ISSN: 2231-3656

International Journal of Pharmacy and Industrial Research (IJPIR)

IJPIR |Vol. 16 | Issue 3 | Jul – Sep 2026

www.ijpir.com

DOI: https://doi.org/10.61096/ijpir.v16.iss3.2026.554.567

In Silico Screening of Selected Phytochemicals for ADME Properties and Therapeutic Potential in PCOS

Rajendran S.S [a*], Neelaveni Thangavel[a], Devanarayanan[a], Nisha. R[a], Sabeer Ahamed. P[a], Seenivasan. K[a], Angalaparameswari. S [b], Nandhini. S[a], Vytheeswari.K[a]

[a] *Department of Pharmaceutical Chemistry, RVS College of Pharmaceutical Sciences, Sulur - 641 402, Coimbatore, Affiliated to The Tamil Nadu Dr MGR Medical University, Guindy, Chennai – 600032, Tamil Nadu, India.*

[b] *Department of Pharmaceutical Analysis, RVS College of Pharmaceutical Sciences, Sulur- 641 402, Coimbatore, Affiliated to The Tamil Nadu Dr MGR Medical University, Guindy, Chennai – 600032, Tamil Nadu, India.*

*Corresponding author: **Dr. S. S. Rajendran**
Email: rajendran@rvsgroup.com

Published on;

22.08.2026
Published by: Futuristic Publications

Abstract:

Background: Polycystic ovary syndrome (PCOS) is a complex endocrine and metabolic disorder involving multiple molecular pathways. Although several phytochemicals show potential anti-PCOS activity, their drug-likeness, ADME characteristics, toxicity, and therapeutic suitability require systematic evaluation. This study aimed to prioritize promising phytoconstituents using an integrated *in-silico* approach.

Materials & Methods: Selected phytoconstituents were evaluated using SwissADME, pkCSM, and OSIRIS Property Explorer. The compounds were assessed for gastrointestinal absorption, pharmacokinetic properties, Lipinski drug-likeness, Caco-2 permeability, AMES mutagenicity, toxicity risks, and overall drug score. The results were comparatively analyzed to identify compounds with favorable pharmacokinetic and safety profiles for further investigation against PCOS-associated targets.

Results & Discussion: Considerable variation was observed among the evaluated phytoconstituents. Curcumin ranked first overall, demonstrating favorable gastrointestinal absorption, ADME characteristics, Lipinski compliance, negative AMES prediction, low predicted toxicity, and a favorable drug score. Gingerol ranked second, primarily due to excellent intestinal absorption and a favorable safety profile. Catechin ranked third, showing favorable ADME and OSIRIS characteristics and the highest drug score (0.89); however, positive AMES prediction and low Caco-2 permeability reduced its suitability. Apigenin and kaempferol showed favorable ADME profiles but were downgraded because of predicted mutagenicity. Eugenol and anethole demonstrated good absorption but comparatively higher predicted toxicity risks. Camphor exhibited the least favorable profile, with predicted mutagenicity, tumorigenicity, irritancy, reproductive toxicity, and the lowest drug score (0.06).

Conclusion: Curcumin emerged as the most promising phytoconstituent,

followed by gingerol and catechin. These findings support prioritization of selected phytochemicals for further anti-PCOS investigation. However, computational predictions remain preliminary and require validation through *in-vitro*, *in-vivo*, pharmacological, toxicological, and mechanistic studies.

Keywords: Polycystic ovary syndrome (PCOS); Phytochemicals; *In-silico* analysis; ADME; Drug-likeness; Toxicity prediction.

1. INTRODUCTION

Polycystic ovary syndrome (PCOS) is the most common endocrine disorder in reproductive-aged women, affecting approximately 8–13% of this population worldwide.[1] It is characterized by a heterogeneous combination of reproductive, hormonal, and metabolic abnormalities, including hyperandrogenism, ovulatory dysfunction, and polycystic ovarian morphology. In addition to reproductive complications such as menstrual irregularities, infertility, and impaired ovulation, PCOS is frequently associated with insulin resistance, obesity, dyslipidemia, and an increased risk of long-term metabolic complications.[2] The complex and multifactorial nature of PCOS presents considerable challenges in its diagnosis and therapeutic management.[3]

Current therapeutic strategies for PCOS primarily focus on controlling individual manifestations of the disorder, including hyperandrogenism, menstrual irregularities, insulin resistance and infertility. Although pharmacological agents such as oral contraceptives, insulin-sensitizing agents, and ovulation-inducing drugs are widely used, their effectiveness varies among individuals, and prolonged treatment may be associated with adverse effects. Moreover, existing therapies mainly provide symptomatic management rather than addressing the multiple underlying pathological mechanisms of PCOS. Consequently, there is growing interest in identifying novel therapeutic candidates with improved efficacy, safety, and multi-target potential.[4-6]

Phytochemicals have emerged as promising sources of bioactive molecules for the management of complex metabolic and endocrine disorders. Several naturally occurring compounds have demonstrated antioxidant, anti-inflammatory, insulin-sensitizing, anti-androgenic, and metabolic regulatory activities that may be relevant to PCOS pathophysiology.[7] However, biological activity alone is insufficient to establish the therapeutic potential of a phytochemical. Pharmacokinetic characteristics, including absorption, distribution, metabolism, and excretion (ADME), as well as drug-likeness and toxicity, are important determinants of the success of a candidate during drug development. Compounds with promising biological activity may fail to progress because of poor absorption, unfavorable metabolism, limited bioavailability, or potential toxicity.[8]

In this context, in silico drug-screening approaches provide an efficient strategy for the preliminary evaluation and prioritization of bioactive compounds. Computational platforms such as SwissADME[9], pkCSM[10], and OSIRIS Property Explorer[11] enable prediction of physicochemical properties, pharmacokinetic characteristics, drug-likeness, toxicity, and other drug-development-related parameters. Such approaches can facilitate the early identification of compounds with favorable pharmacological profiles while reducing the time, cost, and experimental burden associated with conventional drug-discovery workflows. Furthermore, computational screening can help prioritize promising candidates for subsequent molecular docking, experimental validation, and preclinical investigations.[12]

