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The Role of Diet, Salivary pH and Plaque in Dental Caries Development

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ABSTRACT

Dental caries is one of the most common health problems in the world. It is caused by a number of things, such as what you eat, the bacteria in your mouth, and the acidity (pH) levels around your teeth. When you eat sweet meals, some bacteria, such Streptococcus mutans and Lactobacillus, can break down the sugars and create acids. These acids steadily eat away at the enamel that protects our teeth. Not getting enough vital minerals, including calcium, Phosphorus, vitamins C and D, and other things can make our teeth and gums weaker, which makes them more susceptible to get harmed. The relationship between salivary characteristics, such as salivary pH, and plaque biofilms will affect how we treat dental caries as a whole. For dental caries, this involves the consistent disruption of the oral plaque biofilm by mechanical oral hygiene, along with dietary modifications to reduce exposure to fermentable carbohydrates. Eating and drinking too many sweet things can make your mouth more acidic, which can hurt your gums and enamel. At the same time, not getting enough vitamins C and D might make it harder for the body to heal and fight illnesses. Saliva and bacteria in the mouth are the two main things that cause dental caries. It has been shown that there is a link between pH levels and the number of cavities, as well as the effects of local and systemic factors and how changes in pH levels affect tooth structure. An acidic mouth environment causes demineralization and remineralization to happen at different rates, and it also causes more acid-loving bacteria to grow. This article explains how diet, saliva pH, and plaque all work together to affect oral health. It stresses the importance of good nutrition and everyday care for keeping teeth healthy.

Keywords: Dental Caries, Diet, Salivary pH, Plaque

1 Introduction

Dental caries is a polymicrobial disorder arising from dysbiosis in the indigenous microbiome, potentially leading to the progressive demineralization of dental hard tissues [1]. And figure 1 detected the stages of teeth decay. The acidogenic/aciduric bacteria involved in this multifactorial disease are accurately described as pathobionts, as they are present in small quantities even in the dental plaque of caries-free persons [2)]. The onset and development of dental caries are complex and multifactorial processes [3]. The

caries process illustrates dynamic amphibiosis, wherein, under typical environmental conditions, biofilm bacteria exist in a symbiotic association with the host. marked by mutualism and commensalism.[4]. Local environmental stresses, such eating too much sugar or not making enough saliva, can give these pathobionts an edge over commensal bacteria in terms of ecology, which leads to microbiome dysbiosis and the subsequent emergence of carious lesions. Modern molecular techniques have demonstrated that the microbial consortia associated with the caries process display considerable diversity, with Streptococcus mutans representing just a small fraction of the bacterial community implicated in disease pathogenesis [5]. Even yet, S. mutans is thought to be a major player in the caries process because it can use glucosyltransferases (Gtfs) to make both soluble and insoluble glucans from dietary sucrose [Paes Leme et al., 2006]. Insoluble glucans, a type of exopolysaccharide (EPS), are thought to be the main parts of cariogenic biofilms. They change how dental plaque sticks to things and how it causes disease [6]. Plaque and bacteria start to work 20 minutes after eating [7].

Studies show that an increase in plaque index caused by acidogenic bacteria like Streptococcus mutans can make caries more common. This could happen because bacteria in the biofilm make organic acids, which lower the pH of the mouth below the important levels of 5.5 and 6.0 for enamel and dentin, respectively [8]. Dental plaque is a place where microbes can live and grow, which affects how quickly carious lesions grow [9]. People are using less traditional chemotherapeutic treatments for oral diseases since synthetic oral biocides like chlorhexidine (CHX) sometimes have bad side effects and there are worries that germs will become resistant to these compounds. When phosphoric acid and hydroxyl ions are present at quantities below saturation, they can break down the minerals in teeth, making it easier for hydroxyapatite crystals to dissolve and for cavitation to form [8].

Recent studies have shown that mutans streptococci (MS) are mostly responsible for making insoluble glucan, and only a few other cariogenic bacteria can also make glucan [11]. S. mutans, although present in minimal quantities, appears to play a crucial role in the initial development of the cariogenic biofilm matrix. This helps other relevant resident aciduric bacteria (such bifidobacteria, certain lactobacilli, and Scardovia spp.) take over.as the biofilm grows (12). As a result, S. mutans remains a suitable indicator organism for examining cariogenic virulence traits and their possible alteration by novel antimicrobial agents. When bacteria like Streptococcus mutans break down sugar, they make lactic acid, which lowers the pH in the mouth and starts the process of enamel breakdown [13].

