Heat Shock Proteins (HSPs) Inducers for Stress Management in Agricultural Crops

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Abstract

Heat shock proteins (HSP) are expressed in response to various biological stresses, including heat, high pressures, and toxic compounds. It is also one of the most abundant cellular proteins found under non-stress conditions. HSPs are classified into different families and designated by molecular weight in kDa. HSPs 60, 70 and 90: act as molecular chaperons, involving ATP dependent stabilization and folding of proteins and assembly of oligomeric proteins. They can assist in polypeptide transport across membranes into cellular compartments, temporarily bind and stabilize an enzyme at a particular stage in cell development, later releasing the enzyme to become active. Binding of HSP with particular polypeptide within sub cellular compartment avoids denaturation of many proteins at high temperatures.

Keywords:

1. Introduction

Heat Shock Proteins (HSPs), or stress proteins, are highly conserved and present in all plants and animals. Some HSPs also referred to as molecular chaperones, play an important role in protein stabilization such as assembling of multi-protein complexes, folding or unfolding of proteins, transport or sorting of proteins into correct compartments at sub-cellular level, control of cell-cycle and signaling, as well as cell protection against stress or apoptosis . In plants, expression pattern of a number of genes modulated in response to various acute environmental changes. This altered pattern result in altered biochemical and physiological activity of the cell and developmental pursuit of the organism. When plants were exposed to high temperatures a new expression pattern was observed by the biosynthesis of HSPs. The heat-shock response in plants is similar to that of other organisms. Trimerization and activation of heat shock factors (HSFs) regulate the induction of heat shock genes. HSFs act in the promoter region of the HSP genes through a well-defined and highly conserved heat shock element (HSE) (Usman et al., 2014).

HSPs are essential components of cells and developmental processes under normal physiological conditions besides its role in heat stress. Heat stress is one of the main abiotic stresses and affects the production of various crops. High temperatures alter several metabolic processes reducing photosynthetic activity that results mainly in grain yield losses. Plants response to heat shock leads to changes in the cellular membrane structure, protein metabolism, level of enzymes and photosynthesis activity (Miernyk, 1997).

2. Nature of Heat Shock Proteins

• Heat shock proteins (HSP) are expressed in response to various biological stresses, including heat, high pressures, and toxic compounds. It is also one of the most abundant cellular proteins found under non-stress conditions.

• Hsp90 is part of a family of proteins known as “chaperones,” which are solely dedicated to helping other proteins fold and assume their proper functions.

• The chaperones Hsp70 and Hsp90 together with co-chaperones function to fold proteins in the cytoplasm. Sometimes Hsp70 and Hsp90 function sequentially to fold the same protein.

• Cells are vigilant about getting these folds right because misfolded proteins can change the normal life of the cell. In some cases change is good, in others deadly.

• When HSP90 is compromised the number of morphological changes increases, which lead to formation of inactive or abnormally active polypeptides.

3. Types of HSPs

HSPs are classified into different families and designated by molecular weight in kDa.

• HSP 100 k Da

• HSP 90

• HSP 70

• HSP 60

• 15 – 30 kDa low molecular mass HSPs or Small HSPs.

3.1. Functions of various types of HSPs

• HSPs 60, 70 and 90: act as molecular chaperons, involving ATP dependent stabilization and folding of proteins and assembly of oligomeric proteins.

• Some HSPs: assist in polypeptide transport across membranes into cellular compartments.

• Some HSPS: temporarily bind and stabilize an enzyme at a particular stage in cell development, later releasing the enzyme to become active.

• Binding of HSP with particular polypeptide within sub cellular compartment avoids denaturation of many proteins at high temperatures.

4. References

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