In-silico identification and evaluation of plant flavonoids as dengue NS2B/NS3 protease inhibitors using molecular docking and simulation approach

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Abstract: Dengue infection is prevailing among the people not only from the developing countries but also from the developed countries due to its high morbidity rate around the globe. Hence, due to the unavailability of any suitable vaccine for rigorous dengue virus (DENV), the only mode of its treatment is prevention. The circumstances require an urgent development of efficient and practical treatment to deal with these serotypes. The severe effects and cost of synthetic vaccines simulated researchers to find anti-viral agents from medicinal plants. Flavonoids present in medicinal plants, holds anti-viral activity and can be used as vaccine against viruses. Therefore, present study was planned to find anti-viral potential of 2500 flavonoids inhibitors against the DENVNS2B/NS3 protease through computational screening which can hinder the viral replication within the host cell. By using molecular docking, it was revealed that flavonoids showed strong and stable bonding in the binding pocket of DENV NS2B/NS3 protease and had strong interactions with catalytic triad. Drug capability and anti-dengue potential of the flavonoids was also evaluated by using different bioinformatics tools. Some flavonoids effectively blocked the catalytic triad of DENV NS2B/NS3 protease and also passed through drug ability evaluation. It can be concluded from this study that these flavonoids could act as potential inhibitors to stop the replication of DENV and there is a need to study the action of these molecules *in-vitro* to confirm their action and other properties.

Keywords: Medicinal plants, vaccines, drug design, Molinspiration, admetSAR, Lipinski's rule, flavonoids.

INTRODUCTION

Dengue infection is a mosquito-borne viral infection (Guzman and Kouri, 2002) that has turned into a severe health problem worldwide and approximately 2.5 billion people are being infected by this infection, (Idrees and Ashfaq, 2012) with nearly 25,000 deaths per year (Hakim *et al*., 2011). According to the latest research it is revealed that more than 100 countries with approximately 50-100 million people are being influenced by this infection. Asia, Central and South America and Africa are the main areas influenced by dengue virus infection (Gibbons and Vaughn, 2002; Das *et al*., 2008). Dengue virus (DENV) have four serotypes (DENV-1, DENV-2, DENV-3 and DENV-4) belongs to *Flaviviradae* family (Weaver and Vasilakis, 2009). Flavivirus are most often found in the tropical and temperate parts of the world and cause wide range of infections in humans such as dengue fever, tick-borne encephalitis, west nile fever and yellow fever (Akey *et al.,* 2014). DENV infection is transmitted in humans by two mosquito vectors i.e *Aedes aegypti* and *Aedes albopictus* (Thomas *et al*., 2002).

The genomic size of DENV is 11 KB which codes for a polyprotein with 10 structural and nonstructural proteins (Munoz-Jordan *et al*., 2003). Structural proteins comprise 3 proteins, core/capsid protein, membrane associated protein, and an envelope protein. Nonstructural proteins comprise 7 proteins namely NS, NS2A, NS2B, NS3, NS4A, NS4B, NS5. These proteins are positioned in order of 5_-CprM (M) -E-NS1-NS2A-NS2B-NS3-NS4A-NS4B-NS5-3 (Umareddy *et al*., 2007). Structural proteins plays a vital role in the structural organization of virus and viral entrance into host cell while non-structural proteins plays an important role in viral replication and other cellular functions (Hung *et al*., 1999). According to current studies, it has been revealed that at the N terminal region of NS3, a serine protease domain is present and potential of NS3 depends upon its interaction with cofactor (NS2B). As the consequence of interaction between NS3 and NS2B a complex forms called NS2B-NS3 pro complex. This complex has aptitude to cleave viral proteins. Any disturbance in functional behavior of this region, results in the inhibition of viral replication. Therefore, for the screening and assessment of the effects of various drug candidates, NS2B-NS3 complex is believed to be an essential and important target (Rothan*et al*., 2012).

Medicinal plants are used as a source of medicine by approximately three-quarters inhabitants of world. There are perhaps 2, 50,000 species of plants on earth and about 80,000 are medicinal in nature (Joy *et al*., 1998). Phytochemicals are found richly in medicinal plants (Calixto, 2000). In fact, phytochemicals are the chemicals

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which cause pigmentation, odor and taste in plants. In medicinal plants, these phytochemicals are the most important efficient molecules which control and lessen the number of infections (Doss *et al*., 2011). A wide range of phytochemicals can be found in medicinal plants which consist of alkaloids, limonoids, flavonoids, furyl compounds, polyines, thiophenes, organosulfur compounds, peptides, coumarins, terpenoids, polyphenolics and saponins. These phytochemicals provides their remedial function by foraging, scavenging and obstructing viral entry and DNA\RNA replication against a broad range of viruses (Idree and Ashfaq, 2013). Diverse phytochemicals like; (-)-Gossypol, Garcidepsidone A, 4-hydroxyacetophenone4-O-(6'-O-beta-D-apiofuranosyl)-beta-D-glucopyranoside, Mangostenone C, Demethylcalabaxanthone, Mangostanin (Ul Qamar *et al*., 2014[a]) 6'-desmethylthalifaboramin, 3,5-dihydroxythalifaboramine, Betanin, 3-hydroxy-6'-desmethyl-9-0-methylthalifaboramine, Reserpic acid and Tubulosine (Ul Qamar *et al*., 2014[b])previously reported DENV NS2B-NS3 protease inhibitors.

According to earlier studies, flavonoids play a vital function in the treatment of Dengue virus infections due to their competent anti-viral potential (Senthilvel *et al*., 2013). Cure of DENV with medicinal plant costs less contrasted to previous conventional techniques (Ul Qamar *et al*., 2014). It might also be favored due to the multiple target activities, little possible to cause resistance and ostensible side-effects (Jasim and Naji, 2003). It is regrettable that no enormous and considerable research is carried out for the development of a DENV vaccine (Robertson*et al*., 2001). No vaccination is available to contest dengue virus till now. Thus, there is a strong need to find cost valuable treatment that can target all serotypes with equal effectiveness (Idrees and Ashfaq, 2012). Dengue virus has 4 serotypes that evident almost analogous symptom (Ross, 2010; Wang *et al*., 2000). These four serotypes challenged researchers to design a vaccine against Dengue virus.

Recent innovations in computational biology practice have expanded the prospects of research in the vicinity of drug designing (Ul Qamar *et al*., 2016). For prediction of molecular docking foremost binding mode of a ligand with a three-dimensional structure of protein is taken as a key technique in drug designing and screening of recently discovered anti-viral compounds against adverse diseases (Lengauer and Rarey, 1996). Molecular docking is a method of binding orientation prediction of small molecules with their protein targets. These computational methods give information on binding activity and binding affinity of the molecules against their target protein. Therefore, molecular docking is believed as significant method in drug designing and screening of new antiviral compounds against severe illness.

Thus, the plan of the current study is to computationally screen 2500 flavonoids (table 1) of various antiviral medicinal plants against DENV NS2B/NS3 Protease and to screen innovative flavonoids that could aid in inhibition of the DENV infection. We also evaluated the drug capability and anti-dengue potential of the flavonoids by using bioinformatics tools. The result of this study will propose worthwhile information about drug development and would assist in computer aided screening of the drugs against DENV infection.

Methodology

This study involves the docking of 2500 flavonoids against DENV NS2B/NS3 protease. Docking was taken out via the molecular operating environment (MOE) software package. MOE was developed by chemical computing group Incorporation (CCG). MOE is comprehensive software and specifically design for drug designing, protein structure analysis, data processing and docking (MOE, 2009).

Ligand database preparation

An extensive survey on literaturewas performed in order to find the efficient and valuable flavonoids against viral diseases especially against dengue virus. Chemical structures of flavonoid molecules were downloaded from MAPS database (Ashfaq *et al*., 2013), Pubchem (Bolton*et al*., 2008), Zinc database (Irwin *et al*., 2012), ChEBI (Degtyarenko*et al*., 2008), MPD3 (www.bioinform.info) andChEMBL (Gaulton*et al*., 2012). Each and every ligand molecule was saved into the MOE databasein .mol format after energy minimization with parameters; Gradient: 0.05, Force Field: MMFF94X, Chiral Constraint: Current Geometry.

Refinement of receptor protein

Three-dimensional (3D) structure of the Dengue virus NS2B/NS3 protease was taken from the protein data bank (PDB) using PDB ID 2FOM (http://www.rcsb.org/pdb/home/home.do). Removal of water molecules, 3D protonation and energy minimization was done by using MOE with parameters; Force Field: MMFF94X+Solvation, Gradient: 0.05, Chiral Constraint: Current Geometry. This minimized structure was used as receptor for docking analysis.

Molecular docking

Binding pocket containing the catalytic triad (His 51, Asp 75, Ser 135) was selected with the help of site finder tool of MOE. The selected parameters used to calculate the score and interaction of ligand molecules with catalytic triad of Dengue virus NS2/NS3 were; Rescoring function: London dG, Placement: Triangle matcher, Retain: 10, Refinement: Force field, Rescoring 2: London dG. Most appropriate interactions of ligand molecules with target were chosen on the basis of S score and Root-Mean-Square Deviation (RMSD) values.

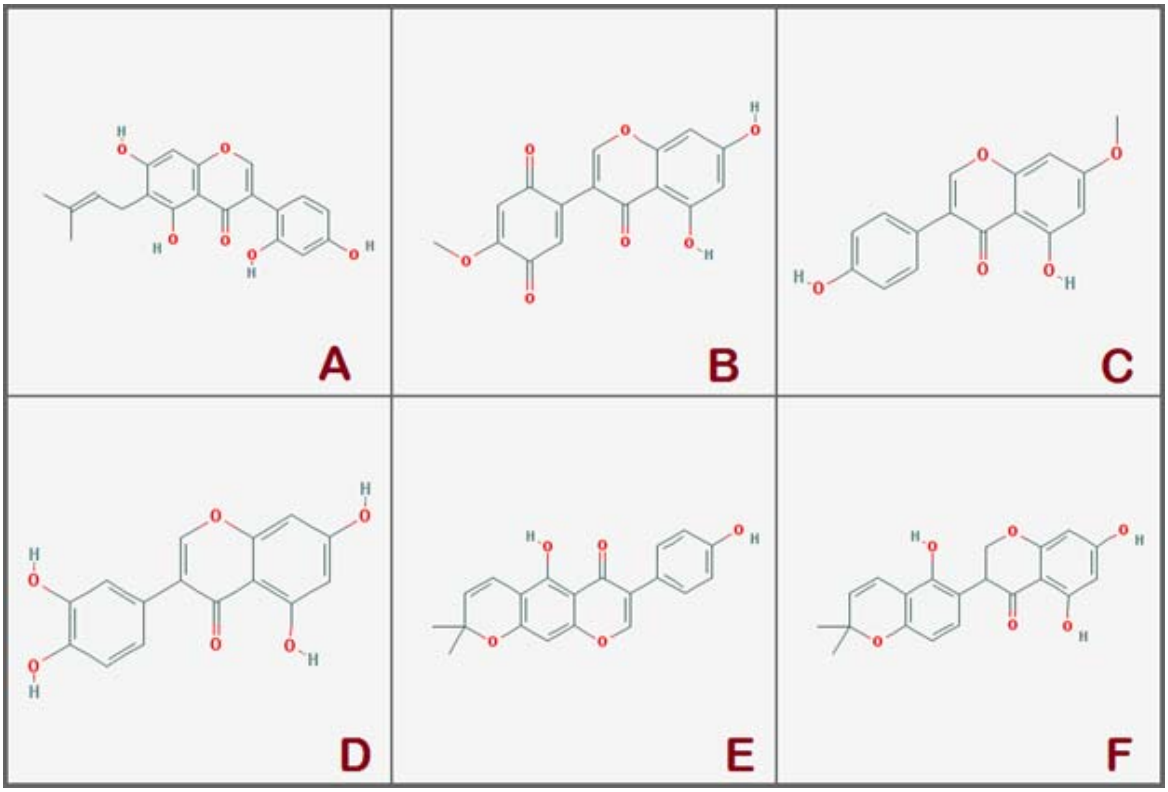

Fig. 1:Chemical structure of A) Uncinanone B B) 5-hydroxybowdichione C) Prunectin D) 5,7,3',4'-tetrahydroxyisoflavone E) Alpinumisoflavone and F) Glicoisoflavanone

Drug scan

Drug scan of flavonoids was executedusing the ligand properties checking tool of Molinspiration server (http://www.molinspiration.com/) to make surethat the compoundsholdappropriate molecular properties to be a potential drug candidate. Molecular properties and drug

Like liness of the compounds are evaluated by molinspiration server on the basis of "Lipinski's Rule of Five" (Lipinski*et al*., 2012). The rule illustrates molecular properties significant for a drug's pharmacokinetics in the human body, including their absorption, distribution, metabolism and excretion.

