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Exploring the Green Synthesis of Pyrazolines as Novel Agents for Combating Inflammation, Microbial Infections, and Oxidative Stress

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Abstract

This study investigates the green synthesis of pyrazoline derivatives and their potential as novel agents for combating inflammation, microbial infections, and oxidative stress. Utilizing eco-friendly methods, the research aims to create and characterize new pyrazoline compounds that may serve as promising therapeutic agents. The synthesized derivatives were assessed for their biological activities, including anti-inflammatory, antimicrobial, and antioxidant effects. The study also evaluates the safety and efficacy of these compounds to support their potential clinical application.

Keywords: green synthesis, pyrazoline derivatives, anti-inflammatory, antimicrobial, antioxidant, therapeutic agents.

1. INTRODUCTION

Pyrazoles are a heterocyclic family with various properties, including anti-microbial, anti-parasitic, anti-tubercular, anti-inflammatory, anti-convulsant, anticancer, antiviral, Pro inhibitory, neuroprotective, cholecystokinin-1 receptor antagonist, and estrogen receptor (trama center) ligand movement. They have been used as non-steroidal anti-inflammatory agents since their classification in 1883. NSAIDs, or non-steroidal anti-inflammatory drugs, are considered helpful restorative agents for managing various inflammatory conditions. They work by repressing cyclooxygenases (COXs) and thromboxane synthase to stifle prostaglandin biosynthesis from arachidonic corrosive and biotransforming arachidonic corrosive by 5-lipoxygenase (5-LOX) to create prostaglandins (PGs) and leukotrienes (LTs), which are strong inflammatory mediators. There are two isoforms of COX chemicals: COX-1, which is constitutive and communicated in many tissues, and COX-2, which is acted at areas of inflammation. Currently, recommended NSAIDs affect the gastrointestinal and renal systems due to the inhibition of both isoforms. Solid COX-2 inhibitors, such as celecoxib, ramifenazone, lonazolac (NSAID), and rimonabant, are accessible pyrazole moiety models. The search for more secure NSAIDs is ongoing, with scientists and physicists working on developing and combining NSAIDs with less harmful side effects.

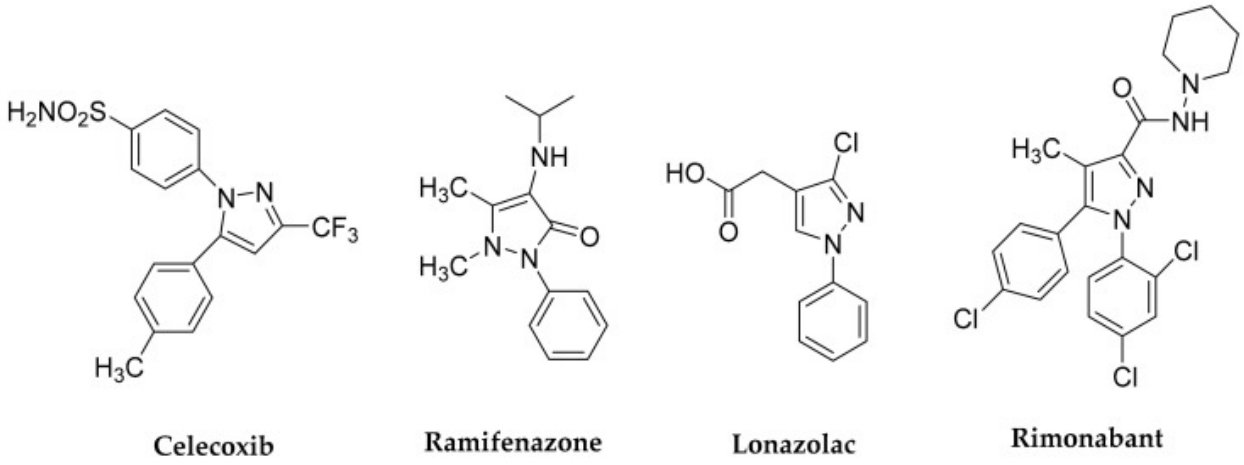

Figure 1: Structure of drugs bearing the pyrazole moiety

1.1. Objectives of the Study

- To Establish environmentally friendly and efficient synthesis methods for pyrazoline derivatives.
- To Create new pyrazoline compounds with potential anti-inflammatory, antimicrobial, and antioxidant effects.
- To Assess the biological activities of the synthesized pyrazoline derivatives.
- To Investigate the safety and efficacy of the compounds for potential clinical use.

