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Mangosteen Peel (*Garcinia mangostana*) Compounds as MTNR1B Modulators for Gestational Diabetes: *In Silico* Study

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Abstract: This study explored mangostin derivatives (3.6-dimethylmangostin, 6-deoxy-gamma-mangostin, and alpha-mangostin) as potential MTNR1B modulators using *in silico* approaches, through a combination of ADMET profiling and molecular docking simulations. Among the tested compounds, 3.6-dimethylmangostin stood out as the most promising, exhibiting strong binding affinity toward MTNR1B, comparable to the standard ligand ML-1, along with favorable pharmacokinetic parameters. Compared with clinically used anti-diabetic agents such as metformin or sulfonylureas, which act mainly through different molecular pathways, mangostin derivatives may offer complementary benefits by targeting MTNR1B in addition to their known glucose-lowering and insulin-sensitizing effects. In contrast, although 6-deoxy-gamma-mangostin showed the most optimal pharmacokinetic parameters, its interaction with the target receptor was the weakest. These results suggest that 3.6-dimethylmangostin holds significant potential for further exploration in *in vitro* and *in vivo* studies aimed at confirming its therapeutic relevance in the treatment of GDM.

Keywords: gestational diabetes mellitus; mangostin; mtnr1b modulators; ADMET; molecular docking.

INTRODUCTION

Gestational Diabetes Mellitus (GDM) is a condition of hyperglycemia in pregnant women characterized by fasting plasma glucose ≥95 mg/dL, 1-hour glucose ≥140 mg/dL, and 2-hour glucose ≥120 mg/dL during a 75-gram oral glucose tolerance test, according to the American Diabetes Association (2023), which was first diagnosed during pregnancy. This hyperglycemic condition is caused by hormonal changes and insulin resistance.[1] Reported from the Cleveland Clinic in August (2024), around 14-18% of total pregnancies in the world experience GDM, with a higher incidence in developing countries, including Indonesia.[4] GDM is often associated with an increased risk of pre-eclampsia, gestational hypertension, and post-partum diabetes mellitus in pregnant women.[2] Meanwhile, in infants, the risks include increased macrosomia, shoulder dystocia, birth defects, premature birth, and perinatal death.[3] GDM can occur due to several conditions, including oxidative stress, insulin resistance, and genetic factors such as polymorphisms in the Melatonin receptor 1B (MTNR1B) gene. Oxidative stress in GDM is caused by increased reactive oxygen species (ROS), mitochondrial dysfunction, and inflammation that damages pancreatic beta cells and worsens insulin resistance. Disruption of melatonin signaling due to MTNR1B mutations can also increase oxidative stress, worsen pancreatic dysfunction, and increase the risk of GDM. The interaction between oxidative stress and MTNR1B dysfunction causes impaired glucose metabolism during pregnancy, so management of oxidative stress and melatonin hormone balance can be a potential approach in the prevention and management of GDM.[5]

Currently, the main therapies for GDM include lifestyle modification (diet and exercise), insulin administration, and oral hypoglycemic drugs such as metformin and glibenclamide. However, the use of these drugs still has several limitations, such as gastrointestinal side effects, risk of hypoglycemia, and potential negative impacts on fetal development. Therefore, the development of natural ingredient-based therapies with high efficacy and minimal side effects is a potential solution in the management of GDM.[6]

Pharmacological agents targeting MTNR1B with a natural ingredient-based approach are an attractive alternative, especially considering Indonesia's biodiversity, which is rich in bioactive compounds. One source of natural ingredients that has potential in managing diabetes is mangosteen peel (*Garcinia mangostana*), which contains various bioactive compounds, especially α-mangostin. This compound has been reported to have various pharmacological activities, including antioxidant, anti-inflammatory, and protective effects on pancreatic β cells. Several studies have also shown that mangostin can increase insulin sensitivity, inhibit oxidative stress, and regulate glucose metabolism, making it a potential candidate therapy for GDM. However, to date, few studies have explored the interaction of mangostin with MTNR1B.[7]

Therefore, this study aims to evaluate the potential of mangostin as an MTNR1B modulator in managing GDM through bioinformatics and *in silico* approaches, including molecular docking to analyze the affinity and molecular interactions between mangostin and MTNR1B.

MATERIALS AND METHODS

Materials

This study utilized a laptop with Windows 11 and PyMOL software. The researchers also employed several web-based tools, including PubChem (https://pubchem.ncbi.nlm.nih.gov/), SwissDock (https://www.swissdock.ch/), and pkCSM (https://biosig.lab.uq.edu.au/pkcsm/). Additional resources like Way2Drug (https://bio.tools/way2drug), Proteins Plus (https://proteins.plus/), and the Protein Data Bank (PDB) (https://www.rcsb.org/) enhanced this study's analysis. The process of *in silico* study is detailed in Figure 1. This study's target protein, MTNR1B (PDB: 6TR5), was obtained from the RCSB PDB. The ligands—3.6-dimethylmangostin, 6-deoxy-gamma-mangostin, and alpha-mangostin—were sourced from PubChem, with their respective IDs: 231412, 13873657, and 5281650.

