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ORIGINAL RESEARCH ARTICLE

In vivo analgesic, anti-inflammatory, sedative, muscle relaxant activities, and docking studies of 3',4',7,8-tetrahydroxy-3-methoxyflavone isolated from *Pistacia chinensis*

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ABSTRACT

Background: *Pistacia chinensis* is extensively employed in traditional medicine. This study aimed to isolate and evaluate the therapeutic effects of 3'4'78-tetrahydroxy-3-methoxyflavone from *P. chinensis* crude extract.
Materials and Methods: The study utilized column chromatography for isolation. The plant extract and its isolated compound were assessed for in vivo analgesic (hot plate model), anti-inflammatory (carrageenan-induced paw edema), sedative (open field model), and muscle relaxing properties (inclined plane and traction test).
Results: In the thermal-induced analgesic model, a significant analgesic effect was observed for the extract (25, 50, and 100 mg/kg) and the isolated compound (2.5, 5, 10, and 15 mg/kg) at higher doses. The extract (100 mg/kg) significantly prolonged latency time (21.98 seconds) after 120 minutes of administration. The isolated compound elevated the latency time (20.03 seconds) after 30 minutes, remaining significant up to 120 minutes with a latency time of 24.11 seconds. The anti-inflammatory effect showed a reduction in inflammatory reactions by 50.23% (extract) and 67.09% (compound) after the fifth hour of treatment. Both samples demonstrated significant sedative effects, with the extract hindering movement by 54.11 lines crossed compared to the negative control (180.99 lines). The isolated compound reduced the number of lines crossed to 15.23±SEM compared to the negative control. Both samples were also significant muscle relaxants. Docking studies indicated that the compound's therapeutic effect is due to inhibiting COX and nociceptive pathways.
Conclusion: The isolated compound from *Pistacia chinensis* exhibits significant analgesic, anti-inflammatory, sedative, and muscle relaxing properties, with potential therapeutic applications by inhibiting COX and nociceptive pathways.

Keywords: Anacardiaceae, Analgesic, Anti-inflammatory, In vivo, Muscle relaxant, *Pistacia chinensis*, Sedative

Introduction

Plants have been acknowledged for millennia as having direct therapeutic effects for treating common disorders (1,2). The etymology of the term *pistachio* can be traced back to its Avestan origin, precisely the word *pstk*, which translates to *pistag*. The term *pistachio* can also be traced back to the word *pista* in many languages, such as Persian and the early classical tongues of Central Asia (3,4). The Anacardiaceae (R.Br.) Lindl. family (order Sapindales) originally comprised 82 genera and 700 species of pantropical (tropical and subtropical) trees, shrubs, and lianas that secrete gums and resins (5). Recently included are 83 genera and 860 tree species (6).

The *kakra shringi* is the Chinese *Pistacia chinensis* variety *integerrima*. Located in the Himalayas from the Indus to Kumaon, this moderate-sized deciduous tree reaches heights of 18 m (7). The leaves and petioles of plants infested by the *Pemphigus* species of bug develop hard, horn-shaped, rugose, hollow galls (8). The crushed and dried galls possess

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a distinct aroma and flavor reminiscent of terebinth. The flavor profile of these items exhibits a sharp and slightly spicy taste reminiscent of terebinthine notes. Additionally, there is a subtle balsamic aroma present (9).

P. chinensis is a widespread *Pistacia* species found in Asia. Traditional applications of *P. chinensis* include wood, seed oil, ornamental uses, and folk remedies for detoxification, sore pharynx, and diarrhea (10). According to De Pooter et al (11), the primary chemical components of *P. chinensis* leaf essential oils grown in Egypt were trans-8-ocimene limonene. Two 3-3'-dimeric 4-phenyl dihydro coumarin compounds with estrogen-like activity were isolated from the twig extract of *P. chinensis* (12). The galls of *P. chinensis* are used in Ayurvedic medicine to treat a wide range of ailments, including but not limited to hiccups, asthma, chronic bronchitis, fever, vomiting in infants, skin diseases, psoriasis, snake bites, scorpion stings, and increased hunger (13). The plant has considerable therapeutic potential under its pharmacological activity and active constituents. The *P. integerrima* plant has captured the interest of researchers, and a wealth of literature is already available (14). Few studies explored particular aspects of *P. chinensis*. In Pakistan, hepatitis and liver disorders are treated with *P. chinensis* galls. There have been reports of its leishmanicidal (15), depressant (16), analgesic and anti-inflammatory (17), spasmolytic (18), and hyperuricemic (10) properties. Noureen et al (19) concluded that bioactive antioxidants found in the bark of *P. chinensis* could be a suitable source for isolating potent antioxidant compounds.

