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CYTOLOGICAL STUDIES OF TOMATO (*Solanum lycopersicum* L.) CULTIVARS IN LAFIA, NASARAWA STATE, NIGERIA

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ABSTRACT
The study was carried out to investigate the cytological relatedness of five different tomato cultivars. Ten (10) seeds from each tomato lines were grown at room temperature in Petri dishes. The germinated Root tips were collected and treated using 0.04 8-hydroxyl quinolone for 2 h. Then, the root tips were fixed using 3:1 (v/v) ratio of alcohol: glacial acetic acid for 24 h. The root tips were hydrolyzed in 1.0 N HCl for 20 min at room temperature. These root tips were placed on slides, stained using 2% aceto-orcein stain and then mounted on Olympus CX40 microscope at X100 mg. Photomicrographs were taken. Karyotype analyses were carried out using Karyotype software, and the ideograms were drawn. Different karyotype parameters were measured and mentioned. The result revealed that the chromosomes number of all the genotypes were the same (2n=24) except for cirea with 2n=26 number of chromosomes. The highest total form index (TF %), symmetricindex (Syi) and the lowest karyotype asymmetric index (ASK), Mona f1 is the most symmetric while boomerang f1 is the most asymmetric. Further studies can be carryout on cirea cultivar to ascertain the variability caused of 2n = 26. It's also recommended that hybridization should be carryout between cirea cultivar and other cultivars having 2n =24 for future genetic improvement.

Keywords: Cultivars, chromosome, cytological, grown, tomato

INTRODUCTION
Tomato (*Solanum lycopersicum* L.) is one of the most important and popular fruit vegetable in the world (Hamid *et al*., 2020). It is a self-pollinated annual crop and belongs to the family *Solanaceae* with chromosome number 2n = 2x = 24 (Peralta *et al*., 2008). The phylogenetic classification of the family *Solanaceae* has recently revised and the genus *Lycopersicon* reintegrated into the genus *Solanum* with its new nomenclature (Peralta *et al*., 2008). As a result, the genus *Solanum* is integrated with the clade Lycopersicon. The clade Lycopersicon contains the domesticated tomato *Solanum lycopersicum* L. and its 12 closest wild relatives (Peralta *et al*., 2008). An estimated arable area of about 300,000 hectares is used for tomato cultivation in tropical Africa with an estimated annual production of 2.3 million tonnes; Nigeria happens to be the largest producer accounting for 541,800 ha and an annual production of 2,143,500 tonnes and ranks 14th in the world in production and 3rd in terms of hectares for cultivation. Despite the high demand of tomatoes in Nigeria there is little information about the morphological and cytological variability that exist about the accession used for study. The aim of this study was to investigate the morphological and cytological characterization of some tomato cultivars for crop improvement programmes. The study is aimed at evaluate tomato (*Solanum lycopersicum* L.) cultivars based on their cytological characteristics.

MATERIALS AND METHODS
Five (5) tomato cultivars were used for this research. Four (4) cultivars were obtained from Technisem while the fifth cultivar was obtained from Nasarawa Agricultural Development Programme (NADP), Lafia, Nasarawa State. The cultivars were: Mona F1, Topaze, Riogrande, Boomerang F1, and Cirea which was obtained from Lafia open market.

Cytological study procedures
Ten (10) seeds from each of the tomato were grown at room temperature in Petri dishes. Root tips were collected and treated with 0.04 8-hydroxyl quinolone for 2 hours. Then, the root tips were fixed in a 3:1 (v/v) ratio of alcohol to glacial acetic acid for 24 hours. The root tips were then hydrolyzed in 1.0 N HCl for 20 minutes at room temperature. These root tips were placed on slides, stained using 2% aceto-orceinstain and then mounted on Olympus CX40 microscope at X100 mg. Photomicrographs were taken. Karyotype analyses were carried out using Karyotype software, and ideograms were drawn. Different karyotype parameters were measured.

