Acid Induced Demineralization of Bovine Enamel and its Effects at Molecular Level

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INTRODUCTION.

Enamel is a protective highly mineralized layer covering the teeth. It is made of carbonated hydroxyapatite microcrystals (95 %) embedded in an organic framework. Crystals making the enamel are long ribbonlike crystals packed in parallel arrays or rods which are in turn arranged in a complex microstructure that confers to enamel outstanding mechanical properties. (Boskey A. L, 2.007). The organic matrix is made of noncollagenous proteins (Lowenstam & Weiner, 1989). There are two main groups of enamels proteins in the organic matrix: 1) A group of hydrophobic proteins of low molecular weight denominated amelogenins. 2) A group of nonamelogenin proteins which are acidic glycoproteins and are denominated enamelins.

The process of acid induced demineralization of teeth is very important for its clinical implications as acid attack are the main cause of dental caries. Additionally, there are different clinical treatments in which chemical agents with demineralization capabilities are commonly applied. Thus, a better understanding of this process could allow us to select or design less aggressive bleaching or acid etching agents. Thus, this paper is mainly focused in investigating in detail the acid induced demineralization of enamel and in particular studying the process at the molecular level.

MATERIALS AND METHODS.

The evolution of the chemical composition of enamel from bovine incisors treated with diluted phosphoric acid at 0,1 % was determined by atomic absorption (AA) and Fourier Transform infrared (FTIR) spectrometries. AA spectrometry is here used to determine the calcium mobilized by the acid treatment.

FTIR can directly and simultaneously give quantitative information about the molecular constituyents of the mineral and organic parts forming enamel mineralized tissue to monitor the compositional and structural changes occurring in enamel at the molecular level during demineralization. (Rodriguez et all., 2006)

RESULTS AND DISCUSSION.

AA analyses indicate that as the time of exposure to acid increases, the amount of calcium mobilized to the solution increases very fast in the first minutes and stabilizes later with time. This result indicates that the mineral part is loss in the initial stages of acid exposure but the acid is neutralized in the later stages.

FTIR analyses indicate that the degree of mineralization (measured as the phosphate to total amide ratio) (Rodriguez et all., 2006) does not change significantly with the time of exposure to the acidic solution. This indicates that both the mineral and organic parts are lost simultaneously and at equal rates during the acid exposure so that the mineral to organic ratio is maintained more or less constant. Nevertheless, other compositional parameters determined from FTIR analyses shows that the exposure to the diluted acid solution modified the composition of mineral and organic parts of enamel samples in a well defined way. Regarding the mineral part, there is a selective and progressive removal of phosphate from poorly crystalline environments by the acid solution during the demineralization process. Additionally, phosphate mineral rich in carbonate are preferentially removed during the demineralization process.

FTIR analyses show that the composition of the organic matrix, characterized by the area of absorption peaks associated to amide groups, changes also in a well defined way due to the exposure to acid. More specifically, we have observed that there is a positive correlation between the peak area of amide I groups and the time during which the enamel was immersed in the acid solution, while there is a negative correlation between the peak area of amide III with time of exposure to the acid solution. These results indicate that the organic components rich in amide III are preferentially lost as the acid induced demineralization progresses. The main contribution of amide III band is from CN and CH molecular groups from proteins and lipids (Jodaikin et al., 1987) which indicate that organic mater of hydrophobic nature is selectively loss by the exposure to the diluted acid. These components are associated to proteins of the amelogenin family.

CONCLUSIONS.

Compositional changes during enamel demineralization can be explained only if considering the complex composition and heterogeneity of the enamel tissue. Additionally, this work reveals the importance of analysing the compositional changes due to acid induced demineralization at the molecular level for evaluating the effects of acid etching and bleaching chemicals during clinical treatments.

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