Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 8 [4] March 2019 : 19-22

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD
Global Impact Factor 0.876
Universal Impact Factor 0.9804
NAAS Rating 4.95

ORIGINAL ARTICLE **OPEN ACCESS**

Studies on Physico-Chemical and Biochemical Characteristics Of Improved Cassava Genotypes

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ABSTRACT

The present investigation was carried out to evaluate thirteen high yielding genotypes of cassava for physico-chemical and biochemical characters in a randomized block design with three replications during 2013 - 2014 at Horticultural Research Station, Venkataramannagudem. Analysis of variance revealed significant differences between genotypes for all the quantitative, physico-chemical and biochemical characters. Maximum plant height was recorded in the genotypes Sree Visakham and Me AP-66. The trait Chlorophyll-A exhibited significant and positive correlation with chlorophyll-B (r=0.906) and total chlorophyll (r=+0.995, p=0.05) at both 1% and 5% level of significance.

Key words: *Cassava, quantitative characters, physico- chemical, biochemical characters, variability*

Received 19.12.2018 Revised 29.12.2018 Accepted 15.01.2019

INTRODUCTION

Cassava (*Manihot esculenta* Crantz) is one of the most important staple food crops grown in the tropics. It plays an important role in ensuring food security in most of the developing world, namely Africa, the Asian Pacific and South America (Koua *et al.,* 2012). It is a woody shrub tolerant to prolonged drought and performs well on low fertility acidic soils, requiring low labor demand than other major food crops (Howeler, 2006). It produces storage roots rich in dietary carbohydrate which can be cooked and consumed fresh by humans when low in cyanogenic glucosides (CG). It can also be processed (when high in CG) into various starch-based food and industrial products such as medicine, cosmetics, and biopolymers (Tonukari, 2004), animal feeds, and bioethanol (Marx and Nquma, 2013). For those utilities, contents of starch, dry matter, carotenoids content and HCN in cassava storage roots are important selection criterion in breeding programs (Jennings and Iglesias, 2002).

The starch and dry matter contents affect the quality of starch products and post harvest shelf-life of harvested storage root, whereas the level of CG determines the bitterness of roots and other parts of the plant, particularly high protein leaves, that are often consumed as human food in Africa and South America. As the contents of those biochemical characters in genotypes vary, it was suggested that a threshold of 17% starch is good for multiple purposes (Jennings and Iglesias, 2002). The most important of biochemical characters are starch, dry matter, carotenoids content and CG contents in storage roots and they vary among cassava varieties. Therefore, high starch content, high dry matter content, high carotenoids content and low CG represent major goals of the cassava breeding program. Hence present investigation was carried out in order to find out high yielding genotypes with better biochemical characters.

MATERIAL AND METHODS

The experiment was conducted with 13 genotypes (Table 1) of cassava from July 2013 to February 2014 at Horticultural Research Station of Dr Y S R Horticultural University, Venkataramannagudem, Andhra Pradesh, India. The experiment was laid-out in randomized block design with three replications. This location is at $16^{o}83^{1}$ N latitude, $81^{o}50^{1}$ E longitude and 34 m above mean sea level. Well matured healthy and disease free stems of previous season of each genotype were used as planting material for the experiment. The recommended synthetic fertilizer rate of 60:60:60 kg ha^{-1} $N:P_2O_5:K_2O$ was applied as urea, single super phosphate and muriate of potash respectively. Five plants of each genotype in each

replication were randomly chosen and labeled for recording the observations. All the six quantitative observations namely plant height, stem girth, tuber number, tuber girth, tuber length and tuber yield per hectare were recorded as per the descriptors for cassava suggested by Fukuda *et al*. (2010) and the pooled data was subjected to statistical analysis.

SAMPLES PREPARATION:

The roots of thirteen cassava genotypes were obtained from nine months old plants grown at Horticultural Research Station, Dr.Y.S.R. Horticultural University, Venkataramannagudem. The fresh roots were washed, peeled manually and cut into small pieces with a knife. The pieces were thoroughly washed and grated finely with a kitchen chopper. The paste obtained was homogenized and stored in portions of 250 g in aseptic polyethylene bags at -18°C until analysis. All reagents used were of analytical grade.

Physico-chemical and biochemical characterization:

The percentage of starch content was determined by using the method outlined by Mc Cready *et al*. (1950). The hydrogen cyanide (HCN) content in tubers was estimated by the method described by Indira and Sinha (1969). Vitamin A and carotenoids contents were evaluated using the spectronic method of Rougereau (1981), reducing and total sugars were evaluated by the methods of Bernfeld (1955) and Dubois *et al.* (1956) respectively.

