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GLUTATHIONE S-TRANSFERASES ENZYME EFFECT IN PLANTS / A REVIEW ARTICLE

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Abstract
Glutathione S-transferases (GSTs) regard mainly multifunctional proteins included into various intracellular events like stress metabolism, both primary metabolism and secondary metabolism, herbicide detoxification process in addition to plant defense oppose heavy metals, ozone destroy and xenobiotic. They consider mainly cytoplasmic enzymes which can be dissolved. Up to now, the crystal structures of More than two hundred of soluble GSTs, that are found into the bacteria, animals in addition to plants are determined. The function of them is affected by crystal structure of GSTs. Both glutathione-s transferases and plant glutathione transferases, actually are consist of many kinds. The types of glutathione transferases (GSTs) and Plant glutathione transferases possess several using by both divergent and convergent paths, phylogenetic studies indicates that every soluble GSTs originated essentially from the old progenitor gene.

Keywords: Plant Glutathione S-transferases, detoxification, Heavy metal stresses.

Introduction

The plant glutathione transferases are known as glutathione *S*-transferases (GSTs: EC 2.5.1.18) previously and regard a big and various types of enzymes that catalyze the conjugation of the tripeptide glutathione (GSH: γ-glu–cys–gly) with the xenobiotic electrophilic substrates. At beginning, they found in the 1970s as result of their ability to combined and thus detoxify the II inhibitor atrazine's chloro-s-triazine photosystem in corn**.** glutathione *S*-transferases with activity upon another herbicides have been depicted now in several major weeds and crops [1] GSTs have been attentively related with abiotic and biotic stresses. Glutathione *S*-transferases are classified into at less 3 main protein groups in eukaryotes, depend on location in the cell ,that named microsomal GSTs , mitochondrial GSTs and cytosolic GSTs. Plant Glutathione *S*-transferases have been generally cytosolic located and act up to two percentages of all soluble proteins.The Glutathione *S*-transferases family is subdivided to fourteen types in photosynthetic organisms, depend on phylogenetic and genomic studies ,the Tau GSTs and Phi GSTs (GSTFs) regard most common kinds than others. Selective herbicides in the form of dimers are detoxified by GSTs, which also catalyze the conjugation of a variety of xenobiotics. [2] One such reductant of protein disulfides is glutathione.

Herbicides are detoxified via the conjugation process, either the function of one glutathione among many-S-transferases or spontaneously in addition to it arrange gene expression in effect to pathogen attack and environmental stress. GSTs have main role in The detoxification of an extensive variety of xenobiotic substances in addition to the normal cellular metabolism and in plants they are highly investigated with regard to herbicide detoxification. Recently, they found plant Glutathione *S*-transferases subclass has been involved in many stress responses that containing these deriving from heavy-metal toxicity, oxidative stress and pathogen attack. As well as , plant Glutathione *S*-transferases have main role in cellular responses to effect of auxins ,

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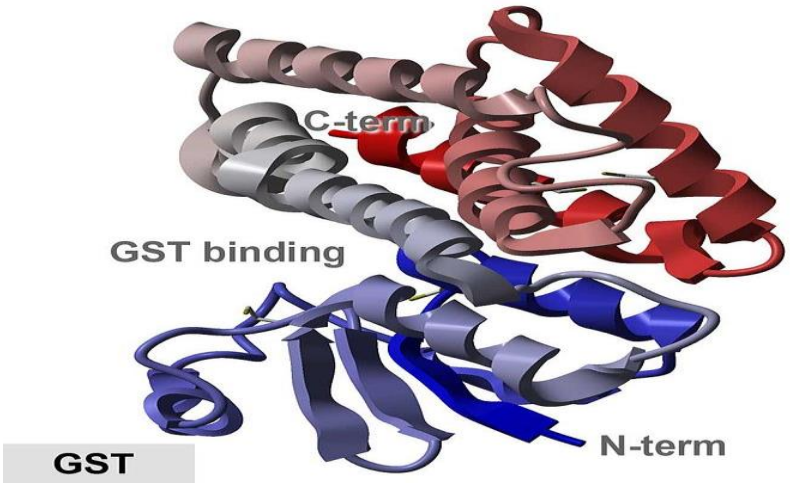
through normal metabolism of secondary products such as cinnamic acid and anthocyanins .[3]

1-1 GSTs chemical structure:

