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A Mini Review on Corn: Structure, Nutrients, Classification and Milling

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Abstract:

In the present paper, an effort has been taken to perform a literature review on types of corn, its nutrition and types of milling. Corn (Zea mays) is annual crop that belongs to the family of grass i.e. Poaceae. It originates from America especially native of South America and now a days it is cultivated approximately all the regions of the world including India. A whole corn kernel is composed of four different parts such as endosperm, germ, bran and tip cap. The normal corn kernel contains starch as a predominant component with highest total antioxidant activity. Corn can be classified on the basis of endosperm and kernel composition viz. flint corn kernels, dent corn, floury corn, waxy corn, pop corn and sweet corn. Corn can be processed by using dry or wet milling to produce diverse food ingredients such as corn meal, corn grit, corn fiber, corn oil etc. It has been established that research is still required in order to fully understand the composition, types and milling process of the corn in order to help food technologist. Therefore, it was the aim of this investigation to review the types of corn, its nutrition and types of milling.

Key words: Corn, structure, nutrient, types, milling

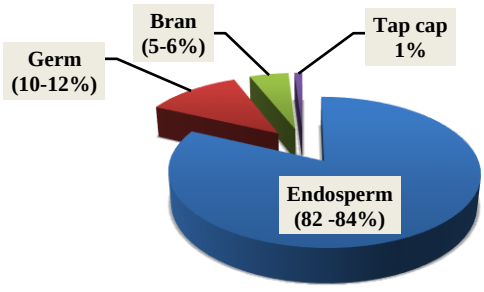
INTRODUCTION

Corn is also known as maize (Zea mays L.). In India, it is called as Makka (Hindi). It is also recognized by different names such as zea and silk corn etc. *Zea mays* are derived from the combination of two languages ancient Taino or Greek. *Zea* comes from Taino which means "life giver" or *mays* from Greek which means "sustain life" (Milind, P., & Isha, D, 2013; Kazerooni, E. G., Sharif, A., Nawaz, H., Rehman, R., & Nisar, S., 2019). It is annual crop that belongs to the family of grass i.e. Poaceae. In 1492, it was discovered by a European explorer Christopher Columbus. It is originated in America especially native of South America. But it is extensively cultivated in

various other countries such as India, Pakistan, Thailand and China, and in several parts of Philippines (Siyuan, S., Tong, L., & Liu, R., 2018; Kumar, D., & Jhariya, A. N., 2013; Smith, C.W., Betran J., & Runge, E. C. (Eds.), 2004; Mangelsdorf, P. C., 1950).

Structure

A whole corn kernel is composed of four different parts such as endosperm, germ, bran and tip cap as shown in pie chart 1. It contains approximately 82% to 84% of endosperm (whole kernel mass), 10% to 12% of germ, 5% to 6% of bran and 1% of tip cap on dry basis (Ai, Y., & Jane, L. L., 2016; Britannica, 2015; Watson, S. A., 2003). The endosperm is mainly made up of starch surrounded by a protein matrix. There are two types of endosperm such as floury and horny (Gwirtz, J.A., & Garcia-Casal, M. N., 2014; Mestres, C., & Matencio, F., 1996).



Pie chart 1: Structural composition of corn kernel (Ai, Y., & Jane, L L., 2016; Britannica, 2015; Watson, 2003)

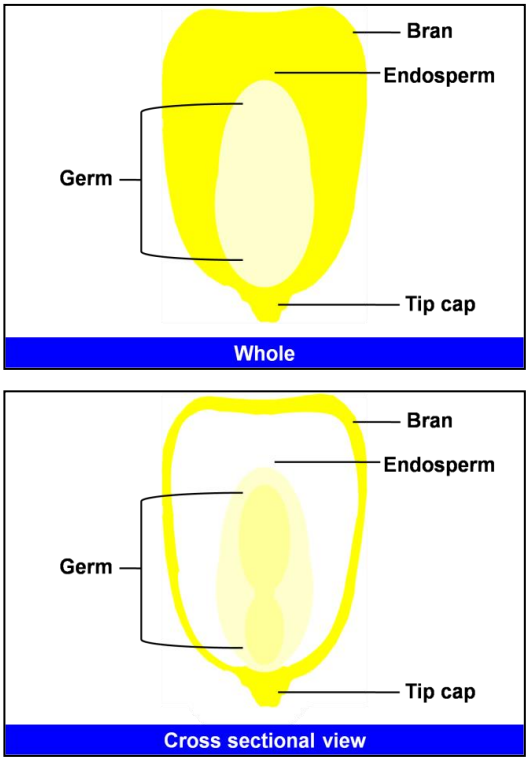


Figure: Whole corn kernel with the indications of endosperm, germ, bran, and tip cap (Ai, Y., & Jane, L L., 2016).

Nutrients

The normal corn kernel contains starch as a predominant component (61% to 78%, db) and it is mainly located in the endosperm. Also it consists of 6% to 12% (db) protein, with the majority located in the endosperm and germ. Also it contains 3% to 6% lipids (db), with the majority located in the germ. The major non-starchy polysaccharides such as cellulose and hemicellulose are major present in the corn bran (Ai, Y., & Jane, L L., 2016). All types of corn are good source of dietary fiber, vitamins (A, B, E, and K), minerals (magnesium, potassium and phosphorus), flavonoids and phenolic acids, plant

sterols, and other phytochemicals etc. (Siyuan, S., Tong, L., & Liu, R., 2018). Corn contains significant amounts of bioactive compounds (Siyuan, S., Tong, L., & Liu, R., 2018; Ranum, P., Pena-Rosas, J. P., & Garcia-Casal, M. N., 2014). Corn has the highest total antioxidant activity (181.4 ± 0.86 mol of vitamin C equiv/g of grain) than rice, wheat and oats (Adom, K. K. and Liu, R. H., 2002). It has antioxidant properties which help to remove free radical that cause cancer (Kazerooni, E. G., Sharif, A., Nawaz, H., Rehman, R., & Nisar, S., 2019).