In addition to its therapeutic uses, *P. chinensis* has numerous applications in ecology and energy production, among others (19). *P. chinensis* oil, mostly fatty acids with 16 to 18 carbon chain lengths, is chemically identical to fossil diesel (C15 C19) (20). *P. chinensis* biodiesel meets EU, US, and Chinese light diesel standards (21). A compound with a chemical structure of 2-(3,4-dihydroxyphenyl)-7,8-dihydroxy-3-methoxy-4H-chromen-4-one compound derived from *P. chinensis* exhibits properties that can help regulate blood sugar levels and prevent glycation (22). *P. chinensis* isolated flavonoids have been shown to exhibit ENPP1 inhibition, which is a therapeutic intervention (23).

To date, only a limited number of flavones have been successfully commercialized, despite their potential as analgesics, sedatives, muscle relaxants, and anti-inflammatory agents. Considerable evidence exists regarding the potential toxicity and adverse effects associated with nearly all commercially available flavones. Hence, the present study was designed to investigate the potential in vivo analgesic, sedative, muscle relaxant, and anti-inflammatory properties of the compound 3',4',7,8-tetrahydroxy-3-methoxyflavone derived from *P. chinensis*. The aim was to determine if these effects could be achieved with minimal adverse effects, taking into consideration the traditional use of the plant.

Materials and methods

Plant collection

P. chinensis (Bunge) seeds were acquired from the University of Peshawar's botanical garden. Dr. Muhammad Ilyas, Department of Botany, University of Swabi, KP, Pakistan, identified the plant species delivered to the department. The specimen with the voucher number *Pistacia chinensis* was stored in the department's herbarium.

The obtained seeds were shade-dried for 20 days and washed with water to remove grit. After that, the desiccated grain was ground into a powder using a grinder. One kilogram of powdered plant material was immersed in methanol for 10 days to extract the most significant number of polar secondary metabolites. The obtained extract was concentrated at low temperature and pressure using a rotary evaporator, yielding 18.9 g of extract (2.11%).

Extraction and isolation

The seeds of *P. chinensis* were rinsed with water to remove dust. The washed seeds (8.32 kg) were pulverized using a machine to produce the powdered plant materials. The plant material was subjected to a 20-day cold extraction with methanol (10 mL). The extract was concentrated using a rotary evaporator under reduced temperature and pressure, yielding 112 g of crude extract. To remove the less polar compounds from the crude extract, it was defatted with n-hexane. The 22.2 g defatted crude extract was subjected to column chromatography, yielding compound 1 (Figure 1). Physical and spectroscopic data were compared to previously reported data to determine the isolated compound chemical structure (20,21,24).

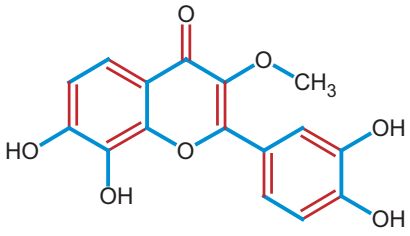

FIGURE 1 - The chemical structure of the isolated compound **1** from *Pistacia chinensis.*

Classification of animals

The BLAB/c mice of either sex weighing 23-27 g were obtained from the National Institute of Heath Islamabad, Pakistan. The animals were classified for the in vivo experiments as negative control (treated with normal saline, 10 mL/kg), positive control (treated with standard drug), and extract/compounds were administered to the tested groups. This study was approved by the ethical committee (SOU/Pharm-23), Department of Pharmacy, University of Swabi, KP, Pakistan, on January 15, 2023.

Analgesic screening

A hot plate analgesia meter was used to evolve the analgesic effect. Animals were classified as above. All the animals were tested on hot plates for positive responses. The animals were treated with extract or compound, and after 30 minutes of treatment, each animal was placed at the center of a

hot plate, and the time of stay on the hot plate was counted in seconds (latency time). The animal that stayed more than 25 seconds (cut-off time) was excluded from the study. The latency time was periodically observed at 30, 60, 90, and 120 minutes posttreatment (25). Tramadol was used as a standard drug.

