Evaluation of the demineralization potential of dental bleaching gel (35% hydrogen peroxide) in bovine enamel

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Objective: This study aimed at performing a quantitative analysis of the demineralization potential of dental bleaching gel (35% hydrogen peroxide), compared to 37% phosphoric acid gel, in bovine enamel samples. **Methods:** fifteen bovine enamel fragments with $30 \pm 2 mm^2$) were prepared and divided into three groups (n = 5): group I – saline solution, without bleaching agent; group II – 35% H_2O_2 bleaching gel applied for three times of 15 minutes each; and group III – 37% phosphoric acid for 30 seconds. The specimens were weighed on an analytical balance before and after the immersion in the solutions. The demineralization was calculated using these weights and the dimensions of the samples. **Results:** the data were submitted to statistical analysis, which indicated that 35% hydrogen peroxide leads to a statistically lower enamel demineralization than 37% phosphoric acid conditioning, and similar to the control group (saline solution). **Conclusion:** it can be claimed that the tooth whitening using 35% hydrogen peroxide presents itself as a viable dental procedure, being tolerated by the dental enamel. **Keywords:** Dental enamel. Demineralization. Tooth bleaching.

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INTRODUCTION

Hydrogen peroxide, in different concentrations, has been widely used in dental bleaching procedures. It is believed that its mechanism of action is in the free radicals' strong oxidative action, acting by broking the polypeptide chain, causing the destruction of the amino acids, which are the organic substances of the dental structure.[15]

However, this agent's aggressive potential that may cause to the dental structure is not totally clarified, more specifically to the enamel. There are researches reporting that bleaching agents containing hydrogen peroxide do not have significant damaging effects upon the enamel surface or dentin, or even in its morphology, chemical composition, microhardness and ultrastructure of its undersurfaces,[6] including researches where the bleaching was performed beyond recommended.[16] Others say that the dental bleaching makes irreversible damages to dental structure, causing changes in the enamel's microstructure, such as initial caries demineralization,[9] as well as the matrix of the enamel,[12] besides calcium and phosphate loss[1]. In this context, there are still doubts about how far those bleaching agents can remove the mineral elements from the teeth, during the bleaching process.

Phosphoric acid, largely used in restorative procedures for conditioning the dental surface previously the adhesive application, also has demineralization potential to the dental structure, since one of its purposes is to create micropores by the consequent demineralization of the dental surfaces, which later will work as micro retentions to resinous materials through the selective dissolution of the enamel's prisms and perimeters.[7,13]

Based on these assumptions, this research aims to accomplish a quantified analysis of the dental bleaching gel's demineralization potential – 35% hydrogen peroxide - comparing to the 37% phosphoric acid, over bovine dental enamel.

OBJECTIVE

This research aimed to make an in vitro evaluation of the bovine dental enamel demineralization by the action of the dental bleaching gel, 35% hydrogen peroxide, compared to 37% phosphoric acid, through water solubility standard.

MATERIALS AND METHODS

Fifteen bovine enamel samples with approximately 30 ± 2 mm^2 of surface area – 5 mm height per 6 mm width - were prepared and divided in three (n = 5) different experimental conditions, as it follows:

- Group 1: saline solution (control);
- Group 2: bleaching gel (35% hydrogen peroxide); and
- Group 3: 37% phosphoric acid.

For this study, inferior incisors bovine teeth, without caries or fractures, were selected and cleaned with periodontal curettes, sodium bicarbonate jet (Profi II, Dabi Atlante), and stored in 0,9% saline solution with thymol in a refrigerator until further analysis.

The vestibular portion of the crown of each tooth was cut with carborundum discs, upon handpiece (straight angle), and later measured and cut again so achieve 5x6x1,7 mm size, approximately.

After being prepared, bovine enamel samples were weighted on an analytical scale (precision of 0.2 mg) and stored inside a desiccator containing silica at 37° C (± 1 °C). After 24 hours, the samples were kept at 23 °C (± 1°C) for one hour and weighted until achieve a constant mass (m1). After this procedure, the samples from group 1 were submerged in saline solution (0,9% sodium chloride) for 7 days at 37 °C; sam-

ples from group 2 were previously submerged in 35% hydrogen peroxide (FGM) for 3 times in a row (15 minutes each); and the samples from group 3 were submerged in 37% phosphoric acid gel (Condac 37 FGM) once for 30 seconds.

Subsequently, samples from both groups 2 and 3 were stored in saline solution for 7 days at 37 °C. All samples were then removed, water washed and the humidity excess taken with the help of gauzes. About one minute after been removed from the solution, samples were weighted and the mass registered as m2.

Figure 1: Bovine dental enamel samples.

Finally, the samples were reconditioned to a constant mass, following the same desiccation procedure mentioned before, using a new silica. The latter constant mass was recorded as m3.

Each sample dimension (height X width X thickness) was measured by a digital pachymeter of 0.01 mm precision. Then, the volume (V) was calculated in mm^3, according to the equation V = base X height X width.