ADMET profiling

Furthermore, we also make use of admetSAR server (Cheng*et al*., 2012) for *in-silico* screening ADMET profiles of the potential compounds. The admetSAR server is a comprehensive online available tool which envisaged the ADMET-associated properties of the active compounds for various kinds of models all of which explained positive results. In this server, more than 2,10,000 ADMET associated data points for over 96,000 potential compounds along with important 45 types of ADMET related properties have been arranged from available literature. This is why, admetSAR server facilitate researchers to predict ADMET properties freely and more accurately with the benefit of time/labor saving (Cheng*et al*., 2012).

RESULTS

The 3D-structure of DENV NS2/NS3 protease was retrieved from PDB. The PDB ID of 3D-structure was 2FOM with the resolution of 1.50 Å. All flavonoids were docked with the catalytic triad of DENV NS2B/NS3 Protease.

Molecular docking

Ten conformations were provided by MOE for each flavonoid. These conformations were arranged according to S score. Top six conformations for every flavonoid with minimum S score were chosen for further investigation. Selected confirmations were sorted in such a way that Uncinanone B was ranked at top conformation followed by 5-hydroxybowdichione, Prunectin, 5,7,3',4'-tetrahydroxyisoflavone, Alpinumisoflavone and Glicoisoflavanone respectively. S score, RMSD value, detail about interacting residues and plant names from which flavonoids were isolated is shown in (table 2). Chemical structures of chosenflavonoids have shown in (fig. 1).

Interaction analysis

Along with minimum S score, Uncinanone B also had potential interactions with His 51, Asp 75, Ser 135and strong hydrophobic contact with Pro132, Gly153 and Leu128 residues of binding pocket.All other flavonoids 5-

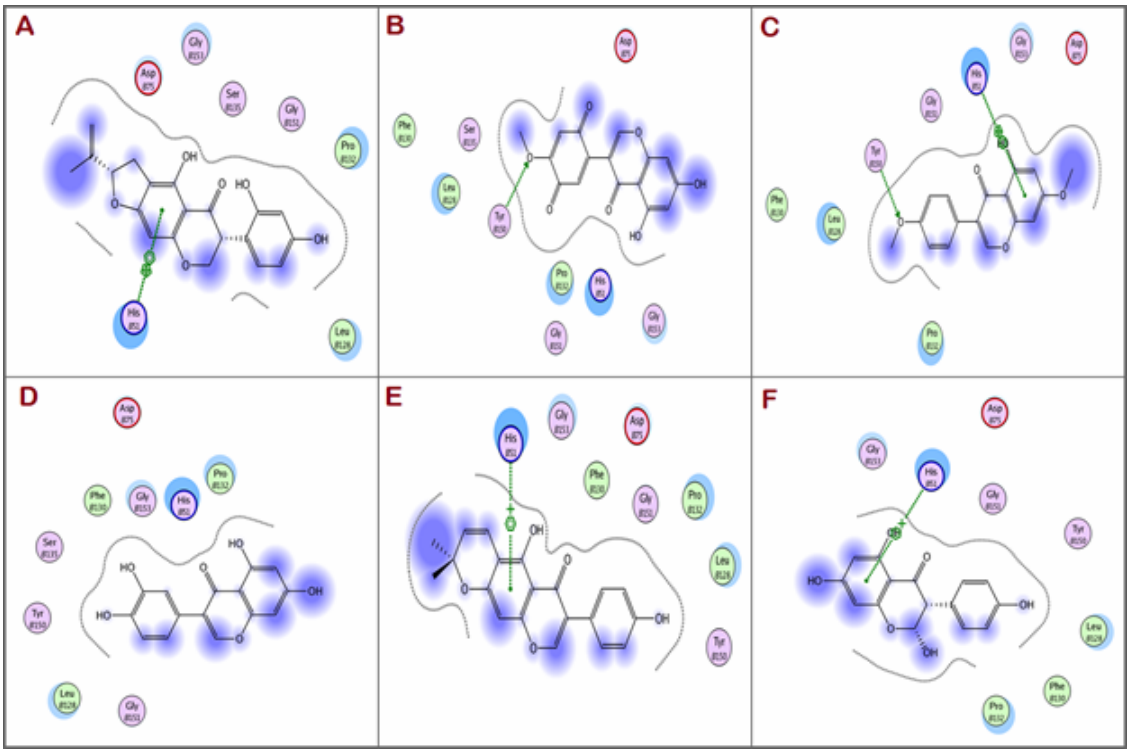

Fig. 2:2D interaction images of A) Uncinanone B with DENV NS2B-NS3 complex B) 5-hydroxybowdichione with DENV NS2B-NS3 complex C) Prunectin with DENV NS2B-NS3 complex D) 5,7,3',4'-tetrahydroxyisoflavone with DENV NS2B-NS3 complex E) Alpinumisoflavone with DENV NS2B-NS3 complex and F) Glicoisoflavanone with DENV NS2B-NS3 complex. Pink color shows polar interactions while green, red, blue color respectively shows hydrophobic, exposed and mild polar bonding of ligands with binding pocket of NS2B-NS3 protease.

hydroxybowdichione, Prunectin,5,7,3',4'-tetrahydroxyisoflavone, Alpinumisoflavone and

Glicoisoflavanone also have strong potential interaction and considerable hydrophobic contact with active residues of catalytic triad. Interacting residues of the DENVNS2B/NS3 Protease are shown in (table 2). Interactions between DENVNS2B/NS3 proteasecatalytic triad and flavonoids are shown in (fig.2). Binding mode of ligands with receptor is shown in (fig. 3).

Drug scan

Along with minimum S score and potential interactions with catalytic triad of the DENV NS2B/NS3 Protease, our preferred flavonoid compounds used in this study accomplish the criteria of being potential drug candidates. Result is shown in (table 3).

ADMET profiling

After drug scan we test ADMET associated properties. Our final selected residues illustrate considerable results. All flavonoids are non toxic, non carcinogenic while in metabolism and absorption, Uncinanone B,5-hydroxybowdichione and 5,7,3',4'-tetrahydroxyisoflavone show some violations but overall result is accepted and compounds are appropriate for use as drug candidate. Results are shown in (table 4).

DISCUSSION

Dengue virus infection has become a main health alarm around the globe. More than 50 million people suffer from dengue every year and approximately 25000 people defeat the battle of life against this deadly disease (Gubler, 1998; Halstead, 2007). Dengue genome codes for a single polyprotein which is slashed into 10 viral proteins (Ul Qamar *et al*., 2014[c]). The precursor of polyprotein needs signal peptidase and NS3 serine protease for cleavage which requires a cofactor termed as NS2B (Khan *et al*., 2008).

Dengue virus has four various serotypes (Li *et al*., 2005) but any inhibitor against the binding pocket of NS2/NS3 protease could effort against all the serotypes. Dengue virus NS3 protease has been stated as important drug target. Catalytic triad is essential in viral replication thus any interruption in it may result in the blocking of viral replication (Van Hell *et al*., 2009). Recently, computational skills have made scientists to evaluate the possibility of binding of various molecules before their production and estimation in lab. More exclusively, molecular docking is used to discover the binding pattern of the small molecules against their targets. Therefore, molecular docking is considered as significant technique

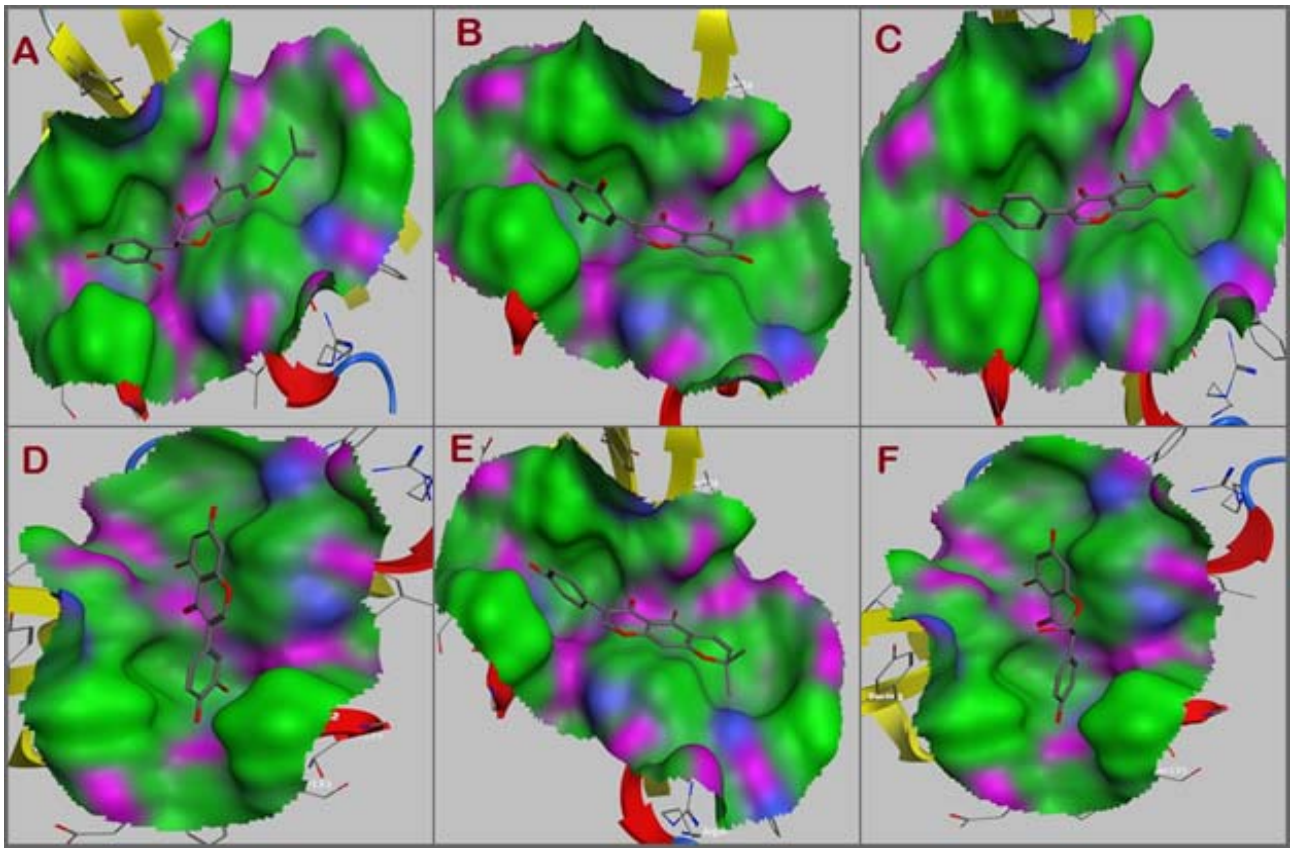

Fig. 3: Binding pocket images of A) Docked Uncinanone B with DENV NS2B-NS3 complex B) Docked 5-hydroxybowdichione with DENV NS2B-NS3 complex C) Docked Prunectin with DENV NS2B-NS3 complex D) Docked 5,7,3',4'-tetrahydroxyisoflavone with DENV NS2B-NS3 complex E) Docked Alpinumisoflavone with DENV NS2B-NS3 complex and F) Docked Glicoisoflavanone with DENV NS2B-NS3 complex.

in drug designing and screening of innovative compounds against this appalling diseases (Lengauer and Rarey, 1996).