Methods

ADMET Prediction

The researchers analyzed physicochemical properties like molecular weight (MW), Log P, rotatable bonds, hydrogen bond acceptors (HBA), hydrogen bond donors (HBD), and polar surface area (PSA). The researchers predicted pharmacokinetic and toxicity characteristics (absorption, distribution, metabolism, excretion, and toxicity - ADMET) using pkCSM. Canonical SMILES ligands were uploaded for this analysis. In addition, ADMET predictions were also carried out to assess the pharmacokinetic and toxicity aspects of this compound as a potential drug candidate. The results of this study are expected to provide a deeper understanding of the potential of mangostin in GDM therapy and become the basis for further research, both in vitro and in vivo, to support the development of safer and more effective natural-based therapies in the management of GDM.

Protein and Ligand Preparation

The researchers prepared the MTNR1B protein (PDB ID: 6TR5) with PyMOL. The researchers removed non-interacting molecules and air atoms. Then, the researchers downloaded ligand structures from PubChem in SDF format and converted them to PDB format using PyMOL for molecular docking.

Molecular Docking and Visualization

The researchers performed molecular docking with SwissDock and Proteins Plus. Visualization was followed by using Proteins Plus to analyze the interaction between MTNR1B and the ligands. A summary of the workflow appears in Figure 1.

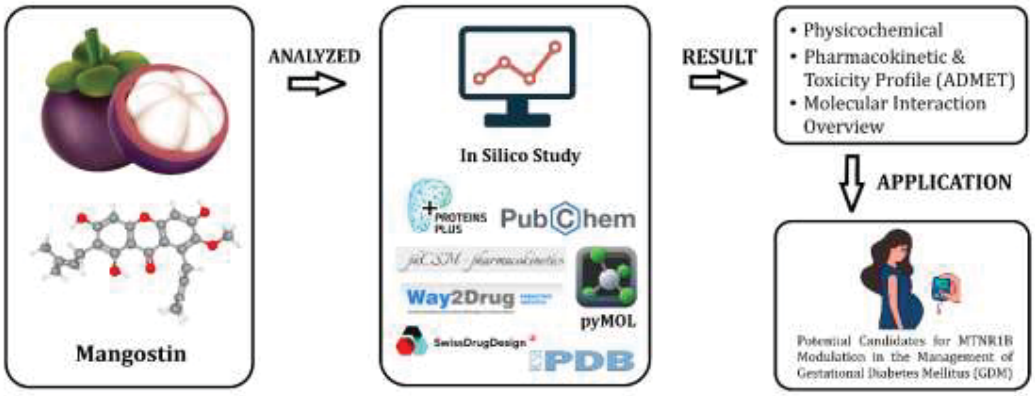

Figure 1. Graphical workflow *in silico* study

RESULTS

The ligands used in this study were 3.6-dimethylmangostin (CID: 231412), 6-deoxy-gamma-mangostin (CID: 13873657), and alpha-Mangostin (CID: 5281650). Their structures were retrieved from PubChem (Figure 2).

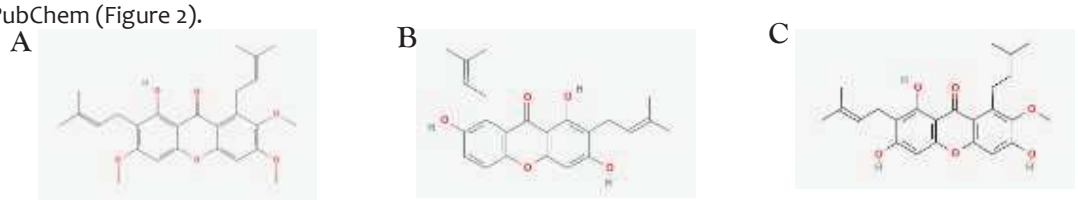

Figure 2. Ligands in this study. 6-dimethylmangostin (A), 6-deoxy-gamma-mangostin (B), and alpha-mangostin (C)

Table 1. Physicochemical, Pharmacokinetic, and Toxicity (ADMET) Characteristics of Mangostin Ligand

Pharmacokinetic & ADMET characteristics		Bioactive compounds		
		3.6-dimethylmangostin	**6-deoxy-gamma-mangostin**	**alpha-mangostin**
Physicochemical	Weight Molecule (g/mol)	438.1	380.43	410.46
	Log P	6.64	5.43	5.52
	Torsion	7	4	5
	HBA	6	5	6
	HBD	1	3	3
	PSA (A2)	78.13	90.9	100.13
Absorption	IA (human) (%)	95.377	95.62	93.647
	CP (log Papp in 10-6) (cm/s)	1.295	0.936	-0.048
	SP (log Kp) (cm/h)	-2.729	-2.736	-2.736
Distribution	VDss (human) (log L/kg)	0.007	-0.405	-0.282
	BBB (log B)	-0.3	0.405	-1.075
Metabolism	CYP2D6 Substrate	No	No	No
	CYP2D6 Inhibitors	No	No	No
Excretion	renal OCT2 S	No	No	No
Toxicity	Hepatotoxicity	No	No	No
	Max. tolerated dose in human (log mg/kg/day)	-0.335	0.363	0.061
	Oral rat acute toxicity (LD50) (mol/Kg)	1.939	1.832	1.949

Table 1 presents the physicochemical properties of mangostin compounds, predicted using SwissADME. The parameters include molecular weight (MW), Log P, rotatable bonds (torsion), hydrogen bond acceptors (HBA), and hydrogen bond donors (HBD). Pharmacokinetic and toxicity predictions are crucial for assessing a compound's potential as a drug candidate. These properties help determine the effectiveness and safety of inhibitors in the human body.

