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RESEARCH PAPER

Studies on physico chemical composition and storage in carambola

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SUMMARY :

The experiment was conducted during the period from April, 2008 to March, 2009 on the agricultural farm, Asond Block, Central Experimental Station, Wakawali, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, dist. Ratnagiri on "Studies on physico chemical composition and storage in carambola". Thirty-five genotypes of carambola having wide range of diversity were evaluated for fruits and quality levels. The carambola fruits had 6.16 to 12.53 cm length, 3.44 to 6.52 cm breadth and 24.4 to 134 g weight. The carambola genotypes had 11.34 to 80.27 kg weight of fruit. The carambola fruits contained 81.57 to 96.18 per cent moisture, 5.50 to 10.1 ^{0}Brix T.S.S., 1.44 to 2.69 pH, 0.65 to 1.16 per cent acidity, 3.20 to 5.98 per cent reducing sugars, 3.92 to 7.37 per cent non-reducing sugar, 7.13 to 13.36 per cent total sugars and 15.6 to 32.8 mg/100g ascorbic acid. On the basis of rating of genotypes on simultaneous consideration of characters of fruit characters, the genotypes C_7, C_{11}, C_{10}, C_{15}, C_{18}, C_{24}, C_{30} and C_{32} were rated as most promising genotypes.

KEY WORDS : Carambola, Chemical composition, Physical parameters

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Carambola or Kamrakh or Star fruit (*Averrhoa carambola* L.) is a curious, attractive fruit of the Oxalidaceae family. *Averrhoa* has now been placed in a new family Averrhoaceae by Hutchinson (1959). The oxalidaceae family possesses seven genera, representing more than two hundred species, which are distributed principally in the tropical and sub-tropical region of the world. The genus *Averrhoa* contains two species: carambola (*Averrhoa carambola* L.) and bilimbi or cucumber tree (*Averrhoa bilimbi* L.).

As it is one of the neglected, underutilized, unexploited fruit crops, no systematic plantations have been found. It is commercially grown in the U.S. in South Florida Hawai. In South India, carambola cultivations are rarely seen. The main step for improvement of the crop like carambola, which has high genetic variability, is to screen the genetic variability and identify promising type which will be used in future commercial orcharding and future breeding programme. In absence of the information about chemical composition of fruit and storage study no work could be carried out. Since the information on these aspects is scanty, the present study was is to step up in that direction. Therefore, research work was done on the studies on physico chemical composition and storage studies in carambola.

EXPERIMENTAL METHODS

The investigation on the studies on physico-chemical

composition and storage studies in carambola was conducted during the period from April, 2008 to March, 2009 on the agricultural farm, Asond Block, Central Experimental Station, Wakawali, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri. The experiment was laid down in Randomized Block Design with thirty five treatments and ten replications. Thirty-five trees of twenty five years old were selected for present study and described as C_1, C_2, C_3, C_4, C_5, C_6, C_7, C_8, C_9, C_{10}, C_{11}, C_{12}, C_{13}, C_{14}, C_{15}, C_{16}, C_{17}, C_{18}, C_{19}, C_{20}, C_{21}, C_{22}, C_{23}, C_{24}, C_{25}, C_{26}, C_{27}, C_{28}, C_{29}, C_{30}, C_{31}, C_{32}, C_{33}, C_{34} and C_{35}. The length of sampled fruits from distal to proximal end was measured with the help of vernier calliper in centimeters and mean length was recorded. The maximum linear distance between two sides of the fruit was considered as breadth and was measured with the help of vernier calliper in centimeter to work out mean breadth. Individual fruit was weighed on monopan electric balance and average was calculated in grams. Circumference of the fruit was measured with the help of cotton thread and then meter scale and recorded in centimeters. The volume of fruit was determined by water displacement method in ml by using a measuring cylinder and average volume was worked out. The specific gravity of fruit was computed by dividing the fresh weight of fruit in grams by that of volume in ml (Sulladmath, 1975). The shape of fruit was visually observed and recorded. The shelf life of fruit was recorded on the basis of extent of physiological loss in weight (PLW) up to 15 per cent. The progressive loss in weight was noted at an interval of two days and per cent loss in weight was calculated by using formula:

$$\text{Per cent PLW} = \frac{\text{Original weight} - \text{Final weight}}{\text{Original weight}} \text{x100}$$

