

Comparative Neuropharmacological Evaluation of Two Herbs (Rosemary and Basil) with Culinary, Medicinal, and Cultural Significance

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Abstract

Background: Rosemary (*Rosmarinus officinalis*) is a perennial herb, while basil (*Ocimum basilicum*) is an annual herb. Both are utilized in culinary practices and have antioxidant as well as anti-inflammatory properties. However, their neuroprotective role remains to be elucidated.

Objectives: This study was carried out to explore the neuroprotective potential of these herbs in the Swiss Albino mouse model.

Materials and Methods: The investigation focused on evaluating the impact of their extracts on anxiety levels and motor performance using a comprehensive set of behavioral assays, including the hot plate analysis, acetic acid-induced writhing analysis, various neuropharmacological tests such as anxiolytic effects, staircase, traction, writhing, the effect of the inclined plane and forced swimming. *O. basilicum* exhibited dose-dependent analgesic effects, enhanced locomotor activity, and improved motor function.

Results: *R. officinalis* showed potential analgesic properties but exhibited decreasing motor function and potential depressive-like effects. Both herbs demonstrated concentration-dependent antioxidant potential. This exploration into the neuropharmacology of rosemary and basil holds promise for the broader field of natural product pharmacology.

Conclusion: The identification of bioactive compounds of these plants and the elucidation of their specific mechanisms in neural behavior are proposed. This may open avenues for the development of targeted treatments as well as complementary therapies.

Keywords

Behavioral assay, neuroprotection, *Ocimum basilicum*, *Rosmarinus officinalis*, Swiss mouse

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Introduction

Herbs have played a vital role in human culture for centuries. They are liked not just for the flavors they bring to our food but also for their incredible healing qualities. Among these botanical treasures, rosemary (Rajendran, 2016) and basil (Verma et al., 2023) stand out for their diverse applications in traditional medicine and modern healthcare. Basil originates from India and has an extensive history in Ayurvedic medicine (Khan, 2023). It is famous for its healing properties and consists of more than a hundred bioactive compounds (comprising vitamins, minerals, electrolytes, and phytonutrients) (da Costa et al., 2015; Marwat et al., 2011). The chemical profile of *O. basilicum* comprises anthocyanins, reducing sugars, anthraquinones, glycosides, tannins, flavonoids, amino acids, and volatile oils (Shahrajabian et al., 2020). The

aqueous extract of *O. basilicum* comprises antioxidants along with compounds having anti-cancer properties (Manikandan et al., 2021; Nadeem et al., 2022). Rosemary extract is rich in compounds like rosmarinic and carnosic acid, carnosol, betulinic acid, and medioresinol (Ribeiro-Santos et al., 2015), whereas its essential oil contains α -pinene, 1,8-cineole, (–)-bornyl acetate, β -pinene, thujene, camphor, and eucalyptol (Arranz et al., 2015; Teixeira et al., 2013). Its flavor profile is derived from a variety of compounds (~100

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constituents), including monoterpene hydrocarbons, sesquiterpene hydrocarbons, oxygenated monoterpenes, and sesquiterpenes (Dhifi et al., 2016; Nieto, 2017).

