



Nature's Dark Superfoods: Health-Promoting Effects of Black Turmeric and Cocoa

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Abstract

Black turmeric (*Curcuma caesia* Roxb.) and cocoa (*Theobroma cacao* L.) are two remarkable natural foods that offer not just nutrition but also a variety of medicinal benefits. Both are packed with bioactive compounds such as curcuminoids, terpenoids, flavonoids, polyphenols, methylxanthines, and essential oils. These compounds showcase powerful antioxidant, anti-inflammatory, antimicrobial, antidiabetic, cardioprotective, neuroprotective, and anticancer properties. In traditional medicine, black turmeric has been widely used to treat wounds, respiratory issues, digestive problems, diabetes, skin conditions, and reproductive disorders. Meanwhile, cocoa has garnered significant scientific interest for its positive impacts on heart health, glucose regulation, brain function, skin protection, and cancer prevention. The health benefits of these plants are largely due to their ability to neutralize harmful free radicals, modulate inflammatory processes, enhance blood vessel function, prevent blood clots, improve insulin sensitivity, and influence the cellular mechanisms related to cell death and growth. Recent studies have highlighted the potential of cocoa flavanols in improving blood lipid levels and controlling blood sugar, while the phytochemicals derived from black turmeric—like germacrone, ar-turmerone, and curcumin derivatives—exhibit promising treatments for various infections and cancers. This review offers a comprehensive look at the characteristics, phytochemical makeup, therapeutic uses, and health benefits of black turmeric and cocoa. It also emphasizes their potential as functional food ingredients and nutraceuticals in preventing and managing chronic diseases. Moving forward, focused research on improving the standardization, bioavailability, clinical validation, and sustainable use of these valuable plants will support their broader application in food, pharmaceutical, and healthcare settings.

Keywords: *Curcuma caesia*; *Theobroma cacao*; black turmeric; cocoa; phytochemicals; antioxidants; flavonoids; nutraceuticals; functional foods; cardioprotective; antidiabetic; anticancer.

Introduction

Black turmeric (*Curcuma caesia* Roxb.), a perennial medicinal herb belonging to the family Zingiberaceae, is distinguished by its bluish-black rhizome and is valued for its extensive therapeutic potential. The rhizomes and leaves of *C. caesia* are widely used in traditional medicine for the treatment of various ailments, including piles, bronchitis, asthma, epilepsy, menstrual disorders, fever, wounds, skin diseases, leprosy sores,

tuberculosis, and splenic enlargement, as well as for enhancing fertility and treating impotency. The plant is rich in diverse bioactive constituents such as alkaloids, terpenes, flavonoids, tannins, steroids, glycosides, anthraquinones, carbohydrates, proteins, and reducing sugars. The volatile oil extracted from its rhizome contains approximately 30 components accounting for 97.48% of the oil, with major constituents including camphor (28.3%), ar-turmerone (12.3%), ar-curcumen (6.8%), (Z)-ocimene (8.2%), 1,8-cineole (5.3%), elemene (4.8%), borneol (4.4%), bornyl acetate (3.3%), and curcumen (2.82%) (Venugopal et al., 2017). Owing to its high medicinal and economic value, *C. caesia* has been classified as an endangered species by the Central Forest Department of India due to overexploitation and biopiracy, particularly in hilly regions where it naturally occurs, highlighting the urgent need for its conservation. Turmeric (*Curcuma* spp.), often referred to as “Indian saffron,” has been revered since ancient times in South Asia as a medicinal agent, condiment, dye, and sacred substance, with its therapeutic applications documented in Ayurvedic texts such as those by Charaka and Sushruta, and referenced in historical records spanning the Vedic period, Indus Valley Civilization, and Greco-Roman medical literature. Venugopal et al., 2017.

Chocolate has a long history of being consumed for its fine flavours as a luxury food since ancient times. The origins of chocolate can be traced back to 400 AD. Verna, 2013. Chocolate is produced from cacao beans through a multistep process involving fermentation, drying, roasting, nib grinding and refining, conching, and tempering to ensure its stability and flavour Di Mattia et al, 2017; Żyżelewicz et al, 2018. The transformation process steps are first, fermentation of cacao beans to develop the chocolate flavour, followed by removal of water content by drying, then roasting, cleaning, and shelling of beans into nibs. Nibs are then ground and refined into cacao liquor, before being finally combined with various ingredients to produce different types of chocolate, such as dark chocolate, milk chocolate, and white chocolate Montagna et al, 2019. The latin name for the cacao tree, *Theobroma cacao* L., means ‘Food of Gods’ Moramarco, 2016. Chocolate contains mostly fat (in the form of cacao butter) and is rich in polyphenols, such as catechins, anthocyanidins, and proanthocyanidins Talbot, 2012. The polyphenol content of chocolate varies with different raw ingredient sources and manufacturing processes Żyżelewicz et al, 2018; Urbanska and Kowalska 2019.

