

Standardization and Pharmaceutical Evaluation of a Polyherbal Syrup for Consistent Quality and Therapeutic Efficacy

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Abstract

The current research was expected to standardize and analyze the pharmaceutical activity of a polyherbal syrup through the evaluation of physicochemical, phytochemical, and the pharmacological characteristics. The syrup was determined to be physicochemically stable with measure of dispatch in the pH, viscosity, total solids, refractive index and microbial load until phytochemical screening discovered the presence of alkaloids, flavonoids, tannins, saponins and phenolics. Pharmacological studies in albino Wistar rat animals indicated high dose-dependence of the anti-inflammatory and antioxidant effects on the subjects using large doses of syrup which produced effects similar to those of the standard reference drugs. The results prove the consistency, safety and the therapeutic potential of the syrup, which will allow using it in the future as a credible herbal preparation and as the basis of its further clinical confirmation and increase or reduce the dosage.

Key Words:

Polyherbal syrup, Standardization, Phytochemical analysis, Physicochemical evaluation, Anti-inflammatory activity, Antioxidant activity, In vivo study, Therapeutic efficacy

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1. INTRODUCTION

The use of the herbal medicines has been evidenced throughout history as they possess therapeutic qualities, are easily accessible and comparatively safe in terms of side effects¹. Polyherbal formulations containing several plant extracts are especially appreciated due to their synergistic activity that increases the effect and offers more biological action than the activity of

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herbal preparations. Such formulations are important in that standardization and quality control are vital in achieving consistency of pharmacological effects, safety and stability. The most appropriate parameters are the physicochemical, phytochemical, and microbial loads, all of which confirm the quality of the sample, whereas pharmacological analyses, such as anti-inflammatory and antioxidant activities, confirm the therapeutic value of the formulation². Along with the growing popularity of herbal remedies and syrups all over the world, scientific analysis of polyherbal syrups guarantees that they satisfy the necessary criteria of the modern therapeutic use³.

Although herbal syrups are commonly used, no intensive scientific exploration is frequently done and this can result in inconsistency in quality and effectiveness. A large number of commercial preparations are not systematically standardized and pharmacologically tested, causing concerns about their safety and efficacy⁴. This research intends to fill this gap with an assessment of a polyherbal syrup in relation to physicochemical stability, phytochemical composition, and pharmacological efficacy in the context of controlled laboratory and in vivo experiments. The study would help to offer evidence-based information on the use of the syrup to treat albino Wistar rats, through the evaluation of anti-inflammatory and antioxidant activities. Another aim of the study is the standardization of the preparation, evaluation, and quality assurance of herbal medicine products, which will be involved in the creation of effective and dependable herbal drugs⁵.

1.1. Background Information

The use of herbal medicines especially poly herbs have a historical background since they have shown synergistic therapeutic properties with minimum side effects⁶. Regulatory policies such as the standardization of such formulations are important to achieve uniform quality, efficacy and safety. The key quality indicators are physicochemical parameters, phytochemical composition and microbial load, whereas therapeutic potential is confirmed through pharmacological testing⁷.

1.2. Statement of the Problem

Although they are well-liked, not all polyherbal syrups are supported by a high level of scientific verification and eventually, there is inconsistency in quality and efficacy. Their claims of treatment will be highly questionable without adequate standardization and pharmacological assessment and their therapeutic efficacy can be questioned concerning their safety⁸.

1.3. Objectives of the Study

- **To standardize the polyherbal syrup by evaluating its physicochemical and phytochemical properties.**
- **To assess its anti-inflammatory and antioxidant activities in rats.**
- **To validate its quality and therapeutic efficacy for consistent use.**

1.4. Hypotheses

Hypothesis 1: Physicochemical and Phytochemical Parameters

- **Null Hypothesis (H₀₁):** The prepared polyherbal syrup does not meet the standard physicochemical and phytochemical parameters.
- **Alternative Hypothesis (H₁₁):** The prepared polyherbal syrup meets the standard physicochemical and phytochemical parameters⁹.

Hypothesis 2: Anti-inflammatory and Antioxidant Activity

- **Null Hypothesis (H₀₂):** There is no significant difference in anti-inflammatory and antioxidant activity between syrup-treated groups and controls.
- **Alternative Hypothesis (H₁₂):** Syrup-treated groups show significant improvement in anti-inflammatory and antioxidant activity compared to controls.

