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A REVIEW ON PHYTOCHEMISTRY AND TRADITIONAL THERAPEUTIC BENEFITS OF SYZYGIUM MALACCENSE (L.)

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ABSTRACT

Syzygium malaccense (L.)(Pomerac) belonging to the Myrtaceae family is widely grown in many countries. This plant spp. is frequently utilised in traditional medicine. The Myrtaceae family plant Syzygium malaccense (L.), also known as the "Malay apple," is grown extensively around the world. Because of its abundance in phytochemicals such as polyphenols, particularly anthocyanins, polysaccharides, and organic acids, this plant is frequently utilised in traditional medicine and has significant potential for application in contemporary therapeutics. This study's main objective is to review and compile all the information that is currently known about the bark and leaves of Syzygium malaccense (L.), with an emphasis on their nutritional value, bioactive components, and potential medical applications. Using the terms of Syzygium malaccense, chemical components and medicinal uses of Pomerac. Further searched were journals, books, and conference proceedings.The majority of studies backed up and supplied evidence for the claim that Syzygium malaccense (L.) and its active ingredients are crucial in the prevention of chronic and degenerative diseases linked to oxidative stress. Our findings imply that further investigation is necessary to develop a potential method that might balance the pomerac's pharmacological and hazardous effects, and that a standardised fingerprint of Syzygium malaccense (L.)is necessary for quality control on a global scale.

Keywords: Syzygium malaccense (L.), Myrtaceae, Myricetin, Polyphenol, anthocyanin

1. INTRODUCTION

The world population today no longer considers food a means for just satisfying hunger, or even as nourishment for the body [1,3]. It has also commenced seeing food as an important agent for maintaining human health. The medium-sized Malay apple tree has been domesticated for a very long period in the tropics [1]. It is present in native forests as relictual stands in a few places where it was introduced (like Hawai'i), where it does not spread (no local birds can disperse the fruit) [2]. It is rarely invasive but may persist in groves that were once planted in the native forest because of its enormous fruit and seed [1]. The huge, fresh edible fruits on this tree are prized. Because of its seasonality and short shelf life, it has not been cultivated in extensive plantations for export and is instead primarily consumed locally [2]. But when sold in neighbourhood marketplaces, it may be a big cash crop. For home gardens and haphazard intercrop plantings, use it is perfect. It can be watered in locations with a dry season and flourishes in areas with adequate year-round rainfall [1]. The tree is frequently utilised in conventional medicine. Although its average grade, the wood is rarely utilised because superior timber species are available [1,4]. Due to its exceptional nutritional potential (as a source of fibre, reducing sugars, minerals, and vitamins), high productivity, exotic sensory qualities of the fruit, high pulp yield, low pH, and other factors, this species is thought to be underutilised as a fruit tree despite having enormous technological potential [2]. Fruits have red, pink, and purple, colours because of anthocyanin pigments. Particular issues with colour stability arise with foods that get their colour from the anthocyanin pigment [5]. Reactive oxygen species (ROS) that are detrimental to humans include superoxide anion, hydrogen peroxide (H2O2), peroxyl (ROO) radicals, peroxynitrite anion (ONOO), and reactive hydroxyl (OH) radicals. ROS are created by pollution, smoking, or

pesticides used on crops [4]. At the normal pace of aerobic metabolism, ROS plays a crucial role in host defence and is an essential component of our bodies.

1.1 Origin, Distribution, and Morphology

Many underdeveloped nations cultivate Syzygium malaccense (L.) [1].A species of blooming tree called S. malaccense is indigenous to Australia and tropical Asia [2, 6]. It is one among the species that the Austronesian people have been cultivating from prehistoric times [2]. An evergreen tree of the Myrtaceae family, Syzygium malaccense (L.). The plant is indigenous to South-east Asia, including Vanuatu, and was most likely found in lowland rainforests in the peninsulas of Malaysia, Java, Sumatra, Indonesia, Southeast Asia,and East Africa [1,6].

