Education

E-ISSN No : 2581-6195 | Volume : 7 | Issue : 10 | October 2024

ASSOCIATION OF FUSOBACTERIUM NUCLEATUM WITH HALITOSIS

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ABSTRACT

This paper focuses on 3 main negative effects of Fusobacterium nucleatum on halitosis. Halitosis, which is known as bad breath, is a common disease among people. Fusobacterium nucleatum produces VSCs, such as hydrogen sulfide and methyl mercaptan, which cause halitosis. Another effect of Fusobacterium nucleatum is that it triggers periodontal disease to induce halitosis. The microbe also collaborates with other bacteria like Porphyromonas gingivalis and Capnocytophaga ochracea to leave a negative influence on bad breath. It is important to recognize this issue in order to further examine and create future treatments.

KEYWORDS: Fusobacterium Nucleatum, Halitosis, Bacteria, Periodontal Diseases, Oral Hygiene

INTRODUCTION

Halitosis, which is also called bad breath, is a condition in which an obnoxious smell is exhaled into the air from our mouth. More than 50% of the general population have this condition (Nachnani, 2011, p. 23). Halitosis could induce embarrassment among people and could impact people socially and mentally by lowering self-esteem, causing anxiety, and overall, lowering quality of life (Briceag et al., 2023). Halitosis is caused by odour-causing bacteria. Those bacteria produce volatile sulfur compounds (VSCs), such as hydrogen sulfide, dimethyl sulfide, dimethyl disulfide, and methyl mercaptan (Hampelska et al., 2020). There are many bacteria affecting halitosis. One of the most significant bacteria is Fusobacterium nucleatum. Fusobacterium nucleatum is a Gram-negative anaerobic bacteria that plays a huge role in many periodontal diseases. It is one of the most overflowing bacteria in both healthy and diseased individuals' mouths (Han, 2015). Fusobacterium nucleatum is known for its negative impact on halitosis, which produces VSCs, triggering periodontal disease, and making synergistic effects with other bacteria. The medical field needs to acknowledge Fusobacterium nucleatum's effect on halitosis and investigate this topic more in order to find more efficient ways to treat diseases.

METHODOLOGY

Google Scholar, PubMed, and Scopus databases were searched using the following keywords: "Fusobacterium", "Fusobacterium nucleatum", "F. nucleatum", "Halitosis", "Bad breath", "Oral malodor", "negative", "bad", "impact", "effect", "affect", "influence" and other relative terms. When searching for the production of VSCs by Fusobacterium nucleatum, the keyword, "production" was added with other words such as "volatile sulfur compounds", "production", "methyl mercaptan", "hydrogen sulfide", "enzymes", "METase", "dimethyl sulfide", "dimethyl disulfide". When searching for F. nucleatum's impact on periodontal diseases to cause halitosis, we added keywords such as, "gingivitis", "periodontitis", "gum", "disease". Keywords, "Porphyromonas gingivalis", "P. gingivalis", "synergistic", "effect", "enhancement", "gingival", "epithelial", "cells", "Capnocytophaga ochracea", "C. ocheracea" and so forth were included when finding the synergistic effect of F. nucleatum with other bacteria on halitosis.

LITERATURE REVIEW

In the article, Basic et al. (2017), researchers examined H_2S production of bacterial strains that were correlated with periodontal diseases. They focused on mostly Fusobacterium species. They constructed a study using cell extracts and in-gel activity assay in order to determine the enzyme's activity. The research found that Fusobacterium species, including F. nucleatum, produce VSC by the gels having brownish bands. H_2S is one of the major VSCs that contribute to halitosis, and it is important to know if the F. nucleatum is responsible for producing volatile sulfur compounds.

In the paper, Yang et al., (2014) investigators executed an in-depth study about the connection between periodontal inflammation and bacteria, Porphyromonas gingivalis, Prevotella intermedia, Tannerella forsythensis, and Fusobacterium nucleatum. They collected 77 subgingival plaque

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HOW TO CITE THIS ARTICLE:
Ireh Choe (2024). Association of Fusobacterium Nucleatum with Halitosis, International Educational Journal of Science and Engineering (IEJSE), Vol: 7, Issue: 10, 20-22

Research Paper

samples from 35 adolescents. Those subgingival plaques were categorized by their conditions and periodontal health. Researchers used real-time PCR to measure the numbers of each bacteria. They found that the number of bacteria, including Fusobacterium nucleatum, in the moderate and severe gingivitis groups was notably higher compared to the mild gingivitis group. This evidence shows that F. nucleatum affects periodontal disease. Periodontal diseases are associated with halitosis because out of 823 participants in the study who suffered from halitosis, 102 of them had gingivitis and 721 had periodontitis (Takeuchi et al., 2010). Therefore, this supports the statement that F. nucleatum affects periodontal disease to influence halitosis.

