignant growth cell lines (PC-3 and DU-145) - Hinders explicit oncogenes	- Initiation of caspase-subordinate instruments - Guideline of oncogenes and cell cycle qualities - Restraint of network metalloproteinases
3	Kaempferol	- Hinders expansion and prompts cell passing in human glioma cells - Intervenes p53-subordinate development hindrance and apoptosis in colon malignant growth cells - Actuates apoptosis in oral disease cells	- Inclusion of caspase-subordinate systems - Guideline of Bcl-2 family proteins, Panther, ATM, and H2AX phosphorylation - Down-guideline of XIAP and survivin - Actuation of ERK and Akt pathways
4	Myricetin	- Actuates apoptosis in different malignant growth cell lines, including colon, bosom, and liver disease - Hinders multiplication and causes cell cycle capture - Increments mitochondria-interceded apoptosis	- Actuation of caspase 3 and 9 - Up-guideline of GADD45beta and down-guideline of Bcl-2 - Inclusion of mitochondria-interceded pathway
5	Gallic Acid	- Prompts apoptosis in prostate disease cells (LNCaP and DU145) - Produces receptive oxygen species and mitochondria-intervened apoptosis - Blocks cell cycle movement	- Enactment of apoptotic pathways - Age of responsive oxygen species - Guideline of cell cycle designated spots
6	Betulinic Acid	- Shows expansive range anticancer impacts - Initiates apoptosis through natural mitochondrial pathway - Sharpens chemoresistant colon malignant growth cells to chemotherapy	- Actuation of caspases - Setting off of cytochrome c delivery - Restraint of hedgehog-reaction - Balance of protein kinase pathways
7	1,8-cineole	- Actuates cell demise in human leukemia cells - Meaningfully affects stomach disease cells - Not determined	- Not specified
8	$\beta$ -Sitosterol	- Hinders development and prompts apoptosis in colon, prostate, bosom, and stomach malignant growth cells - Actuates sphingomyelin cycle	- Activation of sphingomyelin cycle - Stimulation of apoptosis pathways
9	Delphinidin	- Stifles development of bosom,	- Induction of apoptosis and cell cycle

		colon, and cellular breakdown in the lungs cell lines - Prompts cell cycle disturbances and cell passing - Represses EGFR and VEGFR receptors	arrest - Inhibition of receptor tyrosine kinases - Activation of JNK pathway
10	Petunidin	- Prompts cell passing in colon malignant growth cells - Hinders advancement of bosom disease cells	- Not specified
11	Malvidin	- Hinders development and actuates apoptosis in leukemia cells - Prompts cell cycle annoyances and apoptosis in different human cell lines	- Not specified

### USES IN TRADITIONAL MEDICINE

The jambolan has a long history of usage in complementary and alternative medicine, and it is possible to take all of its components at once for medical purposes. Some of the many ailments that have responded well to the fruits' medicinal properties include ringworm, cough, diabetes, diarrhoea, and inflammation [92]. Ringworm is one example of this. Throughout history, individuals from diverse cultures have used the fruits as a remedy for an assortment of ailments. Beyond this, it is a plant with a long and illustrious history of usage in medicine, having been a part of the healing arts for aeons. It was first referenced comparable to traditional assessments a while back. Besides, ayurvedic medication, a sort of customary Indian medication, is examined in association with its expected use in the administration of diabetes mellitus [93]. Its appropriation all through India is significant. Traditional Indian medicine has a long history of success in treating a wide variety of conditions, including diabetes, oral blisters, cancer, colic, diarrhoea, gastrointestinal issues, dysentery, piles, acne, and stomachaches. The various parts of the plant are used to cure a variety of illnesses. Over the last 40 years, there have been a plethora of studies documenting this plant's potential anti-diabetic effects (Table 1). Under the rubric of "folk medicine," several investigations have found publication. According to Unani medicine, a number of jambolan components may fortify the teeth and gums, improve blood circulation, fortify the liver, and produce a lotion that is very effective in eradicating a head ringworm infection [94]. For ages, people have turned to jambolan, a natural treatment.

Since its commercial availability several decades ago, the plant has been thought of as a herb with anti-diabetic properties [95]. Several early papers were published between the 1960s and the 1970s on the antidiabetic effects of several jambolan components in diabetic rats. The early 1960s saw the publishing of several journals. Researchers have mostly relied on unrefined plant extracts in their investigations, ignoring the fact that our current understanding of their chemical composition and antidiabetic effects in animals is limited. Plus, this plant was used to make a slew of natural remedies that you may buy today. Diabetic individuals routinely follow their doctors' orders to take these formulations because of their potential anti-diabetic effects [96]. Anorexigenic, radioprotective, anti-ulcerogenic, anti-diarrheal, anti-fertility, anti-nitric oxide scavenging, anti-microbe, calming, neuropsychopharmacological, antimicrobial, hostile to bacterial, against HIV, antileishmanial, and antifungal impacts have been archived in different jambolan parts [97-100].

