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Extraction and Utilization of Corn

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Abstract
Corn is regarded as a unique cereal crop due to its diverse uses and suitability in a variety of cropping systems. In terms of acreage, it is the third most important cereal crop in India. Eight states contribute more than three-quarters of the country's maize production area: Andhra Pradesh, Bihar, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan, Uttar Pradesh, and Tamil Nadu. With a productivity of 2509 kg/ha, the country produces 21.81 million Tonnes of maize from 8.69 million ha of land. The production potential of composite high yielding varieties (HYVs) and hybrids exceeds the national average. The crop is grown in a variety of climates, land conditions, and cropping systems.

Keywords: Corn, Extraction, Utilisation, Nutritious, Polysaccharides

Introduction
Corn is a grass family monocotyledonous and annual herb cereal crop. It is thought to have originated in Mesoamerica and now grown worldwide in tropical and temperate regions such as the America, East Asia, South Asia, South East Asia and the European Unions (Staller, 2010); (Scott and Emery, 2016). Corn kernels contain 61-78 percent starch on a dry basis (D.B.), about 10% non-starch polysaccharides (D.B.), 6-12 percent protein (D.B.), and 3-6 percent lipids (D.B.) (Kumar *et al*., 2011) [2]. Furthermore, it is easily dried and transportable. As a result, corn is a near-ideal starch grain crop for the food industry. As a result, it is the world's most important cereal crop. It is estimated that global corn production will exceed 1136.3 MMT (million metric Tonnes) in 2020-2021 (Sep-Aug), far exceeding wheat (776.8 MMT) and rice production (504.4 MMT). Furthermore, the United States produced approximately 31.7 percent (360.3 MMT), followed by China (260.6 MMT) and Brazil (109.0 MMT). The previous year, the world consumed 1150.5 MMT, with the United States accounting for half of that total (305.4 MMT). China is the largest corn consumer (289.0 MMT). Approximately 30% of total corn production is consumed as industrial materials, with the United States consuming 40% of those raw materials (Ranum *et al*., 2014) [4]; (Wang *et al*., 2021) [3].

Botanical Description of maize plant
Corn is native to Mesoamerica and was domesticated in Mexico 9,000 years ago, after which it spread over the American continents. It is a tall, determinate, annual plant varying in height from <1 to > 4 meters producing large, narrow, opposing leaves, borne alternatively along the length of a solid stem. It has three types of roots: seminal, adventitious and brace or prop roots. The stem generally contains 3-4 cm thickness. Internodes are short and fairly thick at base of plant, become longer and thicker higher up the stem. The ear bearing internode is longitudinally grooved, to allow proper positioning of the ear. The upper leaves in corn are for light interception. The flowers of corn are monoecism in which the male and female flowers are located in different inflorescences on the same stalk. The male flowers (tassel) at the top of the plant produce yellow pollen. Meanwhile, the female flowers produce corn silk and are situated in the leaf axils. The silks are elongated stigmas which look like a tuft of hairs. The colors of the corn silk, at first are usually light green and later turn into red, yellow or light brown (Hasanudin, *et al.*, 2012) [5]; (Bai, *et al.*, 2010) [6]. The function of corn silk is to trap the pollen for pollination. Each of the silk is pollinated in order to produce one kernel. The length of silk is approx 30 cm with a sweet taste. It is being harvested before pollination occurs and can be utilized in fresh or dried forms.

