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***In vitro* Radical Scavenging and Anti-inflammatory Potentials of Combined Aqueous Extracts of *Curculigo pilosa* (African crocus) and *Gladiolus murielae* Rhizomes (Peacock Lily)**

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ABSTRACT: Oxidative stress and inflammatory processes have been linked to the development of several chronic diseases. The use of medicinal plants, particularly those containing rhizomes, as sources of antioxidants and anti-inflammatories has gained significant attention. Therefore, the objective of this paper was to assess the *in-vitro* radical scavenging and anti-inflammatory potentials of combined aqueous extracts of *Curculigo pilosa* (African crocus) and *Gladiolus murielae* (Peacock Lily) using appropriate standard methods with Combined aqueous rhizomes extracts ratios of 6:0, 5:1, 4:2, 3:3, 2:4, 1:5 and 0:6 respectively for *Curculigo pilosa* (African crocus) and *Gladiolus murielae* (Peacock Lily). Diclofenac sodium was used as standard. The combined extracts were concentration-dependent activities. Combination 4:2 showed lowest IC₅₀ values for 2,2'-Azino-bis(3-ethylbenzothiazoline-6-sulfonic acid) [ABTS] (70.62 µg/mL ± 9.15), 2,2-Diphenyl-1-picrylhydrazyl [DPPH] (90.92 µg/mL ± 10.92), Hydroxyl [OH] (58.63 µg/mL ± 9.99) and Nitric oxide [NO] scavenging (84.86 µg/mL ± 17.95), whereas 5:1 combination had highest Membrane stabilizing (83.10 µg/mL ± 13.86), Heat-induced hemolysis inhibition [HIH] inhibitory (118.60 µg/mL ± 21.31) and Protein denaturation inhibitory (148.7 µg/mL ± 18.25) activities. The individual extract of *Curculigo pilosa* was the most potent in most parameters. The combined aqueous extracts of *C. pilosa* and *G. murielae* rhizomes exhibited a high radical scavenging and anti-inflammatory activity with the 5:1 and 4:2 combinations showing an optimal synergistic effect. This study provides the first scientific evidence of synergistic antioxidant and anti-inflammatory effects of combined aqueous rhizome extracts of *C. pilosa* and *G. murielae*, validating their traditional co-use and identifying optimal combination ratios for potential therapeutic application.

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Oxidative stress, an imbalance between reactive oxygen species (ROS) production and cellular antioxidant defenses, drives chronic diseases including diabetes mellitus, cardiovascular diseases, neurodegenerative disorders, and cancer (Lobo *et al.*, 2010). ROS such as superoxide anion, hydroxyl, and

nitric oxide damage cells through lipid peroxidation and protein oxidation (Pisoschi and Pop, 2015). Closely linked to this, inflammation amplifies ROS generation, contributing to metabolic syndrome, arthritis, and other degenerative conditions (Mishra *et al.*, 2012). Conventional antioxidant and anti-

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inflammatory agents are often accompanied by adverse effects, limited efficacy, and prohibitive costs, especially in developing countries (Newman and Cragg, 2016). As a consequence, there has been renewed interest in medicinal plants as sources of bioactive compounds (Newman and Cragg, 2016). Rhizomes are especially abundant in phenolic acids, flavonoids, alkaloids and terpenoids (Dai and Mumper, 2010). *Curculigo pilosa* Schumacher and Thonn. (Hypoxidaceae family), known as 'Epakun' by the Yoruba of Nigeria, is used traditionally to treat inflammation, wounds and infections; saponins, phenolics and flavonoids with antioxidant, immunomodulatory and anti-inflammatory properties have been reported (Misra and Mujumdar, 2011).

Gladiolus murielae (Iridaceae family) which is known as 'Baka' in Yoruba, contains bioactive compounds in its corms and rhizomes, and related *Gladiolus* species have antimicrobial, antioxidant and wound healing activities due to their phenolic and flavonoid content (Dai and Mumper, 2010). Synergistic interactions could improve the efficacy of combination plant therapy, but no scientific studies have been done on combination extracts of *C. pilosa* and *G. murielae* rhizomes (Wagner and Ulrich-Merzenich, 2009; Zhou *et al.*, 2016).

