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Formulation and Investigation of Herbal Anti-inflammatory Gel from Hydroalcoholic Leaf Extracts of *Cichorium intybus* and *Sida cordata*

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KEYWORDS

Poly Herbal Formulation, Anti-Inflammatory gel, *In-vitro* Antioxidant activity, *In-vitro* Anti-Inflammatory Activity, *In-vitro* Antibacterial activity.

ABSTRACT:

Herbal remedies remain a valuable source of solutions for various health conditions, including **Inflammation**. This study focused on developing and evaluating a novel **herbal gel** formulated with hydroalcoholic extracts of ***Cichorium intybus*** and ***Sida cordata*** leaves. The research involved the extraction and analysis of the chemical components from the leaves to identify their bioactive constituents. Two gel formulations (F1 and F2) were prepared and assessed for physicochemical properties, including color, texture, spreadability, pH, and viscosity, ensuring stability and usability. The **antioxidant activity** of the gels was evaluated using DPPH and nitric oxide scavenging methods, demonstrating their free radical-scavenging potential. The **antibacterial** properties were tested through the disc diffusion method, revealing notable activity against selected bacterial strains. Additionally, the **anti-inflammatory potential** was assessed using the **HRBC membrane stabilization assay**, a method to gauge the ability to inhibit inflammation by stabilizing red blood cell membranes under stress.

The results highlighted the significant therapeutic potential of these gels, with promising antioxidant, antibacterial, and anti-inflammatory properties. These findings support the use of *Cichorium intybus* and *Sida cordata* extracts as effective agents for inflammation-related conditions, emphasizing their role in advancing herbal formulations for natural and accessible health treatments.

1. Introduction

The body's reaction to adverse triggers, such infections or damaged cells, produces inflammation. The five cardinal signs heat, pain, redness, swelling, and loss of function are exactly defining it. Inflammation is a general defence mechanism that involves immune cells, blood vessels, and chemical mediators working together to defend the body, as opposed to adaptive immunity, which targets particular pathogens [1] .

Eliminating the original cause of cell harm, removing damaged cells and tissues, and starting the tissue repair process are the main objectives of inflammation. Since insufficient inflammation might eventually cause tissue damage and risk the organism's health, enough inflammation is essential for survival [2]. But excessive inflammation can also be harmful, as is the case with chronic inflammation, which is linked to a number of diseases like hay fever, periodontal disease, atherosclerosis and osteoarthritis.

There are basically two types of inflammation: acute and chronic. The body's immediate reaction to adverse stimuli is known as acute inflammation, which is defined by an increase in the flow of plasma and leukocytes, especially granulocytes, from the circulation into damaged tissues [3]. Prolonged chronic inflammation causes a gradual change in the cell type at the site of inflammation, with mononuclear cells being predominant. This kind of inflammation, which is frequently linked to chronic disorders, requires the simultaneous destruction and repair of tissue and may cause long-term tissue damage [4].

Pathophysiology of inflammation: Initiation of inflammation, Vasodilation and Increased Vascular Permeability, Leukocyte Recruitment and Activation, Phagocytosis and Release of Mediators, Cytokine

Journal of Chemical Health Risks

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JCHR (2024) 14(6), 1435-1445 | ISSN:2251-6727

Release and Amplification, Resolution and Tissue Repair[5] . Anti Inflammatory agents like Non- steroidal anti- inflammatory drugs NSAIDs include Aspirin, Ibuprofen, Naproxen, and Diclofenac [6], Steroidal Anti-Inflammatory Drugs (Corticosteroids) Examples include: prednisone, dexamethasone and hydrocortisone. Additionally, natural anti-inflammatory substances found in certain foods, such as omega-3 fatty acids, turmeric, ginger, and green tea, can complement medical treatments or be used preventively. Overall, anti-inflammatory agents play a crucial role in the management of inflammatory conditions, helping to alleviate symptoms, reduce tissue damage, and improve overall wellbeing [7].