Anti-inflammatory activity

After correctly classifying animals into the abovementioned categories, the negative control group was administered normal saline, and the positive control group was administered diclofenac sodium. The rest of the groups were treated with extract and isolated compound 1. After 30 minutes of these treatments, carrageenan (1%, 0.05 mL) was administered subcutaneously to the right hind paw of each animal. The induced inflammation was determined in the form of paw edema. This paw volume was measured regularly, and the anti-inflammatory effect percentage was calculated using the following formula:

$$\text{Percent effect} = \frac{A - B}{A} \times 100$$

where A and B represent the paw edema of the negative and positive control groups, respectively (26).

Sedative screening

Using our previously published paradigm, the open-field method was used to evaluate the sedative effect of the extract and the compound. The experimental room's soundproofing consisted of a wooden cage with equal space. The animals were categorized as described earlier, and the positive control group was administered diazepam (0.5 mg/kg). After 30 minutes of treatment with normal saline (negative control), diazepam (positive control), and extract/compound (tested groups), the sedative effect of each animal in the special wooden box was evaluated. The animal was deposited in the center of the box, and for 10 minutes, the number of lines it crossed was recorded. The greater the number of crossed lines, the less sedative the drug, and vice versa (27).

Muscle relaxant activity

Inclined plane and traction tests were used to determine muscle coordination potential. In the inclined plane test, a plane was designed with an angle of 65° on which an animal will slide. A metallic wire coated with rubber was used in case of traction test on which the animal will hang. After correctly classifying animals into various groups as above, the groups were appropriately treated with normal saline, diazepam, and extract/compound. After 30 minutes of these treatments, the animal's muscle coordination effect was checked on an inclined plan for 5 seconds and the hanging duration for 5 seconds. The sliding of animals within 5 seconds meant animals with relaxed muscles, and the passing of animals to hang with wire for 5 seconds reflects no muscle relaxation effect.

Docking

Interaction analysis via docking between receptors and ligands is essential for finding ligand inhibition patterns. We performed docking studies using MOE software version MOE 2016.0802 (Chemical Computing Group, Canada). Interactions of the new ligand and the superimposed co-crystallized ligand have been found.

Results

The extract and isolated compound were significantly analgesic in thermally induced algesia, as shown in Table 1. The analgesic effect of the extract (25, 50, and 100 mg/kg) and the isolated compound (2.5, 5, 10, and 15 mg/kg) was dose dependent. The extract (100 mg/kg) exhibited a significant ($p<0.01$) prolonged latency time (16.76 seconds) as

TABLE 1 - Analgesic effect of *Pistacia chinensis* crude extract and isolated compound

Group	Dose (mg/kg)	Time (minutes)			
		30	60	90	120
NS	10 mL	9.18 ± 0.06	9.19 ± 0.09	9.17 ± 0.10	9.20 ± 0.08
Tramadol	10	25.23 ± 0.07***	25.30 ± 0.13***	26.00 ± 0.15***	26.43 ± 0.12***
Extract	25	9.65 ± 0.90	13.98 ± 0.43	14.00 ± 0.27	13.90 ± 0.87
	50	12.43 ± 0.79	16.09 ± 0.66**	16.98 ± 0.64**	17.00 ± 0.54**
	100	14.76 ± 0.66	19.49 ± 0.65**	17.07 ± 0.43**	16.90 ± 0.23**
	250	16.76 ± 0.76**	21.65 ± 0.54***	22.24 ± 0.21***	21.98 ± 0.11***
Compound 1	2.5	11.76 ± 0.45	14.98 ± 0.54	15.00 ± 0.34	14.87 ± 0.39
	5	13.09 ± 0.66	17.34 ± 0.28**	17.98 ± 0.54**	17.32 ± 0.40**
	10	17.32 ± 0.55	20.87 ± 0.51***	20.98 ± 0.28***	20.07 ± 0.45***
	15	20.03 ± 0.45***	24.08 ± 0.55	24.65 ± 0.54***	24.11 ± 0.43***

ANOVA = analysis of variance; NS = normal saline, SEM = standard error of the mean.
***p<0.001, **p<0.01.
Data are presented as mean ± SEM. The level of statistical significance was calculated through GraphPad Prism using an ANOVA analysis test.

compared to negative control after 30 minutes of administration, and this effect remained significant (p<0.001) up to 120 minutes (21.98 seconds latency time) after administration. The isolated compound elevated the latency time (20.03 seconds) after 30 minutes where the effect remained significant up to 120 minutes with a latency time of 24.11 seconds.