The polyphenols of chocolate, which originate from cacao beans, are thought to partially contribute to the cardiometabolic health benefits of chocolate in modulating blood pressure and lipid profiles García and Hernández, 2020. Several meta-analyses have suggested the benefits of chocolate consumption in reducing the risk of cardiometabolic events, including coronary heart disease, myocardial infarction, stroke, and diabetes Larsson et al, 2016; Yuan et al, 2017. Apart from potential health-promoting cardiometabolic effects, chocolate consumption has also been reported to improve cognition in clinical trials [Shiina et al 2009; Lamport et al 2020],

supported by preclinical studies Bisson et al, 2008; Rozan et al, 2006. The cognitive benefits of chocolate are further supported by a recent systematic review, which reported improvement in cognitive scores or task performance among young adults (less than 25 years old) and children with chronic chocolate consumption, again possibly attributed to polyphenols, including flavanols Martin et al, 2020. In addition to these effects, perhaps one of the most popular yet insufficiently substantiated health benefits or undesirable effects of chocolate consumption is its effect on skin health, including ageing and acne, which remains debatable Chalyk et al, 2018. Other less explored potential medicinal properties of chocolate include anticancer and antimicrobial effects Maskarinec, 2009; Lakshmi et al, 2019; Hirao et al, 2010. Apart from polyphenols (flavonoids), other bioactive compounds of interest that are found in chocolate include methylxanthines such as theobromine and caffeine Septianti and Langkong, 2020.

Why is Black turmeric and Cocoa important to consume?

In simple terms, consuming black turmeric and cocoa is important because they are rich natural sources of bioactive compounds that support overall health and help prevent disease. Black turmeric contains powerful phytochemicals and essential oils that exhibit antioxidant, anti-inflammatory, antimicrobial, and therapeutic properties, making it beneficial for immunity, wound healing, reproductive health, and management of chronic ailments. Similarly, cocoa is abundant in polyphenols, flavanols, and methylxanthines that improve cardiovascular health, enhance brain function, regulate glucose and lipid metabolism, and protect the body against oxidative stress. Regular and moderate consumption of these plant-based foods can therefore

contribute to improved metabolic health, reduced risk of chronic diseases, and overall well being through natural, diet-based interventions.

Table 1. Morphological structure of *C. caesia* Roxb

Morphology of the *C. caesia* Roxb.:

Plant parts	Morphology of <i>C. caesia</i>
Rhizome	The herb is 1.0-1.5m tall, oval, camphoraceous delicious, with various form and size, and grows on dark brown, blueish black rhizomes with a variety of odours.
Root	The propagation of black turmeric does not develop its rhizome, which is covered with yellow brown, fibrous, and tapering adventitious roots.
Leaf	The leaves are approximately 25-50 cm long, 15 cm wide, and oval in form, with reddish edges. The variation in leaves is parallel, which is typical of monocots.
Flower	Pale yellow in colour, reddish at the outer border and shorter than their bracts. Flowers generally bloom in the month of June or July.

Table 2. Morphological Characteristics of Cocoa (*Theobroma cacao* L.)

Characteristic	Description
Scientific name	<i>Theobroma cacao</i> L.
Family	Malvaceae (formerly Sterculiaceae)
Common name	Cocoa, Cacao
Plant type	Small evergreen tropical tree
Tree height	Usually 4–8 m under cultivation; can reach 10–15 m in natural forests
Root system	Deep taproot with extensive lateral roots
Stem	Woody, erect, grayish-brown bark; exhibits cauliflory (flowers and fruits develop on the trunk and older branches)
Leaves	Simple, alternate, entire, elliptic to oblong; 20–35 cm long and 7–15 cm wide; young leaves are reddish or bronze and mature to glossy dark green
Leaf apex	Acuminate (drip tip)
Leaf base	Rounded to cordate

