



GENERATION AND BIO CONFIGURATION OF HYBRID VARIETIES OF MAIZE- A REVIEW

*Patel Milin and Gupta Prerna

School of Agriculture, Department of Food Technology and Nutrition, Lovely Professional University, Jalandhar, Punjab. 144411

ABSTRACT

Maize (*Zea mays L.*), it is most widely cultivated cereal crop, followed by wheat and rice. Andhra Pradesh, Karnataka, Maharashtra, and Rajasthan produce more than half of India's total maize production. While corn is a source for high fibre, antioxidants, phytochemical and other vitamins and minerals, it has a broad range of health benefits. This review gives a detailed view of the activities of different type of maize in the nutritional, phytochemicals and antioxidants. Phytochemicals are important in the prevention of chronic diseases. Phenolic compounds, Carotenoids, and phytosterols are among the main phytochemicals found in it. Maize is also regarded as a low-cost-high-benefit food for humans, as it contains antioxidants such as phenols and phytosterols, which help in the prevention of metabolic syndrome.

KEYWORDS: *Zea mays L.*; nutritional value, antioxidant; phytochemicals

INTRODUCTION

Maize (*Zea mays L.*), also called as corn, it is the most widely cultivated cereal crop, followed by rice and wheat. [1] In 1950-51 the total maize produced was approximately 1.73 million tonnes, which in 2018-19 was about 27.8 million tonnes, approximately 16 times higher as the previous one. During this period, the average productivity increased by 5.42 times to 547 kg/ha from 2965 kg/ha (1950-51 to 2018-19). [2] Maize is grown throughout the year in all regions, including cereals, fodder, grain cereals, sweet maize, baby maize, popcorn, etc. The developing maize crop that contributes the most 80% of the complete maize

creation is Andhra Pradesh (20.9%), Karnataka (16.5%), Rajasthan (9.9%), Maharashtra (9.1%), Bihar (8.9%), Uttar Pradesh (6.1%), Madhya Pradesh (5.7%), and Himachal Pradesh (4.4%). [3]

Year	Area (million ha)	Production (million tonnes)	Productivity (kg/ha)
2007-08	8.12	18.96	2335
2008-09	8.17	19.73	2414
2009-10	8.26	16.72	2024
2010-11	8.55	21.73	2542
2011-12	8.78	21.76	2478
2012-13	8.67	22.26	2566
2013-14	9.07	24.26	2676
2014-15	9.19	24.17	2632
2015-16	8.81	22.57	2563
2016-17	9.63	25.90	2689
2017-18	9.47	28.75	3065
2018-19	9.20	27.8	2965

Table No. 1 Area, production, and productivity of maize in India [4]

HYBRIDIZATION OF MAIZE

Hybridized maize is the result of cross-pollination between different inbred maize lines. Although Gregor Mendel first understood and reported on the methods used to interbreed plants in the 1860s, but they were not widely used in agriculture until the 1930s. The impact on agriculture was astounding, and farmers were suddenly able to produce far more corn than they had been able to produce before. Later, another researcher suggested that two hybrids could be crossed to produce a plant with high production and a high proportion of viable seeds, which improved the crossing process. [5] This hybrid or heterosis vigor occurs when two genetically unrelated inbred parents, they are crossed to create a hybrid. Farmers will select several maize plants which share a desired element, such as disease resistance, poor stability, height, rapid growth, or appearance, and then try to improve these characteristics by planting and allowing them to grow. Hybrid maize results in high yields, higher quality, and lower costs of production. [6] These plants are larger, stronger, and more vigorous. Improved nutritional qualities, like provitamin-A, high-grained zinc, and high-quality protein corn. [7]

NUTRITIONAL COMPOSITION OF MAIZE

Maize is a widely consumed and multipurpose crop. Wholegrain kernels are a great source of carbohydrates and fiber, including whole protein and some micronutrients. [8] The Maize kernel is a plant part that is edible and nutritious. It also includes vitamin E, vitamin C, Vitamin B1 (thiamine), B2 (Niacin), B3 (Riboflavin), B5 (Pantothenic acid), and B6 (Pyridoxine), vitamin K, selenium, Folic Acid, N-Ferulyl Tryptamine, and N-p-coumaryl tryptamine. Potassium is a good nutrient because the average human diet is deficient in it. [9] Corn contains a lot of protein, vitamins, carbohydrates, and minerals like potassium, magnesium, calcium, and sodium salts. [8] The wet grinding method produces corn oil, which is 40 to 50 % of the oil used in food and salads. [10] Saturated fatty acids contribute for 14% of the oil, monounsaturated fatty acids of 30%, and polyunsaturated fatty acids of 56%. Refined maize oil also contains 54-60% linoleic acid, 25-31% oleic acid, 11-13% palmitic acid, 2-3% stearic acid and 1% linolenic acid. [11] Maize seeds are present in the Sugar (16.39 - 21.20 g/100g dw), protein (11.46 – 12.70 g/100g dw), and crude oil (5.73 – 6.21 g/100g dw). [12] Moisture (9.65–10.4%), carbohydrates (65.5–74.3%) protein (9.42–17.6%), fat (0.29–4.74%), ash (1.2–3.91%), and dietary fibre (7.34%) are all present in maize husk. And a good vitamin and mineral composition, including sodium, potassium (28, 1360 mg / 100g dw, respectively), calcium, iron, magnesium, manganese, zinc, and copper (0.1869, 0.005, 0.1939, 0.0109, 0.0165, and 0.0073 mg / 100g dw, respectively). [8, 13, 14]

