

A REVIEW ON PHARMACOLOGICAL ACTIVITIES OF *THEOBROMA COCOA*

Prabith Prabhakaran*, Ashok Shenoy M¹ and AR Shabaraya²

¹Department of Pharmacology, Srinivas College of Pharmacy, Valachil,
Post- Farangipete, Mangalore-574143, Karnataka, India.

²Department of Pharmaceutics, Srinivas College of Pharmacy, Valachil,
Post- Farangipete, Mangalore-574143, Karnataka, India.

ABSTRACT

Cocoa tree is the source of one of the world's most delicious and familiar products, chocolate. The edible properties of *Theobroma cacao* were discovered over 2,000 years ago by the local people of Central America living deep in the tropical rainforests. In the year 2008-2009 world cocoa production was 3,515,000 tonnes. This is equivalent to the weight of a line of double-decker buses stretching more than three times the length of Britain. Cocoa is native to Mexico, Central America and northern South America (Colombia, Ecuador, Venezuela, Brazil, Guyana, Surinam and French Guiana). It has also been introduced as a crop plant into many tropical African and Asian countries. Antioxidant procyanidin (a dimer of catechin) of cocoa has been shown to have biological activity relevant to defense against free radicals (oxidants), vascular health, prevention of tumor and immune function. Other benefits are the improvement of cardiac function and relief of angina pectoris, nervous system stimulation, facilitate digestion and kidney and improve bowel function. In addition, cocoa has been used to treat anemia, mental fatigue, tuberculosis, fever, gout, kidney stones, and even sex drive.

Keywords: *Theobroma cacao*, tumor, immune function, cardiac function.

INTRODUCTION

The use of herbal medicines to cure/prevent illness and to lubricate the wheels of social interaction is a behaviour which antedates civilization and is present in every society irrespective of its level of sophistication. The drugs of today's modern society are products of research and development, whose raw materials are naturally occurring materials which are obtained from plants; either in the roots stems, leaves, fruits and seeds. Up till now, some of the widely used drugs of plant origin are still produced by extraction from plants though, for some, their chemical structures are known and the methods developed for their laboratory synthesis¹.

Medicinal plants play a key role in human health care. About 80% of the world population relies on the use of traditional medicine, which is predominantly based on plant material. Scientific studies available on medicinal plants indicate that promising phytochemicals can be developed for many health problems.² More over some of the pathological condition where the scientific drugs become crippled but traditional herbal therapy can be a satisfying option which demands an ample amount of research.³ The attempt is made to present an overview of phytochemical and

pharmacological activities of the plant *Theobroma cacao*.

Theobroma cacao commonly known as cocoa belongs to the family sterculiaceae is a spindly, evergreen tree 5 to 8 m tall, found growing in the shade of giant trees occupying the top layer of the rain forest. It has a taproot, which penetrates far below the soil surface. In its natural habitat, cocoa grows in the understory of evergreen tropical rainforest. It often grows in clumps along river banks, where the roots may be flooded for long periods of the year. Cocoa grows at low elevations, usually below 300 metres above sea level, in areas with 1,000 to 3,000 mm rainfall per year.

Family: sterculiaceae

Common names: Kannada- koko, Hindi- kokko, Malayalam- kokkoo, Tamil- kakkvo, kona maram

Distribution:

Cocoa is native to Mexico, Central America and northern South America (Colombia, Ecuador, Venezuela, Brazil, Guyana, Surinam and French Guiana). It has also been introduced as a crop plant into many tropical African and Asian countries.

PLANT:

Cocoa is a spindly, evergreen tree 5 to 8 m tall, found growing in the shade of giant trees occupying the top layer of the rain forest. It has a taproot, which penetrates far below the soil surface.

Leaves: Its dark green leaves are shiny, leathery, egg-shaped or elliptic in shape and 20 to 35 cm long and 7 to 8 cm wide. The leaf surfaces are hairless or covered in scattered star-shaped hairs. The base of the leaf is rounded or heart-shaped, and the tip is long and drawn out allowing water to drip from it.

Flowers: Cocoa flowers are small, yellowish white to pale pink, and grouped together in clusters arising directly from the trunk (cauliflory). Flowers are produced throughout the year.

Fruits: In the wild, cocoa trees are pollinated by midges, and only about 5% of flowers receive enough pollen to start fruit development. When they are pollinated there is a dramatic change as the tiny flowers develop into massive fruits

Cocoa pods: The fruit is an egg-shaped red to brown berry (commonly referred to as a 'cocoa pod'), 15 to 25 cm long, with a more or less knobby surface and lines from top to bottom. The 'pod' contains 30 to 40 seeds, each of which is surrounded by a bitter-sweet white pulp. In the wild the seeds are dispersed and eaten by different mammals like agutis and monkeys. When the seeds are dried and fermented in the sun, they are brownish red, and known as cocoa beans.

