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INTRASPECIFIC REPRODUCTIVE VARIABILITIES IN *CAPSICUM FRUTESCENS* (L.) IN NIGERIA

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ABSTRACT

Natural intraspecific and interspecific crosses among *Capsicum* species are very high, resulting in intermediary forms which are complex to categorize. It is likely that through these crosses, new species or varieties may have arisen. The present study evaluated intraspecific reproductive variablities among eight accessions of *C. fructesens*. Each accession was planted in 10-litre plastic buckets arranged in single lines of inter- and intra-row (70 cm x 50 cm) and filled with loamy soil in five replicates at the Department of Pure and Applied Botany Screen House, Federal University of Agriculture, Abeokuta (Latitude 7°9'N, longitude 30°21'E), Nigeria. Quantitative and qualitative reproductive characters were evaluated through measurements and visual observation, respectively. Means were separated using the Duncan's Multiple Range Test at $p < 0.05$ (Statistical Analysis Systems version 9.2). The wide variation in the flower position, corolla colour, corolla spot colour, anthocyanin spots, fruit colour at intermediate and maturity, fruit set, days to flowering and fruiting, number of seeds per fruit and locules between AS002 and other accessions revealed that AS002 was significantly different. The study, therefore, suggests AS002 to be a new species in Nigeria, suspected to be *C. baccatum*, and also the best among the accessions for breeding purposes.

Key words: *C. frutescens*, accessions, reproductive characters, new species

INTRODUCTION

Pepper (*Capsicum* L.) is a highly nutritional and medicinal crop in the family Solanaceae. It originated from South and Central America from where its cultivation spread throughout the world (Pickersgill, 1997; Costa *et al.*, 2009). The genus consists of 40 species with approximately 35 wild species and 5 domesticated species. The five domesticated species are *C. annuum, C. frutescens, C. chinesse, C. pubescens* and *C. baccatum* (Andrews, 1984). The total production of pepper in Nigeria was estimated to be 749,000 metric tons in 2017 (FAOSTAT, 2017).

In Nigeria, the crop is grown in home gardens by peasant farmers and on a large scale by commercial farmers. Nigeria is known to be one of the major producers of pepper in the world and was ranked 7th position in 2017 (FAOSTAT, 2017). Pepper fruits contain antioxidant compounds which prevent cardiovascular diseases, asthma, sore throat, headache and diabetes (Nadeem *et al*., 2011). It can also be used medically for treatment of fevers and colds (Norman, 1992). Bell pepper, being a very rich source of vitamins A, C, B6, folic acid and beta-carotene, provides excellent nutrition for humans (Nadeem *et al*., 2011).

Capsicum species are predominantly perennial shrubs, although several species also display biennial herbaceous growth habit, particularly those of the *Capsicum annuum* complex (*C.annuum, C. frutescens* and *C. chinesse*) (Walsh and Hoot, 2001).The inflorescences vary from solitary to seven flowers at one node while the sepals may range from truncate to spine-like projections (Berke, 2000). The pedicel length varies among cultivars, ranging from 3-8 cm (Berke, 2000). *Capsicum frutescens* is sometimes distinguished as a separate species from *C. annuum*, but many botanists consider the two to be conspecific (Bosland and Vostava, 2000).

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Although a self-pollinated crop, pepper has been considered as a cross-pollinated crop as a result of its high rate of out-crossing which ranges from seven to ninety per cent. Natural intraspecific and interspecific crosses among *Capsicum* species are very high, resulting in intermediary forms which are complex to categorize. Due to the difficulties in identifying intermediary forms resulting from natural crosses, the two domesticated species reported in Nigeria (*C. annuum* and *C. frutescens*) are sometimes treated as one species (*C. annuum*) with four cultivars (Falusi, 2006). Falusi (2006) identified the four cultivated varieties of *C. annuum* in Nigeria as *C. annuum* var. *grossum* L. Sendt. (Tatashe), *C. annuum* var. *abbreviatum* Fingerh (Ata-rodo), *C. annuum* var. *accuminatum* Fingerh (Ata- Sombo) and *C. frutescens* var. *maximum* (Ata-wewe).