Macronutrients		Vitamins		Minerals	
Moisture	10.23g/100g	Thiamine	0.385mg/100g	Calcium	10mg/100g
Carbohydrate	74.3g/100g	Riboflavin	0.10mg/100g	Phosphorus	210mg/100g
Protein	8.84g/100g	Pantothenic acid	0.424mg/100g	Sodium	15.9mg/100g
Fat	4.74g/100g	Vitamin B-6	0.622mg/100g	Sulphur	114mg/100g
Fibre	2.15g/100g	Niacin	3.63mg/100g	Minerals	1.5mg/100g
Ash	1.2g/100g	Folate	19µg/100g	Iron	2.3mg/100g
Sugar	0.64g/100g	Vitamin A	11µg/100g	Potassium	287mg/100g
Energy	365 kcals/100g	Vitamin C	0.485mg/100g	Magnesium	139mg/100g
		Amino acids	1.78mg/100g	Copper	0.314mg/100g
				Zinc	2.21mg/100g
				Manganese	0.485mg/100g
				Selenium	15.5µg/100g

Table No. 2 Nutrient composition per 100g edible portion of maize. [8, 15, 16]

4. ANTIOXIDANT POTENTIAL OF MAIZE

The total phenolic content (TPC) of maize and the total antioxidant activities are higher than wheat, oats, and rice. Corn extract has a TPC of 15.55 ± 0.60 mmol of gallic acid equiv/100g of grain, which is higher than wheat (7.99 ± 0.39 μ mol of gallic acid equiv/100g of grain), oats (6.53 ± 0.19 μ mol of gallic acid equiv/100g of grain), and rice (5.56 ± 0.17 μ mol of gallic acid equiv/100g of grain). In maize extract bound phenolics also were observed to be significantly higher than free phenolics. About 69% of the total phenolics present in corn are in insoluble bound forms, with ferulic acid being the main phenolic compound. Bound phenolic content was also highest for corn (13.43 ± 0.59 μ mol/100g grain), followed by wheat (6.10 ± 0.39 μ mol/100g grain) and then oats (76.7676 ± 0.14 μ mol/100g grain). [17] The phenolic content and antioxidant potential extracted from both typical and mutated corn genotypes, TPCs in mutant maize have been confirmed to be higher than all extraction methods (methanol, HCL / methanol extraction, and alkaline hydrolyzates). [18] Also, corn kernel anthocyanin is rich in antioxidants and bioactive properties that are well established in purple pigmented. [19] In addition, after thermal processing, sweet corn's total antioxidant activity increases by 44%. [20] For their respect to reducing serum cholesterol levels, the industry has concentrated on plant matrices rich in phytosterols and phytostanols. The Phytosterols and phytoesthenol content of various corn kernel fractions (endosperm, pericarp, and germ). The germ contains 25–31% oil compared to other fractions. Corn oil is high in β -sitosterol (62–69%), followed by campesterol (11–18%) and stigmasterol (5–13%). [21]

PHYTOCHEMICALS OF MAIZE

Phytochemicals their derived from the Greek word "phyto," which means "plant." Non-nutrient bioactive chemical compounds found in plants such as fruits, vegetables, and whole grains are called phytochemicals. It can help to reduce the risk of the chronic diseases. [21] Maize is a major component of various essential phytochemicals, including carotenoids, phenolic compounds, and phytosterols. The composition of phytochemicals varies between different types of corn. The carotenoids are found in yellow and red maize, the concentration of anthocyanins in red, blue, purple, and black maize and the concentration of phytosterols in a kernel component of maize. [22, 23]

PHENOLIC COMPOUNDS

One of the most common phenolic compounds found in whole grains is phenolic acid. Maize phenolic acid does include caffeic, coumaric, hydroxybenzoic, protocatechic, syringic, vainillic, sinapic, syringic and gallic acids as well as ferulic acids. [24, 25] The major compound containing 70 % of the total ferulic acid is phenolic acid, including an average maize of 255 mg/100g. [24] Anthocyanins are a common class

of phenolic compounds as called flavonoids. They are the largest group of water-soluble plant pigments that are reddish to purple colour. Corn has the second-largest concentration of anthocyanin. [26]