2. LITERATURE REVIEW

Viveka et al., (2015) progressing audit utilized a multistep reaction progression to capably coordinated various novel subbed pyrazoline subordinates related with a subbed pyrazole stage. The blends were at that point attempted for their antibacterial, torment soothing, and anti-inflammatory properties. The N-acylated and nitro subbed N-phenyl pyrazolyl-pyrazolines

auxiliaries appeared fantastically empowering anti-inflammatory action, as per groundwork examinations, whereas 5h and 6f were captivating analgesics. It was found that the blends with brilliance subbed phenyl bunch at C-3 of the pyrazoline ring were energetic against clinical bacterial microorganisms, with MICs within the scope of 0.2-0.4 mg/mL. The compound that contained N-propionyl pyrazolyl-pyrazoline (5h) was demonstrated to be the foremost energetic in this examination, showing both antibacterial and anti-inflammatory properties.

Shaaban et al., (2012) progressing review clarifies the modern supportive obvious composing, which covers the a long time 2000-2011, counting how pyrazolines and their subordinates are utilized for particular purposes. Different therapeutic purposes of pyrazoline subordinates have been secured, either within the survey's overall writing fragments or within the obvious. Chosen natural substances are consolidated, nearby a rundown of a wide scope of pharmacological subtle elements and applications. The pharmacological impacts of pyrazoline backups are outstanding and join antimicrobial (antibacterial, antifungal, antiamoebic, and antimycobacterial), anti-inflammatory, torment soothing, burdensome, and anticancer properties. Additional pharmacological properties consolidate insecticidal, hypotensive, nitric oxide synthase inhibitor, antioxidant, steroidal, anti-diabetic, antiepileptic, antitrypanosomal, antiviral, antiviral development, MAO-inhibitory, and antinociceptive.

Khalil et al., (2012) cyclizing chalcones 1a-h with thiosemicarbazide or semicarbazide HCl, different unused 5-aryl-3-cyclopropyl-4,5-dihydropyrazole backups 2a-p were made and overviewed as antioxidant and anti-inflammatory masters. Terrible estimations and fundamental examination checked the advancements. It was laid out how well superoxide looks free progressives. It was moreover appeared what they implied for the achievability of hepatocytes and the improvement of nitric oxide (NO) in LPS-animated macrophages. The revelations illustrated that escalate 2e and 2n had the foremost grounded anti-inflammatory and free-revolutionary rummaging properties; subsequently, they may well be valuable within the treatment of incendiary and oxidative weight related afflictions.

He et al., (2015) twenty-eight pyrazoline subsidiaries, which begun from pyranochalcones, have been orchestrated and evaluated for their inhibitory impact on the arrangement of nitric oxide (NO), an fiery go between, in Crude 264.7 cells that have been actuated with lipopolysaccharide (LPS). Among these compounds, three compounds (1c, 11c, and 15c) shown substantial inhibitory effects on NO generation and iNOS activity that were superior to those brought about by the positive control Indomethacin. Of these compounds, 1c was the most effective. Furthermore, at a dosage of fifty milligrammes per kilogramme per day, 1c has the potential to inhibit the progression of carrageenan-induced hind paw edoema and to alleviate the development of adjuvant-induced arthritis (AIA) within a dose-dependent manner. An iNOS inhibitor with a strong binding affinity for the active site of murine iNOS was demonstrated by a docking research, which verified its effectiveness.