Furthermore, considering different types of pepper available nowadays in Nigerian markets and from local farmers, it is likely that through anthropogenic influences and long separation from the wild species, new species or varieties may have arisen displaying useful plant adaptations and desirable fruit traits. This gives a suspicions that additional species or varieties that have not been reported may be among the populations of pepper in Nigeria. The assumption has been made by Grubben and Denton (2014) that many pepper varieties exist, but few are formally known and commercially exploited while many others remain as un-stabilized landraces showing inconsistent fruit quality traits and yield.

Characterization is the only means by which plants can be differentiated and classified based on their physical appearance (Smith and Smith, 1989). Even though morphological characterization is important in variety identification, its application is influenced by prevailing environmental factors and, as such, make its use limited (Gepts, 1993; Geleta *et al*., 2005). Despite the limitations of the morphological traits in species identification because of the environmental interference, reproductive characters have been extensively used in the taxonomy of many plant families in species identification and classification. This is because reproductive characters are usually believed not to be under the considerable influence of the environment (Del *et al*., 2007). Therefore, observed qualitative and measured quantitative variations in reproductive characters could be assumed to have genetic basis and thus considered for classifying accessions into species. This assertion was premised on the reports made in earlier studies in Guajillo pepper by Del *et al*. (2007). They grouped accessions of Guajillo pepper into species based on qualitative and quantitative reproductive characters. In addition, reproductive characterization would provide useful scientific information for genetic improvement of the genus.

In this study, the application of qualitative and quantitative reproductive characters were used to evaluate the intraspecific variabilities among *C. fructesens* accessions. The study focused on characterizing some accessions of *C. frutescens* using reproductive characters with a view to drawing taxonomic conclusions based on the intraspecific variabilities.

MATERIALS AND METHODS

Eight accessions of *C. frutescens* were collected from rural farmers in the pepper-growing areas in Nigeria. The experiment was conducted in the screen house (Latitude 7°9'N and longitude 30°21'E) of the Department of Pure and Applied Botany, Federal University of Agriculture, Abeokuta, Ogun State, Nigeria.

Seedlings were raised in the Nursery for 5 weeks before transplanting into the screen house. After establishment, ten (10) healthy seedlings of each of the accessions were randomly selected and thereafter transplanted into well arranged 10-litre plastic buckets filled with loamy soil, riversand and organic manure in single lines of inter- and intra-row spacing of 70 cm x 50 cm in five replicates.

Qualitative Reproductive characters

The qualitative reproductive characters were visually observed at plant maturity. The International Plant Genetic Resources Institute (IPGRI, 1995) descriptors for *Capsicum* were used to evaluate the accessions on the following characters: flower position, corolla colour, corolla spot colour, corolla shape, filament colour, anther colour, calyx pigmentation, calyx margin, calyx annular constriction, fruit shape at pedicel attachment, anthocyanin spots, fruit colour at intermediate stage, fruit colour at mature stage, fruit shape, neck at base of fruit, fruit shape at blossom end, fruit cross-sectional corrugated, fruit surface, seed colour and seed surface. Visual observation of the transverse section of the fruit was carried out for the following characters: locule, placentation and hollow camber.

Quantitative characters

The quantitative reproductive characters were measured at plant maturity. The International Plant Genetic Resources Institute (IPGRI, 1995) descriptors for *Capsicum* were used to evaluate the accessions on the following characters: days to first flowering, days to 50% flowering, number of flowers per axil, anther length, days to first fruiting, days to 50% fruiting, fruit set, fruit length, fruit width, fruit weight, fruit pedicel length, number of seeds per fruit and placenta length using measuring tape, ruler, vernier caliper and thread where applicable.