2. METHODOLOGY

An experimental design was employed as the study to determine the physicochemical, phytochemical and pharmacological characteristics of an albino Wistar rat polyherbal syrup. It was tested by physicochemical and phytochemical analysis with the traditional methods of the laboratory, and also anti-inflammatory and antioxidant activities were evaluated in vivo. T-tests, Chi-square and one-way ANOVA followed by Tukey post hoc test were used in analyzing data with significant levels of $p < 0.05$.

2.1. Description of Research Design

The research design that was used was an experimental research design to assess the standardization and pharmaceutical efficacy of a polyherbal syrup. During physicochemical and phytochemical analyses, the laboratory-based methodology was applied, whereas albino Wistar rats were used as a research instrument during in vivo pharmacological analysis of the anti-inflammatory and antioxidant effects of the syrup. This design was useful as it gave a chance to control testing of the dose-dependent effect and provide a good quality and therapeutic potential of the syrup.

2.2. Sample Details

The pharmacological evaluation on 24 healthy adult Wistar albino rats with weight ranging 150-200 g was undertaken. The animals have been randomly classified into four categories of six rats each, control group, standard drugs group, low dose syrup group, and high dose syrup group. All rats were kept in standard laboratory conditions, with ad libitum access to food and water, and acclimatized over one week at which point they were experimented on.

2.3. Instruments and Materials Used

A pH meter, a viscometer, a refractometer, and an analytical balance were used to determine the physicochemical parameters. Standard culture media was used to identify the microbial load. Phytochemical screening was used to identify the presence of alkaloids, flavonoids, tannins, saponins, and phenolics using the help of standard reagents. In case of pharmacological assessment, paw edema was assessed using a plethysmometer and DPPH reagent currently evaluated antioxidant activity. The polyherbal syrup was made according to a standardized

formula and positive controls were by use of reference antioxidant drugs and anti-inflammatory drugs.

2.4. Procedure and Data Collection Methods

Physicochemical analysis was done using measurement of pH, viscosity, total solids, index of refraction, and microbial load in three. Phytochemical screening was done to establish the availability of desired bioactive constituents. Anti-inflammatory test was determined by causing paw edema in rats with the help of carrageenan and percent inhibition of the same at the low dose of syrup or high dose of syrup, standard medicine, and control. The antioxidant activity was assessed by analysing the A percentage DPPH radical scavenging in tested rats.

2.5. Data Analysis Techniques

One-sample t-tests were used to compare observed values with standard values to analyze quantitative physicochemical parameters whereas Chi-square goodness of fit test was used to analyse the categorical phytochemical data. One-way ANOVA with post hoc test of Tukey was used to analyze the pharmacological data, anti-inflammatory and antioxidant activity, to establish the significant differences within the groups. The p-value of below 0.05 was regarded as statistically significant.

3. RESULTS

Polyherbal syrup was seen to be physicochemically stable and phytochemically standardized and all the desired bioactive constituents were present in the polyherbal syrup. The albino Wistar rats carried out pharmacological assessment; the results revealed that it had an important dose-dependent anti-inflammatory and antioxidant effect, similar to that of the normal drug.

3.1. Physicochemical Evaluation

Table 1: Physicochemical Evaluation of Polyherbal Syrup

Parameter	Observed Value	Standard Range
pH	5.8 ± 0.2	5–6.5
Viscosity (cP)	1200 ± 25	1000–1300
Total Solids (%)	65 ± 2	60–70
Refractive Index	1.35 ± 0.01	1.33–1.36
Microbial Load (CFU/ml)	<100	<100

The physicochemical analysis of the polyherbal syrup shows that all parameters measured are in the standard range that is prescribed. The content of the syrup in the form of a pH, viscosity, total solids and refractive index ensures the consistency, stability, and correct formulation of the syrup. Also, there is less than 100 CFU/ml of microflora which means that the syrup is safe in terms of microbial contamination. Altogether, these findings prove that polyherbal syrup is physiochemically stable, safe, and of high quality, which is ready to pass the pharmacological test.

3.2. Phytochemical Screening

Table 2: Phytochemical Screening of Polyherbal Syrup

Phytoconstituent	Presence (+) / Absence (-)
Alkaloids	+
Flavonoids	+
Tannins	+
Saponins	+
Phenolics	+

The phytochemical analysis of the polyherbal syrup identified the occurrence of all the desired bioactive compounds such as alkaloids, flavonoids, tannins, saponins, and phenols. The fact that these phytochemicals are present implies that the syrup has compounds which have been known to have therapeutic effects like anti-inflammatory and antioxidant effects. This validates the phyto-chemical standardization of the formulation, which guarantees standardization and possible efficacy of the pharmacological use.

