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Metabolic changes during postharvest physiological deterioration in cassava tuber

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Abstract
The present study was carried out to evaluate cassava genotypes for Postharvest Physiological Deterioration (PPD). Tubers from different genotypes were evaluated at 1,2,3,4 and 5 days after harvest for PPD. Fifteen cassava genotypes were evaluated *viz.*, higher the limitation level of HCN was observed in TCMS 4 (376.88 ppm) and the lowest in TCa 12-7 (10.44 ppm) even five days after harvest. This study can be used to understand the physiological mechanisms of PPD in cassava tubers.

Keywords: postharvest physiological deterioration, cyanide, starch, image analyzer

Introduction
Cassava (*Manihot esculenta* Crantz) is the most widely cultivated tuber crop in the tropics. Worldwide, it is the sixth most important crop in terms of production and is a major staple food crop to over 800 million population in the world. Growth in cassava production is likely to accelerate over the current decade. Cassava has emerged as a multipurpose crop for the 21st century one that responds to developing countries' priorities, to trends in the global economy and to cassava could be one of the most climate change-resilient crops and a food secure future for millions of people. Temperature rises of between 1.2 and 2 degrees Celsius by 2030, combined with changes in rainfall patterns. Cassava thrives in high temperatures and if drought hits, it simply shuts down until the rains come again. So it has the tolerance to extreme environments, such as drought, high temperature and poor soil has earned its name as a *"Famine reserve crop*" and *it can enhance nutrition and reduce climate risk*". India exports several forms of cassava products like starch and sago. In Tamil Nadu, it is grown mainly for industrial purpose. However, the short shelf life of the tuber due to Postharvest Physiological Deterioration (PPD) which limits cassava's economic and industrial potential**.** PPD in cassava is rapid, begins within 24 to 48 hrs after harvest and it release cyanide (HCN) which leads to oxidative burst of Reactive Oxygen Species (ROS). The visible signs of deterioration are vascular streaking with a blue or black discoloration that renders the tubers unpalatable and unmarketable. The present study was undertaken to evaluate 15 cassava genotypes for PPD.

Materials and Methods
Plant material
Fifteen cassava genotypes were collected from the Tapioca and Castor Research Station, Yethapur, Tamil Nadu, India. Cassava tubers 24 hours after harvest to five days of storage were used to evaluate PPD (Salcedo and Siritunga, 2011) [4].

Determination of Total Hydrogen Cyanide (HCN)
HCN content of tuber was estimated by the method of of Indian Standard, IS: 4706 - 1978 Part II, Test for presence of hydrocyanic acid in cassava tubers and expressed as ppm.

Determination of Starch
Starch content of tuber was estimated by the method of Indian Standard, IS: 4706 - 1978 Part II and expressed as percentage.

Result and Discussion
The results presented in Table 1, Fig. 1. show that HCN and starch content of 15 cassava genotypes were evaluated at 1,2,3,4 and 5 days after harvest for PPD. Cassava produces potentially toxic levels of cyanide and undergoes rapid postharvest physiological deterioration (PPD) within 24 hours of harvest, shortening its shelf-life. Mechanical damage that occurs during harvesting operation initiates produce cynogenic glycosides, which break down to release cyanide when cells are damaged. The World Health Organisation (WHO) has set the safe level of cyanogens in cassava flour at 10 ppm (FAO/WHO, 1991). Due to the high perish ability of cassava root, caused by PPD, the economic losses are inevitable, negatively impacting the supply of roots as a raw material for fresh or industrial consumption (Reilly *et al.*, 2004; Zidenga *et al.*, 2012) [3, 7].
Comparing the different genotypes of cassava, the increase in concentration HCN at increase the PPD irrespective of days after harvest and higher the limitation level of HCN was observed in TCMS 4 (376.88 ppm) and the lowest in TCa 12-7 (10.44 ppm) at forth DAH. This could be due to the short storage period that promoted the degradation of starch when cyanide production in cassava tubers due to PPD. Reilly *et al.,* (2004) [3] reported that, bitter taste of cassava is due to high cyanide in parenchyma of roots and gradually increased after harvest. Starch content of the tubers ranged from 28.43 % in TCMS 4 to 19.32 % in TCMS 7 on day one and reduced in all the genotypes ranging from 20.89 % in genotype TCa 12-7 to 4.19 % in TCMS 9 on day five. There was an inconsistent trend of the starch content after fifth day of storage. Salcedo *et al.*, (2010) [5] obtained similar results in different genotype behaviors for PPD tolerance. PPD is a complex process that involves changes in the physicochemical and functional properties of root and tuber starches in storage have been reported for cassava (Moorthy, 2004) [2]. Biochemical changes during PPD include increases in respiration (Sanchez *et al*., 2013) [6], mobilisation of starch to sugars and changes in lipid composition (Lalaguna and Agudo, 1989) [1]. Another negative effect occurring due to extensive in-field storage of cassava roots is their increased susceptibility to attack by pathogens as well as the reduction of extractable starch.