Flowers	Small (1–2 cm), bisexual, white to pale pink, borne in clusters on trunk and main branches (cauliflorous)
Inflorescence	Fascicles on trunk and older branches
Flowering period	Throughout the year under favourable tropical conditions
Fruit (Pod)	Large indehiscent berry (pod), ovoid, oblong, or ellipsoid with prominent longitudinal ridges
Pod size	10–35 cm long; 7–15 cm diameter
Pod color	Green, yellow, orange, red, or purple depending on genotype and maturity
Pod wall	Thick, leathery, and rough with five to ten longitudinal ridges
Seeds (Beans)	20–60 seeds per pod surrounded by sweet, white mucilaginous pulp
Seed shape	Ovoid to flattened
Seed color	White, cream, violet, or purple depending on cultivar
Pollination	Mainly by tiny midges (<i>Forcipomyia</i> spp.)
Habitat	Humid tropical rainforests; optimum temperature 21–32°C with high rainfall and partial shade

The cocoa, as part of the wonderful nature, provides mankind a wide variety of valuable food products and health benefits. There are several proven health benefits by the intake of cocoa and cocoa-based products for the cardiovascular system, cancer, neurological/nervous system, endocrine system, diabetes, dermatological system, and stress.

Coco and Cardiovascular System

Cardiovascular disease is the leading cause of death. Numerous studies have suggested beneficial effects of cocoa in cardiovascular diseases (CVD).

The cardioprotective effects of cocoa are due to the following factors:

- Flavanols inhibit platelet activation and aggregation
- Decrease LDL cholesterol and increase HDL cholesterol
- Maintaining blood pressure
- Reduces endothelial dysfunction

Flavanols Inhibit Platelet Activation and Aggregation

Platelet Activation

The basic function of platelets rapidly binding to damaged blood vessels, aggregate to form thrombi and to prevent excess bleeding. When platelets are circulating through vessels with an intact, healthy endothelium, the platelets remain in their original, inactivated state. The absence of activating factors and the release of prostacyclin (prostaglandin I₂) by the healthy endothelium supports this state.

However, when a platelet encounters a break in the endothelium, it encounters molecules that trigger its activation. One such molecule is collagen, which is characteristically found almost everywhere except inside a blood vessel.

When platelets are activated, it will cause thrombus formation, aggregate at the site of atherosclerotic plaque and prevents blood flow. The atherosclerotic plaques are formed in the artery wall by the accumulation of fats and reduce the blood flow and cause atherosclerosis.

The antiplatelet effect of flavonoids in cocoa is due to the inhibition of thrombus formation by enhancing the production of vasodilating factor nitric oxide (NO).

Bioactive Compounds in Cocoa Decrease LDL Cholesterol and Increase HDL Cholesterol

There are two main types of cholesterol: high-density lipoprotein (HDL) and low-density lipoprotein (LDL). Lipoproteins are made of fat and proteins. HDL is known as "good cholesterol" because it transports cholesterol to the liver to be expelled from the body. LDL is called "bad cholesterol" because it takes cholesterol to arteries, where it may collect in artery walls. Too much cholesterol in arteries may lead to a build-up of plaque known as atherosclerosis. This can increase the risk of blood clots in arteries. If a blood clot breaks away and blocks an artery in the heart or brain, may have a stroke or heart attack. Modification of low-density lipoprotein (LDL) appears to play a vital role in atherosclerosis. Several endogenous factors have been oxidizing LDL cholesterol. Myeloperoxidase (MPO) is an enzyme that participates in the metabolism of nitrogen dioxide (NO); it causes peroxidation of LDL cholesterol. Nitrite, its oxidation product, serves as a substrate of MPO, forming reactive nitrogen species.

The function of flavonoids in cocoa will scavenge the free radicals (reactive nitrogen species) nitrogen dioxide and reduce lipid peroxidation of LDL.

Baba et al. (2007) conducted a study on the effect of supplementing cocoa powder on LDL and HDL cholesterol levels. Normal diets are given to two groups, and an extra 26 grams of cocoa was given to the cocoa group for twelve weeks. After the study, they observed that LDL cholesterol of control group decreased from 135.90 to 131.72. But in the cocoa group, there was a drastic decrease in LDL cholesterol from 135.13 to 118.14. In the case of HDL cholesterol in the cocoa group, it was increased from 52.50 to 55.21 and in the cocoa group, it was increased from 52.89 to 65.25. They concluded that after twelve weeks, LDL cholesterol was decreased and HDL cholesterol was increased in cocoa group compared to control group (Table 3).