Statistical analysis

The means generated from the raw data were subjected to statistical analysis (ANOVA) using the Statistical Analysis Systems (SAS 9.2 version) software package. Duncan's Multiple Range Test (DMRT) was used to test for significant difference in the quantitative reproductive characters at 5 % probability level. Pearson's Correlation Coefficient was used to identify relationship among reproductive characters.

RESULTS

Qualitative reproductive characters of *C. frutescens* accessions

There was a wide difference in the qualitative reproductive characters between accession AS002 and the other seven accessions of *C. frutescens* investigated (Table 1 and Plate 1).

Corolla colour varied from yellow-green in AS001 to yellow in AS006 while AS002 had distinct white corolla colour. The anther colour was green in all accessions except AS002 that had yellow anther colour. Similarly, the filament colour varied from light-purple in AS001 to purple in AS007 while AS002 had a white filament colour. The fruit colour at intermediate stage of all accessions was either yellow or light-yellow except AS002 which had white colour. In addition, the fruit colour at mature stage of all accessions was red except AS002 which had yellow fruit colour. The fruits of all accessions were slightly corrugated while AS002 had intermediate corrugation. The seed colour in the seven accessions was straw colour while AS002 had light yellow seed colour (Table 1 and Plate 1).

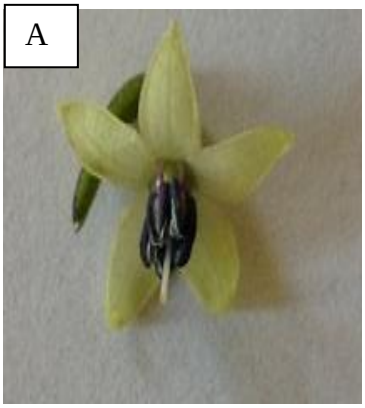
Table 1: Qualitative reproductive characters of *C. frutescens* accessions

Character	AS001	AS 002	AS003	AS004	AS005	AS006	AS007	AS008
FLP	Intermediate	Erect	Intermediate	Pendant	Intermediate	Pendant	Intermediate	Erect
CC	Yellow-green	White	Yellow-green	Yellow	Yellow	Yellow	Light-yellow	Yellow-green
CSC	Yellow	White	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
CS	Campanulate	Campanulate	Campanulate	Campanulate	Campanulate	Campanulate	Campanulate	Campanulate
AC	Green	Yellow	Green	Green	Green	Green	Green	Green
FC	Light purple	White	Purple	Light purple	Light purple	Purple	Purple	Light purple
CP	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
CM	Intermediate	Dentate	Entire	Intermediate	Entire	Intermediate	Intermediate	Intermediate
CAC	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
FRC inter	Light yellow	White	Yellow	Yellow	Yellow	Yellow	Light yellow	Yellow
FRC mature	Red	Yellow	Dark Red	Red	Red	Red	Dark Red	Red
FR shape	Elongate	Elongate	Elongate	Elongate	Elongate	Elongate	Elongate	Elongated
FSPA	Obtuse	Truncate	Obtuse	Obtuse	Obtuse	Obtuse	Obtuse	Obtuse
NBFR	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent
FRS blossom	Pointed	Sunken	Pointed	Pointed	Pointed	Pointed	Pointed	Pointed
Seed colour	Straw	Light yellow	Straw	Straw	Straw	Straw	Straw	Straw

Seed surface	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth
FAS	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent
FR surface	Semi-wrinkled	Semi-wrinkled	Smooth	Smooth	Semi-wrinkled	Smooth	Smooth	Semi-wrinkled
FRC Corrugate	Slightly Corrugated	Intermediate	Slightly Corrugated	Slightly corrugated	Slightly Corrugated	Slightly Corrugated	Slightly Corrugated	Slightly corrugated