Making Nutrition is important for more than just your health; it's also important for your teeth and gums. If you don't have a good diet. There is an increased likelihood of acquiring dental cavities and periodontal disease. This is important at any age. For example, teaching kids to eat healthy is important to keep them from getting cavities and other problems. Saliva is a bodily fluid that serves many purposes and can be very useful for diagnosing diseases. It is good for keeping an eye on the health of the mouth, the ability of bacteria to stick to surfaces, and the ability of acids to buffer. Saliva is a bodily fluid that serves several purposes and is very useful for diagnosing health problems. It may be used to check the health of the mouth and the progress of cavities. Salivary pH is an indicator of the risk of dental caries, and a low pH in the mouth is strongly linked to the chance of getting dental caries [14] . Many studies still argue over the link between nutrition, pH, and cavities. Thus, comprehending the relationship among salivary pH, plaque index, and the prevalence of dental caries is crucial. This study aims to investigate the relationships between eating habits and dental health.

specifically evaluating the impact of salivary hydrogen ion concentration (pH) on tooth caries. It seeks to furnish evidence-based advice for individuals and public health programs to reduce the incidence of tooth decay, examining the interaction of nutrition, saliva pH, and plaque in the etiology of periodontal disease and dental caries.

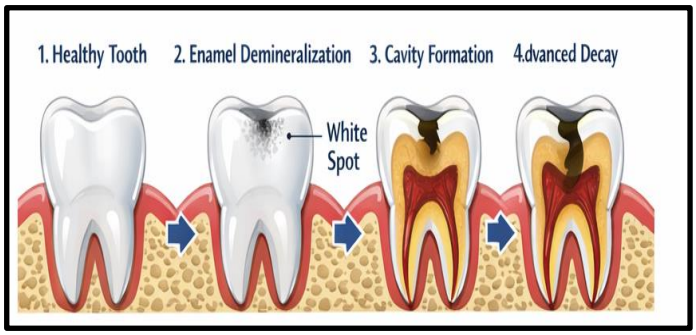

Fig.1 Stages of teeth decay

2 Literature Review

2.1 Diet in Oral Health

The amount and quality of saliva, the state of the teeth, and the presence of certain cariogenic bacteria in dental plaque all affect how quickly dental caries form. Many different environmental factors might affect how teeth grow and how healthy your mouth is. This part is greatly affected by food and nutrients. The diet has both good and bad effects on oral health. An excess or shortage of certain nutrients can affect the overall growth and upkeep of human teeth. Diet refers to the various kinds of foods that are eaten, whereas nutrients include some micronutrients (vitamins and minerals) and macronutrients (carbohydrates, proteins, and lipids). The effect of diet on the growth of teeth depends on when the nutritional imbalance happens, whether it is early or late [15]. Figure 2.

Calcium, along with Magnesium and Phosphorus, makes up most of the bones and teeth. Tooth enamel has crystals of hydroxyapatite in it. Calcium phosphate molecules make up dentin and the extracellular matrix around it. Calcium is an important part of both of these things. Calcium is very important for mineralizing teeth and has a big effect on how teeth grow. Calcium and magnesium are important for keeping your immune system strong, making your muscles contract, and sending signals through your nerves [16].

Vitamin D is essential for the regulation of these minerals. Hypocalcemia can cause bones to become weak and teeth to lose minerals, which can lead to osteoporosis and a lot of cavities. Not having enough of these minerals may raise the risk of periodontal disease [17]. Dietary modification, particularly the restriction of sucrose and other fermentable substrates, is notably difficult in modern society when cariogenic foods are easily obtainable [18]. Additionally, restricting sucrose intake alone is unlikely to completely prevent dental caries if the regular use of other carbohydrates persists [19].

