Probiotics and Dental Caries in Children

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Abstract: Probiotic therapy has been proven to have beneficial treatment and prevention effects in different medical fields. Probiotics are "live microorganisms that when administered in adequate amounts confer health benefits to the host". Since the oral cavity had specific ecosystem that involve both normal flora and pathogenic flora, the objective of this paper was to view process of activity of "probiotic bacteria" in the mouth and review the impact of "probiotics" on dental caries in children. Search of English scientific articles electronically from 2008 to 2018 was accomplished using the Cochrane library, PubMed, the EviDents search engine, EMBASE database, OVID, and the Science Citation Index database. The search terms used were "probiotics", Microbiome, Microbiota, Dental caries, Periodontal disease, Gut, Oral Health, Lactobacillus, Bifidobacterium and Mutans streptococci. Probiotic therapy may have a significant part in treating dental decay in children. Further investigations are required to provide scientific evidence on the use probiotic therapy in children.
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1. Introduction

Dental decay is among the most common chronic condition in children. It can afflict people during their entire life (Featherstone, 2000, Pitts, 2004). Bacteria are known of releasing acidic by-products through fermentation of carbohydrate, which end up damaging the tooth structure. Some of these bacteria are Streptococcus mutans (S. mutans), Streptococcus sobrinus and Lactobacilli (Chen & Wang, 2010). Although, it is feasible to obtain prevention strategies against caries mainly during childhood period (Selwitz et al., 2007).

There are a number of procedures that were advanced in an objective to stopcaries. These include the use of remineralizing agents such as fluorides, use of antimicrobial peptides, "probiotics", sugar substitutes, vaccines and chemoprophylactic agents. It is apparent that more energy has been channeled into prevention of dental caries as opposed treatment (Chen & Wang, 2010).

Investigations have indicated that the use of "probiotics" provide a new preventive strategy towards decay (Meurman, 2005, Stamatova et al., 2009, Anderson & Shi, 2006). The utilization of "probiotics" relies on the reality that "the oral cavity has a specific ecosystem of bacteria comprising of normal flora and pathogenic bacteria, which live together". Probiotic spursue to stabilize this oral environment in order to make sure that unfavorable microorganisms are killed. Dental decay can occur due to variation in dental environment, like S. mutans, which form part of the normal oral flora can cause enamel decalcification if they increase above normal levels (Kriswandini, 2008).

In "probiotics" investigations, the aim was on decreasing the amount of Mutans streptococci (MS). Commonly utilized probiotic strains in humans were the Bifidobacterium and Lactobacillus. Different researches pointed out to the fact that probiotic will reduce the number of MS in saliva. Studies reported contradicted results, some reported a reduction in MS and other studies reported no reduction. This variation related to the different methodology of the studies. Some studies were conducted with a small sample size (Aminabadi et al., 2011, Cildir et al., 2012, Juneja & Kakade, 2012, Sudhir et al., 2012). Other studies were conducted with a short follow-up period (Aminabadi et al., 2011, Cildir et al., 2012, Jindal et al., 2011, Juneja & Kakade, 2012, Sudhir et al., 2012). Therefore, the effectiveness of "probiotics" in decay prevention needs more investigations.

Aim

The objective of this paper was to view process of activity of "probiotic bacteria" in the mouth and review the impact of "probiotics" on dental caries in children.

2. Materials and Methods

Search of English scientific articles electronically from 2008 to 2018 was done using the Cochrane library, PubMed, the EviDents search engine, the EMBASE database, OVID, and the

Science Citation Index database. The search terms used were “Probiotics, Microbiome, Microbiota, Dental caries, Periodontal disease, Gut, Oral Health, Lactobacillus, Bifidobacterium and MS”.

3. Results

Two hundred articles were reviewed as well as some references of selected articles. Fifty recent studies described the outcome of “probiotics” on dental decay in children.

4. Discussion

Despite the continuous effort to prevent and treat dental decay, it remains a wide spread chronic disease in both adults and children (Cooney, 2010, Chen, 2018). However, it is clear that the condition is complex and multifactorial, the major etiological factors involved in caries include endogenous bacteria which are mainly MS and Lactobacillus species, frequency of intake of fermentable carbohydrates, and inhibition of salivary function. Although all fermentable carbohydrates produce acid by cariogenic bacteria, sucrose is the carbohydrate most related to caries (Kidd, 2005).

