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KARYOTYPIC STUDIES OF FOUR *PHYSALIS* SPECIES FROM NIGERIA

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Mitotic chromosomes from root tips of four Nigerian *Physalis* species were investigated using standard cytogenetic methods. *P. angulata* has chromosome number of 2n = 48 with karyotypic formula of 2M + 5m + 16sm + 1st, while *P. micrantha*, *P. peruviana* and *P. pubescens* showed the same chromosome number of 2n = 24 with karyotypic formulae of 1M + 1m + 9sm + 1st, 4M + 6m + 1sm + 1st and 1M + 1 m + 2sm + 8st, respectively. The karyotypes show that *P. angulata* is more advanced when compared to the other three diploids studied.

Key words: chromosome, diploid, karyotype, *Physalis*, tetraploid

INTRODUCTION

The genus *Physalis* (Solanaceae), which consists of about 100 species (El-Sheikha *et al.* 2009, Sultana *et al.* 2008) was divided into nine sections: Pubescentes, Angulatae, Philadelphicae, Carpenterianae, Lanceolatae, Heterophyllae, Viscosae, Crassifoliae and Megista (Menzel 1951). *Physalis* is found both in temperate and tropical America and a few species were discovered in East Asia, India, Australia, Europe and tropical Africa (Menzel 1951). The generic borders are identified by the pendant flowers and inflated fruiting calyx, which contains the berry (Sullivan 1984). Four species were identified in West Africa, as well as Nigeria (Hutchinson and Dalziel 1963, Olatunji 1985). They are *P. angulata* L., *P. peruviana* L., *P. micrantha* Link and *P. pubescens* L.

The basic number for this genus is x = 12 with the exception of *P. lobuta* which has x = 11. The chromosome numbers, 2n = 24 and 2n = 48 have been reported for *P. angulata* and *P. peruviana*, while 2n = 24 was recorded for *P. micrantha* and *P. pubescens* (Burkill 2000, Husaini and Iwo 1990, Martinez 1998, Menzel 1951, Olorode *et al.* 2013, Rodríguez and Bueno 2006, Wahua and Sam 2013). However, there is no record of known work on karyotypic studies on the *Physalis* species in Nigeria. This study investigated mitotic chromosomes of these four *Physalis* species in order to elucidate the karyotypic variation among the species with respect to their karyotype.

MATERIALS AND METHODS

The four Nigerian *Physalis* species studied were collected from different locations in Nigeria. *P. peruviana*, *P. angulata* and *P. pubescens* were collected from Ile-Ife (7º 35′ 25.84″ N, 4º 44′ 00.81″ E) and *P. micrantha* was collected from Ogbomosho (8º 08′ 00.00″ N, 4º 15′ 00.00″ E). Voucher specimens of each species were deposited at IFE herbarium, Obafemi Awolowo University, Ile-Ife, Nigeria.

Mitotic chromosomes were studied from the harvested root tips of seedlings using squash method according to Lasebikan and Olorode (1972). The root tips were also harvested between 9.00 am and 12.00 pm. The harvested root tips were pre-treated in 0.002 M 8-hydroquinoline for 2 hours and then fixed in 1:3 acetic acid: ethanol. The root tips for examination were hydrolysed in 18% HCl for 30 minutes, squashed and stained in FLP-orcein. The photomicrographs of good mitotic chromosome spreads were taken with an Amscope MT microscope Camera version 3.0.0.1 attached to a light microscope.

The chromosomes were paired by physical analysis of chromosomes based on arm length ratio as described by Torres and Liogier (1970). The arm ratio was calculated from the ratio of long arm length to short arm length, while the centromeric index was determined from the ratio of short arm to addition of short arm and long arm. The chromosome types, as well as the centromeric position were determined according to the method of Jiang *et al.* (2011). The chromosome complements were further classified according to Stebbins (1971). The karyotype asymmetry was determined based on variation in chromosome length and proportion of arm ratio (i.e. centromere position of chromosome pairs) greater than 2.

RESULTS

Physalis angulata chromosomes (n = 24) showed that the chromosome pairs were mostly submetacentric with 16 pairs being submetacentric chromosomes out of 24 pairs (Table 1). The mean chromosome length of *P. angulata* ranged between 0.99 and 1.71 μm. The average centromeric index was 34.07%. The ratio of the longest to shortest chromosome was 1.73, while the proportion of chromosomes with arm ratio > 2 was 0.38, thereby placing the karyotype of *P. angulata* in 2A Stebbins category. The karyotypic formula for *P. angulata* was 2M + 5m + 16sm + 1st.

