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Genetic Characterization and Evaluation of Some Pepper Accessions *Capsicum frutescens* (L.): The Nigerian 'Shombo' Collections

[1]*A.O. Adetula and* [2]*S.A. Olakojo*

[1]National Horticultural Research Institute, Idi-Isin, Ibadan, Nigeria
[2]Institute of Agriculture Research & Training, Obafemi Awolowo Univeristy, P.M.B. 5029, Moor Plantation, Ibadan, Nigeria

Abstract: Thirty three pepper accessions (*Capsicum frutescens* L.) were collected and characterized for their agronomic and genetic potential for breeding programmes in 1999 and 2000 at the National Horticultural Research Institute, Ibadan, Nigeria. Evaluation for breeding potential was done by morphological characterization of the pepper accessions. The objectives of the study were to identify suitable genotypes for yield improvement and, to classify them into similarity groups. The results showed that the pepper accessions were significantly different ($p<0.01$) for growth habit, stem pubescence, leaf pubescence and inflorescence position. Fruit characteristics such as fruit position, calyx shape margin, fruit colour at maturity, fruit length, width and weight at pedicel were equally highly significant ($p<0.01$). Similarity groupings revealed that calyx shape margin was the best genetic marker distinguishing clearly an accession from the other. Accessions AOB99-7, AOB 99-107, AOB 99-416, AOB 99-324 and AOB 99-147 were identified as sources of gene for pepper yield improvement programmes.

Key words: *Capsicum frutescens* · morphological characters · genetic potential

INTRODUCTION

Pepper is a member of the family *Solanaceae* and the genus *capsicum.* The primary centre of diversity was Mexico, but secondarily Gauatemala. Distribution of pepper is wide spread especially in tropical and subtropical ecologies including America, either as wild or cultivated forms [1]. Nigeria happens to be the largest producer of pepper in Africa covering about 50% of total African production. A total of about 100-200,000 ha is being assigned to pepper production annually in Nigeria [2]. In 1983, FAO estimate of pepper production in Nigeria stood at 695,000 metric tons from a total area of about 77,000 ha. Although, pepper is largely grown in many parts of Nigeria. The major area for its production is the northern region between Latitude 10°N and 12°30'N [3]. Canning and processing of pepper locally in recent times, therefore, stemmed down export rate of pepper to other sub-African regions [4].

Consumption of pepper in Nigeria accounts for about 40% of average daily in-take either in soup, or as condiments for flavouring and colouring of meats, fish and other food materials. In Nigeria, three major types of peppers are common. The large fruited sweet peppers (tatashe), the medium corrugated fruited hot pepper ('rodo') and the small fruited chilli peppers (shombo). In these three groups, variability exists in terms of fruit shape, size, maturity period and pungency [1]. Ado [2], reported that there are quite a number of different cultivars of pepper both indigenous and exotic with wide variations in morphological characteristics.

Yield improvement programmes of pepper have indicated that some genotypes performed better than the other under certain environmental condition [5]. Aliyu [6] also reported an optimum plant population of 60,000 per hectare. Similarly, Aliyu *et al*. [7] reported that days to 50% flowering, maturity days, number of fruits per plant, fruit diameter and fruit length of chilli peppers were significantly affected by Nitrogen application. In another evaluation, trials conducted earlier by Ado and Samarawira [8, 9] revealed that a considerable variation exists in the Pepper germplasm. This variability will be useful in pepper improvement programmes especially for yield and fruit quality. The need for evaluation and characterization of pepper accessions in the gene bank of the National Horticultural Research Institute, Ibadan,

Corresponding Author: Dr. S.A. Olakojo, Institute of Agriculture Research & Training, Obafemi Awolowo Univeristy, P.M.B. 5029, Moor Plantation, Ibadan, Nigeria

Nigeria, therefore, became imperative, so as to identify genotypes that are suitable for yield and quality improvement.