Despite the increasing evidence supporting the therapeutic relevance of phytochemicals in PCOS, systematic comparative assessment of their ADME, drug-likeness, toxicity, and overall drug potential remains limited. Therefore, the present study focuses on the in silico screening of selected phytochemicals for their ADME properties and therapeutic potential in PCOS. The study evaluates their pharmacokinetic characteristics, drug-likeness, toxicity profiles, and overall drug scores to comparatively identify the most promising candidates. The findings may provide a rational basis for prioritizing lead phytochemicals for further molecular investigation and experimental validation in the development of potential therapeutic strategies for PCOS.

2. MATERIALS &METHODS

2.1. Materials

The materials, databases, software, and online computational tools employed in the *in-silico* study, including the evaluated properties, assessment parameters, desirable criteria, and their respective relevance and justification for anti-PCOS screening, drug-likeness, ADMET, and toxicity assessment of the selected phytochemicals, are summarized in Tables 1–5.

Table 1: Material/Tool used

Material/Tool	Purpose
Scientific literature/databases	Identification of PCOS-related studies and anti-PCOS phytochemicals - PubMed, Google Scholar, ScienceDirect, Scopus, and Web of Science were used to identify research articles related to PCOS and phytochemicals with reported anti-PCOS activity.
PubChem	Retrieval of chemical structures and molecular information of selected phytochemicals
SwissADME	Prediction of physicochemical properties and drug-likeness
pkCSM	Prediction of ADMET and pharmacokinetic properties
OSIRIS Property Explorer	Toxicity risk and drug-score prediction
Computer system with internet access	Execution of computational studies and access to online databases/tools

ADME, Drug-Likeness and Toxicity Prediction

Table 2: In -Silico Tools, Evaluated Properties, and Their Relevance to Anti-PCOS Screening

Software/Tool	Properties to be Evaluated	Relevance to Anti-PCOS Study
SwissADME	Molecular weight, LogP, TPSA, H-bond donors, H-bond acceptors, rotatable bonds, Lipinski's Rule of Five, gastrointestinal absorption, bioavailability score, and solubility	To assess physicochemical properties, oral drug-likeness, and probable bioavailability of phytoconstituents
pkCSM	Water solubility, intestinal absorption, P-glycoprotein interaction, volume of distribution, BBB permeability, CYP450 interactions, total clearance, renal OCT2 substrate, AMES toxicity, hepatotoxicity, skin sensitization	To predict pharmacokinetic behavior and toxicity, helping identify compounds with favorable ADMET profiles
OSIRIS Property Explorer	Molecular weight, LogP, solubility, drug-likeness, drug score, mutagenicity, tumorigenicity, reproductive toxicity, and irritancy	To identify potential toxicity risks and prioritize compounds with better safety and drug-likeness profiles

SwissADME Analysis[13]

Table 3: SwissADME Parameters, Desirable Criteria, and Their Justification for Drug-Likeness Assessment of Selected Phytochemicals

Parameter	Preferred/Desirable Criteria	Justification
Molecular Weight	<500 Da	Lower molecular weight generally favors oral

(MW)		absorption and membrane permeability.
LogP	Moderate/acceptable	Appropriate lipophilicity supports membrane permeability without excessive hydrophobicity.
TPSA (Topological Polar Surface Area)	Preferably <140 Å²	Suitable TPSA helps maintain a balance between polarity, solubility, and permeability.
GI Absorption	High	Indicates better potential for absorption following oral administration.
Lipinski Violations	0 preferred	Fewer violations indicate better predicted oral drug-likeness.
Bioavailability Score	Higher/favorable	Indicates a greater probability of achieving adequate systemic exposure.

pkCSM Analysis[14]

Table 4: pkCSM Parameters, Desirable Criteria, and Their Justification for ADMET and Toxicity Assessment

Parameter	Preferred/Desirable Criteria	Justification
Intestinal Absorption (%)	Higher	Indicates better potential for absorption from the gastrointestinal tract.
Caco-2 Permeability	Higher/favorable	Indicates the potential ability of the compound to cross intestinal epithelial cells.
BBB Permeability	Target-dependent	CNS penetration is not essential, for peripheral anti-PCOS targets.
CYP3A4 Inhibitor	Preferably No	Reduces the potential for CYP-mediated metabolic drug–drug interactions.
AMES Toxicity	Negative	Indicates lower predicted mutagenic/genotoxic potential.

OSIRIS Property Explorer Analysis[15]

Table 5: OSIRIS Property Explorer Parameters, Desirable Criteria, and Their Justification for Drug-Likeness and Toxicity Assessment

Parameter	Preferred/Desirable Criteria	Justification
Mutagenicity	Negative	Indicates lower predicted risk of genetic damage.
Tumorigenicity	Negative	Indicates lower predicted carcinogenic/tumorigenic risk.
Irritant Effect	Negative	Indicates lower predicted risk of irritation-related adverse effects.
Reproductive Effect	Negative	Important because reproductive safety is particularly relevant to compounds investigated for PCOS.
Drug-Likeness	Positive/High	Indicates favorable structural characteristics for potential drug development.
Drug Score	Higher	Represents a more favorable overall balance of drug-likeness and predicted toxicity properties.

