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A Review on Biological Study of Maize

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Abstract

Numerous phytochemicals found in whole grains have been shown to lessen the chance of developing chronic illnesses. When compared to other whole grains, corn exhibits distinct nutritional and phytochemical profiles while being a widely consumed grain product. Vitamins (A, B, E, and K), minerals (Mg, P, and K), phenolic acids (ferulic acid, coumaric acid, and syringic acid), carotenoids and flavonoids (anthocyanins), and dietary fibre are among the nutrients and phytochemicals found in corn. There is mounting scientific evidence that frequent consumption of whole grain corn reduces the incidence of obesity, type 2 diabetes, and cardio-vascular disease as well as enhances digestive health. Additional research on the health effects of corn's bioactive components is required.

The growing consumption of maize has a significant role in the agricultural economy. For the major regions where maize is produced, the significance of planting density as a characteristic determining yield and growth has persisted in being widely acknowledged. Although defining the maize density reaction is a common aspect of research, it is unreliable across different management approaches and environmental conditions.

High production and high export concentrations of corn are global characteristics, yet there is currently a massive, unprecedented transformation taking place in this area. It has become especially crucial to guarantee the worldwide supply of corn and, by extension, the energ

Keywords:- Kernels, Starch, Corn, Health Benefits, origin

Introduction:-

The most frequently grown crop in the world is maize (Zea mays L.), a domesticated cereal grain that originated in Central America. One of the most adaptable developing crops, it has a wide range of uses. Due to its maximum genetic production potential, maize is referred to as the "queen of cereals" internationally.

The only food cereal crop that can be cultivated in a variety of climates, ecosystems, and environments is maize. Maize comes in a variety of forms in addition to this, including regular yellow/white grain, sweet corn, baby corn, popcorn, waxy corn, high-amylase corn, high-oil corn, and quality protein maize, among others. In addition, maize is a significant industrial raw material that offers significant potential for value addition.

After rice and wheat, maize is the third-most significant food crop in India.

According to most recent data (2010–11), it is grown on 8.6 million ha, with 80% of the land being used during the Kharif season. With an average productivity of 2.5 t/ha, the current maize production is 21.7 mt. Although maize is primarily a rainfed crop, it is more productive than rice, which is primarily cultivated in guaranteed irrigated/rainfed circumstances. At present prices, maize makes up roughly 9% of the country's food supply and more than 400 billion of the agricultural GDP.

Zea mays L., also referred to as corn, was first cultivated in America. In the following century, it spread around the world after being discovered in 1492 by a European explorer named Christopher Columbus. One of the main food sources in the globe is corn. Beyond its role as a primary food source, corn includes sizeable levels of bioactive chemicals that offer positive health effects. [10].In addition to corn grain, sweet corn is regarded as one of the most popular vegetables in China and North America, and its ubiquity has grown quickly globally. One of the top six vegetables consumed in the US is sweet corn [3]. The phytochemicals of maize have received less attention than those of fruits and vegetables. Canned and frozen sweet corn is listed third among vegetables consumed in the United States, only behind canned tomatoes and previously. Consuming maize and other whole grain products has been associated with improved digestive tract health, a decreased risk of chronic diseases like cardiovascular disease, type 2 diabetes, obesity, and several malignancies. Fruit and vegetable phytochemicals have been shown to provide a variety of health benefits, including anti-inflammatory and anti-proliferative actions.

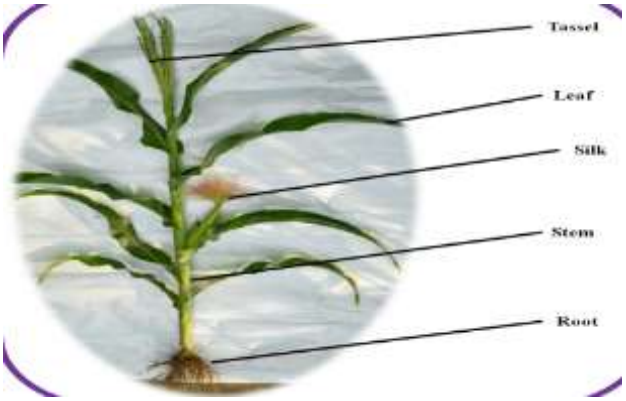

Fig.1

Taxonomy of Maize:-

The grass family Poaceae includes the tribe Maydeae, which includes maize. Zea is a term for a food plant that originated in ancient Greek. There are four species in the genus Zea, with Zea mays L. being the most economically significant.

Though it is acknowledged that the genus Coix played a role in the evolutionary development of the species Zea mays, it is generally understood that the American genera Zea and Tripsacum played a significant role in determining maize phylogeny.