The present study focused on the docking of the plants flavonoids against NS2B-NS3 protease. We observed the activity potential of 2500 flavonoids against Dengue virus NS2B-NS3 protease. Flavonoids were downloaded from several databases. In this present study, flavonoids were docked with the catalytic triad of Dengue virus NS2/NS3 protease in order to discover their attraction as inhibitors. After docking, molecules with top conformations only from 2500 molecules were selected on the basis of minimum S score. Our results demonstrated the potential and considerable interactions of flavonoids with the active site residues of catalytic triad.

Our study revealed that six flavonoids Uncinanone B, 5-hydroxybowdichione, Prunectin, 5,7,3',4'-tetrahydroxyisoflavone, Alpinumisoflavone and Glicoisoflavanone have possible and strong interaction and important hydrophobic contact with catalytic triad. Molecular properties and drug likeliness of these six potential compounds were evaluated on the basis of "Lipinski's Rule of Five". The rule describes that compound have no more than 5 hydrogen bond donors, not more than 10 hydrogen bond acceptors, a molecular mass less than 500 daltons, and an octanol-water partition coefficient log P not greater than 5 (Lipinski*et al*., 2012). They all fulfilled lipinski's rule and showed no desecration. More study is carried out on the ADMET (Absorption, Distribution, Metabolism, Excretion, and Toxicity) of flavonoids predicted as a drug. Assessment of Absorption, Distribution, Metabolism, Excretion and Toxicity (ADMET) properties of lead compounds is a most important challenge in the route of drug development (Brito, 2011). The majority of drugs not pass in the drug development procedure are because of poor pharmacokinetic properties and toxicity (Lin and Lu, 1997). The detection of active lead compounds at early drug discovery is facilitated by development of high throughput and fast ADMET profiling assays (Tsaioun*et al*., 2009). ADMET profiling of potential compounds shows that all the compounds have no side effects on absorption.

Table 1: List of all 2500 flavonoids used in this study

Uncinanone B	5-hydroxybowdichione	Prunectin	5,7,3',4'-tetrahydroxyisoflavone	Alpinumisoflavone
Artopetelin A	Parabaroside A	4-O-Methylabyssinone VI	Angelafolone	Brutieridin
Artopetelin B	Parabaroside B	4-O-Methyldavidigenin	Angolensin	Bryacarpene 1
Artopetelin C	Parabaroside C	4'-O-Methylisowighteone	Angoletin	Bryacarpene 2
Artopetelin D	Paratocarpin B	4'-O-Methylkanzonol W	Angoluvarin	Bryacarpene 3
Artopetelin E	Paratocarpin D	4'-O-Methyllaburnetin	Angophorol	Bryacarpene 4
Artopetelin F	Paratocarpin E	4-O-Methylokanin	Angusticornin A	Bryacarpene 5
Artopetelin G	Paratocarpin G	4'-O-Methylpuerarin	Angusticornin B	Bryaflavan
Artopetelin H	Paratocarpin H	4'-O-Methylpunctatin	Angustone A	Bryaquinone
Artopetelin I	Paratocarpin I	4'-O-Methylvelloquercetin	Angustone B	Bryebinal
Artopetelin J	Paratocarpin J	4'-O-Prenylprunetin	Anhydrobartramiaflavone	Bryebinalquinone
Artopetelin K	Paratocarpin K	5,5'-Bisnortrachelogenin	Anhydrotephrostachin	Bryoflavone
Artopetelin L	Paratocarpin L	5',5'-Bisnortrachelogenin	Anhydrotuberosin	b-Toxicarol
Artopetelin M	Villosin A	5,7,8-Trimethoxy-3-flavene	Anhydrovariabilin	Bucegin
Boeravinone A	Shanciol C	5-Deoxynevadensin	Anthyllin	Bussealin B
Boeravinone B	3'-Chloro-2',5-dihydroxy-3,7,8-trimethoxyflavone	Glicoisoflavanone	Bonannione A	Cochinchinenin
Boeravinone C	Oxytroflavoside D	4-Methoxymaackiain	Andrographidin E	Broussonin F
Boeravinone D	Shanciol D	5'-Deprenylhemihumulone	Anthyllisone	Bussealin C
Boeravinone E	Shanciol E	5"-Deoxyhexaspermone C	Antiarone A	Bussealin D
Boeravinone H	Shanciol G	5-Hydroxy-7,7-dimethylpubeschin	Antiarone B	Butaspermin
Boeravinone I	Shanciol H	5-Hydroxy-7,8-diprenylflavone	Antiarone C	Buteaspermanol
Boeravinone J	Villosin	5-Hydroxyflavanone	Antiarone D	Buteaspermin A
Boeravinone K	Villosinol	5-Hydroxyorientanol F	Antiarone E	Buteaspermin B
Boeravinone N	Tarachisin	5-Hydroxysophoranone	Antiarone F	Butein
Boeravinone O	Taranicin	5-Methoxyafrormosin	Antiarone G	Butesuperin A
Boeravinone Q	Tarantannin A	5-Methoxyauaranetin	Antiarone H	Butesuperin B
Boeravinone R	Tarantannin B	5-Methoxydurmillone	Antiarone I	Butin
Compactin	Vitisifuran B	Aesculitannin C	Baohuosu	Chartaceone B
Complanatin	Virginianin	5-Carboxypyranodelphinidin	Anogeissinin	Buddlenoid A
Complanatuside	Coumaroyljuglanin	5-Carboxypyranomalvidin	Anogeissus pendula Triflavonoid	Buddlenoid B
Comptonin	Wogonin	6-Hydroxydehydrotoxicarol	Arcommunol D	Calopogoniumisoflavone B
Confertin A	Cudraflavone C	6,8-Dimethyldihydrokaempferol	Apollineanin	Calendoflavoside
Conrauinone A	2"-O-Galloylvitexin	Allivictoside A	Blepharocalyxin E	Citronetin
Conrauinone B	2'-O-Methyldihydroisoartonin E	Allivictoside B	Bletilol A	Citronin
Conrauinone C	2'-O-Methylkushenol X	Allivictoside C	Bletilol C	Citrunobin
Conrauinone D	2"-O-Rhamnosylswertisin	Allivictoside D	Blumeatin	Citrusinol
Coptiside I	Tenaxin I	6-Hydroxydelphinidin	Arcommunol E	Calopolyanolide A
Coptiside II	Tenaxin II	6-Hydroxyflavone	Arecatannin A1	Calopolyanolide B
Cordigol	Undulatoside	6-(5-Acetyl-2-hydroxyphe-nyl)-4',5,7-trihydroxyflavone	Apocynin A	Calanone
Cordigone	Dehydromelanoxin	5'-Prenyllicodione	Apiocarpin	Calabricoside B
Cordylasin A	Viscidulin I	6-Ketodehydroamorphigenin	Arenariumoside II	Calquiquelignan A
Cordylasin B	Viscidulin III	6-Hydroxyrotenone	Arenariumoside I	Calopolyanolide D
Coromandelin	Daidzein G1	7-O-Methylhelikrausichalcone	Artocommunol CB	Candenatenin E
Corsifuran A	Ovalichromene A	6-Methoxycalopogoniumisoflavone A	Arenariumoside III	Calquiquelignan B
Corsifuran B	Ovalichromene	6-Methoxyho-mopterocarpin	Arenariumoside IV	Calquiquelignan C
Corsifuran C	Uncinatabiflavone A	6-Methoxykaempferol	a-Rhamnorobin	Calquiquelignan D
Corylin	Wikstrol B	Aescuflavoside A	Baohuoside III	Chartaceone A2
Coumestoside A	Stemofuran G	7-O-Caffeoylorientin	Artocarpol H	Campylopusaurone
Coumestoside B	Stemofuran H	7-O-Feruloylorientin	Artocarpol J	Campylospermone A
Coumestoside C	Stemofuran I	7-O-Galloylepigallocatechin	Artocarpone A	Campylospermone B