Table 2. Ligand Interactions with MTRN1B Active Site

Compound	Membrane Integrity Agonist	Binding Affinity (kcal/mol)	Protein	Interacting with Amino Acids
ML-1	Pa: 0.612 Pi: 0.002	-5.078	MTNR1B	π-π stacking: Phe268A Hydrophobic interaction: **Val187A**
3.6-dimethylmangostin	Pa: 0.928 Pi: 0.004	-4.751	MTNR1B	Hydrogen bond: Gly237A Hydrophobic interaction: **Val187A**, Ala 233A, and Gly235A π-π stacking: Phe319A
6-deoxy-gamma-mangostin	Pa: 0.963 Pi: 0.003	-1.863	MTNR1B	Hydrogen bond: Gly237A, Cys318A Hydrophobic interaction: **Val187A**, Ala 233A, and Gly235A
alpha-mangostin	Pa: 0.950 Pi: 0.004	-4.398	MTNR1B	Hydrogen bond: Cys318A, Phe319A Hydrophobic interaction: **Val187A**, Ala 233A, Gly235A, and Gly237A π-π stacking: Phe319A

Table 2 shows the molecular docking results (3.6-dimethylmangostin, 6-deoxy-gamma-mangostin, and alpha-mangostin). The reference compound ML-1 is associated with the target protein MTRN1B.

Meanwhile, the active site area of the MTRN1B (PDB: 6TR5) and mangostin compounds can be seen in Figure 3.

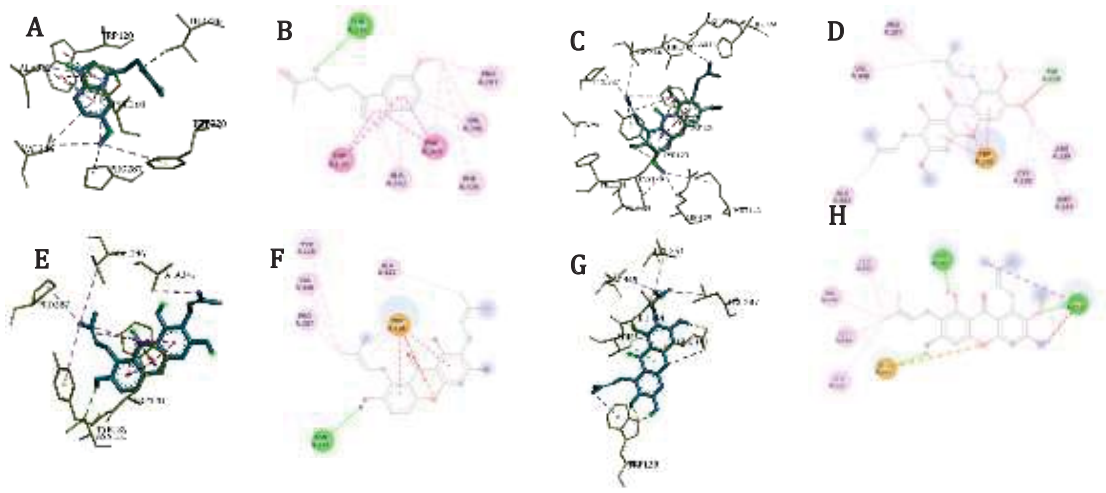

Figure 3. Binding of compounds with MTRN1B protein. ML-1 (A-B), 3.6-dimethylmangostin (C-D), 6-deoxy-gamma-mangostin (E-F), and alpha-mangostin (G-H)

DISCUSSION

ADMET evaluation is key in drug development. It predicts the pharmacokinetics, toxicity, and pharmacodynamics of potential ligands. This study examines the pharmacokinetic and toxicity properties of mangostin compounds to see how they work in the human body. Molecular docking lowers drug failure risks by enhancing target prediction and cutting down unnecessary lab experiments. Mangostin is a bioactive compound from *Garcinia mangostana*. It includes 3.6-dimethylmangostin, 6-deoxy-gamma-mangostin, and alpha-mangostin. These were studied for their potential to treat GDM through MTRN1B modulation. Mangostin was chosen for its rich metabolite content. This includes xanthones, flavonoids, and benzophenones, which are known for their antimicrobial, cytotoxic, antioxidant, agonist, and antidiabetic properties.[10, 11]

Prediction of Physicochemical, Pharmacokinetic, and Toxicity (ADMET) Characteristics

Drug development relies heavily on ADMET prediction. It helps assess a compound's effectiveness and safety before clinical trials. By understanding these traits, drug formulations can be enhanced. This leads to better distribution and lower toxicity risks, making mangostin compounds more effective in pharmaceuticals.[13] Lipinski's (1997) Rule of Five helps gauge if a compound is a good oral drug. A compound is orally safe if it meets at least two of these criteria: molecular weight (MW) < 500 g/mol, Log P < 5, hydrogen bond donors (HBD) < 10, hydrogen bond acceptors (HBA) < 5, and topological polar surface area (TPSA) ≤ 140 Å^2.[14] The molecular docking results in this study align with Lipinski's rules. ADMET predictions assess ligand absorption, distribution, metabolism, excretion, and toxicity (Table 1). Although α-mangostin has been predicted to exhibit favorable drug-likeness characteristics, such as high intestinal absorption but limited systemic distribution,[13] the derivative 3,6-dimethyl mangostin shows more advantageous physicochemical features, including acceptable molecular weight, topological polar surface area, and lipophilicity, supporting its candidacy as a lead compound. Nonetheless, its ADMET profile still requires thorough experimental validation. Moreover, recent studies have reported that certain α-mangostin derivatives display strong α-glucosidase inhibitory activity, surpassing acarbose and further underscoring the antidiabetic promise of this chemical class.[23]