Table 3. Effect of supplementing cocoa powder on LDL and HDL cholesterol levels

<i>Duration</i>	<i>LDL cholesterol (mg/dL)</i>		<i>HDL cholesterol (mg/L)</i>	
	Control group	Cocoa group	Control group	Cocoa group
Baseline	135.90	135.13	52.50	52.89
Week 12	131.72	118.14	55.21	65.25

Cocoa and Cancer

Cancer is a disorder that is characterised by abnormal growth of cells. This abnormal growth and multiplication is caused by free radicals.

The anticarcinogenic property of cocoa is due to the following factors mentioned below: Prevents Oxidation of Free Radicals

Cocoa contains a high antioxidant activity. Free radicals damage the components of a cell including the DNA and lead to the development of cancer. Antioxidants combine with and prevent free radicals from causing any harm to the body (Fig. 1).

John (2001) indicates that cocoa and dark chocolate contain more polyphenol having more antioxidant index compared to the other two products, such as milk and white chocolates. It is evident from the table that cocoa and dark chocolate contain polyphenol content of 224 and 126 $\mu\text{mol/g}$ and their antioxidant index were 710×10^3 and 500×10^3 , respectively. Compared to cocoa and dark chocolate, milk and white chocolate contain less polyphenol (52.2

and 8.2 $\mu\text{mol/g}$) and antioxidant index. In white chocolate, the antioxidant index was nil (Table 4).

Polyphenols Control Abnormal Cell Growth

Bioactive compounds in cocoa help to control abnormal cell growth by interacting with the mechanism of a cell. It does so by changing the structure of the cell membrane of these abnormal cells. It is responsible for interacting with the production of enzymes responsible for inducing tumour growth and malignancy. Another effect of polyphenols is on nucleic acid, including DNA.

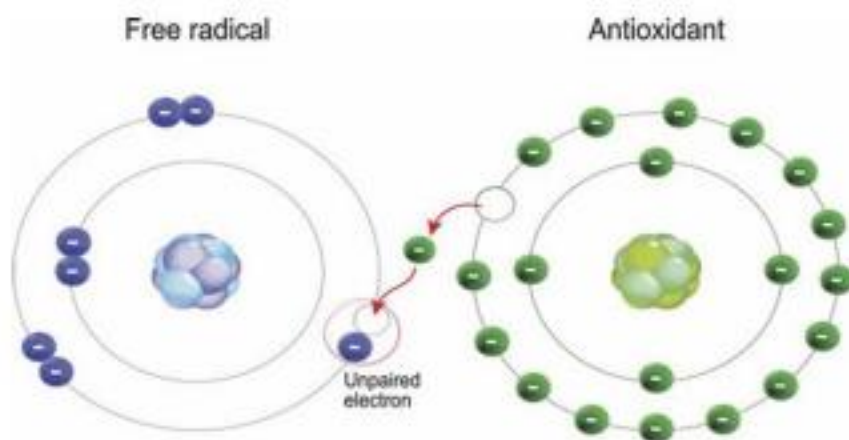


Fig. 1 Antioxidants prevent the oxidation of free radicals

Table 4: Antioxidant properties of cocoa and chocolate polyphenols

<i>Products</i>	<i>Polyphenols ($\mu\text{mol/g}$)</i>	<i>Antioxidant index $\times 10^3$</i>
Cocoa	224 ± 66.4	710 ± 21.3
Dark chocolate	126 ± 17.4	500 ± 20.4
Milk chocolate	52.2 ± 20.4	136 ± 36.3
White chocolate	8.2 ± 2.9	-

Beneficial Effects of Cocoa for Diabetes

Diabetes mellitus (DM) is a group of metabolic disorders in which there are high blood sugar levels over a

prolonged period. Symptoms of high blood sugar include frequent urination, increased thirst, and increased hunger. In normal healthy person beta cells of the pancreas produce the hormone insulin and maintain the glucose level in our body. Diabetes is due to either the pancreas not producing enough insulin or the cells of the body not responding properly to the insulin produced. There are two main types of diabetes mellitus. Type 1

DM results from the pancreas's failure to produce enough insulin, referred to as "insulin dependent diabetes mellitus" (IDDM) or "juvenile diabetes". Type 2 DM begins with insulin resistance, a condition in which cells fail to respond to insulin properly (Fig. 2). As the disease progresses a lack of insulin may also develop. This form was previously referred to as "non insulin-dependent diabetes mellitus" (NIDDM) or "adult-onset diabetes". The function of the bioactive compound in cocoa, especially epicatechin will increase insulin production and control blood sugar levels and help beta cells work better and become stronger.