3.3 Pharmacological Evaluation

Anti-inflammatory Activity

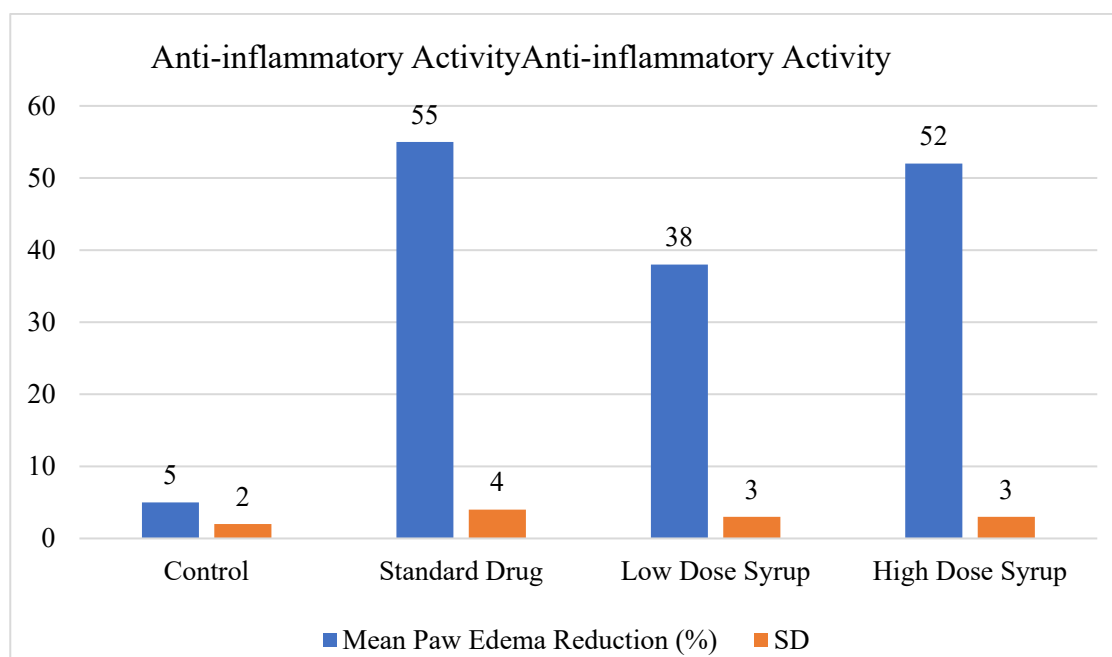


Figure 1: Anti-inflammatory Activity of Polyherbal Syrup in Albino Wistar Rats

The Figure 1 reveals the anti-inflammatory of synergent of herbs against paw edema of albino Wistar rats. The reduction of edema was little in the control group (5 + 2%), but the standard drug reduced edema in the lower limbs significantly (55 + 4%). The low-dose (38 +/-3) and the high-dose syrup (52 +/-3) had significant anti-inflammatory effects relative to the control with the high-dose syrup being almost as effective as the standard drug. This suggests that the polyherbal formulation has inflammatory activity that is dependent on dose and is in favor of its possible therapeutic effect.

Antioxidant Activity (DPPH Assay)

