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Responses of antioxidant potentials in *Dioscorea rotundata* Poir. following paclobutrazol drenching

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Abstract

The effect of paclobutrazol (PBZ) treatments on the antioxidant metabolism of white yam (*Dioscorea rotundata* Poir.) was investigated in the present study. PBZ @ 15 $mg\,l^{-1}\,plant^{-1}$ was given to plants by soil drenching, 30, 60, and 90 days after planting (DAP). The non-enzymatic antioxidant contents like ascorbic acid (AA), reduced glutathione (GSH) and α-tocopherol (α-toc), activities of antioxidant enzymes like superoxide dismutase (SOD), ascorbate peroxidase (APX), polyphenol oxidase (PPO) and catalase (CAT) were extracted and assayed on 100 DAP from leaf, stem and tubers of both control and PBZ treated plants. It was found that PBZ has a profound effect on the antioxidant metabolism and caused an enhancement in both non-enzymatic and enzymatic antioxidant potentials under treatments in white yam. Our results have good significance, as this increase the innate antioxidant potential of this food crop, which is helpful to satisfy the needs of antioxidants in diet and thereby make it an economically important food crop. ***To cite this article: C.A. Jaleel et al., C. R. Biologies 330 (2007).***

Keywords: Dioscorea rotundata; Paclobutrazol; Antioxidants; Antioxidant enzymes

1. Introduction

Cellular damage or oxidative injury arising from free radicals or reactive oxygen species (ROS) now appears the fundamental mechanism underlying a number of human diseases [1]. Antioxidants are radical scavengers, which protect the human body against free radicals that may cause pathological conditions such as anaemia, asthma, arthrists, inflammation, neurodegeneration, Parkinson's diseases, mongolism, ageing process, and perhaps dementias [2]. Free radicals can be scavenged through chemoprevention utilizing natural antioxidant compounds present in foods [3] and medicinal plants [4]. Some medicinal plants have been shown to have both chemopreventive and/or therapeutic effects on human diseases [5].

A pathway for ascorbic acid (AA) biosynthesis featuring GDP-mannose and L-galactose has recently been proposed for plants. AA is a very important reducing substrate for H_2O_2 detoxification in photosynthetic organisms [6]. AA participates in the removal of H_2O_2 as a substrate of ascorbate peroxidase (APX). Re-

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duced glutathione (GSH) is another most important non-enzymatic antioxidant molecule, which functions as an effective ROS detoxifier [7]. α-Tocopherol (α-toc) was consumed predominantly as a radical scavenging antioxidant against lipid peroxidation [8].

The enzymatic antioxidant defence system includes superoxide dismutase (SOD), ascorbate peroxidase (APX), polyphenol oxidase (PPO), catalase (CAT) and glutathione reductase (GR) [9]. SOD is a major scavenger of superoxide anion radical ($O_2^{\bullet -}$) that catalyses the dismutations of $O_2^{\bullet -}$ with great efficiency, resulting in the production of H_2O_2 and O_2 [10]. The H_2O_2 scavenging system represented by APX and CAT are more important in imparting tolerance than SOD, as reported in plants subjected to oxidative sreesses [11]. PPO is believed to be ubiquitous in the plant kingdom and they are primarily associated with the enzymatic browning and off-flavour generation [12].

White yam (*Dioscorea rotundata* Poir.) is one of the important edible tuber crops cultivated in India and many other tropical countries, including Africa [13]. Yams are valuable sources of carbohydrate, fibres, and low-level fats, which makes them a good dietary nutrient, and also processed into various staple, intermediate, and end-product forms [14]. Yams also have medicinal properties. Several species of *Dioscorea* are amongst the principle sources of diosgenin, which can be converted into medicinally important steroids [15]. Diosgenin is transferred to serum dehydroepiandrosterone in human intestine and is associated with reduced lipid peroxidation and lowered serum triglycerides [16]. A lot of works have already covered the food value [17], nutritional aspects [18], cultivation [19], processing technologies [20], medicinal aspects [21,22], growth-regulator effects [14,23,24], tissue culture, and genetic stability studies [25] of yam plants. But only little attention has been drawn to the antioxidant properties of this food plant. Although there are reports on effects of temperature on antioxidative status of yams [26] and antioxidant variations in different physiological regions of yam tubes [12], the literature regarding antioxidant properties and methods to enhance the antioxidant potentials in white yam is scarce. It therefore seems important to test the methods to increase the innate antioxidant potential of this food crop, in order to satisfy the needs for antioxidants in diet and thereby make it an economically important food crop.

Triazoles are a group of compounds, which have both fungitoxic and plant growth-regulating properties [27]. In addition, they can also protect plants against various environmental stresses [28]. Triazoles affect the isoprenoid pathway, and alter the levels of certain plant hormones by inhibiting gibberellin synthesis, reducing ethylene evolution, and increasing cytokinin levels [29]. Some of the previous works carried out in our lab revealed the morphological and physiological changes associated with triazole treatment in various plants, including inhibition of plant growth, decreased internodal elongation, increased chlorophyll levels, enlarged chloroplasts, thicker leaf tissue, increased root-to-shoot ratio, alkaloid production and enhancement in carbohydrate metabolism [14,24,30–38]. Paclobutrazol (PBZ) [(2*RS*; 3*RS*)-1-(4-chlorophenyl)-4,4-dimethyl-2-(1H-12,4-triazol-1-yl)-pentan-3-ol], a triazole, fungicide, having plant-growth regulator (PGR) properties, is reported to inhibit gibberellic acid (GA) biosynthesis and increase abscisic acid (ABA) and cytokinin contents [27]. Therefore, there is a need to investigate the efficacy of this compound in the enhancement of antioxidant potentials in white yam plants in order to increase their medicinal properties, thereby making them an economically valuable crop plant. Hence, this study aims to evaluate the ability of PBZ to enhance the antioxidative potentials, with special emphasis to both non-enzymatic and enzymatic antioxidant constituents.

2. Materials and methods

2.1. Plant materials and PBZ treatment

Tubers of *Dioscorea rotundata* cv. Sree Priya were obtained from the Central Tuber Crop Research Institute (CTCRI), Kerala, India, and planted at the Botanical Garden of the Annamalai University. PBZ was obtained as CULTAR 25% w/v. In the preliminary experiments, four concentrations (10, 15, 20, and 25 $mg\,l^{-1}\,plant^{-1}$) of PBZ were prepared and used for tuber treatment, in order to determine the optimum concentration at which maximum sprouting occurred. Among these concentrations, 15 $mg\,l^{-1}\,plant^{-1}$ was found to enhance the antioxidant potentials; at lower (10 $mg\,l^{-1}\,plant^{-1}$) and higher (20 and 25 $mg\,l^{-1}\,plant^{-1}$) concentrations, there was no significant effect. Hence, 15 $mg\,l^{-1}\,plant^{-1}$ were used for this study. The treatment was given by soil drenching on three vegetative growth periods, i.e., 30, 60, and 90 DAP. For each treatment, one litre of the solution was used. The control plants were given tap water. The plants were uprooted on 100 DAP washed and separated into leaf stem and tubers for extraction and assay of antioxidant potentials.