Keys: FLP: Flower position, **CC:** Corolla colour, **CSC:** Corolla spot colour, **CS:** Corolla shape, **AC:** Anther colour, **FC:** Filament colour, **CP:** Calyx pigmentation, **CM:** Calyx margin, **CAC:** Calyx annular constriction,**FSPA:** Fruit shape at pedicel attachment, **FAS:**Flower Anthocyanin spots, **FRC inter:** Fruit colour at intermediate stage, **FRC mature**: Fruit colour at mature stage, **FR shape:** Fruit shape, **NBFR:** Neck at the base of fruit, **FRS blossom:** Fruit shape at blossom end, **FRC corrugated:** Fruit cross sectional corrugated, **FR surface:** Fruit surface

A



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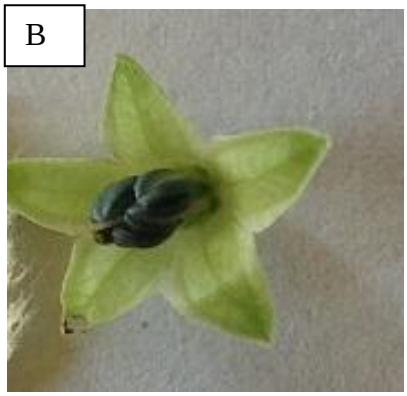

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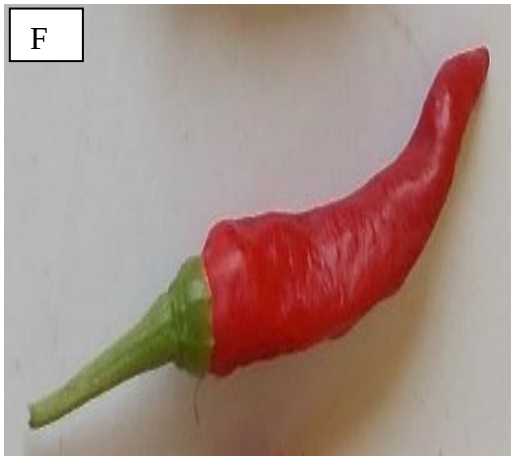

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Plate 1: Variations in reproductive characters among *C. frutescens* accessions
(A) Inflorescence characters in AS006, (B) Inflorescence characters in AS001, (C) Inflorescence characters in AS002, (D) Orange colour of immature fruit in AS004, (E) White colour of immature fruit in AS002, (F) Red colour of matured fruit in AS006, (G) Yellow colour of matured fruit in AS002, (H) Light-yellow seed colour in AS002, (I) Straw seed colour in AS003

Quantitative reproductive characters of *C. frutescens* accessions

Number of days to first flowering ranged from 85.00±0.25 in AS004 to 95.60±1.25 in AS007 among the other seven accessions but was significantly different ($p<0.05$) when compared to AS002 which had the least (75.40±1.00). Also, there was significant difference ($p<0.05$) in number of days to 50% flowering between the other seven accessions and AS002 (86.40±1.21). However, there was no significant difference in the number of flowers per axil among all accessions (Table 2).

The results also revealed that there was no significant difference in the number of days to first fruiting among the other seven accessions which ranged from 96.20±0.37 in AS003 to 106±0.25 cm in AS004 but was significantly different ($p<0.05$) when compared to AS002 84.60±1.29. Similarly, the other seven accessions had close mean values for the number of days to 50% fruiting which was significantly different ($p<0.05$) when compared to AS002 (98.20±0.97). Accession AS002 had the highest number of fruits (7.80±0.58) while the least was recorded for AS006 (4.78±0.43) but there was no significant difference in the fruit length and fruit width among all accessions (Table 2).

Accession AS002 had the highest fresh fruit weight (5.43 ± 0.17g) while AS003 had the least (4.17±0.31 g). There was no significant difference in the fruit pedicel length among all accessions with mean values ranging from 3.30±0.20 cm in AS002 to 3.80±0.52 cm in AS007. Also, there was no significant difference in the number of seeds per fruit among the other seven accessions with values ranging from 32.00±0.51 in AS007 to 38.00±2.44 in AS007 while the highest was recorded in AS002 (53.80±6.04) (Table 2).

