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FORMULATION AND EVALUATION OF CORN SILK (STIGMA MAYDIS) HERBAL SYRUP FOR THE SUPPORTIVE MANAGEMENT OF URINARY TRACT INFECTIONS

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ABSTRACT

Urinary tract infections (UTIs) represent a major global clinical burden, primarily managed through synthetic antibiotics. However, escalating antimicrobial resistance and systemic adverse profiles necessitate the investigation of safe, effective, and patient-compliant herbal alternatives. This study aimed to formulate and comprehensively evaluate a stable oral herbal syrup containing a hydroalcoholic extract of Corn Silk (stigma maydis) for the supportive management of UTIs. Dried, authenticated stigma maydis styles and stigmas were subjected to hydroalcoholic extraction (70:30 ethanol: water) via maceration. Preliminary qualitative phytochemical screening was performed using standard diagnostic chemical tests. An oral liquid syrup (UroSilk) was formulated utilizing active extract, a sucrose base, multi-component paraben preservation, and tartaric acid as a pH modifier. The formulation was standardized using organoleptic evaluation, pH tracking, specific gravity, density analysis, and Ostwald viscometer, alongside a short-term stability study. Phytochemical screening confirmed the presence of bioactive flavonoids, saponins, tannins, phenolic compounds, glycosides, carbohydrates, terpenoids, and steroids. The developed stigma maydis herbal syrup fulfills quality criteria, offering a promising, safe, and stable supportive therapeutic system to promote urinary flushing and alleviate UTI symptoms.

KEYWORDS: Urinary Tract Infection (UTI), Corn Silk, Herbal Syrup, Phytochemical Screening, Hydroalcoholic Extraction, Flavonoids, Stability Study.

1. INTRODUCTION

Approximately 150 million persons are diagnosed with urinary tract infections (UTIs) annually worldwide, making them the second most prevalent infection presentation in general practice. UTIs can affect both the upper and lower urinary tracts, with lower urinary tract infections presenting dysuria, frequency, urgency, and suprapubic discomfort. A wide range of infectious disorders that affect the urinary system from the urethra to the kidneys are together referred to as UTIs. According to reports, between 50% and 60% of women may experience at least one UTI in their lifetime. Bacteria that colonize the urethra migrate into the bladder and trigger an inflammatory response, which is the typical mechanism of infection. Escherichia coli, Klebsiella pneumoniae, and Proteus mirabilis are common examples of uropathogens from the gastrointestinal tract that usually cause illness.

While empirical synthetic antibiotic regimens constitute the primary line of clinical defense, recurrent usage patterns are severely bottlenecked by the rapid emergence of antimicrobial resistance and treatment failures. Consequently, identifying natural phytomedicinal therapies has gained significant importance. Corn silk (Stigma maydis), the yellowish thread-like strands from the female maize blossom, is a readily available waste product from maize farming. It has long been used as a therapeutic medicine for a variety of ailments across China, Turkey, the United States, and France. Cystitis, edema, kidney stones, prostate disorders, urinary infections, bedwetting, and obesity are all traditionally treated with it. It increases urine output and lessens discomfort by calming and relaxing the lining of the bladder and urinary tubules. Phenolic compounds, especially flavonoids, are abundant in corn silk, along with proteins, vitamins, carbohydrates, calcium, potassium, magnesium, volatile oils, steroids, alkaloids, and saponins. Physiologically, *Stigma maydis* syrup facilitates urinary tract health through a multi-targeted mechanism:

1. **Diuretic and Flushing Action:** Due to its flavonoids and high potassium levels, it acts as a natural diuretic, increasing the volume of urine and facilitating the mechanical flushing of bacteria from the urinary tract.
2. **Reduction of Symptoms and Inflammation:** Bioactive compounds inhibit inflammatory mediators, reducing inflammation and pain related to urinary disorders such as burning sensations during urination.

3. **Demulcent and Protective Effects:** It forms a protective mucilage layer on the mucosa of the urinary tract, reducing irritation and discomfort while its high antioxidant capacity protects tissues from oxidative stress.

The objective of this research was to convert this botanical material into a standardized, physically stable, and highly palatable liquid oral herbal syrup (UroSilk) optimized for patient compliance and supportive urinary care.

