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# PREVENTION OF *Treponema denticola* CAUSING GUM DISEASE BY QUERCETIN OF GINGER

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**AUTHORS' CONTRIBUTIONS**

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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## ABSTRACT

Gum disease is caused by *Treponema denticola.* Thmidylate Synthase is one of its major enzymes of that pathogen. *Ginger extract* is known to cure gum disease. The plant extract contains different phytochemical compounds. By using "Biovia Discovery Studio", the molecular docking of the phytochemicals with the enzymes was studied. The results showed that Quercitin can deactivate the Thymidylate Synthase enzyme thereby interrupting the microbe's life cycle.

**Keywords:** Phytochemical; ginger metabolic pathways; gum disease; *Treponema denticola.*

## 1. INTRODUCTION

The use of herbal medicine increased significantly in the world including developed countries due to the pharmacological activities of plants [1,2]. The knowledge about plants has been provided by ancient people.

The stem, roots, leaves etc. were screened to get different phytochemical content [1].

Ginger (*Zingiber officinale*) belongs to family Zingiberaceae. Its extract can fight against disease like Periodontitis. There is a high likelihood that these phytochemicals assume a significant job in relieving a disease. Anyway, there is no report distinguishing the particular phytochemical capable to fix Peridontitis. *Treponema denticola* is known to cause Peridontitis.

## 2. MATERIALS AND METHODS

### 2.1 Software Used

All the operations were carried out in Discovery studio module of Biovia 2020 software (Dassault Systemes of France). Biovia 2020 discovery studio is used for the experiment and identification of molecular docking. The software utilizes machine learning techniques to predict the level of molecular interaction between the receptor (enzyme) and Ligand (Phytochemicals).

### 2.2 Methodology

#### 2.2.1 List of phytochemicals

Phytochemicals do not play any direct function in plants thus they are called secondary metabolites. Phytochemicals are the secondary metabolites

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produced by plants as a response to fight or fight-mechanisms against their predators. Phytochemicals are generally bio-active compounds which can affect animal biochemistry and metabolism. Hence they are widely examined to prove their ability towards our health benefits. It becomes important for us to include them in our foods, as potential nutritionally active ingredients. When we consume them they passed on to our systems from plant products. Published works showed that Ginger contains Alpha- curcumene, Gingerdiol, Gingerol, Naringenin and Quercetin etc. [3]. It has already been established that Ginger plant belonging to Zingiberaceae family has the potential to help controlling Gum disease. This work is focused on the identification of the particular phytochemical responsible for inhibiting and controlling of Gum disease.

### 2.2.2 Enzyme found in *Treponema denticola* gum disease

From published books and papers we can say that Gum disease is caused due to *Treponema denticola* infestation [4]. The survival of pathogen inside its host is highly dependent on certain metabolic pathways. These metabolic pathways require certain enzymes as its co-factor to function properly. Brenda enzyme database helped us to identify and list different enzymes found in *Treponema denticola* responsible for Gum disease. It has been found that Thymidylate Synthase (protein database code 1O26) is involved in Pyrimidine metabolism (KEGG). This metabolism proves to be very crucial for the pathogen thus blocking or inhibiting that pathway results in the death of the particular microbe.

### 2.2.3 Molecular docking

Molecular docking method has been used to identify the phytochemical from the plant extract, which acts as a ligand and forms a strong covalent bond with the bacterial protein to successfully inhibit the microbe. The Discovery studio module of Biovia 2020 software was used for identifying molecular interaction and perform molecular docking. First step involves making a list of phytochemicals present in Ginger from various research papers. Second steps involves the download of the sdf files for the phytochemicals found in the Ginger plant from the various website like PubChem, MolInstincts etc. The protein database code of Thymidylate Synthase enzyme was identified from the RCSB-PDB website. The active site of the enzyme was identified via “receptor cavity” protocol found under "receptor-ligand interaction" menu. Molecular docking was done using the CDocker protocol of Biovia software under “receptor-ligand interaction”. The enzyme molecule was treated as the receptor molecule and the phytochemical was treated as the ligand. The “-CDOCKER_ENERGY” and “-CDOCKER_INTERACTION_ENERGY” were used as an indicator for the quality of molecular docking. The high positive value of those indicators presented a good interaction between the ligand and the receptor. Thus, the interactions with high values might indicate the major phytochemical responsible for curing the disease.

## 3. RESULTS AND DISCUSSION

-CDOCKER energy was calculated based on the internal ligand strain energy and receptor-ligand interaction energy. -CDOCKER interaction signifies the energy of the nonbonded interaction that exists between the protein and the ligand. The criteria for best interaction was chosen based on a) high positive value of -CDOCKER energy and b) small difference between -CDOCKER energy and -CDOCKER interaction energy [5,6].