Kingdom: Plantae
Subkingdom: Tracheobionta
Superdivision: Spermatophyta
Division: Magnoliophyta
Class: Liliopsida
Subclass: Commelinidae
Order: Cyperales
Family: Poaceae
Subfamily: Panicoideae
Tribe: Andropogoneae
Genus: Zea
Species: Zea mays

Origin & Evolution:-

About 10,000 years ago, at the beginning of human agriculture, maize first appeared on earth. When early Mexican farmers simply decided which kernels (seeds) to plant, they made the earliest domestication of maize. [8] They discovered that not all plants were created equal. It's possible that some plants grew bigger than others, or that some kernels had greater flavours or were simpler to crush. The farmers kept the kernels from plants that had desirable traits and planted them for the harvest the following season. Artificial selection or selective breeding are terms used to describe this technique. Over time, maize cobs grew bigger and had more rows of kernels, finally taking on the shape of modern maize.

Fig.2 Maize cobs uncovered by archaeologists show the evolution of modern maize over thousands of years of selective breeding. Even the oldest archaeological samples bear an unmistakable resemblance to modern maize. Photo © Robert S. Peabody Museum of Archaeology, Phillips Academy, Andover, Massachusetts

Developmental Stages [Life Cycle]:-

The typical maize plant grows 18 to 22 leaves in total, silk develops about 55 days after emergence, and matures in about 125 days (Ritchie et al., 1993). However, the precise time frame can change depending on the hybrid, the environment, the planting date, and the location. Therefore, these conditions determine how long there will be between each growth stage. For instance, a hybrid that matures sooner might produce fewer leaves or go through the various growth phases more quickly than is indicated above. A late-maturing hybrid, on the other hand, might sprout more leaves and go more slowly through each stage of growth. [11]

The quantity of collars on the corn plant serves as a marker for the various stages of vegetative growth. The leaf collar is the light-colored band that resembles a collar and is found at the base of an exposed leaf blade, close to where the leaf blade contacts the plant's stem. Not included are whorled leaves that are partially inflated and lack a leaf collar. For instance, a plant with 3 collars is referred to as a V3 plant, even though the plant may have 6 leaves that are visible. [12]

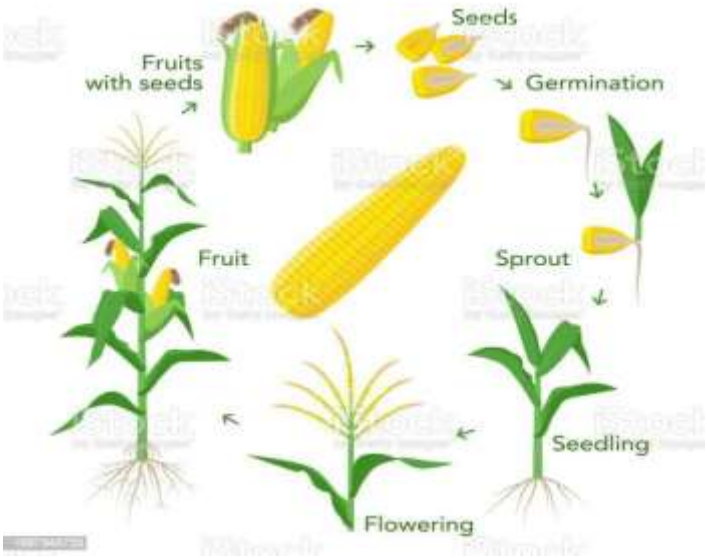

Fig: - 3 Development Stages Of maize

Below is a description of the various stages of maize growth.

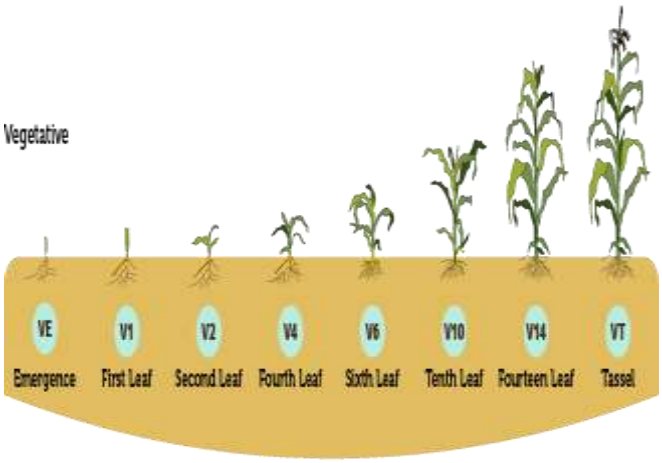

Fig:-4

VE – Emergence

When the coleoptile reaches the soil's surface, the mesocotyl and its elongation are stopped by sunlight. The growth point is roughly 0.75 inches below the soil's surface, just above the mesocotyl. Rapid development and growth of embryonic leaves through the coleoptiles tip. Growth of the seminal roots slows down, and nodal roots start to form at the crown.