The anti-inflammatory effect of the extract and compound is exhibited in Figure 2. The extract reduced the edema by 20.23% after 3 hours of administration and significantly by 50.23% after 5 hours of experimental duration. The isolated compound attenuated the inflammatory reactions up to 86.32% after 3 hours, and this anti-inflammatory process was improved by 67.09% after 5 hours of compound administration.

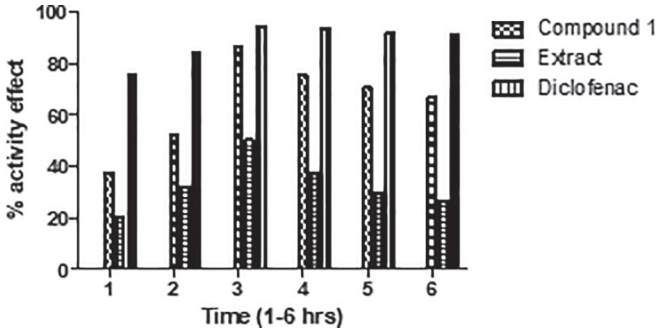

FIGURE 2 - Percentage of the anti-inflammatory effect of crude extract and isolated compound 1 of *Pistacia chinensis* on carrageenan paw in mice.

The crude extract and isolated compound from *P. chinensis* were found to be significant sedatives in the open-field model, as shown in Table 2. No sedative effect was observed in lower doses (25 and 50 mg/kg), while the higher doses (100 and 250 mg/kg) demonstrated significant (p<0.001) hindrance in the movement of animals. The isolated compound resulted in a more sedative effect as compared to the extract. The movement of animals was significantly (p<0.01) hindered (54.11 lines crossed as compared to the negative control – 180.99 lines crossed by animals). The isolated compound reduced the number of lines crossed up to 15.23 compared to the negative control.

TABLE 2 - Sedative activity of crude extract and isolated compound from *Pistacia chinensis*

Samples	Dose (mg/kg)	Number of lines crossed
NS	5 mL	180.99 ± 3.54
Diazepam	0.5	2.32 ± 0.43***
Extract	25	85.29 ± 3.33
	50	76.76 ± 3.09
	100	67.09 ± 2.64*
	250	54.11 ± 2.65**
Compound 1	2.5	45.24 ± 2.01**
	5	36.23 ± 1.77***
	10	25.09 ± 1.50***
	15	15.23 ± 1.32***

ANOVA = analysis of variance; NS = normal saline, SEM = standard error of the mean.
***p<0.001, **p<0.01.
Data are presented as mean ± SEM. The level of statistical significance was calculated through GraphPad Prism using the ANOVA analysis test.

The effect on muscle coordination of crude extract and isolated compound from *P. chinensis* is presented in Table 3. A significant muscle relaxant effect was noticed in both experimental models. Uniform muscle relaxation was noted dose-dependently and time-dependently. The extract (250 mg/kg) demonstrated a 42.88% and 43.56% effect in the inclined plane and traction model, respectively. The isolated compound exhibited up to 70% muscle relaxation at 15 mg/kg.

We also performed docking studies by using Molecular Operating Environment (MOE) software. Compound 3',4',7,8-tetrahydroxy-3-methoxyflavone isolated from *P. chinensis*

TABLE 3 - Muscle relaxant effect of crude extract and isolated compound from *Pistacia chinensis*

Group	Dose (mg/kg)	Inclined plane model (%)			Traction model (%)		
		30	60	90	30	60	90
NS	10 mL/kg	–	–	–	–	–	–
Diazepam	0.5	100 ± 0.0	100 ± 0.0	100 ± 0.0	100 ± 0.0	100 ± 0.0	100 ± 0.0
Crude extract	25	14.43 ± 3.02	20.43 ± 2.76	21.98 ± 2.00	15.23 ± 2.54	21.43 ± 2.87	22.06 ± 2.41
	50	20.98 ± 2.87	26.98 ± 2.80	27.55 ± 2.04	21.64 ± 2.89	27.98 ± 2.98	28.54 ± 2.47
	100	27.43 ± 2.88	33.98 ± 2.82	34.80 ± 2.76	28.09 ± 2.54	34.09 ± 2.93	34.87 ± 2.44
	250	34.54 ± 2.90	41.09 ± 2.66	42.88 ± 2.54	35.88 ± 2.34	43.09 ± 2.65	43.56 ± 2.56
Compound 1	2.5	41.67 ± 2.20	47.54 ± 2.12	48.54 ± 2.10	42.01 ± 2.11	47.99 ± 2.04	48.39 ± 3.01
	5	48.09 ± 2.80	55.87 ± 2.00	55.32 ± 2.11	49.32 ± 1.80	56.43 ± 2.13	56.91 ± 2.98
	10	56.43 ± 2.32	63.98 ± 2.34	63.98 ± 2.65	57.13 ± 1.90	64.36 ± 2.06	65.08 ± 2.662
	15	62.09 ± 2.77	68.33 ± 2.66	69.03 ± 2.90	62.78 ± 1.66	70.02 ± 2.08	70.98 ± 2.14