Saito et al. (2008) investigated the role of Fusobacterium nucleatum on Porphyromonas gingivalis's ability to invade host cells, such as human gingival epithelial and aortic endothelial cells. The study was constructed by adding Ca9-22, which is the cell line of epithelial cells, to a polymicrobial sample (P. gingivalis mixed with F. nucleatum) and a monomicrobial sample (only P. gingivalis). The study showed that F. nucleatum enhances the invasion of host cells by P. gingivalis. Invasion of host cells is unpleasant for halitosis because the invasion contributes to periodontal diseases (Lamont et al., 1995), which could induce halitosis (Takeuchi et al., 2010).

RESULTS

1. Producing Volatile Sulfur Compounds

Firstly, Fusobacterium nucleatum has a negative effect on halitosis by producing volatile sulfur compounds. Some of the main VSCs that induce halitosis are hydrogen sulfide, dimethyl sulfide, dimethyl disulfide, and methyl mercaptan (Hampelska et al., 2020). A study result from a recent investigation shows that Fusobacterium nucleatum was detected to have enzymes that produced H_2S (Basic et al., 2017). The bacterium was shown to have enzymes that produce hydrogen sulfide, which is one of the main contributors to halitosis. Observing that F. nucleatum directly causes halitosis indicates that the bacterium has a bad impact on halitosis. Furthermore, a study shows that F. nucleatum contains an enzyme, METase, which produces methyl mercaptan by going through an enzymatic degradation process with L-methionine (Yoshimura et al., 2002). Not only hydrogen sulfide, but the bacterium generates other VSCs like methyl mercaptan with the help of L-methionine to trigger halitosis.

2. Impacting Periodontal Diseases

Fusobacterium nucleatum directly affects periodontal diseases, which influences halitosis. Periodontal disease affects the gum, and the symptoms include swollen, red or bleeding gum, sensitive teeth, bad breath, etc. Takeuchi et al. (2010) studied 823 halitosis patients and found that 102 of them were diagnosed with gingivitis and 721 with periodontitis. This clearly shows that halitosis is linked to periodontal diseases because all of the participants with halitosis have periodontal disease. A study revealed that the quantity of F. nucleatum in moderate and severe gingivitis groups was considerably higher than in the mild group (Yang et al., 2014). A larger amount of F. nucleatum in the more serious gingivitis implies that the microbe may be correlated to the development of periodontal disease. Severe periodontal disease will induce bad breath; thus, F. nucleatum generates a bad effect on halitosis by impacting periodontal disease.

3. Making Synergistic Effects

Lastly, Fusobacterium nucleatum makes an amplified effect with other bacteria to trigger halitosis. First of all, Porphyromonas gingivalis is a bacterium that is Gram-negative anaerobic and causes many oral diseases, including halitosis and periodontal diseases (How et al., 2016). An investigation found that F. nucleatum elevates Porphyromonas gingivalis has the ability to invade human gingival epithelial cells (Saito et al., 2008). The invasion of gingival epithelial cells by P. gingivalis is significant in periodontal diseases (Lamont et al., 1995). John Hopkins presented that bad breath is one of the symptoms of periodontal diseases. This indicates that P. gingivalis invasion of gingival epithelial cells could be the source of the rise of halitosis. If F. nucleatum enhances the ability of P. gingivalis to invade the cells, it could aggravate the periodontal diseases, worsening the patient's bad breath. Another example of F. nucleatum making synergistic effects is that it impacts the formation of biofilm with Capnocytophaga ochracea. Capnocytophaga ochracea is a gram-negative bacterium known for inducing periodontal disease by forming dental plaques (Okuda et al., 2012). Okuda et al. (2012) found that the amount of biofilm formation by the co-culture of F. nucleatum and C. ochracea was significantly higher than the individual effect. An increase in biofilm formation will eventually lead to worse halitosis by having serious periodontal disease. Therefore, F. nucleatum critically impacts halitosis by enhancing other bacteria.

DISCUSSION

Since this research paper solely focuses on Fusobacterium nucleatum, there could be some limitations. Halitosis-influencing factors do not always relate to F. nulceatum; there are many other factors, including questionable oral hygiene. Even though we try to find a way to alleviate F. nucleatum's negative effect on bad breath, when the person has bad oral hygiene, it will eventually lead to bad breath. Also, F. nucleatum not only has a negative effect on our mouth but also some positive effects. F. nucleatum is found in the oral cavity even in people with normal conditions (Silbergleit et al., 2020). This means that the bacterium could be essential in maintaining the balance of the microbiome in our oral health and be beneficial in halitosis.

CONCLUSION

Overall, the findings imply that the Fusobacterium nucleatum negatively affects halitosis by encouraging the production of volatile sulfur compounds, initiating periodontal disease, and generating a synergistic effect with other bacteria. Recently, studying bacteria's effect on bad breath has been an important issue. Since many people undergo mental distress due to

halitosis, recognizing more on this topic is significant. This paper demonstrates the different effects of Fusobacterium nucleatum on halitosis. There are many treatments for halitosis; however, many people continue to have it. The origin of halitosis should be better researched, and new treatments should be investigated.

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