The Role of Lipids in Teeth Diseases - A Review
Małgorzata Klichowska-Palonka*
Department of Conservative Dentistry with Endodontics, Medical University in Lublin, Lublin, Poland

Abstract:
Background: Salivary lipids have been scarcely studied, but the reported results indicate their important role in the oral diseases.

Objectives: The aim of the work is to present current knowledge on the role of lipids in tooth decay and the formation of dental deposits.

Method: The medical databases were searched using the keywords compatible with the MeSH database.

Results: Studies indicate changes in the concentrations of neutral lipid fractions and salivary phospholipids in the course of caries. Research indicates an increase in triglycerides and cholesterol level in saliva in the course of caries. Studies on the phenomena occurring in the dental plaque simultaneously indicate the important role of phospholipids in controlling the extent of enamel demineralization. In the process of calculus formation, lipids play an important role in maintaining the integrity of the plaque and regulating the processes leading to its mineralization.

Conclusion: The presented studies proved that higher levels of salivary lipid are associated with certain oral diseases. These changes are caused by the oral environment and bacteria in the course of dental caries or dental calculus. There is a need for further research to explain the mechanisms and sources of these changes and on the role of lipids in the oral environment.

Publication History: Received: 20 August 2018 | Revised: 31 August 2018 | Accepted: 14 September 2018

Keywords: Caries, cholesterol, dental calculus, oral diagnosis, triglycerides, saliva, salivary acquired pellicle.

INTRODUCTION
The lipid fraction of the saliva is composed mainly of neutral lipids, but also of glycolipids and phospholipids. The dysfunction of lipid parameters of saliva is observed in the course of diseases related to the oral cavity as well as systemic diseases. Interesting observations were provided by the results of research on the lipid fraction of saliva in people with cystic fibrosis and Sjögren's syndrome. The saliva of cystic fibrosis patients contains much more neutral lipids such as free fatty acids, triglycerides and cholesterol in comparison to saliva of healthy people [1]. In patients with Sjögren's syndrome, salivary glandular mucosa differs from the healthy population by the content and composition of the lipid fraction, by increasing the concentration of glycolipids and phospholipids [2]. In the course of diabetes, gastrointestinal diseases and periodontal diseases the release of malondialdehyde (MDA) - a marker of oxidative stress was observed [3]. An increase in concentration of MDA was found in saliva of people with oral lichen planus and in patients with recurrent aphthae [4]. Studies in healthy adults indicate weak positive correlations between saliva cholesterol and serum cholesterol concentrations [5].

Salivary organic compounds are analyzed for their use in the diagnosis and treatment of diseases. For dentists particularly important is their role in the physiology and pathology of the oral cavity. Among the organic components of saliva, the least documented is the role of the lipid fraction in maintaining dental and periodontium health. Research indicates the importance of salivary proteins in maintaining the health of teeth, periodontium and mucous membranes but the role of the lipid fraction of saliva is not fully explained.

The aim of the work is to present current knowledge on the role of lipids in tooth decay and the formation of dental deposits.

MATERIALS AND METHODS
The review was based on research coming from medical databases and Open Access Scientific Reports. The search was...
done using terms from Medical Subject Headings (MeSH) such as: saliva, dental caries, lipids, glycolipids, phospholipids, cholesterol, triglycerides, dental calculus, and dental plaque. The abstracts were used to select the articles. Analyses of selected studies were made on the basis of full texts (Table 1).

### DENTAL CARIES AND LIPIDS

Early concepts of caries from the early 20th century had based on the research which pointed the presence of lipids in carious dentine. The tooth decays were described as "fatty degradation". Histochemical and microradiographic studies of Swedish scientists on the distribution of lipids in the course of tooth decay did not confirm the previous concepts of fat degradation in its course. Subsequent studies have shown that lipids are a natural component of enamel and dentin associated with its mineral components. In a sclerotic dentin near the pulp chamber, cholesterol and/or triglycerides were found in the similar amount as in normal dentin [6-8].

It is known that saliva plays an important role in protecting teeth against the development of caries. Study on saliva lipid fraction indicates significant differences between volunteers with and without caries experience. Saliva from the parotid and submandibular glands of volunteers without signs of caries contains fewer lipids than saliva of people with dental caries. Changes in concentrations mainly concern neutral lipid fractions and phospholipids. Saliva of people without carious lesions contains much less free fatty acids, triglycerides, cholesterol esters and phospholipids, and slightly less cholesterol and mono and di-glycerides [9]. Subsequent studies by Tomita et al. confirm information on the occurrence of differences in the concentration of lipids in the saliva of adults susceptible to the development of caries compared to those resistant to it [10]. Studies conducted in adolescents also showed an increase concentration of triglycerides and total cholesterol in the saliva in the course of tooth decay [11]. Systematic review da Silva Fidalgo et al. indicates a moderate association between dental caries and salivary lipid content [12]. Sarode et al. observed that there is an association between occurrence of dental caries and levels of salivary oxidative stress marker MDA [13].

At the same time, there are theories about the possibility of protective action of lipids of dietary origin. They can reduce the incidence of tooth decay in humans and animals by protecting the enamel from demineralization, creating a thin lipid film covering teeth [14]. In addition, high fat content in food may have antibacterial effect by inhibiting adherence and aggregation of cariogenic bacteria [15].