Rosemary has a history of medicinal usage, offering treatment for ailments including digestive problems, headaches, and respiratory issues (Ahmed & Babakir-Mina, 2020; Faridzadeh et al., 2022). Basil, including varieties like sweet and holy basil, is valued for its adaptogenic properties, enhancing well-being and stress resilience (Makri & Kintzios, 2008; Shahrajabian et al., 2020). One of the primary medicinal attributes of rosemary and basil lies in their potent antioxidant properties (Salamatullah et al., 2021). Both herbs are rich in polyphenols, flavonoids, and essential oils that exhibit strong antioxidant activity (Diniz do Nascimento et al., 2020). These compounds neutralize free radicals, reducing oxidative stress and inflammation. Their antioxidant potential also aids in preventing and managing chronic diseases like cardiovascular issues and certain cancers (Chakrabartty et al., 2022; Zuzarte et al., 2023). Both herbs have also demonstrated notable anti-inflammatory effects attributed to their bioactive components (Becer et al., 2023; Garnier & Shahidi, 2021; Kamelnia et al., 2023). Traditional uses of rosemary and basil as natural antimicrobial agents are proven by modern research (Salamatullah et al., 2021). Essential oils derived from these herbs have shown antimicrobial activity against various pathogens, including bacteria and fungi (Ciotea et al., 2021; Liu et al., 2017). This characteristic has historically supported their use in food preservation and highlights their potential for developing antimicrobial agents (El-Saber Batiha et al., 2021; Saeed et al., 2016). Rosemary and basil have also been explored for their cardiovascular benefits (Patrignani et al., 2021).

The anti-inflammatory properties of these herbs are especially significant for managing arthritis and inflammatory bowel diseases (Lippert & Renner, 2022; Rubió et al., 2013). The impact of rosemary and basil on neurological health has been a subject of growing interest in recent research (Qneibi et al., 2024). Both herbs have shown promise in enhancing cognitive function and mitigating neurodegenerative processes (Abd Rashed et al., 2021; Agatonovic-Kustrin et al., 2019; Liang et al., 2023). Rosemary, in particular, has been associated with improved memory and concentration. The extract has demonstrated both anti-aging effects and wound-healing properties, aiding in tissue repair and rejuvenation (Ibrahim et al., 2022). Basil, known for its varied chemotypes, has been studied for its potential neuroprotective effects, particularly against neurodegenerative conditions such as Alzheimer's disease (Gradinariu et al., 2015; Karthika et al., 2022; Singh et al., 2023). Ethyl-acetate and *n*-hexane extracts have shown anticonvulsant effects and neuroprotective properties against oxidative damage caused by pentyl-enetetrazol (Mansouri et al., 2022). Rosemary extract, in conjunction with arsenic, demonstrated a beneficial impact by alleviating oxidative stress and reducing hematological parameters (Osman et al., 2020).

This study sought to thoroughly examine the neuropharmacological properties of these plant extracts, aiming to provide a deeper understanding of their effects on neural health and opening avenues for further progress in the development of natural neuroprotective agents.

Materials and Methods

Basil (*Ocimum basilicum*) and rosemary (*Rosmarinus officinalis*) leaf specimens were confirmed by Professor Dr. Abdulrahman Alsoqeer (Plant Production and Protection Department, Qassim University, Saudi Arabia). Reagents included analytical grade ethanol, methanol, diazepam, 0.1 mM solution of 2,2-diphenyl-1-picrylhydrazyl (DPPH) in methanol, distilled water, mortar and pestle, filter paper, centrifuge tubes, normal saline solution, diclofenac sodium, naloxone, tramadol, ascorbic acid/vitamin C (reference antioxidant) (0.9% NaCl). All equipment and glassware were thoroughly cleaned and sterilized. 20 g of dried and powdered leaves of each herb underwent successive extraction using a 1:10 w/v ratio with absolute ethanol (da Silva et al., 2022). The extraction process was conducted utilizing a Soxhlet-type apparatus. A rotary evaporator was used to vacuum evaporate the solvent (Yeddes et al., 2022). The resultant samples were then stored in dark-colored vials in nitrogen gas (4°C) to mitigate the risk of phenolic compound oxidation.