2.2. Methods

2.2.1. Literature Survey and Selection

A comprehensive literature survey will be carried out to identify PCOS-associated mechanisms, molecular targets, and phytochemicals with reported anti-PCOS activity**.** Relevant scientific publications will be collected from databases such as PubMed, Google Scholar, ScienceDirect, Scopus, and Web of Science using appropriate keywords such as *"Polycystic Ovary Syndrome," "PCOS," "anti-PCOS phytochemicals," "medicinal plants," "phytoconstituents," "insulin resistance," "hyperandrogenism,"* and *"ovarian dysfunction."*

Based on the available literature, phytochemicals showing reported therapeutic potential against PCOS or its major associated pathways will be shortlisted. Selection will consider their reported biological activity, molecular targets, availability of chemical structure information, and relevance to PCOS.

The chemical structures of the selected phytochemicals will then be retrieved from the PubChem database**.** The corresponding 2D/3D structures, canonical SMILES, molecular formula, molecular weight, and PubChem CID will be recorded for further computational analysis. The retrieved structures will subsequently be used for ADME, ADMET, toxicity prediction studies**.**

Table 6: Selected phytoconstituents reported for anti-PCOS activity[16]

S. No.	Phytoconstituent	Natural Source	Reported Pharmacological Activity in PCOS	Rationale for Selection	PubChem CID	Reference
1	**Curcumin**	*Curcuma longa* (Turmeric)	Improves glycemic control, insulin sensitivity, lipid metabolism and menstrual abnormalities; reported beneficial effects in women with PCOS.	Strongest clinical evidence among the selected phytoconstituents; established antioxidant and anti-inflammatory activity.	**969516**	**[17–19]**
2	**Apigenin**	*Matricaria chamomilla*, *Apium graveolens*, parsley and other plants	Demonstrated protective effects against PCOS-like reproductive and metabolic abnormalities in an experimental zebrafish model.	Flavonoid with antioxidant and anti-inflammatory properties and recent direct PCOS evidence.	**5280443**	**[20]**
3	**Liquiritin**	*Glycyrrhiza uralensis* (Licorice)	Modulates ovarian granulosa-cell proliferation and apoptosis through the miR-206/PI3K/AKT pathway.	Direct experimental evidence of activity against PCOS-associated granulosa-cell abnormalities.	**503737**	**[21]**
4	**Eugenol**	*Syzygium aromaticum* (Clove)	Improves glucose, insulin, lipid profile, reproductive hormones, oxidative stress and ovarian	Direct experimental anti-PCOS activity with antioxidant,	**3314**	**[22]**

			histopathology in PCOS rats; promotes restoration of ovulation.	anti-inflammatory, anti-androgenic and metabolic effects.		
5	**Barbaloin**	*Aloe vera* (*Aloe barbadensis*)	Aloe-derived preparations have demonstrated beneficial effects on ovarian tissue, folliculogenesis and metabolic abnormalities associated with PCOS; barbaloin is one of the major Aloe constituents.	Selected as a major bioactive constituent of Aloe associated with reported PCOS-related activity, although direct purified-barbaloin evidence is limited.	**12305761**	**[23]**
6	**Kaempferol**	*Ginkgo biloba*, *Camellia sinensis*, *Moringa oleifera* and other plants	Reported to improve metabolic and endocrine abnormalities and oxidative stress in a PCOS rat model.	Recent direct experimental evidence supports its potential as an anti-PCOS flavonoid.	**5280863**	**[24]**
7	**Camphor**	*Cinnamomum camphora* (Camphor tree)	Direct anti-PCOS evidence for isolated camphor is limited; camphor-containing medicinal plants have been investigated for reproductive/metabolic effects.	Selected for preliminary in-silico screening based on its natural occurrence and pharmacological properties; requires stronger PCOS-specific validation.	**10050**	**[25]**
8	**Gingerol**	*Zingiber officinale* (Ginger)	Improves ovarian morphology, biochemical parameters, antioxidant activity and COX-2 expression in an estradiol-valerate-induced PCOS rat model.	Direct experimental anti-PCOS evidence and strong antioxidant/anti-inflammatory potential.	**442793**	**[26]**
9	**Anethole**	*Foeniculum vulgare* (Fennel), *Pimpinella anisum* (Anise)	Improves insulin, oxidative stress, ovarian cystic changes and tissue damage in a PCOS rat model.	Direct experimental evidence demonstrating protective effects against	**637563**	**[27]**

				PCOS-associated metabolic and ovarian abnormalities.		
10	**Catechin**	*Camellia sinensis* (Green tea)	Tea catechins have been associated with improvement of insulin resistance, hyperandrogenism, ovarian morphology and metabolic abnormalities in PCOS models.	Natural flavonoid with antioxidant activity and reported PCOS-related effects of catechin-rich tea preparations.	**9064**	**[28]**

3. RESULT AND DISCUSSION

3.1.1. SwissADME Analysis & Interpretation:

Table 7: SwissADME Analysis

Compound	MW	LogP	TPSA	GI Absorption	Lipinski Violations	Bioavailability Score
Curcumin	368.38g/mol	2.97	93.06 A^2	High	Yes;0 Violation	0.55
Apigenin	270.24g/mol	1.53	90.90 A^2	High	Yes;0Violation	0.55
Liqueritin	418.39g/mol	-0.05	131.32A^2	High	Yes;0Violation	0.55
Eugenol	164.20g/mol	2.22	29.46A^2	High	Yes; 0Violation	0.55
Barbaloin	418.39g/mol	-0.65	167.9A^2	Low	Yes;1Violation: NH/OH>5	0.55
Kaempraferol	286.24g/mol	1.20	111.13A^2	High	Yes;0Violation	0.55
Camphore	152.23g/mol	2.44	17.07 A^2	High	Yes;0Violation	0.55
Gingerol	294.39g/mol	3.04	66.76 A^2	High	Yes;0Violation	0.55
Anethole	148.20g/mol	2.85	9.23 A^2	High	Yes;0Violation	0.55
Catechin	290.27g/mol	0.70	110.38A^2	High	Yes; 0Violation	0.55