Of the edible species, S. malaccense (L.) is the most well-liked in South-East Asia [1,3]. There are unmistakable blossoming seasons, frequently two or even three in a year, although the timing varies. Around March is the typical flowering time for "Pink" in Taiwan [1,6,8]. However, after blossoming, "Pink" continues to bloom and bear fruit for virtually the entire year [4]. As a result, fruits at various stages of development could be found on various trees, in several orchards, and even on the same tree [12]. Despite being called "Pink," this cultivar can produce fruits that range in colour from pink to deep crimson depending on climatic and social factors. Different cultivars of the same species typically differ in their fruit size, shape, and colour. There are just a few exotic wax apple cultivars available [3,6].

It's been farmed for so long that nobody is sure where it came from. However, it originated in a lowland rainforest somewhere in Southeast Asia or the Indo-Malayan region [5].

The tropics are now home to the cultivation of this plant, particularly in Indo-Malaysia, Southeast Asia, Melanesia, Polynesia (where it was first introduced in antiquity as far east as Hawai'i), and Micronesia (where it is apparently a modern introduction in the eastern part of its range, Pohnpei and Kosrae) [6,11].It seems to have been naturalised in some regions, including Melanesia (including Vanuatu and Fiji) [7].It is prevalent in forest groves in Hawai'i, which are likely the remains of previous settlements, but the tree does not readily spread from these [3].

Botanical Description

Scientific name: Syzygium malaccense (L.)
Family: Myrtaceae (myrtle)
Comman name: Malay apple, Mountain apple, Red jambo, pomerac,plumrose
Classification
Kingdom: Plantae
Division: Magnoliophyta
Class: Magnolipsida
Order: Calciflorae
Family: Myrtaceae
Genus: Syzygium
Species: malaccense

Leaf of malay apple Flower of malay apple

Fruit of malay apple Seed of malay apple

Flowers

On the trunk or older branches, an inflorescence of brief, sparsely-flowered cymes up to 6cm long is produced [20]. Long calyx turbinate with rounded, pale yellow lobes 4-6 mm Corolla reddish, red or pink (occasionally white), suborbicular petals that are early caducous and inferior ovary with a long, simple style. Many unattached, red, and long stamens [19-21]. Often, flowering occurs only during specific months in the season.

Leaf

The opposite, simple leaves have an ovate to oblong blade that is typically 10-30 cm (4-12 in) long, acute to rounded at the base, and acute to acuminate at the tip [19, 21]. The leaf surfaces are glabrous, glossy green with entire margins, and the leaves have a thick, red petiole that is 2-10 mm (0.1-0.4 in) long [25].

Fruit

Large, juicy, ovoid fruit that is 3-7 cm long, glossy red, occasionally white, or white with red streaks. Fruiting is variable, just like flowering. It typically occurs in the South Pacific from late spring to early summer (November to February), however, Vanuatu and Java experience it from September to May [33,36]. In India, the major harvest season is from May to July, while a second harvest is frequently harvested in November and December [41]. Fruiting takes place in Pohnpei from January to February and in Hawai'i from June to November or perhaps December [32,44]. The local climate and latitude may be the key drivers of flowering timing. When fully ripe, fruits fall off the tree in under 60 days from the time the blooms fully open. Fruit that is ripe degrades rapidly [37].

Seed

Each fruit has one large, subglobose seed or several smaller, subglobose to hemispherical seeds that are 1.6-2 cm (0.6-0.8 in) in diameter, are green on the inside but light brown on the outside, and have a somewhat meaty texture [23,25]. Some plants produce fruits with no seeds at all. In its native surroundings, fruit-eating birds, particularly pigeons, and fruit bats are likely the reason for transporting the seeds [11].

2. USES OF SYZYGIUM MALACCENSE (L.)

Among the few fruit trees accessible to the earliest occupants of the Pacific islands has been the Malay apple [5,8]. It used to be a significant secondary fruit crop. Malay apple production has diminished in past years because of the affordability of other fruits which fruit more prolifically and have superior flavours [43]. It may still be easily grown in a home garden and is still a valuable crop. The wood is acceptable but isn't used very often so there are and have always been finer woods [34].

2.1 Medicinal Uses

The leaves and bark, which have been demonstrated to have antibacterial activity, are used in traditional medicine [1,2]. The bark is also astringent, and the plant is mildly hypoglycemic. The plant is astringent and contains tannins [8,14]. Malay apple's bark, leaves, and especially roots are used to treat a variety of ailments [17].