For comparison, clinically established antidiabetic agents such as metformin are characterized by high oral bioavailability, minimal hepatic metabolism, and renal excretion, although their use is often limited by gastrointestinal intolerance and contraindications in renal impairment. Sulfonylureas, by contrast, enhance pancreatic β-cell insulin secretion and improve insulin sensitivity but are associated with

hypoglycemia and weight gain.[24] Taken together, this comparison underscores that, in contrast to conventional antidiabetic drugs with well-defined ADMET properties, mangostin derivatives still require systematic assessment—particularly regarding absorption, CYP450-mediated metabolism, renal clearance, and potential hepatotoxicity before advancing toward clinical development.[25]

Absorption

The researchers analyzed the absorption of mangostin compounds using the pkCSM web server. The data included intestinal absorption (%), Caco-2 permeability (log Papp in 10^-6 cm/s), and skin permeability (log Kp in cm/h). The study found that human intestinal absorption of the three compounds was high, over 93%. This suggests they can be well absorbed in the intestine. Among the compounds, 3.6-dimethylmangostin had the highest Caco-2 permeability at 1.295 cm/s. In contrast, alpha-Mangostin had a negative permeability value of -0.048 cm/s, indicating lower absorption. Skin permeability results showed negative values (≤ -2.7) for all compounds. This means they do not easily pass through the skin and are better suited for oral use. Mangostin compounds are absorbed in the intestine mainly through passive diffusion. Their lipophilic nature allows them to pass through the intestinal membrane easily. Good intestinal absorption is defined as >80%. This study shows that all mangostin compounds exceeded 93% absorption, suggesting strong oral bioavailability. However, the CaCO2 absorption mechanism should be considered.

CaCO2 is a common cell model for evaluating oral drug absorption and permeability. The standard for assessment is log Papp in 10^-6 (cm/s). A value below 0 indicates low permeability, 0-1 denotes moderate, and above 1 signifies high permeability.[16] The compound 3.6-dimethylmangostin exhibited the highest permeability at 1.295 cm/s, making it a strong candidate for oral use. For skin permeability, the pkCSM site provides a Log Kp value in cm/h. If the Log Kp value exceeds -2.5, the compound has low permeability.[17] This metric helps predict a compound's ability to penetrate the skin for transdermal or oral use. According to the ADMET prediction via pkCSM, mangostin had a Log Kp value of ≤ -2.7 cm/h, indicating low skin permeability. Therefore, mangostin is better suited for oral administration, as it is well absorbed in the human intestine.

Compared with standard antidiabetic agents, metformin demonstrates nearly complete intestinal absorption (~95%), yet its oral bioavailability remains limited (40–60%) due to substantial intestinal efflux and hepatic first-pass metabolism. In contrast, sulfonylureas typically achieve both high absorption and bioavailability (>80%), a profile that is comparable to the predicted absorption of mangostin derivatives.[24] Collectively, these findings suggest that mangostin derivatives, particularly 3,6-dimethylmangostin, possess favorable absorption properties resembling those of sulfonylureas, although rigorous in vivo validation is still necessary.[16,17,24]

Distribution

Drug candidate development looks at how a drug spreads in the body. The researchers analyzed the volume of distribution (VDss in log L/Kg) and the blood-brain barrier (BBB) permeability (in log BB). The volume of distribution is a theoretical measure. It shows how evenly the total drug dose spreads to match the blood plasma concentration. A higher VDss indicates better distribution at the same plasma level. Kidney failure and dehydration can impact this. VDss is considered low if it is below 0.71 L/kg (log VDss < -0.15) and high if it is above 2.81 L/kg (log VDss > 0.45).[18] The VDss values for the three mangostin compounds were low. In addition, many drugs in the blood can be bound or unbound to plasma proteins like albumin. Bound drugs cannot work directly, while unbound drugs are more active. They penetrate cell membranes and reach targets. The results show that all compounds had a very low unbound fraction. This means most compounds were bound to plasma proteins. As a result, only a small amount of the drug was active, which might reduce its effectiveness (Table 1). Adjustments to formulation or dosage might be needed for better performance in the body.

Furthermore, the human brain is protected by the blood-brain barrier (BBB). This barrier controls which compounds can enter the brain from the blood. In general, it helps lower toxicity and side effects, while a drug's ability to cross the BBB is key to its effectiveness in neurological therapy. Drug permeability to the brain is often measured with the logBB value. This value is the logarithmic ratio of drug concentration in plasma and brain from animal models. Compounds with logBB > 0.3 cross the BBB easily. In contrast, those with logBB < -1 struggle to enter the brain and have low central nervous system distribution.[18] The three mangostin compounds showed different abilities to penetrate the BBB. 6-deoxy-gamma-mangostin (logBB 0.4) crossed into the brain most easily. It has potential for neurological therapy

but also risks side effects outside the central nervous system. 3.6-dimethylmangostin (logBB -0.3) could penetrate the BBB in limited amounts so that it may have some brain effects, but not optimally. Alpha-mangostin (logBB -1.1) barely entered the brain, making it safer for systemic therapy without neurological side effects. For brain treatment, 6-deoxy-gamma-mangostin is the best choice. Alpha-mangostin is more suitable for therapy outside the central nervous system. This denotes that alpha-mangostin has a limited ability to reach the brain through circulation. While this limits its direct effects in the brain, it reduces the risk of neurotoxic side effects, making it safer for systemic use without unwanted brain penetration.