Table 2: Quantitative reproductive characters of *C. frutescens* accessions

Character	AS001	AS002	AS003	AS004	AS005	AS006	AS007	AS008
Days to first flowering	86.25±1.25^{c}	75.40±1.00^{d}	85.60±0.75^{c}	85.00±0.25^{c}	91.60±1.03^{a}	89.60±0.55^{b}	95.60±1.25^{a}	89.22±0.75^{b}
Days to 50% flowering	103.00±1.08^{b}	86.40±1.21^{d}	102.00±0.84^{c}	115.07±0.27^{a}	107.20±0.22^{b}	115.00±0.82^{a}	117.00±0.16^{a}	108.00±0.21^{b}
No of flowers per axil	1.10±0.10^{a}	1.00±0.00^{a}	1.04±0.04^{a}	1.10±0.04^{a}	1.00±0.04^{a}	1.00±0.04^{a}	1.10±0.04^{a}	1.10±0.04^{a}
Anther length (cm)	1.00±0.10^{a}	1.00±0.10^{a}	1.00±0.10^{a}	1.00±0.10^{a}	1.00±0.10^{a}	1.00±0.10^{a}	1.00±0.10^{a}	1.00±0.10^{a}
Days to first fruiting	99.00±0.71^{a}	84.60±1.29^{c}	96.20±0.37^{b}	106.00±0.12^{a}	97.03±0.22^{b}	105.20±0.47^{a}	99.20±0.30^{b}	101.08±0.11^{a}
Days to 50% fruiting	107.25±1.11^{a}	98.20±0.97^{c}	109.20±0.56^{b}	120.20±0.12^{a}	113.20±0.97^{ab}	119.20±0.17^{a}	109.20±0.21^{b}	109.20±0.06^{b}
Fruit set	5.00±0.89^{b}	7.80±0.58^{a}	5.81±0.63^{b}	5.95±0.23^{b}	5.55±0.12^{b}	4.78±0.43^{c}	5.61±0.63^{b}	5.41±0.04^{b}
Fruit length (cm)	6.36±0.19^{a}	6.89±0.13^{a}	5.79±0.58^{b}	6.89±0.63^{a}	6.38±0.08^{a}	5.76±0.29^{b}	5.99±0.07^{ab}	5.41±0.09^{b}
Fruit width (cm)	1.96±0.05^{b}	2.06±0.01^{a}	1.94±0.09^{b}	1.94±0.02^{b}	1.81±0.05^{ab}	1.96±0.01^{b}	1.91±0.12^{b}	1.97±0.92^{b}
Fruit weight (g)	4.41±0.12^{b}	5.43±0.17^{a}	4.77±0.60^{b}	4.71±0.40^{b}	4.99±0.81^{b}	4.38±0.50^{b}	4.17±0.31^{b}	4.31±0.74^{b}
Fruit pedicel length (cm)	3.76±0.15^{a}	3.30±0.20^{a}	3.62±0.17^{a}	3.87±0.04^{a}	3.60±0.20^{a}	3.59±0.83^{a}	3.80±0.52^{a}	3.73±0.18^{a}
No of seeds per fruit	36.50±2.50^{b}	53.80±6.04^{a}	38.00±8.37^{b}	33.00±8.37^{b}	38.00±2.44^{b}	36.00±8.80^{b}	32.00±0.51^{ab}	35.00±0.09^{b}
Placenta length (mm)	0.5±0.001^{a}	0.5±0.001^{a}	0.5±0.001^{a}	0.5±0.001^{a}	0.6±0.001^{a}	0.5±0.001^{a}	0.5±0.001^{a}	0.6±0.001^{a}

Mean values (± standard error) followed by different superscripts across rows are significantly different at 5% using Duncan's Multiple Range Test (DMRT)

No of fruits: <25=low, 25-50=intermediate, >50=high; Placenta length:<1.5 mm=small, 1.5-2.5mm=medium, >2.5 mm=big

Correlation Coefficient among Quantitative Reproductive Characters of *C. frutescens* accessions

The phenotypic correlation coefficients among twelve reproductive quantitative characters of the accessions are presented in Table 3. Positive and significant ($p<0.01$) association was observed between days to flowering and days to 50% flowering ($r = 0.989$), days to fruiting ($r = 0.964$) and days to 50% fruiting ($r = 0.894$). However, days to flowering had negative ($p<0.05$) correlation with fruit weight ($r = -0.687$) and number of seeds per fruit ($r = -0.563$).