The bark is infused to treat stomach aches, abdominal pain, oral infections, and tuberculosis. Children's mouth sores can be healed with the bark. Also, it's employed as a purgative and to cure genital illnesses [27]. Red eyes can be treated using leaves. A wash made from the leaves decoction is applied to skin diseases [28]. Pomerac intake prevented metabolic derangement in the liver and did not enhance the levels of insulin and glucose sensitivity in rats. Faecal lipid and bile acid production was increased by Malay apple consumption [33].

The liver and faeces' fatty acid compositions were altered by malay apple [38, 40]. Cough and yellow urine are some other problems this plant is used to cure. This is done to help the mother's body get rid of the afterbirth and get clean after giving birth or even after a miscarriage [25].

2.2 Traditional Uses

Traditionally, the Malay apple is cultivated for its fruits, leaves and seeds as all parts have industrial, medicinal and other applications [9]. Food is no longer viewed by the majority of people around the globe as a way to only satisfy hunger or even as fuel for the body [24]. Society has also started to recognise food as a vital component of preserving human health [27]. Bark that has been ground into a powder has been used in mouth remedies for lesions as well as for lacerations [35]. The fruit of this plant was once thought to be a useful treatment for sore throats, and the leaves can be processed to make a tonic. Thrush is treated with a decoction of the bark in the Molucca, or Spice Islands [26].

On a cracked tongue, Malayans apply a powder made from dried leaves. The root is prepared as a treatment for itching. The root is administered to treat oedema and functions as a diuretic [42,43]. The root bark functions as an emmenagogue, an abortifacient, and a remedy for diarrhoea. As a febrifuge, Cambodians consume a decoction of fruit, leaves, or seeds. Crushed leaf juice is used in baths and applied as a lotion for the skin [17].

Several plant components are utilised in Brazil as treatments for a variety of illnesses, including headaches, pulmonary catarrh, diabetes, constipation, and coughing. Fruits with seeds, seeds, bark, and leaves exhibit antibacterial activity and some blood pressure and respiratory effects [31]. The bark and root can be processed to create a reddish-brown dye that can be used to create designs on textiles made of tapa bark [36]. The reddish to light brown wood is stiff, heavy, hard to work with, and tends to distort. It is employed for construction locally [38]. Hawaiians have historically fashioned bowls and poi-boards out of wood as well as used them to make beams for their hale and homes [46]. Sturdy, reddish wood is used for building uses such as rafters, rail sleepers, house posts, fence posts, and bowl carvings. It has been employed in Chuuk (Micronesia) to create outrigger booms. On rare occasions, it is utilised as fuel wood. In Hawaii, leis were created using both flowers and fruit [33].

3. THERAPEUTIC BENEFITS OF SYZYGIUM MALACCENSE (L.)

There are many therapeutic benefits of the malay apple.

The polyphenols and anthocyanins found in the leaf of pomerac seem to have a variety of biological effects, according to the research currently available [30]. Numerous studies have identified dried calyces and leaves as prospective sources of natural molecules with influential antioxidant-antiradical, anti-inflammatory, anti-obesity, anti-hyperlipidemic, anti-hypertensive, blood platelet aggregation inhibition, diuretic, anti-urolithicatic, antimicrobial, anticancer, hepatoprotective, renoprotective, antitumor, and immunomodulatory properties [10,13]. The pomerac extract has been consistently utilised to treat diabetes, metabolic syndrome, liver problems, hypertension, and inflammation [32]. S. malaccense (L.) leaves have been primarily used to treat a multitude of autoimmune conditions in Western Samoa (Dunstan, 1997). The plant is used in traditional Pacific medicine to treat infectious diseases since it has been proven to have antiviral, antifungal, and antibacterial effects [39].

4. NUTRITIONAL COMPOSITION

The fruit studied in this review can be considered a good source of macronutrients, vitamins, and minerals [7].Pomerac fruit includes proteins, lipids, fibres, carbs - glucose, fructose, maltose, sucrose, mannose, and galactose, amino acids - cysteine, alanine, asparagine, glutamine, and tyrosine, vitamins - thiamine (vitamin B1), riboflavin (vitamin B2), ascorbic acid (vitamin C), and minerals (K, Ca Zn, Mg, Fe, P and Na) [21].