Moisture percentage was determined by drying the carambola fruits in hot air oven at 55-60^0 C till the constant weight was obtained and it was calculated as the difference between initial and final weight of fruit (Ranganna, 1977). Total soluble solids were estimated by using Erma hand refractometer (0 to 32 ^{0}B) and expressed in degree Brix (A.O.A.C., 1980). The pH of carambola fruit was determined by using pH meter at 28°C. The reducing, non-reducing and total sugars were estimated on fresh weight basis by using Lane and Eynon method with modification suggested by Ranganna (1977). Acidity was determined by titrating with standard sodium hydroxide solution and expressed as percentage (A.O.A.C., 1980). Ascorbic acid content of fruit was determined by using 2, 6 – dichlorophenol indophenol dye titration method (Ranganna, 1977).

EXPERIMENTAL FINDINGS AND ANALYSIS

The fruits of carambola are attractive, medium to bold sized, star-shaped in cross sectionally. Data pertaining to physical parameters of carambola fruits of different genotypes are furnished in Table 1. It could be observed from Table 1 that on an average carambola fruit had 65.57 g weight, 9.41 cm length and 4.74 cm breadth. The variations in these characters were statistically significant. Among the thirty-five genotypes the lowest fruit weight was noticed in C_2 (24.40 g), which was at par with C_{13} and C_{17}. The C_{18} (134.00 g) had highest fruit weight, which was statistically significant with others except C_{32}. As regards the length of the fruit, the highest length was recorded in genotype C_{30} (12.53 cm), which was at par with C_{18}. The lowest average fruit length was noticed in C_2 (6.16 cm), which differed significantly from others. The highest breadth was observed in C_{18} (6.52 cm), which differed significantly from others. The lowest breadth was seen in C_{17} (3.44 cm), which was at par with C_2 and C_3. With respect to fruit shape, majority of the genotypes produced oblong shaped fruits, with star-shaped in cross - section. The colour of ripe fruit was yellowish green, greenish yellow and yellow. These results are in line with the earlier reports. Regarding the weight, Narain *et al.* (2001) and Shrivastava (2005) reported the similar results. With respect to length and breadth also identical observations were made by Morton (1987), Knight (1999) and Rahman *et al.* (2003). About shape and colour of fruit, Morton (1987), reported the similar results in carambola.

The data on fruit circumference, volume and specific gravity are presented in Table 1. The differences in the circumference, volume and specific gravity were statistically significant. The genotype C_{31} recorded the highest circumference (18.72 cm), which was at par with C_7 and C_{18}. The average lowest circumference was noticed in C_{16} (11.74 cm), which was at par with C_2, C_3, C_8, C_{13}, C_{15}, C_{24}, and C_{28}. Similarly, Sawant *et al.* (1997) reported 11.95 to 12.50 cm circumference in different genotypes of kokum (*Garcinia indica* Choisy). The genotype C_{32} recorded the highest volume (138.80 ml), which differed significantly from others except C_{18}. The lowest volume was observed in C_2 (19.60 ml), which was at par with C_3, C_{13}, C_{17} and C_{25}. It could also be observed from Table 1 that the fruit volume was slightly less than that of weight of the fruits. The observations analogous to these were also reported by Nimbalkar (2004) in kokum fruits. Regarding specific gravity it could be revealed that the specific gravity of ripe carambola fruits ranged from 1.00 to 1.27. The specific gravity of ripe carambola fruits was found to be more than one in majority of the genotypes. The average specific gravity of carambola fruits was 1.10. Narain *et al.* (2001) recorded the average density of carambola fruit 1.03 g/cm^3. Similar observations of fruit density were reported by Sawant *et al*. (1977) and Nimbalkar (2004) in kokum. The estimates of correlation co-efficient of quantitative characters of the fruits are presented in Table 4. Among all the fruit characters fruit weight, length of fruit, breadth of