In comparison, the established clinical antidiabetic agent metformin exhibited a relatively low steady-state volume of distribution (VDss, ~1 L/kg) and limited blood–brain barrier (BBB) penetration, consistent with its peripheral mode of action. Similarly, sulfonylureas present moderate VDss values and likewise show minimal BBB permeability.[24] These characteristics parallel those observed for mangostin derivatives, where restricted tissue distribution and low BBB penetration may offer an advantage by supporting systemic antidiabetic efficacy while minimizing neurological risks.[18,24]

Metabolism

Cytochrome P450 is a group of liver enzymes that help detoxify and metabolize various foreign compounds, including drugs. These enzymes oxidize compounds, making it easier for the body to excrete them through urine or bile. One key isoform is CYP2D6, which metabolizes many drugs.[19] This study evaluated how mangostin derivatives affect CYP2D6. The results showed that none of the mangostin compounds inhibited CYP2D6. This means they will not interfere with this enzyme's activity in drug metabolism. Thus, mangostin derivatives are expected to be metabolized normally without major structural modification, making them promising drug candidates with a low interaction risk, especially with the CYP2D6 enzyme. When compared with common antidiabetic drugs (e.g., sulfonylureas), mangostin derivatives show an advantage as they exhibit minimal interference with CYP-mediated metabolism.[19, 26]

Excretion

Excretion removes substances produced by metabolism, mainly through the kidneys. The Renal Organic Cation Transporter 2 (OCT2) is a protein found mostly in the proximal tubules of the kidneys. It helps transport organic cations from the blood into kidney cells. OCT2 is part of the solute carrier family (SLC22A2) and is crucial for excreting drugs and foreign substances. If there are inhibitors or genetic changes affecting OCT2, drugs excreted by it can undergo altered excretion. Drug interactions can also disrupt OCT2 transport, raising the risk of kidney damage, especially with renal excretory drugs.[20] All three mangostin derivatives showed a "No" result on the Renal OCT2 Substrate. This means their excretion did not undergo altered excretion. Thus, mangostin derivatives are more likely eliminated via the liver (biliary) pathway or enzymatic metabolism, not through kidney filtration.[11] This indicates a reduced risk of drug–drug interactions, especially with OCT2-dependent agents such as metformin. Unlike metformin, which relies on renal clearance through OCT2 and may contribute to nephrotoxicity with prolonged use, mangostin derivatives appear advantageous by imposing less renal burden and potentially providing a safer route of excretion.[27]

Toxicity

This study assessed toxicity using these parameters: hepatotoxicity, maximum tolerated dose (MTD), and acute oral toxicity in mice (LD50) (Table 1). Predicting toxicity is crucial in drug design. Computational methods often outperform animal tests. They can cut down the need for animal experiments. Acute oral toxicity in mice matters greatly for evaluating chronic exposure to low doses. Values below 0.50 mM (LC50 log < -0.30 mol/kg) are dangerous. MRTD helps set the initial dose for phase I clinical trials. Values ≤ 0.477 log(mg/kg/day) are low, while higher values show greater tolerance.[14] According to ADMET data (Table 1), the toxicity of the three compounds —3.6-dimethylmangostin, 6-deoxy-gamma-mangostin, and alpha-mangostin— varies significantly. Among the tested compounds, hepatotoxicity was predicted only in 3.6-dimethylmangostin. The other two compounds showed no liver toxicity. Thus, 3.6-dimethylmangostin might cause liver damage at high doses or with long-term use. For MRTD, 6-deoxy-gamma-mangostin had the highest value (log mg/kg/day 0.363), followed by alpha-mangostin (log mg/kg/day 0.061). The lowest value was observed for 3,6-dimethylmangostin (log mg/kg/day -0.335). A negative value reflects a lower safety threshold, pointing to a greater toxicity risk. In terms of Oral Rat Acute Toxicity (LD50), the compounds had similar values: 1.939 mol/kg (3.6-

dimethylmangostin), 1.832 mol/kg (6-deoxy-gamma-mangostin), and 1.949 mol/kg (alpha-mangostin). This shows they share similar acute toxicity levels in mice, with low impact at certain doses.

Overall, 6-deoxy-gamma-mangostin had the best ADMET profile. It showed no hepatotoxicity and had the highest tolerated dose, making it safer than the others. Notably, in comparison with clinically used antidiabetic agents such as metformin and sulfonylureas, which have been linked to adverse effects including hepatotoxicity, hypoglycemia, and renal complications, mangostin derivatives appear to exhibit a more favorable toxicity profile.[24] Its advantages in absorption and distribution make it a better candidate for oral formulations of melatonin protein receptor modulator 1B (MTNR1B). This can help maintain cellular homeostasis and improve melatonin receptor function in circadian rhythm regulation in GDM.

Biological Activity Analysis

Analysis of the biological activity of the four compounds was carried out using the Way2Drug webserver to see the probability of activity (Pa) and probability of inactivity (Pi) scores, namely the prediction of the chance of a compound having a certain biological activity. The results of the Pa and Pi scores (Table 2) show that the four compounds had Pa scores in the range of ≥ 0.5 and Pi in the range of 0.0-0.5; the probability of activity (Pa) was medium-high, and the probability of inactivity (Pi) was low[13]. The Pa and Pi scores indicate that the four compounds had biological activity as membrane integrity agonists and could be further studied for molecular docking.