The present study, therefore, aimed at bridging this gap by systematically evaluating the in vitro radical scavenging and anti-inflammatory potentials of combined aqueous extracts of *C. pilosa* and *G. murielae* rhizomes at multiple ratios *in-vitro* assays, in order to provide scientific justification for their traditional co-use and to identify the optimal combination ratios for potential therapeutic application.

MATERIALS AND METHODS

Reagents and Chemicals: 2,2'-Azino-bis (3-ethylbenzothiazoline-6-sulfonic acid) diammonium salt (ABTS), 2,2 diphenyl-1-picrylhydrazyl (DPPH), butylated hydroxytoluene (BHT), diclofenac sodium, and bovine serum albumin (BSA) were products of Sigma-Aldrich (St. Louis, MO, USA). All other reagents were of analytical grade.

Plant Material: Fresh rhizomes of *C. pilosa* and *G. murielae* were sourced from Ojatuntun, Ilorin West, Kwara State, Nigeria. Botanical authentication was conducted at the Plant Biology Department, University of Ilorin (voucher number UILH/001/1809/2025). The rhizomes were thoroughly washed, diced, and air-dried at room temperature to preserve phytochemical integrity. After drying, samples were pulverized and

stored in airtight containers to prevent moisture uptake prior to extraction.

Membrane Stabilization Activity: Red blood cell (RBC) membrane stabilization was performed per Shinde *et al.*, with modifications by using rat blood. Blood was mixed with equal volumes of Alsever's solution, centrifuged at 3000 rpm for 10 minutes, washed thrice with isosaline (0.85% w/v NaCl), and reconstituted as a 10% v/v suspension. Reaction mixture: 50 µL extract (7.81–1000 µg/mL), 100 µL phosphate buffer (pH 7.4), 200 µL hyposaline (0.36% w/v NaCl), and 50 µL RBC suspension, incubated at 37 °C for 30 minutes and centrifuged at 8000 rpm for 3 minutes. Supernatant (100 µL) absorbance was read at 560 nm with diclofenac sodium as standard.

Extract Preparation: Cold maceration was employed to maximize extraction of water-soluble constituents. Each powdered sample (400 g) was immersed in 4000 mL distilled water (1:10 w/v) for 72 hours at room temperature with intermittent agitation to enhance solute diffusion. The resulting mixtures were filtered through Whatman No. 1 filter paper. Filtrates were lyophilized and stored at 4 °C to maintain stability. Combined extracts were formulated at defined *C. pilosa*:*G. murielae* ratios (5:1, 4:2, 3:3, 2:4, 1:5 w/w), as well as individual extracts (6:0 and 0:6). Stock solutions were freshly reconstituted in distilled water to the required concentrations for each assay.

ABTS Radical Scavenging Assay: Following Pellegrini *et al.*, with modifications: ABTS (7 mM) was reacted with potassium persulfate (2.45 mM) in the dark for 16 hours, then diluted with methanol to an absorbance of 0.70 ± 0.05 at 734 nm. In a 96-well plate, 25 µL sample was added to 200 µL working solution, incubated 30 minutes at room temperature, and absorbance read at 734 nm (Multiskan™ Spectrophotometer, Thermo Fisher Scientific, Waltham, MA, USA). BHT was used as positive control. Percentage inhibition was calculated as shown in Equation 1.

$$\% \text{ Inhibition} = [(A_{\text{control}} - A_{\text{extract}}) / A_{\text{control}}] \times 100 \quad (1)$$

Where A_{control} = absorbance of control; A_{extract} = absorbance of extract

DPPH Radical Scavenging Assay: Per Badami *et al.*, with modifications: stock solutions (10 mg/100 mL) were serially diluted to 10, 20, 40, 60, 80, and 100 µg/mL. Ascorbic acid served as standard. Reaction mixture: 1 mL of 0.3 mM DPPH (methanol) added to 2.5 mL sample, incubated 15 minutes at 37 °C; absorbance measured at 517 nm (Shimadzu UV-1700,

