CPP-ACP and Xylitol – Challengers of demineralisation - A Review Study

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***Abstract*: Dental caries is one of the most common global oral health problem in the world today. It is caused by various acidic byproducts and destruct hard dental tissues. Various remineralising agents are being used nowadays for remineralisation of the various lesion by replacing the lost minerals such as calcium, phosphate etc., These agents helps in reducing the incidence of early dental caries which has been proved through several invitro and invitro studies. They are administered through various oral hygiene products such as chewing gums, toothpaste and restorative materials. Hence, the present study highlights two common used remineralising agents in dentistry such as CPP-ACP and Xylitol.**

***Keywords*: demineralisation, xylitol, calcium, phosphate, dental caries, CPP-ACP**

INTRODUCTION:

In the oral environment, demineralisation and remineralisation are continuously taking place in the tooth structure. If this balance is disrupted,demineralisation will progress leading to a deterioration of tooth structure[1]. Efforts have done on reducing the prevalence of caries in patients, and have indicated the importance of a ‘partnership’ approach between patients and dentists in order to ensure ultimate success in the control of caries[2]. The formation of caries lesions can be avoided with non-invasive interventions, i.e. oral hygiene education and adequate use of fluorides. Fluorides are also capable of remineralising mainly the surface area of non cavitated caries lesions. However, current non-invasive interventions do not completely avoid the formation as well as the progression of caries lesion in the population [Paris et al., 2012]. For this purpose the use of casein phosphopeptide stabilised amorphous calcium phosphate complexes (CPP- ACP) has been proposed[3]. In addition to CPPACP, electron microscopic study reveals that Xylitol can also induce remineralisation of deeper layers of demineralised enamel by facilitating Ca 2+ movement and accessibility[4].

REMINERALISING AGENTS:

A drop in the pH of oral cavity results in demineralization, and the oral environment becomes undersaturated with mineral ions, relative to a tooth’s mineral content. A decrease in the pH is due to the organic acids especially lactic acid that are produced by the action of plaque bacteria in the presence of dietary carbohydrates. It results in the loss of enamel structure and cavitation. When pH rises, the reverse takes place, resulting in the deposition of mineral block to the tooth structure. Thus, conversely, remineralisation occurs when the pH rises and there is the deposition of calcium, phosphate, and fluoride ions in the form of fluoroapatite crystals. Therefore the best strategy for the management of caries is to focus on the methods of improving the remineralising process with the help of remineralisation products[5].

CASEIN PHOSPHOPEPTIDE–AMORPHOUS CALCIUM PHOSPHATE COMPLEXES (CPP–ACP):

CPP–ACP is a product of milk which helps in remineralization and prevention of dental caries. Casein phosphopeptide helps in delivering amorphous calcium phosphate and also for ACP to bind with the dental enamel. CPP has the ability to integrate in pellicle, hence helps in decreasing the count of Strept. Mutans. It is a peptide which contains elements that can bind calcium and can stabilize calcium phosphate present in the solution as amorphous calcium phosphate. Several in vitro studies have shown the role of CPP–ACP in the reversal of the early white spot lesion[6].

MECHANISM OF ACTION OF CPPACP:

Casein phosphopeptides are responsible for the high bioavailability of calcium from milk and other dairy products. CPP has the ability to bind and stabilize calcium and phosphate in solution which in turn bind to dental plaque and tooth enamel. Calcium phosphate forms a crystalline structure at neutral pH, which is normally insoluble in nature. However, the calcium and phosphate are kept in an amorphous, noncrystalline state by the CPP. Calcium and phosphate ions in the amorphous state can enter the tooth enamel. The high-concentration of calcium and phosphate ions in dental plaque have been extensively researched and proven to reduce the risk of enamel demineralization and promote remineralization of tooth enamel. CPP stabilize ACP, localize ACP in dental plaque, thereby maintaining a state of supersaturation with respect to tooth enamel, reducing demineralization . Since CPP–ACP can stabilize calcium and phosphate in the solution, it can also help in the buffering of plaque pH and so calcium and phosphate level in plaque is increased. Therefore calcium and phosphate concentration within the subsurface lesions is kept high which results in remineralization. The CPPs have been shown to keep fluoride ions in solution, thereby enhancing the efficacy of the fluoride as a remineralizing agent[6,7].