Several anti-inflammatory formulations are available; here we go with the gel based topical formulation. Topical gels are a favored dosage form in both cosmetic and medicinal treatments for skin conditions due to their unique advantages over creams and ointments. These gels are formulated by blending a gelator (gelling agent), solvent, active drug, and other substances, categorizing them into organogels or hydrogels based on their solvent composition [8]. A gel is defined as a semi-solid, three-dimensional matrix formed by a dispersed system of colloidal particles or the permeation of a solvent into an entwined polymer chain network. In pharmaceutical applications, gels are prepared by incorporating a gelator into a mixture of solvent and active ingredient, creating a semi-solid mixture where small and large molecules are dispersed within a liquid base. Gelators commonly used include synthetic polymers like carbomer 934, celluloses such as hydroxypropyl cellulose and hydroxypropyl methylcellulose, natural gums like Tragacanth gum, pectin, and agar gum [9].

Herbal gels represent a specialized category of topical formulations that combine the benefits of traditional medicinal herbs with the therapeutic properties of gel-based drug delivery systems. These gels are formulated by incorporating herbal extracts, essential oils, or active phytochemicals into a gel matrix composed of gelators, solvents, and other excipients [10].

2. Objectives

The study aims to prepare hydroalcoholic extracts from the leaves of *Cichorium intybus* and *Sida cordata*, followed by evaluating their physiochemical parameters and conducting preliminary phytochemical screening. An anti-inflammatory herbal gel will be formulated using these extracts, which will then be assessed for its effectiveness. The research includes in vitro antioxidant assays, such as DPPH radical scavenging and nitric oxide scavenging activity, as well as evaluating the anti-inflammatory properties using the HRBC membrane stabilization method. Additionally, the antibacterial activity of the prepared herbal gel will also be investigated.

3. Methods

Collection and preparation of plant extract: the leaves of *Cichorium intybus* and *Sida cordata* were air-dried and powdered.

- **Collection of Plant materials:**

The leaves of *Cichorium intybus* and *Sida cordata* were collected by Mr. V. Chelladurai (Retried Research Officer Botanist, Central Council for Research in Ayurveda and Siddha, Govt. of India) from Sengottai, Tirunelveli, Tamilnadu in the month of May 2024. The plant materials were identified and authenticated by Dr. S. Mutheeswaran Scientist, Xavier research foundation, Palayamkottai. The collected plant materials were free from diseases and also contamination of other plants. The Registered authentication number of *Cichorium intybus* and *Sida cordata* is XCH- 40601.

- **Plant profile:**

➢ ***Cichorium intybus***

Synonym: chicory, blue sailor
Family: Asteraceae
Geographical source: North western Regions, Kashmir, Punjab.
Vernacular names: Hinduba, kasni, kasini vittulu…
Marker constituents: Inulin, caffeic acid derivatives, such as ferrulic acid, caftaric acid, chicoric acid, chlorogenic acid, isochlorogenic acid, dicaffeoyl tartaric acid, hydroxycoumarins, flavonoids, alkaloids, steroids etc.
Uses: Hepatoprotective, Anti-diabetic, Anti-cancer, Anti-inflammatory, Analgesic.

➢ ***Sida cordata:***

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JCHR (2024) 14(6), 1435-1445 | ISSN:2251-6727

Synonym: Country-mallow
Family: Malvaceae
Geographical Source: subtropical Asia, Northeast Tropical Africa.
Vernacular names: Kurunthotti, Bhumibala
Marker constituents: β-phenylamines, 2-carboxylated tryptamines, quinazoline, quinoline, indole etc.
Uses: Anti-inflammatory, Antioxidant, Antipyretic, Antimalarial, Respiratory ailments. [11]

- **Preparation of extracts:**

Sida cordata and *Cichorium intybus* leaves were air-dried and ground into a powder. In a stopped container, 250 g of the powdered material was added to 1000 ml of solvent (ethanol and water) and stirred frequently for a certain amount of time until the soluble stuff was dissolved. After distillation, the extracts were concentrated, and the solvents were retrieved after maceration for 72, 48, and 24 hours.

- **Physio-chemical Parameters:**

➢ **Ash value:**

After boiling the whole amount of ash with water, the water-insoluble ash is filtered and weighed. By deducting the insoluble in water ash from the overall amount of ash, the water-soluble ash was determined.[12]

➢ **Total Ash:**

Total ash is determined by incinerating a 1 gm sample in a pre-ignited silica crucible until constant weight was achieved, as per pharmacopeia methods (I.P. 1998).

➢ **Water Soluble Ash:**

The total ash is boiled with water, filtered, and the water-insoluble ash is weighed. Water soluble ash was calculated by subtracting the water-insoluble ash from the total ash.