3. MATERIALS AND METHODS

A) Materials

Each response utilizes engineered grade beginning fixings and solvents that are gotten from Sigma Aldrich. Thin layer chromatography (tender loving care) and actual steady were utilized

to describe the virtue of the multitude of fixings and orchestrated items. With the utilization of a pre-covered tender loving care plate (Silica gel 60-120), each reaction was seen. For Step-1 mixtures, the dissolvable framework utilized was chloroform:methanol (8:2), and for Step-2 mixtures, chloroform:methanol (9:1). The got tender loving care plates were analyzed in an iodine chamber and under a long UV light to search for spots. Utilizing a microwave from Labline Logical Instruments, all responses were led under microwave radiation. The designs of the combined mixtures were explained and affirmed by spectroscopic techniques like FTIR, Mass, and 1H, 13C NMR.

B) Methods

i. Conventional heating method (1a-i)

Put 2.2 grams of sodium hydroxide, 20 milliliters of water, and 12.5 milliliters of ethanol in a decreased jolt with an appealing stirrer. There was smashed ice around the carafe. 0.43 million mol Utilizing an appealing stirrer, 4.4 ml of acetophenone was included to the liquid over and ceaselessly mixed. Then, 4.6 ml of subbed benzaldehyde (0.43mol) was added dropwise, and the combination's temperature was kept at 25 °C. Short-term, the response combination was put away in a fridge. To encourage the chalcone, the response blend was furthermore weakened with 50 milliliters of cold water and fermented with 10% aq. HCl. In the wake of separating and flushing the resultant item in chilly water until it was litmus-impartial, 10 milliliters of cold redressed soul were added. Methanol was then used to recrystallize the item.

ii. Microwave irradiation method (1a-i)

In the round bottom flask with a capacity of 7.5 mL, substituted acetophenone (5 mmol) and substituted benzaldehyde (5 mmol) were dissolved in 1N NaOH 1N (0.01 mol) of ethanol. The combination was exposed to 3 minutes of 180 W microwave radiation, tracked using TLC, and neutralised with 5 millilitres of 3N HCl. After filtering, cold water was used to wash the product.

iii. Overall pyrazoline derivative production process (2a-i, 3a-i)

replaced 2a-i / phenyl hydrazine hydrate (10 mmol, 1.5g) with chalcone 1a-i (10 mmol) and INH (10 mmol, 1.37g). After dissolving in 10 millilitres of glacial acetic acid, 3a–i refluxed for 36 hours. TLC tracked the reaction's development. After adding the combination to ice-cold water, sodium bicarbonate was used to neutralise it. If necessary, a brine treatment was used to get rid of the sticky nature.

Table 1: Compounds

Compounds			**R (substituted benzaldehyde)**	**R'(substituted acetophenone)**
1a	2a	3a	*m*-nitro	*p*-methyl
1b	2b	3b	3,4,5-trimethoxy	
1c	2c	3c	*m*-hydroxy	
1d	2d	3d	*p*-fluoro	
1e	2e	3e	3,4,5-trimethoxy	*p*-chloro

1f	2f	3f	*m*-nitro	
1g	2g	3g	*m*-hydroxy	
1h	2h	3h	*p*-fluoro	
1i	2i	3i	*p*-nitro	

iv. General pyrazoline derivative synthesis (2a-i, 3a-i):

Comp 2a-i was prepared by adding 2.5 mmol of Compound 1a-i and 2.5 mmol of isonicotinic acid hydrazide, both dissolved in glacial acetic acid. The mixture was then subjected to three to five minutes of microwave irradiation (fig 2).

Following a similar pattern, 2.5 mmol of phenyl hydrazine was added to an open pyrex vessel holding compounds (1a-i). The reaction was then subjected to microwave radiation for the appropriate duration (3-5 minutes) until TLC confirmed that the reaction had finished. After the reaction was complete, the reaction mixture was cooled to room temperature before 50 milliliters of cold water was added. The powerful substance was obtained when it was extracted from methanol, dried, and recrystallized.