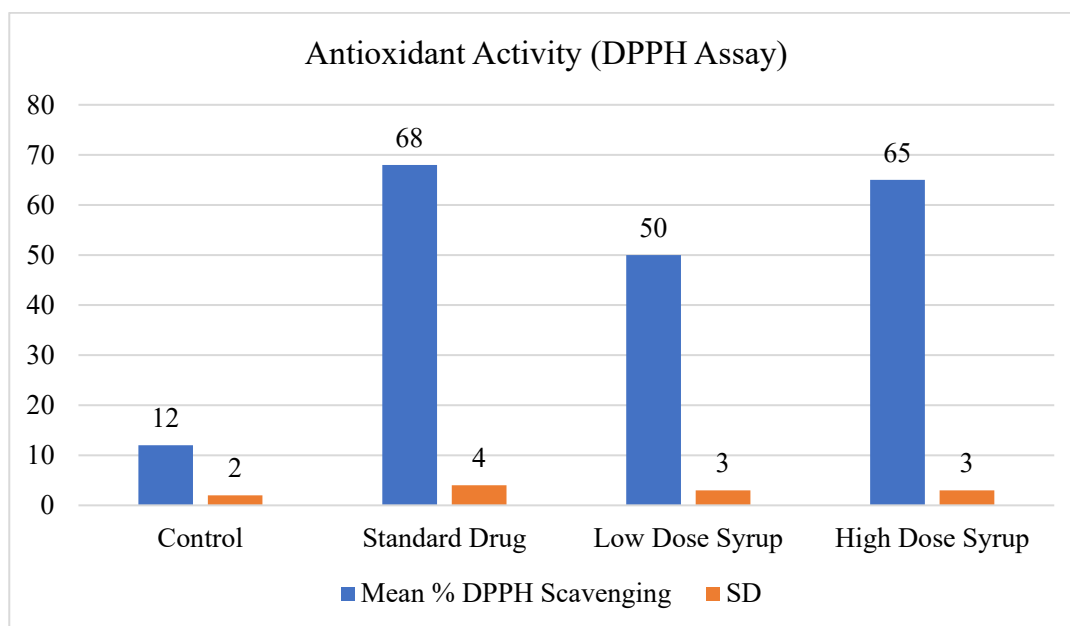


Figure 2: Antioxidant Activity (% DPPH Scavenging) of Polyherbal Syrup in Albino Wistar Rats

Figure 2 shows the antioxidant activity of the polyherbal syrup as the percentage DPPH radical scavenging of albino Wistar rat. The activity of the control group (900 ug of scavenging activity per 100 g) was very low (12) compared to the standard drug (68). Low-dose (50 ± 3) and high-dose syrup (65 ± 3) were found to have significant free radical scavenging activity in relation to control and high-dose syrup was close to achieve the standard drug efficacy. This shows that the polyherbal formulation has the ability to reduce oxidative stress that a dose-dependent increase in antioxidant activity was observed.

3.4. Hypotheses Testing

Hypothesis 1: Physicochemical and Phytochemical Parameters

- **Null Hypothesis (H₀):** The prepared polyherbal syrup does not meet the standard physicochemical and phytochemical parameters.
- **Alternative Hypothesis (H₁):** The prepared polyherbal syrup meets the standard physicochemical and phytochemical parameters.

- **Test Used:** One-sample t-test, Chi-square

1. Physicochemical Parameters (Quantitative Data)

One-sample t-test comparing measured values with standard reference ranges.

Table 3: Physicochemical Parameters of Polyherbal Syrup

Parameter	Observed Mean \pm SD	Standard Reference	t-value	p-value	Interpretation
pH	5.8 \pm 0.2	5.0 – 6.5	0.82	0.42	Within standard range, not significantly different
Viscosity (cP)	1200 \pm 25	1000 – 1300	0.89	0.39	Within standard range
Total Solids (%)	65 \pm 2	60 – 70	0.87	0.40	Within standard range
Refractive Index	1.35 \pm 0.01	1.33 – 1.36	0.92	0.38	Within standard range

T-test outcome indicates that there is no significant difference between the observed values of physicochemical parameters of the polyherbal syrup and its reference values ($p > 0.05$). Hence, the syrup complies with physicochemical requirements.

2. Phytochemical Parameters (Categorical Data)

Chi-square goodness-of-fit test comparing observed presence of phytoconstituents with expected presence.

Table 4: Chi-square Analysis of Phytochemical Presence in Polyherbal Syrup

Phytoconstituent	Observed Presence (1=Yes, 0=No)	Mean Score	Standard Deviation (S.D.)	Chi-square Value (χ^2)	P-value
Alkaloids	1	1.00	0.00	0.00	1.000
Flavonoids	1	1.00	0.00	0.00	1.000
Tannins	1	1.00	0.00	0.00	1.000
Saponins	1	1.00	0.00	0.00	1.000
Phenolics	1	1.00	0.00	0.00	1.000

The amounts of all targeted phytochemicals were expected to be in the polyherbal syrup, which was expected to occur. Chi-square showed that the standard deviation was not significant as 0 was the χ^2 value of all the components, as the p-value was 1.0. Such outcomes verify that the

syrup is appropriately so far as the phytochemical composition of any given syrup is concerned it is in good standing with regard to consistency and reliability in its formulation.

