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Review Article

**Zea mays: A COMPREHENSIVE PHYTOCHEMICAL AND  
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Kiran K J<sup>5</sup>, Dr. Prasobh G.R<sup>6</sup>**

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**Abstract:**

*Corn (Zea Mays) which is also referred to as Indian corn or maize, that belongs to the Poaceae family. A variety of bioactive phytochemical substances with antioxidant properties can be found in all sections of the maize plant. Alkaloids, flavonoids, saponins, maizenic acid, vitamins B1, K, and potassium, phosphorus, and zinc are all found in the plant. Due to the presences of these compounds Zea mays show a lot of pharmacological properties. Its therapeutic properties include blood pressure control, cholesterol control, and cardiovascular disease prevention, as well as antioxidant, antibacterial, anticancer, atherosclerosis, hyperlipidemia, diabetes, and obesity prevention. This study suggest that the presence of phytochemicals in the Zea mays is responsible for the treatment of various disease.*

**KEY WORDS :** *Zea mays, Antioxidants, Flavonoids, Atherosclerosis, Anticancer.*

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**INTRODUCTION:**

Corn (*Zea mays*) which is also referred to as Indian corn or maize, Maize is a major annual grain crop in the world that belongs to the Poaceae family <sup>[1]</sup>. Maize is the most commonly produced and productive cereal crop in the world, coming in first place among the three primary food crops (maize, wheat, and rice). Corn seeds are used as a source of nutrition by humans, while the stem and leaves are used as cattle fodder all over the world. Corn silk and cobs are frequently thrown away as garbage.

A variety of bioactive phytochemical substances with antioxidant properties can be found in all sections of the maize plant. It produces over 780 million metric tonnes annually, with the United States, China, Brazil, and India being the largest producers. It's a 2–20-foot-tall annual herbaceous

plant. In Asian countries such as China, Korea, Taiwan, Vietnam, Laos, Myanmar, Thailand, India, and Pakistan, corn seeds are used as a food <sup>[3]</sup>. Alkaloids, flavonoids, saponins, maizenic acid, vitamins B1, K, and potassium, phosphorus, and zinc are all found in the plant <sup>[4]</sup>. *Zea mays* biological properties include blood pressure control, cholesterol control, and cardiovascular disease prevention, as well as antioxidant, antibacterial, anticancer, atherosclerosis, hyperlipidemia, diabetes, and obesity prevention <sup>[5]</sup>. The ash of the cob is used for the treatment of cough <sup>[6]</sup>.

Species	<i>Zea mays</i>
Family	Poaceae
Sub family	Panicoideae
Kingdom	Plantae
Genus	<i>Zea</i>
Synonym	mays zea var

**PLANT PROFILE OF *Zea mays*** <sup>[1,2]</sup>

VERNACULAR NAMES<sup>[2,3]</sup>

Tamil	Makkacholam
Germany	Mais
English	Indian corn
Indonesia	Jagung
Italy	maiscommune
Laos	khauzSali
Malaysia	Jagong
Netherlands	gewoonemais
Common names	Maize, Indian corn

**GENERAL DESCRIPTION:****Botanical description:**

*Z. Diploperennis*, *z. Luxurians*, *z. Nicaraguensis*, *z. Perennis*, and *z. Mays* are the five species that make up the *zea* genus, but most widely used edible food is *Zea mays*(corn) corn is an erect annual grass which typically reaches 2 to 3 meters (m) in height and occasionally grows as tall as 7 m. The plant possesses a single main culm with nodes and internodes and, depending upon genetic background and plant population density, will occasionally possess 1 to 2 lateral branches known as tillers in the lower leaf axils. Nodes gradually taper towards the top of the plant<sup>[7]</sup>.

Leaves of corn are broad and arranged in two vertical rows on opposite sides of the stalk. Leaf blades possess parallel veins with a prominent mid-rib. The upper surface of the leaf blade is hairy, while the lower surface is hairless. There is considerable variation in the number, size, and orientation of leaves amongst corn varieties, with temperate corn hybrids producing an average of 15 leaves and tropical hybrids producing up to 48 leaves<sup>[8]</sup>. The leaves and stalks of the plant are generally green; however, the accumulation of anthocyanins may result in a purple or reddish-brown colour.