4. General grinding-based pyrazoline derivative synthesis. (2a-i, 3a-i)

The identical process outlined in microwave synthesis. Compound 1a-i (0.01mol), isoniconic acid hydrazide hydrate (0.02mol), glacial acetic acid, and grinding for several minutes were added to compound 2a-i to synthesise it. TLC was used to monitor the reaction's conclusion. The solid with the light greenish-yellow hue was separated. Likewise, comp. 1a-i was combined with phenyl hydrazine hydrate (0.02mol) to create comp. 3a-i. The 3a-i synthesis was thoroughly pulverised for two to three minutes at room temperature in an open mortar using a pestle. This reaction mixture was mixed with acetic acid (0.001 mmol), and grinding was done for a few minutes while TLC tracked the reaction's completion. The solid with a bright greenish-yellow hue split out. The resulting solid was separated from the ethanol by Buchner filtration and recrystallization after being diluted with cold water. This produced the pyrazoline derivative.

- **[5-p-tolyl-3-(4-nitro-phenyl)-4,5-dihydro-pyrazol-1-yl]-pentaenoic acid (2a)**

Chemical formula: C23H19N3O3, molecular weight: 382.50, stretching values for C-H: 3338.03, Sp3 C-H: 2920.23, stretching values for C-N: 1243.55, and stretching values for C-NO2: 1550. Calc. for C23H19N3O3: 382.50; Found: 383.25. Dark powder.

- **The compound is 3-p-tolyl-5-(2,3,4-trimethoxy-phenyl)-4,5-dihydro-pyrazol-1-yl. 2-hydroxy-1-one (2b) formula 2-(2,4-dien-1-one)**

Molecular formula: C26H26N2O; molecular weight: 382.50; infrared absorption band: 1 cm-1; and a dark brown powder. Molecular lengths calculated for C26H26N2O are 382.50, but the measured value is 381.5.

- **This compound is a pyrazolyl ring with three fluoro-phenyl groups attached to it."2c" for pentaenoic acid**

The molecular formula is C23H19FN2O, and the calculated molecular weight is 358.15 kcal/mol. The amount of this compound was 357.

- **The compound is named 5-p-tolyl-3-(4-hydroxy-phenyl)-4,5-dihydro-pyrazol-1-yl.two-deoxypentaenoic acid**

C23H20N2O2 is a chemical formula with a calculated molar weight of 356.15 and a found molar weight of 355.16.

- **3. [(4-chloro-phenyl)][-5-(2, 3, 4-trimethoxy-phenyl)-4,5-dihydro-pyrazol-1-yl]the chemical name for oxyphenylin the absence of oxygen**

Brick red powder has the molecular weight of 450.91 and the chemical formula C25H23ClN2O4. The computed IR cm-1 stretch values for Sp2 C-H and Sp3 C-H, respectively, are 2958.80 and 2835.36. Results for C25H23ClN2O4 were 449.5.

- **[4,5-dihydro-pyrazol-1-yl-3-(4-chloro-phenyl)-5-(4-nitro-phenyl)]2-formyl-pentaenoic acid**

The molecular formula is C22H16 ClN3O3, and the molecular weight is 405.09. The infrared spectra show that the C-H bonds are 3050.39 and 2930.94 cm-1, the C-N bonds are 1016.56 cm-1, the C-F bonds are 1128.43 cm-1, and the C=C bonds are 1590 cm-1. The calculated value for C22H16ClN3O3 is 405.09 cm-1, while the found value is 403.5 cm-1.

- **The following are three compounds: "Five [4-hydroxy-phenyl] the sum of five [4,5-dihydro-pyrazol-1yl]grams of phenyl-methylthanon**

The calculated molecular formula, mass, and IR cm-1 OH stretch for brown powder are C22H17 ClN2O2, 376.84, and 3335.06, respectively. There were 376.84 and 367.5 identified for C22H17ClN2O2.