Continue…

Uncinanone B	5-hydroxybowdichione	Prunectin	5,7,3',4'-tetrahydroxyisoflavone	Alpinumisoflavone
Coumestoside D	Stemofuran C	7-O-Geranylfujikinetin	Artocarpone B	Camsibriside A
Coumestrin	Eryvarin A	Aesculitannin D	Baptigenin	Chartaceone B1
Coumestrol	2"-O-Acetylechioidin	Alliaroside	Bitucarpin A	Cissoside III
Coutareagenin	Uncinatabiflavone B	6-Methoxypterocarpin	Arizonicanol A	Calquiquelignan E
Craibiodendronin A	Uncinatabiflavone C	6-Methoxyvestitol	Arizonicanol B	Calycinigin A
Crassirhizomoside A	Ulexin C	Abruquinone B	Asperopterocarpin	Cathayanon G
Crassirhizomoside B	Ulexflavone	Abruquinone C	Asplenetin	Cathayanon H
Crassirhizomoside C	Ulexone A	Abruquinone D	Assamicain C	Cathayanon I
Cratenacin	Uncinatabiflavone D	6-Methyleriodictyol	Arizonicanol C	Calycopteretin
Cresoside	Sesuvioside A	6-Methylhomoeriodictyol	Arizonicanol D	Calycopterin
Crinatusin A1	Stemofuran J	7-Hydroxy-6,8-dimethylflavanone	Artocarpanone A	Camelliatannin G
Crinatusin A2	Stemofuran L	7-Hydroxy-6-methylflavan	Artocarpaurone	Camelliquercetiside A
Crinatusin B1	Stemofuran N	7-Hydroxyflavan	Artocarpesin	Camelliquercetiside B
Crinatusin B2	Stemofuran O	7-Hydroxyflavanone	Artocarpetin	Camelliquercetiside C
Crinatusin C1	Stemofuran P	7-Hydroxyflavone	Artocarpetin A	Camelliquercetiside D
Crinatusin C2	Stemofuran Q	7-Hydroxyisoflavone	Artocarpetin B	Campanin
Cristacarpin	Urophyllumol	Abyssinoflavanone V	Atricarpan B	Cedrinoside
Crotarin	Sesuvioside E	6"-O-Acetylononin	Aromadendrin	Calythropsin
Crotin	Sesuvioside F	6"-O-Acetylphloridzin	Artaltilin A	Calyxin A
Crotmadine	Sesuvioside C	6-Methyltetrapterol A	Arjunolone	Calyflorenone B
Crotmarine	Sesuvioside D	6"-O-Acetyleruberin A	Arjunone	Calyflorenone D
Cryptocaryanone A	Secundiflorol I	6"-p-Coumaroylprunin	Artemexitin	Cambodianin D
Cryptocaryanone B	Secundiflorol H	6"-Prenylamentoflavone	Artemisidin A	Cambodianin E
Cryptocaryone	Ozturkoside A	6"-O-Acetylprunin	Artaltilin B	Calyxin B
Cryptochinone A	Ozturkoside B	6"-O-Acetylsaponarin	Artaltilin C	Calyxin C
Cryptochinone B	Ozturkoside C	6"-O-Caffeoylisoorientin	Artaltilin D	Calyxin D
Cryptochinone C	Sophoraflavanone J	6"'-O-Caffeoylsaponarin	Artaltilin E	Calyxin E
Cryptochinone D	Sophoraflavanone K	6-O-Demethylvignafuran	Arteanoflavone	Calyxin F
Cryptochinone F	Sophoraflavanone L	6"'-O-Feruloylsaponarin	Artelasticin	Calyxin G
Cryptoflavanone C	Sophoraflavanone H	6-O-Feruloylscutellarin	Artelasticinol	Calyxin I
Cryptoflavanone D	Sophoraflavanone G	6"-O-Galloylcosmosiin	Artelastin	Calyxin J
Cryptogione B	Unanisoflavan	6"-O-Galloylisoorientin	Artelastocarpin	Calyxin K
Cryptogione C	Secundiflorol A	6-O-Methylcaesalpinianone	Artelastochromene	Calyxin L
Cryptogione D	Secundiflorol C	6"'-O-p-Coumaroylsaponarin	Artelastofuran	Calyxin M
Cryptogione F	Secundiflorol E	6"'-O-Sinapoylsaponarin	Artelastoheterol	Camaraside
Cryptogione G	Sophoraflavanone E	6-Prenylpinobanksin	Arthromerin B	Camellianin A
Cryptogione H	Sophoraflavanone A	6'-Prenylsigmoidin C	Artobilochromene	Camellianoside
Cryptogione I	Secundiflorol F	6-Oxodehydrotoxicarol	Artemetin	Camaroside
Cryptogione J	Sophoraflavanone C	6-Prenylisocaviunin	Arthromerin A	Cambodianol
Cudraflavone A	Sorocein G	7a-O-Methylelliptonol	Artocarmin C	Camelliatannin A
Cudraflavone B	Sorocein M	7-Carboxy-3,3',4',5-tetrahydroxyflavone	Artocarmin D	Camelliatannin B
Cudraflavone D	Sorocein C	6-Prenyltaxifolin	Artobiloxanthone	Camelliaside A
Cudranian 1	Sorocein D	6-Rhamnosylluteolin	Artocarmin A	Camelliaside B
Cudranian 2	Sorocein E	6"'-Vanilloylspinosin	Artocarmin B	Camelliaside C
Cuhuoside	Ulmoside A	Abutilin A	Astragaluquinone	Caulesnarinside
Cupressuflavone	Suberectin	7-De-O-methylrobustigenin	Artocarmitin A	Camelliatannin C
Curcucomoside A	Takakin	7-Epikatsumain C	Artocarmitin B	Camelliatannin D
Curcucomoside B	Symposide	7-Geranylformononetin	Artocarmitin C	Camelliatannin E
Curcucomoside C	Stemofuran E	7-Hydroxy-4',5-dimethoxyflavone	Artocarpanone	Camelliatannin F
Cypellogin A	Vitegnoside	Addisofuran B	Azobechalcone A	Chamaejasmenin A
Cypellogin B	Vitisinol	A-Diohobanin	Baeckein A	Chamaejasmenin B
Cypellogin C	Vitisin A	Adonivernitol	Baeckein B	Chamaejasmenin C
Daemonorol A	Stemofuran D	7-O-Geranylpseudobaptigenin	Artochamin A	Camsibriside B
Daemonorol B	Stemofuran A	7-O-Lactoylluteolin	Artochamin B	Camsibriside C
Daemonorol C	Stemofuran B	7-O-Methylallolicoisoflavone A	Artochamin C	Candenatenin A
Daemonorol D	Stemofuran F	7-O-Methylapigeninidin	Artochamin D	Candenatenin B
Daemonorol E	Stemofuran K	7-O-Methylaraneol	Artochamin E	Candenatenin C
Daemonorol F	Unonal	7-O-Methylbonducellin	Artocommunol	Candenatenin D

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Uncinanone B	5-hydroxybowdichione	Prunectin	5,7,3',4'-tetrahydroxyisoflavone	Alpinumisoflavone
Daidzein	Sorocein H	6a,7-Dihydroxymedicarpin	Apulein	Calocoumarin B
Dalberatin A	Daidzein G3	7-O-Methylisowighteone	Artocommunol CE	Candenatenin G
Dalberatin B	Strobilanthin	7-O-Methylluteone	Artoflavanocoumarin	Candenatenin H
Dalberatin C	Struthiolanone	7-O-Methylpeltogynol	Artoflavanone	Candenatenin I
Dalberatin D	Strychnobiflavone	7-O-Methylphelligrin A	Artoflavone A	Candenatenin J
Dalberatin E	Variabiloside E	7-O-Methylporiol	Artoheterophyllin C	Candenatenin K
Daphnodorin A	Tephroapollin A	8-Formyl-5,7-dihydroxyflavanone	Artoindonesianin Z1	Capreoside
Daphnodorin B	Tephroapollin B	8-Galactosylkaempferol	Artoindonesianin Z2	Caragin
Daphnodorin C	Tagetiin	8-Demethylduartin	Artoindonesianin R	Caohuoside F
Daphnodorin D1	Tephroapollin C	8-Geranylpinostrobin	Artoindonesianin Z3	Caragiside A
Daphnodorin D2	Tephroapollin D	8-Glucofuranosyldaidzein	Artoindonesianin Z4	Caragiside B
Daphnodorin E	Tamadone	8-Demethyleucalyptin	Artoindonesianin S	Capensinidin
Daphnodorin F	Tamarixin	8-Demethylkalmiatin	Artoindonesianin T	Capensinin
Daphnodorin G	Taccalin	8-C-Rhamnosylscutellarein	Artoindonesianin Q	Caohuoside E
Daphnodorin I	Tephroapollin E	8-Hydroxycirsiliol	Artoindonesianin Z5	Caragiside C
Daphnodorin J	Tarennane	8-Demethyllatifolin	Artoindonesianin U	Capilliposide I
Daphnodorin K	Taxusbiflavone A	8-Formyl-2,5,7-trihydroxy-6-methylflavanone	Artoindonesianin X	Capilliposide II
Daphnodorin L	Tellimoside	8-Formyl-4,5,7-trihydroxy-6-methylflavan	Artoindonesianin Y	Capitavine
Daphnodorin M	Syzygiol	8-C-Methylgalangin	Artoindonesianin O	Caohuoside C
Daphnodorin N	Uvangoletin	8-C-Methylvellokaempferol	Artoindonesianin P	Caohuoside D
Dehydromillettone	3,9-Dihydroeucomnalin	Alopecurone F	Bonanniol C	Cochinchinenene B
Dehydroneotenone	4',4'-Dimethoxyongokein	Anadanthoside	Broussaurone A	Cudraflavanone B
Derrisisoflavone A	Tephcalostan B	8-Hydroxyphaseollidinisoflavan	Artomunoxanthone	Cardamoside A
Derrisisoflavone B	Tephcalostan C	8-Methoxyeriodictyol	Artonin A	Cardamoside B
Derrisisoflavone C	Tephcalostan D	8-Methoxyneorautenol	Artonin B	Carlinoside
Derrisisoflavone D	Tephrospiroketone I	8-Methylquercetin 3-xyloside	Artonin E	Carpusin
Derrisisoflavone E	Tephrocandidin A	8-Methoxyvestitol	Artonin C	Carpachromene
Derrisisoflavone F	Tephrocandidin B	8-Methylcirsilineol	Artonin D	Carpelastofuran
Derrisisoflavone G	Tephroapollin F	8-Hydroxyeriodictyol	Artolakoochol	Carajuflavone
Derrubone	Tephroapollin G	8-Hydroxygenkwanol A	Artomandin	Carajurin
Derrugenin	Tephropurpulin A	8-Hydroxyirigenin	Artomunoflavanone	Carajurone
Derrusnin	Tephcalostan	8-Hydroxyisoscoparin	Artomunoxanthentrione	Cardamomin
Derrustone	Tephrostachin	8-Hydroxyiristectrigenin A	Artomunoisoxanthone	Carambolaflavone
Desmethylisoxanthohumol	12a-Hydroxyrotenonic acid	Agehoustin A	Beilschmieflavonoid B	Chrysoeriol
Desmethylxanthohumol B	2',5,7-Trihydroxyflavone	Albafuroflavan A	Bidenoside A	Cilicicone B
Desmethylxanthohumol J	2',5',7-Trihydroxyisoflavone	Albanin A	Bidenoside B	CinchonainIA
Desmodianone A	Crassifolin	8-Prenyllepidissipyrone	Artonin I	Cartormin
Desmodianone B	Tephrorianin	8-Prenyllisetin	Artonin J	Caryatin
Desmodianone C	Tephroleocarpin B	8-Prenylluteone	Artonin K	Caryatin glucoside
Desmodianone D	Cuneatin	8-Prenylmucronulatol	Artonin L	Cassiaflavan
Desmodianone E	Tephrodin	8-Prenylphaseollinisoflavan	Artonin M	Cassiaoccidentalin A
Desmodianone F	Dehydroisoderricin	9-O-Demethyl-6-O-methyl-8-prenylstemonal	Artonin N	Cassiaoccidentalin B
Desmodianone G	Tephroglabrin	9-O-Methylphilenopteran	Artonin O	Cassiaoccidentalin C
Dilobenol A	Villinol	Abacopterin F	Artonin X	Castillene A
Dilobenol B	Villol	Abacopterin G	Artonin Y	Castillene B
Dilobenol C	Villosol	Abacopterin H	Artonitidin A	Castillene C
Dilobenol D	Villosone	Abacopterin I	Artonol C	Castillene D
Dilobenol E	Tephrosol	Abacopterin J	Artonol E	Castillene E
Dilobenol F	Tephrinone	Abbottin	Artopeden A	Castillicetin
DilobenolG	Viridiflorin	Abiesanol A	Artorigidin A	Castilliferol
Dorsilurin A	Wallichin	Abiesinol A	Artosimmin	Cathafuran A
Dorsilurin B	Shanciol F	Abronisoflavone	Aspalalinin	Cathayanon E
Dorsilurin C	Tephrowatsin A	Abiesinol B	Artotonin A	Cathafuran B