Kyoto, Japan). Percentage inhibition was calculated as shown in Equation 2.

$$\% \text{ Inhibition} = [(A_{\text{blank}} - A_{\text{test}}) / A_{\text{blank}}] \times 100 \quad (2)$$

Where A_{blank} = absorbance of blank; A_{test} = absorbance of test sample

Hydroxyl Radical Scavenging Assay: Extracts (7.81–1000 µg/mL) were incubated with 0.25 mL of 2 mM EDTA-Fe²⁺, 0.25 mL of 3% H₂O₂, and 2.25 mL of sodium phosphate buffer (150 mM, pH 7.4) for 30 minutes. Extracts were then centrifuged at 7450 rpm for 5 minutes and absorbance was measured at 520 nm with BHT as standard.

Nitric Oxide Scavenging Assay: Per Liu *et al.*, 50 µL extract (7.81–1000 µg/mL) was mixed with 20 µL of 10 mM sodium nitroprusside in phosphate buffered saline (pH 7.4) and 130 µL phosphate buffered saline, incubated at 37 °C for 30 minutes. Then 50 µL of 2% sulfanilamide in 20% glacial acetic acid was added (5 minutes), followed by 50 µL of 0.1% naphthyl ethylenediamine dihydrochloride (30 minutes). Absorbance was read at 550 nm with BHT as standard.

Protein Denaturation Inhibitory Activity: Per Padmanabhan and Jangle and Elias and Rao with modifications: 1 mL of extract or diclofenac sodium at 100, 200, 500, or 1000 µg/mL was mixed with 1 mL of 5% BSA and incubated at 27 °C for 15 minutes. Denaturation was induced at 70 °C for 10 minutes; after cooling, absorbance was measured at 660 nm in triplicate. Distilled water/BSA served as control.

Statistical Data Analysis: Data were presented as mean ± standard deviation of three replicates (n = 3). IC₅₀ and RS₅₀ values were determined using GraphPad Prism 10 (GraphPad Software, San Diego, CA, USA).

RESULTS AND DISCUSSION

This study assessed the radical scavenging and anti-inflammatory properties of combined aqueous extracts of *C. pilosa* and *G. murielae* rhizomes using complementary *in vitro* assays, with both individual and combined extracts demonstrating notable bioactivity.

Radical Scavenging Activities: *In vitro* antioxidant potentials of combined aqueous extracts of *C. pilosa* and *G. murielae* rhizomes are shown in Figure 1.

ABTS: *C. pilosa* was most potent, followed by the 4:2, 3:3, and 5:1 combination; *G. murielae* was moderate. BHT gave an RS₅₀ of 61.63 µg/mL (Figure 1A).

DPPH: The 3:3 combination was best (RS₅₀ = 66.49 µg/mL), followed by *G. murielae* (77.49 µg/mL) and 2:4 combination (79.08 µg/mL). BHT gave RS₅₀ = 92.24 µg/mL (Figure 1B).

Hydroxyl Radical: The 4:2 combination was best (RS₅₀ = 58.63 µg/mL), outperforming *C. pilosa* alone (73.01 µg/mL) and BHT (86.28 µg/mL). The 5:1 combination gave 77.36 µg/mL; *G. murielae* was moderate (95.21 µg/mL) (Figure 1C).

Nitric Oxide: The 5:1 combination was most potent (RS₅₀ = 54.63 µg/mL), followed by 3:3 (54.69 µg/mL), *C. pilosa* (71.55 µg/mL), and 4:2 (84.86 µg/mL). *G. murielae* gave 150.3 µg/mL; BHT gave 136.9 µg/mL (Figure 1D).