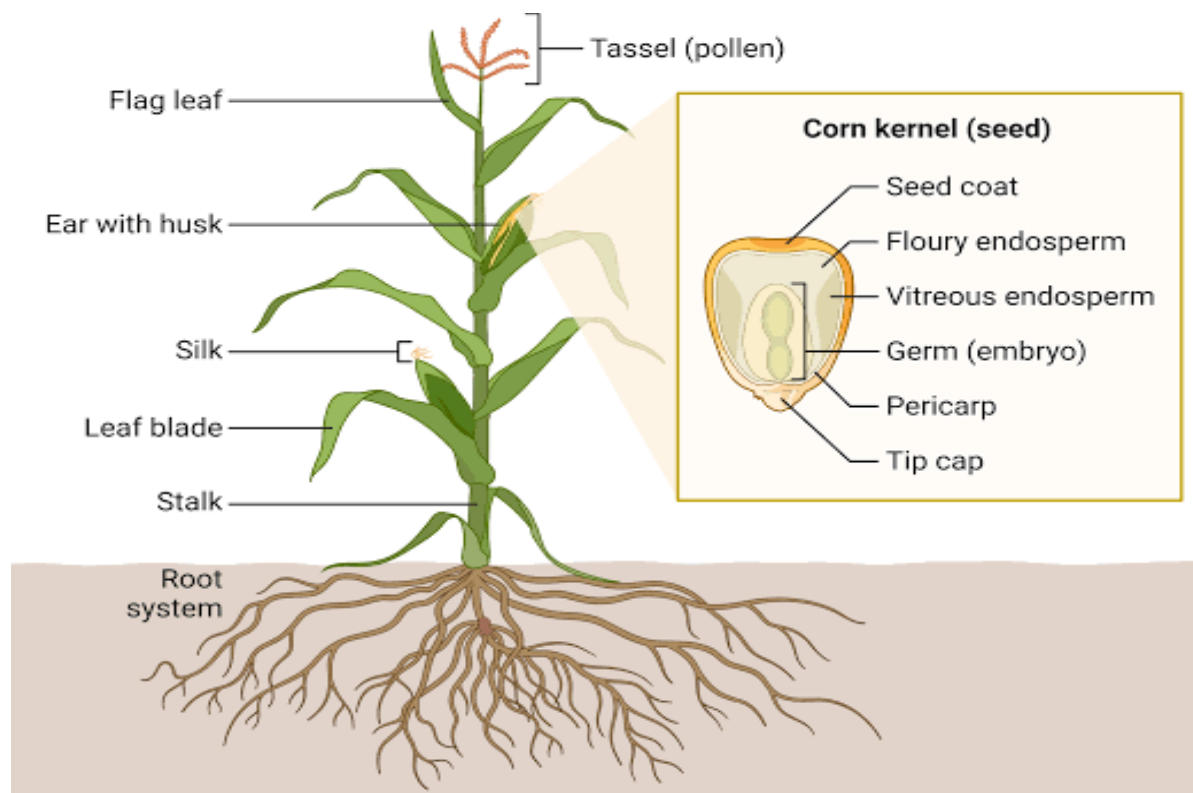
Corn is a monoecious plant with imperfect flowers (that is, separate male and female flowers on the same plant). The male flower is called the tassel and the female flower is called the ear. The cob consists of a robust rachis, with 4 to 30 rows of florets, each containing a single ovule. From each floret, a style

will elongate towards the tip of the cob, forming long strands of tissue known as silks. The silks are covered by short hairs used to capture pollen grains. Silk colour can vary from green to red, and following mechanical damage, silk tissues may turn brown due to oxidation of phenolic compounds<sup>[8,9]</sup>.