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Uncinanone B	5-hydroxybowdichione	Prunectin	5,7,3',4'-tetrahydroxyisoflavone	Alpinumisoflavone
Dorsilurin D	Tephrowatsin B	Abiesinol C	Artotonin B	Cathafuran C
Dorsilurin E	Tephrowatsin C	Abiesinol D	Artotonkin	Cathafuran D
Dorsilurin F	Tephrowatsin D	Abiesinol F	Arvensan	Catharticin
Dorsilurin G	Tephrowatsin E	Abiesinol H	Ascaside	Cathayanin B
Dorsilurin H	Ulexin D	Abruquinone A	Aspalathin	Cathayanon F
Dorsilurin I	Crotonoylcosmosiin	Abietin	Asebogenin	Cathayanin C
Dorsilurin J	Taxillusin	Abrectorin	Asebotin	Cathayanon A
Dorsilurin K	Wyomin	Abronione	Asiaticalin	Cathayanon B
Eryvarin C	Vincanin B	Acetylisostachyflaside	Auricularin	Cephalotaxoside
Eryvarin E	Vincanin A	Acetylmalonylawobanin	Auriculasin	Cephaside
Eryvarin H	Viscumneoside II	Acuminatin	Axillaroside	Chaetocyclinone C
Eryvarin I	Vincetoxicoside B	Acetylpatulitrin	Auriculatin	Cerarvensin
Eryvarin J	Violarvensin	Acetylrhodalgin	Auriculin	Cerasidin
Eryvarin K	Violetruscoside	Acetylrhodalin	Auriculoside	Cerasin
Eryvarin L	Violanthin	Acetylspectabiflaside	Aurmillone	Cerasinone
Eryvarin M	Virolanol C	Acetylvitexin	Australisin A	Ceratiolin
Eryvarin N	Virolaflorine	Acetylvitisin B	Australisin B	Ceratoside
Eryvarin O	Virolane	Acetylxanthorhamnin B	Australisin C	Cernuoside
Eryvarin P	Virolanol	Acicerone	Australone A	Ceroptin
Eryvarin R	Viscumneoside III	Acuminatoside	Ayamenin A	Chafuroside A
Eryvarin S	Viscartin B	Actinoside C	Awobanin	Chaenomone
Eryvarin T	Viscumside A	Aciculatinone	Australone B	Cerrosillin
Eryvarin U	Visartiside A	Acinoside	Austraone A	Cerrosillin B
Eryvarin V	Visartiside B	Actinoflavoside	Avicularin	Cesioside
Eryvarin W	Viscolin	Acuminatanol	Axillarin	Chaerophyllin
Flemistrictin B	Viniferone B	Adunctin B	Baeckein D	Chamaemeloside
Flemistrictin C	Viniferone C	Adunctin C	Baicalein	Chamanetin
Flemistrictin D	Vitisin C	Adunctin D	Baicalin	Champanone A
Flemistrictin E	Vittarin F	Adunctin E	Baimaside	Champanone B
Flemistrictin F	Urakunoside	Aegicin	Bakoside	Champanone C
Flemiwallichin A	Desmethylwedelolactone	Aervanone	Bakuchalcone	Chamuvaritin
Flemiwallichin B	Wedelolactone	Aervin A	Balaninvolin	Chandalone
Flemiwallichin C	Sikokianin D	Aervin B	Balsacone A	Chapelieric acid
Flemiwallichin D	Sikokianin B	Aervin C	Balsacone B	Chaplashin
Flemiwallichin E	Sikokianin A	Aescuflavoside	Bannamurpanisin	Chartaceone A1
Flemiwallichin F	Sikokianin C	Aervin D	Balsacone C	Chartaceone A
Gancaonin A	12a-Hydroxyerosone	Agecorynin D	Bavadin	Chrysandroside B
Gancaonin B	(+)-Leucodelphinidin	Agapanthus Pigment 2	Bauhibenzofuran A	Chiricanin B
Gancaonin C	12a-Hydroxyerythrinone	Agecorynin E	Bayin	Chrysin
Gancaonin D	(R)-Flavaprin	Agastachin	Bauhiniaside A	Chiricanin C
Gancaonin E	12a-Hydroxymunduserone	Agecorynin F	Beccamarin	Chrysocauloflavone I
Gancaonin F	(+)-Afzelechin	Afzelin C	BartericinB	Chiiricanin
Gancaonin G	(S)-Violanone	Agastachoside	Bauhiniaside B	Chiricanin D
Gancaonin H	(+)-Kurarinone	Agamanone	Bartramic acid	Chiricanin A
Gancaonin I	12a-Hydroxypachyrrhizone	Agecorynin G	Beilschmieflavonoid A	Chrysocauloflavone II
Gancaonin J	(+)-Duartin	Afzelone A	Bartericin C	Chiirin
Gancaonin K	(+)-Epiafzelechin	Afzelone B	Bartericin D	Chiirirhamnin
Gancaonin L	Oxytroflavoside F	4'-Methylgenkwanol A	Andrographin	Broussonol B
Gancaonin M	1",2"-Didehydro-4'-O-methyleuchrenone b10	Agathisflavone	Bauhiniasin	Chiricanin E
Gancaonin N	1",2"-Didehydroeuchrenone b10	Agathisflavone B	Bausplendin	Chlorflavonin
Gancaonin O	12a-Hydroxyelliptone	Agecorynin C	Bavacoumestan B	Chrysandroside A
Gancaonin P	1,2-Dihydroparatocarpin A	Ageconyflavone A	Bavachalcone	Chlorflavonin A
Gancaonin Q	11-Deoxystemonal	Agecorynin B	Bavacoumestan A	Chrozophorin
Gancaonin X	1,3,9-Trimethoxycoumestan	Ageconyflavone B	Bavachin	Chlorospermin
Gancaonin Y	(+)-Krachaizin A	Afzelone C	Bartramiaflavone	Chiisanin
Gancaonin Z	(+)-Krachaizin B	Afzelone D	Bartramiatriluteolin	Chinendihydrochalcone
Germanasim A	2,5-Diamino-3-methoxy-6-(3-phenylpropanoyl)-1,4-benzoquinone	Albanin B	Bidenoside F	Cinchonain Ib

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Uncinanone B	5-hydroxybowdichione	Prunectin	5,7,3',4'-tetrahydroxyisoflavone	Alpinumisoflavone
Germanasim B	2,5-Dihydroxydalbergiquinol	Albanin C	Bidenoside G	Cinchonain Ic
Germanasim C	2',6,7-Trihydroxyisoflavone	Albanin D	Bidwillol A	Cinchonain Id
Germanasim D	2",6"-Di-O-acetylononin	Albanin E	Bidwillol B	Cinchonain IIa
Germanasim E	2',8-Diprenylquercetin	Albanin F	Bidwillon A	Cinerarin
Germanasim F	2'-Hydroxyophiopogonone A	Albanin G	Bidwillon B	Cinerascenone
Germanasim G	2'-O-Methylglabridin	Albanin H	Bidwillon C	Cinnabarone
Glyasperin A	Tectochrysin	Aesculitannin E	Baptisin	Chartaceone B2
Glyasperin B	(-)-Leucodelphinidin	Afzelin B	Bartericin A	Chiiribanin
Glyasperin C	Vicenin 2	Aesculitannin F	Barbacarpan	Chartaceone B3
Glyasperin D	Wrightiadione	Aesculitannin G	Barbaside A	Chartaceone B4
Glyasperin G	Uvarinol	Affinetin	Barbatoflavan	Chartaceone C
Glyasperin I	Tambulol	Africanutin 4'-galactoside	Barbigerone	Chartaceone D
Glyasperin J	Tambuletin	Afformosin	Barleriside A	Chartaceone E
Glyasperin L	(-)-Epitaxifolin	Afroside	Barpisoflavone A	Chartaceone F
Glyasperin M	(-)-Isoscoparin	Afzelin	Barpisoflavone B	Cheliensisine
Glyasperin N	(-)-Kurarinone	Afzelin A	Barpisoflavone C	Chiiribaconin
Griffonianone A	2"-O-Vanilloylvitexin	Allivictoside E	Bobgunnioside A	Cladrastin
Griffonianone B	2'-Prenylsemilicoisoflavone B	Allivictoside F	Bobgunnioside B	Cladrin
Griffonianone C	2'-Undecanoylquercetin	Allivictoside G	Boehmerin	Clandestacarpin
Griffonianone D	3,3',3",3"',4',4"',5,5",7,7"-Decahydroxy-8,8"-biflavone	Allivictoside H	Boeravinone G	Claussequinone
Griffonianone E	3,3",3"',4',4"',5,5",7,7"-Nonahydroxy-3',6"-biflavanone	Allolicoisoflavone A	Boerharotenoid A	Clematine
Griffonianone F	3,3',4',5-Tetra-O-methylvelloquercetin	Allopatuletin	Boerharotenoid B	Clerodendrin
Griffonianone H	3,3',5-Tri-O-methylvelloquercetin	Alluaudiol	Boesenbergin A	Clerodendroside
Lupindipyranoisoflavone A	2-Hydroxypterocarpin	Albireodelphin E	Bioquercetin	Cinnamtannin III
Ophiopogonanone A	4'-Hydroxyongokein	Anagyroidisoflavone A	Broussin	Cudraflavanone C
Ophiopogonanone B	4'-Hydroxyflavone	Andirol A	Broussoflavonol F	Cycloaltilisin 6
Ophiopogonanone C	4?-O-Galloylgallocatechin	Ananaflavoside B	Broussinol	Cudraflavanone D
Ophiopogonanone D	4-Cinnamyl-3-methoxycatechol	Ananaflavoside C	Broussochalcone A	Curcucomoside D
Ophiopogonanone E	4"-cis-p-Coumaroylprunin	Ananaflavoside D	Broussochalcone B	Cuspidan B
Ophiopogonanone F	4'-Hydroxy-3-methoxyxuulanin	Anaphaloside	Broussoflavan A	Cyananin
Ophiopogonanone G	4-Hydroxyartolakoochol	Anastatin A	Broussoflavonol A	Cyanidin 3,5-diglycosides
Ophiopogonone A	4-Hydroxycordoin	Andinermal A	Broussoflavonol B	Cyanidol
Ophiopogonone C	4-Hydroxyderricin	Andinermal B	Broussoflavonol C	Cyanodelphin
Ophiopogonone D	4'-Hydroxyedunol	Andinermal C	Broussoflavonol D	Cyanomaclurin
Ophiopogonone E	4'-Hydroxye-moroidocarpan	Andinermol	Broussoflavonol E	Cycloaltilisin
Orientanol A	Vatalbinoside C	Abyssinone I	Aulacomniumtriluteolin	Centabractein
Orientanol B	Uvaretin	Abyssinoflavanone VII	Atricarpan C	Cedrusone A
Orientanol C	Vaccarin H	Abyssinone B	Atriplexoside A	Celtidifoline
Orientanol D	Vaccarin	Abyssinone C	Atriplexoside B	Celtiside A
Orientanol F	Vahliabiflavone	Abyssinone D	Aulacomniumbiaureusidin	Celtiside B
Ovalichromene B	3,4-Didehydroglabridin	Alnustin	Bolusanthin	Coatline B
Ovaliflavanone A	3',4',5-Trihydroxyisoflavone	Alluceposide	Boesenbergin B	Cleroflavone
Ovaliflavanone B	3',4',Di-O-methylvelloquercetin	Alnusin	Bolucarpan D	Coatline A
Ovaliflavanone C	3,4',5-Tri-O-methylvelloquercetin	Almeidein	Bolucarpan A	Clitoriacetal
Ovaliflavanone D	3',4',7-Trihydroxyisoflavone	Alnetin	Bolucarpan B	Clitorin
Ovalitenin A	2"-O-Galloylisoorientin	Alliuocide G	Blepharocalyxin A	Citflavanone
Ovalitenin B	2"-O-Galloylisovitexin	Allivicin	Blepharocalyxin B	Citromitin
Ovalitenin C	3,4,9-Trihydroxycoumestan	Alnifoliol	Bolucarpan C	Clovin
Oxytroflavoside A	4'-Methoxydaphnodorin D2	Andrographidin B	Broussonin C	Cycloartocarpin
Oxytroflavoside B	4'-Methoxyflavan	Andrographidin C	Broussonin D	Cycloartocarpin A
Pachycarin A	3,4-Dihydroxanthohumol C	Alnustinol	Bolusanthin II	Coccineone B
Pachycarin B	3,4'-Di-O-methylvellokaempferol	Aloeresin H	Bolusanthol A	Coccineone C
Pachycarin C	3',5',7-Trihydroxyisoflavone	Aloeresin I	Bolusanthol B	Coccineone D
Pachycarin D	3,5-Di-O-methylvellokaempferol	Alopecurone A	Bolusanthol C	Coccineone E