Fruits from the Myrtaceae family are a good source of vitamins, minerals, and volatile organic compounds [21]. The leaves, seeds, and peel of S. malaccense (L.) displayed high levels of carotenoids, flavonoids, and phenolic compounds in addition to their antioxidant capacity. The fruit included cyanidin-3-O-glucoside, cyanidin-3,5-O-diglucoside, and peonidin-3-O-glucoside as anthocyanins. Red jambo fruit trees contain polyphenols that can inhibit the enzymes glucosidase and amylase [35]. The Myrtaceae family of fruits may help lower blood sugar levels [21]. Consuming fruits from the S. malaccense (L.) may lower cholesterol and triglyceride levels. The significance of S. malaccense (L.) extends beyond the fruit's potential

nutritional worth; the plant's stem, leaves, blossoms, and seeds all possess qualities that are advantageous in pharmacology and medicine. Different Syzygium malaccense (L.) tissues have antioxidant potential. The Malay apple peel contained three anthocyanins which are cyanidin 3-glucoside, cyanidin 3,5-diglucoside and peonidin 3-glucoside. Red jambo fruit was assessed to have sixteen polyphenols [31]. The hydrophilic antioxidant capacity of leaves was evident. The significance of S. malaccense extends beyond the fruit's potential nutritional worth; the plant's stem, leaves, blossoms, and seeds all possess qualities that are advantageous in pharmacology and medicine [39].

5. BIOACTIVE COMPOUNDS

For many years, these characteristics have been empirically beneficial in the prevention and treatment of diseases. The high concentration of certain phytochemical components known as bioactive compounds, which, when consumed in considerable amounts, are responsible for boosting human health, is now understood to be the cause of these advantageous effects. However, research on the potential bioactivity of the various S. malaccense (L.) parts, as well as their ensuing biological activities and usage patterns [42, 44]. Myricetin, oxalic acid, gallic acid, citronellol, cyanidin diglucoside, hotrienol, phytosterols, flavonoids, carotenoids, and polyphenols are the main bioactive chemicals found in the edible part and are responsible for a number of health advantages [44]. The leaf, seeds, and peel of S. malaccense (L.) displayed high levels of carotenoids, flavonoids, and phenolic compounds in addition to their antioxidant capacity [46]. The fruit included cyanidin-3-O-glucoside, cyanidin-3,5-O-diglucoside, and peonidin-3-O-glucoside as anthocyanins [40]. A strong association between hydrophilic antioxidant capability and polar bioactive substances was observed.Because they can improve human health, substances having antioxidant properties have caught the attention of scientists as well as pharmaceutical and food corporations [30]. Benefits include the ability to scavenge free radicals and stop oxidative processes, both of which can help avoid human disease situations [31]. Together with the interest in natural antioxidants, there is a huge global need for new antimicrobial agents that are natural in origin for use in food products and the development of conventional antibiotics [46].

5.1 Myricetin

Myricetin, also abbreviated as myricetol, is a naturally occurring substance that belongs to the class of substances known as flavonoids, and it is present in high concentrations in S. malaccense [40]. The antioxidant abilities of flavonoids are well established. In this group, the antioxidant myricetin stands out as being extremely potent. Besides this, myricetin is bonded to several carbohydrate compounds in plants (glycosides) [47]. Those with high blood pressure benefit from the glycosides in pomerac blooms because they lower blood pressure.The "anti-hangover" benefits of the oriental raisin tree are most likely due to a myricetin variation designated dihydromyricetin or ampelopsin [50]. Due to its ability to lower the level of alcohol in the blood, the oriental grape tree has been utilised as a migraine remedy. Enzyme interactions and activity suppression are caused by myricetin (enzyme inhibition). PDEs, which are involved in systemic inflammation to toxins or injuries, are inhibited by it [24].

A further enzyme that myricetin inhibits is aromatase, which changes testosterone into oestrogen. Scientists have researched it for the avoidance of breast cancer because of this impact [33]. Like all flavonoids, myricetin possesses potent antioxidant effects. In test-tube research, the combination of iron and ascorbic acid boosted myricetin's antioxidant activity. An essential step in the process of inflammation is the blood cell coagulation that myricetin inhibits [37].