Table 1: Variation in physical parameters of fruits in carambola genotypes

		Physical parameters of fruit						
Geno-types	Fruit shape	Weight (g)	Length (cm)	Breadth (cm)	Circum-ferance (cm)	Volume (ml)	Specific gravity	Yield kg/ plant
C_1	Oblong	64.40	9.32	4.64	14.88	56.00	1.15	36.45
C_2	Oval	24.40	6.16	3.68	13.17	19.60	1.24	11.34
C_3	Oblong	40.80	8.56	3.80	12.24	34.40	1.18	24.07
C_4	Oblong	69.20	9.60	4.66	15.76	59.60	1.16	59.16
C_5	Oblong	80.20	9.80	5.18	16.20	76.20	1.05	67.44
C_6	Oval	42.80	8.34	4.32	13.52	43.00	0.99	30.13
C_7	Oval	90.80	10.35	5.82	18.22	84.70	1.07	74.18
C_8	Oblong	57.40	8.88	4.62	14.54	50.70	1.13	47.52
C_9	Oblong	85.20	10.71	5.14	16.36	83.40	1.02	66.96
C_{10}	Oblong	52.20	8.51	4.24	13.72	47.80	1.09	28.29
C_{11}	Oblong	46.00	8.86	4.12	13.92	36.20	1.27	30.49
C_{12}	Oblong	88.40	10.46	5.40	16.74	86.60	1.02	72.93
C_{13}	Oblong	33.60	7.88	4.28	12.60	30.80	1.09	23.21
C_{14}	Oblong	68.20	9.14	4.84	17.02	61.60	1.10	53.05
C_{15}	Oblong	88.60	11.53	5.28	13.28	84.30	1.05	80.27
C_{16}	Oblong	86.60	10.79	4.80	11.74	81.80	1.05	63.73
C_{17}	Oblong	24.80	7.48	3.44	18.30	24.60	1.00	16.04
C_{18}	Oblong	134.00	12.39	6.52	17.16	123.60	1.08	55.34
C_{19}	Oval	66.60	9.49	5.08	14.44	61.80	1.07	45.82
C_{20}	Cylindrical	62.40	10.43	4.76	16.64	57.80	1.07	44.17
C_{21}	Oval	73.80	9.24	5.36	15.70	67.20	1.09	39.99
C_{22}	Oblong	65.40	9.50	4.72	14.74	61.60	1.06	29.10
C_{23}	Oblong	52.80	8.34	4.62	15.84	47.60	1.10	25.18
C_{24}	Oblong	70.40	9.25	4.82	12.78	68.20	1.03	53.22
C_{25}	Oblong	41.00	7.90	4.00	16.08	31.80	1.28	29.19
C_{26}	Oblong	75.80	9.30	5.10	13.74	74.60	1.01	61.32
C_{27}	Oblong	45.20	8.72	4.36	15.34	38.80	1.16	29.60
C_{28}	Oblong	65.00	10.00	4.66	13.24	61.80	1.05	39.52
C_{29}	Oblong	52.40	8.91	4.06	14.98	50.00	1.04	43.23
C_{30}	Cylindrical	80.00	12.53	4.88	16.34	75.00	1.06	54.40
C_{31}	Oblong	71.80	9.70	4.86	18.72	72.00	0.99	51.12
C_{32}	Oblong	124.80	11.58	5.74	15.46	138.80	0.89	69.63
C_{33}	Oblong	68.80	8.84	4.86	15.02	67.20	1.02	39.49
C_{34}	Oval	46.20	8.72	4.92	14.96	47.80	0.96	36.26
C35	Oval	55.00	8.30	4.32	16.04	52.80	1.04	25.19
Mean		65.57	9.41	4.74	15.12	61.70	1.10	44.49
Range		24.40	6.16	3.44	11.74	19.60	1.00	11.34
		To	To	To	To	To	To	To
		134.00	12.53	6.52	18.72	138.80	1.27	80.27
S.E. ±		4.36	0.30	0.14	0.63	5.70	0.05	
S.D.		23.53	1.32	0.61	1.72	24.67	0.08	17.73
C.V.		21.07	10.29	9.81	13.23	29.24	14.82	39.86
C.D.5%		12.16	0.85	0.40	1.76	15.87	0.14	