➢ **Acid Insoluble Ash:**

The ash is boiled with dilute HCl, filtered, ignited in a crucible, cooled, and the acid-insoluble ash is weighed.

➢ **Extractive Values:**

Successive extraction using solvents of increasing polarity was done via maceration, as per the Indian Pharmacopoeia.

➢ **Water Soluble Extractive:**

5g of plant powder was macerated with 100ml of chloroform water for 24 hours, then filtered, evaporated, dried at 105°C, and weighed. [13]

➢ **Ethanol Soluble Extractive**:

Dried plant powder was macerated in 100ml of 90% ethanol for 24 hours, with frequent shaking during the first 6 hours. After filtration, 25ml of the filtrate was evaporated, dried at 105°C, and weighed.

➢ **Loss on Drying**:

1g of each formulation was dried in a tarred dish at 105°C for 5 hours, and the weight loss was calculated as a percentage of the initial weight. [14]

➢ **Phytochemical Screening of Extracts:**

The various solvents extract of the leaves of *Cichorium intybus* and *Sida cordata* was subjected to chemical tests for characterization of its phytoconstituents. Several chemical tests was performed to identify the Alkaloids, steroids, coumarins, tannins, saponins, flavonoids, phenols, proteins, carbohydrates, terpenoids.[15]

- **Formulation of Anti-Inflammatory gel:**

The hydroalcoholic extracts were dissolved in half of the distilled water, and Propylene Glycol 400 was added. Carbapol-940 was dissolved in the remaining water, with methyl and propyl parabens added. Both solutions were combined, and triethanolamine was added dropwise to achieve gel consistency. Various concentration gel F_1, F_2 were prepared. [16]

➢ **Evaluation of Herbal gel:**

Physical evaluation, washability, pH, viscosity, Spreadability were evaluated. [17]

- ***In-vitro* Antioxidant activity**

➢ ***In-vitro* DPPH radical scavenging activity:**

DPPH scavenging activity was measured by preparing an 8 mg DPPH stock solution (200 µM) in 100 ml ethanol. Test compounds prepared in ethanol at concentrations 10, 50,100,200,400,800 & 1000 µg/0.1

Journal of Chemical Health Risks

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JCHR (2024) 14(6), 1435-1445 | ISSN:2251-6727

ml, were added to 1.9 ml of the DPPH solution. The mixtures were kept in the dark for 20 minutes, and absorbance was measured at 517 nm to calculate % inhibition, representing DPPH radical scavenging. [17]

Percentage inhibition =

$$\frac{\text{OD of control- OD of test}}{\text{OD of control}} \times 100.$$

➢ **Nitric Oxide Scavenging Activity:**

An aqueous solution of sodium nitroprusside (10 mg) in +1000 µg/ml of leaf and bark extracts from Sida cordata and Cichorium intybus were left at 37°C for 4 hours. Griess reagent (0.5 ml) were added after incubation, and absorbance at 546 nm were measured. By comparing the absorbance values of the test and control, the percentage inhibition of nitric oxide formation were computed.[18]

Percentage inhibition =

$$\frac{\text{OD of control- OD of test}}{\text{OD of control}} \times 100$$

▪ ***In vitro* Anti-Inflammatory Activity of Herbal gels (F_1 & F_2):**

➢ **HRBC (Human Red blood cell corpuscle) Membrane stabilization Method:**

In the HRBC method for anti-inflammatory activity, blood was collected from healthy volunteers, mixed with Alsever's solution, and centrifuged at 3000 rpm to separate packed cells. These cells were washed with isosaline, and a 10% v/v HRBC suspension was prepared. Test samples, a reference, and a control were each combined with phosphate buffer, hyposaline, and HRBC suspension, then incubated at 37°C for 30 minutes and centrifuged again. The hemoglobin content in the supernatant was measured at 560 nm using a spectrophotometer to evaluate anti-inflammatory effects. [19]

The percentage stabilization activity was calculated as follows,

% Stabilization =

$$\frac{\text{OD of test solution - OD of Product Control}}{\text{OD of test control}}$$

▪ ***In Vitro* Antibacterial Activity of Herbal gel:**

➢ **Disk diffusion method:**

The antibacterial activity of the test samples was assessed using the disc diffusion method. Targeted microorganisms were cultured in Mueller-Hinton broth and incubated for 24 hours. Petri dishes with Mueller Hinton agar were inoculated with the bacterial strain, and sterile discs were placed on the medium. Test samples at concentrations of 1000 µg, 2000 µg, and 4000 µg were applied to the discs. The plates were then incubated at 37 °C for 24 hours, after which the diameter of the clear zone around each disc was measured in millimetres to determine antibacterial activity.[20]

4. Results:

▪ **Physiochemical parameters of leaves extract of *Cichorium intybus and Sida cordata***

Identifying the type of phytoconstituents it has, the recent research on physiochemical screening offers helpful information that may help in confirming the authenticity of the plant.