2. MATERIALS AND METHODS

2.1 Plant Procurement and Processing

The freshly collected corn silk was washed properly to remove dust and foreign particles. The plant material was officially authenticated as zea mays (Family: poaceae) prior to use. The cleaned corn silk was dried in a hot air oven at 40 to 45°C for 4–6 hours until complete removal of moisture was achieved. The dried material was cooled at room temperature and crushed using a grinder to obtain a fine powder for further use in formulation of herbal syrup.

2.2 Hydroalcoholic Extraction

For extraction, the required quantity of dried powder was transferred into a clean conical flask. A hydroalcoholic solvent containing ethanol and water in the ratio of 70:30 was added. The mixture was kept for maceration for 48–72 hours with occasional shaking to ensure proper extraction of active constituents. After completion, the mixture was filtered through muslin cloth followed by filter paper. The obtained filtrate was concentrated by evaporating the solvent on a water bath at a controlled temperature until a semisolid extract was obtained, which was stored at 4°C in an airtight container.

2.3 Qualitative Phytochemical Screening

The concentrated Stigma maydis extract was subjected to exploratory qualitative chemical testing according to established pharmacognostic protocols to identify key secondary metabolites:

- **Shinoda Test (Flavonoids):** To 2 mL of metabolic extract, 5 mL of 95% ethanol, a few drops of HCl, and 0.5 g of magnesium turnings were added to observe an orange colour.
- **Lead Acetate Test (Flavonoids/Tannins):** To 2 mL of extract, a few drops of a 5% lead acetate solution were added to check for a yellow precipitate.
- **Ferric Chloride Test (Phenolics/Tannins):** To 2 mL of extract, a few drops of FeCl3 solution were added to observe a blue-black or black coloration.

- **Foam Test (Saponins):** 2 mL of metabolic extract was shaken vigorously with water to confirm the formation of stable, persistent foam.
- **Molisch's Test (Carbohydrates):** A few drops of alpha-naphthol in ethanol were added to the extract, followed by concentrated H2SO4 along the sides of the tube to check for a violet-coloured ring.
- **Fehling's and Benedict's Tests (Reducing Sugars):** Extract samples were treated with mixed Fehling's A and B solutions (boiled for 1 minute) and Benedict's reagent independently to observe yellow/brick-red and reddish-brown precipitates respectively.
- **Killer-Kiliani Test (Glycosides):** To 2 mL of extract, a few drops of glacial acetic acid, 1 drop of FeCl3, and H2SO4 were added to check for a reddish-brown colour at the junction and a bluish- green upper layer.
- **Salkowski Test (Steroids and Terpenoids):** To 2 mL of extract, 2 mL of chloroform and 2 mL of concentrated H2SO4 were added; vigorous shaking was applied to observe a greenish-yellow fluorescence in the acid layer.

2.4 Formulation of UroSilk Herbal Syrup

The master formula optimized for a target batch size of 50 mL is detailed in Table 1.

Table 1: Master Formula Composition for UroSilk Syrup.

Sr. No.	Ingredients	Qty for 50 mL	Role
1	Corn Silk Extract	5 ml	Active Pharmaceutica Ingredient (API)
2	Sucrose	33.35 g	Sweetening agent / Viscosity builder
3	Glycerine	2.5 ml	Humectant
4	Methyl Paraben	0.075 g	Preservative (antifungal)
5	Propyl Paraben	0.01 g	Preservative (antibacterial)
6	Tartaric Acid	0.05 g	pH modifier
7	Flavour (Orange Oil)	q.s.	Flavouring agent
8	Purified Water	q.s. ad 50 ml	Vehicle

Stepwise Preparation Procedure

1. **Preparation of preservative solution:** Methyl paraben and propyl paraben were accurately weighed and dissolved in the measured quantity of glycerine with gentle heating around 50 to 60°C and stirring until a clear solution was obtained.
2. **Preparation of sucrose syrup base:** In a separate beaker, the required amount of sucrose was dissolved in a portion of purified water and heated gently while stirring to form a clear syrup, avoiding excessive heating to prevent caramelization. The base was allowed to cool to room temperature.

3. **Addition of API:** The required volume of corn silk liquid extract was measured and added slowly to the cooled syrup base with continuous stirring.
4. **Incorporation of preservative solution:** The previously prepared paraben-glycerine solution was added to the mixture and mixed thoroughly.
5. **pH adjustment:** Tartaric acid was accurately weighed, dissolved in a small quantity of purified water, and added to the formulation to adjust the pH for stability and preservative efficacy.
6. **Addition of flavour and volume makeup:** The orange oil flavouring agent was added and mixed uniformly. Purified water was added to make up the final volume to 50 ml.
7. **Packaging:** The final formulation was transferred into a clean, dry, amber-coloured glass bottle and labelled appropriately.