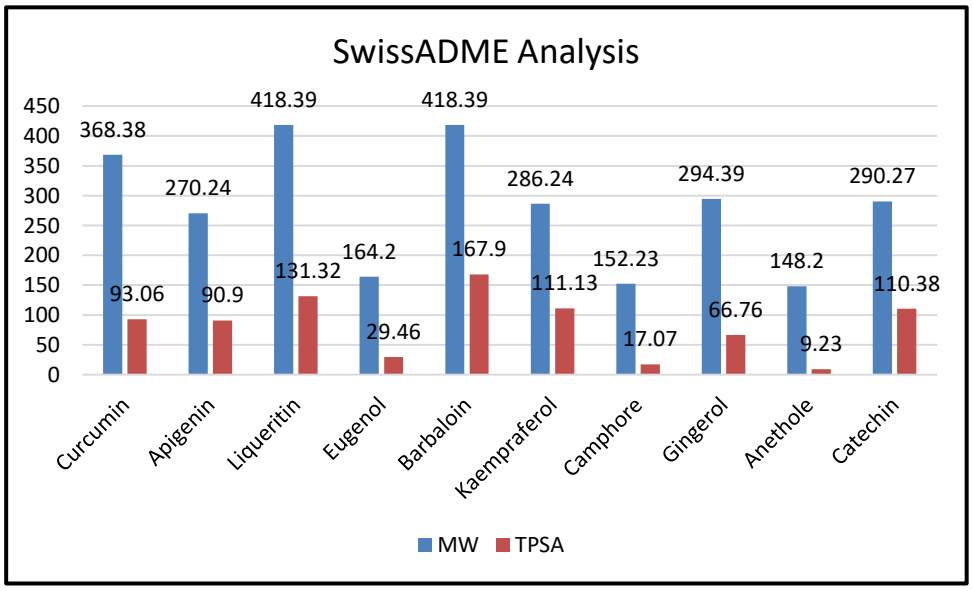

Fig 1: Molecular weight & TPSA-SwissADME Analysis

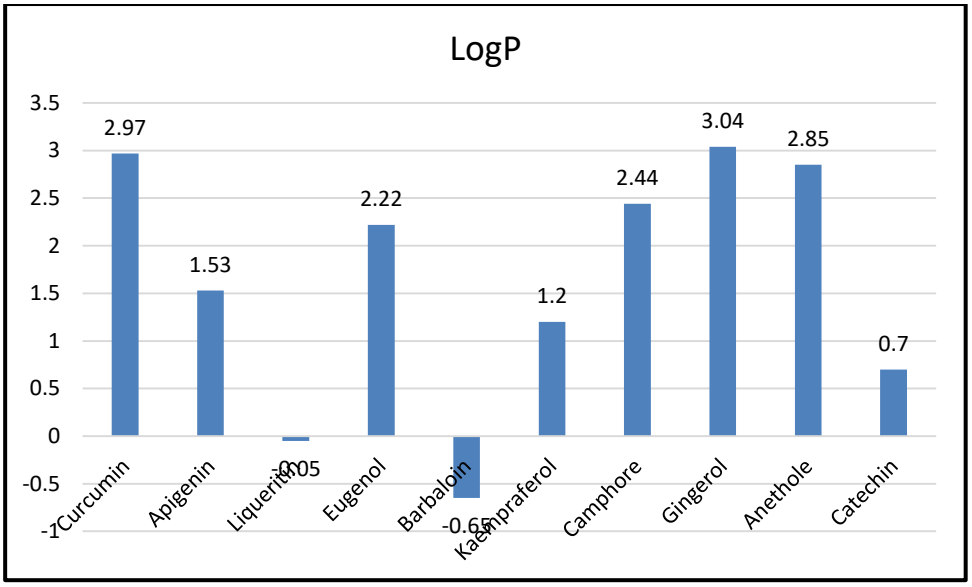

Fig 2: Log P -SwissADME Analysis

The results of the SwissADME analysis are shown in Table 7 and Figures 1 and 2. The SwissADME analysis demonstrated considerable variation in the predicted physicochemical and pharmacokinetic properties of the selected phytoconstituents. Curcumin exhibited a favorable overall drug-likeness profile, characterized by high gastrointestinal (GI) absorption, a moderate LogP value of 2.97, a TPSA of 93.06 Å², and no Lipinski rule violations, suggesting acceptable oral drug-like characteristics. Apigenin, Liquiritin, Kaempferol, and Catechin also showed high GI absorption with zero Lipinski violations, indicating favorable oral drug-likeness. Eugenol, Camphor, Gingerol, and Anethole demonstrated high GI absorption and acceptable Lipinski profiles, with comparatively lower TPSA values that may support improved membrane permeability. In contrast, Barbaloin displayed the least favorable predicted ADME profile, with low GI absorption, a high TPSA of 167.90 Å², and one Lipinski violation due to an excessive number of hydrogen-bond donors. Interestingly, all selected compounds showed an identical predicted bioavailability score of 0.55, indicating comparable predicted oral bioavailability; therefore, additional parameters such as permeability, toxicity, drug-likeness, and molecular docking interactions are important for comprehensive candidate prioritization. Overall, Curcumin, Apigenin, Gingerol, and Catechin demonstrated comparatively favorable physicochemical and ADME characteristics. Considering its overall SwissADME profile, Curcumin may be prioritized as a lead phytoconstituent for subsequent in vitro and in vivo validation against PCOS, although its final selection should be supported by integrated toxicity, ADMET, and molecular docking results.

