**ABSTRACT**

Phytochemicals from *Boswellia serrata* Roxb. ex Colebt. plant extract are traditionally used to cure diarrhea. It is caused by *Escherichia coli*. Molecular docking method applied using “Biovia Discovery Studio”. “High positive values of -CDOCKER energy and -CDOCKER interaction energy” suggested that p-cymene can effectively deactivate the alcohol dehydrogenase enzyme thereby interrupting the life cycle of the organism.

**Keywords**: *Boswellia serrata*; *Escherichia coli*; phytochemical; diarrhea.

**1. INTRODUCTION**

Forest is a significant source of medications [1]. The remedial estimation of the plants is an immediate consequence of the phytochemicals present in it. Phytochemicals can be gotten from various parts of plants. Various remedial plants and their phytoextracts have indicated the adversary of microbial action [2]. These medicinal plants acknowledge a key movement in human social assurance. Different individuals depend upon the use of standard medication [3].

*Corresponding author: E-mail: mohapatraa098@gmail.com;*
Boswellia serrata belongs to family Burseraceae. B. serrata extract is used to cure disease like Gonorrhoea. The objective of the study is to identify the phytochemical responsible to cure the disease.

B. serrata contains "p-cymene, boswellic acid" etc. These phytochemicals might act against diarrhea. However, there is no such study available.

This objective of the study is to identify the phytochemical of B. serrata capable of curing diarrhea.

2. MATERIALS AND METHODS

2.1 Software Used

Discovery studio module of Biovia software (Dassault Systemes of France) was used for analysis. The software utilizes machine learning techniques to predict the level of molecular interaction.

2.2 Methodology

2.2.1 List of phytochemicals

Phytochemicals are produced by plants as secondary metabolites to protect them from predators. The potential threats to plants include bacteria, viruses, fungi etc. When these plants or their parts are consumed by humans these phytochemicals fight off threats to health. Some phytochemicals have been used as poisons and others as traditional medicine. Published works showed that Boswellia serrata contains Boswellic acid, D-limonene, Incensole acetate, P-cymene, sabinene, Terpinen-4-ol etc. It has already been established that Boswellia serrata plant belonging to Burseraceae family has potential to help controlling diarrhoea. This work is focused on identification of the particular phytochemical responsible for inhibiting and controlling of diarrhoea.

2.2.2 Enzyme found in Escherichia coli

It has been reported that diarrhoea can cause as a result of Escherichia sp. infestation. Various metabolic cycles have been seen in the bacterial life cycle for its survival. These metabolic cycles are regulated by different enzymes. Brenda enzyme database was used to identify and list different enzymes found in Escherichia sp. bacteria. It has been found that alcohol dehydrogenase enzyme (protein database code 4GKV) is involved in metabolism like Tryptophan metabolism, Tyrosine metabolism, Phynylalanine metabolism, Leucine metabolism, valine metabolism, Methionine metabolism, Ethanol metabolism, Propanol degradation (BRENDA) and very crucial for survival of the particular microbe.

2.2.3 Molecular docking

Molecular docking method has been used to identify the phytochemical from the plant extract, that act as a ligand and form a strong covalent bond with the bacterial protein to successfully inhibit the microbe. The Discovery studio module of Biovia software was used for identifying molecular interaction and perform molecular docking. In this process first the sdf files for the phytochemicals found in the Boswellia serrata plant were downloaded from the website (Pub-Chem). The protein database code of the alcohol dehydrogenase enzyme was identified from the website (WWW.rcsb.org). 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 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 non bonded 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 [4,5]. Table 1 shows that alcohol
Table 1. Results of C Docking of phytochemicals with alcohol dehydrogenase (receptor)

| Sl. no. | Ligand             | -CDOCKER energy | -CDOCKER interaction energy | Difference between-CDOCKER interaction energy and -CDOCKER energy | Remarks                                      |
|--------|------------------|-----------------|-----------------------------|----------------------------------------------------------------|-----------------------------------------------|
| 1      | P-Cymene         | 10.8695         | 11.3695                     | 0.4997                                                         | Maximum inhibition of microbial enzyme        |
| 2      | Boswellic acid   | 21.8488         | 9.12843                     | 12.72037                                                      |                                               |
| 3      | Sabinene         | -19.9735        | 8.35549                     | 28.32899                                                      |                                               |
| 4      | Terpinene-4-ol   | -11.5523        | 17.4518                     | 29.0041                                                       |                                               |
| 5      | D-limonene       | 11.3501         | -26.8754                    | -38.2255                                                      | Minimum inhibition of microbial enzyme        |
| 6      | Incensole acetate| -35.0946        | 27.3344                     | 62.429                                                        |                                               |

dehydrogenase-Boswellic acid interaction has the highest positive value of -CDOCKER energy (21.8488) and minimum value of the difference (12.72037) between -CDOCKER interaction energy and -CDOCKER energy. Thus the results indicated that Boswellic acid and P-Cymene can effectively deactivate the glycerol dehydrogenase enzyme thereby interrupting the biological cycle of *Escherichia* species. Higher positive values for Boswellic acid indicated that it was the most active ingredient against *Escherichia* species. On the other hand, P-Cymene can deactivate the enzyme (negative -CDOCKER energy but positive -CDOCKER interaction energy). Thus, the key phytochemicals preventing diarrhoea caused by *Escherichia* species. are Boswellic acid and P-Cymene.

4. CONCLUSIONS

It was previously known that *Boswellia serrata* plant has medicinal action against diarrhoea. Diarrhoea is caused by *Escherichia sp.*. This study was carried out to provide the theoretical basis of this observation. Using Discovery studio module of Biovia software, molecular docking operation was performed to identify the phytochemicals (Boswellic acid, D-limonene, Incensole acetate, P-cymene, sabinene, Terpinen-4-ol), which can have a significant interaction with the vital enzyme (alcohol dehydrogenase) of the microbe. It was found that Boswellic acid and P-Cymene can deactivate the alcohol dehydrogenase enzyme. Thus, this study could explain that the presence of Boswellic acid and P-Cymene provided the medicinal values to *Boswellia serrata* against diarrhoea caused by *Escherichia sp.*

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.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Henrich J, Heine S, Norenzayan A. The weirdest people in the world? Behavioral and Brain Sciences. 2010;33(2-3):61-83. DOI: 10.1017/S0140525X0999152X
2. Hussain I, Ullah R, Ullah R, Khurram M, Ullah N, Basee A, Khan F, Khattak M, Zahoor M, Khan J, Khan N. Phytochemical analysis of selected medicinal plant. African Journal of Biotechnology. 2011;10: 7487-7492.

3. Arulselvan P, Karthivashan G, Fakurazi S. Journal of Chemical and Pharmaceutical Research. 2013;5(7):233-239.

4. Das D, Das S, Pandey M, Bhattacharyay D. In silico analysis of phytochemicals from Mucuna pruriens (L.) DC against Mycobacterium tuberculosis Causing Tuberculosis. European Journal of Medicinal Plants; 2020.

5. Brinda OP, Mathew D, Shylaja MR, Davis PS, Cherian KA, Valsala PA. Isovaleric acid and avicequinone-C are Chikungunya virus resistance principles in Glycosmis pentaphylla (Retz.) Correa. Journal of Vector Borne Diseases. 2019; 56(2):111.