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AQUAPORINS AS A WATER CHANNEL PROTEINS

Shahid Raza and Hira Mubeen*

Department of Biotechnology, University of South Asia, Lahore, Pakistan.

***Corresponding Author: Hira Mubeen**

Department of Biotechnology, University of South Asia, Lahore, Pakistan.

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ABSTRACT

Aquaporins are water channel membrane proteins found as a part of major intrinsic protein (MIP) superfamily. MIP was considered as the basis for nomenclature PIP, TIP and NIP also indicating the subcellular localization plasma membrane, tonoplast and nodule of the respective founding member. More than 150 MIPs have been identified in organisms ranging from bacteria to animals and plants. In plants, aquaporins are present in the plasma membrane and in the vacuolar membrane where they are abundant constituents. Plants contain a large number of aquaporin isoforms with distinct cell type- and tissue-specific expression patterns. Some of these are constitutively expressed, whereas the expression of others is regulated in response to environmental factors, such as drought and salinity. Studies suggested the role for aquaporins in regulating transmembrane water transport during the growth, development, and stress responses of plants. Hence it is suggested to research out the integrated functions of aquaporin in water transport and to explore its more functions as a transport protein.

KEYWORDS: Transmembrane, MIP, constitutively, salinity.

INTRODUCTION

Aquaporins are water channel membrane proteins with the extraordinary ability to combine a high flux with a high specificity for water. Aquaporins allows movement of water according to its water potential gradient. The activity of aquaporins must help to control the rate of transmembrane water flux. Water transport occurs by diffusion through lipid bilayer and also by water channels. The transport of water across cell membrane lipid bilayer is not efficient for flux. This flow of water is possible because of presence of aquaporins.

Aquaporins are considered as highly abundant sequence related water channel proteins that belongs to the MIP superfamily many membrane proteins. According to previous studies, more than 150 partial and full length clones have been reported and isolated. Generally, MIPs can be divided into two main groups, aquaporins as transporters of glycerol and other some other small neutral molecules. It was found from previous reports that all members of intrinsic proteins have evolved from bacterial paralogs along with an aquaporin and a glycerol facilitator.[1]

Abundance of Aquaporins

Expression levels of aqupurins vary according to their type and location of expression. Hence, many aquaporins are found to be expressed in roots. [2-3] For example, the tobacco PIP1 aquaporin NtAQP1 was shown to be present in cells and controls the flow of water. [4] Due to the fact, the plants were found to be more susceptible to water stress.[5] Another member of PIP2 subfamily, AtPIP2 of Arabidopsis is present in root endodermis. Studies shown if PIP2 will be silenced it will result in reduced expression and root hydraulic conductivity by 14%. [6]

Plant Aquaporin

Plant aquaporin was first described in 1993 with occurrence of *Arabidopsis* tonoplast intrinsic protein γ-TIP. It was known to exhibit water transport activity when expressed in *Xenopus* oocytes. [7] The γ-TIP was first isolated by homology cloning with a corresponding cDNA molecule to α-TIP which is a seed-specific tonoplast integral protein. This was found as an abundant protein which plays an important role as a total protein content of bean cotyledons. [8]In plants, multiple plasma membrane proteins were identified by using a polyclonal antiserum raised against integral membrane proteins of Arabidopsis roots.

Screening is important for cDNA library to obtain positive and large number of clones. Studies shown, the immunoscreening of cDNA library for an *Arabidopsis* root resulted in various positive clones. Similarly, many of these clones were found to encode proteins of about 30 kDa, which were found to be aquaporins. [9] It was found from previous research, *Arabidopsis thaliana* has 35 sequences with high similarity to aquaporin genes. Similarly, in maiz 36 in rice genome 33 aquaporin sequences were reported. [10-14]

Subfamilies of Aquaporins

Plant aquaporins are divided into four subfamilies on the basis of sequence similarity. Including, the plasma membrane intrinsic proteins (PIPs), the tonoplast intrinsic proteins (TIPs), the nodulin26-like intrinsic proteins (NIPs) and a small group named the small and basic intrinsic proteins (SIPs). Various complexieties about their location exisits but PIPs and TIPs are largely targeted to the plasma membrane and the vacuolar membrane [10]. This shows the plant aquaporins are highly divergent. This evidence was best indicated by the presence of aquaporins in the *Physcomitrella patens* leading to same type of four subfamilies.[15]

DISCUSSION AND CONCLUSION

Aquaporins are members of specialized protein family which were discovered and cloned from human erythrocytes. [16-17] Members of this integral membrane protein family were found in abundance nearly in all living organisms. Aquaporin proteins are connected through conserved six transmembrane helices connected by three extra and two intracellular loops. Also, with the N- and C-terminal domains protruding into the cytoplasm.The existence and presence of aquaporins in cellular membranes is important for rapid transmembrane water transport. It was also found to provide an opportunity to an organism to regulate and control the flux of water between and within cells. This regulation of aquaporins has been observed at the transcriptional level and also in some post-translational modifications. Various problems related to their role exist in the plants are need to be solved. Most important is to know how they function at cellular and whole plant level. Hence, it is suggested to explore the major functions of aquaporins to understand its structure at molecular level and to highlight its role in water transport mechanisms.

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