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Effects of copper and its environmentally friendly alternatives in plant protection on sarcoplasmic reticulum Ca^{2+}-ATPase

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Copper is an essential trace element for any living organism and microorganism. However, copper is highly toxic when in excess, affecting several physiological and biochemical processes. Copper accumulates in the soil and the environment, so that a dramatic increase of free Cu^{2+} occurs in the agrosystems due to intensive copper applications as fungicides and bactericides in plant protection. As an alternative to copper in the control and management of bacterial diseases of plants, an innovative strategy is currently being developed which is based on the design and use of environmentally friendly biomolecules, *e.g.* oligopeptides and polyphenolic compounds extracted from plants. The aim of the present study was to evaluate and compare the effects of such environmentally friendly biomolecules on the sarcoplasmic reticulum (SR) Ca^{2+}-ATPase, to exclude their possible toxicity on common subcellular targets for any living organism. The SR Ca^{2+}-ATPase belongs to the highly-conserved P-type ATPase family. P-type ATPases are a large, ubiquitous and heterogeneous family of membrane proteins that are involved in many transport processes in virtually all living organisms [1]. In particular, SR Ca^{2+}-ATPase sustains active transport of Ca^{2+} ions and plays a major role in cell Ca^{2+} signaling and homeostasis. In our study we employed an electrical method, which makes use of a solid supported membrane (SSM) [2]. ATP concentration jumps were performed on Ca^{2+}-ATPase incorporating vesicles adsorbed on a SSM and the ATP-induced current signals were recorded, in the presence of copper (Cu^{2+}) and of these potential copper substitutes (oligopeptides and polyphenolic compounds). We found that copper completely suppresses the ATP-induced current at sub-micromolar concentration, while the peptide AP17 does not affect the Ca^{2+}-ATPase current signal over a concentration range from 1 to 30 μM. In the case of the polyphenolic compound epigallocatechin-3-gallate (EGCG) no effect on the ATP-induced current was observed at 1μM, while a reduction of the current amplitude was recorded at 10 μM. Thus, our results indicate that as compared to copper, AP17 and EGCG do not interfere with ATP-dependent Ca^{2+} translocation through the enzyme in the submicromolar concentration range.

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