3.1.2. pkCSM Analysis & Interpretation:

Table 8: pkCSM Analysis

Compound	Intestinal Absorption (%)	Caco-2 Permeability	BBB Permeability	CYP3A4 Inhibitor	AMES Toxicity
Curcumin	81.7	0.556	-0.642	Yes	No
Apigenin	90.14	1.062	-0.708	No	Yes
Liqueritin	63.574	-0.312	-1.239	No	Yes
Eugenol	96.594	1.48	0.348	No	No
Barbaloin	49.874	-0.311	-1.065	No	Yes

Kaempraferol	79.391	0.27	-0.886	No	Yes
Camphore	99.611	1.369	0.457	No	No
Gingerol	93.293	0.959	-0.221	No	No
Anethole	98.814	1.391	0.662	No	No
Catechin	71.562	-0.38	-0.905	No	Yes

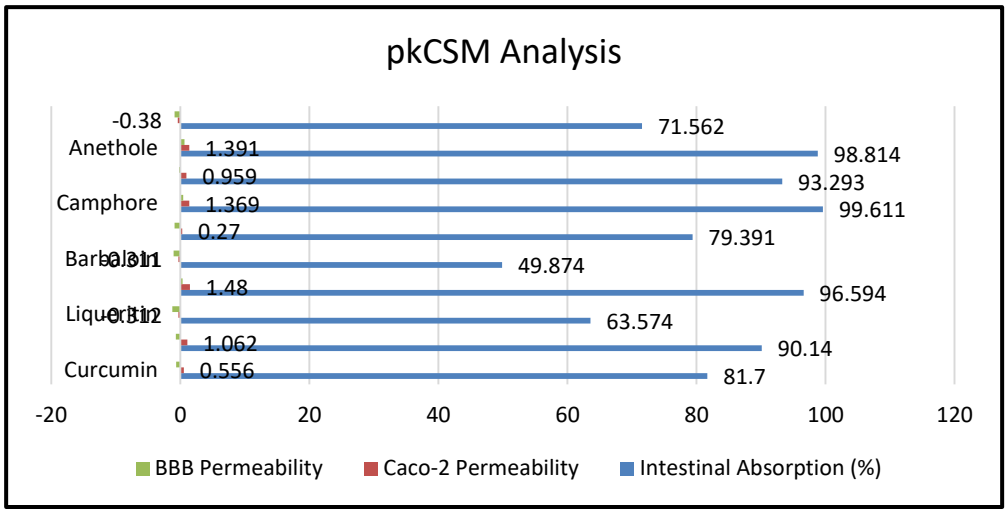

Fig 3: BBB Permeability, Caco-2 Permeability & Intestinal Absorbtion- pkCSM Analysis

The results of the pkCSM analysis are shown in Table 8 and Figures 3. The pkCSM analysis revealed considerable differences in the predicted pharmacokinetic and toxicity profiles of the selected phytochemicals. Most compounds exhibited good predicted intestinal absorption, with Camphor (99.61%), Anethole (98.81%), and Eugenol (96.59%) showing the highest absorption values, whereas Barbaloin (49.87%) and Liquiritin (63.57%) demonstrated comparatively lower absorption. In terms of Caco-2 permeability, Eugenol (1.48), Anethole (1.391), Camphor (1.369), and Apigenin (1.062) showed comparatively favorable predicted permeability, while Liquiritin, Barbaloin, and Catechin exhibited lower permeability. Eugenol, Camphor, and Anethole showed positive predicted blood–brain barrier (BBB) permeability values, suggesting a greater potential for BBB penetration, whereas the remaining compounds showed negative values. With respect to CYP3A4 inhibition, Curcumin was the only compound predicted to inhibit CYP3A4, indicating a potential for metabolic drug–drug interactions that warrants further investigation. The AMES toxicity prediction indicated that Curcumin, Eugenol, Camphor, Gingerol, and Anethole were AMES-negative, suggesting a comparatively favorable predicted mutagenicity profile, whereas Apigenin, Liquiritin, Barbaloin, Kaempferol, and Catechin were predicted to be AMES-positive and therefore require additional safety evaluation. Overall, Curcumin demonstrated a favorable balance of intestinal absorption, Caco-2 permeability, and AMES-negative prediction, although its predicted CYP3A4 inhibition should be considered during further evaluation. Gingerol also exhibited a favorable overall profile, with good absorption, moderate permeability, and an AMES-negative prediction. In contrast, Barbaloin showed the least favorable predicted ADME and safety profile, owing to its relatively low intestinal absorption, poor Caco-2 permeability, and AMES-positive prediction. Based on the integrated pkCSM findings, Curcumin and Gingerol may be prioritized as promising candidates for further investigation, while compounds showing unfavorable toxicity predictions should undergo additional safety validation before experimental consideration.

3.1.3 Osiris Property Explorer Analysis & Interpretation:

Table 9: Osiris Property Explorer

Compound	Mutagenicity	Tumorigenicity	Irritant Effect	Reproductive Effect	Drug-Likeness	Drug Score
Curcumin	Low Risk	Low Risk	Low Risk	Low Risk	-3.95	0.44
Apigenin	High Risk	Low Risk	Low Risk	Low Risk	1.21	0.50
Liqueritin	Low Risk	Low Risk	Low Risk	Low Risk	-5.98	0.43
Eugenol	High Risk	High Risk	High Risk	Low Risk	-2.78	0.11
Barbaloin	Low Risk	Low Risk	Low Risk	Low Risk	-2.33	0.47
Kaempraferol	High Risk	Low Risk	Low Risk	Low Risk	0.90	0.49
Camphore	High Risk	High Risk	High Risk	High Risk	-3.71	0.06
Gingerol	Low Risk	Low Risk	Low Risk	Low Risk	-7.78	0.43
Anethole	High Risk	High Risk	Low Risk	High Risk	-3.42	0.11
Catechin	Low Risk	Low Risk	Low Risk	Low Risk	1.92	0.89