Table 2: Physiological loss in weight (%) of carambola fruits

Genotypes	Days of storage				
	1	3	5	7	9
C_1	0.00	7.67	15.61	Spoiled	
C_2	0.00	11.30	25.00	Spoiled	
C_3	0.00	9.17	16.82	Spoiled	
C_4	0.00	8.19	14.97	19.71	Spoiled
C_5	0.00	9.05	12.87	14.93	19.80
C_6	0.00	8.21	17.23	Spoiled	
C_7	0.00	7.49	13.93	21.01	Spoiled
C_8	0.00	10.76	18.63	Spoiled	
C_9	0.00	9.18	14.55	18.28	Spoiled
C_{10}	0.00	9.38	17.50	Spoiled	
C_{11}	0.00	8.45	15.20	Spoiled	
C_{12}	0.00	5.59	11.47	15.11	Spoiled
C_{13}	0.00	5.08	12.51	18.73	Spoiled
C_{14}	0.00	9.98	10.88	13.39	17.23
C_{15}	0.00	2.53	5.64	8.64	16.75
C_{16}	0.00	5.91	10.43	13.55	17.44
C_{17}	0.00	9.41	17.32	Spoiled	
C_{18}	0.00	4.56	8.16	10.81	19.95
C_{19}	0.00	7.79	11.85	15.23	Spoiled
C_{20}	0.00	11.29	17.31	Spoiled	
C_{21}	0.00	9.69	15.69	Spoiled	
C_{22}	0.00	7.57	12.33	15.49	Spoiled
C_{23}	0.00	7.49	12.25	15.29	Spoiled
C_{24}	0.00	8.65	11.82	14.50	18.32
C_{25}	0.00	13.68	20.55	Spoiled	
C_{26}	0.00	9.60	13.91	17.56	Spoiled
C_{27}	0.00	10.34	15.16	Spoiled	
C_{28}	0.00	6.93	9.97	13.35	25.00
C_{29}	0.00	9.09	14.48	18.29	Spoiled
C_{30}	0.00	12.04	18.07	Spoiled	
C_{31}	0.00	9.11	13.28	17.44	Spoiled
C_{32}	0.00	6.38	9.69	16.13	Spoiled
C_{33}	0.00	16.15	23.03	Spoiled	
C_{34}	0.00	9.65	20.38	Spoiled	
C_{35}	0.00	11.25	16.22	Spoiled	
Mean	0.00	8.82	14.71	15.65	19.11
S.E.±	0.00	0.91	1.21	1.14	0.54
C.D. 5%	0.00	2.55	3.36	3.20	1.54
C.V.	0.00	32.85	26.02	23.15	9.00