Tassels are prominent branch structures located at the top of the corn plant and consist of a central spike and a variable number of lateral branches. Anthers can be yellow, purple, or red. After fertilization, the each ovule will develop into a kernel. Grain and cob colour often vary between varieties. Cob colour can be white, red, purple, or brown. The pericarp (seed coat) of the kernel can be colourless, red, purple, or brown.

The aleurone (outside layer of the endosperm tissue) can be blue, purple, or brown due to anthocyanins, white due to the lack of anthocyanins and carotenoids, or yellow or orange due to the presence of carotenoids.

Unique physicochemical characteristics produce a range of corn types including dent, flint, flour, pop, and sweet corn. The root system of corn is seasonal with brace roots that start 2 or 3 joints above the ground and main roots that descend up to 2 m vertically and 1.2 m horizontally. Brace roots range in colour from green to red due to the presence of anthocyanins<sup>[7,9]</sup>.



#### ORIGIN AND DESCRIPTION:

##### NATIVE RANGE

- **North America** Mexico (Chihuahua, Durango, Guanajuato, Jalisco, Michoacán)
- **South America** Guatemala<sup>[9]</sup>

##### INTRODUCED RANGE

Corn is grown worldwide. The following 20 countries were the highest corn producing countries in 2017.

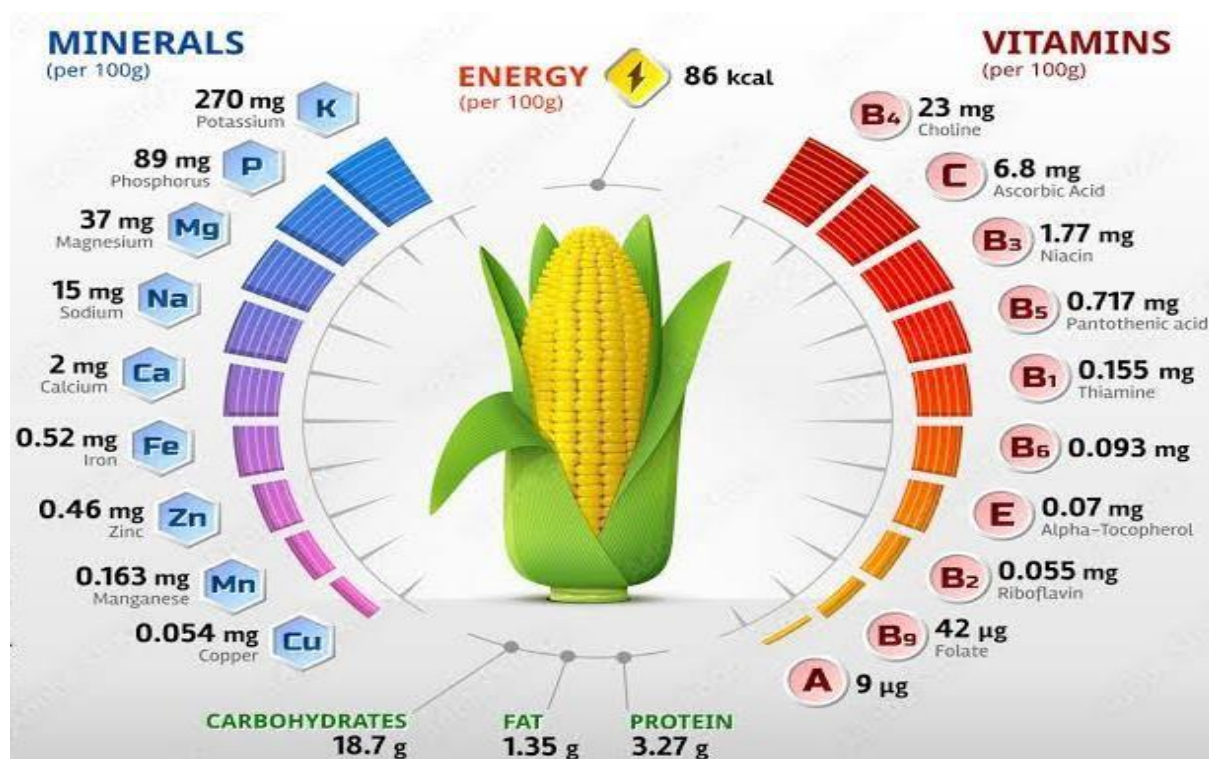
- **Asia** : China, India, Indonesia, Philippines
- **Africa** : Egypt, Nigeria, South Africa, Ethiopia, Tanzania
- **North America** : Canada, Mexico, United States
- **South America** : Argentina, Brazil
- **Europe** : France, Hungary, Italy, Romania, Russian Federation, Ukraine