Thermal Nociception Assessment Using a Hot Plate

The welfare and humane treatment of the animals were prioritized throughout the experiment. Swiss albino (Bagg albino laboratory-bred/c (BALB/c)) mice (both male and female; weight: 18–22 g) were used for the hot plate test. Efforts were made to minimize any potential distress or discomfort, and appropriate measures were implemented to ensure their well-being. The mice were kept under standard environmental conditions, including a temperature of $22 \pm 3^\circ\text{C}$, relative humidity of $14 \pm 1\%$, and a 12-h light/dark cycle, with free access to food and water. An initial test was conducted using a hot plate with a temperature of $55 \pm 0.1^\circ\text{C}$, and mice with a latency time (the duration a mouse remained on the hot plate without licking, flicking its hind limbs, or jumping) >15 s were excluded from the analysis (Muhammad et al., 2012). The remaining mice were allocated into eight groups. Group I received a saline treatment (10 mL/kg), Group II was administered Tramadol® (30 mg/kg, intraperitoneally), and Groups III, IV, and V were given intraperitoneal doses of the plant extract at 100, 200, and 300 mg/kg, respectively. After half an hour, the mice were placed on a hot plate, and their latency time (in seconds) was recorded (Hafizh et al., 2021). A cutoff time of 30 s was established for all animals to prevent tissue damage. To examine the opioidergic mechanism underlying the analgesic effects of *O. basilicum* and *R. officinalis* herbal

extracts, Groups VI and VII were given naloxone (0.5 mg/kg s.c.) and treated with *O. basilicum* and *R. officinalis* extracts (200 and 300 mg/kg, i.p.) after 10 min. Group VIII was given Tramadol (30 mg/kg i.p.) following a 10-min interval after naloxone injection. Latency times for all groups were recorded at 30-min intervals: 0, 30, 60, 90, and 120 min, and % analgesia was calculated as: $(\text{Test latency} - \text{control latency}) / (\text{Cutoff time} - \text{control latency}) \times 100$ (Reche et al., 1996).

Pain Sensitivity Assessment Using Acetic Acid

Before the commencement of pain sensitivity assessment, all animals underwent a 2-h fasting period, during which they were withdrawn from food. The animals were divided into five groups. Group I received an injection of normal saline (10 mL/kg) as the control. Group II was administered the standard drug, diclofenac sodium (10 mg/kg). At the same time, Groups III, IV, and V were injected intraperitoneally with 100, 200, and 300 mg/kg of *O. basilicum* and *R. officinalis* herbal extracts, respectively. After half an hour of saline/plant extract or diclofenac sodium injection, the animals were given 1% acetic acid intraperitoneally. Writhes were counted 5 min after the acetic acid administration and recorded over 10 min (De la Puente et al., 2015).

Motor Coordination Assessment

The staircase test was conducted as described previously (Alnasser, 2023). A stair structure consisting of five identical steps, each measuring $2.5 \times 10 \times 9 \times 7.5$ cm, was positioned on a raised surface. The inclined plane test was conducted on a similar group of mice and used two plywood boards, connected in such a way that one acted as the base while the other was positioned at a 65° angle relative to the base (Abid et al., 2006). Six mice were put in control, standard, and each treated group. Controls were given distilled water (10 mL/kg). The standard group was given diazepam (1 mg/kg), and the treated groups were administered varying doses of *O. basilicum* and *R. officinalis* herbal extracts (0.3, 0.4, and 0.5 g/kg body weight). After a 30-min treatment, the mice were placed on an elevated staircase, where their behavior was tracked. Counting was done for the number of times they reared up during a 3-min observation and climbed how many steps. Feces and urine were cleaned from the staircase between trials (Muhammad et al., 2013). For the inclined plane, the animals were placed on the higher section of the plane and observed for half a minute to determine whether they could hang on or fall from the surface.

Muscular Strength and Grip Coordination Test

A rubber-coated metal wire was used to assess traction (Ilahi et al., 2021). Mice groups received treatments at various time points (as mentioned in Section 2.3). During the test, each

animal was suspended by its hind legs from the wire, and the duration of hanging was recorded (for a 5-s interval). If an animal failed to hang <5 s, it was considered an indication of muscle relaxation. In contrast, successful hanging for the full 5-s duration was interpreted as an absence of muscular relaxation effects, suggesting increased muscular strength.

