Moringa oleifera Derived Phytochemicals against 2-hydroxy-3-oxopropionate Reductase of Salmonella typhi Causing Typhoid

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ABSTRACT

Phytochemicals from Moringa oleifera plant extract can cure Typhoid. It is caused by Salmonella typhi. Molecular docking method applied using “Biovia Discovery Studio”. “High positive values of -CDOCKER energy and -CDOCKER interaction energy” suggested that 4,8,12,16-tetramethylheptadecan-4-olide can effectively deactivate the 2-hydroxy-3-oxopropionate reductase enzyme thereby interrupting the life cycle of the organism.

Keywords: Phytochemical; Moringa oleifera; Salmonella typhi; typhoid.
Plants play a key role in human health care. Many people rely on the use of traditional medicine [3].

*Moringa oleifera* belongs to family moringaceae. *Moringa oleifera* extract is used to cure disease like Typhoid. The objective of the study is to identify the phytochemical responsible to cure the disease.

*Moringa oleifera* contains “3, 7, 11, 15-trtramethyl-2-hexadecent-1-ol, 3-ethyl-2, 4-dimethylpentane, 4, 8, 12, 16-tetramethyl heptadecan-4-olide, 4-hydroxyl-4-methyl-2-pentanone, 4-hydroxyphenyl tanamide-alpha-L-rhamnopyranoside, 9-octadecenoicacid” etc. These phytochemicals might act against Typhoid. However, there is no such study available.

The objective of the study is to identify the phytochemical of *Moringa oleifera* capable of curing Typhoid.

### 2. MATERIALS AND METHODS

#### 2.1 Software Used

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

#### 2.2 Methodology

##### 2.2.1 List of phytochemicals

Phytochemicals as secondary metabolites are produced from plant to protect them from predators and having important medicinal properties. Bacteria, viruses, fungi etc. are potential threats to plants. When human consume these plants or their parts these phytochemicals having medicinal properties fight off threats to health. Some phytochemicals have been used as poisons and others as therapeutically medicine. Published works showed that *Moringa oleifera* contains phytochemicals like 3,7,11,15-trtramethyl-2-hexadecent-1-ol,3-ethyl-2,4-dimethylpentane,4,8,12,16-tetramethylheptadecan-4-olide,4-hydroxyl-4-methyl-2-pentanone,4-hydroxyphenyltanamide-alpha-L-rhamnopyranoside,9-octadecenoicacid etc.It has already been established that *Moringa oleifera* plant is one of the species of Moringaceae family has potential to help cure typhoid. This work is focused on identification of the particular phytochemical responsible for inhibiting and controlling of typhoid.

#### 2.2.2 Enzyme in Salmonella

It has been reported that typhoid can caused by *Salmonella* sp. bacteria. For survival, bacteria requires various metabolic pathway. Different enzymes regulate these metabolic cycles. Brenda enzyme database was used to identify and list different enzymes found in *Salmonella* sp. bacteria. It has been found that 2-hydroxy-3-oxopropionate reductase enzyme (protein database code4DLL) is involved in glyoxylate and dicarboxylate metabolism (KEGG) 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 *Moringa oleifera* plant were downloaded from the website [4]. The protein database code of the enzyme was identified from the website [5]. 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 nonbonded interaction that exists between the protein and the ligand.
Table 1. Results of C Docking of phytochemicals with 2-hydroxy-3-oxopropionatereductase (receptor)

| Sl. no. | Ligand                                   | -CDOCKER energy | -CDOCKER interaction energy | Difference between -CDOCKER interaction energy and -CDOCKER energy | Remarks                              |
|--------|------------------------------------------|-----------------|----------------------------|---------------------------------------------------------------|--------------------------------------|
| 1      | 3,7,11,15-Tetramethyl-2-Hexadecent-1-Ol  | 15.7857         | 47.0737                    | 31.2867                                                       |                                      |
| 2      | 3-ethyl-2,4-dimethylpentane              | 13.5053         | 21.3761                    | 7.8708                                                        |                                      |
| 3      | 4,8,12,16-tetramethylheptadecan-4-olide  | 33.9622         | 48.1479                    | 14.1857                                                       | Maximum inhibition of microbial enzyme |
| 4      | 4-hydroxyl-4-methyl-2-pentanone          | 26.6276         | 28.639                     | 2.0114                                                        |                                      |
| 5      | 4-hydroxyphenyltanamide-alpha-L-rhamnopyranoside | 25.292     | 27.8167                    | 2.5247                                                        |                                      |
| 6      | 9-octadecenoic acid                      | 30.0714         | 43.551                     | 13.4796                                                       |                                      |

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 2-hydroxy-3-oxopropionatereductase -4-hydroxyl-4-methyl-2-pentanone interaction has the highest value of CDOCKER energy (28.639) and minimum value of the difference (2.0114) between CDOCKER interaction energy and CDOCKER energy followed by 4-hydroxyphenyltanamide-alpha-L-rhamnopyranoside. Thus the results indicated that 4-hydroxyl-4-methyl-2-pentanone and 4-hydroxyphenyltanamide-alpha-L-rhamnopyranoside can effectively deactivate the 2-hydroxy-3-oxopropionatereductase enzyme thereby interrupting the biological cycle of salmonella typhi. Higher positive values for phytochemical 4-hydroxyl-4-methyl-2-pentanone and 4-hydroxyphenyltanamide-alpha-L-rhamnopyranoside indicated that it was the most active ingredient against salmonella sp. On the other hand 3,7,11,15-trtramethyl-2-hexadecent-1-ol and 4,8,12,16-tetramethylheptadecan-4-olide can deactivate the enzyme to a small extent (negative-CDOCKER energy but positive-CDOCKER interaction energy).

Thus, the key phytochemicals preventing typhoid caused by salmonella sp. are 4-hydroxyl-4-methyl-2-pentanone and 4-hydroxyphenyltanamide-alpha-L-rhamnopyranoside.

4. CONCLUSIONS

It was previously known that Moringa oleifera plant has therapeutically action against typhoid. salmonella typhi is the causative agent of typhoid. 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 phytochemical (3,7,11,15-trtramethyl-2-hexadecent-1-ol, 3-ethyl-2,4-dimethylpentane, 4,8,12,16-tetramethylheptadecan-4-olide, 4-hydroxyl-4-methyl-2-pentanone, 4- hydroxyphenyltanamide-alpha-L-rhamnopyranoside, 9-octadecenoic acid etc.), which can have a significant interaction with the vital enzyme (2-hydroxy-3-oxopropionate reductase) of the microbe. It was found that phytochemicals 4-hydroxyl-4 -methyl-2-pentanone and 4-hydroxyphenyltanamide-alpha-L-rhamnopyranoside can form strong bond with the enzyme successfully inhibiting the metabolic cycle of microbes. 3,7,11,15-trtramethyl-2-hexadecent-1-ol and 4,8,12,16-tetramethylheptadecan-4-olide were found to be not much effective in deactivating the enzyme of the microbe. This study could explain that the presence of phytochemicals 4-hydroxyl-4-methyl-
2-pentanone and 4-hydroxyphenylalanamide-alpha-L-rhamnopyranoside provided the medicinal values to *Moringa oleifera* against typhoid caused by *Salmonella typhi*.

**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, 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.

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