5.2 Polyphenols

They have the capacity to function as antioxidants, which means they can squelch dangerous free radicals before they can harm your cells and raise your risk of developing diseases like cancer, diabetes, and heart disease. There are more than 8,000 different varieties of polyphenols [48]. They can be divided into 4 major groups there are also supplements available that include polyphenols. Flavonoids. Over 60% of all polyphenols come from them. Examples include the antioxidants quercetin, kaempferol, catechins, and anthocyanins, found in foods like the leaves of the Malaysian apple [48]. Acids phenolic. Thirty percent or so of all polyphenols belong to this category. Examples are the mostly present lignans and stilbenes in fruits and seeds. amides made of polyphenol. This topic covers the origin,

ripening, cultivation, transportation, storage, and preparation of capsaicinoids [32]. With regard to the SW-480 human colon cancer cell line, the phenolic and flavonoid components of wax apple fruits exhibit positive cytotoxic, antibacterial, anti-diabetic, and antioxidant action [44]. In addition to having analgesic, anti-inflammatory, spasmolytic, antioxidant, antidiabetic, anticancer, and tannin-like properties, Malaysian apple leaves also contain terpenoids, alkaloids, and flavonoids.[42]

5.3 Anthocyanins

Fruits have red, and pink colours because of anthocyanin pigments. Particular issues with colour stability arise with foods that get their colour from the anthocyanin pigment (Jurd, 1972) [27]. Skrede (1985) asserts that meals containing anthocyanins might lose their natural red or purple colour and turn a duller shade of brown [26]. Enzymes, heat, oxygen, pH, light, and other variables all affect how stable they are. According to the statement that both peroxidase and polyphenol oxidase is involved in the tanning of the litchi pericarp, anthocyanin-rich foods can brown by enzymatic or nonenzymatic pathways [52]. There are more anthocyanins in dried pomerac fruits kept in darkness than in daylight, and discolouration was discovered to be nonenzymatic. The main reason for the discolouration was the anthocyanin's deterioration to furfural under the influence of light [34]. In order to establish the best technology for commercial storage, this research was carried out to ascertain how light affects the colour stability of pomerac held at 5°C. The need for non-synthetic food colourants is still rising as a result of the rapidly expanding natural, organic, and sustainable food sectors. Throughout the past three decades, anthocyanins have filled this void [45, 50]. The Malay apple peel contained three anthocyanins which are cyanidin 3-glucoside, cyanidin 3,5-diglucoside and peonidin 3-glucoside [51].

Anthocyanins hold a distinct place among anthocyanins in this industry due to their added health advantages. Because of their vivid hues, anthocyanins have been researched for use in food colouring. the anthocyanin-containing fruits and vegetables' antioxidant capabilities.[33] In general, polyphenolic concentration and antioxidant capabilities are connected. Many anthocyanins showed antioxidant properties comparable to those of -tocopherol, Trilox, Quercetin, and Catechin [43].

6. PHARMACOLOGICAL ACTIVITIES

6.1 Anticancer Activity

The anticancer properties of S. malaccense (L.) have been demonstrated against ovarian cancer (SKOV-3 cell line), pancreatic cancer (PANC-1 cell line) [45], prostate cancer (DU-145 cell line), and esophageal cancer (TE-13 cell line) [41]. When tested on leukaemia HL-60 cells, S. malaccense was found to have anticancer properties [39], whilst S. malaccense (L.) was found to have cytotoxic properties when tested on DU-145 cells. Throughout this investigation, researchers disclose the isolation of five triterpenes, including 2-hydroxybetulinic acid (1), betulinic acid (2), platanic acid (3), ursolic acid (4), and hyptatic acid A, from the stem of Syzygium malaccense (L.) [5]. All were discovered for the first time from this native Taiwanese plant. The high potency of compounds 1 (IC50, 5.7–7.6 M) and, especially, 4 (IC50, 1.7–3.7 M) in suppressing cell viability calls for further mechanistic studies [46]. These compounds were tested for their cytotoxic activities against a panel of human tumour cell lines, including the MCF-7 breast, PC-3 prostate, and SCC2095 oral squamous cell cancers [21]. Although cancer can be prevented and treated, its prevalence is increasing. Chemotherapy, radiation, and surgery are examples of traditional cancer treatment approaches [52,53]. The quantity of bioactive phytochemicals in plants like Syzygium malaccense (L.) makes them a common component of supplementary treatments [22]. There have been many natural substances produced from Syzygium sp. that have been found to have anticancer properties, including phenolics, oleanolic acids, betulinic acids, and dimethyl cardamonins. Apoptosis induction and cell proliferation inhibition are two common abilities [54].