Depression Assessment Using Forced Swim Test

The antidepressant effects of the extract were assessed using the forced swim test (FST). All mice were trained to swim in a designated bath (size: $42 \times 19 \times 19$ cm; water temperature: $25 \pm 2^\circ\text{C}$; box depth: 15 cm) prior to the experiment (Lim et al., 2016). The animals were also acclimated to the laboratory setting before the experiment. This included dim red lighting and soundproofing. The mice were then divided into five groups: a control group, a standard group treated with fluoxetine, and three groups that received different doses of herbal extracts (as outlined in section 2.3). Following their treatments, the mice were allowed to swim for 6 min. The duration of immobility was documented during the final 4 min of the swimming session.

Antioxidant Activity Assessment

This was done using the DPPH radical scavenging assay, following established procedures outlined in the literature (Gulcin & Alwasel, 2023). Vitamin C was used as the positive control. The capacity of the various extracts, fractions, and standards to donate hydrogen atoms or electrons was evaluated by monitoring the decolorization of a purple methanol solution of DPPH. Replicates were performed for each experiment. A 1 mM solution of DPPH radical was prepared in methanol, with 1 mL of this solution mixed with 3 mL of the sample solutions (ranging from 10 to 100 μg for different fractions and 5 to 100 μg for pure compounds) as well as a control without any sample. The mixture was kept in the dark for half an hour, and then absorbance was measured (at 517 nm). Lower absorbance of the DPPH solution means a higher scavenging of the DPPH radicals. The percentage of DPPH radical scavenging activity was calculated using the formula: $\% \text{ DPPH} = (\text{OD control} - \text{OD sample}) \times 100 / \text{OD control}$.

Results

Thermal Nociception

At a dose of 0.25 mg/kg of *O. basilicum*, the animals displayed varied responses over the observation periods (Table 1). For instance, at 0 min, the latency ranged from 8.2 to 9.5 s across the three animals. As time progressed, there was a trend of increased latencies at 30, 60, 90, and 120 min, suggesting a potential cumulative effect of the administered dose. This pattern indicates a dose-dependent impact on the thermal nociception, with higher doses potentially leading to

Table 1. Latency Responses to Thermal Stimulus for *O. basilicum* and *R. officinalis* at 0.25 mg/kg Dose Over Various Time Intervals.

Test Compound	Dose 5 mg/kg	Animals	0 min/s	30 min/s	60 min/s	90 min/s	120 min/s
<i>O. basilicum</i>	0.25	1	8.2	12.1	9.6	8.9	7.3
		2	8.7	12.4	10.3	9.1	8.3
		3	9.5	12.7	11.2	9.3	8.1
<i>R. officinalis</i>	0.25	1	7.2	11.5	7.6	6.1	5.4
		2	8.4	11.8	8.8	7.4	7.9
		3	7.9	12.7	10.4	8.1	7.2

Table 2. Latency Responses in Mice to Acetic Acid-induced Wreathing. Mean Values for Readings Measured at Various Time Points are Given.

Test Compound	Dose 5 mg/kg	Mice	No. of Wreathing
<i>R. officinalis</i>	0.25	1	25
		2	28
		3	21
<i>O. basilicum</i>	0.25	1	12
		2	20
		3	16

increased latency, signifying an analgesic or pain-relieving effect. Similarly, *R. officinalis* also demonstrated dose-dependent effects on thermal nociception. At a dose of 0.25 mg/kg, the latencies varied at each time point, reflecting individual variations in the mice's responses. The trend over time indicates that higher doses of *R. officinalis* may lead to increased latency, suggesting a potential analgesic effect.

Pain Sensitivity Assessment

For both herbs, at a dose of 0.25 mg/kg, the number of writhing responses varied among individual mice (1, 2, and 3), ranging from 21 to 28 for *R. officinalis* and 12 to 20 for *O. basilicum* (Table 2). There was a noticeable variability in the response among the mice, suggesting individual differences in pain sensitivity.