The objectives of this study, therefore, were (1) to evaluate and characterize the available pepper accessions of '*shombo*' for yield, agronomic characters and suitability for use in pepper breeding programme (2) to group them into similarity group(s) based on their genetic potential and (3) to make appropriate recommendation(s) for possible use by plant breeders in pepper improvement programmes.

MATERIALS AND METHODS

A total of thirty-three pepper accessions were selected from the gene bank of the National Horticultural Research Institute, Ibadan, Nigeria and were evaluated on replicated field trial in 1999 at Idi-Isin Ibadan. The seeds of each pepper accession were nursed in wooden trays containing sterilized top soil for about 6 weeks in the glass house. They are watered thrice in a week until the seedlings were due for transplanting.

Land preparation was done mechanically by two regimes of ploughing, one harrowing and ridging. Six-week old pepper seedlings were transplanted when rainfall in Ibadan became stable at the wet season in June. Plantings were done on ridges in a 4-row plot of 3 x 5 m spaced at 75 x 40 cm to obtain a plant population of 60,000 per ha as recommended by Ado and Asiribo [10] and were replicated three times. Fertilizer was applied three weeks after planting at 140 kg N ha^{-1}, 25 kg P ha^{-1}. Other cultural and agronomic practices such as weeding and farm hygiene were carried out as at when due.

The following data were taken for the purpose of characterization: Fruit position using ratings 3-7 where 3= Declining, 5= Intermediate and 7= Erect; Calyx margin shape with 3= Smooth, 5= Intermediate and 7= dentate; Fruit shape at pedicel attachment, where 1= acute, 3= obtuse, 5= truncate, 7= cordate and 9= lobate; Fruit colour at maturity with 1= green 2= yellow, 3= orange, 4= reddish, 5= Ralph red, 6= purple, 7= brown; Fruit length (cm) was measured using meter rule; fruit width (cm) was measured with veneer caliper; fruit weight (g) was determined using digitalized weighing balance while fruit crossectional corrugation was determined using ratings 0= smooth, 3= slightly corrugated, 5= intermediate and 7= very corrugated. Other parameters taken included fruit pungency with 0= not pungent (i.e., sweet), 3 = Low, 5= Intermediate and 7= high pungency; Fruit wall thickness with a ratings of 3 = thin, 5= Intermediate and 7= thick; while growth habit were rated with 3= prostrate, 5= compast and 7= erect; stem and leaf pubescences were scored with ratings of 0= glabrous, 3= sparse, 5= Intermediate and 7= abundant as well as Inflorescence position where 3= endent, 5= intermediate and 7 = shoot. Similarly, fruit shape at blossom were rated using scale 3= pointed, 5= blunt, 7= dented.

Data was analyzed using Mstat soft ware package for analysis of variance (ANOVA), while pertinent means were separated using Duncan Multiple Range Test according to Duncan [11]. Means for the quantitative characters and qualitative traits scores were used in putting them into similarity groups (Figs. 1-7).

RESULTS AND DISCUSSION

From ANOVA result, mean square (MS) for vegetative characters are presented in Table 1. Pepper accessions differed significantly from one another ($p<0.01$) with respect to growth habit, stem pubescence, leaf pubescence and inflorescence position. The MS magnitudes of these significant characters were above 4.0 especially for growth habit, stem pubescence and leaf pubescence. MS Value for inflorescence position was however generally low with 2.53 (Table 1). Table 2 presents mean square (MS) value for fruit characteristics. Fruit position, calyx shape margin, fruit colour, fruit length and width as well as fruit shape at pedicel were significantly different from one another at $p<0.05$ and $p<0.01$ showing wide genetic variations that exist among these pepper accessions for use by the plant breeders in pepper improvement programme. Adamu *et al.* [12] also reported sufficient genetic variation in local chilies which warrant selection and hybridization among this species for development of superior genotypes. Other characters

Table 1: Mean squares for vegetative characters of Shombo Pepper collections evaluated in 1999/2000 cropping seasons