According to the type of mutated cells, cancers are categorised as carcinoma, sarcoma, lymphoma, leukaemia, germ cell tumours, and blastomas. In this sense, the types of cancer involved affect sex discrepancies differently [54]. For instance, the leading cause of death among women is breast cancer.There are several types of cancer treatments. In order to lower the chance of recurrence, radiotherapy involves the delivery of strong doses of radiation that kill any remaining cancer cells within the tumour bed [51]. Phytochemicals from plants are a

popular source of complementary and alternative therapies [3]. Phytochemicals are organic substances derived from plants that have been associated with a lower risk of developing serious chronic diseases including cancer [51]. The role of phytochemicals in controlling oncogene and tumour suppressor expression in cancer cells is just one of many roles they play. Moreover, phytochemicals are involved in the cell cycle arrest and apoptosis induction processes [45]. Hence, phytochemicals may actually be the main ingredient in future anticancer drugs. Several studies have demonstrated the potential of bioactive chemicals from plant sources, including those from the underappreciated Malay apple, as supplementary and alternative cancer treatments [43]. Therefore, in this study, we made an effort to highlight key results regarding the anticancer potential of several Syzygium malaccense (L.).

6.2 Antibacterial Activity

The effects of Syzygium malaccense (L.) methanolic extract against antifungal isolates from candiduria and biofilm inhibition activity were emphasised for the first time in an in vitro investigation by Alshami and Alharbi [49]. From patients with recurrent candiduria, they employed six strains of fluconazole-resistant C. albicans. Malay apple was shown to be efficient in inhibiting C. albicans at all concentrations, with minimum inhibitory concentration values ranging from 0.5 to 2.0 mg/ml. Its usage in traditional medicine for treating and preventing urinary tract infections now has a scientific foundation thanks to this study [49].

The two bacterial strains employed to test their antibacterial activity are Escherichia coli and Staphylococcus aureus. The most effective way to assess the effectiveness of antibacterial activity is with the agar well diffusion technique [36]. The fruit includes phenols, flavonoids, terpenoids, alkaloids, carbohydrates, lipids, proteins, enzymes, and other organic compounds that act as reducing and stabilising agents. The Ag+ ions are converted into Ag nanoparticles during the reduction process [23]. The flavonoids in pomerac extract are thought to be responsible for the antibacterial properties because they can form a complex with bacterial cell walls and increase the permeability of bacterial cell surfaces to the extract. The suppression of electron transport protein translocation, phosphorylation processes, and other enzyme-dependent events are thought to be the possible mechanisms of action [40]. This is followed by an increase in plasma membrane permeability, which causes an ion to leak from bacterial cells [10].In this study, 29 additional species and the S. malaccense (L.) plant's methanolic extract were tested for their ability to fight off infectious illnesses [52]. It also demonstrated the interaction between the S. malaccense (L.) leaf and rhizome extracts. By using different chromatography techniques and spectroscopic examination, substances were isolated and identified using bio-guided approaches (UHPLC-UV-MS, HRMS, EI-MS, NMR). Six-alkenyl or six-alkyl salicylic acids, seven antibacterial substances, were extracted from S. malaccense (L.) methanolic leaf extract and were recognised for the first time in this species [56]. Pomerac contains proanthocyanidins, which combine or alter the P-fimbriae of bacterial cells, preventing their adherence to the uroepithelium and the in vitro formation of biofilm. It is advised to conduct more research to confirm that in vitro outcomes are reproducible in vivo.