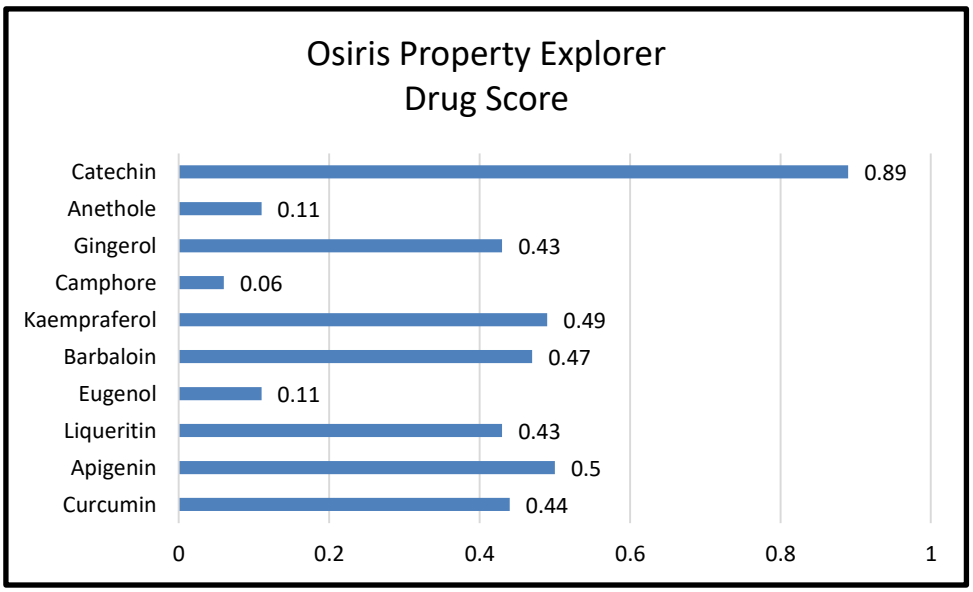

Fig 4: Drug score-Osiris Property Explorer

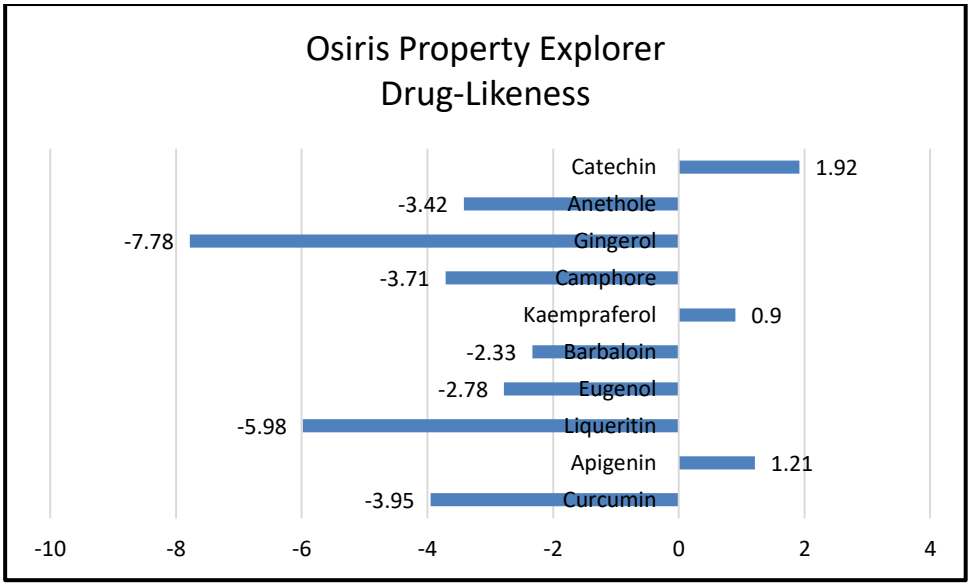

Fig 5: Drug Likeness-Osiris Property Explorer

The results of the Osiris Property Explorer analysis are shown in Table 9 and Figures 4 and 5. The OSIRIS Property Explorer analysis demonstrated considerable variation in the predicted toxicity profiles and drug scores of the selected phytochemicals. Curcumin exhibited a low-risk profile across all evaluated toxicity parameters, including mutagenicity, tumorigenicity, irritation, and reproductive toxicity, with a moderate drug score of 0.44, indicating a favorable overall safety profile. Liquiritin and Barbaloin similarly showed low predicted toxicity risks across all parameters, with drug scores of 0.43 and 0.47, respectively. Gingerol also demonstrated low toxicity risks, although its drug score was comparatively moderate (0.43). In contrast, Apigenin and Kaempferol showed high predicted mutagenicity risks despite low risks for the remaining toxicity parameters, with drug scores of 0.50 and 0.49, respectively. Eugenol exhibited high predicted risks for mutagenicity, tumorigenicity, and irritation, resulting in a low drug score of 0.11. Similarly, Anethole demonstrated high predicted risks for mutagenicity, tumorigenicity, and reproductive toxicity and had a low drug score of 0.11. Camphor displayed the least favorable predicted safety profile, with high risks across mutagenicity, tumorigenicity, irritation, and reproductive toxicity, together with the lowest drug score (0.06). Notably, Catechin demonstrated the most favorable OSIRIS profile, showing low predicted toxicity risks across all evaluated parameters and the highest drug score (0.89), suggesting superior overall drug-development potential among the screened compounds. Overall, Catechin emerged as the most promising candidate based on OSIRIS analysis, while Curcumin, Barbaloin, Liquiritin, and Gingerol also demonstrated comparatively favorable safety profiles. Conversely, Camphor, Eugenol, and Anethole appeared less promising due to their multiple predicted toxicity risks and lower drug scores.

3.1.4. Overall Prediction - SwissADME, pkCSM, and OSIRIS:

Based strictly on the SwissADME, pkCSM, and OSIRIS results you provided, the compounds can be comparatively ranked by giving greater weight to overall ADME profile and safety, while considering drug-likeness and toxicity together. A compound with good absorption but significant predicted toxicity should not rank highly.