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Uncinanone B	5-hydroxybowdichione	Prunectin	5,7,3',4'-tetrahydroxyisoflavone	Alpinumisoflavone
Pachycarin E	3,6,8-Trichloroluteolin	Alopecurone B	Bolusanthol E	Coccinoside A
Palmatoside A	4',5-Dihydroxy-7-prenyloxyflavanone	Anacarduflavanone	Brosimone H	Cucumerin A
Palmatoside B	4',5'-Dihydroxyedunol	Anacheiloside	Brosimone I	Cucumerin B
Palmatoside C	4',7-Di-O-prenylgenistein	Anadanthoflavone	Brosimone L	Cudraflavanone A
Paratocarpin C	Coruscanone B	5-Deoxykievitone	Anthemoside	Burttinone
Paratocarpin F	Shanciol	5-Deoxylespedol B	Anthocyanin A	Burttinonedehydrate
Sanggenol B	3'-Deoxysappanol	Alpinnanin C	Bonducellin	Cochinchinenone
Sanggenol C	3-Epilarixinol	Alpinone	Bongosin	Cochinchinol A
Sanggenol D	3-Epipadmatin	Alpinumisoflavone	Bosistoabiflavanone	Cochinchinol B
Sanggenol E	3-Epipallasiin	a-L-Pyranose-form	Bowdichione	Cochliophilin A
Sanggenol F	3'-Formyl-4',5,7-trihydroxyisoflavone	Alternanthin	Brachyrachisin	Cocus I
Sanggenol G	3-Galloyl-(-)-epiafzelechin	Alternanthin B	Brackenin	Columnin
Sanggenol H	3-Hydroxyasebotin	Ambanol	Brainoside B	Combretol
Sanggenol I	3-Galloylgallocatechin	Altilisin H	Bracteatin	Colutehydroquinone
Sanggenol J	3-Galloylprocyanidin B1	Altilisin I	Bracteatin 6-glucoside	Coluteol
Sanggenol K	3-Galloylprocyanidin B3	Altilisin J	Bractein	Colutequinone A
Sanggenol L	3-Hydroxyflavanone	Ambofuracin	Brandisianin A	Combretol B
Sanggenol M	3'-Hydroxyflavone	Ambofuranol	Brandisianin B	Combretol C
Sanggenol N	3-Deoxy-7-hydroxyflemistrictin F	Alpinnanin A	Bonannione B	Cochinchinenin B
Sanggenol O	3-Deoxysappanchalcone	Alpinnanin B	Bonanzin	Cochinchinenin C
Sanggenon A	3"-Hydroxydorsmanin A	Ambocin	Brainoside C	Combretol A
Sanggenon B	3-Hydroxyflavone	Ambonane	Brandisianin C	Combretol D
Sanggenon C	3'-Hydroxy-4'-methoxyglabridin	Amaronol A	Brainicin	Combrequinone A
Sanggenon D	3-Hydroxy-4-O-demethylxuulanin	Amaronol B	Brainin C	Combrequinone B
Sanggenon E	3-Methoxyneosakuranin	Ammopiptanoside A	Brassicin	Confusoside
Sanggenon F	3-Methoxyxuulanin	Ammothamnidin	Brassicoside	Conrauiflavonol
Sanggenon G	3-Methylluteolin	Amoenin A	Brassidin	Conyzatin
Sanggenon H	3'-Methylpelargonidin	Amoenin A3	Brauhenefloroside C	CorbulainIa
Sanggenon I	3'-Hydroxyxanthoangelol I	Ambonone	Brandisianin E	Communin A
Sanggenon J	3'-Nitrogenistein	Amoenin B	Brauhenefloroside D	Corbulain Ib
Sanggenon K	3"-O-Acetylechinacin	Amoenin C	Brauhenefloroside E	Corchoruside A
Sanggenon L	3-Galloylprodelphinidin B1	Altisin	Bractelactone	Colutequinone B
Sanggenon M	3-Galloylrobidanol	Alysifolinone	Bracteoside	Comanthoside A
Sanggenon N	3-Hydroxyxuulanin	Amentoflavone	Brandisianin F	Communin B
Sanggenon O	3-Galloylrobinetinidol	Amarbelin	Brahene	Comanthoside B
Sanggenon Q	3-Hydroxyisolonchocarpin	Ambonin	Brandisianin D	Combretol E
Sanggenon S	3'-Methoxydaidzein	Ammopiptanin A	Brasimarin B	Comosin
Sanggenon T	3'-Methoxydaidzin	Ammopiptanin B	Brasimarin C	Confertin B
Secundiflorol D	3,7-Di-O-methylgancaonin P	Alopecurone C	Bonanniol A	Coccinoside B
Sedonan A	Swartzioside	8-C-Galactopyranosylapigenin	Artoindonesianin E1	Cannabinidin
Sedonan B	Swertifrancheside	8-C-Glucofuranosylapigenin	Artoindonesianin G	Cannabiscitrin
Sedonan C	Swertiajaponin	8-C-Glucopyranosylprocyanidin B1	Artoindonesianin H	Cannflavin A
Sedonan D	Swertisin	8-C-Glucopyranosylprocyanidin B2	Artoindonesianin I	Cannflavin B
Sedonan E	Vacciniifolin	8-C-Glucosyleriodictyol	Artoindonesianin J	Cannflavin C
Sedonan F	Syzalterin	8-Cinnamoyl-3,4-dihydro-5,7-dihydroxy-4-phenylcoumarin	Artoindonesianin L	Caohuoside B
Shanciol B	4-Hydroxypterocarpin	Androechin	Broussonin A	Cycloartobiloxanthone
Sigmoidin A	Viscioside	Acetylembinin	Auriculacacidin	Cephalocerone

Continue…

Uncinanone B	5-hydroxybowdichione	Prunectin	5,7,3',4'-tetrahydroxyisoflavone	Alpinumisoflavone
Sigmoidin B	Velloeriodictyol	Abyssinone III	Auranetin	Centaflavone A
Sigmoidin C	Veronicoside A	Aceronidin	Aureusin	Centrolobofuran
Sigmoidin D	Vellokaempferol	Abyssinone V	Aurantinidin	Centaflavone B
Sigmoidin E	Veronicastroside	Acerosin	Auricassidin	Cephacoside
Sigmoidin F	Vafzelin	Abyssinone A	Atricarpan D	Cehrioside
Sigmoidin G	Velloquercetin	Abyssinone VI	Aurapin	Centaradixin
Sigmoidin H	Uguenenprenol	Abyssinone VII	Aurentiacin	Centaureatin
Sigmoidin I	Verbacoside	Acanthocarpan	Aurentiacin A	Centaureidin
Sigmoidin J	Verbenachalcone	Acanthophorin A	Aureol	Centaurein
Sigmoidin L	Vernovan	Acanthophorin B	Aureusidin	Centaurocyanin
Styracifolin A	Villosin B	5,7-Di-O-galloylepigallocatechin	Anisofolin A	Buceracidin A
Styracifolin B	Tanariflavanone D	5'-Formylpratensein	Anisofolin B	Buceracidin B
Styracifolin C	Vinaxanthone	5-Allyloxysalvigenin	Anisofolin C	Buchananiflavanone
Subcoriacin	Viniferone A	Adunctin A	Baeckein C	Chamaejasmenin D
Sublaetentin A	Ulexone C	Abruquinone E	Astilbin	Cathayanon J
Sublaetentin B	Ulexone D	Abruquinone F	Astraciceran	Cathayenone A
Sublaetentin C	Derrone	Abruquinone G	Astradsurnin	Catiguanin A
Sublaetentin D	Ulexin B	Abruquinone H	Astragalin	Catiguanin B
Subscandenin	Ulexone B	6a-Hydroxymaackiain	Apuleirin	Calocoumarin C
Subulin	Oxytropisoflavan B	4-O-Cadinylangolensin	Andropaniculosin A	Broussonol D
Sudachiin A	Glyasperin F	6-C-(6-Deoxy-b-D-glucopyr-anosyl)-3',4',5,7-tetrahydroxyflavone	Aquilarisin	Calodenin B
Sudachiin B	Boeravinone F	6-C-b-D-Xylopyranosyl-4',5,7-trihydroxyflavone	Aquiledine	Calodenone
Sudachiin C	Sophoraflavanone D	6-C-Galactopyranosylapigenin	Aracarpene 1	Caloflavan A
Sudachiin D	Eryvarin D	6-C-Galactosyl-8-C-xylosylapigenin	Aracarpene 2	Caloflavan B
Sudachitin	Oxytroflavoside E	4-Methoxypterocarpin	Andrographidin F	Broussonol A
Sulcatone A	4'-Methoxydaphnodorin D1	Andrographidin A	Broussonin B	Cycloartocarpesin
Symplocoside	Oxytroflavoside C	4-Methoxyhomopterocarpin	Andrographidin D	Broussonin E
Symplocosidin	Succedaneaflavanone	6,8-Dimethylapigeninidin	Apocynin E	Calendoflavobioside
Syriacatin	Violdelphin	5-Carboxypyranocyanidin	Annulatin	Buchenavianine
Syrianone	4-Hydroxymaackiain	Andirol B	Broussoflavonol G	Cycloartelastoxanthone
Syringetin	Tepanone	6-Alkyl-6H,7H-[1]benzo-pyrano[4,3-b]benzopyran-7-ones	Apuleitrin	Calodenin A
Tabularin	Secundiflorol G	6a-Hydroxyphaseollin	Apuleisin	Calodendroside A
Tachrosin	2'-Hydroxyflavone	Albireodelphin A	Bilinderone	Cinnamtannin B2
Taiwanhomoflavone B	Vogelin A	6a,12a-Di-dehydroelliptone	Apometzgerin	Callunin
Taiwanhomoflavone C	Sanggenol A	6a,7-Dihydroxymaackiain	Apuleidin	Calocoumarin A
Taiwaniaflavone	Crenuloside	6,8-Di-C-methylquercetin	Apocynin C	Calendoflaside
Taliflavonoloside	Vitexin	Addisofuran A	Azobechalcone	Chamaecyparin
Talosin A	2'-Hydroxydihydrochalcone	Albanol B	Bignonoside	Cinnamtannin B1
Tamarixetin	Oxytropisoflavan A	4'-Methylpreglabridin	Andropaniculoside A	Broussonol C
Tanariflavanone A	2"-Isopropenylsmiranicin	Alfalone	Bipinnatone A	Cirsiliol
Tanariflavanone B	2'-Methoxybonducellin	Algerianin	Bipinnatone B	Cirsimarin
Taxifolin	2-Hydroxypisatin	Albireodelphin D	Biochanin A	Cinnamtannin D2
Tazettin	4-(2-Aminoethylthio)-3,3',4',5,7-pentahydroxyflavan	Amyrisin A	Brosimone B	Cryptochrysin
Tazettone A	4',5,7-Trihydroxy-3',5',6-tri-prenylflavanone	Amyrisin B	Brosimone D	Cryptomerin A
Tazettone B	4',5'-Dehydro-6'-oxo-7'-nor-rotenolone	Amyrisin C	Brosimone G	Cryptomerin B
Tectoridin	Strobochrysin	5-Carboxypyranopelargonidin	Anogeissusin A	Burttinol A
Tectorigenin	Sylpin	5-Deoxyabyssinin II	Anogeissusin B	Burttinol B