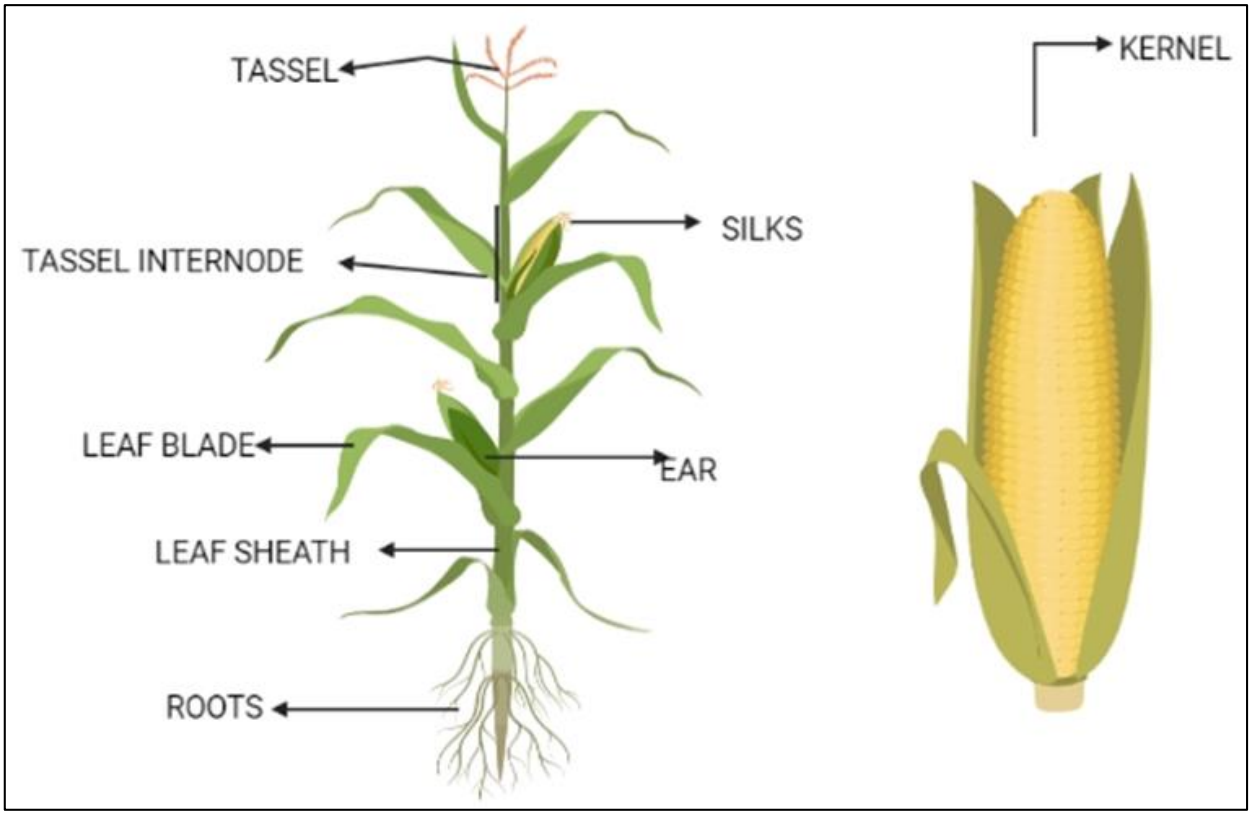

Fig 1: Structure of Maize (Zea Mays) Plant

Nutritional significance of corn

Maize as a crop is at Per excellence for food, feed and industrial utilization, however it is deficient in essential amino acids: lysine and tryptophan. It is nutritious and highly appetizing. It prevents constipation as easily digested by the body. In addition it is starch free, not-fattening, and is converted into intermediate carbohydrates and dextrin. It reduces stomach acidity by facilitating the removal of toxic food substance, it combats the symptoms of certain cancers and reduce the risk of diabetes and heart diseases. The edible portion of dry maize comprises 342kcal energy, 14.9g moisture, 66.2g carbohydrates, 11.1g protein, 3.6g fat, 2.7g fibre, 1.5g minerals, 2.3 g iron and etc. (Wadhwani, 2016) [8].

Extraction

It is the way to separate a desired substance when it is mixed with others. The mixture is brought into contact with a solvent in which the substance of interest is soluble, but the other substances present are insoluble. The substances that can be extracted were starch from corn, polysaccharides from the silk of corn, anthocyanin's from the cob, flavonoids from the silk and oil from corn. There are two types of methods for extraction one is conventional and other one is modern.

Conventional Methods: Aqueous extraction, Acidic or Alkali extraction, Solvent extraction, Ethanol reflux extraction.

Modern Methods: Enzymatic extraction, Fermented extraction, Ultrasonic assisted extraction, Microwave assisted extraction and Supercritical fluid extraction.

Since ancient times, Aqueous extraction has been thought to be the first extraction method used. The disintegration of the material, in this case maize kernels, into smaller particles or fine powder in the first step in this method. The next step is to soak the material in water for an extended period of time to affect the cell membrane. The mixture is then boiled, centrifuged and filtered, a process is typically repeated for a higher extraction yield. The benefits of using this method are thought to be low cost, simplicity and the fact that the resulting solution is compatible with many applications that typically require aqueous media. However the disadvantages are too significant to ignore, such as high water requirements and long extraction times (Arlet *et al*., 2021) [9]. Corn oil was extracted using an aqueous enzymatic oil extraction process made from wet milled corn germ milling the germ, incubating it with cellulase enzyme, and centrifugation to separate the free oil were all part of the process. Maximum yields were approximately 80% of total oil in the reservoir (Moreau *et al*., 2014) [10].

Acidic or Alkali extraction: Although alkaline extraction is the most commonly reported method for releasing ferulic acid from agricultural byproducts, it also releases arabinoxylans. A sequential two-step extraction process with different operating conditions for the release of ferulic acid and then arabinoxylans is not possible. As a result, an efficient separation is required to achieve an efficient recovery of these two compounds for use in different applications. Due to the high viscosity of the alkaline extract caused by the presence of arabinoxylans, this separation is quite difficult. Indeed, the high viscosity of arabinoxylans makes adsorption difficult to use to purify ferulic acid in an alkaline extract (Zhao *et al*., 2014) [11]; (Galinha *et al*., 2021) [12].

In ethanol reflux extraction, the dried silk of corn was pulverised into a fine powder (particle size 0.149 mm) and extracted separately with distilled water and 40% v/v ethanol.

Each dried sample (300 g) was macerated three times with 40 percent v/v ethanol (1.5 L) at room temperature for 24 hours before being digested with distilled water (1.5 L) for 1 hour at 45°C. The extract solutions were filtered separately using Whatman No. 1 filter paper, and the solvents were evaporated at 40°C using a rotary evaporator at 40ºC.