Overall Ranking- Selected phytoconstituents

Curcumin > Gingerol > Catechin > Apigenin > Kaempferol > Liquiritin > Barbaloin > Eugenol > Anethole > Camphor

Result Interpretation

Among the ten phytoconstituents, Curcumin ranked first because it demonstrated a favorable balance of physicochemical properties, high gastrointestinal absorption, no Lipinski violations, negative AMES

toxicity, low OSIRIS toxicity risks, and an acceptable drug score. Gingerol ranked second, showing particularly good intestinal absorption and a favorable safety profile.

Catechin ranked third because of its favorable SwissADME and OSIRIS profiles and the highest OSIRIS drug score (0.89); however, its positive AMES prediction and low Caco-2 permeability require consideration. Apigenin and Kaempferol showed favorable ADME characteristics but were downgraded because of predicted mutagenicity.

Eugenol, Anethole, and Camphor, despite showing good absorption, were ranked lower because of their multiple predicted toxicity risks. Camphor showed the least favorable overall profile, with high predicted risks for mutagenicity, tumorigenicity, irritancy, and reproductive toxicity and the lowest drug score (0.06).

- **Curcumin – 1st:** Best overall balance of ADME, high GI absorption, no Lipinski violations, negative AMES, low toxicity, and good drug score.
- **Gingerol – 2nd:** Excellent intestinal absorption and favorable safety profile.
- **Catechin – 3rd:** Favorable ADME/OSIRIS profile and highest drug score (0.89), but positive AMES and low Caco-2 permeability.
- **Apigenin & Kaempferol:** Good ADME properties but downgraded due to predicted mutagenicity.
- **Eugenol & Anethole:** Good absorption but lower ranking due to multiple predicted toxicity risks.
- **Camphor – Lowest:** High predicted mutagenicity, tumorigenicity, irritancy, and reproductive toxicity; lowest drug score (0.06).

4. CONCLUSION

The *in-silico* ADME, drug-likeness, and toxicity assessment demonstrated considerable variation among the selected phytoconstituents. Curcumin ranked first overall, showing a favorable balance of gastrointestinal absorption, ADME properties, Lipinski compliance, negative AMES prediction, low toxicity risk, and a good drug score. Gingerol ranked second, primarily due to excellent intestinal absorption and a favorable predicted safety profile. Catechin ranked third, with favorable ADME and OSIRIS characteristics and the highest drug score (0.89); however, its positive AMES prediction and low Caco-2 permeability reduced its overall suitability. Apigenin and kaempferol exhibited generally favorable ADME profiles but were downgraded because of predicted mutagenicity. Eugenol and anethole demonstrated good absorption but showed comparatively higher predicted toxicity risks. Camphor showed the least favorable profile, with predictions indicating mutagenicity, tumorigenicity, irritancy, and reproductive toxicity, together with the lowest drug score (0.06).

Overall, the in silico findings suggest that curcumin is the most promising phytoconstituent among the compounds evaluated, owing to its favorable pharmacokinetic profile, drug-likeness, and comparatively lower predicted toxicity. Gingerol and catechin also demonstrated potential, although specific limitations in permeability or toxicity predictions should be considered. The predicted mutagenic and toxicity concerns associated with apigenin, kaempferol, eugenol, anethole, and particularly camphor warrant further investigation before therapeutic consideration. These computational findings provide a useful basis for prioritizing phytoconstituents for subsequent experimental validation, but the predictions should be interpreted as preliminary and confirmed through appropriate in vitro and in vivo pharmacological, toxicological, and mechanistic studies.

Future Studies

Future studies should focus on molecular docking, in vitro, and in vivo validation of promising phytoconstituents such as curcumin, gingerol, and catechin. Their pharmacological activity, toxicity, pharmacokinetics, and molecular mechanisms should be further investigated. Ultimately, clinical studies are required to confirm their safety and therapeutic potential in PCOS.

References

1. Bhandari P, Adhikari G, Manandhar L, Kandel D. Polycystic Ovary Syndrome (PCOS): Causes, Symptoms, Diagnosis & Treatments. The American Journal of Patient Health Info. 2025 Apr 4;2(2).

