



## Evidence of Polyploidy in Fluted Pumpkin (*Telfairia occidentalis* Hook F.)

M. I. Uguru<sup>1</sup> and J. C. Onovo<sup>2</sup>

<sup>1</sup>Department of Crop Science, University of Nigeria, Nsukka, Nigeria.

<sup>2</sup>Department of Biological Sciences, Nasarawa State University, Keffi, Nasarawa State, Nigeria.

E-mail: onovjos@yahoo.com

### ABSTRACT

Mitotic studies were carried out on fluted pumpkin (*Telfairia occidentalis* Hook. F.) lines collected from South East, South West, South South and North Central geopolitical zones of Nigeria where the crop is mainly cultivated. The results obtained revealed diploids ( $2n = 22$ ), aneuploids ( $2n = 22 + 1$ ), triploid ( $3n = 3x = 33$ ) and tetraploid ( $4n = 4x = 44$ ) chromosome numbers among the cells investigated. About 4% of the 123 cells investigated were aneuploids ( $2n = 22 + 1$ ), 1.2% were triploid ( $3n = 33$ ), 1.2%, tetraploid ( $4n = 44$ ). About 84% of the total cells investigated had  $2n = 22$ . The implications of these polyploidized conditions on the evolutionary trend of the Nigerian fluted pumpkin lines have been discussed.

**Key Words:** Aneuploid, chromosomes, evolutionary trend, landraces, tetraploid, triploid.

### INTRODUCTION

Polyploids do arise naturally, although many plant species are polyploidized by man through the creation of conditions, which disrupt mitosis and meiosis by preventing anaphase separation. AGARWAL and ROY [1] revealed that added advantage of polyploids in cucurbitaceae is their capacity to propagate vegetatively and a prolonged fruiting season, affecting uniformity of fruits, yield and availability of fruits during the off - season.

Polyploidy is an important source of evolutionary novelty in plant evolution and speciation [2]. It can lead to novel gene combinations or novel patterns of gene expression, which in turn provides the variation on which natural selection can act [3]. It has extensive effects on gene expression, with gene silencing accompanying polyploid formation and continuing over evolutionary time [4].

In recent years, studies have shown that polyploidy entails far more than the mere merger of two genomes, but instead significantly enhance gene expression, resulting in epigenetically induced gene silencing [5, 6]. This genomic amalgam results in novel phenotypes, including some with high expressions that would enhance selection [4]. In some plant species, polyploids have been associated with the production of larger plant parts (e.g. leaves, flowers, fruits and seeds) and specialized characteristics such as seedlessness [7]. Fluted pumpkin farmers prefer plants with broad succulent leaves as they attract higher premium in both rural and urban markets. The generation of polyploids with such potentials would be a virtue and would lead to increased yield and enhance rural income in Tropical West Africa.

This study was therefore undertaken to provide some information on the existing ploidy levels of the Nigerian fluted pumpkin landraces.

### MATERIALS AND METHODS

The study was initiated in the Laboratory of the Department of Crop Science, Faculty of Agriculture, University of Nigeria, Nsukka and completed in November, 2007 at the Cytogenetic Laboratory of the Department of Genetics, Faculty of Agriculture, Minia University, Egypt. Mitotic analysis of *Telfairia occidentalis* was carried out using the cold-induced method as an integral part of the conventional techniques. Tender root tips of germinating seeds extracted from fluted pumpkin pods collected from the South East (SE), South West (SW), South South (SS) and

North Central (NC) zones of Nigeria, were harvested (excised) at 11.00 am when mitotic activities are believed to be high [8], using sterilized forceps and scalpel. The root tips, nearly 1cm in length excised from the seeds were washed with distilled water and cooled at 4°C for 48 hours in a refrigerator.

The root tips were fixed with freshly prepared farmer solution (3 parts ethyl alcohol : 1 part glacial acetic acid) for 24 hours and stored in 70% ethanol. Prior to staining, the root tips were hydrolyzed in 18% HCl for 10 minutes at 60°C and rinsed in distilled water. The meristematic regions were squashed and stained in 1% acetoorcein. Observations were made on the nuclei at the mitotic metaphase and screened for the existence of polyploidy among the fluted pumpkin lines from the four geopolitical zones of Nigeria. The slides were examined under a compound microscope. The slides with well spread metaphase were photographed at x 1000 using an Olympus, BX 51 model of photomicroscope equipped with Olympus C 4040 digital camera.