RESULTS AND DISCUSSION
The results presented in Table 1, revealed that all the cultivars were characterized by the chromosome number 2n= 24 except for the cultivar cirea which has the chromosome number 2n= 26. Karyotype formula nearly metacentric (nm) and metacentric (m) was observed in all the cultivars whereas karyotype formula

nearly submetacentric (nsm) was found in Topaze, Boomerang F1 and Cirea only. The highest values for the coefficient of variation of centromeric index (CVCI), mean centromeric asymmetry (MCA), Karyotype asymmetry index (ASK%), intrachromosomal asymmetry index (A1), interchromosomal asymmetry index (A2), and asymmetry index (AI) parameters were recorded in the Boomerang F1 cultivar, being 14.76, 16.75, 58.05%, 0.27, 0.17, and 2.56, respectively. In contrast, the lowest values of these parameters were present in the Mona F1 cultivar, at 6.19, 8.87, 54.44%, 0.16, 0.09, and 1.15, respectively. On the other hand, the total form percentage (TF %) and symmetry index (Syi) were found to have the highest values, at 45.56% and 83.69%, respectively, in the Mona F1 cultivar. TF% and Syi had the lowest values in the Boomerang F1 cultivar, at 41.95% and 72.25%, respectively, as shown in Table 1.

Table 1: Different karyotype parameters for five tomato cultivars

Cultivars	Chro No. (2n)	THL (µm)	CVCI	CVCL	MCA	ASK (%)	TF (%)	Syi Index (%)	Rec Index (%)	A1	A2	A	DI	AI	Stebb	KF
MonaF1	24	375.22	6.19	18.52	8.87	54.44	45.56	83.69	65.74	0.16	0.19	0.09	8.43	1.15	1B	18nm+6m
Topaze	24	393.11	10.37	16.28	13.51	56.96	43.04	75.55	72.92	0.23	0.16	0.14	6.85	1.69	1 A	6nsm(-)+ 14nm+4m
Riogrande+	24	323.08	6.38	22.22	13.16	56.48	43.52	77.04	64.99	0.23	0.22	0.13	10.04	1.42	1B	22nm+ 2m
Boomerang F1	24	452.75	14.76	17.31	16.75	58.05	41.95	72.25	69.59	0.27	0.17	0.17	7.56	2.56	2 B	4nsm(-)+ 18nm+2m
Cirea	26	464.48	9.77	22.49	12.81	56.54	43.46	76.88	63.61	0.22	0.22	0.13	9.79	2.20	2 B	2nsm(-) + 18nm+ 6nm

Chor No.: Chromosome number; THL: Total haploid chromosome length; CVCI: Coefficient of variation of centromeric index; CVCL: Coefficient of variation of chromosome length; MCA: Mean centromeric asymmetry; ASK: Karyotype asymmetry index; TF%: Total form percentage; Syi: Symmetry index; Rec index: Resemblance between chromosomes; A1: Intrachromosomal asymmetry index; A2: Interchromosomal asymmetry index; AI: Asymmetry index; Stebb: Stebbins classification; KF: Karyotype formula