2.5 Physicochemical Evaluation Protocols

2.5.1 Organoleptic Characterization

5 mL of the final syrup was transferred into watch glasses and placed against a white background to visually examine colour, while odour and taste were assessed individually.

2.5.2 Determination of pH

An accurately measured amount of 10 mL of the final syrup was placed in a 100 mL volumetric flask and made up to volume with distilled water. The solution was sonicated for 10 minutes, and the pH was measured using a pH meter.

2.5.3 Density and Specific Gravity Evaluation

A specific gravity bottle was cleaned thoroughly with chromic or nitric acid, rinsed with distilled water, and dried. The weight of the empty dry bottle with its capillary tube stopper was taken (w1). The bottle was filled with the syrup formulation, excess liquid was wiped from outside the tube, and it was weighed on an analytical balance (w2). The calculated weight of the sample liquid was determined by w3 = w2 - w1. Density was computed using the formula Density = w3 / v, For specific gravity, the bottle was also filled and weighed with distilled water (w2 for water), and weights were processed to extract the ratio of sample weight (w5) to water weight (w4).

2.5.4 Viscosity Measurement via Ostwald Viscometer

The Ostwald viscometer was thoroughly cleaned and mounted vertically on a suitable stand. Water was filled up to mark G, and the time required for water to flow from mark A to mark

B was counted in triplicate to obtain the mean flow time. The procedure was repeated for the syrup sample to obtain its mean flow time.

2.5.5 Stability Testing

Stability testing of the prepared herbal syrup was performed by keeping the samples in culture tubes at room temperature. The sample was evaluated for changes in all physicochemical parameters, turbidity, and homogeneity at the interval of 15 days.

3. RESULTS AND DISCUSSION

3.1 Qualitative Phytochemical Screening Results

The phytochemical screening confirmed the presence of multiple active secondary metabolites in the corn silk extract, which are responsible for its therapeutic activity. The detailed outcomes are compiled in Table 2.

Table 2: Phytochemical Screening Results of Corn Silk Extract.

Phytoconstituent	Diagnostic Test Applied	Observation Recorded	Inference
Flavonoids	Shinoda / Lead Acetate / FeCl3	Orange colour / Yellow ppt / Blue-black	Present
Saponins	Foam Test	Formation of stable foam	Present
Carbohydrates	Molisch / Fehling / Benedict	Violet ring / Yellow-brick red / Red-brown ppt	Present
Glycosides	Killer-Kiliani Test	Reddish brown at junction, bluish green top	Present
Tannins & Phenolics	FeCl3 / Lead Acetate / Iodine / NaCl	Black / Yellow ppt / Red colour / Yellow solution	Present
Terpenoids & Steroids	Salkowski Test	Greenish yellow fluorescence	Present

Fig.No.1 Shinoda test.

Fig. No. 2 Lead acetate test.

Fig.No. 3 Ferric chloride test.

Fig.No.4 Molish's test

Fig.No.5 Fehling's test

Fig.No.6 Benedict's test

Fig.No.7 Foam test

Fig.No.8 Killer killani test

Fig.No.9 Salkowski test

Fig.No.10 Acetic acid test

Fig.No.11 Dilute iodine test

Fig.No.12 Sodium chloride test

Figure: Qualitative phytochemical screening of stigma maydis hydroalcoholic extract.

3.2 Physicochemical Characterization of Formulated Syrup

The evaluation tests conducted on the final herbal syrup formulation showed highly acceptable pharmaceutical characteristics. The recorded data parameters are detailed in Table 3.

Table 3: Evaluation Results of Formulated Herbal Syrup.