Table 3 : Variation in chemical composition of fruits of carambola genotypes

Geno-types	Moisture (%)	T.S.S. (°Brix)	pH	Acidity (%)	Reducing sugar (%)	Non-reducing sugar (%)	Total sugars (%)	Ascorbic acid (mg/ 100g)
C_1	92.24	6.40	1.69	0.97	3.84	4.58	8.43	19.60
C_2	83.64	7.40	1.96	0.83	4.42	5.32	9.74	18.00
C_3	87.94	7.90	2.09	0.78	4.76	5.57	10.33	21.60
C_4	91.49	7.40	1.97	0.81	4.40	5.41	9.82	20.00
C_5	92.84	7.10	1.88	0.82	4.29	5.17	9.46	15.60
C_6	89.62	5.90	1.58	0.97	3.54	4.39	7.93	17.60
C_7	87.11	6.40	1.70	0.94	3.86	4.65	8.51	21.60
C_8	85.86	6.70	1.77	0.90	4.01	4.92	8.94	19.20
C_9	90.55	6.40	1.68	0.98	3.83	4.68	8.51	25.20
C_{10}	90.42	8.35	2.22	0.71	5.02	6.03	11.06	19.20
C_{11}	82.76	6.10	1.61	0.93	3.64	4.44	8.09	32.80
C_{12}	91.91	8.05	2.16	0.80	4.76	5.57	10.34	21.60
C_{13}	90.75	6.50	1.72	0.96	3.90	4.77	8.68	21.60
C_{14}	89.81	6.40	1.67	0.91	3.76	4.49	8.25	22.40
C_{15}	91.58	5.55	1.44	1.04	3.24	4.10	7.35	28.00
C_{16}	87.69	7.50	1.94	0.81	4.42	5.51	9.94	21.20
C_{17}	89.80	7.90	2.05	0.80	4.76	5.54	10.31	18.80
C_{18}	96.18	7.20	1.85	0.81	4.34	5.14	9.48	16.00
C_{19}	86.08	8.45	2.09	0.69	4.97	6.18	11.16	24.40
C_{20}	88.46	9.40	2.46	0.67	5.34	6.83	12.17	26.40
C_{21}	86.05	5.60	1.56	0.90	3.43	4.52	7.96	24.40
C_{22}	92.68	7.05	1.80	0.80	4.03	5.38	9.42	16.00
C_{23}	81.51	7.65	2.01	0.80	4.60	5.61	10.22	21.60
C_{24}	89.30	5.55	1.46	1.05	3.28	4.05	7.34	25.60
C_{25}	91.38	7.15	1.87	0.80	4.18	5.16	9.34	26.80
C_{26}	88.44	5.80	1.53	1.03	3.39	4.35	7.74	17.60
C_{27}	86.51	5.85	1.53	1.01	3.61	4.15	7.76	16.40
C_{28}	89.00	9.00	2.37	0.68	5.31	6.23	11.55	18.40
C_{29}	87.90	7.80	2.04	0.80	4.69	5.52	10.22	16.40
C_{30}	88.21	7.65	2.05	0.76	4.58	5.53	10.12	23.20
C_{31}	88.48	6.15	1.66	0.93	3.66	4.62	8.29	26.80
C_{32}	89.72	10.10	2.69	0.65	5.98	7.37	13.36	22.00
C_{33}	86.03	5.50	1.47	1.16	3.20	3.92	7.13	24.00
C_{34}	87.26	5.75	1.46	1.03	3.36	4.18	7.55	23.20
C_{35}	85.87	6.35	1.65	0.94	3.65	4.62	8.27	19.60
Mean	88.72	7.02	1.85	0.87	4.17	5.10	9.28	21.50
Range	81.57	5.50	1.44	0.65	3.20	3.92	7.13	15.6
	To	To	To	To	To	To	To	To
	96.18	10.10	2.69	1.16	5.98	7.37	13.36	32.8
S.D.	2.98	1.14	0.29	0.12	0.67	0.79	1.45	3.91
C.V.	1.89	1.43	2.54	1.23	2.38	3.62	2.02	10.29
S.E. ±	1.19	0.07	0.03	0.007	0.07	0.13	0.13	1.66
C.D. at 5%	3.42	0.20	0.09	0.02	0.20	0.37	0.38	4.77

fruit, and volume of fruit had significant positive correlation with yield. It indicated that fruit weights, fruit length, fruit breadth, volume of fruit were involved directly in the contribution of yield. Fruit weight was significantly and positively associated with fruit weight, breadth of fruit, volume of fruit, seed weight and significantly negative associated with specific gravity of fruit. The fruit length was significantly and positively associated with breadth of fruit, volume of fruit, seed weight and number of seeds. The breadth of fruit exhibited significantly positive correlation with volume of fruit, seed weight, and negatively correlation with specific gravity. Volume of fruit had positive and significant correlation with the seed weight and negatively significant correlation with specific gravity of fruit. Seed weight had positive significant correlation with the no. of seeds. The data thus indicated that, in carambola most of the characters were associated positively and significantly with each other. The yield had significant and positive correlation with fruit weight, length of fruit, breadth of fruit and volume of fruit which indicated their involvement in determination of yield.