The soluble plant Glutathione *S*-transferases super-family include dimeric enzymes which considers commonly tiny proteins (200 –250 amino acids) . All The protein dimer's GST subunit has a specific catalytic region that consist of 2 components.The 1st component is made up of a conserved set of amino acid residues in the polypeptide's amino-terminus domain that bind specifically to GSH and nearly related homolog (the G site) The H site in the 2nd component facilitates binding of the hydrophobic substrate, that is greatly much alterable in structure. It is constructed from residues that lies in the carboxy-terminus domain. (Fig. 1) There is short variable linking area from five to ten residues between the 2 domains. The enzyme's H and G sites are both completely mobile whenever the crystal structure has been ascertained, suggesting that the GST subunits endure considerable conformational varieties upon binding the substrates. Furthermore, plant Glutathione *S*-transferases have greater cleft to co-substrate binding contrast with mammalian Glutathione *S*-transferases and thus they can admit larger and greatly more various substrates [4]



1-2 Plant (GSTs) classes:

In plants, A broad and varied gene family that may be categorized based on sequences has encoded the GSTs

That identity generally into the tau, phi, zeta, theta and lambda types which has been depend on the protein sequences(Fig. 2). [5] The both plant-specific Phi and Tau GSTs are biggest classes. The two types possess main roles in the herbicide detoxification event**.**As well as , Those GSTs serve as glutathione peroxidases in endogenous metabolism, which is one of their lesser-known functions which

preventing oxidative stress and in addition they are representing as regulators of apoptosis , stress signaling and flavonoid-binding of proteins, In contrast, the smaller Zeta and Theta classes of GSTs are also found in animals and fungi, indicating conserved and essential functions for these enzymes in all eukaryotes.[6]**.**The rest types of GSTs have diverse roles such as , isomerase activity ,sharing in exhibiting peroxidase and hormone signaling [7]

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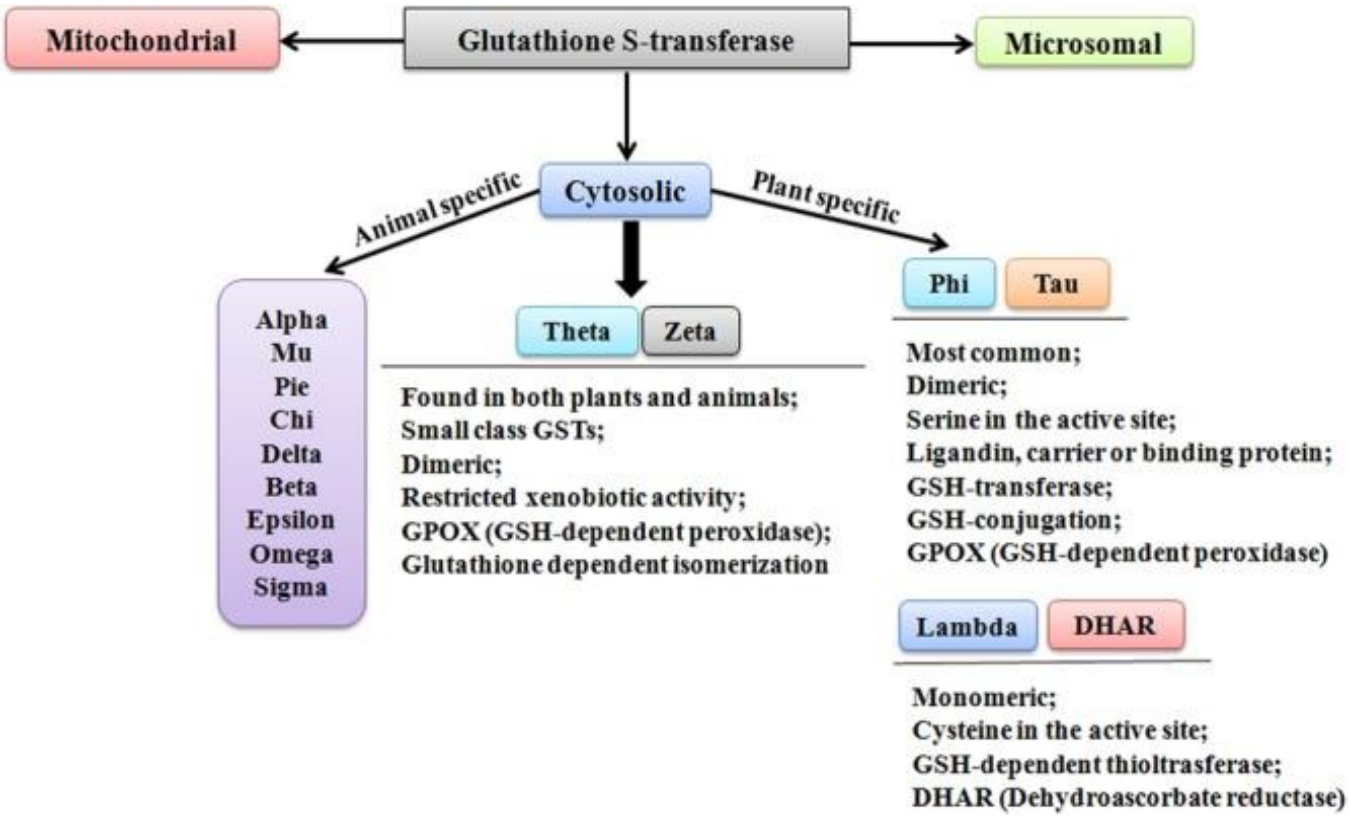