CULTIVATION: *Theobroma cocoa* grows best under tropical conditions, with strong light and high humidity. A loam-based compost with plenty of organic matter (such as coir) should be used. The tree should be kept moist and the foliage damped-over daily, except during sunny weather when scorching may occur. Soft water should be used to prevent limescale deposits on the leaves. Mulching around the base of the tree with well-rotted compost will help the soil to retain moisture and prevent weeds. A balanced liquid of leaves should be given during the summer and high potash during the winter, once a week. Pruning should be carried out to maintain the required shape.



Theobroma cocoa fruit:

CHEMICAL CONSTITUENTS:⁴

Cocoa contains high active compounds such as theobromine, flavonoids (-)-epicatechin, (+)-catechin and their dimers procyanidins B2 (PB2) and B1, although other polyphenols such as quercetin, isoquercetin (quercetin 3-O-glucoside), quercetin 3-O-arabinose, hyperoside (quercetin 3-O-galactoside), naringenin, luteolin and apigenin have also been found in minor quantities.

THERAPEUTIC USES:⁵

Protects Skin from UV Damage: With great sun protection properties, it shields your skin against detrimental UV rays and thus helps in preventing conditions like sunburn and skin cancer.

Reduces hair loss: It helps in promoting blood circulation in the scalp which leads to increased growth of healthy, lustrous locks. Thanks to being a circulation-booster, it is also found to be very effective in reducing hair loss.

Heart diseases: cocoa contains antioxidants such as flavonoids. Antioxidants are the best elements that a body can receive or produce as they have the capacity to prevent aging by free radicals that can also cause heart diseases.

Blood sugar levels: It is hard to believe that a sugar-enriched substance can balance the blood sugar levels, but it is true! The amount of sugar in cocoa does not affect your body much as its glycemic index is low. And the flavonoids that it is enriched with aids the influence that insulin offers on the sugar levels.

Mood booster: Stress is a bad factor, and one should steer clear of it as much as possible! The contents of cocoa help in the production of endorphins which are produced by the brain cells and are known to alleviate the mood. It stimulates the brain cells and is known to relax a person.

Stroke prevention: The increased levels of flavonoids like epicatechin are known to protect the brain against stroke. This is found in dark chocolate in a good quantity. The nerve cells of people consuming dark chocolate are less prone to a stroke as compared to people who do not consume dark chocolate.

Blood pressure: cocoa is rich in minerals such as copper and magnesium which are responsible for keeping the blood pressure normal especially in case of people with excessive fluctuation in their BP.

Cognitive function: The cognitive function in the human body is enhanced with the consumption of dark chocolate as it improves the blood flow to the brain

Relieves bronchial asthma: Cacao beans contain xanthine and theophylline, which aid in relaxing bronchial spasms and opening constricted bronchial tubes. This facilitates easy flow of air and is valuable in curing various allergies, including asthma and shortness of breath. Its consumption, therefore, helps in providing relief from bronchial asthma.

PHARMACOLOGICAL ACTIVITIES:

1. ANTI-OXIDANT ACTIVITY:⁶

In vitro and cultured cells studies showed that cocoa polyphenols, and in particular epicatechin, may act as free radical scavengers, prevent and/or inhibit NADPH-dependent lipoperoxidation, LDL oxidation, and inhibit LOX activity (one order of magnitude less potently than epigallocatechin gallate). In chocolate there is a high correlation between the cocoa content and the antioxidant activity. Four weeks of cocoa supplementation in obese diabetic rats resulted in a significant reduction in a marker of oxidative stress (plasma 8-isoprostane), and in an increase in activity of superoxide dismutase. Similar results were showed in human studies, were cocoa polyphenols decreased LDL oxidation, improved plasma antioxidative status and reduced various biomarkers of lipid peroxidation.

2. ANTI-INFLAMMATORY ACTIVITY:⁷

In vitro studies have shown that some cocoa polyphenols mildly inhibit LOX pathways, down regulate the production of pro-inflammatory cytokines (IL1 β , IL2, IL4, IL6 and TNF- α), and inhibit iNOS gene expression via NF κ B and AP1. Polyphenols might also inhibit activation of

T and B cells. In a feeding trial a cocoa-enriched diet (procyanidin content of 147 mg pro dose) increased the expression of vasodilatory and anti-platelet prostacyclins and decrease that of pro-inflammatory, vasoconstrictive, pro-aggregant leukotrienes, compared the consumption of a low procyanidin (3.3 mg) chocolate. A study on animal models evaluated the effects of cocoa supplementation on adipose tissue inflammation. The mice were fed either a high-fat diet, a high fat diet with with 8% unsweetened cocoa powder, or a low-fat diet for 18 weeks. Compared to the group fed a high-fat diet only, the group fed also cocoa powder showed reduced adipose tissue inflammation, as showed by reduced levels of mRNA coding for TNF- α , IL-6, iNOSynthase, and EMR1, and by decreased levels of NF- κ B.