Continue…

Uncinanone B	5-hydroxybowdichione	Prunectin	5,7,3',4'-tetrahydroxyisoflavone	Alpinumisoflavone
Tenuifolin A	2-Hydroxyscillascillin	Alboside	Biorobin	Cirsilineol
Tenuifone	2'-Hydroxyaurone	Albanol A	Bifloridin	Cinnamtannin A2
Tephrone	Shanciol A	5-Deoxylicoisoflavanone	Anthocyanin B	Bussealin A
Tephrosin	Sesuvioside B	6-Methylsequoiaflavone	Arizonicanol E	Calycopterone
Tephrospinosinol	Vitisin B	6,7,8-Trihydroxyflavanone	Apocynin B	Calaustralin
Ternatin	2"-O-a-L-Rhamnopyranosyl	Alliosidin	Bitucarpin B	Cissusin
Ternatin A1	Glyasperin K	6-C-Glucopyranosylisoscutellarein	Arachniodesin A	Calomelanol B
Ternatin A3	Glyasperin H	6-C-Glucopyranosylprocyanidin B1	Arachniodesin B	Calomelanol C
Ternatin B	Sophoraflavanone I	6-C-Glucosylpilloin	Arachnitannin	Calomelanol D
Ternatin B1	Secundiflorol B	6-Chlorocatechin	Araneol	Calomelanol E
Ternatin B3	Sorocein B	6-Chloroepicatechin	Araneosol	Calomelanol F
Ternatin B4	Sorocein F	6"-Epicalyflorenone C	Arapetaloside A	Calomelanol G
Ternatin C1	Tambulin	6-Farnesyl-3',4',5,7-tetrahydroxyflavanone	Arapetaloside B	Calomelanol H
Ternatin C2	Tetranin B	6-Formyl-4,5,7-trihydroxy-8-methylflavan	Arborestin	Calomelanol I
Ternatin C3	Tetrapterol A	6-Formylisoophiopogone A	Arbusculoside	Calomelanol J
Ternatin C4	Tetrapterol B	6-Formylisoophiopogone B	Arcapillin	Calomelanone
Ternatin C5	Tetrapterol C	6-Geranylpinocembrin	Arcommunol A	Calophyllic Acid
Ternatin D1	Tetrapterol E	6-Geranylpinostrobin	Arcommunol B	Calophyllolide
Ternatin E	Verbenacoside	6-Hydroxybiochanin A	Arcommunol C	Calopocarpin
Ternatumoside I	Tarachin	5'-Methoxyhydnocarpin D	Antiarone K	Butrin
Ternatumoside II	Taraninin	5-Methoxyxanthocercin A	Antoside	Cabenegrin A I
Ternatumoside IV	Valafolone	5-Methyllupiwighteone	anylsophoraflavanone A	Cabenegrin A II
Ternatumoside V	Vogelin	5-O-Demethylnobiletin	Apetatolide	Cabreuvin
Ternatumoside VI	Viviparum A	5-O-Methyleriostemin	Aphyllanthoside	Cacticin
Ternatumoside VII	Viviparum B	5-O-Methylglovanone	Apicin	Caesalpin J
Ternatumoside VIII	Verecundin	5-O-Methylhoslundin	Apigeniflavan	Caesalpinianone
Ternatumoside X	Ternoside	5-O-Methylhoslunfuranine	Apigenin	Caesalpiniaphenol A
Ternatumoside XI	Tetrahydroprotogenkwanin	5-O-Methylisovitexin	Apigenin 4',7-diglycosides	Cajaflavanone
Ternatumoside XII	Tetrahydroprotogenkwanone	5-O-Methylkushenol C	Apigenin 7-glycosides	Cajaisoflavone
Ternatumoside XIII	Corylidin	5-O-Methylmallotophilippen F	Apigeninidin	Cajanin
Ternatumoside XIV	Corylifol A	5-O-Methylmikanin	Apigenosylide A	Cajanol
Ternatumoside XV	Corylifol B	5-O-Methylmyricitrin	Apigenosylide B	Cajanone
Ternatumoside XVI	Corylifol C	5-O-Methylobovatachalcone	Apigenosylide C	Cajanuslactone
Ternatumoside XVII	Corylinal	5-O-Methylpinobanksin	Apimaysin	Calabricoside A
Ternifloroside A	Eryvarin Q	6-C-Galactosylluteolin	Arachidoside	Calofloride
Tetrahydrobilobetin	Stemofuran R	7-Methoxyneochamaejasmin B	Artocarpin	Campanoside
Tetrahydroprotoapigenin	2-Methoxymaackiain	Alhacin	Bisdemalonylsalvianin	cis-Praecansone A
Texasin	Coruscanone A	5-Deoxyhomoflemingin	Anthelminthicol A	Burttinol D
Ugonin A	12a-Methoxyrotenone	Agehoustin B	Belamcandin	Chrysograyanone
Ugonin B	12-Dihydrodalbin	Agehoustin C	Belamcanidin	Chrysoquinone A
Ugonin C	12-O-Ethylinophyllum D	Agehoustin D	Benthamianin	Chrysosplenetin
Ugonin D	12-O-Methylinophyllum D	Agehoustin E	Benthamitin	Chrysosplenol C
Ugonin E	12-O-Methylinophyllum P	Agehoustin F	Benzquercin	Chrysosplenol D
Ugonin F	1a-Hydroxyphaseollone	Agehoustin G	Betagarin	Chrysosplenol E
Ugonin G	1-Methoxyerythrabyssin II	Agestricin B	Betavulgarin	Chrysosplenol F
Ugonin H	1-Methoxyficifolinol	Agestricin D	Betmidin	Chrysosplenol G
Ugonin I	1-Methoxyphaseollidin	Agrandol	Betuletol	Chrysosplenoside A
Ugonin J	2-(4-Chlorobenzyl)-2-hydroxy-3(2H)-benzofuranone	Ailanthoidol	Betuletrin	Chrysosplenoside B
Ugonin K	2,3-Dehydrokievitol	a-Isoderrubone	Betulifol B	Chrysosplenoside C

Continue…

Uncinanone B	5-hydroxybowdichione	Prunectin	5,7,3',4'-tetrahydroxyisoflavone	Alpinumisoflavone
Ugonin L	2,3-Dehydrokievitone	Alangiflavoside	b-Hydroxydihydrohelilandin A	Chrysosplenoside D
Ugonin M	2',3-Diepilarixinol	Alatachalcone	Biaureusidin	Chrysosplenoside E
Ugonin N	2,3-Dihydrochamaecyparin	Alatanin 1	Bicaryanone A	Chrysosplenoside H
Ugonin O	2,3-Dihydrohinokiflavone	Alatanin A	Bicaryanone B	Chrysosplin
Ugonin P	2,3-Dihydroisocryptomerin	Alatanin B	Bicaryanone C	Cicerarietinuoside A
Ugonin Q	2,3-Dihydrotephroapollin C	Alatanin C	Bicaryanone D	Cicerfuran
Ugonin R	2,3-Dihydrotephroglabrin	Albafuran A	Bicolosin A	Cicerin
Ugonin S	2",3"-Epoxywighteone	Albafuran B	Bicolosin B	Ciliatin A
Ugonin T	2,4-Dihydroxydalbergiquinol	Albafuran C	Bicolosin C	Ciliatin B
Umuhengerin	Wikstroemin	Aesculitannin B	Baohuoside VII	Chartaceone A4
Uncinacarpan	Tephrorin A	a,a-Dimethylallylcyclolobin	Artonin Q	Cassinopin
Uncinanone B	Tephrorin B	Abacopterin B	Artonin R	Castanoside A
Uncinanone C	Tephrosone	Abacopterin C	Artonin T	Castanoside B
Uncinanone D	Tepurindiol	Abacopterin D	Artonin U	Castavinol
Uncinanone E	Tepicanol A	Abacopterin E	Artonin V	Casticin
Uralene	1,3-Diphenyl-1-propanone	Ageconyflavone C	Bavachromanol	Choerospondin
Uralenol	10-Oxoartogomezianone	Agecorynin A	Bavachromene	Chromanoartobilochromene
Urucuol A	Tephrospiroketone II	8-Prenyldaidzein	Artonin F	Carthamidin
Urucuol B	Tephrospirolactone	8-Prenyldihydroisorhamnetin	Artonin G	Carthamin
Urucuol C	Crassichalcone	8-Prenylflavanone	Artonin H	Carthamone
Urundeuvine A	3-Phenylchromone	Amurensin	Brosimacutin M	Crotaramosmin
Urundeuvine B	3'-Prenylaromadendrin	Amurensin H	Brosimine A	Cryptochinone G
Urundeuvine C	3'-Prenylrubranine	Amurensisin	Brosimine B	Cryptochinone H
Usararotenoid A	3,8,9-Trihydroxypterocarp-6-ene	Alopecurone D	Bonanniol B	Cochinchinenene A
Usararotenoid B	3',5-Bigenistein	Alopecurone G	Bonanniol D	Cochinchinenene C
Usararotenoid C	3'-Galloylprodelphinidin B	Alphitonin	Bonanniol E	Cochinchinenene D
Variabilin	Variabiloside F	7-O-Methylrobustaflavone	Artoheterophyllin D	Candenatone
Vavain	Sigmoidin K	6-[2-(Aminocarbonyl)ethe-nyl]-4',4",5,5",7,7"-hexahydroxy-3,3"-biflavanone	Apollinin	Callistephin
Veronicafolin	Dehydropachyrrhizone	4'-O-Methylabyssinone V	Angeflorin	Broussonone A
Verticilliside	Uldavioside A	Abruquinone I	Astragaloside	Caulesauroneside
Vesticarpan	2-Methoxyjudaicin	Alhacidin	Bisdeacylplatyconin	Cisilandrin
Vestitol	Stemofuran M	7-O-(Hydroxygeranyl)formononetin	Artocarpol B	Campanuloside
Vestitone	2-Methoxypterocarpin	Alhagidin	Biseryvarin A	Cissampeloflavone
Vicarin	Upunoside D	Abyssinoflavanone IV	Atricarpan A	Cedreprenone
Vicinin 2	Tephropurpurin	a,2-Dihydroxydihydrochalcone	Artonin P	Cassiglucin
Vignafuran	2-Hydroxymaackiain	Albireodelphin C	Bilobetin	Cinnamtannin D1
Villostyrene	2-Methoxyhomopterocarpin	Alginin	Biscyclolobin	CIS-Echinacin
Violanone	Variabiloside G	7-O-Methyltaiwaniaflavone	Artoindonesianin A	Candidachalcone
Violastyrene	Daidzein G2	7-O-Methylisolupalbigenin	Artocommunol CD	Candenatenin F
Viscoflavone B	Vogeletin	Abiesin	Artorigidin C	Catechin
Viscosol	Vogeloside	Abiesanol B	Artorigidin B	Catappanin A
Vochysine	Vitexcarpan	Acutissimin C	Azharone	Chamaechromone
Vogelin C	Viscumneoside IV	Acumitin	Ayamenin B	Chafuroside B
Vogelin D	Viscumneoside IX	Acutifolin A	Ayamenin C	Chakaflavonoside A
Vogelin E	Viscumneoside X	Acutifolin B	Ayamenin D	Chalcocaryanone A
Vogelin F	Viscoside A	Acutifolin C	Ayamenin E	Chalcocaryanone B
Vogelin G	Viscumneoside I	Acutifolin D	Ayanin	Chalcocaryanone C
Vogelin H	Viscumneoside V	Acutifolin E	Azaleatin	Chalcocaryanone D
Vogelin I	Viscutin 2	Acutissimin A	Azalein	Chalcomoracin