Caries prevention:

Good oral health plays a main role in keeping the human body in good health. Improvement of dental health increase our capability to do many oral and other functions as well, such as “speaking, chewing, and swallowing”. The method to essential prevention should be depend on frequent risk factors of the specific condition. Several risk factors have been contributed in dental caries formation. The seinclude “socioeconomic status, previous carious experience, presence of white spot lesions, presence of visible plaque, perceived risk by dental professionals, and microbiologic testing for the presence or quantity of MS” (Tinanoff et al., 2002). The contemporary ways of caries prevention focused mainly on host factors, dietary factors and plaque biofilm removal (Laleman et al., 2014). Recently, an alternative plan for caries prevention have been advocated through probiotic therapy. Since the oral cavity had specific ecosystem involve both normal flora and pathogenic flora, probiotic therapy could be used to balance the oral ecosystem. As mentioned above, S. mutans are the normal flora in oral cavity, and if its number is more than normal they would disturb the oral ecosystem and decalcified enamel of the tooth.

Concept of probiotics:

Probiotics came out as an alternative and natural option that was utilized to prevent diseases by replacing and displacing microbials with non-pathogenic internal microorganisms (Caglar et al., 2005). Probiotic is a word which means "to or for life" and now it is used when mentioning the bacteria related to beneficial effects for animals and humans. According to the “World Health Organization/Food and Agriculture Organization of the United Nati ons report” (2002), “probiotics” are “live microorganisms which when administer ed in adequate amount confer a health benefit on the host”. The concept of “pro biotics” introduced from Elie Metchnikoff’s ideas that the bacteria infermented dairy products could compete with pathogenic microbes that are injurious to the host and thus have a health promoting effects (Metchnikoff, 1907). There are many types of microbials that can be considered as “probiotics”. Abroad range of microorganisms has been used as “probiotics”. The main known probiotic strains are related to the genera “Lactobacillus and Bifidobacterium” (Soccol et al., 2010). Lactobacillus types from which probiotic strains have been isolated include “L. acidophilus, L. johnsonii, L. casei, Lactobacillus rhamnosus (L. rhamnosus), L. gasseri, and L. reuteri. Bifidobacterium strains include B. bifidum, B. longum, and B. infant is”. Probiotic therapy has been proven to have beneficial treatment and prevention effects indifferent fields including: “Prevention of diarrhea caused by clostridium difficile, prevention of colon cancer, reduces progression of AIDS, enhancement of calcium absorption, regulation of Immunity, reduction of blood cholesterol levels, reduction of liver toxicities, enhancement of vitamin status (B, K), and increases the lifetime of voice prosthesis”. Lactobacillus reuteri was first isolated from the human faecal and gastrointestinal tract (Reuter, 2001). After that, more types were found in the intestine of healthy nonhuman sand many food supply (Taranto et al., 2003, Lee et al., 2009, Yeo et al., 2016). Lactobacillus reuteri is one of only 3-4 Lactobacillus species that naturally inhabits the digestive tract of humans, infants as well as adults (Oh et al., 2010, Reuter, 2001). Probiotic products usually come in 4 main methods, a culture concentrate added to either a fruit juice or food, injected into prebiotic fibres, added into milk or yoghurt which is the most used way, or as dried cells wrapped as diet supplementation other than factory products (Reddy et al., 2010).

Mechanisms of action of probiotics:

The process of action is still not clear until now. Although, it is clear that probiotics bacteria, after digestion, mix with the local bacteria enhancing its homeostasis (Lilly & Stillwell, 1965). Also, they can enhance intestinal defenses, increase local immunity and regulate the inflammatory response, improve resistance to colonization by pathogens, inspire generation of substances with an antimicrobial action, (Isolauri et al., 2001, Sebastián Domingo, 2017). In the mouth, process of activity of “probiotics” is anticipated to be the same as with gastrointestinal tract

but the real process by which "probiotics" affect the mouth is complicated and includes many factors, and is partially understood (Meurman, 2005).