In terms of radical scavenging, the ABTS assay, which measures electron/hydrogen-atom donation to the ABTS⁺ radical cation (Pisoschi and Pop, 2015), showed *C. pilosa* as most potent (RS₅₀ = 67.63 µg/mL), comparable to BHT, with the 5:1 combination also performing well (79.05 µg/mL), consistent with the hydrogen-donating capacity of phenolic antioxidants (Kedare and Singh, 2011). DPPH scavenging was greatest in the 3:3 combination (RS₅₀ = 66.49 µg/mL), reflecting the reducing properties of phenolics and flavonoids (Mishra *et al.*, 2012). More remarkably, the 4:2 combination surpassed *C. pilosa* alone in hydroxyl radical scavenging (RS₅₀ = 58.63 vs. 73.01 µg/mL), indicating true synergy. This is significant because hydroxyl radical is among the most reactive ROS, causing lipid peroxidation and damage to DNA, proteins, and membranes, with roles in diabetes, cardiovascular, and neurodegenerative diseases (Pacher *et al.*, 2007). Furthermore, since excess NO from iNOS reacts with superoxide to generate peroxynitrite, a potent mediator of tissue injury (Pacher *et al.*, 2007; Sharma *et al.*, 2007), the observed NO scavenging suggests additional protection against peroxynitrite-driven oxidative damage. These activities are consistent with the phenolic acids, flavonoids, and saponins reported in *Curculigo* (Misra and Mujumdar, 2011) and the phenolic compounds and flavonoid glycosides of *Gladiolus* (Dai and Mumper, 2010), which act through radical scavenging, metal chelation, and enzyme modulation (Dai and Mumper, 2010). Figure 1: Radical scavenging potentials of combined aqueous extracts of *Curculigo pilosa* and *Gladiolus murielae* rhizomes (CAECPGMR). A: ABTS; B: DPPH; C: OH; D: Nitric oxide; CPRAE: *Curculigo pilosa* Rhizome Aqueous Extract; GMRAE: *Gladiolus murielae* Rhizome Aqueous Extract; CPR: GMR: *Curculigo pilosa* ratio *Gladiolus murielae* Rhizomes in

varying ratios. The RS_{50} Values for Radical Scavenging Assays are shown in Table 1

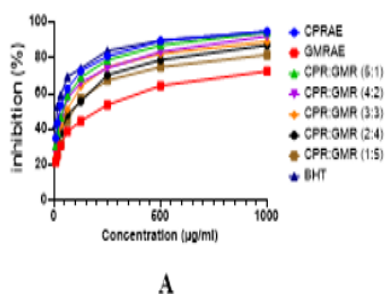


Fig. 1a: Radical scavenging potentials of combined aqueous extracts of *Curculigo pilosa* and *Gladiolus murielae* rhizomes for 2,2'-Azino-bis (3-ethylbenzothiazoline-6-sulfonic acid) diammonium salt (ABTS)

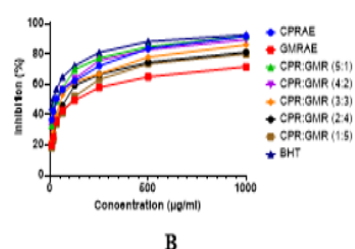


Fig. 1b: Radical scavenging potentials of combined aqueous extracts of *Curculigo pilosa* and *Gladiolus murielae* rhizomes for 2,2-diphenyl-1-picrylhydrazyl (DPPH)

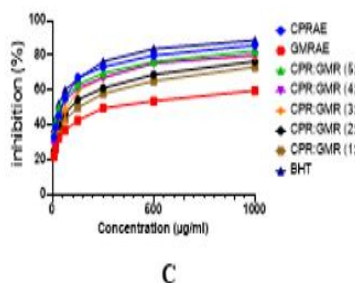


Fig. 1c: Radical scavenging potentials of combined aqueous extracts of *Curculigo pilosa* and *Gladiolus murielae* rhizomes for Hydroxyl (OH)

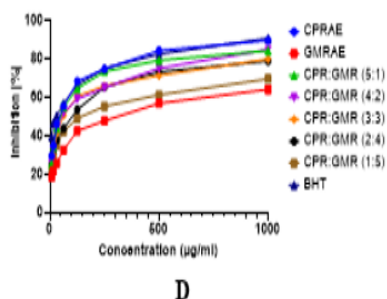


Fig. 1d: Radical scavenging potentials of combined aqueous extracts of *Curculigo pilosa* and *Gladiolus murielae* rhizomes for Nitric oxide

Anti-inflammatory Activities: All combined extracts inhibited inflammatory markers in a dose-dependent manner (Figure 2).

