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On the Potash Content and Enzymic Activity of Coconut Water in Relation to the Nutrient Need Assessment of the Coconut Palm

K. M. Pandalai¹ and M. Nagarajan

Department of Chemistry, Central Plantation Crops Research Institute, Kasaragod
(India)

Introduction

The fact that a particular plant itself, is the best indicator of the nature and quantity of nutrients it can absorb and utilize from the soil is now very well recognised, and also applied in the case of several crop plants such as rubber, the oil palm, ground nut, tea, cocoa, etc. *Nagarajan and Pandalai* (1) have recently shown that coconut water furnishes by and large, an elegant and good experimental material to study the nutrient needs of the palm, particularly from an approach made by the study of its enzyme activity during the various stages of the development of the nut. This kind of work may provide guidance for the selection and adoption of cultural and manurial practices in coconut gardens.

Salgado (2) found that information on the potash content of coconut water, provides a simple method of assessing the potash availability in the soil in relation to the needs of this element for the palm. He indeed claimed superiority for this method over the conventional methods of soil analysis assuming coconut water to be analogous to plant sap in indicating the physiological status of the palm and of the soil conditions in which it grows. He distinguished between what he called 'intensity factor' and 'capacity factor' the former being the information available from conventional soil analysis data while the latter is actually a concept of the capacity of the plant tissue system to absorb and utilize the required nutrients from the soil. Therefore for an evaluation of the nutrient need of a plant, tissue analytical studies would be more helpful and this could be done by an assessment of the pattern of enzyme activity of the coconut water.

Our object was to evolve a scheme for nutrient sufficiency or deficiency diagnosis and to prescribe appropriate treatments to be given to the palms based on the results of such studies. The determination of enzyme activity in plants has been shown to provide information about the effects which fertilizers have on the plants by other workers notably *Hofmann* (3) who concluded that the concentration and activity of the enzymes depend on the nature of the soil, on the fertilizers used as well as on

¹ Retired Director of Coconut Research, Vilayil Mahtom, Mavelikara, Kerala, India.

the methods of cultivation given to the plant during the vegetative period. A supreme advantage in the case of enzyme activity studies in plant samples is that activity determinations are simple to carry out, at the same time quick and capable of giving comparable results.

Experimental procedure

Correlation between enzyme activity and manuring

To obtain representative average samples, nut water of mature nuts from palms of comparable age were collected in dry weather in the early morning when all the assimilation products of previous day have been transported from the leaves and before renewed assimilation commenced. The analysis was carried out immediately and directly as the samples needed no preparation or pre-treatment. Selected trees belonged to medium yield groups, standing in the permanent observation plots of the Kasaragod Research Station, where three sister plots are maintained, the first receiving absolutely no cultivation or manuring, the second receiving cultivation operations only while the third receives both cultivation and manurial treatments. These three plots under three entirely different experimental conditions afforded the ideal samples for this study. The activity of the three oxidising enzymes *catalase*, *peroxidase* and *polyphenolase* usually found active in all growing plants, were determined by the methods described by *Sumner and Somers* (4) and *Hawk, Bernard and Summerson* (5). Suitable modifications wherever found necessary were standardised and adopted. For *catalase* assay, the reaction mixture consisted of 5.0 ml of phosphate buffer (pH 6.8), 1.0 ml of 0.2 NH_2O_2 , 2.0 ml of fresh coconut water (treated with CaCO_3 and filtered through glass wool) and incubated for exactly 30 minutes in the ice-bath. The reaction is stopped by the addition of 5% sulphuric acid and the remaining H_2O_2 is determined using 0.01 N KMnO_4 . For *peroxidase* assay the reaction mixture consisted of 10.0 ml of 0.25% pyrogallol, 7.0 ml of phosphate buffer (pH 5.3), 1.0 ml 0.025% H_2O_2 and 1.0 ml of fresh centrifuged nut water. 1.0 ml of 5% H_2SO_4 was added after 5 minutes to arrest the reaction and the optical density was directly measured in the photovolt colorimeter using 420 filter. A reaction mixture consisting of 10.0 ml of 0.25% pyrogallol, 8.0 ml of phosphate buffer (pH 6.5), 1.0 ml of centrifuged nut water served for the assay of *polyphenolase* activity. After allowing the reaction for exactly 10 minutes, 1.0 ml of 5% H_2SO_4 was added and the optical density was directly measured as above. Suitable controls were run with distilled water in place of the nut water as well as by initial inhibition of the enzyme by addition of sulphuric acid. Typical results selected from three replications carried out during 1965, 1966 and 1967 showing the pattern of enzyme activity in the nut water samples are given in table 1.