Table 1: Impact of PPD on Starch content of cassava tubers (%)

Genotypes	DAY-1	DAY-2	DAY-3	DAY-4	DAY-5	MEAN
TCMS 1	27.53	22.3	17.54	14.38	9.58	18.27
TCMS 2	27.54	19.98	14.82	10.86	5.89	15.82
TCMS 3	26.43	20.89	17.21	12.25	6.82	16.72
TCMS 4	28.43	22.12	16.15	10.19	5.94	16.57
TCMS 5	27.71	21.34	15.67	12.55	7.26	16.91
TCMS 6	26.29	17.54	12.84	8.04	5.33	14.01
TCMS 7	19.32	16.59	10.92	7.86	5.68	12.07
TCMS 8	28.32	22.18	18.2	15.24	10.32	18.85
TCMS 9	27.07	21.32	14.65	9.49	4.19	15.34
TCa 12-1	20.45	18.56	14.89	11.78	7. 98	14.73
TCa 12-2	21.49	19.51	16.52	13.63	10.61	16.35
TCa 12-3	26.89	21.43	17.46	13.6	5.99	17.07
TCa 12-4	26.21	20.52	16.55	14.39	11.04	17.74
TCa 12-5	24.77	22.76	19.09	15.43	11.25	18.66
TCa 12-6	22.41	20.87	17.88	15.1	11.45	17.54
TCa 12-7	25.21	24.98	22.11	21.25	20.89	22.66
Mean	25.38	20.81	16.41	12.75	8.45	16.76

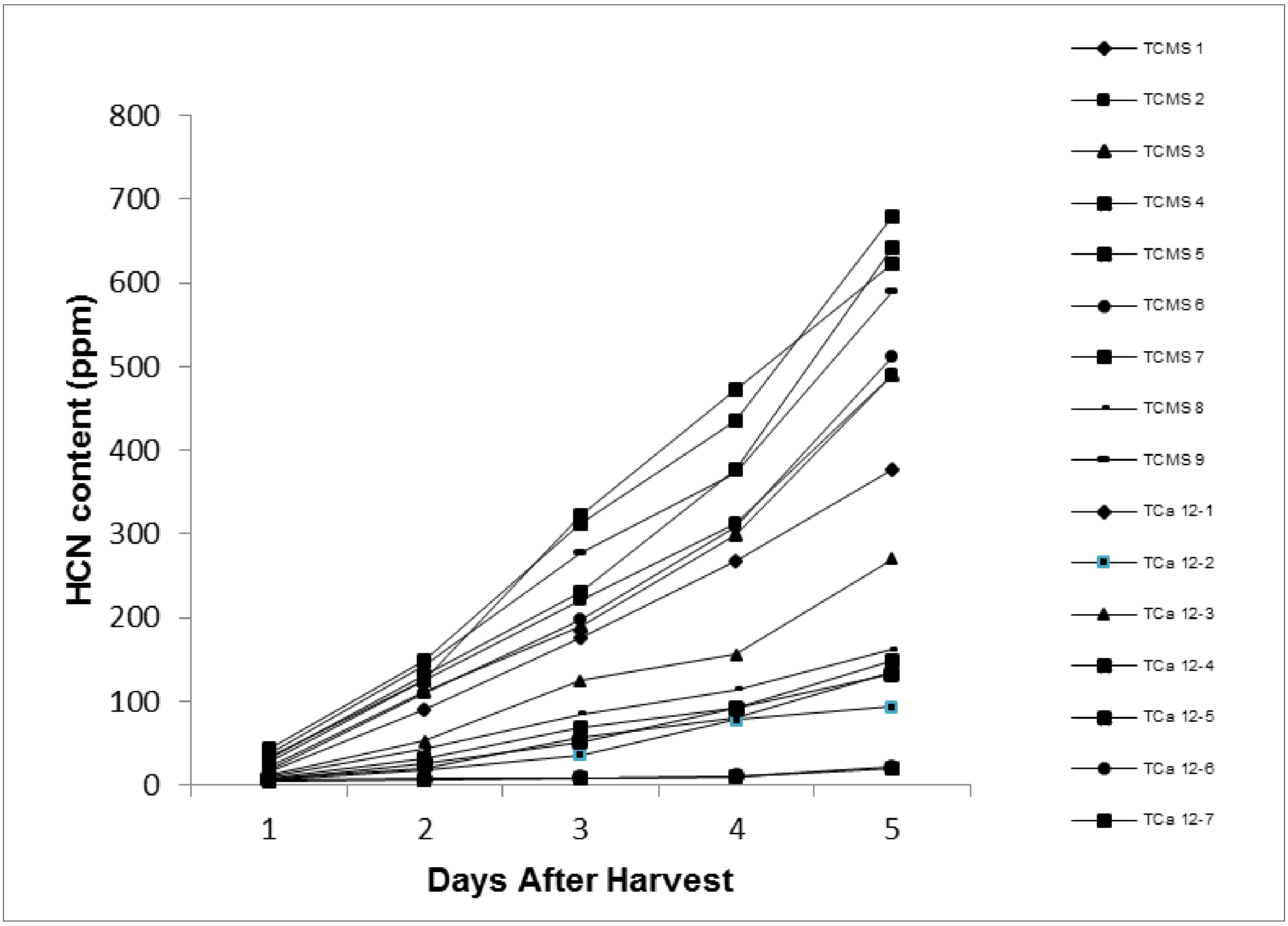

Fig 1: HCN content (ppm) of cassava tuber at storage period

Conclusions

Thus study requires an understanding of the physiology of PPD in cassava tuber. This works has identified TCa12-7 genotype tolerance to PPD. In contrast, the selection of tolerant genotypes to PPD constitutes to ensure higher cassava competitiveness by increasing its root shelf life after harvest. A solution leading to the reduction of PPD, which is subsistence-farmer-friendly, would greatly impact not only food security but also environmental pollution and climate change since less land, water and energy will be necessary for cassava production, handling and transport to both consumers as well as processors.

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