3. ANTI-CANCER ACTIVITY:⁸

Study evaluated cocoa's effect in colon cancer, both in-vivo and in-vitro. Several preclinical studies concluded that dietary polyphenols, in large amounts, can exert a desirable effect. Cocoa is a food rich in polyphenols (flavonoids and phenolic acids). Its main flavonoids are flavan-3-ols, epicatechin, and catechin. Total polyphenols in raw cocoa is up to 60% in monomeric and oligomeric forms. In-vivo studies, demonstrated an antiproliferative effect of cocoa-rich diet. In-vitro studies were done on caco-2 cell line, considered as human epithelial colonic adenocarcinoma cells. Crude procyanidin and procynidin-enriched extracts showed an inhibitory effect on G2/M phase of cell cycle, leading to non-apoptotic cell death. Studies have shown potential inhibition on pro-inflammatory mediators on TNF- α -sensitized Caco-2 cells. Study concludes suggesting large scale, long term, randomized, placebo-controlled studies.

4. IMMUNE ACTIVITY:⁹

Study evaluated the effect of (-)-epicatechin and cocoa extract on the activation of a lymphoid cell line. Extract down-modulated T lymphocyte activation and the acquired immune response which could be important in immune system reactivity such as autoimmune or chronic inflammatory disease.

5. EFFECT ON INSULIN:¹⁰

Improvements in insulin sensitivity have been observed following clinical dietary

interventions with flavanol containing foods and beverages. A systematic review and meta-analysis of 24 randomised, controlled trials evaluated the effect of flavonoid-rich cocoa (FRC) on cardiovascular disease risk factors, and found a decrease in insulin resistance. Reductions in fasting serum insulin levels and insulin resistance were also reported in a meta-analysis of 42 studies, 4 of which included people with impaired glucose tolerance or diabetes. These changes were seen with 19-54 grams of cocoa per day, or 46-100 grams of polyphenols rich cocoa (PRC) per day.

6. EFFECT ON CARDIOVASCULAR DISEASES:¹¹

The data from a total of 136 publications suggests that cocoa and chocolate may exert beneficial effects with regard to cardiovascular risk via various mechanisms, including lowering blood pressure, anti-inflammation, anti-platelet function, increasing HDL level while decreasing LDL oxidation. In addition, prospective studies of flavonoids suggest that the phenolic content of chocolate may reduce the risk of cardiovascular mortality. Phenolics from cocoa also decrease the tendency of blood to clot. For example, an acute dose of flavanols and oligomeric procyanidins from cocoa powder was found to inhibit platelet activation and function for over 6 h in humans. In a blinded parallel-design study, 32 healthy subjects were assigned to consume 234 mg cocoa phenolics a day.

7. NEURODEGENERATIVE DISEASES:¹²

Studies demonstrated that a cocoa polyphenol extract (Acticoa powder) may help delay age-related brain impairments, including cognitive deficits in normal ageing and perhaps neurodegenerative diseases. In experiments using rats, administration of Acticoa powder (24 mg/kg/day, orally, between 15 and 27 months of age) did not show any influence on weight or food and water consumption throughout the study period; the benefits observed with the cocoa extract are thus not due to dietary restriction. While the results of this study suggest that Acticoa powder may be beneficial in retarding age-related brain impairments.

8. ANTIMALARIAL EFFECTS:¹³

Numerous anecdotal reports of reduced episodic malaria in people from Ghana who drink a natural, unsweetened cocoa beverage daily prompted a search for scientific mechanisms to account for cocoa's possible antimalarial effects. In a review of the data from the literature on this subject, Addai established five possible antimalarial mechanisms for cocoa. Thus, the effects could be due to the increased availability of antioxidants in plasma, membrane effects in general and in the erythrocyte membrane in particular, increased plasma levels of NO, specific antimalarial activity of cocoa flavonoids and their derivatives, and enhancement of the immune system mediated by components of cocoa including cocoa polyphenols.

CONCLUSION:

The present review reveals the description, active constituents, therapeutic uses and pharmacological activities of *Theobroma cocoa*. It also reveals that *Theobroma cocoa* contains several phytoconstituents including high active compounds such as theobromine, flavonoids (-)-epicatechin, (+)-catechin and their dimers procyanidins B2 (PB2) and B1, although other polyphenols such as quercetin, isoquercetin (quercetin3-O-glucoside), quercetin 3-O-arabinose. Cocoa also contains minerals and trace elements such as calcium, copper, iron, manganese, magnesium, phosphorus, potassium, and zinc.

The plant has been studied for its various pharmacological activities like antioxidant activity, anti-inflammatory activity, anticancer activity, effect on immunity, effect on cardiovascular diseases and antimalarial effect. *Theobroma cocoa* has a great perspective for the treatment of diseases like stroke, heart diseases, skin diseases, depression, asthma etc. Further studies and investigations can be performed on the plant for its various pharmacological activities.

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