In contrast, widely prescribed antidiabetic agents such as metformin and sulfonylureas act mainly by activating AMP-activated protein kinase (AMPK) or stimulating insulin secretion, without directly affecting membrane integrity. This distinction suggests that mangostin derivatives may offer an alternative mechanistic pathway for antidiabetic therapy, potentially providing complementary benefits alongside conventional drugs.[24]

Molecular Docking of Mangostin Compounds with MTRN1B Target Protein

The researchers performed molecular docking to explore how mangostin compounds interact with the MTRN1B protein. Melatonin helps regulate circadian rhythms, including insulin secretion and sensitivity. Variants in the MTRN1B gene may increase the risk of type 2 diabetes and GDM due to impaired insulin secretion. MTRN1B agonists can help restore circadian rhythms and improve glucose metabolism in pregnant women at risk of GDM.[7] Mangostin compounds might boost activities that normalize circadian rhythms, enhance insulin sensitivity, and lower GDM risk.[5]

Genetic variants of MTNR1B are linked to the risk of GDM. A case-control study in Wuhan, China, showed that certain polymorphisms in the MTNR1B gene, like rs10830962 and rs10830963, are linked to higher GDM risk. In contrast, rs4753426 seems protective against GDM. This association stems from MTNR1B's role in regulating circadian rhythms and insulin secretion. Disruption in MTNR1B can lead to insulin resistance and higher blood glucose levels. These findings suggest that some genetic variants in MTNR1B influence glucose regulation during pregnancy, making it a potential target for GDM prevention and management.[22]

Considering the psychochemical and ADMET profiles (Table 1), mangostin compounds, especially 6-Deoxy-gamma-mangostin, may act as MTRN1B agonists for GDM management. Thus, the researchers conducted molecular docking to assess its interaction with MTRN1B and its binding affinity. The researchers used ML-1 as a reference compound since it modulates MTRN1B. Melatonin, a hormone, plays a key role in regulating circadian rhythms, which control sleep, metabolism, and other bodily functions. MTNR1B is one of two main melatonin receptors involved in this process. It is mainly found in the pancreas and brain, influencing insulin secretion and glucose metabolism. Through melatonin, MTNR1B activation helps synchronize the internal clock with the light-dark cycle. Variants in the MTNR1B gene are linked to a higher risk of type 2 diabetes, affecting nocturnal insulin secretion and sensitivity. Disruption of MTNR1B can lead to altered glucose metabolism, insulin resistance, and sleep issues, worsening conditions like GDM. Thus, targeting MTNR1B may offer a way to address metabolic disorders linked to circadian rhythm dysfunction.[21] In this study's docking analysis, ML-1 was the control, showing a strong binding affinity of -5.078 kcal/mol with the receptor. ML-1 interacted through π-π stacking with Phe268A and hydrophobic interactions with Val187A, which are key residues in ligand binding (Table 2, Figure 2). In comparison, 3.6-dimethylmangostin (-4.751 kcal/mol) and alpha-mangostin (-4.398 kcal/mol) showed close binding affinities, suggesting they may act as MTNR1B agonists. Both compounds also formed hydrogen bonds with Gly237A and hydrophobic interactions with Val187A, similar to ML-1. Conversely, 6-deoxy-gamma-mangostin had a much lower binding affinity (-1.863 kcal/mol), indicating it may be a weaker agonist. Overall, 3.6-dimethylmangostin and alpha-

mangostin showed greater potential to mimic ML-1's activity, laying the groundwork for further research in MTNR1B modulation.

Importantly, unlike metformin, the current first-line antidiabetic therapy—mangostin derivatives appear to act through circadian rhythm regulation via MTNR1B rather than hepatic glucose production. Metformin primarily lowers glucose levels by activating AMP-activated protein kinase (AMPK) and suppressing hepatic gluconeogenesis, with additional contributions from the lysosomal PEN2–ATP6AP1 complex.[28] By contrast, sulfonylureas stimulate pancreatic insulin secretion, while insulin therapy directly compensates for β-cell dysfunction.[29] These mechanisms differ fundamentally from MTNR1B agonism, which modulates circadian regulation of insulin release.

It implies that mangostin derivatives could serve as complementary or adjuvant therapies. Through enhancement of circadian rhythm signaling via MTNR1B, they may improve β-cell responsiveness and insulin sensitivity, thereby reducing the dosage requirements of conventional agents. This could, in turn, mitigate the long-term risks of hypoglycemia associated with sulfonylureas and the weight gain often linked to insulin therapy. Moreover, their predicted low nephrotoxicity profile suggests an advantage over metformin, which is contraindicated in patients with renal impairment.[11, 20]

Collectively, the docking data combined with biological plausibility support the idea that mangostin derivatives represent a novel therapeutic strategy targeting MTNR1B. While unlikely to replace current drugs, they may serve as safer adjunctive candidates capable of integrating circadian and metabolic regulation in diabetes management.