Source of variation	Df	Growth habit	Stem pubescence	Leaf pubescence	Inflorescence position
Replicate	2	6.34	0.81	1.72	3.75
Pepper line	32	4.84**	4.19**	4.15**	2.53**
Error	64	1.96	1.09	1.16	1.34
Total	98				

**: Significant at $p<0.05$

Table 2: Mean squares for fruit characteristics of 'shombo' pepper evaluated in 1999/2000 cropping seasons

Source of variation	Df	Fruit Position	Calyx shape margin	Fruit color at maturity	Fruit length	Fruit width	Fruit weight	Fruit shape	Fruit shape at pedicel	Fruit shape at blossom	Fruit cross-section	Fruit pungency	Fruit wall thickness	Fruit color
Replicate	2	0.84	0.00	0.34	40.68	5.13	943.31	2.19	0.27	2.25	63.84	3.40	2.61	0.63
Pepper accession	32	1.68**	0.45**	1.48*	9.78*	4.41*	1093.75	2.51	3.24**	1.23	2.67	0.66	1.24	0.32
Error	64	0.64	0.13	0.49	8.37	2.89	1765.52	1.75	1.89	1.14	2.98	0.82	1.38	0.81
Total	98													

*, **: Significant at $p<0.05$ and 0.01, respectively

Table 3: Character means for some agronomic traits in 'Shombo' pepper

Pepper accession	Growth habit (2-7)	Stem pubescence (0-3)	Leaf pubescence (0-3)	Inflorescence position
OAB99-7	7.0a	3.0a	3.0a	7.0a
OAB99-407	7.0a	3.0a	3.0a	7.0a
OAB99-416	7.0a	3.0a	0.0b	7.0a
OAB99-313	3.0c	0.0b	2.0ab	7.0a
OAB99-212	4.3a-c	1.0b	3.0a	5.0a-c
OAB99-324	7.0a	3.0a	3.0a	7.0a
OAB99-147-1	7.0a	3.0a	0.0b	7.00a
OAB99-440	5.0a-c	0.0b	1.0ab	5.0a-c
OAB99-478A	3.6bc	0.0b	0.0b	5.0a-c
OAB99-246	4.3a-c	0.0b	1.0ab	5.0a-c
OAB99-148	4.3a-c	0.0b	1.0ab	4.0bc
OAB99-478B	5.6a-c	1.0ab	2.0ab	5.0a-c
OAB99-432	6.3ab	1.0ab	1.0ab	6.3ab
OAB99-412	7.0a	2.0ab	0.0b	6.3ab
OAB99-20	5.6a-c	1.0ab	2.0ab	3.7c
OAB99-434	5.6a-c	0.0b	3.0a	5.0a-c
OAB99-422	7.0a	2.0ab	1.0ab	6.3ab
OAB99-381	6.3ab	3.0a	2.0ab	5.0a-c
OAB99-409	4.3a-c	1.0ab	1.0ab	6.3ab
OAB99-425	5.0a-c	3.0a	0.0b	5.00a-c
OAB99-432	7.0a	1.0ab	0.0b	5.667a-c
OAB99-179	3.6bc	2.0cb	1.0ab	5.00a-c
OA99-404	6.3ab	1.0ab	0.0b	6.33ab
OA99-14	7.0a	0.0b	0.0b	5.0a-c
OA99-301	5.6a-c	0.0b	0.0b	3.7a-c
OA99-346	3.6bc	1.0ab	0.0b	4.33bc
OA99-149	5.6a-c	0.0b	0.0b	5.0a-c
OA99-4	7.0a	0.0b	0.0b	5.0a-c
OA99-123-3	5.0a-c	1.0ab	0.0b	5.0a-c
OA99-399	5.6a-c	0.0b	0.0b	5.0a-c
OA99-301	7.0a	0.0b	0.0b	5.0a-c
NH84-22	7.0a	0.0b	0.0b	5.0a-c
NH84-175	7.0a	0.0b	0.0b	5.0a-c
Mean	5.76	1.09	1.15	5.4
C.V (%)	24.33	96.12	93.70	20.88
L.S.D (0.05)	2.28	1.71	0.57	1.88