- **Three [4-chloro-phenyl] five [3-fluoro-phenyl] five [4,5-dihydro-pyrazol-1-yl]-2-hydroxyphenyl-methanone**

Reddish dark powder with the following properties: molecular weight: 376.83, IR cm-1 OH stretch: 3365, and chemical formula: C22H16 ClFN2O. Results for Ar-CH, Ali-CH, C=O, C=N, and C-O stretches were calculated to be 30, 65, 29, 35, 1611, and 1,125, respectively. Total: 376.83 for C22H16ClFN2O; 268.14 for the chemical, itself.

- **[3-dihydro-pyrazol-1-yl, 5-(4-chloro-phenyl)-5-(3-nitro-phenyl)-4]-pentaenoic acid (2i)**

The compound is a dark brown powder with the molecular formula C22H16 ClN3O3. Its molecular weight is 405.83 and its different stretching parameters are 3326 for OH, 3059 for CH, 2948 for Ali CH, -1744 for C=O, 3059 for Ar-CH, 1625 for C=N, and 1122 for C-O. The calculated value for C22H16ClN3O3 is 405.83, whereas the actual value is 268.1441.

- **1-Phenyl-3-p-tolyl-3-nitro-phenyl-4,5-dihydro-1H-pyrazole (3a)**

Chemistry: C22H19 N3O2, molecular weight: 357.41, absorption spectra: IR cm-1 Sp2, and a brown powder. The calculated C-H values are 2967. Results for C22H19N3O2: 357.41 vs 268.1441.

- **The compound 1-phenyl-3-p-tolyl-5-(3,4,5-trimethoxy-phenyl)-4,5-dihydro-1H-pyrazole(3b)**

The reddish brown powder has the molecular formula C25H26N2O3, a molecular weight of 405.49, and the following stretching parameters: OH: 3343, ArCH: 2934, C=N: 1645, C-NO2: 1572, CO: 1120, N-H: 1329, and C=O: 1739. The calculated value for C25H26FN2O3 is 405.49, while the actual value is 404.5.

- **Phenol (3c)-(2-phenyl-5-p-tolyl-3,4-dihydro-2H-pyrazol-3yl)**

Composition: C22H20 N2O; Mass: 328.41; Wavenumber: IR cm-1; Particle Color: Brick Red We calculated 267.3258 stretching moments for C23H19FN2O, but we found 268.1441.

- **3-p-tolyl-3-(4-fluoro-phenyl)-1-phenyl-4,5-dihydro-1H-pyrazole (3d):**

Chemical formula: C22H19FN2, molecular weight: 330.40 calcd. Found: 268.1441 for C23H19FN2O, with a value of 267.3258.

- **3-(Chloro-phenyl)1.-phenyl-5-(trimethoxy-phenyl 3.4.5)1-H-pyrazole -4,5-dihydro (3e):**

Analyzed as a light brown powder with the molecular formula C24H23 ClN2O3 and a molecular weight of 422.90. Found: 268.1441 for C23H19FN2O, with a value of 267.3258.

- **Phenyl-3-(4-chloro)-5-(3-nitro)-1-phenyl-4,5-dihydro-1H-pyrazole (3f):**

Calculated molecular weight: 377.82 and molecular formula: C21H16 ClN3O2. The powder has a dark brown color. Found: 268.1441 for C23H19FN2O, with a value of 267.3258.

- **3-[4-dihydro-2H-pyrazol-3-yl,5-(4-Chloro-phenyl)-2-phenyl-3]-phenol (3g):**

Properties: a yellowish brown powder with the molecular formula C21H17ClN2O, a molecular weight of 348.83, and an IR cm-1 OH stretch of 3333.06. The calculated stretching moments of Ar-CH are 3060, Ali-CH is 2967, C=O is 1674, C=N is 1588, C-O is 1125, and C-Cl is -825.47. Total: 348.83 for C21H17ClN2O; 268.1441 for the chemical formula.

- **3-Phenyl-3-(4-chloro)-5-(4-fluro)-1-phenyl-4,5-dihydro-1H-pyrazole (3h):**

Molecular formula: C21H16 ClFN2, molecular weight: 350.85, and IR cm-1 OH stretch: 3369; the powder has a brown color. Ar-CH is 3066, Ali CH is 2938, C=O is 1737, C=N is 1601, and C-O is 1123 HR.Chemical shift: calculated using MS (ESI, m/z) [M+H]+.