ANOVA = analysis of variance; NS = normal saline, SEM = standard error of the mean.
***p<0.001, **p<0.01.
Data are presented as mean ± SEM. The level of statistical significance was calculated through GraphPad Prism using the ANOVA analysis test.

(Anacardiaceae) docked in the binding sites of pain modulating and inflammatory receptors having PDB accession codes 1EQG, 1CX2, 4EJ4, 4DJH, 4DKL for COX-1, COX-2, DOR, KOR, and MOR (28-31).

Two-dimensional interaction plots of native ligand ibuprofen and isolated flavon in the binding sites of cyclooxygenase (COX)-1 are shown in Figure 3. Ibuprofen showed hydrogen bonding interaction with the receptor COX-1 (Fig. 3A). Isolated flavone interacts with COX-1 residues (Gly526, Ser530, Tyr355) and showed good interactions for inhibiting pain and inflammation modulation that includes one conventional hydrogen bond with residue Ser530, π-π interaction with residue Gly526, and amide-π stacking with residue Tyr355 (Fig. 3B).

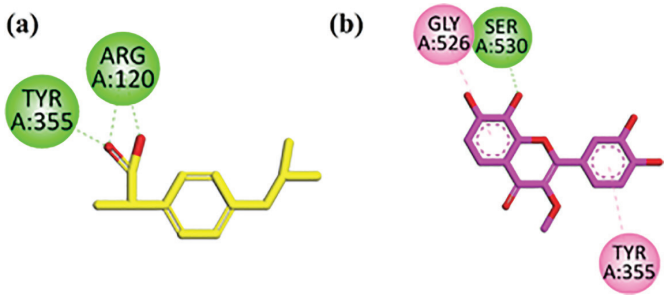

FIGURE 3 - A) Ibuprofen (co-crystalized native ligand) two-dimensional interaction plot in the cyclooxygenase-1 (COX-1) receptor binding site. **B)** Isolated compound 3',4',7,8-tetrahydroxy-3-methoxyflavone two-dimensional interaction plot in the COX-1 receptor.

Two-dimensional interaction plots of native ligand SC-558 and isolated compound in the binding site of COX-2 are shown in Figure 4. SC-558 inhibitor has good hydrogen bonding interaction with the receptor COX-2 (Fig. 4A). Isolated flavone interacts with the COX-2 receptor and showed five conventional hydrogen bond interactions with residues Tyr385, Leu352, His90, Arg120, and Tyr355, which enhance the ligand-inhibiting efficacy (Fig. 4B).

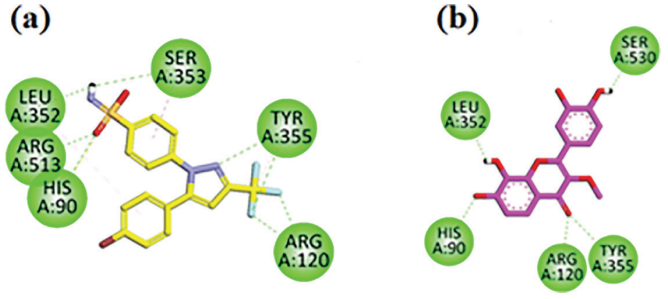

FIGURE 4 - A) SC-558 (co-crystalized native ligand) two-dimensional interaction plot in the cyclooxygenase-2 (COX-2) receptor binding site. **B)** Isolated flavone two-dimensional interaction plot in the COX-2 receptor binding site.

