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Review on; Origin, Taxonomy, Cytology and Reason for Variation of Chromosome Number in Okra (*Abelmoschus esculentus* L. Moench.)

Ravindrakumar and G Shanthakumar
Department of Genetics and Plant Breeding,
College of Agriculture, University of Agricultural Science's, Dharwad-05
Corresponding author email id: ravimgpb@gmail.com

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Abstract **– Okra (*Abelmoschus esculentus L. Moench*) is one of the important vegetables grown in India during both summer and rainy seasons. This is an often cross-pollinated crop showing 4–19% cross pollination and is a traditional vegetable crop with considerable area under cultivation in Africa and Asia with huge socio-economic potential in West and Central Africa. It has been called "a perfect villager's vegetable" because of its robust nature, dietary fibers and distinct seed protein balanced in both lysine and tryptophan amino acids (unlike the proteins of cereals and pulses) it provides. In Cultivated okra there is significant variation in the chromosome numbers and ploidy levels in cultivated *Abelmoschu species.* The chromosome number of this species has been variously reported as 2n = 56, 2n = 108, 2n = 108 and 2n = 144; in a number of varieties as examined by various researchers, the chromosome number was invariably found to be 2n = 130.This present review describes a general overview of okra's nutritional status, Origin, Taxonomy, Cytology and reason for variation of chromosome number in Okra.**

Keywords **– *Abelmoschus*, Genetic Improvement, Germplasm, Okra, West And Central Africa (WCA).**

I. Introduction

Okra *Abelmoschus esculentus* (L.) Moench] is one of the most important vegetable crops grown extensively throughout the country during both summer and rainy seasons for its green tender fruits. It is a good source of vitamin A, B, and C, protein and mineral elements. Its fast growth, short duration and photo insensitive nature, genetical study can be completed in short span of time. Moreover, its large flower and monadelphous nature of the stamens make emasculation and pollination process easier. With the ease in fruit set and good number of seeds per pod, okra can be well exploited for hybrid vigour. In this paper we are briefing the origin, taxonomy, cytology, nutritional potential and uses of okra.

Domesticated Species

There are four known domesticated species of *Abelmoschus*. Among these, *A. esculentus* (common okra) is most widely cultivated in South and East Asia, Africa, and the southern USA. In the humid zone of WCA, *A. caillei* (West African okra) with a longer production cycle, is also cultivated (Siemonsma, 1982). Plants of *A. manihot* sometimes fail to flower and this species is extensively cultivated for leaves in Papua New Guinea (Hamon and Sloten, 1995), Solomon Islands and other South Pacific Islands (Keatinge, 2009). The fourth domesticated species, namely, *A. moschatus,* is cultivated for its seed, which is used for ambretee in India and several animism practices in South Togo and Benin (Hamon and Sloten, 1995).

Taxonomy, Cytology and Origin

Okra was previously included in the genus *Hibiscus*. Later, it was designated to *Abelmoschus*, which is disti-

-nguished from the genus *Hibiscus* by the characteristics of the calyx: spatulate, with five short teeth, connate to the corolla and caduceus after flowering (Kundu and Biswas, 1973; Terrell and Winters 1974). Although about 50 species have been described, eight are most widely accepted (Borssum, 1966; IBPGR, 1990). There is significant variation in the chromosome numbers and ploidy levels in *Abelmoschus.* The lowest chromosome number known is $2n = 56$ for *A. angulosus* (Ford, 1938) and the highest are close to 200 for *A. caillei* (Siemonsma, 1982). Even within *A. esculentus*, chromosome numbers $2n = 72$, 108, 120, 132 and 144 are in regular series of polyploids with $n = 12$ (Dutta and Naug, 1968). Contradicting evidence exists on the geographical origin of *A. esculentus*. One putative ancestor (*A. tuberculatus*) is native to Uttar Pradesh in North India, suggesting that *A. esculentus* originated in India. The other evidence is based on the plants cultivation in ancient times, and the presence of another putative ancestor (*A. ficulneus*) in East Africa, suggesting northern Egypt or Ethiopia as the geographical origin of *A. esculentus*. So far *A. caillei* ($2n = 196$ to 200) has been located only in WCA, so this region can be recognized as its origin and is believed to be amphipolyploids between *A. esculentus* ($2n = 130$ to 140) and *A. manihot* ($2n = 60$ to 68).

Potential of Okra: Potential for Enhancing Livelihoods

Okra has huge potential for enhancing livelihoods in urban and rural areas and to several stakeholders (Table 1) (NAP, 2006). It offers a possible route to prosperity for small-scale and large-scale producers alike and all those involved in the okra value chain, including women producers and traders. Okra is a popular health food due to its high fiber, vitamin C, and folate content. Okra is also known for being high in antioxidants. Okra is also a good source of calcium and potassium.

Nutritional Potential and Composition:

Okra bast, a multicellular fiber was analyzed and the estimated average chemical compositions of OBF (*Abelmoschus esculentus* variety) are 67.5 % a-cellulose, 15.4 % hemicelluloses, 7.1 % lignin, 3.4 % pectic matter, 3.9 % fatty and waxy matter and 2.7 % aqueous extract. It is clear that the main constituents of OBF are a-cellulose, hemicelluloses and lignin and the rest are very minor in proportion, so render a little influence to the structure of OBF. Therefore, the structure of a-cellulose, hemicelluloses and lignin and the mode of combinations that exist in between themselves are dominating the structure of OBF.

Okra Raw Nutrition Value per 100g.