V1 - First leaf collar

The lowest leaf in variation one (short with rounded tip) has the first leaf collar, which is clearly visible. Its extension begins at the nodal roots.

V3 -Third leaf collar

there hasn't been any stalk elongation, so the growing point is still below the soil's surface. The expansion of the seminal root system has stopped, and lateral roots are starting to sprout from the nodal roots. At this stage, the plant starts to generate all of its leaves and ear shoots. Lower soil temperatures may lengthen the interval between leaf stages, increase the total number of leaves generated, postpone tassel production, and decrease nutrient uptake since the growth point lies below the soil's surface.

V7 - Seven leaf collar

the rapid growth phase and kernel row determination start in the V7 and V8 growth stages. Lower leaf senescence may happen if the plant is stressed, but it must still be considered one of the growth stages.

V10 - Ten leaf collar

The stalk enters a phase of rapid growth between the V9 and V10 growth phases, acquiring both dry matter and nutrients. The stalk is still growing longer, and the tassel has started to grow quickly. The stalk can be easily dissected to reveal several ear sprouts.

VT - Tasseling

When the final branch of the tassel is seen and the silks have not yet developed, the VT stage starts. This phase starts a few days or so before silk emergence. Anthesis starts while the plant is almost at its greatest height. Anthesis usually takes place in the morning or evening. The VT/R1 plants are particularly susceptible to leaf loss and moisture stress.[1]

R1 Silking

When silk begins to poke out of the husk, this stage starts. Over the course of 24 hours, pollen tubes that land on the stigmatic surface will develop through the silk and fertilise the ovule, which matures into a kernel. Three days are needed for all the silks on one ear to become exposed and pollinated. At this stage, the quantity of fertilised ovules is determined. Ovules that are not fertilised will not develop into kernels and eventually degenerate. Pollination, fertilisation, and seed germination are all negatively impacted by environmental stress at this stage, and moisture stress results in the desiccation of silks and pollen grains. As nitrogen and phosphorus contents in the plant are significantly associated with final grain production,

R6 - Physiological Maturity

The maximum dry weight of every kernel on the ear is reached 45 to 50 days after silking. Where the kernel joins to the cob, a black or brown coating has formed, signifying that physiological maturity has been reached. Although the plant's stalk might still be green, the tissue of the leaves and husks has turned brown by this point. At this stage, the moisture level of the kernels varies greatly depending on the hybrid and the environment, ranging from 30 to 35 percent.

Botanical Nature of Maize:-

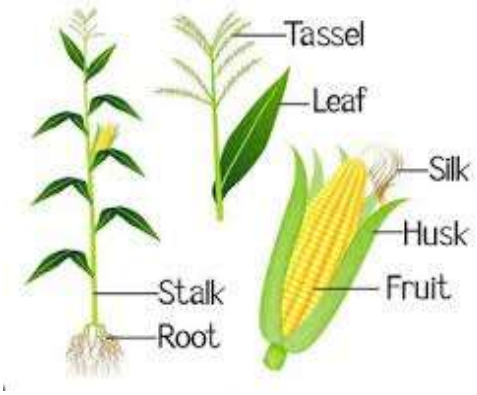

Fig:-5

The tall, determinate, annual C4 plant known as maize produces broad, thin, opposing leaves that are borne alternately along the length of a sturdy stem. Its height ranges from 1 to >4 metres. The following are the botanical characteristics of various plant parts:

1] Root:

Maize plants typically have three different types of roots: I seminal roots, which form from the radical and last for a long time; (ii) adventitious roots, which are fibrous roots that form from the lower nodes of the stem below ground and are the plant's active and effective roots; and (iii) brace or prop roots, which are created by the lower two nodes. The roots spread outward and downward approximately equally quickly. Corn roots may expand up to 60 cm laterally and in depth in suitable conditions.