Membrane Stabilization: The 5:1 combination had the lowest IC_{50} (83.10 $\mu\text{g/mL}$), followed by 3:3 (83.68 $\mu\text{g/mL}$) and 4:2 (89.69 $\mu\text{g/mL}$). Diclofenac gave $IC_{50} = 115.30 \mu\text{g/mL}$ (Figure 2A).

Heat-Induced Hemolysis: *C. pilosa* was most protective ($IC_{50} = 80.68 \mu\text{g/mL}$), followed by 4:2 (94.21 $\mu\text{g/mL}$) and 3:3 (95.41 $\mu\text{g/mL}$). The 5:1 combination gave 118.60 $\mu\text{g/mL}$; diclofenac gave 108.40 $\mu\text{g/mL}$ (Figure 2B).

Protein Denaturation Inhibition: *C. pilosa* was most potent ($IC_{50} = 65.57 \mu\text{g/mL}$), followed by 3:3 (85.14 $\mu\text{g/mL}$), *G. murielae* (89.71 $\mu\text{g/mL}$), and 4:2 (99.39 $\mu\text{g/mL}$). The 5:1 gave 148.70 $\mu\text{g/mL}$; diclofenac gave 127.40 $\mu\text{g/mL}$ (Figure 2C). Regarding anti-inflammatory activity, membrane stabilization by the extracts suggests inhibition of lysosomal enzyme release, a key anti-inflammatory mechanism (Lobo *et al.*, 2010), likely through phytochemical interaction with membrane phospholipids (Zhou *et al.*, 2016).

The inhibition of heat-induced protein denaturation is particularly relevant to conditions like rheumatoid arthritis, where denatured proteins act as auto-antigens driving inflammatory responses (Sharma *et al.*, 2007), and protection against heat-induced hemolysis further reinforces the membrane-stabilizing capacity of these extracts (Wagner and Ulrich-Merzenich, 2009). Across combinations, the 5:1 (*C. pilosa*: *G. murielae*) ratio consistently matched or exceeded *C. pilosa* alone, with *C. pilosa* clearly the dominant bioactive contributor and *G. murielae* playing a supportive role. As the latter's proportion increased from 5:1 to 1:5, potency generally declined.

Synergy, where the combined effect exceeds the sum of individual contributions through complementary or multi-target mechanisms (Wagner and Ulrich-Merzenich, 2009; Zhou *et al.*, 2016), was most evident in hydroxyl radical scavenging. Several combinations also performed within the same order of magnitude as BHT and diclofenac, supporting clinical relevance.

Natural products generally offer lower toxicity, better tolerability, and greater affordability over synthetic drugs, particularly in resource-limited settings (Newman and Cragg, 2016), and their multi-targeted action may be advantageous in conditions involving both oxidative stress and inflammation.