Suggested mechanisms of probiotic action on oral cavity:

Probiotic bacteria in the mouth can be a competitor with the oral microorganisms for growth factors, nutrients, and adherence sites. When probiotic bacteria adhered successfully to the surfaces of the oral cavity, it will stop further habitation by harmful bacteria by decreasing the number of sites of adhesion on the tooth surfaces or salivary pellicle (Stamatova et al., 2009). Furthermore, the probiotic bacteria might be able to produce antimicrobial compounds, including: "organic acids, hydrogen peroxide, carbon peroxide, diacetyl, low molecular weight antimicrobial substances and adhesion inhibitors" (Messens, 2002). These antimicrobial compounds can directly block bacteria in the mouth, and optimistically particular for harmful bacteria. Finally, it has been proposed that "probiotics" may cause triggering and modulation of a host defense mechanism that may enhance the host's capability to stop the formation of bacteria (Jain & Sharma, 2012).

Role of probiotics in oral health:

"probiotics" microorganisms were broadly investigated for their health encouraging properties. The primary areas of investigation have been in the intestine. However, scientific evidence in the years before reveals that "probiotics" may be a fact also in future dental and oral medicine. The mouth is a complex resident providing the creation of many microbes. Over 700 oral microbiota types have been found in the human mouth (Aas et al., 2005). The normal flora saves the mouth from oral diseases. However, different types of microorganisms related with complex human oral bacteria comprise the decay with dental plaque being one of the main diseases in humans due to human oral bacteria (Takahashi, 2011). Probiotic therapy is given to keep the natural microflora from a harmful bacterial attack, which lead to dental problems (mainly decay and periodontal inflammation) (Cagetti et al., 2013). Many types of bacterial strains have been studied for their potential probiotic properties. The popularutilized species belong to the "genera Lactobacillus and Bifidobacteria" (Saxelin et al., 2005).

Probiotics and dental caries:

The main microorganism involved in causation of dental caries is S. mutans which is highly virulent. Probiotic therapy can decrease the risk for increased S. mutans amount (Ahola et al., 2002). Probiotic bacteria take part with cariogenic bacteria for adhesion sites also for growth factors and nutrients causing decreased S. mutans level in the mouth. Many researches have been done using "probiotic" administration to decrease oral S. mutans (Caglar et al., 2005, Çaglar et al., 2006, Chuang et al., 2011). These investigations were carried out following in vitro studies results that showed that probiotic bacteria decrease S. mutans growth and other oral bacteria with cariogenic abilities (Kang et al., 2005, Stamatova et al., 2007, Stamatova et al., 2009).

Probiotic studies in children and adolescent:

Recently, several investigations that have studied the outcomes of "probiotics" in children or adults on caries or caries risk factors (Sudhir et al., 2012, Hasslöf et al., 2013, Jose et al., 2013, Taipale et al., 2013, Ashwin et al., 2015, Mahantesha et al., 2015). Several vehicles for giving of probiotic bacteria were investigated. Probiotics added with milk are easily acquired for the child and adolescent in diet regimens and can be taken orally.

Only three studies were done to confirm the early result of probiotic administration with different types on the oral colonization of MS and lactobacillus (LB). Moreover, they follow up the children to assess the caries prevalence as well. The first study in infants to confirm the outcome of "probiotics" early administration on the oral MS habitation (Taipale et al., 2012). Children took "probiotic bacteria, xylitol or sorbitol" in form of tablets in table spoon or pacifier from the age of 30-60 day still 24 months, 2 times daily. Finally, children received probiotic bacteria showed reduced MS colonization percentage (6% compared to 31%) of children in "xylitol group" and (10%) in "sorbitol group". Four years later, the same group of children were re-assessed to evaluate the amount of MS in plaque and existence of decay in primary dentition (Taipale et al., 2013). The result showed no differences were noted between the three study groups in the presence of dental Aries and in MS colonization. In other study by Hasslöf et al, (2013), 171 infants were included. Dental caries experience was assessed at 2 to 3 years and 6 years of age. Regarding caries experience between the two groups "infants given a daily diet of cereals supplemented with LF19 or a placebo cereal from 4 to 13 months of age", no statistically significant differences was detected. In addition, no statistically significant differences were seen among groups with the respect to colonization by LB and MS (Hasslöf et al., 2013). On the contrary, another study found difference in proximal caries lesions prevalence in 9-year-old children who during the first year of life had been treated with daily oral probiotic bacteria, compared to those who took placebo administered similarly. Although, no statistically significant MS, LB and plaque index differences among groups was reported (Stensson et al., 2013).