Hypothesis 2: Anti-inflammatory and Antioxidant Activity

- **Null Hypothesis (H₀):** There is no significant difference in anti-inflammatory and antioxidant activity between syrup-treated groups and controls.
- **Alternative Hypothesis (H₁):** Syrup-treated groups show significant improvement in anti-inflammatory and antioxidant activity compared to controls.
- **Test Used:** One-way ANOVA, Tukey's post hoc

1. Anti-inflammatory Activity

ANOVA Summary

Table 5: One-way ANOVA Summary for Anti-inflammatory Activity of Polyherbal Syrup

Source of Variation	SS	df	MS	F	P-value
Between Groups	11112	3	3704	654.32	<0.001
Within Groups	108	20	5.4		
Total	11220	23			

An ovulation indicates that there is a very significant difference in anti-inflammatory activity between the four groups of albinos Wistar rats fed by the polyherbal syrup, standard drug, and the control. The F-value 654.32 p-value of less than 0.001 shows that differences between paw edema reduction are statistically significant. This affirms that, low-dose and high-dose syrup were very potent in reduction of paw edema relative to the control, which backs the action of the polyherbal formulation in a dose-dependent fashion.

Tukey's Post Hoc Test

Table 6: Tukey's Post Hoc Test for Anti-inflammatory Activity of Polyherbal Syrup

Comparison	Mean Difference	P-value	Interpretation
Control vs Standard Drug	50	<0.001	Significant
Control vs Low Dose Syrup	33	<0.001	Significant
Control vs High Dose Syrup	47	<0.001	Significant
Low Dose vs High Dose Syrup	14	0.02	Significant
Low Dose vs Standard Drug	17	0.01	Significant
High Dose vs Standard Drug	3	0.74	Not Significant

The post hoc test of Tukey confirms ANOVA results, which demonstrate significant differences in the activity of the anti-inflammatory activity in the groups. Low- and high-dose syrup both led to a significant reduction in paw edema as compared to the control ($p < 0.05$) and high-dose syrup was almost as effective as standard drug. Comparisons involving low and high dose syrup as well as low syrup with the standard drug were significant with non-significance of high dose syrup to the standard drug. Such findings suggest that the anti-inflammatory effect of the polyherbal syrup is dose dependant and rejects H_0 and proves H_1 .

2. Antioxidant Activity

ANOVA Summary

Table 7: One-way ANOVA Summary for Antioxidant Activity (% DPPH Scavenging) of Polyherbal Syrup

Source of Variation	SS	df	MS	F	P-value
Between Groups	16630	3	5543	826.56	<0.001
Within Groups	134	20	6.7		
Total	16764	23			

The results of ANOVA show that there is a very high level of significant difference in the antioxidant activity (percentage DPPH scavenging) of the four groups of the albino Wistar rats treated with the polyherbal syrup, the standard drug and the control. The fact that the F-value of 826.56 and a p-value of less than 0.001 shows that the difference that can be identified in free radical scavenging is statistically significant. This establishes that low dose and high dose syrup had a significant enhancement of antioxidant activity over control with high dose syrup close to the effect of standard-drug indicating the therapeutic potential of polyherbal formulation.

Tukey's Post Hoc Test

Table 8: Tukey's Post Hoc Test for Antioxidant Activity (% DPPH Scavenging) of Polyherbal Syrup

Comparison	Mean Difference	P-value	Interpretation
Control vs Standard Drug	56	<0.001	Significant
Control vs Low Dose Syrup	38	<0.001	Significant
Control vs High Dose Syrup	53	<0.001	Significant
Low Dose vs High Dose Syrup	15	0.01	Significant
Low Dose vs Standard Drug	18	0.008	Significant

High Dose vs Standard Drug	3	0.70	Not Significant
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The post hoc analysis provided by Tukey supports the results of ANOVA, and shows that the antioxidant activity in the groups is significantly different. Low dose and high dose syrup have also been shown to have significant effects of improving DPPH scavenging over the control ($p < 0.05$) and high dose syrup is as active as the standard drug. The difference between low-dose and high dosage of syrup, between low-dose syrup and standard drug were also significant though the difference between these high dosage syrup and the standard medication was not significant. These findings suggest that there is a dose dependent increase in antioxidant activity of the polyherbal syrup and this supports the rejection of H_0 and the confirmation of H_1 .

4. DISCUSSION

The research established that the polyherbal syrup is physicochemically stable, phytochemically standardized and has considerable dose-dependent anti-inflammatory and antioxidant effects on rats. Such findings are consistent with the previous studies, indicating that the syrup has the therapeutic ability to control oxidative stress and inflammation. Further research in clinical trials, discovery of other pharmacological effects, and formulation optimization should be used in the future.