S.No	Parameters	Value (F_1) %w/w	Value (F_2) %w/w
1	Total ash value	4.8	4.75
2	Water soluble ash	1.45	1.52
3	Acid insoluble ash	2.25	1.97

Journal of Chemical Health Risks

www.jchr.org

JCHR (2024) 14(6), 1435-1445 | ISSN:2251-6727

4	Moisture content	6.24	6.65
5	Water soluble extractive	5.81	6.41
6	Alcohol soluble extractive	4.43	5.29

- **Preliminary Phytochemical Analysis of Leaves Extract of *Cichorium intybus and Sida cordata*** :

The leaf extracts of *Cichorium intybus* and *Sida cordata* demonstrated the presence of various phytochemicals. *Cichorium intybus* showed alkaloids, flavonoids, saponins, and terpenoids, while *Sida* cordata contained phenols, flavonoids, alkaloids, tannins, terpenoids, carbohydrates, and saponins. Phytochemical test results are summarized in a table, where (+) indicates presence and (-) indicates absence of compounds.

S.No	Particulars	F_1	F_2
1	Phenols	+	+
2	Flavonoids	+	+
3	Quinones	+	+
4	Amino acid	+	+
5	Terpenoids	+	+
6	Coumarins	-	-
7	Alkaloids	+	+
8	Tannins	+	+
9	Saponins	+	+
10	Proteins	-	-
11	Carbohydrates	+	+

- **Evaluation Parameters of Herbal Gel**

Formulation	Color	pH	Viscosity (cp)	Homogeneity	Consistency	Spreadability
F_1	Light green	6.78	4500	Good	Semi-solid	11.73±0.01mm
F_2	Light green	6.25	3000	Good	Semi-solid	9.85±0.04 mm

- ***In vitro* antioxidant activity of herbal gels (F_1,F_2)**

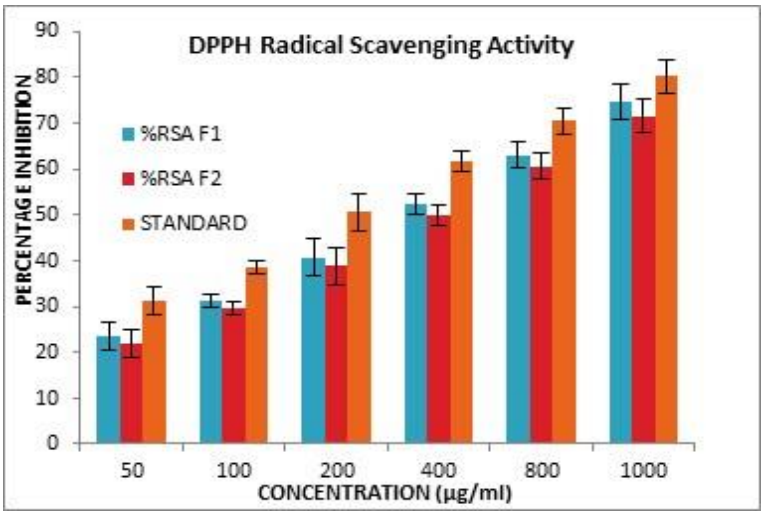
➢ ***In vitro DPPH Radical Scavenging Activity:***

Journal of Chemical Health Risks

www.jchr.org

JCHR (2024) 14(6), 1435-1445 | ISSN:2251-6727

CON µg/ml	F_1 % INHIBITION	F_2 % INHIBITION	STD % INHIBITION (ASCORBIC ACID)
50	23.56±0.18	21.93±1.30	31.39±0.48
100	31.21±0.32	29.70±0.12	38.41±0.95
200	40.73±0.18	38.78±0.28	50.52±0.12
400	52.42±1.21	49.76±1.01	61.63±0.04
800	62.96±0.74	60.55±0.51	70.4±0.13
1000	74.59±0.11	71.49±0.25	80.23±0.76
IC_{50}mol/L	213	252	185