- **3-(4-nitro-phenyl)-5-(4-chloro-phenyl)-1-phenyl-4,5-dihydro-1H-pyrazole (3i)**

Powder with a reddish brown color, molecular formula C21H16 ClN3O2, molecular weight 377.8, OH stretch 3326, CH stretch 3059, Ali CH stretch 2948, C=O stretch -1744, Ar-CH stretch 3059, C=N stretch 1625, and C-O stretch 1122. The calculated molecular weight for C21H16ClN3O2 is 377.8, while the measured molecular weight is 376.5.

V. BIOLOGICAL ACTIVITY

a. Antioxidant Activity

It is generally recognized that the DPPH revolutionary rummaging procedure can be used to evaluate the radical searching movement of antioxidant components. DPPH provides a stable, revolutionary alternative. A constant violet color is observed in the DPPH free revolutionary in methanol. It becomes a yellowish or watery color when combined with antioxidant or diminishing synthetics. By enduring the antioxidant's occasional electron or hydrogen, these radicals can transform into stable diamagnetic atoms (yellow). To determine the antioxidant effect, the coordinated compounds were dissolved in 100 µg/ml of methanol. When a stable 1,1-diphenyl 2-picryl hydrazyl stable free revolutionary (violet tone) was present, the DPPH arrangement in the other compartment showed its maximum absorbance at 517 nm. The mixture was allowed to sit at room temperature for half an hour after 4 milliliters of each test ingredient were added to 4 milliliters of DPPH solution. The absorbance at 517 nm was measured using a Shimadzu UV spectrometer. In addition, the absorbances of both clear and reference samples were calibrated. By adjusting the absorbance in the recipe, we were able to assess the antioxidant effect of the ascorbic corrosive subordinates:

$$Percentage\ inhibition = \frac{Absorbance\ of\ Control - Absorbance\ of\ sample}{Absorbance\ of\ sample} \times 100$$

b. DPPH method

The DPPH assay's great reproducibility and short analysis time make it a great way to assess the antioxidant activity of recently synthesised compounds. When the antioxidant molecule gives the DPPH free radical an electron, the absorbance decreases. The majority of the substances exhibited strong antioxidant capacity. in contrast to ascorbic acid, the reference. Table 2. displays the chemicals that were synthesised and their anti-oxidant activity.

Table 2: Antioxidant activity of pyrazoline derivatives (IC_{50} in µg/mL)

Sr. No.	Comp. code	% Inhibition				
		5 µg/ml	10 µg/ml	15 µg/ml	20 µg/ml	IC50 µg/ml
1	3a	20.50	35.60	79.70	86.00	10.35
2	3b	35.80	42.65	70.15	85.40	10.75
3	3c	19.50	38.90	62.50	75.80	12.70
4	3d	28.60	39.60	59.70	86.70	11.70
5	3e	24.40	44.70	71.50	77.80	11.50
6	3f	30.60	43.60	79.10	87.90	10.30

7	3g	28.60	39.60	73.40	90.00	10.80
Std.	**Ascorbic acid**	**38.90**	**55.70**	**72.50**	**93.10**	**9.50**

c. Anti-inflammatory Activity

The cyclooxygenase enzymes that convert arachidonic acid to prostaglandins are inhibited by anti-inflammatory drugs. The avoidance of hypotonicity-induced HRBC membrane lysis is taken into consideration as a metric in determining anti-inflammatory activity because the membranes of these cells bear similarities to the components of lysosomal membranes. Therefore, all synthesised compounds' anti-inflammatory efficacy was estimated using the HRBC membrane stabilisation method.

This finding suggested that, in comparison to β-diketones and flavones, the recently synthesised pyrazolines exhibited more promising anti-inflammatory effect.