2. Chan JL, Masini I, Pisarska MD. Polyendocrine metabolic ovarian syndrome (PMOS)/polycystic ovary syndrome (PCOS): current and future trends. The Journal of Clinical Investigation. 2026 Jun 15; 136(12).
3. Stańczak NA, Grywalska E, Dudzińska E. The latest reports and treatment methods on polycystic ovary syndrome. Annals of medicine. 2024 Dec 31; 56(1):2357737.
4. Saadati S, Mason T, Godini R, Vanky E, Teede H, Mousa A. Metformin use in women with polycystic ovary syndrome (PCOS): opportunities, benefits, and clinical challenges. Diabetes, Obesity and Metabolism. 2025 Jun;27: 31-47.
5. Karkera S, Agard E, Sankova L. The clinical manifestations of polycystic ovary syndrome (PCOS) and the treatment options. European Journal of Biology and Medical Science Research. 2023 Jan; 11(1):57-91.
6. Rani R, Priyanka YR, Bajal N, Mandal BS, Kumar A. Polycystic ovary syndrome (PCOS): from diagnosis to treatment. International Journal of Environment Agriculture and Biotechnology. 2024; 9(4):031-7.
7. Luo ED, Jiang HM, Chen W, Wang Y, Tang M, Guo WM, Diao HY, Cai NY, Yang X, Bian Y, Xing SS. Advancements in lead therapeutic phytochemicals polycystic ovary syndrome: A review. Frontiers in Pharmacology. 2023 Jan 9; 13:1065243.
8. Liu S, Wang R, Yu W, Shi C, Wang X, Liu A, Zhang L. Natural Products in the Metabolic and Endocrine Modulation of Polycystic Ovary Syndrome: Current Perspectives. Nutrients. 2026 Mar 18;18(6):964.
9. Daina A, Michielin O, Zoete V. SwissADME: a free web tool to evaluate pharmacokinetics, drug-likeness and medicinal chemistry friendliness of small molecules. Scientific reports. 2017 Mar 3; 7(1):42717.
10. Pires DE, Blundell TL, Ascher DB. pkCSM: predicting small-molecule pharmacokinetic and toxicity properties using graph-based signatures. Journal of medicinal chemistry. 2015 Apr 10; 58(9):4066.
11. Thomas Sander, Actelion Pharmaceuticals Ltd https://www.cheminfo.org/flavor/cheminformatics/Utility/Property_explorer/index.html
12. Sliwoski G, Kothiwale S, Meiler J, Lowe Jr EW. Computational methods in drug discovery. Pharmacological reviews. 2014 Jan 1; 66(1):334-95.
13. Bai A. Swiss ADME properties screening of the phytochemical compounds present in Bauhinia acuminata. Journal of Pharmacognosy and Phytochemistry. 2021 Jan 1.
14. Araujo NG, da Silva Junior FC, de Souza Santos LV, de Medeiros SR, Felzenszwalb I, Araújo-Lima CF. Molecular docking and in silico analysis of the pharmacokinetics, toxicological profile and differential gene expression of bioactive compounds from Cyrtopodium glutiniferum. Toxicology Reports. 2024 Dec 1; 13:101810.
15. Nalini CN, Deepthi SR, Ramalakshmi N, Uma G. Toxicity risk assesment of isatins. Rasayan Journal of chemistry. 2011; 4(4):829-33.
16. Rajendran S.S, Neelaveni Thangavel, Devanarayanan, Nisha R, Sabeer Ahamed P, Seenivasan K, Angalaparameswari S, Nandhini S, Anuyashika T. Int. J Pharm. Hea. care Res. Vol-15(1) 2026, 82–94.
17. Heshmati J, Moini A, Sepidarkish M, Morvaridzadeh M, Salehi M, Palmowski A, et al. Effects of curcumin supplementation on blood glucose, insulin resistance and androgens in patients with polycystic ovary syndrome: a randomized double-blind placebo-controlled clinical trial. Phytomedicine. 2021;80: 153395. doi:10.1016/j.phymed.2020.153395. PMID:33137599.
18. Asemi Z, Khorrami-Rad A, Alizadeh SA, et al. Effects of curcumin on body weight, glycemic control and serum lipids in women with polycystic ovary syndrome: a randomized, double-blind, placebo-controlled trial. Clin Nutr ESPEN. 2020;36: 128-133. doi:10.1016/j.clnesp.2020.01.005. PMID:32220355.

19. Ghanbarzadeh-Ghashti N, Ghanbari-Homaie S, Shaseb E, Abbasalizadeh S, Mirghafourvand M. The effect of curcumin on metabolic parameters and androgen level in women with polycystic ovary syndrome: a randomized controlled trial. BMC Endocr Disord. 2023;23: 40. doi:10.1186/s12902-023-01295-5. PMID:36788534.
20. Sudhakaran G, Gopi S, Priya S, Pachaiappan R, Soundharrajan I, Almutairi BO, et al. Apigenin regulates bisphenol-A induced polycystic ovarian syndrome (PCOS) symptoms in-vivo zebrafish. Reprod Sci. 2025;32(6):1912-1925. doi:10.1007/s43032-025-01845-3. PMID:40148704.
21. Cui X, Zhou S, Lin Y. Protective effects of liquiritin on polycystic ovary syndrome through modulating ovarian granulosa cell proliferation and apoptosis via miR-206/PI3K/AKT pathway. Cytotechnology. 2022;74(3):385-393. doi:10.1007/s10616-022-00531-5. PMID:35733703. Correction published 2025;77(3):97, doi:10.1007/s10616-025-00746-2.
22. Kokabiyan Z, Yaghmaei P, Jameie SB, Hajebrahimi Z. Therapeutic effects of eugenol in polycystic ovarian rats induced by estradiol valerate: a histopathological and a biochemical study. Int J Fertil Steril. 2022; 16(3):184-191. doi:10.22074/ijfs.2021.537724.1176. PMID:36029055.
23. Chakraborty K. Therapeutic implication of Aloe barbadensis Mill. (Aloe vera) for the management of polycystic ovarian syndrome (PCOS): a systematic review. J Biochem Int. 2022;9(1):22-26. doi:10.56557/jobi/2022/v9i17437.
24. Nejabati HR, Roshangar L. Kaempferol ameliorates PCOS by alleviating metabolic and endocrine abnormalities as well as oxidative stress. Steroids. 2026; 229:109767. doi:10.1016/j.steroids.2026.109767.
25. Jaiswal AK, et al. Note: Direct isolated-camphor anti-PCOS evidence could not be verified to the same standard as the other compounds. Therefore, camphor should be described as a candidate for exploratory in-silico screening, rather than as an established anti-PCOS phytochemical.
26. Pournaderi PS, Yaghmaei P, Khodaei H, Noormohammadi Z, Hejazi SH. The effects of 6-gingerol on reproductive improvement, liver functioning and cyclooxygenase-2 gene expression in estradiol valerate-induced polycystic ovary syndrome in Wistar rats. Biochem Biophys Res Commun. 2017; 484(2):461-466. doi:10.1016/j.bbrc.2017.01.057. PMID: 28093231.
27. Moradi Negahdari F, Hadjzadeh MA, Gholamnezhad Z, Sohrabi F, Samadi Noshahr Z. The protective effects of trans-anethole against polycystic ovary syndrome induced histopathological and metabolic changes in rat. Int J Fertil Steril. 2022; 16(3):192-199. doi:10.22074/ijfs.2021.532941.1148.
28. Shen W, et al. Effects of tea consumption on anthropometric parameters, metabolic indexes and hormone levels of women with polycystic ovarian syndrome: a systematic review and meta-analysis of randomized controlled trials. Front Endocrinol (Lausanne). 2021; 12:736867. doi:10.3389/fendo.2021.736867.