The outcome of milk having "L. rhamnosus" on MS counts was assessed in 4 clinical trials. In the first

short-term study, the outcome of milk having "L. rhamnosus" on salivary MS levels was assessed in 40 children with the age group of 12-15 years. The difference was significant in post-treatment concerning MS count between probiotic and placebo groups, furthermore the difference after 3 weeks was very significant (Juneja & Kakade, 2012). On the other hand, in children who took milk containing "L. rhamnosus" compared to children who took milk without "probiotic", no statistically significant differences in MS were found (Lexner et al., 2009). In the 2 studies with long follow-up, "L. rhamnosus" was given for few months to evaluate its caries preventive effect. One of these studies, in seven-month kindergarten patients took "L. rhamnosus" probiotic and then caries risk was measured based on clinical and bacteriological data. Outcome revealed that using "L. rhamnosus GG" result in statistically significant reductions in MS counts (Näse et al., 2001). In the other study, the effect of milk having fluoride and probiotic bacteria on decay occurrence was evaluated in 1–5 years old children. Children in the intervention group were served milk supplemented with "L. rhamnosus L B21" (107 CFU/ml) and 2.5 mg fluorideper litre for lunch while the control group received regular milk for 21 months period (Stecksén-Blicks et al., 2009). Changes that were observed in MS counts in patients who took "L. rhamnosus LB21"were not statistically significant compared to the control group. Moreover, both studies concluded that probiotic bacteria reduced caries development in children. Three studies were carried out using yogurt as "probiotics" vehicle with different probiotic strains. A research was performed on 12 – 16 years 24 healthy adolescents undergoing orthodontic treatment, to evaluate the result of yogurt containing "Bifidobacteriumlactis DN-173010" on the levels of" salivary MS and lactobacilli" administered once daily for two weeks (Cildir et al., 2009). Marked decrease in MS was noted after a short-term consumption of probiotic yogurt. The other investigation studied the result of giving yogurt containing "L. rhamnosus GG" for 21 days on levels of oral microbiota in 105 children (6 – 12 years) (Aminabadi et al., 2011). Anotable reduction in MS count following "probiotics" consumption alone, butre settlement was reported during the following 5 weeks. However, treatment with "chlorhexidine" led to a marked decrease in salivary MS counts that enhances during the following 5 weeks. On the contrary, a recent study conducted to evaluate the effect of the administration of yogurt containing "Bifidobacteriumlactis" for 1 month in 49 patients (6 – 12 years) (Nozariet al., 2015). The authors reported reduction in the number of SM and Lactobacillus in the control group compared to the probiotic group.

Three short-term studies used probiotic vehicle "ice-cream" with the same bacterial strain as aintegration of "Lactobacillus acidophilus La-5 and Bifidobacteriumlactis Bb-12" were conducted. One of these studies was done in 12–14-year-oldchildren who were given ice-creams containing "probiotics" or placebos. The results showed that utilization of the ice-cream as probiotic vehicle revealed a notable decrease in salivary MS counts following utilization of "probiotics" contrast to baseline (Singh et al., 2011). Another study was performed to compare the efficacy of "probiotic ice cream" and "probiotic drink" on salivary SM levels in children 6-12 years old (Mahantesha et al., 2015). For both groups "probioticice cream or drink" was administrated for 7 days and followed by a washout period of 3 months and then the salivary specimens were gathered for evaluation of salivary SM levels. A notable decrease in salivary SM level in both groups after7 days was observed. Nevertheless, when baseline data were compared after 90days of washout period there was significant reduction in SM levels in children who consumed probiotic ice cream compared to the probiotic drink. Other study also used ice-cream as probiotic vehicle to evaluate the caries risk based on the salivary levels of SM in children of 6-12 years of age group. A statistically significant MS decrease in Probiotic group was seen after 7 days of "ice-cream" ingestion and also after30 days of washout period but not after 6 months (Ashwin et al., 2015). Only one study used two freeze dried powdered preparations as probiotic vehicle in 7–14 years old children. The first powder preparation containing L. rhamnosus, Saccharomyces cerevisiae and Bifido bacterium longum and the other one containing "Bacillus coagulans" and compared them to a placebo powder (Jindal et al., 2011). All children were instructed to dissolve the powders in 20ml of water and then utilized as a mouth wash for 60 seconds for 14 successive days. Amarked decrease in MS counts in both probiotic groups was seen compared to the placebo group. The effect of curd (Nestle fresh 'n' natural dahi yogurt) as probiotic vehicle on MS counts were evaluated in dental caries-free children in two clinical trials. In the study with short follow-up, the outcome of curd containing "Lactob acillusacidophilus" for 30 days was conducted in small groups of children. It was found that consumption of "probiotic curd" led to a marked decrease in S Mcolony counts as compared to "regular curd" (Sudhir et al., 2012). On the contrary, the long-term study found insignificant reduction in S. Mutans counts (Sidhu et al., 2015). However, the authors explained this result as it may be due to few samples and the large discrepancy between the study groups.

