3-a-day™ DAIRY may keep dental caries away

Despite the widespread use of fluoride in an effort to reduce tooth decay, dental caries remain one of the most common childhood diseases. Although not life threatening, caries cause pain and discomfort, resulting in reduced food intake and therefore affecting quality of life. Dental caries is a multifactorial disease that is affected by physical and biological factors (morphology and composition of teeth, cariogenic bacteria, and fluoride exposure), lifestyle and behavioural factors (oral hygiene practices and dietary habits), as well as social status[1]. Dairy products offer many health benefits beyond the well-known contribution to building strong bones, specifically with regard to preventing dental caries and periodontitis. Milk not only has carioprotective characteristics, due to the buffering activity of milk protein, but also contains various bioactive peptides, calcium, casein and lipids, which have proven to be important in the maintenance of dental health because of their associated cariostatic properties [1,2,3].

The facts

There is substantial evidence for the role of milk and dairy products in promoting dental health.

- Several studies support the association between the consumption of milk and dairy products and the occurrence of fewer caries due to the presence of bioactive compounds [1,2,4,5,6].
- Milk consumption does not increase plaque acidity, which makes it an essentially 'tooth-friendly' food [1,2,7,8].
- Cheese significantly increases the concentration of calcium in saliva and plaque, which confers a cariostatic effect. Eating cheese (especially aged cheese) before or after sugary foods prevents a drop in the pH of plaque and therefore confers an enamel-protective effect [1,4,5].
- A low dietary intake of calcium may lead to the development of periodontal disease, whereas increased calcium and vitamin D intake seems to facilitate a protective effect that prevents tooth loss [1,7,8,9].
- Studies have shown that adding milk, or the milk ions calcium and phosphate, to food not only diminishes the extent of tooth demineralisation but may also promote remineralisation [1,3,5,6,10].
- A high consumption of yoghurt may be associated with a lower prevalence of dental caries in young children [1,5,6,8,9,11,12].

What is dental decay?

Dental decay refers to the development of dental caries and subsequent compromise of the underlying periodontal tissue. Tooth enamel is a polymeric substance that consists of crystalline calcium phosphate embedded in a protein matrix. Dental caries form when calcium and phosphate of the tooth enamel dissolves owing to the action of acid in the mouth (acidic demineralisation). Demineralisation can occur directly (when acidic food is consumed) or indirectly (by fermentation products of oral bacteria growing on residual food particles between teeth or adhering to the plaque) [2,3].

Benefits of dairy products for dental health

Several studies substantiate the beneficial effect of dairy on dental health. Evidence shows that milk or dairy products can reduce the demineralisation of enamel, promote its remineralisation and prevent the adhesion of *Streptococcus mutans* to the surface of teeth [12]. The concentration of calcium in dental plaque and that of calcium and phosphate ions in the saliva affect the balance between demineralisation and remineralisation of enamel. Calcium, phosphate, casein, proteins and fats in dairy are considered to be anticariogenic and therefore these nutrients offer further dental protection.

A study among 12 764 American adults (older than 18 years) showed an inverse association between the intake of dairy and the prevalence of periodontitis. Individuals who consumed milk and dairy products more than four times a week were 20% less likely to present with periodontitis than those who consumed dairy only once a week or less [1,7]. Also, higher maternal intake of total intake of dairy products, yoghurt and calcium during pregnancy was found to be associated with a reduced risk of dental caries in children [1,8,9]. Higher intakes of calcium and dairy servings are also reported to be associated with lower plaque scores, especially when the vitamin D intake exceeds 6.8 µg/day [7].

Cheese

Chewing hard cheese, particularly Cheddar cheese, has been found to prevent enamel demineralisation not only by stimulating salivary flow, which buffers the pH of dental plaque, but also by increasing the calcium and phosphorus concentrations in dental plaque, which favours remineralisation [1,2]. A prospective study from Japan also found that higher maternal intake of cheese during pregnancy was associated with a decreased risk of dental caries in children [1].

Yoghurt

Regular yoghurt intake (≥4 times/week) was found to be significantly associated with lower prevalence of caries compared with intakes of less than once a week, showing a

clear dose-response relationship [1,8]. A study investigating the relationship between the intake of various dairy products and periodontitis concluded that lactic acid foods such as yoghurt may be beneficial in preventing periodontal disease [1]. Similar results were obtained in a cross-sectional study among Italian toddlers (3–5 years old), with the consumption of yoghurt shown to be significantly inversely associated with rampant early childhood dental decay [8,13].

Flavoured milk products

It is reasonable to assume that adding sucrose to milk will increase cariogenicity. However, the concentration at which the added sucrose overcomes the carioprotective properties of plain white milk needs to be considered. The question is complicated by the knowledge that cocoa in chocolate flavoured milk has been shown to have protective properties itself [14]. Recent findings indicate that the cariogenic load of flavoured milk products is negligible to low [10,15]. This is supported by the observation that children who consumed conventional chocolate milk (which contains cocoa and sugar) regularly over a two-year period had a slight yet non-significant increase in caries compared to those who drank plain, white milk [3,15].

Therefore, although the sugar content of flavoured milk has raised health concerns, sweetened dairy is regarded to be a preferable alternative to similarly sweetened beverages such as cordials, soft drinks and citrus juices. Regular consumption of the latter examples promotes dental erosion through direct acidic demineralisation rather than through increased bacterial activity because of a high sugar content. The high concentration of calcium and phosphate in dairy buffers acidic action associated with bacterial metabolism. Sweetened dairy products can also promote milk consumption among both adults and children, which delivers protective essential nutrients such as casein, calcium and phosphorus [10,15].