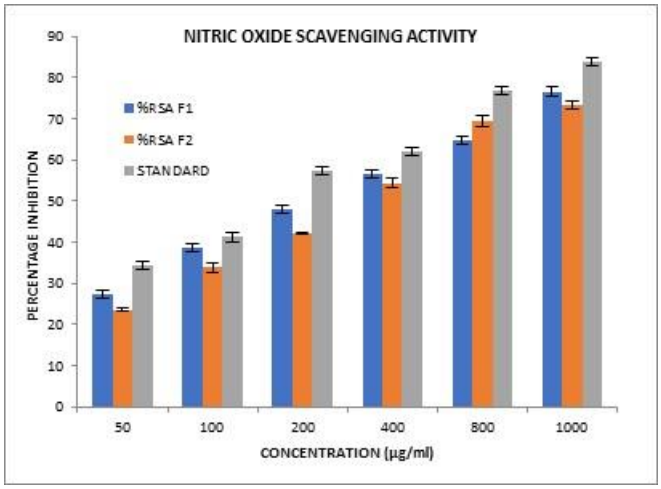
As reduced by hydrogen or electron donation, DPPH, a stable nitrogen-centered free radical, turns from violet to yellow. The DPPH radical scavenging activity showed that ascorbic acid (standard) had 80.23% inhibition, while the herbal gels demonstrated **75.65%** inhibition for **F_1** and 73.65% for F_2.

- ***In vitro* Nitric Oxide Radical Scavenging Activity:**

CON µg/ml	F_1 % INHIBITION	F_2 % INHIBITION	STD % INHIBITION (ASCORBIC ACID)
50	27.27±0.41	23.52±0.32	38.41±0.49
100	38.72±0.60	33.75±0.71	50.52±0.12
200	47.97±1.51	42.20±0.16	61.63±0.76

Journal of Chemical Health Risks
www.jchr.org
JCHR (2024) 14(6), 1435-1445 | ISSN:2251-6727

400	56.62±0.11	54.28±0.29	70.40±0.91
800	64.58±0.62	69.28±0.73	80.23±1.25
1000	76.56±1.42	73.33±1.21	89.56±0.43
IC_{50} mol/L	225	283	196



Nitric oxide (NO) is a chemical mediator produced by endothelial cells, macrophages, and neurons, playing a crucial role in various physiological processes. Table showed significant inhibition of nitric oxide radical generation by herbal gels (F_1 and F_2) and standard ascorbic acid at a concentration of 1000 µg/ml. The percentage inhibition for ascorbic acid was 89.56%, while the herbal gels demonstrated **F_1 at 83.66%** and F_2 at 79.19%.

- ***In vitro* Anti-Inflammatory Activity of Herbal gels (F_1 & F_2):**

➢ **HRBC Membrane stabilization Method:**

CON µg/ml	**F_1% INHIBITION**	**F_2% INHIBITION**	**STD% INHIBITION (DICLOFENAC GEL)**
10	35.59±0.07	30.82±0.47	29.46±0.41
50	48.64±0.41	44.78±0.28	38.19±0.23
100	56.77±0.52	53.18±0.46	46.81±0.46
200	62.27±1.05	57.20±0.39	53.37±0.93
400	72.09±0.42	66.78±1.52	61.82±0.18
800	78.48±0.81	73.49±0.52	72.71±1.02
1000	81.10±0.22	77.40±0.91	89.18±0.72
IC_{50} mol/L	254	348	216