## RESULTS AND DISCUSSION

The locations from which the materials for the mitotic study were collected are presented in Table 1. These are the areas where fluted pumpkin is popular and commonly cultivated for domestic and industrial uses.

**Table 1. Locations where the fluted pumpkin lines were collected**

Line	State / Town	Ecological Zone	Geographical Zone	Location
SE-01	Enugu State/ Nsukka	Derived guinea savannah	South East	Lat.06 <sup>0</sup> 52 <sup>1</sup> , Long. 07 <sup>0</sup> 24 <sup>1</sup> E
SW-02	Oyo/Ibadan	Sub humid Savannah	South West	Lat.07 <sup>0</sup> 26 <sup>1</sup> , Long. 03 <sup>0</sup> 26 <sup>1</sup> E
SS-03	Rivers/ Portharcourt	Mangrove Vegetation	South South	Lat.04 <sup>0</sup> 40 <sup>1</sup> , Long. 07 <sup>0</sup> 10 <sup>1</sup> E
NC-04	Nasarawa/Keffi	Guinea savannah	North Central	Lat.08 <sup>0</sup> 50 <sup>1</sup> , Long. 07 <sup>0</sup> 52 <sup>1</sup> E

SE- South East, SW- South West, SS- South South, NC- North Central.

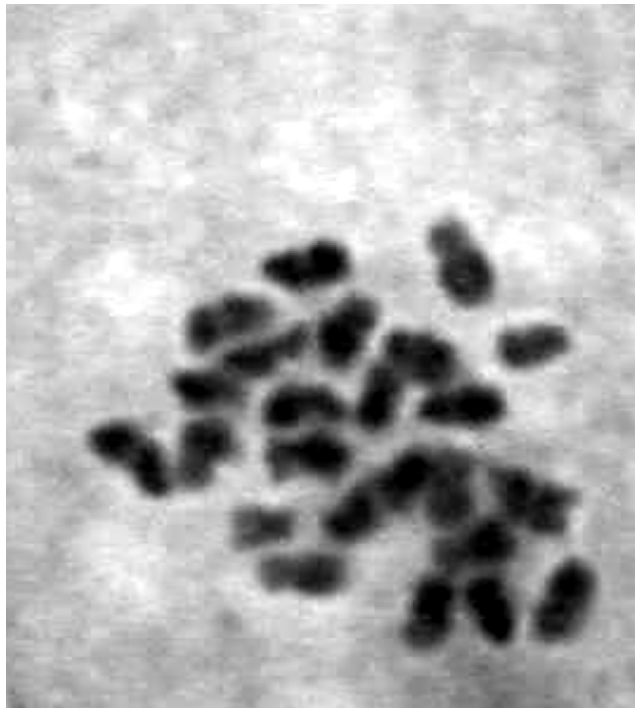


Plate 1. Mitotic Metaphase Chromosomes Showing the Diploid ( $2n = 22$ ) Chromosome Number

The in-depth analysis of the mitotic metaphase of fluted pumpkin revealed different conditions of the cells. Mitotic chromosome number of  $2n = 22$  (Plate 1) was observed in about 84% of the 123 cells investigated. About 4% of the cells were aneuploids,  $2n = 22 + 1$  (Plate 2); 1.2% were triploids (Plate 3) and 1.2%, tetraploid (Plate 4). These observations constitute *prima facie* evidence for polyploidized lines of fluted pumpkin among the existing landraces in Nigeria thereby showing that the karyotypes are not as fully constant as have been postulated [9]. Most of the landraces are diploid, with polyploids as rare exceptions. Because of its extremely low occurrence, polyploids cannot adequately account for the large variability among the landraces. Earlier reports (Nath and Denton [10]; Schippers [11]) also implicated large genetic variations of fluted pumpkin in terms of pod size and colour of petiole, seed coat and cotyledon in Nigeria. The large variations in chromosome size and



Plate 2. Mitotic Metaphase Chromosomes of *T. occidentalis* Showing Aneuploidy ( $2n = 22 + 1$ ) in the three cells, A, B and C. Chromosome Number.