DIABETES MELLITUS

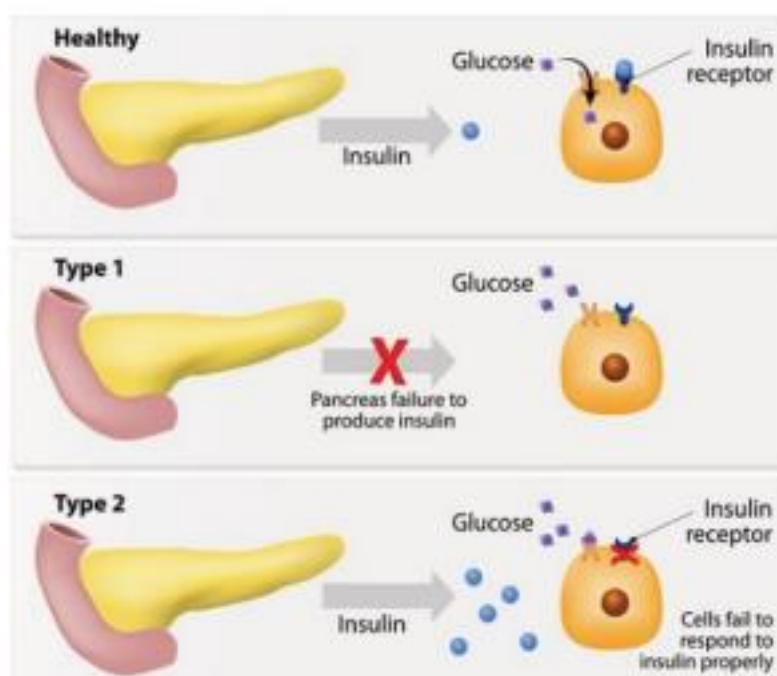


Fig 2. Types of Diabetes

Olasope et al., (2017) conducted a study on the effect of cocoa powder on the fasting blood glucose level of the experimental rats. For this study, they selected three groups of rats, first normal control; second, a diabetic control and third one diabetic and also giving 2% cocoa powder. Initial fasting blood glucose level and final fasting blood glucose level of three groups tested. From Table 5, it is clear that the third group those who consume 2% cocoa powder have a drastic decrease in final fasting blood glucose level from 418.0–144.0 mg/dL.

Table 5. Effect of cocoa powder on the fasting blood glucose level of the experimental rats

<i>Groups</i>	<i>Initial fasting blood glucose (mg/dL)</i>	<i>Final fasting blood glucose (mg/dL)</i>
Normal (control)	79.5	82 .0
Diabetic (control)	378 .0	367 .0
Diabetic + 2% cocoa powder	418 .0	144 .0

Cocoa and Skin Health

Skin is prone to the development of several diseases, and the mechanisms in the pathogenesis of aged skin are still poorly understood. However, a growing body of evidence from clinical and bench research has begun to provide scientific validation for the use of cocoa-derived phytochemicals as an effective approach for skin protection. The bioactive compounds of cocoa may have a positive impact on skin health. When we are exposed to ultraviolet light, it will cause overproduction of reactive oxygen species (ROS). This will cause inflammation to activate, physiological acceleration, and epidermal degeneration. The antioxidants in cocoa scavenge these free radicals and reduce the skin problem and increase skin health.

Protection from Neurodegeneration and Neuroinflammation

Flavonoids in cocoa exert a multiplicity of neuroprotective actions, including the capacity to protect neurons from damage induced by neurotoxins, reduce neuroinflammation, and promote memory, learning, and cognitive function. These effects are related to two common processes, flavonoids interact with signalization cascades involving protein and lipid kinases that lead to the inhibition of neuronal death by apoptosis induced by neurotoxins (such as oxygen radicals) and to the promotion of neuronal survival and synaptic plasticity. Concurrently, they induce beneficial effects on the vascular system and on CBF mainly by improving endothelial function and stimulating angiogenesis. Via these mechanisms, the lifelong consumption of flavonoid-rich nutrients has the potential ability to limit neurodegeneration and prevent or even reverse age-related cognitive decline. Flavanols in cocoa increase cerebral blood flow and induce angiogenesis and new cell growth in the hippocampus. Angiogenesis is the formation of new blood vessels from existing blood vessels.