Also, days to 50% flowering was positively and significantly ($p<0.01$) correlated with days to fruiting ($r = 0.960$) and days to 50% fruiting ($r = 0.922$). A significant but negative correlation ($p < 0.01$) was recorded between days to 50% flowering and fruit weight ($r = -0.705$) and number of seeds per fruit ($r = -0.538$) (Table 3).

Fruit length had a significant positive correlation ($p<0.01$) with fruit width ($r = 0.809$) and fruit weight ($r = 0.934$). Also, fruit width was positively and significantly ($p<0.01$) correlated with fruit weight ($r = 0.822$), and number of seeds per fruit ($p<0.05$) ($r = 0.658$). A significant but negative correlation ($p<0.05$) was recorded between fruit width and fruit pedicel length ($r = -0.523$). A significant positive correlation ($p<0.05$) was recorded between fruit weight and number of seeds per fruit ($r = 0.633$). A significant but negative correlation ($p < 0.05$) was recorded between fruit pedicel length and number of seeds per fruit ($r = -0.601$) (Table 3).

Table 3: Correlation coefficient among quantitative reproductive characters of *C. frutescens* accessions

Character	DAFL	D50%FL	FPA	FL	DAFR	D50%FR	FS	FRL	FRWI	FRWE	FRPDL	NSPFR
DAFL	1											
D50%FL	.989**	1										
NFA	.414	.383	1									
FL	-.322	-.340	.424	1								
DAFR	.964**	.960**	.288	-.438	1							
D50%FR	.894**	.922**	.239	-.387	.933**	1						
FS	-.248	-.219	.175	.431	-.351	-.369	1					
FRL	-.545*	-.580*	-.175	.200	-.444	-.621*	.047	1				
FRWI	-.490	-.486	-.104	-.065	-.389	-.572*	.135	.809**	1			
FRWE	-.687**	-.705**	-.081	.280	-.595*	-.716**	.238	.934**	.822**	1		
FRPDL	.531	.478	.083	-.280	.449	.436	-.280	-.438	-.523*	-.580*	1	
NSPFR	-.563*	-.538*	.115	.190	-.526*	-.515*	.303	.481	.658*	.633*	-.601*	1

**Correlation is significant at 0.01 probability level, *correlation is significant at 0.05 probability level

Key: DAFL: Days to flowering, D50%FL: Days to 50% flowering, NFA: Number of flowers per axil, FL: Filament length, DAFR: Days to fruiting, D50%FR: Days to 50% fruiting, FS: Fruit set, FRL: Fruit length, FRWI: Fruit width, FRWE: Fruit weight, FRPDL: Fruit pedicel length, NSPFR: Number of seeds per fruit

Characteristics of the fruit transverse sections in the *C. frutescens* accessions

A variation was also observed in the transverse section between accession AS002 and the other accessions (Table 4). Locule of fruit transverse section of all accessions was bilocular except AS002 that was tetralocular (Table 4 and Plate 2). All the accessions had axile placentation (Table 4 and Plate 2).