Statistical analysis: The data analysis was conducted using O.P.STAT. For physico-chemical and biochemical parameters, simple statistic analysis was used to get means and standard deviations.

RESULTS AND DISCUSSION

Quantitative characteristics

Analysis of variance revealed significant differences ($P < 0.05$) among the genotypes for all the quantitative characters (Table 1). In the present investigation, maximum plant height was recorded in Sree Visakham (346.1 cm) followed by Me Ap-66 (338.8 cm), whereas the minimum plant height was recorded in Me Ap-30 (255.3 cm). Highest stem girth was observed in Me Ap-63 (12.3 cm) followed by Me Ap-21 (11.20 cm). In contrast, the lowest stem girth was observed in Me Ap-30 (9.10 cm). Highest number of tubers was observed in Me Ap-13 (12.5) followed by Me Ap-66 (12.0) whereas Me Ap-63 recorded the lowest number of tubers (6.2). Maximum tuber length (45.3 cm) was found in the genotype Me Ap-8 followed by Me Ap-66 (43.9 cm). Tuber girth was recorded in Me Ap-66 (21.0 cm) followed by Me Ap-8 (19.5 cm). The genotype Me Ap-8 was recorded highest tuber yield per hectare (36.8 t/ha) followed by Me Ap-21(35.8 t ha^{-1}) while it was recorded lowest in Me Ap-63 (12 t ha^{-1}). A wide range of variations for different quantitative traits had also been reported in cassava by various workers [16, 17, 1, 2, 13,, 3, 14].

Table 1: Quantitative characteristics of thirteen cassava genotypes

S.No	Entry/ Variety	Plant height (cm)	Stem girth (cm)	Tuber No.	Tuber length (cm)	Tuber girth (cm)	Tuber yield (t/ha)
1	Me Ap-8	328.2	10.7	11.8	45.3	19.5	36.8
2	Me Ap-21	336.6	11.2	9.5	40.3	18.4	35.8
3	Me Ap-23	272.9	9.3	10.7	32.7	17.5	18.0
4	Me Ap-24	278.7	10.3	9.5	33.3	16.5	17.2
5	Me Ap-13	327.0	9.9	12.5	31.2	17.2	20.7
6	Me Ap-18	325.1	9.3	10.5	32.9	17.1	19.4
7	Me Ap-20	287.3	10.1	11.0	31.9	18.8	26.8
8	Me Ap-30	255.3	9.1	9.7	31.9	17.5	20.8
9	Me Ap-31	267.4	9.7	9.5	28.5	16.1	19.5
10	Me Ap-63	292.9	12.3	6.2	32.1	12.3	12.0
11	S.Visakham	346.1	10.6	9.8	41.3	17.7	20.5
12	Me Ap-65	338.3	9.4	10.7	40.8	17.8	27.6
13	Me Ap-66	338.8	9.7	12.0	43.9	21.0	34.9
	CD (P=0.05)	41.3	1.1	2.1	7.4	1.8	8.64
	CV%	7.9	6.2	12.0	12.2	6.3	19.0

Table 2: Physico-chemical and biochemical characteristics of thirteen cassava genotype

S.No	Genotype	Chlorophyll-A (mg/g)	Chlorophyll-B (mg/g)	Total Chlorophyll (mg/g)	Reducing Sugars (%)	Non-Reducing Sugar (%)	Total Sugars (%)	Starch (%)	HCN (ppm)	Protein (mg/100g)	β-Carotene (mg/100g)	Total carotenoid (mg/100g)
1	Me Ap-8	1.16	0.46	1.65	2.35	2.45	4.80	27.0	42.8	3.2	0.92	4.30
2	Me Ap-21	1.20	0.39	1.67	2.70	2.45	5.15	24.7	29.2	2.0	1.02	3.45
3	Me Ap-23	1.19	0.51	1.65	2.83	3.57	6.40	28.0	50.5	2.5	0.87	4.55
4	Me Ap-24	1.33	0.49	1.96	2.05	3.90	5.95	25.0	37.4	3.3	1.02	5.00
5	Me Ap-13	1.33	0.58	1.89	2.33	4.32	6.65	26.5	80.0	3.3	0.97	6.45
6	Me Ap-18	1.30	0.55	1.83	2.95	2.20	5.15	23.2	44.9	1.3	0.99	5.55
7	Me Ap-20	1.78	0.69	2.50	2.70	3.20	5.90	27.3	42.7	1.6	0.55	2.80
8	Me Ap-30	1.50	0.57	2.10	2.65	3.03	5.68	26.1	50.8	1.9	0.91	4.10
9	Me Ap-31	1.40	0.50	1.98	3.17	2.93	6.10	25.0	99.2	2.0	0.67	2.95
10	Me Ap-63	1.33	0.60	1.96	2.90	4.20	7.10	28.7	76.8	3.8	0.97	4.65
11	S.Visakham	1.92	0.78	2.76	3.00	3.83	6.83	26.0	56.4	1.9	0.77	2.85
12	Me Ap-65	1.70	0.58	2.36	2.40	2.45	4.85	27.2	99.4	2.2	0.97	3.35
13	Me Ap-66	1.78	0.76	2.46	2.55	3.35	5.90	23.5	103.6	2.0	0.92	3.65
	CD (P=0.05)	0.39	0.11	0.49	0.31	0.85	0.80	0.70	13.3	0.6	0.11	0.54
	CV%	16.2	11.66	14.19	7.02	15.81	8.09	1.6	12.6	16.5	7.68	7.77