Enzyme assisted extractions are mainly based on the ability of cell wall degrading enzymes to hydrolyze the structural components of plant tissues, therefore by releasing the bioactive compounds. In this method, one gram powdered corn husks and 10 ml of 0.1ml of 0.1M PCB at Ph 5.0 were added and mixed in a screw-capped glass flask. Cellulase was subsequently added an amount so as to achieve the required nzyme dosage. The resulting solution was incubated at 40º C. then the enzyme was inactivated in boiling water for 5 minutes and the preheated material was then subjected to solvent extraction. Batch experiments wre performed at 80ºC for 2 hours using aqueous ethanol as solvent. This method is mainly used to extract the total yield of flavonoids present (Zuorro *et al*., 2019) [14].

Ultra sonic-assisted extraction: The most inexpensive, simple and efficient method used to extract flavonoids that increases the extraction yield (Zheng *et al*., 2016) [15]. The extraction was carried out in a clean ultrasonic bath (300 150 150 mm, Kunshan Ultrasonic Instrument Co. Ltd., Jiangshu, China). In a polypropylene tube, 5 g of fortified corn was mixed with 25 mL of methanol-water (3:1, v/v). After placing the tube in the clean bath, the extraction process was carried out for 10 minutes at room temperature, with the output powder set at 120 W. Following ultra-sonication, the tube was centrifuged at 5000 rpm for 5 minutes before being filtered through a 0.22-m filter and injected into the LC system (Yang *et al*., 2012) [19]. Ultra sonic-assisted extraction were used to extract flavonoids from corn silk.

A Speed SFETM-2 extraction device was used to extract flavonoids from *M. stigma* under supercritical CO_2 extraction method. The SFE equipment was calibrated before the experiment began. To obtain the operational temperature (3–5ºC), thermostatic baths were turned on. This method is used to extract flavonoids and carotenoids (Wang *et al*., 2011) [3]. The experiments were carried out in a laboratory scale unit that included a CO2 cylinder (White Martins SA, Brazil, 99.5 percent purity), one syringe pump, one extractor, and two thermostatic baths. In each experiment, the extractor had an internal capacity of 63 cm3 (diameter 1.98 cm, height 20.5 cm) and was loaded with approximately 25 g of sample. One thermostatic bath (Thermo Scientific, A-10, USA) was used to cool the solvent before it entered the pump, while the other (TECNAL, TE-184, Brazil) was used to keep the extractor heated to the desired temperature. After a 30-minute pre-extraction period, the extraction was started. Every ten minutes, the weight of the collection flask was measured (Marinho *et al*., 2019) [18].

Utilization

Corn is the world's third most important plant-based food source. Despite its importance as a staple food in many parts of the world, corn has lower nutritional value than other cereals. Its protein is of poor quality, and it lacks niacin. Corn contains a lot of dietary fiber and antioxidants. Corn flour, unlike many other cereal grains, is gluten-free and cannot be used alone to make rising breads. It is, however, widely used in Latin American cuisine to make MASA, a type of dough used in staple foods such as tortillas, AREPAS, and tamales. Sweet corn is boiled or roasted on the cob, creamed, converted into hominy (hulled kernels) or meal, and cooked in corn puddings, mush, polenta, griddle cakes, cornbread, and scrapple in the United States and many other places. It is also used in popcorn, confections, and various prepared breakfast cereals.

It is also used fermented into number of alcoholic beverages, notably bourbon and other corn whiskeys. Many parts of the corn plant are used in industry, and several types of corn are grown primarily for industrial purposes. Corn grain is processed through wet milling, in which the grain is soaked in a dilute solution of sulfuric acid; dry milling, in which the corn is exposed to a water spray or steam; and fermentation, in which starches are converted to sugars and yeast is used to convert the sugars to alcohol.

Future perspectives

Maize is a staple food in many developed and developing countries around the world. In developed countries, it is widely used for animal feed and industrial raw material, whereas in developing countries, it is mostly used for feed. Maize is a prominent crop in Indian agriculture, and every part of the maize plant is used in some way, with nothing going to waste. Among the cereal crops in India, maize ranks fifth in area, next to rice, wheat, Jower, and Bajra, fourth in production, and third in productivity, with an annual production of around 10 million Tonnes covering 6 million hectares. Maize production in the country is completely consumed domestically, and exports are negligible. Even with the spectacular increase in production of finer cereals such as rice, wheat, and Jowar coarse grain in recent years, there is no problem of maize surplus. As a result, with increasing demand for food grains and population growth, maize is expected to maintain its position as an important cereal food grain. Considering that maize contributes approximately 6% of total cereal production and approximately 23% of total coarse grains, the maize requirement for food will be approximately 8.25 million Tonnes.

Conclusion

Corn has been considered as most relevant and largest production crop. It is a healthy crop loaded with phytochemicals and essential nutrients. It is the only crop in which inflorescence is separated into male and female flower. Many essential products we can extracted from it by various methods. The extracted products will be beneficial to our food industry. Its different parts like leaves, tassel, roots, silks, cob were proved to be very potent. It is mainly used for food, feed or by industries.

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