Table 4: Characteristics of the fruit transverse sections in *C. frutescens* accessions

Accession	Locule	Placentation	Hollow
AS001	Bilocular	Axile	Hollowed
AS002	Tetralocular	Axile	Hollowed
AS003	Bilocular	Axile	Hollowed
AS004	Bilocular	Axile	Hollowed
AS005	Bilocular	Axile	Hollowed
AS006	Bilocular	Axile	Hollowed
AS007	Bilocular	Axile	Hollowed
AS008	Bilocular	Axile	Hollowed

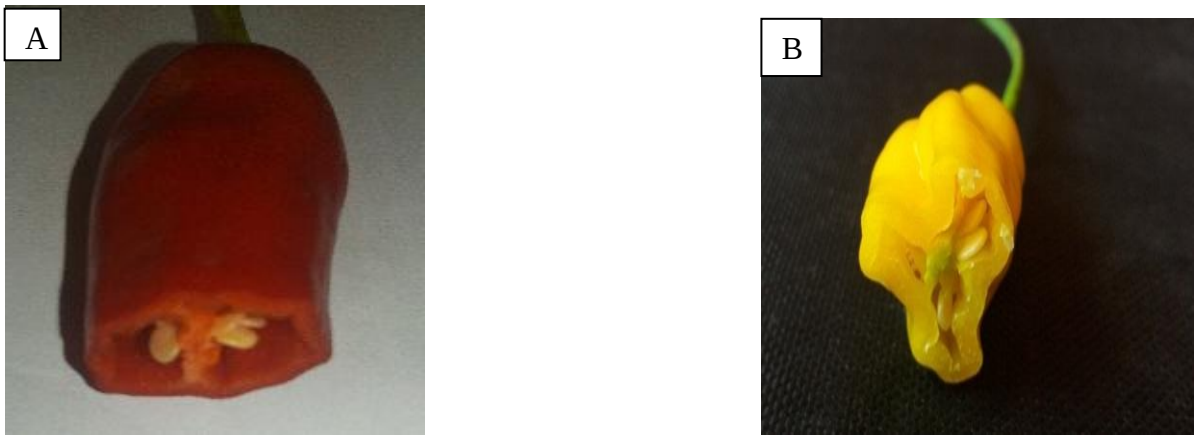

Plate 2: Variations in fruit transverse cut among *C. frutescens* accessions

(A) Fruit of two fused carpels with axile placentation (bilocular) in AS003
(B) Fruit of four fused carpels with axile placentation (tetralocular) in AS002

DISCUSSION

In this study, phenotypic variability was observed in both the qualitative and quantitative reproductive characters with the highest degree of polymorphism. Variations were observed in flower position, calyx margin, anther colour, corolla colour and filament colour between accession AS002 and the other accessions studied. This finding is in agreement with the earlier report on flower position, anther colour, filament colour and corolla colour by Silva *et al.* (2013). They suggested the use of these descriptors because they have discriminative capacity when applied to distinguishing *Capsicum* species. Baral and Bosland (2004) also reported the use of two inflorescence-related descriptors, such as the flower position and colour in differentiating *C. frutescens* from *C. baccatum*. Also, Ortiz *et al.*(2010) were of the opinion that qualitative descriptors and quantitative multivariate analysis related to reproductive parts are useful for the identification of *Capsicum* species.

Flower and fruit colour have been a major basis of differentiating *Capsicum* species. Therefore, the observed difference in corolla colour between AS002 and the other accessions in this study conformed with the report of Sudré *et al.* (2010), who suggested the use of corolla colour in distinguishing the cultivated pepper from wild pepper relatives. Observed variation in the anther colour of AS002 (white) and that of the other accessions (green) in this study agreed with the report of IPGRI (1995) that the colour of the anther is regarded as a key descriptor for the genus *Capsicum* because it is highly discriminatory.

Variations were expressed in the fruit characters of the accessions such as fruit anthocyanin spots, fruit set, fruit colour at maturity, fruit at blossom end, fruit surface, days to fruiting, days to fruit ripening, fruit weight, and number of seeds per fruit. The variations in the populations with respect to fruit shape at blossom end showed that pointed fruits were predominant while only accession AS002 was sunken. The result on fruit shapes at blossom end agreed with the finds of Valšíková *et al.* (2006), who reported high diversity in fruit shape at blossom end of 15 Slovak cultivars of pepper cultivated in an open field and used the characters to group the cultivars. Singh (2006) also used differences in fruit shape at blossom end to characterize the domesticated *Capsicum* species. The reports of the findings of these workers justified the use of these variations in this study in characterizing and subsequently classifying the studied accessions.