Motor Coordination Assessment

O. basilicum exhibited more significant activity in terms of rearing and stairs ascending and descending compared to *R. officinalis* across all time intervals (Table 3). The behavioral patterns suggest a potential neuropharmacological effect of *O. basilicum* on locomotor activity and exploratory behavior.

The hanging time for *O. basilicum* showed a decrease from 30 to 60 min and then a slight increase at 90 min (Figure 1). This suggests a potential behavioral effect that needs further investigation. The hanging time for *R. officinalis* shows a decrease from 30 to 60 min, followed by stability at 90 min. Overall, both *O. basilicum* and *R. officinalis* herbal

extracts exhibited hanging times greater than 30 s in the inclined plane analysis compared to the control group. The longer hanging time seen in all mice treated with plant extracts suggests an enhancement in muscle endurance and neuromuscular coordination.

Grip Coordination

There was a consistent increase in traction force from 30 to 90 min for *O. basilicum* extract. This suggests that this herb may have a cumulative effect on motor function over time. A decrease in traction force from 60 to 90 min for *R. officinalis* extract indicates a potential diminishing effect over time for the two groups (Table 4). It is important to note the decline in force as it may suggest fatigue or adaptation. The biphasic responses also hint at complex interactions and potential adaptation mechanisms. The observed changes in traction force suggest that both *O. basilicum* and *R. officinalis* may have an influence on motor function in the tested animals.

Depression Assessment

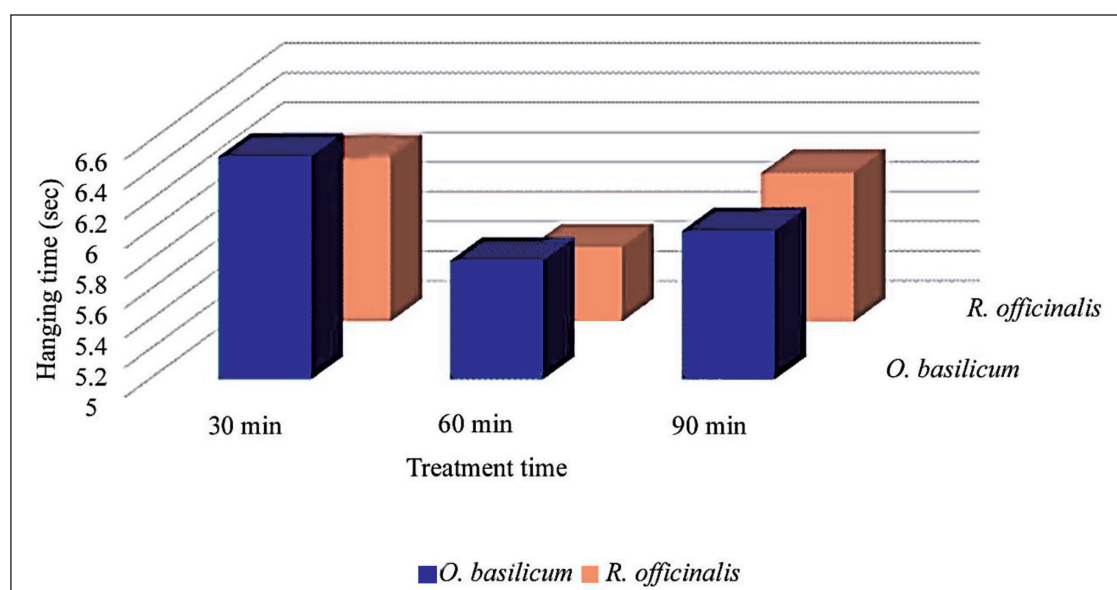
In the FST, increased time of immobility is considered an indicator of a potential depressive-like state in animals. Lower immobility times may suggest antidepressant-like effects. The immobility time was recorded for individual animal groups ($n = 3$) within each treatment category (Table 5). Animal groups treated with *R. officinalis* generally exhibit higher immobility times compared to those treated with *O. basilicum*. The longer immobility times in the *R. officinalis* groups may imply a potential depressive-like effect. In comparison, the shorter immobility times in the *O. basilicum* groups may suggest a relatively lower susceptibility to a depressive-like state.