##### NUTRITIONAL VALUE OF MAIZE

Maize kernel is an edible and nutritive part of the plant. It also contains vitamin C, vitamin E, vitamin K, vitamin B1 (thiamine), vitamin B2 (niacin), vitamin B3 (riboflavin),

vitamin B5 (pantothenic acid), vitamin B6 (pyridoxine), folic acid, selenium, N-p-coumaryl tryptamine, and N-ferrulyl tryptamine. Potassium is a major nutrient present which has a good significance because an average human diet is deficient in it. Roasted maize kernels are also used as coffee substitute. Maize germ contains about 45–50% of oil that is used in cooking, salads and is obtained from wet milling process. The oil contains 14% saturated fatty acids, 30% monounsaturated fatty acids, and 56% polyunsaturated fatty acids. The refined maize oil contains linoleic acid 54–60%, oleic acid 25–31%, palmitic acid 11–13%, stearic acid 2–3% and linolenic acid 1%. The two main forms of vitamin E present in our diet are alpha ( $\alpha$ ) and gamma ( $\gamma$ ) tocopherols. Maize oil is amongst the rich sources of these tocopherols, especially  $\gamma$ -tocopherol and their reported concentration was 21.3 and 94.1 mg/100 g, respectively. Maize silk contains various constituents essential for our diet such as maizenic acid, fixed oils, resin, sugar, mucilage, salt, and fibers.<sup>[10,11,12]</sup>





### PHYTOCHEMICAL VALUE OF MAIZE

Phytochemicals are bioactive chemical compounds naturally present in plants that provide human health benefits and have the potential for reducing the risk of major chronic diseases. Maize is an essential source of various major phytochemicals such as carotenoids, phenolic compounds, and phytosterols.<sup>[13,14]</sup>

#### CAROTENOIDS

Carotenoids belong to a family of red, orange, and yellow pigments. There is a large quantity of carotenoid pigments present in yellow maize grains, especially in horny and floury endosperm. These pigments are divided into two classes: carotenes, which are purely hydrocarbons containing no oxygen, and xanthophylls (lutein and zeaxanthin) which are hydrocarbons containing oxygen.<sup>[14]</sup>

#### PHENOLIC COMPOUNDS

Phenolic compounds are most widely distributed category of phytochemicals in the plant kingdom. They are specified as

- Phenolic acids
- Flavonoids
- Stilbenes
- Coumarins,

#### ➤ Tannins.

These compounds are abundantly present in maize, especially in bran. The major phenolic compounds from maize are ferulic acid (FA) or 4-hydroxy-3-methoxycinnamic acid and anthocyanins. Refined corn bran contains the highest FA content, followed by barley and wheat.

Anthocyanins are common class of phenolic compounds collectively known as flavonoids. They are the largest group of water-soluble plant pigments which are reddish to purple in color. Maize has the second highest concentration of anthocyanins. The most abundant anthocyanin compounds reported in maize are, pelargonidin-3-glucoside, peonidin-3-glucoside, pelargonidin-3 (6"-malonylglucoside), cyanidin-3-glucoside, cyanidin-3-(3", 6"-malonylglucoside) and cyanidin-3-(3", 6" dimalonylglucoside).<sup>[13,15]</sup>

#### PHYTOSTEROLS

Phytosterols also called as plant sterols are the essential components of plant cell walls and membranes. More than 250 different phytosterols have been found so far which are divided into three classes based on their number of methyl groups at C-4 position: simple sterols or 4-desmethylsterols, 4, 4-dimethylsterols, and 4-monomethylsterols. Maize oil is very rich in phytosterols. The most commonly

consumed phytosterols from maize oil are:

- Sitosterol,
- Stigmasterol
- Campesterol

Their distribution varies in different fractions of maize kernel such as endosperm, pericarp, and germ.<sup>[16]</sup>

### PHARMACOLOGICAL BENEFITS

#### Effect on cardiovascular system:

The presence of essential fatty acids, especially linoleic acid in maize oil plays an important role in the diet by maintaining blood pressure, regulating blood cholesterol level, and preventing cardiovascular maladies. Moreover a tablespoon of maize oil satisfies the requirements for essential fatty acids for a healthy child or adult. Vitamin E in maize oil which is known as a key chain breaking antioxidant prevents the promulgation of oxidative stresses in biological membranes and prevents the development of atherosclerosis through intervention of maize oil in the diet.<sup>[10]</sup>

#### Anti-HIV activity:

Maize is believed to have potential anti-HIV activity due to the presence of Galanthus nivalis agglutinin (GNA) lectin also referred as GNA-maize. Lectins are special proteins that can bind onto carbohydrates or carbohydrate receptors found on cell membranes. In some micro-organisms including the HIV virus, the binding of lectins onto sugars is believed to inhibit activity of the virus.<sup>[11]</sup>

#### Effect on GIT :

Resistant starch (RS) from maize, also called as high-amylose maize has various health beneficial effects. Maize endosperm contains 39.4 mg/100 g. It escapes digestion and its consumption helps in altering microbial populations, lowering cholesterol and enhancing its fecal excretion, increasing the fermentation and short-chain fatty acid production in large intestine, reducing symptoms of diarrhea, which altogether reduce the risk of cecal cancer, atherosclerosis, and obesity-related complications. RS enhances the desirable composition of colonic bacteria in mice therefore might possess potential prebiotic properties. Its consumption influences cholesterol metabolism, lowers body fat storage therefore reduces the risk of atherosclerosis, hyperlipidemia, diabetes, and obesity. It can significantly shorten the intestinal transit time that leads to elimination of waste material through feces in a quicker time. RS as dietary fiber helps in weight control as it reduces the food intake by diluting

energy density of the diet as well as by modulating certain gene expressions.<sup>[13]</sup>

#### Antioxidant activity:

It has potent antioxidant properties and protects the cell membranes against oxidation.

Due to the potent antioxidant properties they are able to decrease capillary permeability and fragility, immune system stimulation, inhibit platelet aggregation, anticancer, anti-inflammatory, preventive effects against bone loss, anti-diabetic.<sup>[16]</sup>

#### Anticancer activity :

The consumption of anthocyanins from purple maize at 5% dietary level during 36-week administration period demonstrated a pronounced inhibition of colorectal carcinogenesis in male rats showing that the lesion development of colon was significantly suppressed.<sup>[15]</sup>

#### Antihypertensive effect

The dietary administration of purple maize pigment has been reported to have anti-hypertensive effects on spontaneously hypertensive male rats through lowering the systolic blood pressure.<sup>[14]</sup>

#### Effect on atherosclerosis :

Phytosterols have many health benefits. Dietary consumption of phytosterol is negatively related to cholesterol absorption, serum total, and LDL cholesterol. The major mechanism involved in the health benefits of dietary phytosterols is the inhibition of cholesterol absorption through intestine and stimulation of cholesterol synthesis resulting in the enhanced elimination of cholesterol in stools. To test the contribution of phytosterols in maize oil on cholesterol-lowering effect, a study compared cholesterol absorption between the human subjects who consumed original and phytosterol-removed commercial maize oil. The study reported that the cholesterol absorption of healthy subjects was 38% higher in the group consuming the phytosterol-removed commercial corn oil than the group consuming the original commercial corn oil for two weeks. When corn oil phytosterols were added back to phytosterol-removed maize oil the cholesterol absorption was reduced significantly again. Thus, the consumption of corn oil in a long-term period can reduce cholesterol concentrations and prevent atherosclerotic disease.