### PELLICLE AND LIPIDS

The oral cavity is covered with an approximately 1μm thick, amorphous structure, the acquired pellicle. It occurs on the surface of the enamel, root cement and on the mucosa membrane of the mouth. It is composed of proteins, glycoproteins and lipids from saliva and gingival fluid. Pellicle formation is a highly selective process that does not correlate directly with salivary composition. Reich et al. in his investigation of the pellicle samples gained from different subjects examined the fatty acid profiles which were remarkably similar, whereas the amount of fatty acids showed significant individual variability [16].

The pellicle plays an important role in the process of caries and erosion due to its selective permeability to ions during transportation to and from hard dental tissues. In in vitro study on enamel demineralization in saliva environment it was proven that the pellicle protects against demineralization [17].

Extending the experimental time of enamel exposure to saliva reduces the depth and severity of demineralization. An important role in the protection of enamel from demineralization is attributed to lipids. Significant amounts of lipids in the pellicle allow to stop the diffusion of acids produced by acid-producing bacteria, thus controlling the size of enamel demineralization [18]. Studies have been carried out on people who are sensitive and resistant to the development of dental caries to determine to what extent lipids in the membranes impede the passage of acids between the saliva and the surface of the teeth. It was found that salivary phospholipids combine with the film mucins and are a factor responsible for protecting the tooth surface against acidic demineralization. Research indicates the important role of lipids in controlling the extent of enamel demineralization. However, the mechanism of occurring reactions is poorly understood. There is also no information about lipids of dental root cement’s pellicle and their role in the penetration of acids.

It is known that tooth enamel’s and cementum’s pellicles

---

**Table 1. Search results from databases and Open Access Scientific Reports with using the MeSH (Medical Subject Headings) terms.**

<table>
<thead>
<tr>
<th>MeSH</th>
<th>Result Electronic Retrieved (Abstract)</th>
<th>Year of Publication</th>
<th>Abstracts Selected</th>
<th>Articles Retrieved</th>
<th>Articles Finally Selected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saliva and lipids</td>
<td>9</td>
<td>2014-1972</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Saliva and cholesterol</td>
<td>8</td>
<td>1990-1967</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Salivary and lipids</td>
<td>34</td>
<td>2018-1958</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Dental caries and lipids</td>
<td>6</td>
<td>2012-1986</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Dental calculus and lipids</td>
<td>8</td>
<td>2017-1963</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Dental plaque and lipids</td>
<td>3</td>
<td>1990-1972</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
contain similar amounts of lipids, although they differ in the composition of other substances, e.g. proteins and cystatins [18].

The colonization of dental membranes by bacteria takes place via specific adhesion mechanisms. It is presumed that the attachment of selective bacteria to the surface of teeth is possible due to reaction of bacterial surface receptors with their ligands in the pellicle. In this way, the lipid biofilm of the teeth can modulate the adhesion of bacteria to the surface. Recent research indicates the role of a phosphorylated dihydroceramide (PDHC) lipids produced by periodontal bacteria in promotion of IL-6 secretion and inhibition of osteoblasts. The PDHC lipids are synthesized by oral Bacteroides, Parabacteroides, Prevotella, Tannerella and Porphyromonas genera [19]. Moreover, Nichols and Rojanasomith found the PDHC lipids in subgingival plaque, subgingival calculus, diseased teeth, and gingival tissue produced by Porphyromonas gingivalis [20]. Murty et al. observed changes in lipids during maturation of dental plaque. The level of neutral and phospholipids increased in the mature bacterial plaque [21]. The pellicle populated by bacteria is transformed into plaque, which in turn forms the basis for the formation of dental calculus.

CALCULUS AND LIPIDS

Dental calculus mainly consists of inorganic minerals. In scanning electron microscopy, tartar formation was found around fragments of cellular organelles such as mitochondria, lysosomes, or bacterial fragments [22]. In the process of calculus formation, lipids play an important role in maintaining the integrity of the plaque and regulating the processes leading to its mineralization. The organic composition of the dry matter of supragingival tartar is 54.9% protein and 10.2% lipid. Tartar lipids mainly include neutral lipids, with a large amount of free fatty acids and a small amount of triglycerides, but also glycolipids and phospholipids [18]. The studies found that the concentration of phospholipids in the saliva of people with a large amount of calculus is significantly higher than in people with a small amount of it. Saliva of people with heavy tartar contains 50% more lipids than people with a small amount of tartar [23].

CONCLUSION

The presented studies prove that higher salivary lipid levels are associated with the certain oral diseases. It can be said that saliva in caries-experiencing people have higher concentration of free fatty acids, triglycerides, and cholesterol, whereas the presence of dental calculus, usually associated with periodontal diseases, is accompanied by an increase in the concentration of free fatty acids and triglycerides. This higher value of salivary lipids in dental caries or tartar deposits is probably connected with the changes in the oral environment. Further research is needed to explain the mechanisms and sources of these differences.

LIST OF ABBREVIATIONS

MDA = malondialdehyde

PDHC = phosphorylated dihydroceramide lipids

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

REFERENCES