Antioxidant Potential

The standard antioxidant exhibits high inhibition across all concentrations, reaching maximum inhibition at 80 and 100 $\mu\text{g/mL}$. The antioxidant potential of *O. basilicum* increased with higher concentrations (Table 6). It showed a substantial increase in inhibition from 10 to 60 $\mu\text{g/mL}$, with the maximum inhibition observed at 100 $\mu\text{g/mL}$. The antioxidant potential of *R. officinalis* also increased with

Table 3. Behavioral Responses in Experimental Animals, Including the Number of Rearing and Stairs Ascended and Descended.

Test Comp	Dose 5 mg/kg	Experiment Replicate	30 min/No. of Rearing	30 min/ Stairs Up and Down	60 min/No. of Rearing	60 min/ Stairs Up and Down	90 min/No. of Rearing	90 min/ Stairs Up and Down
<i>O. basilicum</i>	0.250	1	7	7	3	0	3	8
		2	9	6	0	2	2	5
		3	6	5	1	1	4	6
<i>R. officinalis</i>	0.250	1	2	0	0	0	0	0
		2	2	1	2	0	1	0
		3	3	2	1	0	2	0

**Figure 1.** Illustration of the Extract Treatment Duration for Mice on the x-axis, with Hanging Time and 30-s Intervals Represented on the y-axis.

concentration. It demonstrated a notable increase in inhibition from 10 to 60 $\mu\text{g/mL}$, reaching maximum inhibition at 87.23% at 100 $\mu\text{g/mL}$.

Discussion

R. officinalis is an aromatic evergreen shrub of the Lamiaceae family with needle-like leaves, thriving in arid conditions. *O. basilicum*, also in this family, has broad green leaves and a pleasant aroma. Both are widely cultivated and climate-adaptable (Dhama et al., 2021; Sharma & Modi, 2023). The potential anxiolytic and antidepressant effects of rosemary and basil have captured the attention of researchers exploring natural remedies for mental health disorders (Ali et al., 2017; Machado et al., 2009). Preliminary studies suggest that they may modulate neurotransmitter levels, influencing mood and anxiety. Their neuropharmacological effects were investigated in this study through a series of behavioral and

biochemical assessments. At a dose of 0.25 mg/kg of *O. basilicum*, the mice exhibited varying responses in thermal nociception, with increased latencies over time. This dose-dependent impact suggests a potential analgesic effect. This dose is significantly lower than a previous study in Swiss mice, where the tail immersion test showed a distinct nociceptive effect at 200 mg/kg compared to aspirin (Bilal et al., 2012). The difference may be attributed to the varied techniques. Apart from this, its oil has also demonstrated analgesic activity at doses around 50 mg/kg, possibly due to the inhibition of cyclooxygenase activity and suppression of pain mediator biosynthesis (Umamageswar & Kudagi, 2015). The antinociceptive effect of *O. basilicum* flower volatile oil has previously been investigated in adult zebrafish, with oral administration at different concentrations (0.25, 1.25, or 2.5 mg/mL). The hydro-distilled volatile oil, mainly composed of linalool (>50%), showed no acute toxicity or behavioral effects, suggesting its pharmacological potential in treating acute pain by moderating the opioid system

Table 4. Traction Force Measurements for Mice Treated with *O. basilicum* and *R. officinalis*.