6.3 Anti-inflammatory Activity

The body's physiological response to harm or disturbance from external stimuli is inflammation. hs-CRP, IL-6, TNF-, and IL-18 are inflammatory chemicals that are brought on by diabetes.Tumor necrosis factor (TNF) levels were reduced by 72 mg and 288 mg of pomerac per day per 200 g of body weight, respectively, demonstrating the anti-inflammatory effect of the malay apple, to evaluate the effect of pomerac extract on the streptozotocin-induced diabetic rats.Lipid, carbohydrate, and ash concentrations were higher in the fruits and leaves of Syzigium malaccense (L.), respectively [48]. The well-researched topic of anthocyanin study for human health and wellness may be its anti-inflammatory properties. It has also been investigated if anthocyanins can inhibit the enzymes cyclooxygenase 2 and lipoxygenase. Worldwide, obesity is a metabolic condition that is frequently linked to other chronic illnesses like cancer, type II diabetes, and cardiovascular ailments. The pathophysiology of obesity is heavily influenced by inflammation. Inflammatory bowel disease (IBD), of which ulcerative colitis (UC) is a significant subtype, is a chronic relapsing condition. Several studies have shown that anthocyanins have anti-inflammatory characteristics and have the potential to be employed as innovative therapeutic agents in the treatment of UC [50]. The purpose of this work was to identify the major bioactive components in the most

active fraction of S. malaccense (L.) leaves using UHPLC-QTOF-MS/MS and to assess the nutritional and in vitro anti-inflammatory activities of the crude ethanol-water extract and their various fractions [56].The most prevalent elements in this study were determined to be the macro-elements potassium, magnesium, and calcium. The primary electrolytes in the human body are potassium and magnesium, which regulate blood pressure, pH, and are involved in muscular contraction, hydration, and energy production (WHO, 1996). The proper absorption of calcium, which according to the Institute of Medicine (2011) is 1000 mg for people, can be ensured by consuming about 116 g of S. malaccense (L.) leaves per day [53]. A study examined the anti-inflammatory effects of Syzygium malaccense (L.) leaf extract on the inflammation that was intentionally produced in an experiment. By inhibiting Cyclooxygenase, 5-lipoxygenase, and protein denaturation, another study assessed the in-vitro anti-inflammatory activity of Syzygium malaccense (L.) leaves [60].The inflammatory process is a strong reaction that tissues start in order to regain equilibrium following a damaging input. Pain is one of the primary reasons for medical visits since inflammation frequently results in observable symptoms (Treed et al., 2019). Because chronic pain is one of the main causes of disability worldwide, according to the Global Burden of Diseases, national governments are urged to prioritise pain management as a matter of public health and develop national policies to address this problem (Fayaz et al., 2016). Suicidal ideation, plans, and behaviours, which are signs of suicidality, are significantly increased by pain and pose a considerable risk for mental health issues to develop.

6.4 Antioxidant Activity

The phytochemical composition and antioxidant activity of eleven underused Andaman Islands (India) fruits, including Syzygium malaccense (L.), the range of the antioxidant activity was 74.27% to 98.77% [17]. Applying -carotene bleaching and the 2,2-azinobis (3-ethyl-benzothiazoline-6-sulfonic acid) (ABTS) radical cation test, the antioxidant activity of both freshly harvested and dried plant extracts of Syzygium malaccense (L.) was investigated. All extract samples' antioxidant activity ranged from 58 to 80% as a percentage. The fresh samples of plants demonstrated more antioxidant activity than their dried counterparts [54]. Analysis was done on the prooxidant and antioxidant properties of the Syzygium malaccense (L.) leaf. Low pro-oxidant activity and strong DPPH scavenging activity are both present in Syzygium malaccense (L.) leaf [59].

6.5 Antiproliferative Activity

Two types of cancer-originating cells, MCF-7 (a hormone-dependent breast cancer cell line) and MDA-MB-231 (a non-hormone-dependent breast cancer cell line), were used to test the antiproliferative effects of Syzygium fruits, specifically water apple (Syzygium aqueum) and malay apple (Syzygium malaccense (L.)). A colourimetric MTT test was used to assess the antiproliferation properties of aqueous and methanolic extracts over the course of 24, 48, and 72 hours. The results indicated that the three fruit extracts had no discernible effects for 24 and 48 hours, while water apple and malay apple extracts had an antiproliferative impact on MCF-7 cell lines after 72 hours [56]. There were no effects on the non-cancer origin cell line. In the instance of MCF7, the methanolic extract of the Malay apple was more significant with 79% viable cells. This discovery showed that fruit extract had antiproliferative effects on MCF-7.

