H+-PPase hyper-coupling and sugar accumulation are induced during stress caused by low temperature in Saccharum officinarum

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At the cellular level, low temperatures cause energy stress in plants. This affects plant growth, especially by physical and biochemical changes of cell membranes influencing these membrane proteins and their functions. The plasmalemmal H+-ATPases and the vacuolar H+ pumps (V-ATPase and H+-PPase) energize the transmembrane transport systems, control extra and intracellular pH and participate in ion homeostasis, being modulated in response to environmental stresses. In order to investigate the effects of low temperatures on the sugarcane H+ pumps, two parental genotypes were studied: Saccharum officinarum and Saccharum spontaneum. These plants were grown at room temperature for the control group and at 10°C for 30 days as a stress treatment. Microsomal vesicles were isolated by differential centrifugation of the stem, and the pumps hydrolytic activity and H+ transport were measured spectrophotometrically. In vitro analyzes were performed at 10 and 25°C and sugars content were quantified by enzymatic method. S. officinarum cultured at 10°C accumulated more fructose and sucrose and its ATP-dependent pumps were shown to be uncoupled during the in vitro assay at 10°C, while the H+-PPase shows a hyper-coupling. S. spontaneum grown at 10°C decreased sucrose, but the glucose and fructose levels remain unchanged. Their plasmalemma pumps remain well coupled even at 10°C, in vitro. The results suggest a clear correlation between the H+ pumps coupling capacity with the resistance to stress by low temperature, highlighting the P-ATPase and H+-PPase activities as potential biochemical targets for breeding programs aiming the development of hybrids adapted to subtropical and temperate climates.

Keywords: Energy Stress; Proton Pumps; Plant Production.