Test Compound	Dose 5 mg/kg	Animal Groups	30 min/s	60 min/s	90 min/s
<i>O. basilicum</i>	0.250	1	5.8	6.1	6.4
		2	5.9	5.9	6
		3	5.2	5.6	6.1
<i>R. officinalis</i>	0.250	1	5.6	6.1	5.9
		2	5	5.3	5.8
		3	6.1	5.6	6

Table 5. Forced Swim Test Results for *O. basilicum* and *R. officinalis*.

Test Compound	Dose 5 mg/kg	Animal Groups	30 sec/min
<i>O. basilicum</i>	0.250	1	3.22
		2	3.31
		3	3.52
<i>R. officinalis</i>	0.250	1	3.31
		2	4
		3	3.42

alongside other receptors (Batista et al., 2021). The *O. basilicum* herbal extract in the mouse model has demonstrated promising results in pain relief. Bae et al. (2020) have suggested that this mediation is potentially through the delta- and mu-opioid pathways. *R. officinalis* has exhibited a dose-dependent trend in thermal nociception, suggesting analgesic potential. Its oil has shown agonistic effects on $\alpha 1$ and $\alpha 2$ adrenergic receptors, enhancing circulation and reducing pain in guinea pigs (Sagorchev et al., 2010). Additionally, the antinociceptive properties of rosemary ethanolic extract have been shown to be comparable to tramadol or acetylsalicylic acid in rodent models of arthritic pain (González-Trujano et al., 2007).

O. basilicum appears to have a stimulatory effect on locomotor activity, as evidenced by higher rearing and stairs ascending and descending. Previously, Seyed et al. (2021) conducted a comprehensive review highlighting the potential therapeutic benefits of *O. basilicum* L. along with its bioactive components, including their neuroprotective efficacy on various signaling pathways, suggesting a promising role in neurodegenerative diseases. Analysis of hanging time exhibited a decline for *O. basilicum* from 30 to 60 min, succeeded by a slight upturn at 90 min, suggesting potential induction of muscular strength. Related species like *O. sanctum* and *O. tenuiflorum* have been associated with muscle recovery (Prakash & Gupta, 2005), while antispasmodic effects and muscle relaxant activity have been observed for *O. basilicum* (Zahra et al., 2015). However, further exploration is needed to investigate the specific impact on muscular strength. *R. officinalis* showed minimal behavioral changes, indicating

a potentially less pronounced impact on locomotor activity. *R. officinalis* also exhibited a decrease in hanging time from 30 to 60 min, stabilizing at 90 min. Rosemary essential oil has shown decreased creatine kinase (muscle-damaging agent) after leg curl exercise (Rezaee et al., 2020). Carnosol in the herb has been shown to induce muscular hypertrophy (Morel et al., 2021). Several patents highlight the significance of this herb as a complementary approach in sports medicine for addressing issues such as sore muscles, muscle and ligament injuries, sprains, strains, bruises, spasms, tendinitis, tendon rupture, and cartilage and joint injuries (Nakisa, 2022).

The FST results indicated that animal groups treated with *R. officinalis* exhibited longer immobility times compared to *O. basilicum*-treated groups. Immobility is considered a passive coping strategy and is interpreted as a measure of behavioral despair, reflecting a state of “giving up” in response to a stressful situation (Armario, 2021). Longer immobility times may suggest a potential depressive-like effect for *R. officinalis*, while shorter immobility times in *O. basilicum*-treated groups may indicate a lower susceptibility to a depressive-like state. Machado et al. (2012) demonstrated that an extract of *R. officinalis* L., similar to fluoxetine, alleviates depression without impairing learning abilities in olfactory bulbectomized mice. This is probably arbitrated by contact with the monoaminergic system (Machado et al., 2009). In *O. basilicum*-treated mice, the dose may need to be increased to achieve the anti-depressive impact as there is evidence of its antidepressant activity in mice models of chronic unpredictable mild stress (Ali et al., 2017). Both plant extracts exhibit concentration-dependent antioxidant activity, with higher concentrations showing increased free radical inhibition. *O. basilicum* showed a substantial increase in inhibition from 10 to 60 $\mu\text{g/mL}$, reaching maximum inhibition at 100 $\mu\text{g/mL}$. Previously, it has demonstrated a notable mitigation of oxidative damage initiated by monosodium glutamate, as demonstrated through the T-maze test carried out on mice (Badiana et al., 2021). This effect was marked by a reduction in malondialdehyde levels and an increase in the concentrations of catalase, glutathione, and superoxide dismutase, indicating potential antioxidative and neuroprotective properties of the herb. Similarly, *R. officinalis* demonstrated increased inhibition with higher concentrations, reaching maximum inhibition at 87.23% at 100 $\mu\text{g/mL}$. Hence, the extracts