7. TOXICITY OF SYZYGIUM MALACCENSE (L.)

Pomerac leaf oil is safe to ingest at concentrations lower than 1500 ppm, and the recommended daily intake of pomerac is 2.5 mg/kg of body weight [50, 51]. The mean lethal dosage (LD50) of clove oil was 18.2 5.52 and 1.7 0.8 mg/mL, respectively. At doses as high as 1000 mg/kg b.wt./day, a polyphenolic extract of S. malaccense demonstrated no discernible toxicological effects on Wistar rats. Salmonella typhimurium strains tested for genotoxicity by the substance did not exhibit any.Other toxicity research on the same plants, however, produced contradictory results. S. malaccense water extract demonstrated a low percentage of fatality at concentrations of less than 125 g/mL in a study utilising the brine shrimp lethality test (a straightforward assay for toxicity screening of chemicals) [60]. However, when ethanol was used as the extraction solvent, it became hazardous even at low concentrations, with a 100% death rate being seen at concentrations of 250 g/mL and higher. 100% death was seen at doses of 250 g/mL and higher for clove essential oil, just like the ethanolic extract [60]. In summary, whereas methanol extract and essential oils from S. malaccense are hazardous even at low concentrations, the water extract from the plant may

be safe at lower levels. The ethanolic and aqueous fractions of S. malaccense extracts did not significantly demonstrate cytotoxic impact on 3 T3 cells at the measured concentration range (50 and 100 g/mL) when tested against 3 T3 mouse embryonic fibroblasts cell line. The methanolic S. malaccense leaf extract that was fed to Sprague-Dawley rats did not cause any acute or subchronic toxicity. The outcome suggests there is no hazardous risk associated with this extract.

When tested on albino Swiss mice, (Mollika et al.) [55] demonstrated that methanolic leaf extract of S. malaccense was safe up to a level of 1000 mg/kg. the little toxicity of bioactive substances obtained from Pomerac dichloromethane leaf extract on zebrafish embryonic tissues, including cycloartenyl stearate, lupenyl stearate, sitosteryl stearate, and 24-methylenecycloartenyl stearate. By giving oral doses of up to 2 g/kg of mice and rats the hydroalcoholic leaf extract of the Malaysian apple, it was demonstrated that neither it had an acute toxic effect nor did it result in chronic toxicity. However, at 1 g/kg, 100% mortality was noted when the extract was given intraperitoneally. In mice, the LD50 was determined to be 0.489 g/kg, while the greatest dose of 2 g/kg in rats resulted in 67% death [57]. Using Lorke and Dietrich models, Ugbabe et al. [58] assessed the toxicity of a 70% methanolic extract. For the stem bark, the LD50 in mice was found to be greater than 5 g/kg and to be 3.87 g/kg for the leaf extract.Artemia franciscana was poisonous to the S. malaccense leaf extract, which had a 48-hour medium lethal concentration (IC_{50}) of 387.9 38.8 g/mL [36]. When examined on healthy cell lines such as MCF-10A human normal epithelial cell lines and CCD-18Co human normal fibroblasts, the malay apple did not exhibit any cytotoxicity [40].

8. CONCLUSION

The many positive effects of Syzygium malaccense (L.) and its alleged mode of action have been thoroughly supported by extensive evidence. The majority of earlier research on the phytochemical makeup and medicinal applications of Syzygium malaccense (L.) has been evaluated in this publication to determine its current state. Several conventional uses of this plant have been confirmed by phytochemical and pharmacological research. According to studies on phytochemical composition, pomerac has bioactive chemicals that are useful for treating a number of degenerative disorders. According to studies, pomerac use is safe in small dosages and has no negative effects on the liver or kidney.

In conclusion, the diverse Syzygium species provide several health advantages, particularly with regard to their anticancer characteristics. Their potential offers a wide range of opportunities for further research. The results of these next investigations will be crucial for the creation of novel therapeutic solutions for the treatment of cancer. The focus of further study may be on examining how different Syzygium species affect distinct cancer kinds. Furthermore, in vivo models using active ingredients that have been isolated could be used to assess efficacy. Clinical trial data on the anticancer potential of Syzygium species are currently quite scarce, hence the importance of such efforts should be considered.

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