Two-dimensional interaction plots of native ligand naltrindole and isolated compound in the binding site of delta opioid receptor (DOR) are shown in Figure 5. Naltrindole has good interactions such as conventional hydrogen bonding interaction and π-sulfur with the DOR (Figure 5A). Isolated compound flavone interacts with the DOR by residues Met132, His278, Asp128, Ile304 and exhibited three conventional hydrogen bonds with residues His278, Asp128, Ile304 and a π-sulfur interaction with residue Met132 (Figure 5B).

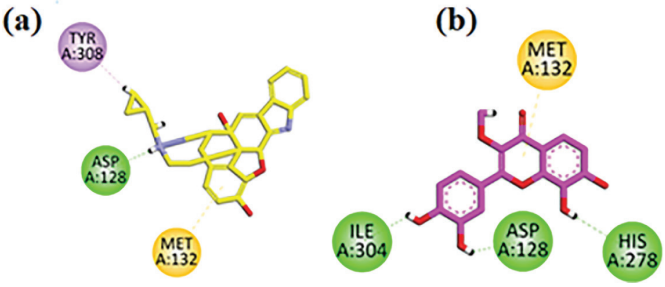

FIGURE 5 - A) Naltrindole (co-crystalized native ligand) two-dimensional interaction plot in the delta opioid receptor (DOR) receptor binding site. **B)** Isolated flavone two-dimensional interaction plot in the DOR binding site.

Two-dimensional interaction plots of native ligand JDTic and isolated compound in the binding site of kappa opioid receptor (KOR) are shown in Figure 6. JDTic inhibitor has good interactions such as conventional hydrogen bonding, π-π stacking, and π-sulfur interaction with KOR (Figure 6A). Isolated flavone interacted with KOR residues (Met142, His291, Tyr312, Tyr139) and showed three conventional hydrogen bonds with residues His291, Tyr312, Tyr139 and π-sulfur interaction with residue Met142 (Figure 6B).

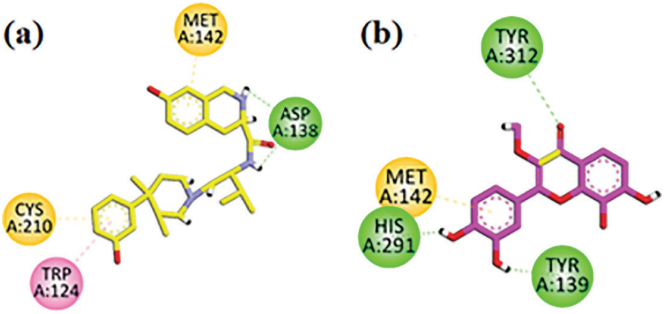

FIGURE 6 - A) JDTic (co-crystallized native ligand) two-dimensional interaction plot in the kappa opioid receptor (KOR) receptor binding site. **B)** Isolated flavone two-dimensional interaction plot in the KOR binding site.

Two-dimensional interaction plots of native ligand (b-FNA) and isolated compound in the binding site of mu opioid receptor (MOR) are shown in Figure 7. The co-crystalized ligand has good interactions, such as conventional hydrogen bonding and π-sulfur interaction with the MOR (Figure 7A). Isolated compound interacts with MOR binding site residues Val300, Asp147, Tyr326, Asn150, and His297 and showed good interactions for inhibiting pain, euphoria, sedation, and respiratory depression receptors, which included three conventional hydrogen bonds with residues Asp147, Asn150, His297, π-π stacking with residue Tyr326, and π-sigma interaction with residue Val300 (Figure 7B).

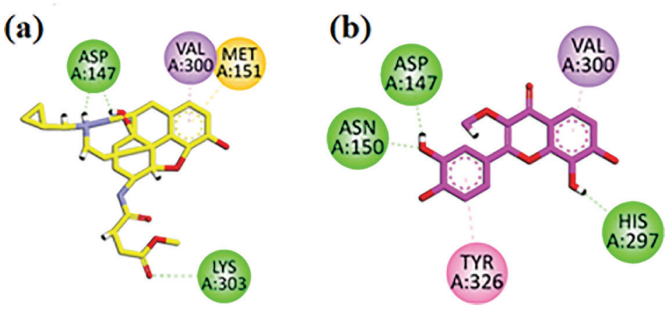

FIGURE 7 - A) b-FNA (co-crystalized native ligand) two-dimensional interaction plot in the mu opioid receptor (MOR) receptor binding site. **B)** Isolated compound two-dimensional interaction plot in the MOR binding site.