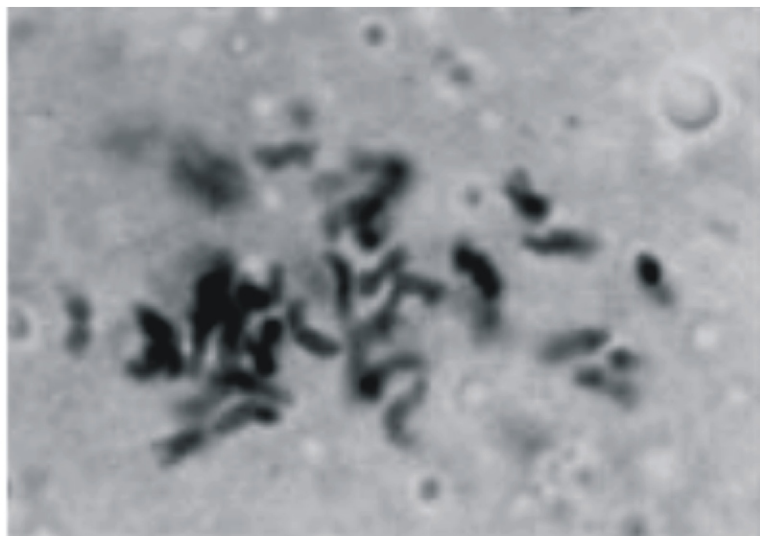


Plate 3. Mitotic Metaphase Chromosomes Showing Triploid ( $3n = 33$ ) Chromosome Number.

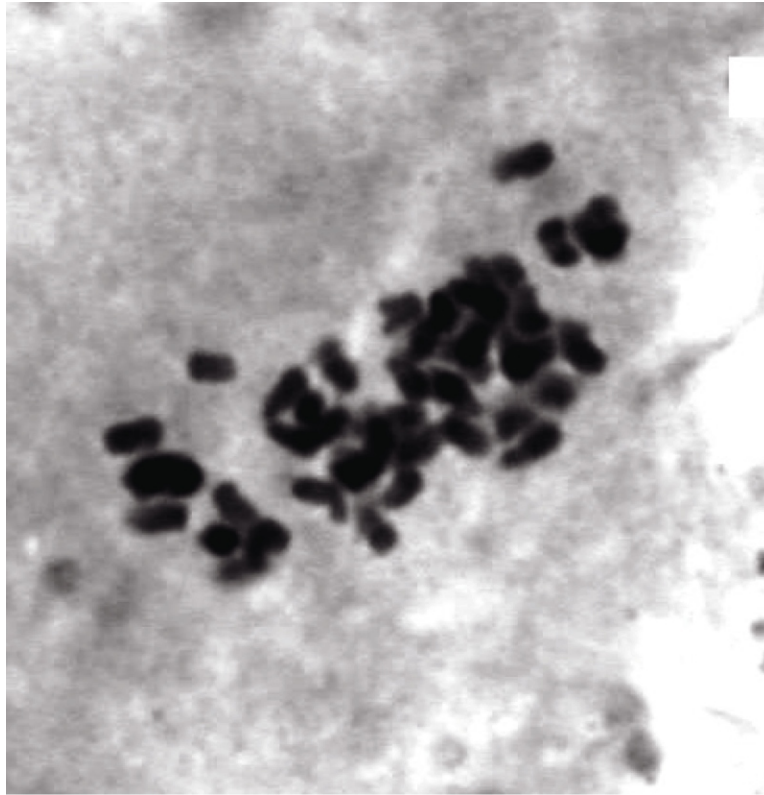


Plate 4. Mitotic Metaphase Chromosomes Showing Tetraploid ( $4n = 44$ ) Chromosome Number.

structure may provide an elegant explanation for the large variability and may have also played an important role in the evolution of *Telfairia* species. Polyploidization has also been reported in other members of the Cucurbitaceae family [12].

The variation in ploidy level in fluted pumpkin would appear to suggest some form of ploidy switching from one form of ploidy level to the other with the diploid stage more prominently emphasized over the others among the aboriginal landraces. The extremely low percentage of the higher ploidy levels may be providing some information about the likely progenitor of the cultivated fluted pumpkin which may have arisen from extensive genomic rearrangement in the course of evolution. Many polyploids experience extensive and rapid genomic alterations, some arising with the onset of polyploidy [4].