such as fruit weight, fruit shape, fruit shape at blossom end, fruit cross-sectional corrugation, fruit pungency, fruit wall thickness and fruit colour were not significantly different from one another (Table 2), indicating that these parameters might not be significantly contributing to expected variability in pepper improvement programme with respect to these characters. Ado and Gupta [13] similarly reported high coefficient of variation (CV) in chili pepper and suggested that breeders should select from such genotypes to develop superior varieties. Breeders might need to place premium attention to these four characters especially in grouping and selecting for improved varieties during varietal improvement programmes. Growth habit rating ranged between 3.0 and 7.0, while stem and leaf pubescences ranged both from 0.0 to 3.0, inflorescence position had rating of 3.0-7.0 (Table 3). The best accessions that combined genes for these four traits were OAB 99-7, OAB 99-407, OAB 99-324

Table 4: Fruit character means for 'Shombo' Pepper collections

Pepper accession	Fruit position	Calyx margin shape	Fruit shape at pedicel	Fruit color at maturity	Fruit length (cm)	Fruit width (cm)	Fruit weight (g)	Fruit cross sectional corrugation	Fruit pungency (1-5)	Fruit wall thickness
OAB99-7	7.0a	3.0c	3.7bc	4.3	5.6	3.3	38.6	1.6	5.0	5.6
OAB99-407	7.0a	3.0c	5.0abc	4.6	10.0	5.3	29.0	2.6	5.0	7.0
OAB99-416	7.0a	3.0c	3.7bc	5.6	7.8	4.9	34.4	0.0	5.0	7.0
OAB99-313	7.0a	5.0a	3.7bc	4.3	7.3	4.5	44.9	0.0	5.0	5.6
OAB99-212	5.0b	3.7b	3.7bc	4.3	10.6	6.5	24.3	1.0	5.0	5.6
OAB99-324	7.0a	3.0c	4.3bc	4.3	8.3	5.1	21.8	1.6	5.0	5.0
OAB99-147-1	7.0a	3.0c	4.3bc	4.3	10.0	4.0	16.1	0.0	5.0	5.0
OAB99-440	6.3ab	3.0c	7.0a	5.0	8.6	3.9	35.1	3.3	5.0	5.6
OAB99-478A	6.3ab	3.0c	3.7bc	4.3	9.5	4.6	14.6	1.0	4.3	5.6
OAB99-246	5.7ab	3.7b	3.0bc	4.6	9.6	3.8	20.0	1.6	4.3	6.3
OAB99-148	5.0b	3.7b	2.7c	4.6	10.6	5.6	32.5	1.0	3.3	4.6
OAB99-478B	5.7ab	3.0c	3.7bc	4.3	10.3	5.1	13.1	0.0	5.0	7.0
OAB99-432	5.7ab	3.0c	3.0bc	4.0	7.0	2.1	14.3	0.0	5.0	7.0
OAB99-412	6.3ab	3.0c	5.7ab	4.6	13.6	5.5	30.8	1.0	5.0	6.3
OAB99-20	5.7ab	3.0c	3.0bc	4.3	9.6	5.3	31.9	1.6	5.6	5.0
OAB99-434	5.0b	3.0c	4.3bc	4.6	10.6	5.3	49.1	2.6	4.3	5.6
OAB99-422	6.3ab	3.0c	4.3bc	4.6	8.3	4.1	58.5	2.0	5.0	6.3
OAB99-381	6.3ab	3.0c	2.3c	4.3	8.0	8.3	20.2	1.0	3.6	6.3
OAB99-409	6.3ab	3.0c	4.3bc	4.3	8.6	6.0	111.6	1.0	4.3	5.6
OAB99-425	6.3ab	3.0c	5.0abc	4.6	8.0	4.1	47.7	2.0	4.3	5.6
OAB99-432	5.7ab	3.0c	5.0abc	5.0	8.0	3.1	63.3	3.3	4.3	6.3
OAB99-179	5.7ab	3.0c	3.7bc	4.3	5.0	3.4	25.6	1.6	4.3	6.3
OA99-404	6.3ab	3.0c	3.7bc	4.3	5.0	3.1	39.9	1.6	4.3	5.6
OA99-14	5.0b	3.0c	3.7bc	4.6	8.4	3.5	21.5	1.6	5.0	5.6
OA99-301	5.7ab	3.0c	5.7ab	4.6	7.0	5.6	43.0	1.0	4.3	6.3
OA99-346	5.7ab	3.0c	4.3bc	4.6	6.0	4.0	32.6	2.6	4.3	5.0
OA99-149	5.00b	3.0c	3.0bc	4.3	8.5	3.6	31.0	1.6	5.0	5.6
OA99-4	5.0b	3.0c	5.0abc	4.6	8.0	4.3	32.0	1.0	5.0	5.6
OA99-123-3	5.0b	3.0c	3.7	4.6	5.83	6.0	36.1	1.6	5.0	7.0
OA99-399	5.0b	3.0c	3.7bc	4.0	8.0	3.8	29.7	1.0	5.0	6.3
OA99-301	5.0b	3.0c	5.7ab	4.3	8.0	3.8	21.6	1.0	5.0	6.3
NH84-22	5.0b	3.0c	2.3c	4.0	7.5	6.8	28.3	1.0	5.0	6.3
NH84-175	5.0b	3.0c	4.3bc	4.6	9.3		57.3	2.6		5.6
Mean	5.84	3.12	1.89	4.50	8.41	4.67	34.40	1.48	4.70	5.90
C.V (%)	13.68	11.33	69.75	15.59	34.39	36.40	122.13	116.30	19.25	19.76
L.S.D (0.05)	1.30	0.57*	2.24*	0.34*	1.42*	0.83*	20.06	2.80	1.48	1.92