The physiological loss in weight of the carambola fruits of different genotypes under ambient storage are presented in Table 2. The physiological loss in weight was slow in the genotype C_{15}, followed by C_{14}. Most of the genotypes had the highest (above 15 %) physiological loss in weight on 4 to 5 day of storage. Among all the genotypes, genotype C_{15} showed lowest physiological weight (5.64 %) on 5th day of storage. It was followed by genotypes C_{32} (9.69 %) and C_{14} (10.88 %), respectively. It was highest on 7th and 9th days of storage irrespective of genotypes and fruits start rotting. In case of all the genotypes, the physiological loss in weight was found to be increased as the storage period increased. This could be due to the fact that fruit being living entities continue to respire and transpire after harvest leading to loss moisture, which in turn resulted into loss in weight. Prado *et al.* (2005) described carambola fruit loss of fresh mass (%) 11.7 at 7th day of storage.

Chemical compositions of fruits of different genotypes in carambola are presented in Table 3. The variations in chemical composition of fruits were statistically significant. The data presented in Table 3 showed that the moisture content of fruit varied from 81.51 per cent in genotype C_{23} to 96.18 per cent in C_{18}. The highest moisture per cent was observed in genotype C_{18} (96.18 %), which was statistically significant with others except C_5. The lowest moisture per cent was noticed in C_{23} (81.51 %), which was at par with C_2 and C_{11}. The moisture content of carambola fruits reported by Shrivastava (2005) and Mandal and Muzumdar (1988) was close to the present investigation. From Table 3 it could be seen that the average T.S.S. of the carambola fruit was 7.02 °Brix. The T.S.S. ranged from 5.50 (C_{33}) to 10.10 (C_{32}). The highest T.S.S. was observed in C_{32} (10.10), which differed significantly from others. The lowest T.S.S. was recorded in C_{33} (5.50), which was at par with C_{15}, C_{21} and C_{24}. The observations analogous to these findings were reported by Wagner *et al.* (1975) and Sawant *et al.* (1997). It could be observed that the average pH of carambola fruit was 1.85. The highest pH was noticed in C_{32} (2.69), which was statistically significant with others. The lowest pH was observed in C_{15} (1.44), which was at par with C_{24}, C_{33} and C_{34}. The observations similar to these findings were also reported by Sawant *et al.* (1997) and Shrivastava and Rajput (2003). The average titratable acidity of carambola fruits was 0.87 per cent. The average highest percentage of acidity was noticed in C_{33} (1.16 %), which differed significantly from others. The lowest acidity was found in C_{32} (0.65 %), which differed significantly from other genotypes. The observations similar to these findings were also reported by Shrivastava (2005) who reported average acidity 0.87 per cent.

The data pertaining to the reducing, non-reducing and total sugars from the carambola fruits of different genotypes are presented in Table 3. It could be seen from the data that an average reducing, non-reducing and total sugars in fruits of different genotypes of carambola were 4.17, 5.10 and 9.28 per cent, respectively. Regarding reducing sugars, it ranged from 3.20 per cent (C_{33}) to 5.98 per cent (C_{32}). With respect to non-reducing sugars it ranged from 3.92 per cent (C_{33}) to 7.37 (C_{32}). It was observed that the total sugars ranged from

Table 4 : Correlation co-efficients for yield in carambola

Characters	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	Y
Fruit weight (X_1)	1.00								
Fruit length (X_2)	0.87**	1.00							
Breadth of fruit (X_3)	0.91**	0.78**	1.00						
Circumference (X_4)	0.25	0.21	0.30	1.00					
Volume of fruit (X_5)	0.95**	0.80**	0.86**	0.27	1.00				
Specific gravity (X_6)	-0.34*	-0.30	-0.34*	-0.18	-0.51**	1.00			
Seed weight (X_7)	0.49**	0.52**	0.37*	0.18	0.43**	-0.08	1.00		
No. of seeds (X_8)	0.25	0.35*	0.13	0.09	0.19	-0.03	0.91**	1.00	
Yield (Y)	0.81**	0.78**	0.76**	0.20	0.72**	-0.31	0.30	0.09	1.00