Journal of Chemical Health Risks
www.jchr.org
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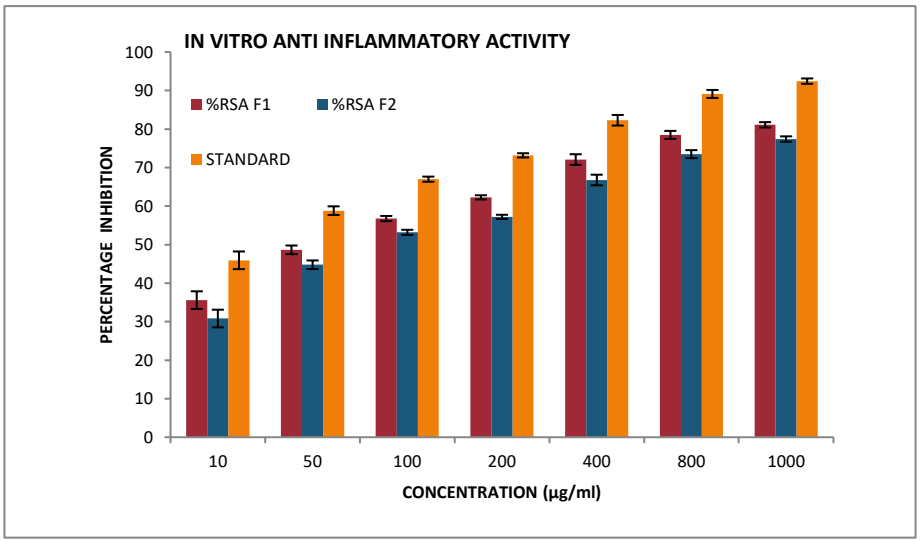

In vitro anti-inflammatory activities of different concentrations of herbal formulations were evaluated using the HRBC membrane stabilization method. **F_1 exhibited more potent activity** than F_2, attributed to the presence of flavonoids and terpenoids identified in the preliminary phytochemical screening. F_2's anti-inflammatory effect was linked to the presence of flavonoids and coumarins. This study demonstrated that the in vitro anti-inflammatory activity of the herbal gel formulations could effectively control inflammation.

➢ **Antibacterial activity of Herbal Gel:**

Sample	**Zone of Inhibition (mm)**											
	Microorganisms											
	S.aureus			***E.faecalis***			***P.aeruginosa***			***E.coli***		
Concentration	1000 µg	2000 µg	4000 µg	1000 µg	2000 µg	4000 µg	1000 µg	2000 µg	4000 µg	1000µg	2000 µg	4000 µg
F_1 (CI)	-	-	10	-	-	12	-	-	-	-	-	-
F_2 (SC)	-	-	10	-	-	10	-	-	-	-	-	-
Streptomycin (20µg)	22			20			16			22		

The anti-inflammatory herbal gel was evaluated for *in-vitro* antibacterial activity at concentrations of 1000 µg, 2000 µg, and 4000 µg against both Gram-positive and Gram-negative bacteria, including Staphylococcus aureus, Enterococcus faecalis, Pseudomonas aeruginosa, and Escherichia coli. Formulation **F_1 exhibited moderate activity** against Enterococcus faecalis and Staphylococcus aureus, while **F_2** also showed moderate activity against the same bacteria.

Journal of Chemical Health Risks

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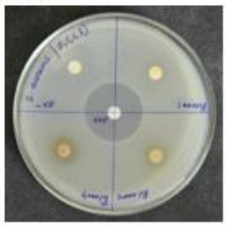
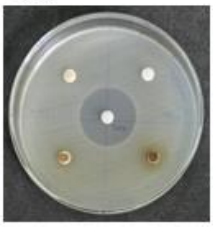
Zone of Inhibition of F_1 Herbal Gel:

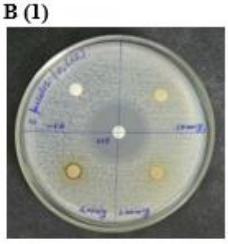
A (1)



A (2)



B (1)



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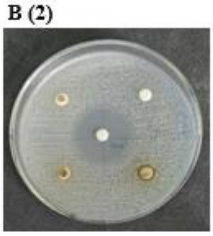
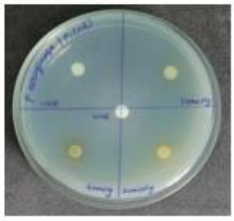
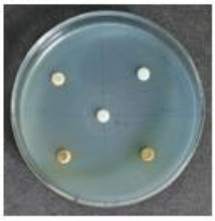


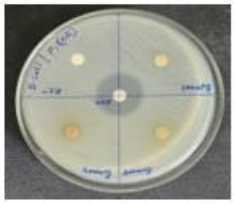
C (1)



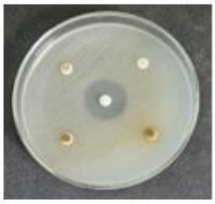
C (2)



D (1)

