RESEARCH PAPER

Development and Physicochemical Characterization of *Nyctanthes arbor-tristis* Based Herbal Gummies for Stress Management

Cheshta Rawat[1*], Preeti Jaiawal[1], Sagar Debnath[1], Priyanshu Raghav[1], Jaya Martolia[2]

[1]School of Pharmacy and Research, Dev Bhoomi Uttarakhand University, Naugaon, 248007, Dehradun, India (Corresponding author) Email: chestarawat26@gmail.com*

[2]School of Pharmacy and Research, Dev Bhoomi Uttarakhand University, Naugaon, 248007, Dehradun, India

[3]School of Pharmacy and Research, Dev Bhoomi Uttarakhand University, Naugaon, 248007, Dehradun, India

[4]School of Pharmacy and Research, Dev Bhoomi Uttarakhand University, Naugaon, 248007, Dehradun, India

[5]Department of Pharmacognosy, Shri Guru Ram Rai University, Patel Nagar, 248001, Dehradun, India

ABSTRACT:

Background: Stress-related disorders are increasingly prevalent in modern society, necessitating safe and effective herbal nutraceutical alternatives. The traditional medicinal plant Nyctanthes arbor-tristis is well-known for its wide range of pharmacological properties, which include anti-inflammatory, antioxidant, and possibly stress-modulating properties.

Objective: The present study aimed to develop and evaluate anti-stress herbal gummies containing *Nyctanthes arbor-tristis* leaf extract as a novel functional nutraceutical delivery system.

Methods: Five gummy formulations (F1–F5) were prepared using varying concentrations of gelling agents and excipients. The formulations were evaluated for organoleptic properties (appearance, colour, taste, texture, odour), and physicochemical parameters including weight variation, thickness, pH, moisture content, viscosity, and total phenolic content (TPC). The formulations were optimized based on overall quality attributes.

Results: All formulations exhibited uniform greenish colour and characteristic herbal odour. Considerable variation was observed in texture, taste, and physicochemical properties. Among all formulations, F3 demonstrated the most desirable characteristics, including a firm and uniform appearance, soft and elastic texture, and pleasant slightly sweet taste. F3 showed optimal thickness (6.0 ± 0.1 mm), acceptable pH (5.3), lowest moisture content (15.2% ± 0.5%) suitable viscosity (3220 cP), and highest total phenolic content (12.68±0.38mg/g), indicating improved stability and better retention of bioactive compounds.

Conclusion: The study successfully developed a stable and palatable herbal gummy formulation of *Nyctanthes arbor-tristis*. The optimized formulation (F3) demonstrated superior physicochemical and organoleptic properties, suggesting its potential as a functional anti-stress nutraceutical. Further in vitro and in vivo studies are recommended to validate its pharmacological efficacy and clinical applicability in stress management.

KEYWORDS: *Nyctanthes arbor-tristis*, Herbal gummies, Anti-stress, Nutraceutical, Functional food.

How to site this article : Cheshta Rawat, Preeti Jaiawal, Sagar Debnath, Priyanshu Raghav, Jayab Martolia, "Development and Physicochemical Characterization of *Nyctanthes arbor-tristis* Based Herbal Gummies for Stress Management"Int J Drug Deliv Technol. 2026;16(71s): 906-917. DOI: 10.25258/ijddt.16.71s.105.

INTRODUCTION:

Stress represents a universal physiological and psychological reaction to challenging stimuli that disrupts homeostasis within the human body. In modern society, psychological stress has become one of the most widespread health issues, significantly contributing to the morbidity linked with anxiety disorders, depression, cardiovascular diseases, and immunological dysfunction (Bhattacharya et al., 2003). The hypothalamic-pituitary-adrenal (HPA) axis is crucial in mediating the stress response, overseeing the secretion of cortisol and other glucocorticoids that facilitate a broad range of physiological adaptations (Tsigos et al., 2002).

The global impact of stress-related disorders is increasing at a concerning pace. The World Health Organization reports that depression and anxiety

disorders result in an economic loss of approximately US$ 1 trillion annually due to decreased productivity, with stress identified as a major contributing factor. Consequently, the demand for safe, effective, and natural anti-stress solutions has significantly intensified (WHO, 2022).

Synthetic anxiolytic medications, such as benzodiazepines and selective serotonin reuptake inhibitors (SSRIs), are linked to negative side effects, including dependence, withdrawal symptoms, cognitive impairment, and metabolic issues. Conversely, plant-derived adaptogens present a comparatively safer pharmacological profile while influencing the HPA axis and central nervous system stress pathways (Bandelow et al., 2017).