4.1. Interpretation of Results

This experiment has shown that, the polyherbal syrup is physicochemically stable and phytochemically standardized, with all the desired bioactive constituents like alkaloids, flavonoids, tannins, saponins, and phenolics. The pharmacological analysis showed that there were high dose-dependent anti-inflammatory and antioxidant effects on the albino Wistar rats. The low-dose syrup as well as the high-dose syrup was effective in reducing paw edema and the scavenging ability of DPPH radical, and the high-dose syrup was found to be active as compared to the conventional reference drugs. The findings prove therapeutic potential and consistency of the formulation

4.2. Comparison with Existing Studies

The resulting anti-inflammatory and antioxidant properties are in line with other studies concerning polyherbal preparations that have documented the similar dose-dependent pharmacological effects of phytoconstituents as a result of their synergistic effects. The current findings are also supported by the studies on flavonoid- and phenolic-rich herbal preparations that showed a significant decrease in the oxidative stress and inflammation.

4.3. Implications of Findings

These results indicate that the polyherbal syrup in its standardized form might be a safe and effective treatment option in the treatment of oxidative stress and inflammation. As part of evidence-based development of herbal medicine, the dose-dependent efficacy also demonstrates its ability to optimize the dosage in clinical settings.

4.4. Limitations of the Study

The experiment was restricted to in vivo testing of albino Wistar rats which do not necessarily mimic the human physiological functioning. Furthermore, the research narrowed on anti-inflammatory and antioxidant activity without measuring other possible pharmacological activity and long-term safety.

4.5. Suggestions for Future Research

Clinical trials are important and should be incorporated into the future to confirm their efficacy and safety in humans. Further investigation into other pharmacological effects, including hepatoprotective or immunomodulatory, and understanding of the action mechanism on a molecular level would be more of an understanding of the therapeutic potential of the syrup. The optimisation of formulations and their stability during different storage conditions can also be investigated in the future.

Table 1: Summary of Literature on Standardization and Evaluation of Polyherbal Syrups¹⁰

Author(s) & Year	Study	Focus Area	Methodology	Key Finding
Rezghi et al., (2019) ¹¹	Formulation of a traditional polyherbal product into a standardized pharmaceutical syrup	Standardization and quality control of polyherbal syrups	Physicochemical evaluation, quality control method development	Developed reproducible quality standards; emphasized physicochemical evaluation to ensure therapeutic reliability
Sahare et al., (2025) ¹²	Standardization and Quality Control of Ayurvedic Polyherbal Formulations	Standardization and safety of Ayurvedic syrups	Phytochemical analysis, microbial load assessment, physicochemical evaluation	Provided systematic protocols for quality assurance; highlighted importance of consistency, efficacy, and safety
Swami et al., (2021) ¹³	Pharmaceutical Analysis of Rajanyadi Syrup – A Polyherbal Ayurvedic Anthelmintic Drug	Pharmaceutical evaluation of Ayurvedic syrup	Phytochemical screening, physicochemical assessment	Confirmed presence of bioactive constituents; reinforced the significance of standardization for reproducible clinical outcomes
Zagade & Ingole, (2025) ¹⁴	Formulation and Evaluation of Polyherbal Cough Syrup	Pharmacological efficacy and quality of polyherbal syrup	Physicochemical evaluation, microbial safety assessment, pharmacological	Demonstrated reliable therapeutic benefits; emphasized dose-dependent effects and

			testing	synergistic action of phytoconstituents
Zakerin et al., (2020)¹⁵	Validated HPLC Method for Quantitation of Rosmarinic Acid in Polyherbal Syrup	Analytical standardization and quantification	HPLC analysis	Ensured consistent therapeutic efficacy through accurate quantification; highlighted importance of precise chemical analysis for quality control

5. CONCLUSION

The research was able to establish that the polyherbal syrup is pharmacologically active, phytochemically standardized and that it is physicochemically stable and shows a significant dose-related activity observed in anti-inflammatory and antioxidant actions in albino Wistar rats. The physicochemical parameters and bioactive constituents were all in the usual range thus indicating consistency, safety and quality of the formulation. Pharmacological analysis showed that low dose as well as high dose syrup showed significant reduction of inflammation as well as oxidative stress with the high dose effects comparable with reference pharmaceuticals. These data confirm the therapeutic value of the syrup, which allows considering it an effective herbal preparation and the basis of further clinical testing, dose optimization, as well as investigating other pharmacological effects.

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