The striking influence of cultural and manurial practices have on the enzyme activity of coconut water is proved by the experiments described, typical results of which are presented in table 1.

Correlation between potassium content of coconut water and enzyme activity

Several workers who studied the nutritional aspects of the coconut palm have shown (literature summarised by *Menon and Pandalai* (8)), that the coconut requires potassium as its major mineral nutrient. It has been shown to play several fundamental and dominant roles in the many physiological aspects of the palm.

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Table 1 Influence of agricultural operations (cultivation and manuring) on the enzyme activity of coconut water

Enzyme activity	Not cultivated or manured	Cultivated only	Cultivated and manured
<i>Catalase</i> (Micromoles of H ₂ O ₂ decomposed per mg of nitrogen in 30 minutes)	130,5	116,5	65,5
<i>Peroxidase</i> (Optical density of purpurogallin formed per mg of nitrogen in 5 minutes in 20 ml reaction mixture)	1,61	1,55	0,211
<i>Polyphenolase</i> (Optical density of purpurogallin formed per mg of nitrogen in 10 minutes in 20-ml reaction mixture)	0,714	0,565	0,165

Experiments were therefore carried out to trace out any possible relationship between the potash content and the enzyme activity of coconut water. The enzymes studied and the technique followed were the same as those used in the first series of experiments. Typical results selected as before are presented in table 2.

Table 2 Influence of potash content of coconut water on its enzyme activity

Treatment given to the palms	Potash content of nut water mg per 100 ml	Enzyme activity (Expressed as in table 1)		
		<i>Catalase</i>	<i>Peroxidase</i>	<i>Polyphenolase</i>
Cultivated and manured	320,7	65,6	0,211	0,165
	335,9	76,9	0,244	0,185
Cultivated only	184,7	116,5	1,23	0,529
	203,2	145,2	1,55	0,565

Discussion

The results reveal that the lower values for the potash content of nut water obtained from the uncultivated and/or unmanured plots are associated with relatively higher enzyme activity and that the potash content of the water has some definite influence on the activity of the enzymes studied. These facts can be independently used as a diagnostic tool for the potash needs of the coconut palm. A higher enzymic activity of the nut water indicates, in our opinion, that the palms required to be manured with potash.

Variations in the pattern of enzyme activity in plant tissue materials have been observed and correlated to the mineral contents of the concerned tissues of crop plants, particularly in the case of the oxidising enzymes and potassium status by other workers also. Thus, the activity of the enzyme *catalase* and *saccharase* in estimating the biological activity and fertility of soils has been emphasised by

Kozlov (6). *Perur, Smith and Wiebe* (7) showed that a measure of the *catalase* activity in the soyabean leaf tissues reveals indications of its physiological response to iron. *Newman and James* (9) have mentioned that the enzymes are the ultimate biochemical components to be studied both qualitatively and quantitatively to understand the environmental influences on plants. *Hofmann* (3) reported that an idea of the activity of different enzymes in plants while growing and after their harvests would afford information on the fertilizer requirements of the concerned plants. *Fijimura, Osaki and Ikeda* (10) found that ascorbic acid oxidase activity in soyabean leaves of potassium deficient groups was stronger than in the normal potassium supplied groups. *Amberger* (11) observed that the respiratory enzyme activity was vigorous in the leaves of spinach, sugarbeet and pasture grass under potassium deficient conditions. *Brown and Hendricks* (12) reported studies on enzyme activities as indications of copper and iron deficiencies in plants. Our results on the nut water studies also give similar trends.

Summary

The enzymic activity of coconut water with respect to *catalase*, *peroxidase* and *polyphenol oxidase* has been studied and found to be correlated with its potash content. These appear to be influenced by the agricultural treatments received by the palms. Data in relation to these interrelationships afford a diagnostic tool for the assessment of the nutritional requirements of the coconut crop. There is a need to carry out thorough statistically planned studies in respect of the interrelationships between the activity of other enzymes shown to be present in the coconut as influenced by graded application to the soil of the other mineral nutrients including the trace elements. Studies on the influence of seasonal conditions, the soil types on which coconuts are found to grow etc. may also be expected to provide interesting information on the possibilities of using enzyme activity assessments in the nutrient deficiency diagnosis of the coconut palm.

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