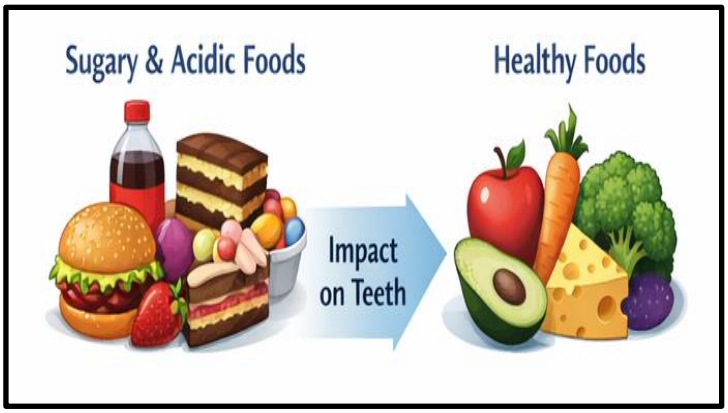

Fig.2 Diet in Oral Health

2.2 Salivary pH and Buffering

Saliva plays an important role in keeping the pH level in the mouth stable and maintaining oral homeostasis [20].Saliva is a clear, thick biofluid that contains proteins and is constantly secreted by the salivary glands. Made mostly of water (approximately 99 %).It protects the mouth in several ways, such as by cleaning it, helping with digesting and swallowing, protecting oral tissues from physical and microbiological harm, keeping the pH level normal, and helping to stop demineralization [21] Saliva protects against the main forms of enamel demineralization, which are caries and tooth erosion.

The buffering capacity of saliva and the salivary pellicle can change both of these [22]. Caries is the localized deterioration of dental hard tissues induced by organic acids generated by bacteria within the plaque biofilm [23]. Less saliva production or secretion is a known risk factor for cavities, candidiasis, and other disorders with the mucous membranes [24]. Saliva acts as a buffer, which helps keep the acid-base balance stable. Saliva in the mouth cavity not only dilutes and removes acids, but it also protects against chemicals by neutralizing small amounts of extra acid.Salivary buffering activity refers to the ability of saliva to maintain a stable pH level [25].

Proteins, phosphates, and bicarbonates are examples of molecules and electrolytes that quickly neutralize acids and bases. This keeps the salivary pH at or above 7.0. The saliva's ability to neutralize acids is important for keeping the pH balance in the mouth. Bicarbonate ions have a big effect on the pH and buffering capacity of saliva, which protects teeth by neutralizing acid generated by bacteria [26]. Dental cavities is the most typical result of less saliva. This means that keeping a balanced mouth is just as important as brushing your teeth. The critical pH level for enamel dissolving is around pH 5.5, however the exact pH level for demineralization changes based on other things, like the amounts of calcium and phosphate in saliva that come into contact with enamel When the pH within the mouth is higher than 5.5 [27] as in figure 3.

The oral environment promotes enamel remineralization when there is enough saliva and flow. Mature human enamel is the most durable mineralized material in the body, mostly composed of complex configurations of hydroxyapatite crystallites formed through matrix-mediated biomineralization. [28] Saliva's complex mix of calcium and phosphate ions helps keep the mouth's balance by keeping the enamel surfaces stable [29]. Mucins and other salivary components help make the enamel pellicle, which protects both hard and soft tissues [6].

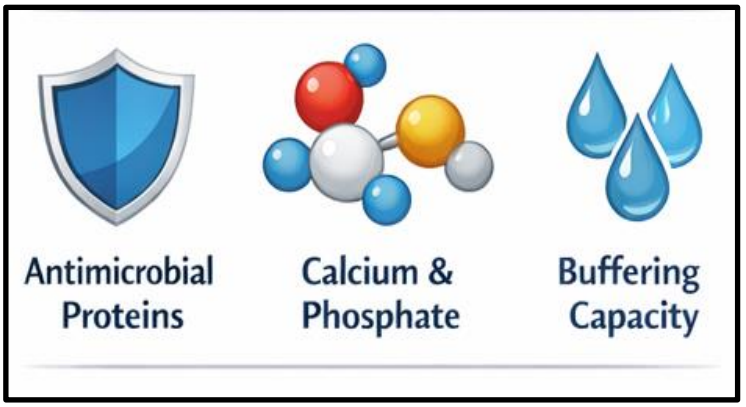

Fig.3 Protective factors in saliva

2.3 Plaque and Biofilm

Dental plaque is the complex group of microbes that grows on the surface of teeth and is held together by a matrix of polymers made from bacteria and saliva [31]; figure 4. Plaque is made up of both organic and inorganic materials that come from saliva, gingival crevicular fluid, and waste products of bacteria [32]. Polysaccharides, proteins, glycoproteins, and lipids make up the organic parts of plaque. Calcium and phosphorus make up most of the inorganic parts of plaque. There are also small amounts of sodium and potassium in it. People call it calcified plaque calculus or tartar. Most of the plaque is in the protected and immobile parts of the tooth surface, which includes fissures, the spaces between teeth, and the gingival sulcus.