Table 1: Summary of RS₅₀ Values (µg/mL) for Radical Scavenging Assays

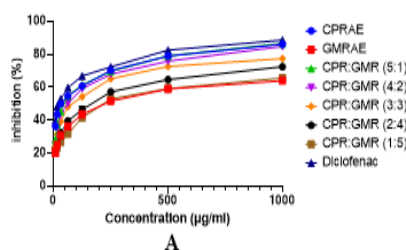
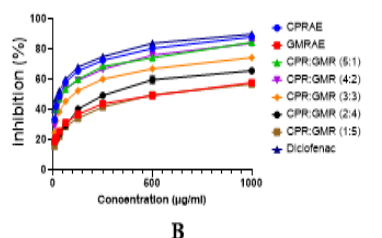
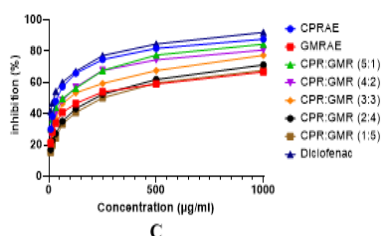
Extract/Assay	ABTS (µg/mL)	DPPH (µg/mL)	OH (µg/mL)	NO (µg/mL)
CPRAE	67.63 ± 6.19	167.20 ± 25.57	73.01 ± 4.38	71.55 ± 5.70
GMRAE	179.10 ± 19.10	77.49 ± 10.35	95.21 ± 12.41	150.30 ± 15.65
CPR: GMR (5:1)	79.05 ± 5.33	80.84 ± 9.13	77.36 ± 11.24	54.63 ± 3.82
CPR: GMR (4:2)	70.62 ± 9.15	90.92 ± 10.92	58.63 ± 9.98	84.86 ± 17.95
CPR: GMR (3:3)	77.72 ± 5.53	66.49 ± 9.78	97.40 ± 17.26	54.69 ± 6.51
CPR: GMR (2:4)	111.70 ± 10.78	79.08 ± 4.55	86.03 ± 12.13	119.90 ± 9.35
CPR: GMR (1:5)	98.45 ± 5.91	108.20 ± 8.27	111.50 ± 16.70	92.49 ± 14.49
STND (BHT)	61.63 ± 8.65	92.24 ± 6.21	86.28 ± 9.74	136.90 ± 13.90

ABTS: 2,2'-Azino-bis (3-ethylbenzothiazoline-6-sulfonic acid) diammonium salt (ABTS); DPPH: 2,2-diphenyl-1-picrylhydrazyl; OH: Hydroxyl radical scavenging; NO: Nitric oxide scavenging; STND: Standard (BHT). Values are expressed as mean ± SD of triplicate determinations (µg/mL).

Table 2: Summary of IC₅₀ Values (µg/mL) for Anti-inflammatory Activities

Extract/Assay	MSA (µg/mL)	HHI (µg/mL)	PD (µg/mL)
CPRAE	147.50 ± 24.02	80.68 ± 25.57	65.57 ± 11.85
GMRAE	120.80 ± 21.69	170.50 ± 10.35	89.71 ± 19.17
CPR: GMR (5:1)	83.10 ± 13.86	118.60 ± 10.93	148.70 ± 21.31
CPR: GMR (4:2)	89.69 ± 14.84	94.21 ± 10.92	99.39 ± 18.63
CPR: GMR (3:3)	83.68 ± 9.64	95.41 ± 9.78	85.14 ± 14.30
CPR: GMR (2:4)	156.50 ± 14.82	192.80 ± 4.55	163.40 ± 11.65
CPR: GMR (1:5)	167.70 ± 11.57	205.80 ± 8.27	152.50 ± 28.80
STND (Diclofenac)	115.30 ± 21.60	108.40 ± 6.21	127.40 ± 12.29

MSA: Membrane stabilization activity; HHI: Heat-induced hemolysis inhibition; PD: Protein denaturation inhibition; STND: Standard (Diclofenac sodium). Values are expressed as mean ± SD of triplicate determinations (µg/mL).

**Fig. 2a:** Anti-inflammatory potentials of combined aqueous extracts of *Curculigo pilosa* and *Gladiolus murielae* rhizomes for Membrane Stabilization**Fig. 2b:** Anti-inflammatory potentials of combined aqueous extracts of *Curculigo pilosa* and *Gladiolus murielae* rhizomes for Heat-Induced Hemolysis**Fig. 2c:** Anti-inflammatory potentials of combined aqueous extracts of *Curculigo pilosa* and *Gladiolus murielae* rhizomes for Protein Denaturation Inhibition

The study is limited by its *in vitro* design, which cannot replicate *in vivo* pharmacokinetics, and the absence of phytochemical characterization. Future work should include HPLC-MS/MS or LC-ESI-MS profiling, bioassay-guided fractionation, *in vivo* validation, and pharmacokinetic and toxicological assessment toward clinical evaluation. The study is limited by its *in vitro* design, which cannot replicate *in vivo* pharmacokinetics, and the absence of phytochemical characterization. Future work should include HPLC-MS/MS or LC-ESI-MS profiling, bioassay-guided fractionation, *in vivo* validation, and pharmacokinetic and toxicological assessment toward clinical evaluation.