CONCLUSION

Based on ADMET analysis and molecular docking results, 3.6-dimethylmangostin is identified as the most promising candidate for MTNR1B modulation in the management of GDM. This compound exhibited strong binding affinity to MTNR1B, comparable to the reference ligand ML-1, along with favorable pharmacokinetic properties, including high absorption and a well-tolerated predicted toxicity profile. Although 6-deoxy-gamma-mangostin showed the best pharmacokinetic profile, its interaction with the target protein was relatively weak. These findings support the potential of 3.6-dimethylmangostin and warrant further in vitro and in vivo studies to validate its therapeutic application in GDM.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

1. Care, D. (2023). Standards of care in diabetes–2023. *Diabetes care*, *46*, S1-267. https://doi.org/10.2337/dc23-S002
2. Simmons, D., Immanuel, J., Hague, W. M., Teede, H., Nolan, C. J., Peek, M. J., ... & Cheung, N. W. (2023). Treatment of gestational diabetes mellitus diagnosed early in pregnancy. *New England Journal of Medicine*, *388*(23), 2132-2144. https://pubmed.ncbi.nlm.nih.gov/37144983/
3. Wicklow, B., & Retnakaran, R. (2023). Gestational diabetes mellitus and its implications across the life span. *Diabetes & Metabolism Journal*, *47*(3), 333-344. DOI: https://doi.org/10.4093/dmj.2022.0348
4. Cleveland Clinic. Gestational Diabetes: Causes, Symptoms & Treatment. Cleveland (OH): Cleveland Clinic; [updated 8 Aug 2024; cited 2025 Mar 3]. Available from: https://my.clevelandclinic.org/health/diseases/9012-gestational-diabetes
5. Suthon, S., & Tangjittipokin, W. (2024). Mechanisms and physiological roles of polymorphisms in gestational diabetes mellitus. *International Journal of Molecular Sciences*, *25*(4), 2039. https://doi.org/10.3390/ijms25042039
6. Tocci, V., Mirabelli, M., Salatino, A., Sicilia, L., Giuliano, S., Brunetti, F. S., ... & Brunetti, A. (2023). Metformin in gestational diabetes mellitus: to use or not to use, that is the question. *Pharmaceuticals*, *16*(9), 1318. https://doi.org/10.3390/ph16091318

7. Omar, A. M., AlKharboush, D. F., Mohammad, K. A., Mohamed, G. A., Abdallah, H. M., & Ibrahim, S. R. (2022). Mangosteen metabolites as promising alpha-amylase inhibitor candidates: in silico and in vitro evaluations. *Metabolites*, *12*(12), 1229. https://doi.org/10.3390/metabo12121229
8. Pires DEV, Blundell TL, Ascher DB. pkCSM: Predicting small-molecule pharmacokinetic and toxicity properties using graph-based signatures. J Med Chem. 2015; 58(9): 4066–4072. https://pubs.acs.org/doi/10.1021/acs.jmedchem.5b00104
9. Pradeepkiran, J. A., Sainath, S. B., & Shrikanya, K. V. L. (2021). In silico validation and ADMET analysis for the best lead molecules. In *Brucella Melitensis* (pp. 133-176). Academic Press. https://doi.org/10.1016/B978-0-323-85681-2.00008-2
10. Omar, A. M., AlKharboush, D. F., Mohammad, K. A., Mohamed, G. A., Abdallah, H. M., & Ibrahim, S. R. (2022). Mangosteen metabolites as promising alpha-amylase inhibitor candidates: in silico and in vitro evaluations. *Metabolites*, *12*(12), 1229. https://doi.org/10.3390/metabo12121229
11. Maulana, A. F., Sriwidodo, S., Rukayadi, Y., & Maksum, I. P. (2022). In silico study of mangostin compounds and its derivatives as inhibitors of α-glucosidase enzymes for anti-diabetic studies. *Biology*, *11*(12), 1837. https://doi.org/10.3390/biology11121837
12. Prasetyanti, I. K. (2021). Admet prediction and in silico analysis of mangostin derivatives and sinensetin on maltase-glucoamylase target for searching anti-diabetes drug candidates. *Pharmacognosy Journal*, *13*(4). https://phcogj.com/article/1608
13. Muslikh, F. A., Kurniawati, E., Ma'arif, B., Zenmas, S. Z., Salmasfattah, N., Dhafin, A. A., & Prasetyawan, F. (2023). ADMET Prediction of the Dominant Compound from Mangosteen (Garcinia mangostana L.) using pkCSM: A Computational Approach. *International Journal of Contemporary Sciences (IJCS)*, *1*(1), 33-38. https://doi.org/10.55927/ijcs.v1i1.7271
14. Jesus, G. A. D., & Kok, T. (2024). Curcuminoid Compounds Inhibit Macrophage Migration Inhibitory Factor: In Silico Study for Their Association to Anti-diabetic Potency. *Keluwih: Jurnal Kesehatan dan Kedokteran*, *6*(1), 48-58. https://doi.org/10.24123/kesdok.V6i1.7345
15. Chander, S., Tang, C. R., Al-Maqtari, H. M., Jamalis, J., Penta, A., Hadda, T. B., ... & Sankaranarayanan, M. (2017). Synthesis and study of anti-HIV-1 RT activity of 5-benzoyl-4-methyl-1, 3, 4, 5-tetrahydro-2H-1, 5-benzodiazepin-2-one derivatives. *Bioorganic chemistry*, *72*, 74-79. https://doi.org/10.1016/j.bioorg.2017.03.013
16. Pierotte, I. C., Silva, I. R., Santos Jr, V. S. D., Almeida, G. P., Santos, P. H. G. D., Maltarollo, V. G., ... & César, I. C. (2024). Evaluation of Intestinal Permeability of the Antifungal Compound PD76: Comparison of in silico Platforms and in vitro Assay in Caco-2 Cell Model. *Journal of the Brazilian Chemical Society*, *35*(7), e-20240011. https://doi.org/10.21577/0103-5053.20240011
17. Meily, A., & Purwanto, A. (2021). Studi Penambatan Molekul Senyawa Flavonoid Daun Tabat Barito (Ficus deltoidea Jack) dalam Menghambat Enzim Tirosinase: Molecular Docking Study of Flavonoid Compounds in Tabat Barito Leaves (Ficus deltoidea Jack) for Inhibiting Tyrosinase Enzyme. *Medical Sains: Jurnal Ilmiah Kefarmasian*, *6*(1), 25-34. https://doi.org/10.37874/ms.v6i1.215
18. Abdullah, S. S., Putra, P. P., Antasionasti, I., Rundengan, G., Suoth, E. J., Abdullah, R. P. I., & Abdullah, F. (2022). Analisis sifat fisikokimia, farmakokinetik dan toksikologi pada pericarpium pala (Myristica fragransa) secara artificial intelligence. *Chemistry Progress*, *14*(2), 81-92. https://doi.org/10.35799/cp.14.2.2021.37112
19. Fatisa, Y., Utami, L., Syahri, J., Jasril, J., & Lazulva, L. (2024). Studi Molecular Docking dan Evaluasi Farmakokinetik Senyawa Analog Pirazol Turunan Benzen-Sulfonilurea sebagai Inhibitor Enzim Aldose Reduktase and α-Glukosidase Menggunakan Pendekatan In Silico. *Jurnal Riset Kimia*, *15*(2), 11-26. https://doi.org/10.25077/jrk.v15i2.633
20. Klatt, O. C., de Brouwer, L., Hendriks, F., Dehne, E. M., Ataç Wagegg, B., Jennings, P., & Wilmes, A. (2025). Human and rat renal proximal tubule in vitro models for ADME applications. *Archives of Toxicology*, 1-29. https://link.springer.com/article/10.1007/s00204-025-03987-4
21. Zhu, H., Zhao, Z. J., Liu, H. Y., Cai, J., Lu, Q. K., Ji, L. D., & Xu, J. (2023). The melatonin receptor 1B gene links circadian rhythms and type 2 diabetes mellitus: An evolutionary story. *Annals of Medicine*, *55*(1), 1262-1286. https://doi.org/10.1080/07853890.2023.2191218