Plaque causes cavities by eating away at teeth with its acids after you eat. Repeated acid attacks can wear down the enamel on teeth and cause cavities to form If plaque isn't eliminated, it can irritate the gingival tissue around the teeth, which can lead to gingivitis (red, swollen, and bleeding gums), periodontal disease, and tooth loss. Consequently, the recognition of the substantial health benefits of a symbiotic oral microbiota has resulted in a preference for virulence-targeted treatments over broad-spectrum antimicrobials [33].

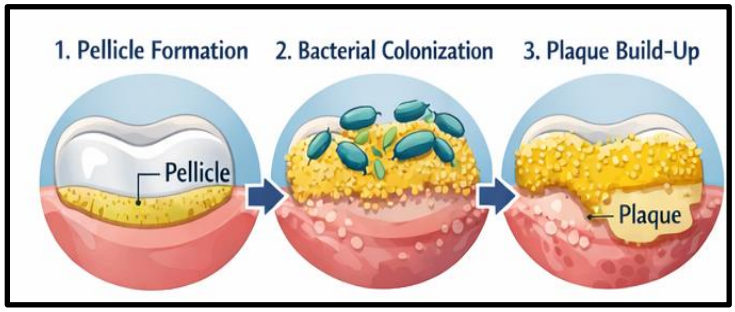

Fig.4 Dental plaque grows on the surface of tooth

This is especially important for biofilm-related diseases like dental caries, where fixing the microbiome dysbiosis that causes caries is more important than just getting rid of the dental plaque biofilm [32]. Plaque is a thick biofilm made up of germs that builds up on teeth. These bacteria break down sugars from diet, turning them into acid and lowering the pH around the teeth. After eating sweets, the plaque pH drops quickly and then slowly returns to normal. But if someone eats a lot of sugar, the pH stays low for a long time. When plaque gets thicker, it makes it harder for saliva to reach the tooth surface and neutralize the acid.

Over time, this causes areas of persistent acidity to form in certain places, which damages enamel and irritates the gums. A rise in plaque buildup is linked to a higher chance of getting cavities. Caries is characterized by a progressive trajectory that is initially reversible, signifying that the aforementioned elements must have cumulative effects over a certain period. Dental caries results from the interaction between the oral microbiome on the tooth surface (dental plaque) and fermentable sugars from the diet, which negatively impacts the buffering capacity of saliva, lowers its pH, and disrupts the normal remineralization process [34].

3 Methodology and Discussion

This study compiles information from several research papers, clinical reports, and guidelines provided by entities such as the WHO. The goals were to understand how diet, mouth pH, and plaque are all related to periodontal disease and tooth caries.The data came from trusted sources like Google Scholar and PubMed. This clarified the interplay and impact of these three factors on oral health problems. Dental caries generally results from the interplay between bacteria in plaque and the food we ingest (34). Eating too many sweet or starchy foods makes bacteria turn sugars into acids, which lowers the pH of the mouth. When the pH drops below 5.5, the minerals in enamel start to break down, which leads to cavities. Some foods can help prevent cavities. Animal studies suggested that diets high in fat, protein, calcium, and fluoride might offer protection against tooth caries. Fats surround the tooth, which slows the buildup of sugar and plaque and may have negative effects on bacteria. Proteins make saliva better at buffering and protect enamel.After eating carbs, fats and proteins raise the pH together. Another type of food that has this protective property is one that, when chewed, increases saliva production, which neutralizes acidity and helps the enamel remineralize. Xerostomia or reduced salivary flow worsens the problem. since saliva helps to balance out acids and keep teeth healthy. Bad diets not only make you eat more sugar, but they also don't have the vitamins and minerals your body needs to mend gum tissue and enamel. Not receiving enough vitamins C and D might harm your gums and your immune system. The enamel gets weaker when you don't receive enough calcium. Not obtaining enough nutrients and having a low pH level together make it simpler for bad microorganisms to proliferate,This causes gum irritation and tooth decay that lasts for a long time.