Conclusions: Combined aqueous extracts of *C. pilosa* and *G. murielae* rhizomes demonstrate significant radical scavenging (ABTS, DPPH, hydroxyl, nitric oxide) and anti-inflammatory (membrane stabilization, protein denaturation inhibition, heat-induced hemolysis protection) activities. *C. pilosa* alone was most potent overall; the 5:1 and 4:2 combinations showed optimal synergistic effects, particularly in hydroxyl radical scavenging. These findings support the traditional use of these plants and their therapeutic potential in oxidative stress- and inflammation-related disorders. Phytochemical characterization, *in vivo* validation, and safety assessment are warranted.

DECLARATIONS

Ethical Approval: This study did not involve human participants or animal experimentation and therefore

did not require formal ethical approval. All procedures involving data handling and analysis were conducted responsibly and in accordance with standard academic and institutional guidelines.

Disclaimer on Artificial Intelligence usage: Author(s) hereby declare that no generative Artificial Intelligence (AI) technologies such as Large Language Models (ChatGPT, COPILOT, XLNet, Ernie 3.0 Titan etc) and text-to-image generators have been used during writing or editing of this manuscript.

Declaration of Conflict of Interest: The authors declare that there is no conflict of interest regarding the publication of this study.

Declaration of Data Availability Statement: The data supporting the findings of this study are available from the corresponding author upon reasonable request.

REFERENCES

- Dai, J; Mumper, RJ (2010). Plant phenolics: Extraction, analysis and their antioxidant and anticancer properties. *Molecules*. 15(10): 7313–7352. DOI: <https://doi.org/10.3390/molecules15107313>
- Kedare, SB; Singh, RP (2011). Genesis and development of DPPH method of antioxidant assay. *J. Food Sci. Technol.* 48(4): 412–422. DOI: <https://doi.org/10.1007/s13197-011-0251-1>
- Lobo, V; Patil, A; Phatak, A; Chandra, N (2010). Free radicals, antioxidants and functional foods: Impact on human health. *Pharmacognosy Rev.* 4(8): 118–126. DOI: <https://doi.org/10.4103/0973-7847.70902>
- Mishra, K; Ojha, H; Chaudhury, NK (2012). Estimation of antiradical properties of antioxidants using DPPH assay: A critical review and results. *Food Chem.* 130(4): 1036–1043. DOI: <https://doi.org/10.1016/j.foodchem.2011.07.127>
- Newman, DJ; Cragg, GM (2016). Natural products as sources of new drugs from 1981 to 2014. *J. Nat. Prod.* 79(3): 629–661. DOI: <https://doi.org/10.1021/acs.jnatprod.5b01055>
- Pacher, P; Beckman, JS; Liaudet, L (2007). Nitric oxide and peroxynitrite in health and disease. *Physiol. Rev.* 87(1): 315–424. DOI: <https://doi.org/10.1152/physrev.00029.2006>
- Pisoschi, AM; Pop, A (2015). The role of antioxidants in the chemistry of oxidative stress: A review. *Eur. J. Med. Chem.* 97: 55–74. DOI: <https://doi.org/10.1016/j.ejmech.2015.04.040>
- Sharma, JN; Al-Omran, A; Parvathy, SS (2007). Role of nitric oxide in inflammatory diseases. *Inflammopharmacology*. 15(6): 252–259. DOI: <https://doi.org/10.1007/s10787-007-0013-x>
- Wagner, H; Ulrich-Merzenich, G (2009). Synergy research: Approaching a new generation of phytopharmaceuticals. *Phytomedicine*. 16(2–3): 97–110. DOI: <https://doi.org/10.1016/j.phymed.2008.12.018>
- Zhou, X; Seto, SW; Chang, D; Kiat, H; Razmovski-Naumovski, V; Chan, K; Bensoussan, A (2016). Synergistic effects of Chinese herbal medicine: A comprehensive review of methodology and current research. *Front. Pharmacol.* 7: 201. DOI: <https://doi.org/10.3389/fphar.2016.00201>