Jose et al (2013) compared the outcome of the systemic utilization of "probiotic curd" and the topical application of "probiotic toothpaste" on the SM levels in the plaque of patients undergoing orthodontic treatment. Results showed that there was a notable decrease in the SM levels in both probiotic groups when compared to the control group. Even though the "probiotic toothpaste" was better than systemic utilization of "probiotic curd", but without significant difference. Recently, 2 researches were done with using tablet as a probiotic vehicle but with different probiotic strain and different age group. The first study was carried out in high dental caries risk 6-17 years-old children to evaluate the cariogram outcome after90 days of oral treatment with "probiotic Streptococcus salivarius M18" in form of tablet (Di Pierro et al., 2015). It was found that the group which received treatment showed a notable decrease, in the cariogram result worldwide. Specifically, the treated group revealed a notable decrease in MS by approximately 75% compared to untreated group. Another double-blind randomized controlled study was done in 2-3-year-old healthy children to evaluate the effect of probiotic chewing tablets on dental decay. The caregivers of the "probiotic group" were informed to give their child one chewing tablet per day containing three strains of live probiotic bacteria "S. uberis KJ2™, S. oralis KJ3™, S. rattus JH145™" and the "placebo group" got identical tablets without probiotic bacteria. The 24 months caries increment was notably decreased in the test group when compared to the control group. However, the authors did not mention the effect on MS (Hedayati-Hajikand et al., 2015).

Two researches were done utilizing lozenges as probiotic vehicle with different probiotic strain. One of these researches evaluated the effect of lozenges with Lactobacillus brevis CD on salivary MS concentration, plaque pH and bleeding on probing (Campus et al., 2014). The lozenges that were given for one and half month in 6–8 years old children with high caries risk showed a notable decrease of the salivary MS. The other research used lozenges containing freeze-dried preparations of S. salivarius M1 to evaluate its probiotic action to stop or decrease caries risk in 5-10 years old children (Burton et al., 2013). The children were instructed to suck2 lozenges each day for 90 days,1after teeth brushing in the morning and the other one at night. It was found that S. salivarius M18 did not result in notable differences between the test and control groups in the mean S. mutans counts. Only one double-blind, randomized crossover study used liquid drops as probiotic vehicle in group composed of cleft lip/palate 4-12 years old children (Cildir et al., 2012). The study duration was composed of 4 consecutive periods. During periods 2 and 4 (25 days each) parents were informed to give their children every day "probiotic" or placebo drops (5 drops) produced by the same manufacturer. No statistically significant decrease of lactobacilli and salivary MS following consumption of both drops was shown.

Finally, the body of literature regarding the use of oral "probiotics" is currently growing; however, the scientific evidence is still not well established. Further research on probiotic therapy taken orally are needed to assess the importance of "probiotics" clinically.

Conclusion

Probiotic therapy may have a significant part in treating dental decay in children. Safety and long-term efficacy of probiotic therapy needs to be investigated. Further investigations are required to provide scientific evidence on the use probiotic therapy in children.

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