Type of Maize	Phenolic Compounds	Concentration (mg/100gm)	Reference
Yellow Maize (Whole)	Ferulic acid	178.8	[24]
	P-Coumaric acid	24.2	
	Vainillic acid	20.1	
	Sinapic acid	13.3	
	p-Hydroxybenzoic acid	2.0	
	Syringic acid	11.6	
	Total phenolic acid	255.0	
Yellow Maize	Ferulic acid	1840.0	[24]
Purple Maize	Cyanidin 3-O-(6''-malonyl-glucoside)	39.9	[27]
	Pelargonidin 3-O-(6''-malonyl-glucoside)	5.1	
	Peonidin 3-O-(6''-malonyl-glucoside)	14.5	
	Cyaniding-3-glucoside	113.5	
	Pelargonidin-3- glucoside	11.6	
	Peonidin-3- glucoside	28.5	
	Total anthocyanins	1640	[27, 28]
Red Maize	Total anthocyanins	5.1	[29]
Blue Maize	Total anthocyanins	36.8	[27]

Table No.3 show the Phenolic Compounds of different types of maize.

CAROTENOIDS

Carotenoids are yellow, orange, and red natural pigments. There were more than 600 in nature carotenoids. [29] Carotenoids have 40 carbon polysiopreoids, which are rich in colouring plants. Grains that give a yellow colour to endosperm. [30] Most carotenoids that occur in nature are in trans form. The carotenoids exhibit light absorbing and a unique single oxygen cooling capacity due to their large chain of conjugated

double bonds in the middle part of their chemical structure. [31] Carotene is almost non-existent in white corn, while the yellow genotype contains large quantities of both carotene and xanthophyll's. [32, 33] Yellow and high carotenoid kernels contain between 50 to 80mg/g and among the 95 to 120mg/g of carotenoids. As expected, most carotenoids are associated with endosperm. [34] The most detected carotenoids are corneal endosperm (74 to 86%), followed by flour endosperm (9 to 23%), germ (2 to 4%) and pericarp (1%). [35]

Type of Maize	Carotenoids	Concentration (mg/100gm)	References
White Maize	α – Carotene	0.01	[36, 31, 37]
	β – Carotene	0.04	
	γ – Carotene	0.09	
	Lutein	0.06	
	Zeaxanthin	0.03	
	Total Carotenoids	0.30	
Yellow Maize	β -Cryptoxanthin	0.41	[38]
	13-cis- β - Carotene	0.09	
	All trans- β - Carotene	0.30	
	Lutein	0.21	
	Zeaxanthin	0.53	
	9-cis- β - Carotene	0.10	
	Total Carotenoids	6.60	
High Carotenoids Maize	α – Carotene	0.72	[39, 33, 31, 37]
	β – Carotene	5.93	
	γ – Carotene	0.48	
	Lycopene	2.28	
	Lutein	1.46	
	Zeaxanthin	3.57	
	α - Cryptoxanthin	1.34	
	β - Cryptoxanthin	0.52	
Total Carotenoids	6		

Table no.4 show the Carotenoids of different types of maize.

PHYTOSTEROLS

The only difference between phytosterols and cholesterol is in the side chains of plant sterols and stenols. [38] Most phytosterols are connected to the germ oil. The oil amounts to between 3.1% and 5.7% of the raw maize kernel weight. For the sum of phytosterols the germ content is 310 mg/100 g. [30] Corn oil is rich in phytosterols, and between 56 to 60 % of corn esters contain phytosterols. [40] The most consumed phytosterols from maize oil are sitosterol (60.75%), stigmasterol (6.44%), and campesterol (19.60%). [41]

Type of Maize part	Phytosterols	Concentration (mg/100gm)	References
Maize oil	Sitosterol	510	[42]
	Sitostanol	184	
	Stigmasterol	46	
	Campesterol	135	
	Campestanol	74	
	Total Phytosterols	1109	
Maize Germ	β - Sitosterol	198	[43]
	Stigmasterol	17	
	Campesterol	65	
	Δ^7 - Campesterol	1	
	24-Methylencholesterol	2	
	Total Phytosterols	311	
Maize Germ Oil	Sitosterol	503	[40]
	Sitostanol	30	
	Stigmasterol	54	
	Campesterol	151	
	Campestanol	13	
	Total Phytosterols	840	
Maize Fiber Oil	Sitosterol	1897	[43]
	Sitostanol	2964	
	Stigmasterol	142	
	Campesterol	594	
	Campestanol	1182	

	Total Phytosterols	7939	
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Table no.5 show the Phytosterols of different types of maize.

CONCLUSION

Maize is a widely consumed and multipurpose crop. Maize wholegrain kernels are a rich source of carbohydrate and fiber, with moderate amounts of total protein, some micronutrients and minerals. Corn is rich in phytochemicals including phenolic acids, flavonoids, and carotenoids. The high nutritional value of maize pollen, as well as abundance of its bioactive compounds with high antioxidant capacity.

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