Discussion

The search for new, safe and effective economical drug candidates is challenging for medicinal chemists in the modern era. The pain, inflammation, and insomnia are treated with various drug regimens, and each of these analgesic, anti-inflammatory, and sedative drugs has mild or significant side effects. Due to these side effects, patient compliance is declining, and ultimately, the patient seeks an alternative therapeutic agent. This switching of therapeutic options leads to therapy failure. Therefore, searching for a safe and effective drug molecule is essential. The present study was conducted to find a suitable drug molecule from *P. chinensis.* This medicinal plant is used locally to treat pain, inflammation (31), fever, and depression (10). To provide a scientific background to this folklore, the crude extract and isolated compound of *P. chinensis* were tested for analgesic, anti-inflammatory, and muscle coordination effects. The extract and isolated constituent demonstrated a significant analgesic effect in the thermal-induced pain model. This pain model is used to find central analgesic potential (32). The prolongation of latency time by extracting and isolating molecules reflects the central analgesic potential. The central analgesic pathway is attributed to the stimulation of opioid receptors (25). Once these inhibitor receptors link with inhibitor proteins and are stimulated with ligand, the neurotransmitters' (substance p) release is blocked, and pain sensation is diminished. The results of the hot plate indicate that the extract or compound might be agnostic for opioid receptors. The samples to be tested also attenuated the induced paw edema in the inflammatory model. This attenuation of induced paw edema by inflammatory mediators (carrageenan) indicates the COX inhibitory potential. The extract and compound also proved to be a sedative following previous studies (33). The muscle relaxation effect is also a promising adjuvant with analgesic and anti-inflammatory effects.

Docking studies were performed for the isolated compound against COX-1,2, DOR, KOR, and MOR, and their interactions were also compared with native co-crystalized ligands of each receptor. Analgesic drugs help to reduce the pain and are also called painkillers. In our current study, we performed analgesic and anti-inflammatory in vivo activity by keeping the tramadol and diclofenac as standard drugs. Results showed that isolated compounds have good analgesic and anti-inflammatory effects. COX receptors synthesize prostaglandins, prostanoids, and thromboxane, which cause inflammation and pain. COX receptor inhibition helps to get relief from pain and inflammation. COX-1 and COX-2 are the two COX receptors. Opioid receptors belong to the seven transmembrane G protein-coupled receptors (GPCRs). Opioid receptors are known for mediating the hormones and neurotransmitters. Opioid receptors are also the primary target for anti-analgesics, anti-inflammatory drugs, antidepressants, sedatives, and muscle relaxant medications. Opioid receptors are extensively dispersed in the central and peripheral nervous systems (CNS and PNS). Opioid receptors are classified as delta, kappa, and mu opioid receptors.

In our current study, the experimental results showed that the isolated compound has a significant sedative and muscle relaxant effect. We performed docking studies on two forms of COX (COX-1, COX-2) and three opioid receptors (delta, kappa, and mu). Isolated flavone from *P. chinensis* (Anacardiaceae) showed strong interactions with COXs. In the binding site of COX-1, the compound exhibited one hydrogen bond formed with residue Ser530, π-π interaction with Gly526, and amide-π stacking with residue Tyr355. In contrast, the isolated flavone interacted with two critical residues (His90 and Leu352) in the COX-2-specific binding site. The computed crucial energy values for isolated flavone in the binding sites of COX-1 and COX-2 are −6.374 and −7.019 kcal/mol, respectively. These values showed that it predominantly inhibited COX-2. However, it may be classified as a non-selective COX inhibitor. Isolated flavone also exhibited strong interactions with all studied opioid receptors. The calculated binding energy values for DOR, KOR, and MOR are −6.2942, −6.7136, and −6.6148 kcal/mol, respectively. Docking studies on COX isoforms and opioid receptors showed that the compound exerts its therapeutic effect by inhibiting COX and nociceptive pathways.

P. chinensis extract and isolated compound exhibited potent analgesic, anti-inflammatory, sedative, and muscle relaxant properties. Consequently, our findings justify using *P. chinensis* extract and isolated compounds to treat numerous diseases. The discovery of novel pharmaceutical products will result from the detailed mechanism studies conducted for drug discovery**.** Docking studies on COX isoforms and opioid receptors showed that the compound exerts its therapeutic effect by inhibiting COX and nociceptive pathways.

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Disclosures

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