and OAB 99-147 with growth habit, stem pubescence, leaf pubescence and inflorescence positions of 7.0, 3.0, 3.0 and 7.0, respectively in them (Table 3).

Means for fruit characters are presented in Table 4. Characters such as fruit positions calyx margin shape, fruit shape at pedicel as well as fruit length and fruit width were significantly different from one another. Across variety means for these characters were 5.84, 3.12, 1.89, 4.50, 8.41 and 4.67 respectively. No wonder Eshbaugh *et al*. [14] recognized 20-30 species in the genus out of which four were domesticated species. Fruit weight, though not statistically different, varied markedly among the pepper accessions with a range of 14.6 to 58.5 (Table 4). The CV for theses parameters ranged between 11.33 and 122.13%. These significant variabilities among the papper accessions for the fruit characteristics will enhance good selection and better genetic manipulations for yield, in 'shombo' pepper' improvement programmes. For fruit characters such as cross-sectional corrugation, fruit pungency and thick wall, there were no significant differences among these accessions (Table 4). Gene for higher fruit weight could be derived from accessions AOB99-7, AOB99-416, AOB99-20, AOB99-434, AOB99-381, AOB99-432, AO99-404, AO99-301 and NH84-175 with fruit weight of between 38.0 and 11.6 g.

Classification of 'shombo' pepper accessions in similarity groups using agronomic characteristics

