UNIVERSITI TEKNOLOGI MARA

THE EFFECT OF VITAMIN D_3 ON ENAMEL DEMINERALISATION AND REMINERALISATION: *AN IN-VITRO* STUDY

MOHD ZULFADLI BIN HARUN

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ABSTRACT

Dental caries is initiated as a white spot lesion on the enamel as an early sign of demineralisation. Enamel demineralisation is caused by acid production by oral bacteria. On the other hand, remineralisation is a process by which minerals return to the enamel to restore its strength and prevent tooth decay. Vitamin D is a fat-soluble vitamin that plays an important role in the mineralisation of bones and teeth by maintaining the appropriate levels of calcium and phosphorus ions in the blood. The potential remineralisation effect of vitamin D_3 on enamel is still unknown. Hence, this research aims to investigate the effect of remineralisation of vitamin D_3 on enamel microhardness, enamel surface morphology, enamel mineral and organic content, enamel density, and progression of caries lesion. The 45 extracted premolars were randomly divided into three groups: Group A (vitamin D_3), Group B (5% sodium fluoride), and Group C (vitamin D_3 and sodium fluoride). All samples were subjected to various evaluation methods such as microhardness testing, Scanning Electron Microscopy (SEM), Energy Dispersive X-ray Spectroscopy (EDX), Fourier Transform Infrared Spectroscopy (FTIR), and Micro CT. The evaluation was performed for three readings: baseline reading (before any treatment was given), demineralisation reading (after artificial caries lesions were created), and remineralisation reading (after pH cycling). During the pH cycling procedure, each sample was remineralised using the respective remineralising testing solution. Microhardness and mineral content (Ca and P weight%) were significantly reduced after demineralisation and significantly higher after remineralising solution application. The FTIR results verified the trend towards an increased mineral composition in the remineralised enamel. Meanwhile, the SEM image revealed the surface morphology of both demineralised and remineralised enamel differed across groups. Thin new formed crystallite layer following remineralisation with vitamin D_3 was observed. While all remineralising treatments failed to increase enamel density significantly, differences in the progression of lesions between demineralised and remineralised enamel were noticeable. Therefore, the results of this study provide evidence that vitamin D_3 has a positive impact on the remineralisation of enamel, which indicates that an improvement in the enamel's mechanical properties and morphological changes enhanced the remineralisation process and inhibited the progression of caries lesion.

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CHAPTER ONE
INTRODUCTION

1.1 Research Background

Dental caries, also known as tooth decay, is a global public health problem that affects all ages, including young children. It is considered a chronic and transmissible disease that rapidly progresses. Although it is not life-threatening, it has a negative impact on an individual's life if left untreated (Zero et al., 2009; Frencken et al., 2017). The disease gives an advance in severity and tooth destruction, ranging from subclinical changes to lesions involving the enamel and dentin, either with an intact surface or apparent cavitation. The original theory of "drill and fill," which involves drilling out pits and fissures or surgically removing decayed and diseased tissue and restoring with permanent restorations, does not address the entire caries disease process (Manjit Talwar, 2019). Stopping or preventing the caries process from developing cavitated lesions requires careful and systematic methods for documenting and monitoring the disease at an early stage and interfering before advanced lesions develop (de Carvalho et al., 2014).

Dental caries is a multifactorial disease that is a site-specific disease initially on the enamel surface that undergoes multiple demineralisation and remineralisation cycles during the development of carious lesions (Gonzalez-Cabezas, 2010). Demineralisation is a reaction of protons (H+) resulting from plaque acid disassociation with tooth enamel, causing mineral dissolution. When the critical pH of 5.5 is breached, calcium and phosphate ions exit the enamel, weakening it and eventually causing chalky white spots of demineralisation that may eventually become caries (Gonzalez-Cabezas, 2010). This event represents the outcome of very complex biological and chemical interactions occurring at the interface between the external oral environment, biofilm colonizing hard tissues, and dental hard tissues themselves.

Salivary ion concentration and buffering capacity can compensate for the demineralisation process under physiological conditions to create a delicate equilibrium where demineralisation and remineralisation phases occur, resulting in an equal ionic balance. Changes in the oral environment, such as high carbohydrate consumption, might disrupt this balance and promote demineralisation (Ionescu et al., 2022). An additional supply of calcium and phosphate ions is recommended to change the equilibrium toward remineralisation.