1-3 Plant(GSTs) Mechanism:

In terms of how plant GSTs have been modified to carry out a variety of their functions, hence the studying the enzymatic chemistry of the GSTs is highly important. The fact that the G site is retained suggests that glutathione binding and proper orientation are crucial.. The G site aids in the ionization of GSH's sulphydryl group during hydrogen bonding with a neighboring hydroxyl group, generating a highly reactive thiolate anion
[8]

2- Plant (GSTs) Physiological functions:

Glutathione S-transferases (GSTs) have generally main roles in both the detoxification process of a great diversity of xenobiotic components in addition to metabolism during cell activity , thus in the plants they are widely researched on regard to herbicide detoxification. Recently, they found plant Glutathione *S*-transferases subclass has been involved in many stress responses that containing these deriving from heavy-metal toxicity, oxidative stress and pathogen attackAs well as , plant Glutathione *S*-transferases have main role in cellular responses to effect of auxins , through normal metabolism event of secondary products like the cinnamic acid and anthocyanins [9] The functional variability range into GSTs does them outstanding in researching the developing sides of gene family and open up way to determine the many actions of Glutathione S-transferases in plant response and evolution into environmental indications.

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2-2 Plant glutathione S-transferases with Stress Response:

Glutathione S-transferases have been known crucially to convey the various levels of plant evolution . Scientific researches propose that Glutathione S-transferases expressions are caused via many environmental stimulator that involving the biotic stresses factors for instance, pathogen attack and fungal elicitors [10] All hormone treatments, drought, cold, phosphate starvation, heavy metals, H_2O_2, wounding, salts regard examples for abiotic stresses [11]

2-1 Plant GSTs are the detoxification:

In plants, Glutathione S-transferases have been typically included in the detoxification processs of intracellular oxidized molecules in addition to exogenous xenobiotic , like lipid peroxides, to lessen oxidative and chemical destroy and anthocyanin transfer to the vacuole. There are two enzymatic activities: the peroxidase and transferase the activities, GST-mediated cellular detoxification has highly depend on both of them , The G site aids in the ionization of the GSH sulphydryl group during hydrogen bonding with a neighboring hydroxyl group, generating a highly reactive thiolate anion. The resulting conjugates were then exported to an apoplast or vacuole from the cytosol As peroxidases, Certain glutathione S-transferases demonstrate GSH-dependent glutathione peroxidase (GPOX) activity, allowing lipid peroxide compounds to be reduced to alcohol compounds
[12]

2-3 Plant GSTs and Heavy Metal Stress:

The heavy metals (HMs) consider the one of major abiotic stress that can induce hazardous affects in the plants. The heavy metals toxicity may be cause to excessive accumulation of methylglyoxal (MG) and reactive oxygen species which is known as (ROS) causing to the oxidation of proteins, lipids peroxidation, impairment of DNA, enzymes inactivation, or/and effecting main components of the plant cells [13] Glutathione S-transferases has response to various heavy metals involving arsenic. The scientific studies indicate that in plants **,**thus lipid peroxidation processis brought on by the induction of the Reactive Oxygen Species (ROS). and oxidative stress [14] Arsenic toxicity causes phytochelatins(PCs) synthesis also induces to produce non-translationally from (GSH). When HMs are exposed to plants, their GSH levels rise, It has associated with the process of induction of feedback that cause rising genes encoding members expression of gene family of glutathione peroxidases (GPX) in addition to family of Glutathione S-transferases under As stresses**.** phytochelatins do many complexes with As, that may be more isolated to each vacuole during both ABCC2/ABCC1 transporters. [15]

3- Conclusions

In biological treatment of plant , GSTs are essential when subjected to both biotic and abiotic stress
hence, Future research on this enzyme might be beneficial in increasing agricultural productivity
Because of their versatile features and fascinating area of research for functional properties

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