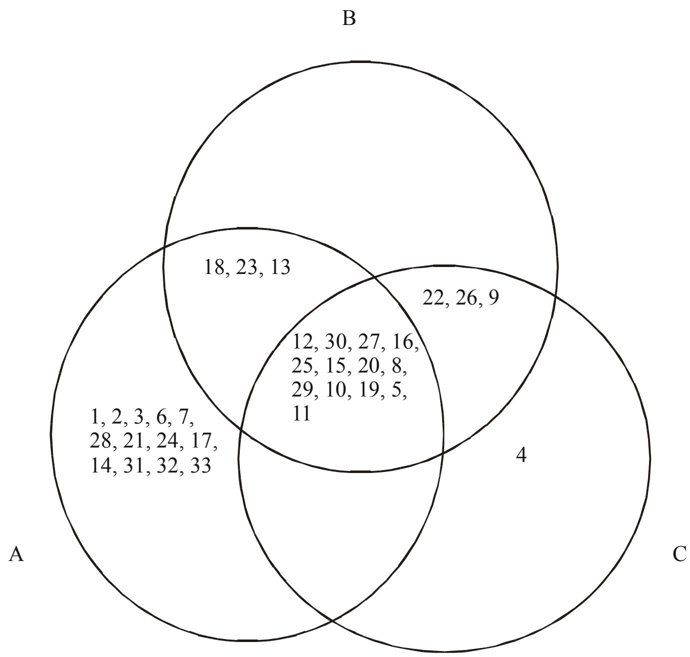

Fig. 1: Growth habit

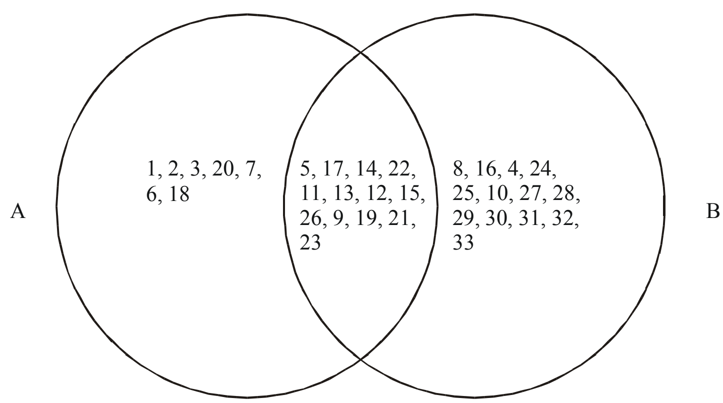

Fig. 2: Leaf pubescence

Grouping of '*shombo*' pepper accessions into similarity groups are presented in Figs. 1-7 using the agronomic parameters. In these figures, each accession is placed in a sub set-diagram, showing its distinct group while some shared values in between two or more distinct groups as seen in the intersections. The higher the position in the group using vertical orientation, the higher the rating for such parameter. For growth habit (Fig. 1), thirteen accessions fell into set A, while one was uniquely fell into set C. Three of the 33 accessions were placed in between set A and B. Similarly, these accessions found their places in between set B and C. In Fig. 2, two distinct groups were identified, while seven accessions were in group A, thirteen were in group B as the other thirteen accessions found themselves in between groups A and B with respect to leaf pubescence. Yamamoto and Nawata [15] also recognized some closely related accession in Indonesia collections. Similarity grouping for stem pubescence (Fig. 3) revealed two distinct groups. Seven of the thirty-three accessions were found in group A, fifteen were placed in group B, the rest thirteen were in between these major two groups as found in the intersect