Several studies have looked at the relation between antioxidant intake and dementia, most often the risk of Alzheimer's disease. In Alzheimer's disease, excessive production and deposition of amyloid beta (A β) peptide lead to microglial activation, and the resultant production of inflammatory mediators further boosts A β production and induces death and dysfunction of neurons. The main symptom of Alzheimer's disease is the loss of memory. So the cocoa flavanol will increase angiogenesis and new cell growth in the hippocampus and thereby reduce the symptoms of Alzheimer's disease. Shahanas et al, 2019.

THERAPEUTIC USES

Table 6: Therapeutic uses of Curcuma caesia Roxb.

Disease	Part used	Mode of Administration
wounds and cuts	Rhizome	To treat wounds and cuts and has a quick healing effect.

Asthma, cough, cold	Powder	Boil 1 cup of milk with 1 tsp of turmeric powder. Drink warm.
Digestive Disorders	Powder	Take ½ tsp of black turmeric powder or juice in water, 3 times per day
Osteoarthritis Rhizome		Make a paste by mixing 1 tsp turmeric and 2 tsp ginger with water. Spread the mixture on a cloth and apply to the afflicted region, then bandage. Before going to bed, mix 1 tsp turmeric with 1 cup warm milk.
Diabetes	Powder	½–1 tsp of turmeric should be taken 3 times a day
Ears, Eyes, Nose and Mouth Disorder	Rhizome	Black turmeric dust, with alum 1:20, is blown into the ear to treat chronic otorrhea. Mix a pinch of black Turmeric with organic ghee and apply it to the mucus lining of nose to stop the sniffles. It also stops nosebleeds, helps to clear the sinuses, restore a more acute sense of smell, and helps to purify the mind and brain.
Dental problems	Rhizome	Mix 1 tsp of black turmeric with ½ tsp of salt. Add mustard oil to make a paste. Rub the teeth and gums with this paste twice daily. Powder is used to cure a toothache.
Other uses	Rhizome	Turmeric, a yellow colouring agent in cooking, is a significant herb in Hindu rituals and cosmetics. Burning black turmeric repels insects and aids in coughs, asthma, and nasal congestion.

Mudli and Dhal (2024)

PHARMACOLOGICAL ACTIVITIES

Caesia exhibits a wide range of pharmacological activities, including anti-inflammatory and antiemetic effects, as well as antibacterial, anthelmintic, and anxiolytic properties. The pharmacological studies highlight these various activities that this plant possesses Ahn *et al.*, 1989; Karhikeyan *et al.*, 2009)

Major Activities Include:

1. Anti-Cancer Activity
2. Antifungal activity
3. Antibacterial activity

5. Anti-Ulcer Activity

6. Neuropharmacological activity Hadem *et al.*, (2015), GR *et al.*, (2012)

1. Anti-Cancer Activity: Black turmeric contains germacrone and curcumin derivatives, which have been found to exhibit anticancer properties, accompanied by a slightly bitter and pungent smell. Hadmi *et al.*, (2015)

2. Antifungal Activity: The main ethanolic and aqueous extracts of *Caesia* demonstrate antifungal activity, making them highly beneficial. Liu *et al.*, (2013)

3. Antibacterial Activity: The methanol and ethanolic extracts from black turmeric rhizome contribute to its antibacterial effects, proving effective against various human and plant pathogenic bacteria. Liu *et al.*, (2014)

4. Antioxidant Activity: This plant possesses free radical scavenging properties, acting as an antioxidant and aiding in neutralisation. Zhong *et al.*, (2011)

5. Anti-Ulcer Activity: The ethanolic extract of *Caesia* helps reduce gastric acid volume and pepsin, which contributes to its anti-ulcer properties. Behar *et al.*, (2014)

6. Neuropharmacological Activity: This activity has been studied in rodent models, demonstrating anti-convulsant and muscle relaxant effects. Behar *et al.*, (2014)

Overall, *Caesia* shows a diverse range of beneficial pharmacological effects, highlighting its potential in various therapeutic applications.

Conclusion

Black turmeric (*Curcuma caesia* Roxb.) and cocoa (*Theobroma cacao* L.) are nutrient-rich functional foods with significant therapeutic potential due to their abundance of bioactive compounds. Scientific evidence suggests that they possess antioxidant, anti-inflammatory, antimicrobial, antidiabetic, cardioprotective, neuroprotective, and anticancer properties, making them valuable in promoting overall health and reducing the risk of chronic diseases. While current findings are promising, further clinical studies and standardization are needed to confirm their efficacy and safety. Overall, black turmeric and cocoa hold great promise as natural ingredients for the development of functional foods and nutraceuticals aimed at improving human health.

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