Table 6. Antioxidant Potential of *O. basilicum* and *R. officinalis* Extracts.

Samples	Test Concentration					
	10 µg/mL	20 µg/mL	40 µg/mL	60 µg/mL	80 µg/mL	100 µg/mL
Standard	91.09	92.22	92.61	93.45	96.01	96.23
<i>O. basilicum</i>	14.09	24.23	31.65	55.30	66.32	79.76
<i>R. officinalis</i>	18.23	30.37	37.20	65.23	76.81	87.23

demonstrate significant antioxidant potential, particularly at 100 µg/mL, although the efficacy varies. *R. officinalis* has formerly demonstrated elevated levels of lipid peroxidation in erythrocytes and reduced basal antioxidant activity in diabetic rats. However, the combination of rosemary extract and endurance exercise in diabetic rats has demonstrated the potential to mitigate oxidative stress through an upsurge in antioxidant enzyme activities along with diminished lipid peroxidation (Nazem et al., 2015).

The study largely aligns with previously reported findings, highlighting the analgesic and antioxidant potential. However, the observed variations in behavioral responses underscore the need for a nuanced understanding of the multifaceted effects of these herbal extracts. While this study enhances the understanding of the neuropharmacological and antioxidant properties of *O. basilicum* and *R. officinalis*, its broader implications should be interpreted with caution. Variations in herbal preparations, extraction methods, and dosages could influence outcomes, introducing potential confounders. The use of animal models may not precisely replicate human responses (Shrestha et al., 2020), limiting the generalizability of the results of this study. Additionally, behavioral assessments, though informative, provide indirect insights into complex neuropharmacological mechanisms, warranting further elucidation. Exploring the molecular pathways involved and conducting human clinical trials could bridge the translational gap and enhance the applicability of these findings.

Conclusion

In conclusion, the comprehensive investigation into the neuropharmacological and antioxidant properties of *O. basilicum* and *R. officinalis* extracts provides valuable insights into their potential therapeutic benefits. The hot plate analysis results suggest that both *O. basilicum* and *R. officinalis* may possess analgesic properties, as indicated by the increased latency to respond to the thermal stimulus. *O. basilicum* exhibited dose-dependent analgesic effects, enhanced locomotor activity, and improved motor function over time. *R. officinalis* demonstrated potential analgesic properties but displayed decreasing motor function and potential depressive-like effects. Both herbs exhibited concentration-dependent antioxidant potential. These findings underscore the complex and varied neuropharmacological and antioxidant attributes of *O. basilicum* and *R. officinalis*, emphasizing the need for further research

to elucidate their specific mechanisms and optimize therapeutic applications.

Abbreviations

BALB/c: Bagg albino laboratory-bred/c; DPPH: 2,2-Diphenyl-1-picrylhydrazyl; FST: Forced swim test; i.p.: Intraperitoneal; mg/kg: Milligrams per kilogram; mL/kg: Milliliters per kilogram; mM: Millimolar; nm: Nanometers; OD: Optical density.

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Declaration of Conflicting Interests

The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethical Approval

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Informed Consent

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