Evaluation Parameter	Result Value	Inference / Status
Colour	Golden brown	Acceptable appearance
Odour	Pleasant and slightly citrus	Good patient acceptability
Taste	Sweet	Palatable
Appearance	Smooth and little viscous	Uniform formulation
pH	4	Suitable for oral syrup
Density	1.22 g/ml	Proper consistency
Specific Gravity	1.26	Stable formulation
Viscosity	24.84 cp	Good pourability
Stability	Colour, odour, taste, appearance remain same	Stable preparation over 15 days

Fig.No13Organoleptic evaluation

Fig.No.14 pH determination

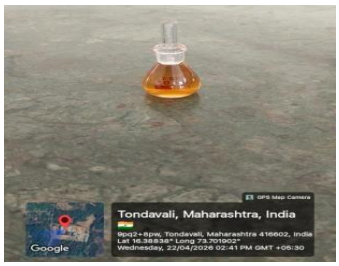

Fig.No.15 Density test of syrup

Fig.No.16 Viscosity of syrup

Fig.No.17 Viscosity of water

Fig.No.18 Syrup at first day

Fig.No.19 Syrup at 15th day.

Mathematical Derivations for Physical Parameters

- **Density Analysis:** Weight of empty dry bottle (w1) = 15.24 g Weight of bottle with unknown liquid (w2) = 27.24 g Calculate weight (w3 = w2 - w1) = 12 g Volume of unknown sample (v) = 9.8 ml.
- **Specific Gravity Analysis:** Weight of empty dry bottle (w1) = 15.24 g Weight of bottle with water (w2) = 24.72 g Weight of bottle with unknown liquid (w3) = 27.24 g Weight of water (w4 = w2 - w1) = 9.48 g Weight of sample (w5 = w3 - w1) = 12 g
- **Viscosity Analysis:** The viscometric flow periods generated using the Ostwald setup are tabulated in Table 4.

Table 4: Viscosity Flow Observation.

Liquid Medium	Time in Sec (Trial 1)	Time in Sec (Trial 2)	Time in Sec (Trial 3)	Mean Flow Time (t)
Water Reference	60	63	65	62.66 sec
Syrup Sample	1413	1450	1397	1420 sec

Given: (Density of sample) = 1.22 g/ml, (Density of water) = 0.99 g/ml, t2 = 62.66 s, t1 = 1420 s, and (Viscosity of water) = 0.89 cp.

The dynamic viscosity value of 24.84 cp represents ideal flow and pourability characteristics for administrative liquid systems. The short-term accelerated stability testing performed over a 15-day layout showed that the parameters of colour, odour, taste, and general appearance remained identical to day one. No signs of phase modification, precipitation, or bacterial turbidity were observed.

4. CONCLUSION

The present study successfully formulated and evaluated a Corn Silk (Stigma maydis) herbal syrup intended for the supportive management of urinary tract infections. Hydroalcoholic extraction of corn silk successfully yielded essential phytoconstituents such as flavonoids,

tannins, saponins, glycosides, phenolic compounds, terpenoids, and steroids, which are responsible for its medicinal properties. The prepared herbal syrup exhibited satisfactory organoleptic characteristics including acceptable golden- brown colour, pleasant citrus-like odour, and sweet taste, alongside appropriate physicochemical properties such as pH, viscosity, density, and specific gravity.

The formulation also demonstrated good short-term stability under room temperature storage conditions. Corn silk possesses natural diuretic, antioxidant, and anti-inflammatory activities, which help in relieving symptoms associated with urinary tract infections by promoting the flushing out of uropathogens. The herbal syrup formulation was found to be simple to prepare, economical, and suitable for patient compliance. Therefore, the formulated Corn Silk herbal syrup can serve as a promising, safe, and effective herbal alternative or supportive therapy for urinary tract infections with minimized risks of synthetic drug resistance or side effects.

5. Future prospects

1) Antimicrobial Profiling: Further antimicrobial studies can be carried out against different UTI-causing microorganisms such as Escherichia coli, Klebsiella pneumoniae, and Proteus species.
2) Advanced Phytochemical Analysis: Advanced phytochemical analysis and isolation of active constituents from Corn Silk can be performed for a better understanding of its therapeutic activity.
3) Clinical Trials and Safety: Clinical studies on human volunteers may be conducted to evaluate the safety, efficacy, and dosage optimization of the herbal syrup.
4) Long-term Stability: Stability studies for longer durations can be performed to determine the exact shelf life of the formulation.
5) Formulation Modification: The formulation may be modified into a sugar-free syrup suitable for diabetic patients.
6) Synergistic Combinations: The combination of Corn Silk with other medicinal herbs possessing antimicrobial activity may enhance therapeutic effectiveness against UTIs.
7) Commercial Scale-Up: Large-scale industrial production and standardization of the herbal syrup can be developed for commercial pharmaceutical applications.

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