Continue…

Uncinanone B	5-hydroxybowdichione	Prunectin	5,7,3',4'-tetrahydroxyisoflavone	Alpinumisoflavone
Vogelin J	Viscutin 3	Acutissimin B	Azamicroside	Chalconaringenin
Volkensiflavone	Wikstrol A	Aesculitannin A	Baohuoside IV	Chartaceone A3
Volubilin	Variabiloside H	7-O-trans-Sinapoylisovitexin	Artoindonesianin A2	Candidol
Volubilinin	Variabiloside A	8,3'"-Bi[4',7-dihydroxyflava-none]	Artoindonesianin A3	Candidone
Volubinol	Variabiloside B	8,8"-Bigenkwanin	Artoindonesianin B	Candirone
Volubolin	Variabiloside C	8-C-Ascorbylepigallocatechin 3-O-gallate	Artoindonesianin D	Canescacarpin
Voludal	Variabiloside D	8-C-b-D-Glucopyranosyl-4',5,6,7-tetrahydroxyflavone	Artoindonesianin E	Cannabin
Wairol	2'-Methoxyvinaxanthone	Alhagitin	B-Isoderrubone	Cissoside I
Wanepimedoside A	Ulmoside B	Abutilin B	Astrasikokioside I	Caviunin
Wharangin	2"-O-b-D-Xylosylvitexin	Alliumoside A	Bladhianin	cis-Vitisin B
Wighteone	Coumaroyloxymyrioside	4-O-Ethylpetiveral	Androyol	Broussonol E
Wistin	2-Methyldihydroorobol	Aliarin	Bissigmodiol	Cissoside II
Wittifuran A	3-O-Acetylfustin	Amoenin D	Brauhenefloroside F	Corchoruside B
Wittifuran B	3"-O-Acetylphloridzin	Amoenin E	Brazilein	Cordifoliflavan A
Wittifuran C	3-O-Demethyldigicitrin	Amoradicin	Brazilide A	Cordifoliflavan B
Wittifuran D	3-O-Galloylepigallocatechin	Amoradin	Brazilin	Cordifolin
Wittifuran F	3-O-Galloylprodelphinidin B2	Amoradinin	Breverin	Corniculatusin
Wittifuran G	3"-O-Galloylprunin	Amoricin	Brevicornin	Corymboside
Wittifuran P	3-O-Methy-labyssinone A	Amoridin	Breviflavone A	Corymbosin
Wittifuran Q	3-O-Methylcalycopteretin	Amorilin	Breviflavone B	Cosmosiin
Wittifuran R	3-O-Methylcoumestrol	Amorin	Brickellin	Crateside
Wittifuran S	3-O-Methylfisetin	Amorinin	Brosimacutin A	Cristatein
Wittifuran T	3-O-Methylgancaonin P	Amorisin	Brosimacutin B	Crombenin
Wittifuran U	3-O-Methylmacarangin	Amoritin	Brosimacutin C	Crombeone
Wittifuran V	3-O-Methylokanin	Amorphaquinone	Brosimacutin D	Crosatoside A
Wittifuran W	3-O-Methylpinobanksin	Amorphigenin	Brosimacutin E	Crotafuran A
Wittifuran X	3-O-Methyluralenol	Amorphigenol	Brosimacutin F	Crotafuran B
Wittiorumin A	3-O-Methylvellokaempferol	Amorphispironone	Brosimacutin G	Crotafuran C
Wittiorumin B	3-O-Methylvelloquercetin	Amorphol	Brosimacutin H	Crotafuran D
Wittiorumin C	3-O-p-Coumaroylepigallocatechin	Amorpholone	Brosimacutin I	Crotafuran E
Wittiorumin E	3-O-Syringoylepigallocatechin	Ampelopsin	Brosimacutin J	Crotaoprostrin
Wittiorumin F	3-O-Vanilloylepigallocatechin	Amurenoside A	Brosimacutin K	Crotaorixin
Wittiorumin G	3-Oxykoaburagenin	Amurenoside B	Brosimacutin L	Crotaramin
Woorenoside XII	Wogonoside	6-Hydroxyluteolin	Arecatannin B1	Calopolyanolide C
Wushanicariin	Uncariagambiriine	Abyssinin I	Atalantoflavone	Cayratinin
Wushanicaritin	Uncariechin	Abyssinin II	Atanasin	Cedeodarin
Wushankaempferol	Unonal 7-methyl ether	Abyssinin III	a-Toxicarol	Cedrediprenone

Table 2: Flavonoids interaction with DENV NS2/NS3 catalytic triad

	Phytochemical Name	Plant Name (Scientific)	Plant Name (Common)	Phytochemical isolation source	Score	RMSD Value	Residues interacting with Ligand (H-Bonding)
A	Uncinanone B	Desmodium uncinatum	Silver leaf desmodium	Roots	-12.156	1.85	His51, Pro132, Asp75, Gly153, Leu128, Ser135
B	5-hydroxybowdichione	Dalbergia candenatensis	Takoli	Heartwood	-12.110	1.31	His51, Tyr150, Asp75, Gly153, Ser135, Pro132, Leu128
C	Prunectin	Glycine max	Soybean	Seeds	-11.369	1.38	His51, Tyr150, Asp75, Gly153, Leu128, Pro132
D	5,7,3',4'-tetrahydroxyisoflavone	Calophyllum polyanthum	Sirpoon tree	Seeds	-10.534	1.13	His51, Pro132, Gly153, Leu128, Ser135, Asp75
E	Alpinumisoflavone	Ficus microcarpa	Chinese banyan	Roots	-10.449	1.98	His51, Gly153, Asp75, Pro132, Leu128
F	Glicoisoflavanone	Glycyrrhiza uralensis	Chinese liquorice	Roots	-10.015	0.94	His51, Asp75, Pro132, Leu128, Gly153

Table 3: Molecular properties and drug likeliness of flavonoids evaluated through Molinspiration

	Phytochemical Name	Molecular formula	Molecular weight	Log P	Hydrogen bond donor	Hydrogen bond acceptor	Rotatable bond
A	Uncinanone B	$C_{20}H_{18}O_6$	354.358	3.251	3	6	1
B	5-hydroxybowdichione	$C_{16}H_{10}O_7$	314.249	0.593	2	7	2
C	Prunectin	$C_{16}H_{12}O_5$	298.294	3.339	1	5	3
D	5,7,3',4'-tetrahydroxyisoflavone	$C_{21}H_{20}O_{11}$	286.239	1.778	4	6	1
E	Alpinumisoflavone	$C_{20}H_{16}O_5$	336.343	3.949	2	5	1
F	Glicoisoflavanone	$C_{20}H_{18}O_6$	288.255	1.674	4	6	1

Table 4: ADMET profile for potential flavonoids

3.1 Absorption						
Models	Uncinanone B	5-hydroxybowdichione	Prunectin	5,7,3',4'-tetrahydroxyisoflavone	alpinumisoflavone	Glicoisoflavanone
Blood-Brain Barrier	BBB-	BBB -	BBB +	BBB -	BBB +	BBB +
Human Intestinal Absorption	HIA+	HIA +	HIA +	HIA +	HIA +	HIA +
Caco-2 Permeability	Caco2+	Caco2+	Caco2+	Caco2+	Caco2+	Caco2+
P-glycoprotein Substrate	Substrate	Substrate	Substrate	Substrate	Substrate	Non Substrate
P-glycoprotein Inhibitor	Non Inhibitor	Inhibitor	Non Inhibitor	Non Inhibitor	Non Inhibitor	Non Inhibitor
Renal Organic Cation Transporter	Non Inhibitor	Non Inhibitor	Non Inhibitor	Non Inhibitor	Non Inhibitor	Non Inhibitor
3.2 Metabolism						
CYP450 2C9 Substrate	Non Substrate	Non Substrate	Non Substrate	Non Substrate	Non Substrate	Non Substrate
CYP450 2D6 Substrate	Non Substrate	Non Substrate	Non Substrate	Non Substrate	Non Substrate	Non Substrate
CYP450 3A4 Substrate	Substrate	Non Substrate	Non Substrate	Non Substrate	Substrate	Non Substrate
CYP450 1A2 Inhibitor	Inhibitor	Inhibitor	Inhibitor	Inhibitor	Non Inhibitor	Non Inhibitor
CYP450 2C9 Inhibitor	Inhibitor	Inhibitor	Inhibitor	Non Inhibitor	Inhibitor	Inhibitor
CYP450 2D6 Inhibitor	Non Inhibitor	Non Inhibitor	Non Inhibitor	Non Inhibitor	Non Inhibitor	Non Inhibitor
CYP450 2C19 Inhibitor	Inhibitor	Inhibitor	Inhibitor	Non Inhibitor	Inhibitor	Non Inhibitor
CYP450 3A4 Inhibitor	Non Inhibitor	Inhibitor	Inhibitor	Inhibitor	Inhibitor	Inhibitor
3.3 Toxicity						
AMES Toxicity	Non Ames toxic	Non Ames toxic	Non Ames toxic	Non Ames toxic	Non Ames toxic	Non Ames toxic
Carcinogens	Non carcinogens	Non carcinogens	Non carcinogens	Non carcinogens	Non carcinogens	Non carcinogens

The barrier is formed between endothelial cells of brain capillaries by the occurrence of high resistance tight junctions which avoids the brain uptake of nearly all pharmaceuticals (Stamatovic *et al*., 2009). Blood brain barrier (BBB) is measured as the ratio of the compound concentration in the brain to that in the blood. Information of the dissemination of drugs through BBB is one of the main factors to be optimized in drug discovery (Alavijeh *et al*., 2005). Oral bioavailability frequently considered as a significant factor to find out the drug likeness of active

compounds as remedial agents (Thomas*et al*., 2006). In addition, oral drug bioavailability can be noticeably influenced by physiological, physiochemical and certain biopharmaceutical parameters (Hurst*et al*., 2007). High penetration of blood brain barrier is requisite for central nervous system (CNS)-active drugs while for non- CNS low penetration is enviable to lessen CNS-related side effects. In many studies, dengue infection has been reported in patients due to involvement of CNS (Araujo *et al*., 2012). In recent study, two cases oligosymptomatic dengue which caused meningitis has been reported in the city of Kolkata, West Bengal, India (Goswami *et al*., 2012). Lipophilicity, hydrogen-bond desolvation potential, molecular size and pKa/charge are the various parameters on which BBB permeability of compound depends (Abraham, 2004; Goodwin and Clark, 2005). ADMET-associated properties of the potential compounds for several types of models such as P-glycoprotein substrate, BBB penetration, human intestinal absorption, renal organic cation transporter and $CaCO_2$ permeability showed positive results which strongly supports the ability of compounds to work as drug candidate. Cytochrome P450 (CYP) is cluster of isozymes involves in the metabolism of drugs, steroids, fatty acids, bile acids and carcinogens. Fifty-seven CYP are encoded by human genome of which fifteen are involved in the xenobiotic chemicals and other metabolism of drugs (Guengerich, 2003). Approximately, 75% of phase I drug metabolism depends on the association of CYP enzymes (Bibi, 2008). All selected flavonoids are found to be non toxic.

Selected flavonoids uncinanone B, 5-hydroxybowdichione, prunectin, 5,7,3',4'-tetrahydroxyisoflavone, alpinumisoflavone and glicoisoflavanone are found in desmodium uncinatum, dalbergia candenatensis, glycine max, calophyllum polyanthum, ficus microcarpa and glycyrrhiza uralensis plants respectively. Different *in-vitro* studies showed that, extracts of desmodium uncinatum have potential tyrosinase inhibition ability (Heo *et al*., 2014), anti-parasitic activities (Tsanuo *et al*., 2003), anti-oxidant and anti-viral activities (Tsai *et al*., 2013). Extracts of salbergia candenatensis have anti-fungal, anti-viral and anti-bacterial activities (Hamburger *et al*., 1987). Extracts of glycine max have anti-promotional, anti-oxidant (Wei *et al*., 1995), anti-cancer (Yanagihara *et al*., 1993) and anti-viral activates (Zimmerman, 1995). Extracts of calophyllum polyanthum have potential anti-cancer and anti-microbial activities. Different successful *in-vitro* and *in-vivo* experiments have been performed to confirm the anti-cancer potential of its extracts (Hodek *et al*., 2002; Nguyen *et al*., 2006; Vauzour *et al*., 2007). While, extracts of ficus microcarpa and glycyrrhiza uralensis have anti-cancer, anti-viral and anti-bacterial activities (Hatano *et al*., 2000; Namkoong *et al*., 2011). Thus, we can conclude that selected flavonoids (Uncinanone B, 5-hydroxybowdichione, Prunectin, 5,7,3',4'-tetrahydroxyisoflavone, Alpinumisoflavone and Glicoisoflavanone) could be utilized as potential and strong drug candidate against Dengue virus NS2B/NS3 Protease.

CONCLUSION

In summary, this study has discovered the strong binding of six flavonoids from medicinal plants (Uncinanone B, 5-hydroxybowdichione, Prunectin, 5,7,3',4'-tetrahydroxy-isoflavone, Alpinumisoflavone and Glicoisoflavanone) with catalytic triad of NS2/NS3 protease. This study has also revealed that these flavonoids could be utilized as potential and strong drug candidate against Dengue virus NS2B/NS3 Protease. The outcome from this study will be useful before manufacturing and trying of flavonoids for drug design and development. Therefore, it can be concluded that in future flavonoids could serve as a strong and potential drug candidates against DENV as these possess significant binding affinity against NS2/NS3 protease.

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