22. Liu, J., Li, W., Liu, B., Dai, A., Wang, Y., She, L., ... & Yang, M. (2022). Melatonin Receptor 1B Genetic Variants on Susceptibility to Gestational Diabetes Mellitus: A Hospital-Based Case–Control Study in Wuhan, Central China. *Diabetes, metabolic syndrome and obesity: targets and therapy*, 1207-1216. https://doi.org/10.2147/DMSO.S345036
23. Sanachai, K., Chamni, S., Nutho, B., Khammuang, S., Ratha, J., Choowongkomon, K., & Puthongking, P. (2025). Mechanistic study of α-mangostin derivatives as potent α-glucosidase inhibitors. *Molecular Diversity*, 1-17. https://doi.org/10.1007/s11030-025-11141-6
24. Susilawati, E., Levita, J., Susilawati, Y., & Sumiwi, S. A. (2023). Review of the case reports on metformin, sulfonylurea, and thiazolidinedione therapies in type 2 diabetes mellitus patients. *Medical Sciences*, *11*(3), 50. https://doi.org/10.3390/medsci11030050
25. Wang, D., Jin, J., Shi, G., Bao, J., Wang, Z., Li, S., ... & Hou, T. (2025). ADMET evaluation in drug discovery: 21. Application and industrial validation of machine learning algorithms for Caco-2 permeability prediction. *Journal of Cheminformatics*, *17*(1), 3. https://doi.org/10.1186/s13321-025-00947-z
26. Ajaghaku, D. L., & Chinwuba, P. (2025). Plant-drug Interactions: Mechanisms and Clinical Implications of Cytochrome P450 Modulation by Common Phytochemicals. *Journal of Advances in Medical and Pharmaceutical Sciences*, *27*(8), 44-66. DOI: https://doi.org/10.9734/jamps/2025/v27i8808
27. Hatmal, M. M. M., Abuyaman, O., Al-Hatamleh, M. A., Tayyem, H., Olaimat, A. N., Mussa, A., ... & Qawaqzeh, R. (2025). Influence of OCT2 gene variants on metformin efficacy in type 2 diabetes: insights into pharmacogenomics and drug interactions. *Journal of Translational Medicine*, *23*(1), 884. https://doi.org/10.1186/s12967-025-06720-y
28. Sugawara, K., & Ogawa, W. (2022). New mechanism of metformin action mediated by lysosomal presenilin enhancer 2. *Journal of Diabetes Investigation*, *14*(1), 12. https://doi.org/10.1111/jdi.13925
29. Tomlinson, B., Patil, N. G., Fok, M., Chan, P., & Lam, C. W. K. (2022). The role of sulfonylureas in the treatment of type 2 diabetes. *Expert Opinion on Pharmacotherapy*, *23*(3), 387-403. https://doi.org/10.1080/14656566.2021.1999413

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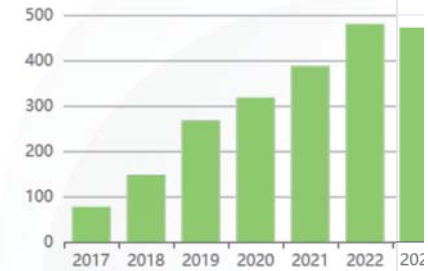

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