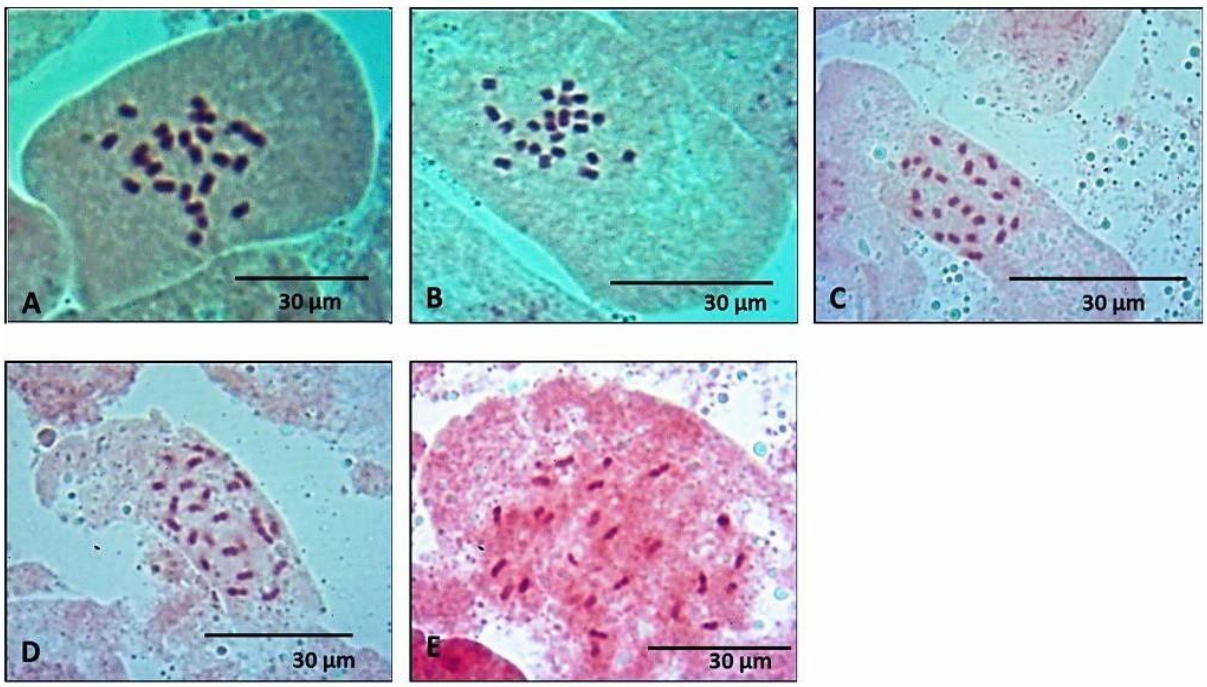

Plate 1: Photomicrographs of chromosomes of the various cultivars studied

According to the highest TF% and Syi value and the lowest ASK value, Mona F1 is the most symmetrical, and Boomerang F1 is the most asymmetrical. According to A1 and A, the Mona F1 germplasm was the most primitive, and Boomerang F1 was the most advanced. A higher value of A1 points to a higher level of asymmetry (Murat *et al*., 2015). The result also shows that the chromosome number of all tomato lines were 2n = 24, except for the Cirea cultivar, in which the number was 2n = 26, as shown in Plate 1. Ideograms of haploid chromosome numbers for the five studied cultivars are illustrated in Plate 1. Different karyotype parameters were presented in Table 1. Karyotype formulas nearly metacentric (nm) and metacentric (m) were recorded in all five cultivar, whereas karyotype formula nearly submetacentric nsm (-) was found in

Topaze, Boomerang F1 and Cirea cultivars. The highest values for the coefficient of variation of centromeric index (CVCI), mean centromeric asymmetry (MCA), the Karyotype asymmetry index (ASK%), intrachromosomal asymmetry index (A1), interchromosomal asymmetry index (A2), and asymmetry index (AI) parameters were recorded in the Boomerang F1 cultivar, being 14.76, 16.75, 58.05%, 0.27, 0.17, and 2.56, respectively. In contrast, the lowest values of these parameters were present in the Mona F1 cultivar, at 6.19, 8.87, 54.44%, 0.16, 0.09, and 1.15, respectively.

On the other hand, the total form percentage (TF %) and symmetry index (Syi) were found to have the highest values, at 45.56% and 83.69%, respectively, in the Mona F1 cultivar. TF% and Syi had the lowest values in the Boomerang F1 cultivar, at 41.95% and 72.25%, respectively, as shown in Table 1. The chromosome number of studied cultivars was 2n = 24, except for the Cirea cultivar in which the number was 2n = 26, which is in agreement with the results found by Banks (1984) and Badr *et al*. (1997) who recorded the basic number of Solanaceae as x = 7, 9, 12, 14. The difference in chromosome number or chromosome formula was associated with morphological variation, as Cirea varied from the other cultivar in several characteristics, such as leaves, plant height, and leaf area. The main karyotype formulas of studied tomato cultivars were nearly metacentric nm, and nearly submetacentric nsm(-), which was in accordance with the results reported by Moscone *et al*. (2007) who reported that the majority of chromosomes in Solanaceae are m or sm. The evolution of a plant, associated with variation of karyotype parameters, is estimated using different indices of symmetry. Rec and Syi indices vary from 0 to 100 (Fonsêca *et al*., 2013), and TF % vary from 0 to 50 (Zuo *et al*., 2011). According to the highest TF and Syi value and the lowest ASK value, Mona F1 was the most symmetrical, and Boomerang F1 was the most asymmetrical. According to A1 and A, the Mona F1 gerplasm was the most primitive, and Boomerang F1 was the most advanced. A higher value of A1 points to a higher level of asymmetry (Murat *et al*., 2015).

CONCLUSION

In conclusion, highest values for the coefficient of variation of centromeric index (CVCI), mean centromeric asymmetry (MCA), the Karyotype asymmetry index (ASK %), intrachromosomal asymmetry index (A1), interchromosomal asymmetry index (A2), and asymmetry index (AI) parameters. Higher values were recorded in the Boomerang F1 cultivar. In contrast, the lowest values of these parameters were present in the Mona F1 cultivar. On the other hand, the total form percentage (TF %) and symmetry index (Syi) were found to have the highest values, in the Mona F1 cultivar. TF% and Syi had the lowest values in the Boomerang F1 cultivar. The chromosome number of studied cultivars was 2n = 24, except for the Cirea cultivar in which the number was 2n = 26.

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