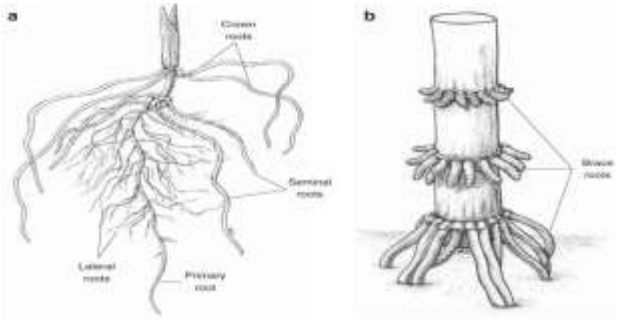

Fig:-6

2] Stem:

The stem typically grows to be three to four centimetres thick. At the plant's base, the internodes are short and somewhat thick; as they ascend the stem, they get longer and thicker before beginning to taper once more. The ear carrying internode has a longitudinal groove that enables the ear head to be positioned correctly (cob). In maize, the higher leaves intercept more light and are a key source of photosynthate for the grain.[1]

3] Flower:

The female inflorescences (cobs or ears) are borne at the apex of condensed, lateral branches known as shanks that protrude from the leaf axils. The male flowers are inflorescences that end in tassels at the tip of the stem. A loose panicle-like male (staminate) inflorescence produces pairs of free spikelets, each of which is surrounded by a fertile and a sterile floret. Pairs of spikelets are produced by the female (pistillate) inflorescence, a spike, on the surface of a tightly packed rachis (central axis, or "cob"). The female flower can't easily be seen until the pale-yellow silks that emerge from the leaf whorl at the end of the ear. This is because the female flower is densely covered over by multiple layers of leaves and is so enclosed by them to the stem. The silks are the elongated stigmas, which at first resemble tufts of hair before turning green or purple. Each female spikelet contains two fertile florets, one of which will develop into a maize kernel after being sexually fertilised by pollen carried by the wind.

4] Grain:

A caryopsis, a dry fruit with a single seed united to the inner tissues of the fruit case, is the botanical name for a single grain of maize. The seed has two sister structures: an endosperm that will supply nourishment to the germinating seedling until it has enough leaf area to transition to autotrophy, and a germ that contains the plumule and radical from which a new plant will grow. The germ is where maize's "vegetable oil" comes from; the grain's overall oil content is 4% by weight. A maize kernel's endosperm makes up around two thirds of its volume and weighs in at roughly 86% of its dry mass. White or yellow endosperm can be seen in the kernels of maize. Starch is the main component of endosperm

Type of corn:-

The several types of corn kernels, such as dent, flint, flour, sweet, pop, and pod corn, can be artificially classified. These categories, with the exception of pod corn, are not based on natural relationships but rather on the quality, quantity, and pattern of the endosperm composition in the kernel (Brown and Darrah, 1985).

[1] Dent Corn

Dent corn has soft, floury endosperm that extends to the endosperm's crown in the centre of the kernel and corneous, horny endosperm on the sides and rear of the kernels. On drying, it collapses to leave a clear indentation. The degree of denting varies depending on the genetic makeup. Dent corn is mostly used as animal fodder, although it is also a common food source and a raw resource for industry. It continues to play a significant role in human nutrition and industry, finding its way into numerous specialised goods through the dry- or wet-milling sector. However, due to its whiter starch, white dent frequently commands a higher price in the dry milling sector, where it is used for a variety of human food products. [1]

[2] Flint Corn

Flint corns often have a small, soft granular centre encircled by a thick, hard, vitreous (glassy) or corneous endosperm coating. Though the proportions of soft and corneous starch change between kinds. Typically, the ears are tall and slender with a relatively modest number of rows or kernels, and the

kernels are smooth and spherical. Flint corn often matures sooner than dent variants in temperate zones, germinates better, has more spring vigour, more tillers, and fewer prop roots.

[3] Flour Corn

This is among the earliest varieties of corn, dating back to the time of the ancient Incas and Aztecs. The delicate kernels were crushed by American and Native Americans into flour. Almost little hard, vitreous endosperm is present in floury maize kinds, which results in their opaque kernel phenotype. When dried, kernels typically shrink uniformly and exhibit little to no denting. They are simple to grind when dry, but damp environments can cause mould to grow on mature ears.

[4] Sweet Corn

During the development of the endosperm, the sugary gene in sweet corn blocks or delays the normal conversion of sugar into starch, causing the kernel to amass a water-soluble polysaccharide known as "phytoglycogen." The resultant dry, sugary kernels are glassy and wrinkled. In addition to sweetness, the higher water-soluble polysaccharide content also contributes to texture quality.

[5] Popcorn

The surviving races of maize that produce popcorn are arguably the most basic. This variety of corn is distinguished by a highly tough, corneous endosperm that only contains a trace amount of soft starch. Popcorns are mainly flint kinds with little kernels. The kernels can be either spherical or pointy (rice-like) (pearl-like). While some of the more archaic semi-popcorns, like the Argentine popcorns, have thin pericarps (seed coats), some of the more recently formed popcorns have thick pericarps.