Several authors have implicated tropical Africa, as the centre of origin of fluted pumpkin [13, 14, 15, 16]. Traces of the crop were reported in the semi-temperate region but these were killed by frost [17, 18]), thus affirming its tropical origin.

#### ACKNOWLEDGMENTS

The authors wish to thank Prof. Abdel Tawab M. Ata of the Department of Genetics, Faculty of Agriculture, Minia University, Egypt for availing us his expertise in cytogenetics and photomicrography.

#### REFERENCES

- [1] Agarwal, P. K., and Roy, R. P. (1976). Natural Polyploids in Cucurbitaceae. *Cytogenetical Studies in Triploid *Momordica dioica* Roxb. *Caryologia*, (29): 7-13.*
- [2] Mable, B. K. (2004). 'Why polyploidy is rarer in animals than in plants': myths and mechanisms. *Biological Journal of Linnean Society*. **82** (4): 453-466.
- [3] Darren, J. O., Stephen, A.H., Richard, J.A.B. John, R. P. (2006). Hybridization, Polyploidy, and the Evolution of Sexual

- Systems in *Mercurialis* (Euphorbiaceae). *Evolution*. **60**(9):1801-1815.
- [4] Adams, K. L. and Wendel, J. F. (2005). Polyploidy and Genome Evolution in Plants. *Curr Opin Plant Biol.*, **8**(2): 135-141.
- [5] Osborn, T. C., Pires, J. C., Birchler, J. A., Augler, D. L., Chen, Z. J., Lee H. S, Comal, L, Madlung A, Doerge, R.W AND Colot, V (2003). Understanding mechanisms of novel gene expression in polyploids. *Trends Genet.*, **19**:141-147.
- [6] Liu B, and Wendel, J. F. (2003). Epigenetic Phenomena and the Evolution of Pant Allopolyploids. *Mol Phylogenet Evol.*, **29**:365-379.
- [7] Uguru, M. I. (1998). Crop Genetics and Breeding. Ephrata Press. 113pp.
- [8] Jackson, R. C. (1962). Interspecific hybridization in Haplopappus and its bearing on chromosomes evolution in the Blepharodon Section. *American Journal of Botany* **49** (2): 119-132.
- [9] Okoli, B. E. and Mgbeogwu, C. M. (1983): Fluted Pumpkin *Telfairia occidentalis*, West African Vegetable Crops. *Economic Botany* **3**(2): 145-149.
- [10] Nath, P. and Denton, L. (1979). Germplasm Collection in Common Vegetable Crops in Nigeria. Tech. Communication. No. 15 NIHORT, Ibadan. p 103.
- [11] Schippers, R. R. (2000). African indigenous Vegetables. An overview of cultivated species. Chatham, U.K. 214pp.
- [12] Dutt, B., and Roy, R. P., (1969). Cytogenetic Studies in the Interspecific Hybrid of *Luffa cylindrical* L. and *L. graveolens* Roxb. *Genetica*, **40**: 7-18.
- [13] Synge, P. M. (1974). Dictionary of Gardening. Royal Horticultural Society. Vol.IV: PT-2Y. Oxford Press. London. pp. 2087.
- [14] Oyolu, C. (1978). Relatively Unknown Vegetables Fluted Pumpkin (*Telfairia occidentalis*). *Acta Horticulturae* **123**: 105-109.
- [15] Martin, F. W. and Ruth, R. M. (1979). Edible Leaves of Tropics. 2<sup>nd</sup> Edition. Agric. Research Southern Region Science and Education Administration, U.S.D.A. pp. 31-32.
- [16] Esiaba, R. O. (1982). Cultivating the Fluted Pumpkin in Nigeria. *World Crops*, March/April. 70-72.
- [17] Purseglove, J. W. (1984). Tropical Crops. Dicotyledons. Volumes 1 and 2. English Language Book Society and Longman, London. p 100.
- [18] Cobley, L. S. and Steele, W. M. (1976). Bambara Groundnut (*Voandzeia subterranean*) in: An Introduction to the Botany of Tropical Crops. 2<sup>nd</sup> edition, London, English Language Book Society and Longmans. pp 131-134.