The solubility or demineralization (Wsl) was calculated in $\mu g/mm^3$ for each sample using the equation Wsl = (m1 - m3)/V, where m1 is the samples's mass conditioned before immerged in saline solution, m3 is the sample's mass reconditioned and V is the volume of each one.

The data were submitted to analysis of variance (ANOVA) ($p<0.05$) considering saline solution, bleaching gel and phosphoric acid as sources of variation.

RESULTS

The results of water solubility in bovine enamel samples are presented in Table 1 and graph 1. Phosphoric acid (37% H_2PO_4) presented the highest demineralization level (54.64 $\mu g/mm^3$) compared to bleaching gel (35% H_2O_2) and the saline solution (6.76 and 1.12 $\mu g/mm^3$, respectively).

Figure 2: Stored samples in a container with silica.

Figure 3: Measurement with a digital pachymeter of 0.01 mm precision.

Table 1: Average and standard deviation values of water solubility in bovine enamel samples under three different treatments.

GROUP	WSL (MG/MM³) (AVERAGE ± SD)
1- Saline solution	1.128542742 ± 1.200741199[a]
2- Bleaching gel	6.769064613 ± 3.710728971[a]
3- Phosphoric acid	54.647534044 ± 21.123053972[b]

Different letters indicate statistically significant difference (sd<0.05)

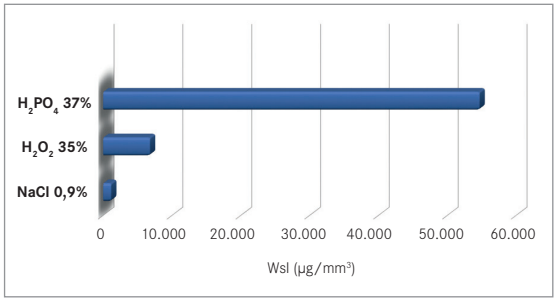
DISCUSSION

The concern with aesthetics has been increasing, and it has not been different in dentistry. The restorative and dental bleaching procedures are being largely seek by even more demanding patients, where the dental structures are exposed at several chemical substances, that are oftentimes aggressive to the enamel and dentin.

The enamel is a highly mineralized substrate, composed by 96% mineral and 4% organic substance, and water. The enamel inorganic content is composed specially by hydroxyapatite crystals and the organic matter builds a thin wire between the crystals.[9]

The demineralization of the enamel happens as a chemical dissolution of the tissue, that can occur in two different ways: bacterial acid dissolution – resulting in dental caries – and the non-bacterial dissolution that characterize the dental erosion.[10,11]

Some of the acids that are used frequently in dental procedures for conditioning the tooth surface: eliminating smear layer, promoting cleanliness, increasing surface energy and creating micro pores. It provides a better infiltration of the adhesive system, with consequent better adhesion of the resinous materials,[7,12,13] and also causes the enamel demineralization. Among them, the 37% phosphoric acid can be highlighted, when presented in a gel form, while a 15 to 30 seconds application time,[13] creating micro retentions in the enamel by the dental surface demineralization.[7,8]



Graph 1: Average values of water solubility.

At the moment that the enamel is exposed to acid nature compounds, hydrogen ions quickly dissolves the mineral portion, causing calcium and phosphorus ions loss, resulting into the crystal reduction and expansion of the intercrystalline spaces. Through the dissolution process, the carbonate in the enamel structure also can be loss.[14]

Several dental bleaching systems with hydrogen peroxide are formulated under extremely low pHs (usually under 4), giving them an acid nature to ensure stability.[15] With low pH and high hydrogen peroxide levels combination, it is expected that it affects the dental tissue's surface and subsurface integrity and reacts with the tooth mineral substrates,[16] causing calcium and phosphorous loss in different levels.[6]

The bleaching agents' effects on the dental tissues structures remain controversial. It was noticed that even the tooth bleaching per-

formed beyond recommended, does not make changes when the enamel and dentin's subsurfaces are analyzed, or even in their ultrastructures or architectures.[3]

On the other hand, it was observed that continuous dental bleaching causes, at the same time, a progressive enamel demineralization and matrix degradation of a layer that probably has only a few microns of deepness.[5]

The obtained results in the comparative/quantitative analysis of this study showed that the dental bleaching agent (35% hydrogen peroxide) is responsible for most of the enamel demineralization, but it is statistically lower than the conditioning with 37% phosphoric acid, and similar to the control group (saline solution), demonstrating that since demineralization process is similar to the one that naturally happens in the mouth cavity, whitening is then a clinically viable method. It's presumed that the remineralization of the substrate exposed to the bleaching agent occurs, since inside the mouth cavity the demineralization and remineralization are dynamic processes that happens constantly.[6]

CONCLUSION

According to this research methodology, performed with bovine teeth, and later statistical analysis, it can be concluded that:

- the enamel fragments demineralization caused by the 35% hydrogen peroxide was lower than caused by the 37% phosphoric acid; and

- for presenting a demineralization level close to the enamel fragments stored in saline solution (control group), it can be claimed that the tooth whitening using 35% hydrogen peroxide presents itself as a viable dental procedure, being tolerated by the dental enamel.

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