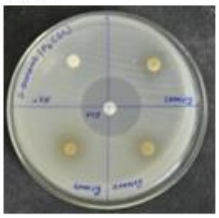


D (2)



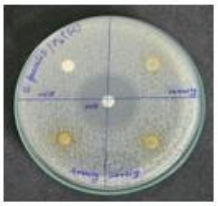
Zone of Inhibition of F_2 Herbal Gel:

E (1)

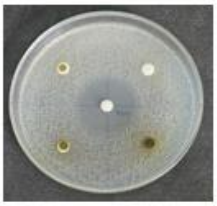


E (2)

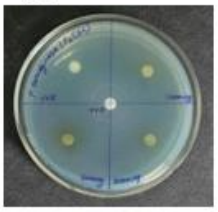
F (1)



F (2)

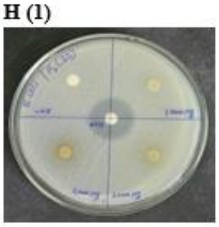


G (1)

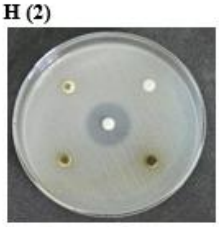


G (2)

H (1)



H (2)



A(1) & A(2) – zone of inhibition of F_1 using *S. aureus*

B(1) & B(2) – zone of inhibition of F_1 using *E. faecalis*

C(1) & C(2) – zone of inhibition of F_1 using *P.aeruginosa* .

D(1) & D(2) – zone of inhibition of F_1 using *E. coli*

E(1) & E(2) – zone of inhibition of F_2 using *S. aureus*

F(1) & F(2) – zone of inhibition of F_2 using *E. faecalis*

G(1) & G(2) – zone of inhibition of F_2 using *P.aeruginosa*

H(1) & H(2) – zone of inhibition of F_2 using *E. coli*

5. Discussion

Cichorium intybus (Asteraceae) and *Sida cordata* (Malvaceae) are medicinal plants with antioxidant, anti-inflammatory, anti-diabetic, and antimicrobial properties. Leaves were collected, identified, and hydroalcoholically extracted for evaluation. Phytochemical screening revealed the presence of

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JCHR (2024) 14(6), 1435-1445 | ISSN:2251-6727

phenols, flavonoids, alkaloids, and tannins. Two herbal gel formulations (F_1, F_2) with different concentration were developed using these extracts and assessed for physicochemical properties. *In vitro* assays demonstrated antioxidant activity (DPPH and nitric oxide scavenging), anti-inflammatory effects (HRBC membrane stabilization), and moderate antibacterial activity, with **F_1** outperforming F_2 in antioxidant and anti-inflammatory effects. This suggests that the developed herbal gels have the potential to be a safe and viable alternative to existing synthetic anti-inflammatory gels. The findings of this research emphasize the promising use of plant resources for developing novel and effective anti-inflammatory agents.