**PHARMACOLOGICAL ACTIONS OF JAMBOLAN**

Multiple clinical and experimental investigations have linked various jambolan components—most notably the fruits, seeds, and stem bark—to the possibility of acting as a diabetic mellitus therapy. [101] Multiple researches have confirmed the reliability of these findings. Multiple components of jambolan were discovered to have an anti-diabetic effect in diabetic rats, as per analysts Chirvan Nia and Ratsimamanga, Sigogneau-Jagodzinski et al, Lal and Choudhuri, Shrotri et al, Bose, and Sepha and Vaish. These discoveries were discovered in the early 70s and 60s. Consumption of tea made from jambolan plant leaves has been linked to an antihyperglycemic effect [102]. Researchers found that mice administered the plant's stem bark had significantly lower blood glucose levels when tested using an oral glucose tolerance test. It was shown by the test findings. The plant's stem bark stimulated the growth of insulin-stained cells in the pancreatic duct epithelium of mice given it. Animals given infusions of the plant showed this. Several parts of the jambolan, especially the seeds and fruits, are thought to offer anti-diabetic properties [103]. The results of several experimental and clinical trials supported this conclusion.

Anorexigenic, gastroprotective, anti-ulcerogenic, neuropsychopharmacological, anti-microbial, anti-bacterial, anti-HIV, antileishmanial, antifungal, antifertility, anorexigenic, behavioural effects, radioprotective, and nitric oxide scavenging properties have been reported from various parts of jambolan, despite the tremendous advances in diabetic treatments. In addition, Jagetia and Baliga [104] investigated how different concentrations of the plant's leaf extracts affected the maturation of micronuclei produced by radiation. These results were on top of the previously stated ones.

**Table 7. *Sambucus operculatum* (L.) Skeels has traditional medical applications.**

<b>Ethnic Group / Place of Origin</b>	<b>Specifics of Plant</b>	<b>Preparation</b>	<b>Administration</b>	<b>Conditions Treated</b>
Residents of Southern Brazil	Jambolan leaves	Infusion or decoction in water at a concentration of 2.5 g/L	Orally, daily consumption of around 1 litre	Diabetes
Towns of Lakher and Pawi in India's Northeast	Jambolan fruit, powdered bark and fruit, juice extracted from seeds	Oral infusion, oral administration of powdered seeds and sugar, topical application	Orally, topically	Diabetes, dysentery, sores and ulcers, indigestion, centipede bites, opium overdose, repeated abortions
Residents of the Indian state of Maharashtra	Jambolan fruit and stem bark	Not specified	Orally	Diabetes, diarrhea, increased hunger, headache
North Eastern Indian ethnic groups (Nepalese, Lepchas, Bhutias)	Jambolan stem bark	Decoction	Orally, three times daily for two to three weeks	Diabetes

Quilombolas and native Amerindians of Northeastern Brazil	Jambolan leaves	Not specified	Orally	Diabetes, renal issues
Southern Indian Kani people	Jambolan leaf juice, fresh fruits	Oral consumption, leaf mashed into paste with goat's milk	Orally, twice daily after meals	Diabetes, stomachaches, dyspepsia
People from Malayalam	Jambolan seeds, Momordica charantia leaves, Cassia auriculata flowers	Paste made with leaves and flowers, oral consumption	Orally, once daily for three months	Diabetes
Traditional medical healers of Madagascar	Jambolan seeds	Not specified	Orally	Diabetes
Indian state of Andhra Pradesh	Jambolan seeds	Ground into powder	Orally, three times daily	Diabetes
Kerala, India's Siddis	Jambolan leaf juice, stem bark juice	Combined with milk, combined with buttermilk	Orally, first thing in the morning, before bedtime	Diabetes, constipation
Brazilian rural residents	Jambolan leaves	Tea made from leaf infusion or decoction	Orally	Diabetes
Individuals from the Maharashtra tribal group	Jambolan young leaves	Not specified	Orally	Jaundic

## CONCLUSION

The ethnopharmacological importance of *S. cordatum* has been supported and justified by pharmacological study on its numerous components, which has also provided support and explanation for the traditional usage of the plant. Burns, colds, cough, fever, gastrointestinal issues, respiratory issues, STDs, skin rashes, sores, TB, and wounds are just some of the many ailments that *S. cordatum* is used to treat. The anti-inflammatory, antiplasmodial, antibacterial, and antimicrobial properties of the fungus are in line with these therapies. Extracts from *S. cordatum*'s bark, fruits, leaves, and seeds seem to contain a wide range of plant derivatives and active compounds. In particular, anthocyanidin, phenolics, essential oils, flavonoids, leucoanthocyanidin, phytosterols, and triterpenoids stand out among these chemicals. Almost no pharmacological examinations have analyzed the organic impacts of the phytochemical substances disengaged from *S. cordatum* as yet. Research in this space has been done. Thusly, studies inspecting the pharmacokinetics and directing clinical preliminaries of *S. cordatum*-inferred items and mixtures ought to be focused on for future review.

Extra examination including randomized clinical preliminaries, target-organ harmfulness concentrates on utilizing *S. cordatum* synthetic substances, specialists, and subordinates, as well as exploratory creature examinations, is exceptionally urged to increase this work. Examination into the novel bioactive synthetic compounds and plant portions of *S. cordatum* is essential to recognize their physiological courses, pharmacokinetics, exact sub-atomic methods of activity, and other pertinent data. This is because of the reasoning referenced previously.

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