Understanding Antagonistic Interactions between Heartburn Drugs and the Effectiveness of Heartburn Drug Combinations

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Antagonistic drug interactions can negatively impact treatment effectiveness. This project investigated the antagonistic interaction between two heartburn drugs: aluminium hydroxide and calcium alginate. Research has shown that aluminium hydroxide weakens the alginate gel barrier, which normally blocks acid reflux. To investigate this weakening mechanism, the alginate gel was tested for its ion binding capability. Mass spectrometry analysis found that aluminium ions can replace calcium cross-linkers in the gel, possibly leading to structural defects in the polymeric network and causing noticeable weakening. Atomic force microscopy experiments could not successfully image the structure of the alginate gels because the gels were too soft. Magnesium hydroxide was then trialled as a non-disruptive additive. It was predicted that Mg^{2+} would not interfere with alginate gelation given the widely reported finding that Mg^{2+} has a low affinity for alginate. In this experiment, magnesium or aluminium ions were added to calcium alginate (Ca Alg) gels. Mg^{2+} and Al^{3+} exchange with Ca^{2+} occurred for 20 minutes. The volumes of hydration of Ca Alg gels were measured as a structural indication of gel porosity. Results showed that aluminium addition disturbed gel structure (i.e., porosity) to a greater extent than magnesium addition. Magnesium also maintained Ca Alg elasticity whereas aluminium addition produced brittle gels, which are less effective as anti-reflux barriers as they are more easily fractured by erratic stomach movement. Hence, the drug combination of magnesium hydroxide and Ca Alg may more effectively unite the chemical and physical mechanisms of heartburn treatment without unintended gel weakening.