Table 3: Pearson's correlation between physico-chemical and biochemical characteristics of thirteen cassava genotypes

	Chlorophyll-A	Chlorophyll-B	Total Chlorophyll	Reducing sugars	Non reducing sugars	Total sugars	Starch	β-Carotene
Chlorophyll-A	**1.000**							
Chlorophyll-B	**0.906****	**1.000**						
Total Chlorophyll	**0.995****	**0.944****	**1.000**					
Reducing sugars	-0.096	-0.189	-0.118	**1.000**				
Non reducing sugars	0.190	0.073	0.166	0.109	**1.000**			
Total sugars	0.144	0.007	0.115	0.414	**0.950****	**1.000**		
Starch	0.052	-0.022	0.037	-0.144	**0.650***	0.550	**1.000**	
β-Carotene	-0.460	-0.341	-0.439	-0.145	-0.366	-0.380	0.039	**1.000**
Total Carotenoides	**-0.563***	-0.485	-0.553	-0.195	-0.298	-0.334	0.130	**0.966****

Note-**5% level of significance, *1% level of significance, NB: Significant correlations are marked bold

Physico-chemical and biochemical characteristics

The data pertaining to the physico-chemical and biochemical characters are given in Table 2. In all the genotypes the nutritional characteristics varied between chlorophyll-A (1.16 – 1.92 mg g^{-1}), chlorophyll-B (0.39-0.78 mg g^{-1}), total chlorophyll (1.65–2.76 mg g^{-1}), reducing sugars (2.05-3.17 %), non-reducing sugars (2.20-4.32%), total sugars (4.80-7.10 %), starch (23.2-28.7 %), HCN (29.2-103.6 ppm), protein (1.3-3.8 mg. $100g^{-1}$), β-Carotene (0.55-1.02 mg. $100g^{-1}$) and total carotenoids (2.80-6.45 mg. $100g^{-1}$). ANOVA revealed significant differences between the genotypes (Table 2). The highest content were registered by genotypes Sree Visakham for Chl-A (1.92 mg/g), Chl-B (0.78 mg/g), total chlorophyll (2.76 mg/g) and total sugars (6.83 %), Me Ap-31 for reducing sugars (3.17 %), Me Ap-13 for non-reducing sugar (4.32 %) and Me Ap-63 for total carotenoids (7.10 mg/100g) and for starch (28.7 %) and protein (3.8 mg/100g) and Me Ap-21, Me Ap-23 for β-Carotene (1.02 mg/100g).

Correlation

The trait Chlorophyll-A exhibited significant and positive correlation with chlorophyll-B (r=0.906) and total chlorophyll (r=+0.995, p=0.05) at both 1% and 5% level of significance (Table 3) whereas it showed

significant negative correlation with total carotenoids (r=-0.563, p=0.05). The trait chlorophyll-B has significant positive correlation with total chlorophyll (r=+0.944, p=0.05) at both 1% and 5% level of significance. Non reducing sugars recorded significant positive correlation with total sugars (r=+0.950, p=0.05) at both 1% and 5% level of significance and starch (r=+0.650, p=0.05) at 1% level of significance while the trait β-Carotene exhibited significant positive correlation with (r=+0.966, p=0.05) at both 1% and 5% level of significance.

CONCLUSION

It can be concluded that high yielding genotypes *viz*., Me Ap-8, Me Ap-21 and Me Ap-66 recorded higher values of total chlorophyll and total sugars. Hence, due consideration need to be given to the physiological characters while selecting the high yielding genotypes.

ACKNOWLEDGEMNT

I acknowledge Dr. Y.S.R. Horticultural University, Venkataramannagudem for supporting the research to complete this endeavour.

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CITATION OF THIS ARTICLE

P. Ashok, M. Rajasekhar and B. Babu Rao. Studies on Physico-Chemical and Biochemical Characteristics of Improved Cassava Genotypes. Bull. Env. Pharmacol. Life Sci., Vol 8 [4] March 2019 : 19-22