SOURCE:

CPPACP is an ingredient derived from casein, part of the protein found in cow's milk which promotes the remineralization of tooth enamel.

ADMINISTRATION:

Chewing gums, dentifrice, tooth mousse, mouth rinses, toothpaste and CPP–ACP helps in the reduction of tooth sensitivity when it is present in tooth pastes.

DOSAGE :

The remineralizing effect of CPP-ACP in milk was dose-dependent with milk containing 0.2% CPP-ACP and 0.3% CPP-ACP producing an increase in mineral content of 81% and 164%, respectively, relative to the control milk[8]..

XYLITOL

SOURCE:

Xylitol is a 5-carbon sugar alcohol naturally found in the fibers of many fruits and vegetables, including raspberries, strawberries, yellow plum, lettuce, cauliflower, corn, and corn husks. It is a natural product that may be extracted from the bark of birch trees and other hardwood species containing xylan[9].

ADMINISTRATION:

Candies,chewing gums, supplements sweetened with xylitol, Lozenge , dentrifices, syrups, oral rinses.

DOSAGE:

Dosing frequency should be minimum of two times a day ,not to exceed 8 grams per day[10].

SIDE EFFECTS:

Common side effects that may occur with the use of xylitol are gas and osmotic diarrhoea. These symptoms usually occur at higher doses and will subside once xylitol consumption is stopped. To minimize gas and diarrhoea, xylitol should be introduced slowly, over a week or more, to acclimate the body to the polyol, especially in young children.

MECHANISM OF ACTION :

When remineralizing solution containing xylitol is used, xylitol may act as Ca^{2+} ion carrier and may maintain constant Ca^{2+} ion content by introducing Ca^{2+} ions from the surface layer to the middle and deep demineralized layers, thereby enhancing total remineralisation.[11]

xylitol-sweetened gum can also encourage remineralization as it increases salivary flow whose buffering capacity and high concentration of calcium and phosphate ions remineralize dental enamel preventing caries development.

xylitol has been shown to protect and reduce tooth decay by reducing M. streptococcus levels in plaque and saliva thereby reducing lactic acid production[12]. Streptococcus mutans transports the sugar into the cell in an energy-consuming cycle that is responsible for growth inhibition. Xylitol is then converted to xylitol-5-phosphate via phosphoenolpyruvate: fructose phosphotransferase system by S. mutans resulting in development of intracellular vacuoles and cell membrane degradation[11]. Unwittingly contributing to its own death, S. mutans then dephosphorylates xylitol-5-phosphate. The dephosphorylated molecule is then expelled from the cell. This expulsion occurs at an energy cost with no energy gained from xylitol metabolism. Thus, xylitol inhibits S. mutans growth essentially by starving the bacteria. Xylitol can inhibit the growth of harmful oral bacteria such as S. mutans, but its benefits do not stop in the oral cavity. Xylitol alcohol has been shown to impact growth of nasopharyngeal bacteria such as S.pneumonia and S. mitis, and hence has a role to play in nasopharyngeal pneumonia[13].

CONCLUSION :

CPP–ACP can be used to remineralize early carious lesions. It has the ability to counteract the action of acids in cases of erosion. CPP–ACP can also block the dentinal tubules and in turn can reduce the sensitivity. CPP–ACP alone or its combination with fluoride can be utilized as a prophylactic agent before the bonding of orthodontic brackets. CPP–ACP products have provided a new direction to preventive dentistry. From this, the role of CPP–ACP in the prevention of dental caries is quite evident and therefore its incorporation in various dental materials should be encouraged. Xylitol has been shown to be the most effective in preventing dental decay and improving oral health due to it's noncariogenicity. Regular exposure to xylitol (at least three times per day) can alter the bacterial population of the oral cavity, reducing the amount of M. streptococcus levels in both dental plaque and saliva.

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