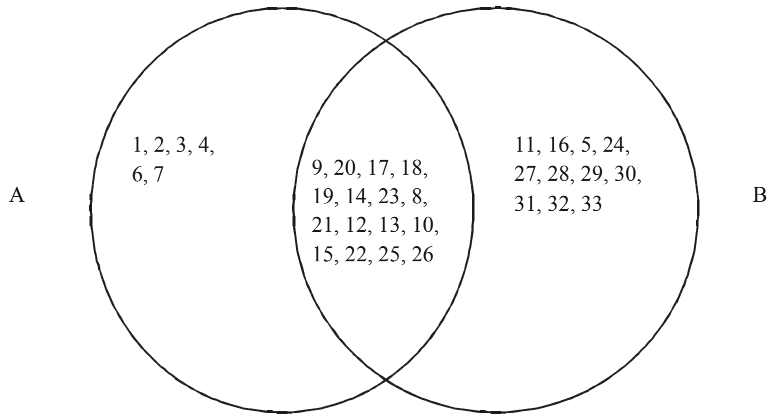

Fig. 3: Stem pubescence

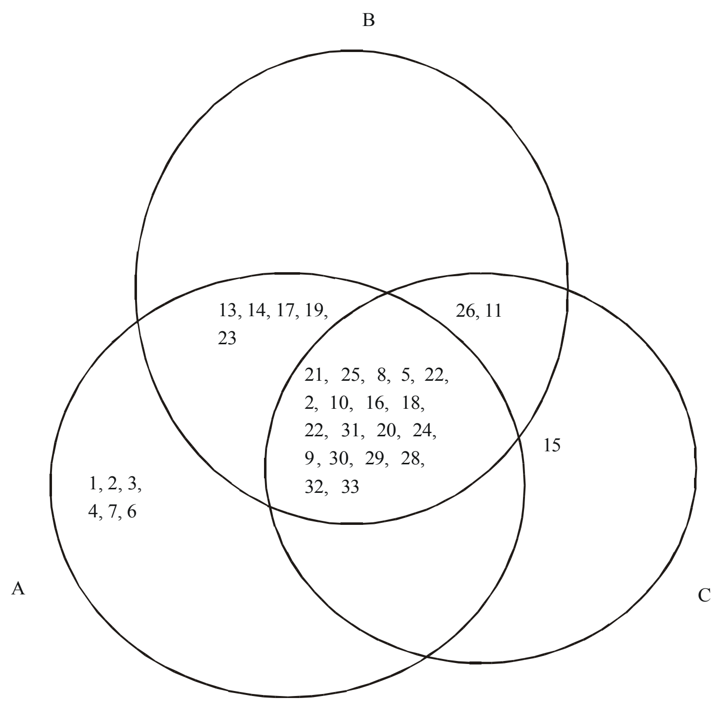

Fig. 4: Inflorescence position

in Fig. 3. Similarly, Fig. 4, presents inflorescence position by similarity grouping. Group A had five accessions, while group C distinctively had one accessions ('15'). Three accessions shared intersect between B and C as against five accessions found in the intersect of A and B. The rest of the accessions were naturally located in the segment between the 3 major groups. For fruit position (Fig. 5), accessions 1, 2, 3, 4, 6 & 7 occupied groups A, group B contained accessions 5, 11, 16, 24, 27, 28, 29, 30, 31 and 33. The other accessions have their places in the intersect between A and B similarity groups. Figure 6, presents grouping of fruit shape among the pepper accessions. Only one accession was conspicuously placed in group A as against three that were found in set