Furthermore, variation in the fruit colour at maturity between AS002 and the other seven accessions was significant. This variation in the population suggests some level of out-crossing in the studied accessions which could be the reason for new species or varieties among the accessions studied. This finding corroborated the work of Dagnoko *et al.* (2013), who suggested the use of variation in fruit type, colour and shape in characterizing and classifying some species in the genus *Capsicum*. The high coefficient of variation observed shows that there is heterogeneity within the accessions. Similar results were obtained on chili in Tunisia by Lahbib *et al.* (2013) and in India by Yatung *et al.* (2014).

Since quantitative reproductive characters are usually believed not to be under the considerable influence of the environment, the variations in measured characters in this study could be assumed to have genetic basis and thus were considered for classifying the accessions. This assertion was premised on the similar findings made earlier in Guajillo pepper by Del *et al.* (2007), who grouped accessions of Guajillo pepper based on the quantitative characters. In addition, the difference observed between the ovary chambers of AS002 (tetralocular) and the other accessions (bilocular) suggests phylogenetic diversity between accession AS002 and the other seven accessions.

All the variations between AS002 and the other accessions of *C. frutescens* investigated were significant; these observations have not been reported in Nigeria either at varietal or specific level in the genus *Capsicum*. In addition, the description of AS002 does not fit into the taxonomic descriptions of *C. annuum* and *C. frutescens* as the two species and their varieties have been reported in Nigeria. Therefore, it may be regarded as a new specides.

It is pertinent to report that eight descriptors were monomorphic in all the accessions (corolla shape, calyx pigmentation, calyx annular constriction, fruit shape, fruit pedicel length, placenta length, seed surface and fruit surface), i.e., they did not vary or it was difficult to discriminate accessions within the *C. fructesens*, and thus could be eliminated in a future intraspecific characterization. This resemblance could be responsible for the difficulty in differentiating AS002 from *C. fructesens* by previous workers.

The strong positive correlation observed among the different characters such as days to flowering, days to 50% flowering, days to fruiting, days to 50% fruiting, fruit length, fruit width, fruit weight, fruit set and number of seeds per plant suggested that these characters could be used as selection indices in the genetic improvement of

the genus. These results are in line with those of Sasu *et al.* (2013) in Romania. Bonny (2011) also reported the use of strong positive correlation of some characters for varietal selection and genetic improvement of crops. It is also evident from the results of this study that AS002 had the highest fruit set, early days to flowering and fruiting which are agronomic characters. If this reasoning is held and since most farmers would prefer species or varieties with high fruit set and short life cycle (early maturity), AS002 could best be selected and cultivated by farmers and plant breeders for breeding purposes.

CONCLUSION

The study, therefore, suggests AS002 to be a new species in Nigeria suspected to be *C. baccatum*. In addition, accession AS002 is hereby recommended to farmers and breeders since most farmers would prefer species or varieties with a high fruit set and early maturity.

Based on the reproductive features observed, the following dichotomous keys have been developed to allow for separation of *C. frutescens* from *C. baccatum* in Nigeria:

(1a) fruit shape elongate, fruit internal structure hollowed, surface semi-wrinkled —2
(2a) flower position pendant, corolla colour yellow-green, spot absent —3
(2b) flower position erect, corolla colour white, spot present —3
(3a) anther colour green, filament colour light purple —4
(3b) anther colour yellow, filament colour white —4
(4a) fruit colour at intermediate stage yellow —5
(4b) fruit colour at intermediate stage white —5
(5a) fruit colour red, number of seeds low, bilocular —*Capsicum frutescens*
(5b) fruit colour yellow, number of seeds high, tetralocular —*Capsicum baccatum* var. *baccatum*.

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