When the mouth gets acidic, the enamel, which is the outer layer of the tooth, starts to lose minerals like calcium and phosphate. This happens when bacteria generate lactic acid that reacts with enamel and pulls minerals out. If fluoride or saliva doesn't replenish them, the enamel gets weaker and holes form [35]. If you don't receive enough vitamin C, your gums will bleed more and take longer to heal. When vitamin D levels are low, the body has a difficult time absorbing calcium. This is bad for your teeth and bones. These factors make it easier for plaque bacteria to irritate the gums and start gingivitis faster.

Overall health and treatments that directly influence the balance of oral microorganisms, salivary flow, and pH levels can change the mouth's environment. There is considerable interest in clarifying the composition, characteristics, and consequences of the oral microbiome and its influence on salivary pH, oral diseases, and systemic conditions. Saliva plays an important role, and its rate and makeup are very important for starting and moving the cariogenic process forward. As the body fluid that is always in contact with teeth and soft oral tissues, it is responsible for their health and the constant remineralization of dental structures. The amount of saliva that flows, the characteristics of saliva, and its ability to buffer help keep the mouth healthy. Changes to these qualities can change the process of demineralization, which is what causes cavities. The elements of saliva may substantially affect the reduction of risk factors linked to the development of dental caries [3].

The factors that affect the occurrence of dental caries are the host (teeth and saliva), the oral microbiome (the bacteria that live in the mouth), and the way a person eats (how much carbohydrates they eat). All of these things help the disease grow. An accurate evaluation of dental caries risk must consider the involvement of saliva in the process. The use of a salivary test to assess individual risk could impact prevention strategies, screening, and the early diagnosis of dental caries, hence influencing the incidence statistics of dental caries [36]. It's very important to keep the pH of saliva at neutral levels (between 6.5 and 7.5). To keep that balance, drink enough water, eat balanced meals, and limit acidic snacks [37]. When saliva stays neutral, it can fix little enamel damage before it gets worse.

4 Conclusion

When bacteria break down carbohydrates in meals, they cause localized destruction of tooth tissues, which is called

dental caries. Cavities begin as little spots of demineralization beneath the enamel surface. Acids take minerals out of the enamel. a thick specifically lactic acid, which is generated when microorganisms break down the carbohydrates in meals. The enamel starts to wear away when the pH level drops below 5.5. Plaque,Biofilm of bacteria makes this problem worse by trapping acid on the tooth surface and inhibiting the enamel from rebuilding again.This starts a cycle of tooth decay, gums that are swollen and infected. There are basic genetic mechanisms in the mouth that affect things that create cavities, like having saliva.This can change how well acids can be buffered and how well germs stick to items. The contemporary ecological framework of Dental caries exemplifies a complicated, multifaceted, pH-dependent illness, with its initiation and course influenced by several infections and systemic variables. and genetic elements, and genetic components, intertwined with nutritional, behavioral, environmental, socioeconomic, and physiological risk factors. The way this relationship works may change.as the local ecology changes, mutualism becomes parasitism.

The key principle underpinning what we know now is that we can change Too about how diseases like tooth decay originate and spread. A healthy diet is just as vital for your teeth as it is for your whole body. Having too much or too little of a certain vitamin could create difficulties in the mouth. What we consume affects how healthy our teeth and the pH level in our mouths and how much plaque builds up. Bacteria have more food to generate acid when you eat a lot of sugar. This makes your mouth less acidic and wears down your enamel. Not receiving enough vitamins and minerals makes it tougher for the body to mend itself or fight off sickness at the same time. Saliva is crucial for protecting enamel, keeping the pH level stable, and getting rid of food particles. To avoid cavities and gum disease, you should drink a lot of water, eat healthy meals, and brush your teeth often.

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Ethical consideration: The study was approved by Thi-Qar University, Al- Nasiriyah, Iraq.

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