33kcal	Carbohydrates 7.45 G (140 Kj)
Sugars 1.48 G	-Dietary Fibers 3.2 G
Fat 0.19g	Protein 2g
Water 90.19g	Vitamin A 36μg (7%)
Thiamine (B1) 0.2 Mg (17%)	Riboflavin (B2) 0.06mg (5%)
Niacin (B3) 1mg (7%0	Vitamin C 23mg (28%)
Vitamin E 0.27 Mg (2%)	Vitamin K 31.3 Mg (30%)
Calcium 82mg (8%)	Iron 0.62 Mg (5%)
Magnesium 57 Mg (16%)	Potassium 299mg (6%)
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Calcium 82mg (8%)	Iron 0.62 Mg (5%)
Magnesium 57 Mg (16%)	Potassium 299mg (6%)
Zinc	0.58 Mg (6%)

Percentages are related to US Recommendations to for Adults.

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Parts used: fruit, leave seed, root20.

However, fresh okra pods are the most important vegetable source of viscous fiber, an important dietary component to lower cholesterol (Kendall and Jenkins, 2004). Seven-days-old fresh okra pods have the highest concentration of nutrients (Agbo et al., 2008).

Seed as Potential Edible Oil and Flour Source

Like soybean oil, okra seed oil is rich (60 to 70%) in unsaturated fatty acids (Crossly and Hilditech, 1951; Savello et al., 1980; Rao, 1985). Seed protein is rich in tryptophan (94 mg/g N) and also contains adequate amounts of sulfur-containing amino acid (189 mg/g N) — a rare combination that makes okra seeds exceptionally useful in reducing human malnutrition (NAP, 2006). Okra seed protein with good protein efficiency ratio (PER) and net protein utilization (NPU) values is comparable to many cereals (except wheat) and its oil yield is comparable to most oil seed crops except oil palm and soybean (Rao, 1985). Moreover, okra seed oil has potential hypocholesterolemic effect (Rao et al., 1991).

The potential for wide cultivation of okra for edible oil as well as for cake is very high (Rao, 1985). Okra seed flour could also be used to fortify cereal flour (Adelakun et al., 2008). For example, supplementing maize ogi with okra meal increases protein, ash, oil and fiber content (Akingbala et al., 2003). Okra seed flour has been used to supplement corn flour for a very long time in countries like Egypt to make better quality dough (Taha el-Katib, 1947). However, long-term rodent/animal feeding trials would be pertinent before making final recommendations for wider consumption of okra seed flour.

Mucilage and its Potential

Okra mucilage refers to the thick and slimy substance found in fresh as well as dried pods. Mucilaginous substances are usually concentrated in the pod walls (not in seeds) and are chemically acidic polysaccharides associated with proteins and minerals (Woolfe et al., 1977). Although nature of the polysaccharides varies greatly, neutral sugars rhamnose, galactose and galacturonic acid have been reported often (Hirose *et al.,* 2004, Kumar *et al. 2009*; Sengkhamparn et al., 2009). The okra mucilage can be extracted as a viscous gum using various procedures. Such diversity in the extraction procedures seems to contribute to the observed variability in the mucilage chemical composition (Ndjouenkeu et al., 1996). Okra mucilage is a renewable and inexpensive source of biodegradable material. Its physical and chemical properties include high water solubility, plasticity, elasticity and viscosity (Be Miller et al., 1993).

Most physical and chemical properties are influenced by factors such as temperature, pH, sugar and salt contents, and storage time (Woolfe et al., 1977; Baht and Tharanathan, 1987). Okra mucilage has potential for use as food, non-food products, and medicine. Food applications include use as a whipping agent for reconstituted egg whites, as an additive in the formulation of flour-based adhesives, and as an additive in India for clarifying sugarcane juice. Non-food applications include brightening agents in electro deposition of metals, as a deflocculant in paper and fabric production, and as a protectant to reduce friction in pipe-flow (BeMiller et al., 1993; Ndjouenkeu et al., 1996). Polysaccharides can be combined with acrylamide to develop new biodegradable polymeric materials (Mishra et al., 2008). Potential of mucilage for medicinal applications includes uses as an extender of serum albumin (BeMiller et al., 1993), as tablet binder (Ofoefule et al., 2001) and as suspending agent in formulations (Kumar et al., 2009). Okra mucilage is used in Asian medicine as a protective food additive against irritating and inflammatory gastric diseases (Lengsfelf et al., 2004).

II. Conclusion

Okra (*Abelmoschus esculentus*) is the only vegetable crop of significance in the Malvaceae family and is very popular in the Indo-Pak subcontinent. In India, it ranks number one in its consumption it is an oligo purpose crop, but it is usually consumed for its green tender fruits as a vegetable in a variety of ways. These fruits are rich in vitamins, calcium, potassium and other mineral matters. The mature okra seed is a good source of oil and protein has been known to have superior nutritional quality. Okra seed oil is rich in unsaturated fatty acids such as linoleic acid, which is essential for human nutrition. Its mature fruit and stems contain crude fibre, which is used in the paper industry1. It is also having excellent anti-oxidant activity and memory enhancement activity.

Okra was previously included in the genus *Hibiscus*. Later, it was designated to *Abelmoschus*, which is distinguished from the genus *Hibiscus* by the characteristics. The variation in chromosome number in okra is due to origin of species in different geographical regions and spontaneous doubling of chromosomes and polyploidy breeding among those species led to the variation in chromosome number for okra.

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