The centromeric position of the chromosome pairs of *P. pubescens* was mostly in the subtelocentric region and terminal point. The mean chromosome length ranged between 1.89 and 1.26 μm. All the chromosome pairs were either medium, long or medium short chromosomes (Table 1). The average centromeric index was 43.18%. The longest : shortest chromosome length

Table 1
Summary of karyomorphological features of the four *Physalis* species studied

Species	Mean total chromosome length	Centromeric index (%)	Karyotypic formula	Stebbin's category
P. angulata (n = 24)	31.81±0.02	34.07	2M + 5m + 16sm + 1st	2A
P. pubescens (n = 12)	18.68±0.09	43.18	1M + 1m + 2sm + 8st	3A
P. micrantha (n = 12)	24.98±0.14	35.21	1M + 1m + 9sm + 1st	2A
P. peruviana (n= 12)	17.43±0.17	42.77	1M + 1m + 9sm + 1st	2B

ratio was 1.5. The proportion of chromosome length arm ratio > 2 was 0.83. This made the karyotype to be in the 3A Stebbins category. The karyotypic formula was 1M + 1m + 2sm + 8st.

In *P. micrantha* (n = 12), the mean chromosome length ranged between 1.53 μm and 2.52 μm. The chromosome pairs were mostly submetacentric and the chromosome type fell between medium, short and medium, long chromosomes, except chromosome 12 which was short (Table 1). The mean centromeric index was 35.21%. The longest/shortest chromosome ratio was 1.65. The chromosome pair proportion > 2 was 0.5. This made the karyotype to be in 2A Stebbins category. The karyotypic formula of *P. micrantha* chromosome pairs was 1M + 1m + 9 sm + 1st.

The chromosome length in *P. peruviana* was between 0.90 and 1.98 μm. The centromeric position in these chromosome pairs were mostly in the median region and at the median position (Table 1). About 50% of the chromosome pairs were medium, long chromosomes. The mean centromeric index was 42.77%. The proportion of chromosome arm ratio greater than 2 was 0.08. The longest : shortest chromosome length ratio was 2.2. This placed the karyotype in the 2B Stebbins category. The karyotypic formula was 4M + 6m + 1sm + 1st.

DISCUSSIONS AND CONCLUSION

The average centromeric index of the chromosome pairs of the four *Physalis* species studied was between 34.07–43.18%. The predominance of submetacentric and metacentric chromosomes observed in *P. angulata* is in agreement with the report of Menzel (1951). The centromeric index calculated for *P. angulata* in this study was 34.07%, while Menzel (1951) reported between 34 and 38% for the section Angulatae, where *P. angulata* belongs to. *Physalis pubescens* and *P. lagascae* (which was reported as synonymy of *P. micrantha* by Raju *et al.* 2007) belong to the section Pubescentes, which has the centromeric index of 27–29%. The chromosome complements were mainly subterminal as

observed by Menzel (1951). However, only one chromosome pair was found to have its centromere at the subterminal region in *P. micrantha* as compared to 8 pairs in *P. pubescens*.

Physalis peruviana belongs to the section Heterophyllae. A centromeric index of 37% was reported for the section (Menzel 1951). In this study, the centromeric index calculated for *P. peruviana* was 42.77%. Ten chromosome pairs had their centromeres at median points and median regions. The other 2 pairs were submetacentric and subterminal chromosomes. In Menzel (1951) reports (with n = 24), 16 pairs were metacentric and submetacentric chromosomes, while 8 pairs were subterminal chromosomes.

Out of the four *Physalis* species studied, only *P. angulata* is tetraploid. El-Nahas *et al.* (2000) stated that the presence of polyploidy in a certain taxon is an evidence of advancement. It is therefore hypothesised that *P. angulata* is the most advanced among the four *Physalis* species studied. The advancement of *P. angulata* over the other three species can explain its wider latitudinal range of distribution, as well as its large population reported by Olorode *et al.* (2013) as a result of its larger genome when compared to the rest. In ancient and primordial plants, symmetric karyotype was found to be predominant, while the asymmetric karyotype was mostly seen in the recent and specialised plants (Jiang *et al.* 2011). Therefore, asymmetric karyotypes are more advanced compared to symmetrical ones (Malik and Srivastava 2009). Symmetric karyotypes were reported by Laura *et al.* (2010) for *Lycium* species, which were mostly metacentric chromosomes with slight differences in size. This work suggested that *P. pubescens* is the most recent of the three diploid species followed by *P. micrantha*, while *P. peruviana* is the most primitive as evident by the presence of the highest number of metacentric chromosomes. This submission is in line with the report of Menzel (1951), who stated that section Pubescentes and Angulatae are more advanced than Heterophyllae.

It can therefore be concluded that *P. angulata* is the most advanced among the species studied, while *P. peruviana* is the most primitive.

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