Table 1 shows that Thymidylate Synthase - Quercetin interaction has the highest positive value of -CDOCKER energy (31.5469) and minimum value of the difference (10.307) between - C DOCKER interaction energy and - C DOCKER energy followed by Gingerol . Thus the results indicated that Quercetin and Gingerol can effectively deactivate the Thymidylate Synthase enzyme thereby interrupting the biological cycle of *Treponema denticola*. Higher positive values for Quercetin indicated that it was the most active ingredient against *Treponema denticola*. On the other hand, Alpha- curcumene and Gingerdiol can deactivate the enzyme to a small extent. Thus, the key phytochemicals preventing Gum disease caused by *Treponema denticola* are Quercetin and Gingerol.

**Table 1. Results of C Docking of phytochemicals with thymidylate synthase (receptor)**

| Sl. no. | Ligand | -CDOCKER energy | -CDOCKER interaction energy | Difference between - C DOCKER interaction energy and - C DOCKER energy |
|---|---|---|---|---|
| 1 | 1dehydro-10-gingerdene | 26.0979 | 37.2598 | 11.1619 |
| 2 | Alpha-curcumene | 4.57777 | 29.2071 | 24.62933 |
| 3 | gingerdiol | 9.22074 | 28.1376 | 18.91686 |
| 4 | Gingerol | 30.7412 | 46.0179 | 15.2767 |
| 5 | Naringenin | 20.0931 | 33.5451 | 13.452 |
| 6 | Querecetin | 31.5469 | 41.8539 | 10.307 |

## 4. CONCLUSION

We have been relying on chemical drugs highly which has put an adverse effect on our body. Thus we need to incorporate more plant-based drugs in our life. One of the important plants that can be used as a plant-based drug is Ginger. Ginger is well-known for its use as spices and condiments. Ginger is known to have a various biological activities such as Anti-inflammatory, anti-analgesic activity, Anti-microbial activity, Hepato-protective activity, Anti-oxidant and anti-cancerous activity [7]. It was previously known that the Ginger plant has medicinal action against Gum disease. Gum disease is caused by *Treponema denticola*. This study was carried out to provide the theoretical basis of this observation. Using Discovery studio module of Biovia 2020 software, molecular docking operation was performed to identify the phytochemical (Quercetin and Gingerol), which can have significant interaction with the vital enzyme (Thymidylate Synthase) of the microbe. It was found that Quercetin and Gingerol can form strong bond with the enzyme successfully inhibiting the metabolic cycle of the microbe. Alpha- Curcumene and Gingerdiol were found to be not much effective in deactivating the enzyme of the microbe. Thus, this study could explain that the presence of Quercetin and Gingerol provided the medicinal values to Ginger against Gum disease caused by *Treponema denticola*. But we can also conclude that other phytochemicals may or may not inhibit other enzymes present in other biological cycles of *Treponema denticola*.

## DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

## REFERENCES


1. Mario Gajdacs, Edit Urban. The relevance of anaerobic bacteria in brain abscesses: A ten-year retrospective analysis (2008–2017), from infectious disease. 2019;15:789-781.
2. Farckkarahan, Kamhuravsar, et al. Antimicrobial and antioxidant activities of medicinal plant *Glycyrrhiza glabra* var; glandulifera from deffination habitats. 2016; 30(4):797-804.
3. Anosike CA, Obidoa O, Ezeanyika LU, Nwuba MM. Anti-inflammatory and anti-ulcerogenic activity of the ethanol extract of ginger (*Zingiber officinale*). Afr J Biochem Res. 2009; 3(12):379-84.
4. Simonson LG, Goodman CH, Bial JJ, Morton HE. Quantitative relationship of *Treponema denticola* to severity of periodontal disease. Infection and Immunity. 1988;56(4): 726-728.
5. Marissa L. Puzan, Belete Legesse, Ryan A. Koppes, Hicham Fenniri, Abigail N. Koppes. Bioactive organic rosette nanotubes support sensory neurite outgrowth. ACS Biomater. Sci. Eng. 2018;4(5):1630-1640.
6. Brinda OP, Deepu Mathew, Shylaja MR, Sangeetha Davis P, Anita Cherian K, Valsala PA. Isovaleric acid and avicequinone-C are Chikungunya virus resistance principles in *Glycosmis pentaphylla* (Retz.) Correa. 2019; 56(2):111-121.
7. Rahmani AH. Active ingredients of ginger as potential candidates in the prevention and treatment of diseases via modulation of biological activities. International Journal of Physiology, Pathophysiology and Pharmacology. 2014;6(2):125.


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