Health Benefits Of Maize:-

Cardiovascular disease (CVD)

According to the World Health Organization, 17.7 million individuals worldwide passed away from cardiovascular diseases in 2015, and by 2030, that number will rise to 23 million. Increased consumption of whole grains and products derived from them is strongly associated with a lower risk of cardiovascular disease, according to numerous recent epidemiological studies and clinical interventional trials [5, 6, and 7].

Obesity

There were 1.9 billion and 650 million overweight and obese people globally in 2016, respectively, according to estimates.

Since 1975, the number of obese people has almost tripled. According to the findings of both short-term [14] and long-term [13] epidemiological studies, eating whole grains and meals derived from them reduces the risk of becoming obese.

Digestive Health

The improvement of intestinal health was facilitated by a daily intake of 20 g of resistant starch [15]. Insoluble dietary fibre in the form of resistant starch is abundant in corn and products made from corn. Every 100 g of white and yellow maize grains included 7.3 g of dietary fibre, according to the USDA National Nutrient Data Base [16]. The appropriate intake requirement of 14 g of dietary fibre per 1000 kcal, or 25 g for adult women and 38 g for adult males, is only met by less than 3% of the US population [17]. RSs have the ability to improve digestion and fermentation, increase mineral absorption, act as prebiotics, and lessen diarrheal symptoms.[10]

Vitamin E

The tocopherols (-tocopherol, -tocopherol, -tocopherol) and the tocotrienols (-tocotrienol, -tocotrienol, and -tocopherol) are a family of eight isomers (vitamers) that have different types of structures [4]. Tocopherols and tocotrienols share a similar chemical structure with just slight changes on the phytol side chain, with the generic structures of the two classes of vitamin E consisting of a 6 hydroxychroman group and a phytol side chain built of isoprenoid units.[9]

Table1:-

Nutrient profiles of corn and sweet corn (data reported on wet basis

	Units	White corn	yellow corn	white sweet corn	yellow sweet corn
Water	g/100g	10.37	10.37	75.96	76.05
Energy	kcal/100g	365	365	86	86
Protein	g/100g	9.42	9.42	3.22	3.27
Total lipid (fat)	g/100g	4.74	4.74	1.18	1.35
Carbohydrate, by difference	g/100g	74.26	74.26	19.02	18.7
Fiber, total dietary	g/100g	N.D.	7.3	2.7	2
Sugars, total	g/100g	N.D.	0.64	3.22	6.26
Minerals					
Calcium, Ca	mg/100g	7	7	2	2
Iron, Fe	mg/100g	2.71	2.71	0.52	0.52
Magnesium, Mg	mg/100g	127	127	37	37
Phosphorus, P	mg/100g	210	210	89	89
Potassium, K	mg/100g	287	287	270	270
Sodium, Na	mg/100g	35	35	15	15
Zinc, Zn	mg/100g	2.21	2.21	0.45	0.46
Vitamins					
Vitamin C, total ascorbic acid	mg/100g	0	0	6.8	6.8
Thiamin	mg/100g	0.385	0.385	0.2	0.155
Riboflavin	mg/100g	0.201	0.201	0.06	0.055
Niacin	mg/100g	3.627	3.627	1.7	1.77
Vitamin B-6	mg/100g	0.622	0.622	0.055	0.093
Folate, DFE	µg/100g	N.D.	19	46	42
Vitamin A, RAE	µg/100g	0	11	0	9
Pro -Vitamin A, IU	IU/100g	0	214	1	187
Vitamin E (alpha-tocopherol)	mg/100g	N.D.	0.49	0.07	0.07
Vitamin K (phylloquinone)	µg/100g	N.D.	0.3	0.3	0.3
Lipids					
Fatty acids, total saturated	g/100g	0.667	0.667	0.182	0.182
Fatty acids, total monounsaturated	g/100g	1.251	1.251	0.347	0.432
Fatty acids, total polyunsaturated	g/100g	2.163	2.163	0.559	0.487

Conclusion:-

The conclusions of this study are as follows: First, family farms in Argentina, the US, Ukraine, and other nations produce corn at a reasonably high level of technological efficiency and at the cutting edge of production technology. However, some farms are impacted by pure technology's poor efficiency. In conclusion, it is evident that maize is a crucial crop in the modern agricultural sector. The development of several varieties, methods, and procedures makes the subject one that is particularly intriguing to study. The current crop of maize is unquestionably of a very high quality, which makes its cultivation particularly appealing to farmers due to the favourable returns, particularly when maize is used as a feed supplement for dairy and beef herds.

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