* and ** indicate significance of values at P=0.05 and 0.01, respectively

7.13 per cent (C_{33}) to 13.36 per cent (C_{32}). The highest reducing sugars was noticed in C_{32} (5.98 %), which was significant over others. However, it was lowest in C_{33} (3.20 %), which was at par with C_{15}, C_{24}, C_{26}, and C_{34}. The non-reducing sugars was highest in C_{32} (7.37 %), which was significant from others. While, it was lowest in C_{33} (3.92 %), which was at par with C_{15}, C24, C_{27} and C_{34}. The total sugars was recorded highest in C_{32} (13.36 %), which differed significantly from others. However, it was lowest in C_{33} (7.13 %), which was at par with C_{15} and C_{24}. Similar observations were recorded by Narain *et al.* (2001) and Shrivastava (2005). The chemical analysis of carambola fruit showed that average ascorbic acid content was 21.50 mg/100 g. The highest ascorbic acid content was noticed in C_{11} (32.81 mg/100 g), which differed significantly from others. The lowest ascorbic acid was observed in C_5 (15.60 mg/100 g), which was at par with C_1, C_2, C_4, C_6, C_8, C_{10}, C_{17}, C_{18}, C_{22}, C_{26}, C_{27}, C_{28}, C_{29} and C_{35}. These reports are in line with the earlier reports of Narain *et al.* (2001).

LITERATURE CITED

A.O.A.C. (1980). Methods of Analysis. Association of Official Analytical Chemists. 13th Ed. Washington. 218 pp.

Knight, R.J. (1999). Carambola. *Hort. Sci.*, **34**(2): 185-186.

Mandal, U. and Muzumdar, B.C. (1988). Qualitative constituents in some tropical and subtropical minor fruits during development. *Indian Biologist*, **30**(1): 70-79.

Morton, J.F. (1987). *Carambola. Fruits of warm climates*. Julia F. Morton (Ed.), Southern Book Service, Miami, Fla pp. 25-128.

Narain, N., Bora, P.S., Holschuh, H.J., Das, M.A. and Vasconcelos (2001). Physical and chemical composition of carambola fruit (*Averrhoa carambola* L.) at three stages of maturity. *Ciencia Tecnologia Alimentaria*, **3** (3): 144-148.

Nimbalkar, S.R. (2004). Variability studies and characterization in kokum (*Garcinia indica* Choisy). M.Sc. (Ag.) Thesis, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth Dapoli, Ratnagiri, M.S. (INDIA).

Prado, R.M., Natale, W., Correa, M.C.M. and Silva, J.A.A. (2005). Liming and postharvest quality of carambola fruits. *Brazilian Archives Biol. & Technol.*, **48** (5): 689-696.

Rahman, S.M.L., Ghose, G.H., Rahman, M.A., Khan, M.A.I. and Hossain, M.S. (2003). Performance of exotic carambola under Bangladesh condition. *Pakistan J. Appl. Sci.*,**3**(6): 410-413.

Ranganna, S. (1977). *Manual of analysis of fruits and vegetables products*. Tata Mc Graw Hill Publishing Company, Ltd., NEW DELHI, INDIA.

Sawant, D.S., Rajput, J.C., Magdum, M.B. and Dumbre, R.B. (1997). Release proposal for konkam Amruta by Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth Dapoli, Ratnagiri, M.S. (INDIA).

Srivastava, K.K. (2005). Studies on fruit set, fruit drop and fruit quality of carambola genotypes (*Averrhoa carambola* L.). *Orissa J. Hort.*, **33**(2): 20-25.

Sulladhmath, V.V. (1975). Studies on fruit growth and development in sapota var. Kallipatti. M.Sc. (Ag.) Thesis University of Agricultural Sciences, Bengaluru, KARNATAKA (INDIA).

Wagner, C.J., Bryan, W.L. and Berry, R.E. (1975). Carambola selection for commercial production. Florida state Horticultural society, 1975 pp. 466-469.