Table 3: Anti-inflammatory activity of pyrazoline derivatives

Compounds	**Anti-inflammatory activity in µg/mL (EC_{50}±SD)**
2a	57.21±2.35
2b	55.01±2.12
2c	53.24±2.18
2d	34.01±2.02
3a	51.14±2.02
3b	48.90±1.32
3c	12.24±1.25
3d	15.04±2.14
3e	16.99±0.56
Aspirin	12.71±0.97

d. Antimicrobial activity

Utilizing a changed agar dispersion examine strategy, the integrated mixtures were all tried for their antibacterial action against Escherichia coli and Staphylococcus aureus. Streptomycin was utilized as the positive control. The temperature and term of brooding for antibacterial action was 37°C for an entire day. The zone of restraint is utilized to communicate antimicrobial movement results. Table 4 shows the result of the engineered mixtures' movement. Compounds are ordered as extensively dynamic, decently dynamic, less dynamic, and least dynamic in view of the ZOI esteem in millimeters. As per the investigation of antibacterial screening, compound 3b showed the best action against Staphylococcus aureus and E. Coli, individually. Compounds 3a and 3e for the most part had great adequacy against microscopic organisms that were Gram positive and Gram negative.

Table 4: Antimicrobial activity of pyrazoline derivatives

Microorganisms	**Zone of inhibition (mm) of compounds**	
Comp. code	**Gram negative *E.Coli***	**Gram positive *S.aureus***
2a	12 mm	13 mm
2b	17 mm	16 mm
2c	13.2 mm	8 mm
2d	11.2 mm	11.2 mm
2e	15.2 mm	12.5 mm
Streptomycin	22 mm	25 mm

VI. RESULTS & DISCUSSIONS

Microwave-assisted synthesis significantly impacts synthetic organic chemistry, saving time and resulting in higher yields. The traditional method of synthesizing chalcones required a longer reaction time and a reasonable yield (65-70%). However, microwave irradiation under solvent-free conditions was used to determine optimal reaction conditions and produce chalcones with improved yields in just 3-5 minutes. Spectroscopic investigation revealed the chemical structures of pyrazolines from chalcones, with IR spectra showing specific retention bands at 3251 cm1 and 3384 cm1. Nitrogenous bases can react with a, b-unsaturated ketones to create matching pyrazolines. Chalcones were refluxed with hydrazine hydrate (2a-I) and INH (3a-I) in ethanol to yield pyrazoline subordinates. However, the reaction took more time and produced low yields (57-68%).

Microwave light was used to revive the reaction and increase product yield. The dissolvable-free microwave-aided reaction was completed in three to five minutes with a decent yield of items (76-89%). Mass otherworldly examination, 1H NMR, and infrared spectra were used to design pyrazolines (3a, 2d, and 2h).

The microwave-aided combination of mixtures 2a-I and 3a-I was time-explicit, created compounds rapidly, and delivered a higher overall yield than the standard method. The antioxidant movement of each blended pyrazoline subordinate was examined using the DPPH free extremist rummaging test. Some compounds showed strong antioxidant action, while others had weak action. The anti-microbial activity of the combined pyrazolines was also evaluated, with compounds 2b and 2e having the best action against S. aureus and E. coli, while compound 2c had the greatest zone of restraint against E. coli. The anti-inflammatory properties of the combined pyrazolines were particularly promising, with compound 3c showing the most promising activity.

VII. CONCLUSION

Chalcones were used to create new heterocyclic derivatives with pyrazoline rings, using IR, 1H NMR, 13C NMR, and mass spectrometry for structural elucidation. Antibacterial, anti-inflammatory, and antioxidant activity screens were performed. Microwave synthesis produced higher yields and shorter time compared to traditional methods. Antioxidant activity was

moderate to good, with compounds 3b and 3g showing moderate activity. Compounds 3a and 3f showed the most potent action. Further structural modifications may result in a robust anti-inflammatory moiety. The most effective anti-inflammatory medications were found to be 3c and 3d, possibly due to electron-drawing groups. The broth weakening strategy was used to evaluate antimicrobial action, with compounds 2b and 2e being the most dynamic and compounds 2a, 2c, and 2d showing destitute action.

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