Refrences

1. Ferrero-Miliani, L., Nielsen, O. H., Andersen, P. S., & Girardin, S. E. Chronic inflammation: importance of NOD2 and NALP3 in interleukin-1beta generation. *Clinical and experimental immunology*, (2007) *147*(2), 227–235.
2. Chen, L., Deng, H., Cui, H., Fang, J., Zuo, Z., Deng, J., Li, Y., Wang, X., & Zhao, L. . Inflammatory responses and inflammation-associated diseases in organs. *Oncotarget*, (2017) *9*(6), 7204–7218
3. Bacchi, S., Palumbo, P., Sponta, A., & Coppolino, M. F. Clinical pharmacology of non- steroidal anti-inflammatory drugs: a review. *Anti-inflammatory & anti-allergy agents in medicinal chemistry*, . (2012). *11*(1), 52–64.
4. Bellik, Y., Boukraâ, L., Alzahrani, H. A., Bakhotmah, B. A., Abdellah, F., Hammoudi, S. M., & Iguer-Ouada, M. Molecular mechanism underlying anti-inflammatory and anti- allergic activities of phytochemicals: an update. *Molecules (Basel, Switzerland)*, *18*(1), 322–353.
5. Zarghi, A., & Arfaei, S. Selective COX-2 Inhibitors: A Review of Their Structure- Activity Relationships. *Iranian journal of pharmaceutical research : IJPR*, (2011)*10*(4), 655–683.
6. Bindu, S., Mazumder, S., & Bandyopadhyay, U. Non-steroidal anti-inflammatory drugs (NSAIDs) and organ damage: A current perspective. *Biochemical pharmacology*,(2020) *180*, 114147.
7. Assiri, G. A., Alanazi, B. M., & AlRuthia, Y. The Prevalence of High-Risk Prescribing of Oral Non-Steroidal Anti-Inflammatory Drugs in Primary Healthcare: A Single- Centre Retrospective Chart Review Study. *Healthcare (Basel, Switzerland)*,(2022) *10*(5), 867.
8. Wichmann, M. A., Cruickshanks, K. J., Carlsson, C. M., Chappell, R., Fischer, M. E., Klein, B. E., Klein, R., & Schubert, C. R. NSAID Use and Incident Cognitive Impairment in a Population-based Cohort. *Alzheimer disease and associated disorders*, (2016)*30*(2), 105–112.
9. Ghasemian, M., Owlia, S., & Owlia, M. B. Review of Anti-Inflammatory Herbal Medicines. *Advances in pharmacological sciences*, *2016*, 9130979.
10. Street RA, Sidana J, Prinsloo G. Cichorium intybus: Traditional Uses, Phytochemistry, Pharmacology, and Toxicology. Evid Based Complement Alternat Med. 2013;2013:579319. doi: 10.1155/2013/579319. Epub 2013 Nov 26. PMID: 24379887; PMCID: PMC3860133.
11. Zia, S., Saleem, M., Asif, M. et al. Diospyros malabarica (Desr.) Kostel fruits extract attenuated acute and chronic inflammation through modulation of the expression of pro- and anti-inflammatory biomarkers in rat models. Inflammopharmacol 30, 2211– 2227 (2022).
12. Ghosh A, Sarmah P, Patel H, Mukerjee N, Mishra R, Alkahtani S, et al. Nonlinear molecular dynamics of quercetin in Gynocardia odorata and Diospyros malabarica fruits: Its mechanistic role in hepatoprotection. PLoS One [Internet]. 2022;17(3):e0263917.
13. Zreen Z, Hameed A, Kiran S, Farooq T, Zaroog MS. A comparative study of Diospyros malabarica (gaub) extracts in various polarity-dependent solvents for evaluation of phytoconstituents and biological activities. Biomed Res Int [Internet]. 2022;2022:4746223.
14. Bharadwaj KK, Rabha B, Pati S, Choudhury BK, Sarkar T, Gogoi SK, et al. Green synthesis of silver nanoparticles using Diospyros malabarica fruit extract and assessments of their antimicrobial, anticancer and catalytic reduction of 4-nitrophenol (4-NP). Nanomaterials (Basel) [Internet]. 2021;11(8):1999.
15. Purane L, Vidyadhara S. nephroprotective effect of diospyros malabarica (desr.) kostel against cisplatin induced nephrotoxicity in rats. jasr

Journal of Chemical Health Risks

www.jchr.org

JCHR (2024) 14(6), 1435-1445 | ISSN:2251-6727

[Internet]. 31Dec.2021 [cited 1Jul.2023];12(04 Suppl 1):150-4.

16. Misal, G., Dixit, G., & Gulkari, V. (2012). Formulation and evaluation of herbal gel. In Indian Journal of Natural Products and Resources (Vol. 3, Issue 4).
17. Yamini, K., & Onesimus, T. (n.d.). Int J Pharm Bio Sci 2013 Apr; 4(2): (P) 956-960 International Journal of Pharma and Bio Sciences ISSN 0975-6299 PREPARATION AND EVALUATION OF HERBAL ANTI-ACNE GEL.
18. Gandhidasan R,Thamaraichelvan A. Baburaj. Anti-inflammatory action of Lanea coromandelica by HRBC membrane Stabilisation. Fitotherapia 1991;62:82-3.
19. X. Zhao, J.M. Courtney. Redirecting [Internet]. Doi.org. 2023 [cited 2023 Jul 4]. https://doi.org/10.1533%2F9780857092939.2.97 (accessed 2023 Jul 4)
20. EK Elumalai, M Ramachandran, T Thirumalai, P Vinothkumar. Antibacterial activity of various leaves extracts of Merremiae marginata. Asian Pac J of Trop Biomed. 2011; 1(5): 406-408.