The pigments from black glutinous maize cob have shown to possess potent anti-hyperlipidemic effects in high-fat-fed mice by improving the serum lipids profile and reducing the atherogenic index.<sup>[13,16]</sup>

#### Noval pharmacological application:

Zein an alcohol-soluble prolamine is an important component found in maize endosperm. It is GRAS

(generally recognized as safe), nontoxic, and biodegradable protein. It possesses great potential to provide important health benefits to human beings. It acts as a nanoscale biomaterial that has unique solubility and film-forming properties. It has novel applications in pharmaceutical and nutraceutical areas to coat nanoparticles, develop promising nanocomposite antimicrobial agents, produce novel food packaging, encapsulate nutrients, and provide target delivery with controlled release.<sup>[14,15]</sup>

#### HEALTH BENEFITS OF MAIZE :

Maize has various health benefits. The B-complex vitamins in maize are good for skin, hair, heart, brain, and proper digestion. They also prevent the symptoms of rheumatism because they are believed to improve the joint motility. The presence of vitamins A, C, and K together with beta-carotene and selenium helps to improve the functioning of thyroid gland and immune system. Potassium is a major nutrient present in maize which has diuretic properties. Maize silk has many benefits associated with it.

In many countries of the world such as India, China, Spain, France and Greece it is used to treat kidney stones, urinary tract infections, jaundice, and fluid retention. It also has a potential to improve blood pressure, support liver functioning, and produce bile. It acts as a good emollient for wounds, swelling, and ulcers. Decoction of silk, roots, and leaves are used for bladder problems, nausea, and vomiting, while decoction of cob is used for stomach complaints.<sup>[15]</sup>

#### THERAPEUTIC BENEFITS:

- Maize is an essential source of various phytochemicals that play an important role in our health. There is inverse correlation between the consumption of phytochemicals and the development of chronic diseases. The phytochemicals in whole grains have received less attention and sometimes been underestimated. The research has suggested that phytochemicals in grains due to their potent antioxidant activities demonstrate significant beneficial contribution in reducing the risk of many diseases.
- Maize grains, especially yellow variety contains large quantities of the carotenoid pigments and has a vital significance in the diet as human beings are not able to biosynthesize carotenoids. These pigments are also beneficial in preventing cancer. Carotene has many health benefits associated with it. Yellow maize, maize silage, and stalklage has carotene content of 22, 17.3, and 6.5 mg/kg, respectively.

- Alpha ( $\alpha$ ) and beta ( $\beta$ ) carotene possess provitamin A activity. High concentration of  $\beta$ -carotene has been observed to act as a pro-antioxidant and induces apoptosis of colon cancer cells, leukemia cells, melanoma cancer cells, and gastric cancer cells, thus rendering potent chemopreventive effect.
- Xanthophylls (lutein and zeaxanthin) in maize have some pivotal and specific biological functions. Lutein supplementation in food at dose-dependent manner increases tumor latency, inhibits mammary tumor growth, enhances lymphocyte proliferation, lowers the incidence of palpable tumor, and significantly protects cells against oxidant-induced damages.
- Lutein and zeaxanthin are found to be the only carotenoids in the macula of the retina that are responsible for sharp and detailed vision. They also appear to protect humans against phototoxic damage; also play a role in protection against age-related macular degeneration and age-related cataract formation. Supplementing lutein to the subjects diets for a period showed a significant enhancement in macular pigment optical density and notable protection of the macula from light damage.
- Lutein also acts as a cancer chemopreventive suppress ing agent by presenting inhibitory actions during promotion of disease.
- Anthocyanins have been well known for their health-promoting benefits such as anti-carcinogenic, anti-atherogenic, lipid lowering, anti-diabetic, antimicrobial, and anti-inflammatory properties.<sup>[13,15,16]</sup>

#### CONCLUSION:

Maize is a healthy food due to the presence of nutrients and phytochemicals. Based on the health benefits of maize discussed in this article, it can be recommended and made a part of our daily diet. The Zea mays contain different levels of phenolic compounds , flavonoids etc and possess the various pharmacological activity.

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