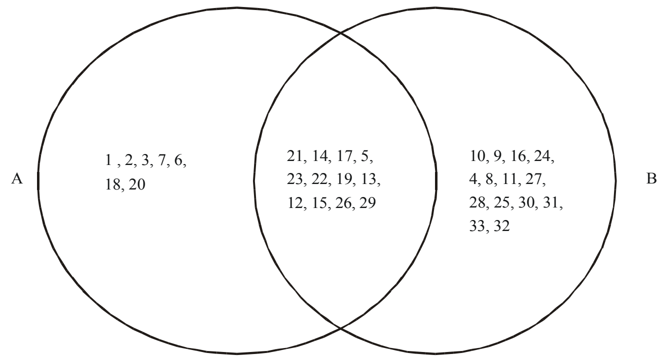

Fig. 5: Fruit position

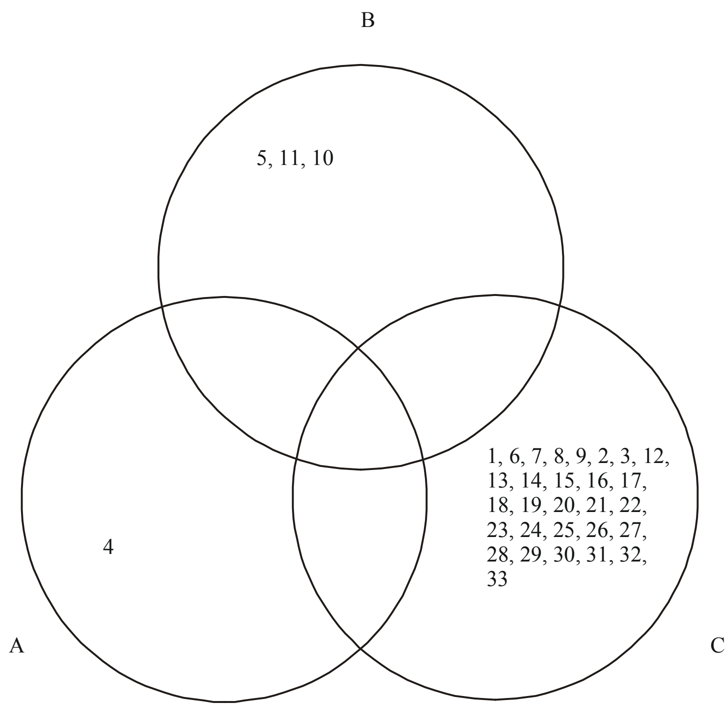

Fig. 6: Fruit shape

B, the rest were grouped in the intersect of A and B, B and C as well as A & B. Figure 7, revealed similarity grouping for the pepper accessions using calyx margin shape. In these groupings, three different groups were obtained (A, B & C). It was only in this character that intersection did not exist in the grouping. This parameter seems to be the best delimiting trait for broad classification of pepper accession into similarity group. It may also serve as the best genetic marker in pepper breeding for improved agronomic attributes. The great importance attached to pepper as a major fruit vegetable motivated Jarret *et al*. [16] to assemble them for use in breeding progammes aiming at yield and quality improvement.

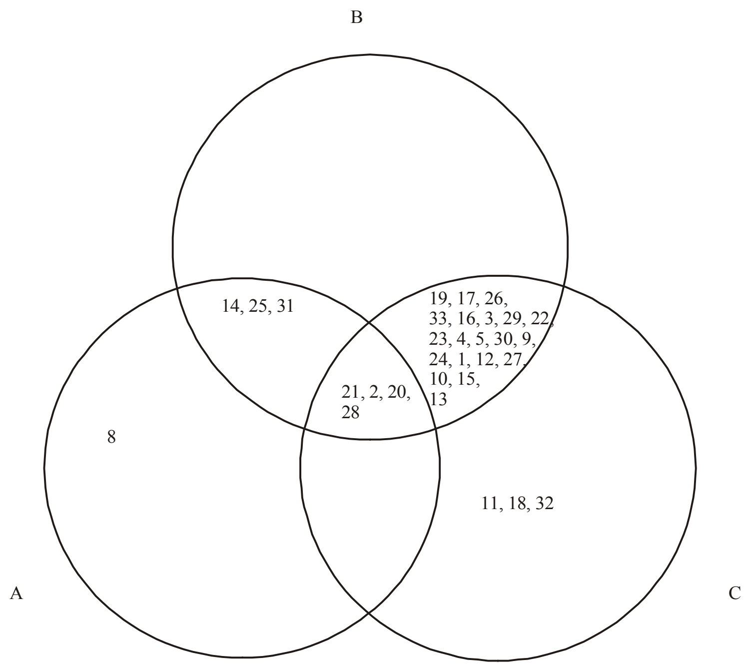

Fig. 7: Calyx margin shape

CONCLUSIONS

From this study, potentials of Nigerian *Capsicum frutescens* accessions were discovered, especially for use in breeding for higher yield and fruit quality improvement. Accessions AOB 99-7, AOB 99-407, AOB99-416, AOB99-324 and OAB99-147 were identified as good sources of gene for pepper improvement programmes. Also, calyx margin shape among other traits seems the best genetic marker in pepper identification.

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