Corn classification

Corn can be classified on the basis of endosperm and kernel composition. (Version, 2008; Darrah, L. L., McCullen, M. D., Zuber, M. S., 2003; Paliwal, R. L., 2000; Brown, W. L., & Darrah, L. L., 2002).

1. **Flint corn kernels:** These are characterized by their high percentage of hard endosperm around a small soft centre.
2. **Dent corn:** In this type, hard endosperm is present on the sides and base of the kernel. The remainder of the kernel is filled with soft starch.
3. **Floury corn:** In this type, endosperm is mainly composed of soft starch.
4. **Waxy corn:** In this type, kernels contain entirely amylopectin as their starch.
5. **Pop corn:** In this type, kernels are characterized by a high proportion of hard endosperm, which is much higher than any other corn kernel (White, P. J., & Johnson, L. A. (Eds.), 2003).
6. **Sweet corn:** In this type, sugar content is higher due to one or more recessive mutation blocking conversion of sugar to starch. It is well-liked by consumers because of its distinctive flavor, unique taste, and sweetness (Swapna, G., Jadesha, G., & Mahadevu, P., 2020).

Milling of the corn

Milling processes can be used to transform whole grains into forms suitable for conversion into consumable products (Vanara, F., Scarpino, V., & Blandino, M., 2018; Kent, N. L., 1994). Corn can be processed by using dry or wet milling to produce diverse food ingredients such as corn meal, corn grit, corn fiber, and corn oil etc. (Duensing, W. J., Roskens, A. B., & Alexander, R. J., 2003). The products obtained from the dry and wet milling of corn are utilized to manufacture breakfast cereals, snacks and tortillas with or without further modifications (Ai, Y., & Jane, L L., 2016; Nuss, E. T., & Tanumihardjo, S. A., 2010).

Dry milling

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The dry milling of corn produces corn meal, corn flour, and corn grit and corn bran of a wide range of particle sizes. In this milling hominy feed is obtained as a co-product (Duensing, W. J., Roskens, A. B., & Alexander, R. J., 2003). Corns are subjected to full fat milling process or bolted milling process or tempering-degerming milling process (Duensing, W. J., Roskens, A. B., & Alexander, R. J., 2003). Also this milling could be carried out by using dry de-germination system (DD) or tempering de-germination system (TD).

Wet milling

The wet milling of the corn consists of different operations such as sample preparation, steeping, first grinding, germ separation, final grinding, fiber separation and starch-protein separation etc. (Singh, N., & Eckhoff, S. R., 1996). Major products derived from the wet milling of corn are corn starch and oil. The corn gluten, corn fiber (seed coat) and steeping solids are obtained as co-products (Johnson, L. A., & May, J. B., 2003; Rose, D. J., Inglett, G. E., & Liu, S. X., 2010).

1. **Sample preparation:** In this, the corn is cleaned using screens (reciprocating) to remove some foreign materials and broken kernels before steeping.
2. **Steeping:** This process softens the corn kernels. It facilitates disintegration of the protein matrix that encapsulates the starch granules in the endosperm. It increases the germ recovery by removing soluble especially from the germ (Cox, M. J., MacMasters, M. M., & Hilbert, G. E., 1944).
3. **First grinding:** The objective of this process is to detach the germ from other corn kernel components without damaging the germ (de-germination).
4. **Germ separation:** After the first grinding, germ is separated from the rest of the slurry. The lighter germ floats on the top of ground mash due to density difference.
5. **Final grinding:** After the germ recovery, the de-germinated slurry is finely ground to separate the remaining starch from the endosperm and the softened protein matrix. Two types of mills can be used for grinding the slurry such as “refiners" and "impact mills" (Blanchard, P. H., 1992).
6. **Fiber separation:** In this process, fibrous material derived from the pericarp and endosperm cell walls is removed by a series of pressure fed screens.
7. **Starch-protein separation:** Mill starch consists of starch and corn protein (gluten) particles that can be separated by using centrifuge. The recovered starch fraction is washed

counter currently by using a battery of hydro cyclones.

Conclusion

Corn (Zea mays L.) is annual crop that belongs to the family of grass i.e. Poaceae. It originates from America especially native of South America and now a days it is cultivated approximately all the regions of the world including India. A whole corn kernel is composed of four different parts such as endosperm, germ, bran and tip cap. The normal corn kernel contains starch as a predominant component with highest total antioxidant activity. Corn can be classified on the basis of endosperm and kernel composition viz. flint corn kernels, dent corn, floury corn, waxy corn, pop corn and sweet corn. Corn can be processed by using dry or wet milling to produce diverse food ingredients such as corn meal, corn grit, corn fiber and corn oil etc. It has been established that research is still required in order to fully understand the composition, types and milling process of the corn in order to help technologist. It has been established that research is still required in order to fully understand the composition, types and milling process of the corn in order to help food technologist.

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