To understand the effect of sugar on cariogenicity, Bowen and Pearson studied the effect of added 10% sucrose or 10% fructose to milk [10]. There was little difference in cariogenicity between these two sweetened milk products and although both were more cariogenic than plain, white milk, they were still less cariogenic than 10% sucrose in water. The experiment also showed that 4% lactose in water had a very low cariogenicity, which suggests that the natural sugar content of milk is unlikely to promote the development of caries. This observation is supported by a study which showed that despite the addition of 2% sucrose to milk enhancing its cariogenic activity, such sweetened milk is significantly less cariogenic than similar water–sucrose solutions [10].

Findings from a number of studies therefore suggest that the benefits of moderate consumption of flavoured milk outweigh any possible negative effects, particularly if efforts are made to find a balance between trying to increase milk consumption and control sugar intake [15].

Potential mechanisms of protection

In addition to the nutritional benefits of dairy, an increasing amount of data demonstrates a bioactive function of dairy components in preventing dental caries among adults [6]. The non-cariogenic and cariostatic properties of milk appear to be related to several factors.

The carioprotective effect of dairy is thought to be associated with a number of mechanisms (although only partially understood) that involve more than the presence of calcium. Research has shown that the removal of casein, fat or lactose does not affect the protective remineralisation potential of milk. Although the removal of free calcium and phosphate showed some effect, water-soluble proteose-peptones, which were found to be powerful protective factors, were still present [6].

Milk contains two major protein groups, namely casein (insoluble) and whey proteins (soluble), distinguished according to their solubility in unheated milk (pH 4.6; 20 °C). Both groups have specific physiochemical and biological properties [2]. Bioactive proteins and peptides are embedded in casein and whey primary sequences [2,7]. Milk-derived bioactive sequences are involved in a variety of regulatory activities, such as modulating digestive and gastrointestinal functions, regulating haemodynamics (hypertension and gastric blood flow), conferring anticariogenic and analgesic properties, synthesis of growth factors and immunoregulation. Caseins, which account for 80% of milk proteins, contain several bioactive peptides. In general, bioactive peptides with anticariogenic activity prevent dental lesions through several mechanisms, including bacterial inhibition, competitive exclusion to enamel binding sites, improved buffering capacity in the pellicle surrounding teeth, reduced enamel demineralisation and enhanced enamel remineralisation [4].

The adherence of oral bacteria to saliva-coated hydroxylapatite of tooth enamel has been found to be specifically inhibited by three milk-derived compounds, namely casein phosphopeptide, sodium caseinate and glycomacropeptide [16]. Research showed that a paste of casein phosphopeptide– amorphous calcium phosphate (CPP–ACP), found in higher concentrations in yoghurt than in equal-weight portions of cheese and milk, can bind and stabilise calcium and phosphate in solution. CPP–ACP also influences the demineralisation/remineralisation process of dental enamel by binding to both dental plaque and tooth enamel [2,3,4,9].

Lactose cariogenicity has been intensely debated for many years. Much of this debate stems from evidence that organic acid metabolites produced from lactose fermentation by the oral microflora have a deleterious effect on tooth enamel. Although lactose comprises 80% of the carbohydrate content of milk – sufficient to render milk cariogenic – evidence shows that lactose is the least cariogenic of the common dietary sugars.

Also, the co-presence of bioactive components in dairy has been found to provide a buffering action against the possible cariogenicity of lactose [10,17]. The high concentrations of calcium and phosphorus in milk help to prevent dissolution of enamel (which consists mainly of calcium and phosphate), while other components of milk may reduce the ability of plaque microflora to adhere to enamel and produce acids. The lactose content in fermented dairy products (e.g. yoghurt) was found to be substantially reduced, supporting low cariogenic capability. Beside the reduced lactose content, the lactic acid in fermented milk also results in a drop in pH, which inhibits growth of many pathogenic organisms [1,5,11].

Probiotics are defined as live microorganisms that, when administered in adequate amounts, confer a health benefit on the host through balancing the microbial flora. Probiotics may have beneficial effects in the mouth, possibly by changing the level of pathogenic bacteria present in the oral cavity and dental plaque. This is likely to be due to the displacement of *S. mutans* or other cariogenic microorganisms from their binding sites on dental surfaces or in oral biofilms. Studies have shown that probiotics in milk products such as yoghurt reduce *S. mutans* counts, possibly by modifying the composition of the salivary film, which prevents bacterial adhesion. This finding is supported by a study comparing the effect of two types of probiotic and plain yoghurt on pathogenic oral bacteria, as the number of *S. mutans* decreased significantly with consumption of the probiotic yoghurts [3,5,11]. Consumption of products that contain probiotics is currently considered an appropriate method in preventing dental caries [4].

Lactoferrin, an iron-binding protein found in, among others, cow's milk, also inhibits the aggregation and surface adherence of Gram-negative bacteria such as *S. mutans*, the main bacteria involved in dental caries *[2]*. The inhibitory effect of bovine milk on saliva aggregation of *S. mutans* is ascribed to the interference of lactoferrin with a streptococcal surface protein antigen [6].

Conclusion

There is consistent scientific evidence that milk and dairy products are beneficial to dental health. Both the low cariogenic potential of milk and its carioprotective role have been demonstrated. The protective action appears to be facilitated by several properties of milk, namely (1) low cariogenic potential of lactose, (2) casein (and possibly also milk fats) being carioprotective, (3) the presence of bioactive peptides and (4) the protective and buffering role of calcium and phosphorus. The addition of probiotics to milk may also benefit oral health, although evidence is limited at present. The benefits of dairy for dental health should be advocated as a complement to proper oral hygiene to help reduce the incidence of dental caries.

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