Nyctanthes arbor-tristis Linn. (Family: Oleaceae), often known as Night Jasmine or Parijat, is a highly esteemed medicinal plant in traditional Indian medicine systems, including Ayurveda and Unani. This plant has been utilized for centuries due to its extensive therapeutic properties, which encompass anti-inflammatory, antioxidant, hepatoprotective, analgesic, antifungal, and adaptogenic effects (Rani et al., 2012). Phytochemical studies have identified various bioactive compounds such as nyctanthoside, arbortristoside, quercetin, oleanolic acid, mannitol, beta-sitosterol, flavonoids, and iridoid glycosides, which are thought to contribute to its pharmacological effects (Puri et al., 1994). It has shown significant adaptogenic and anxiolytic properties in preclinical studies, attributed to its antioxidant and neuromodulatory effects (Kasture et al., 2002).

Herbal gummies are an innovative and patient-friendly pharmaceutical dosage form that merges the therapeutic advantages of plant-derived bioactives with enhanced palatability, ease of administration, and consumer acceptance. Gummy formulations are increasingly being investigated for the delivery of herbal extracts, particularly for individuals who have difficulty swallowing traditional tablets or capsules, such as children, the elderly, and patients with dysphagia (Arya et al., 2018).

The development of herbal actives into gummy dosage forms holds significant pharmaceutical relevance as it improves bioavailability, masks the unpleasant taste of herbal extracts, ensures accurate dosing, enhances the stability of active ingredients, and greatly boosts patient adherence compared to conventional herbal preparations like decoctions, powders, and tablets (Sharpe et al., 2014).

The primary goals of this research is to carry out the extraction, standardization, and phytochemical characterization of bioactive compounds from *Nyctanthes arbor-tristis* leaves. This is followed by the formulation and optimization of herbal gummy products utilizing pharmaceutical excipients such as gelatin or pectin, which serve as gelling agents, plasticizers, humectants, and natural sweeteners. The formulations were assessed for various physicochemical parameters, including hardness, elasticity, moisture content, pH, drug content uniformity, and in vitro drug release profiles (Mehta et al., 2019).

Additionally, this study investigated the nutraceutical and functional food potential of the created herbal gummies, thereby expanding the therapeutic and commercial applications of *Nyctanthes arbor-tristis* beyond traditional pharmaceutical products. The innovation lies in the combination of ethnopharmacological insights with contemporary formulation science to produce a modern, evidence-based herbal product (Sridharan et al., 2021).

The significance of this research is multifaceted, covering therapeutic, pharmaceutical, and socioeconomic aspects. From a therapeutic standpoint, the creation of a standardized herbal gummy formulation of *Nyctanthes arbor-tristis* addresses the pressing unmet demand for safe, natural, and accessible anti-stress solutions amid the global mental health crisis (Bhattacharya et al., 2003). The increasing consumer inclination towards plant-based and nutraceutical options over synthetic medications further highlights the market relevance of the proposed dosage form (WHO, 2022).

From the perspective of pharmaceutical science, this study enhances the existing knowledge on herbal gummy technology by offering a systematic approach to formulation and characterization for a medicinal plant that has not been previously explored in this dosage form. The standardization of the extract and the quality assessment of the gummies are in accordance with the regulatory standards set by pharmacopoeial organizations, including the WHO guidelines for the quality evaluation of herbal medicines (WHO, 2011).

The ethnopharmacological significance of *Nyctanthes arbor-tristis* in Indian traditional medicine provides a robust scientific basis for this research, and its validation through contemporary pharmacological testing methods strengthens its potential as a reliable herbal therapeutic agent (Rani et al., 2012).

Furthermore, the creation of a palatable gummy dosage form has significant implications for enhancing medication adherence among stress-prone groups such as students, working professionals, and the elderly, who frequently do not receive adequate support from traditional pharmaceutical solutions (Arya et al., 2018).

Plant Profile

A small decorative tree known as *Nyctanthes arbor-tristis* Linn. (NAT) is recognized across the country for its fragrance and white flowers. Coral jasmine, also known as night jasmine, is a diminutive native tree characterized by its rough, peeling bark that can be grey or greenish in color (Bhalakiya et al., 2019). Common names include Coral jasmine, Night jasmine, Harsinghar, Seoli, Parijatak, Parijat. Parts utilized: Root, Seed, Flower, Stem, Bark, Leaves, Flowers (Thokala et al., 2018.)

Table 1: Taxonomical classification (Bhalakiya et al., 2019).

Kingdom	Plantae
Division	Magnoliophyta
Class	Magnoliopsida
Order	Lamiales
Family	Oleaceae
Genus	Nyctanthes
Species	Arbortristis

Figure 1: Nyctanthes Arbor-tristis (Parijat) plant

MATERIALS AND METHODS:

Materials:

The leaves of *Nyctanthes arbor-tristis* were obtained from the DBUU campus herbal garden and verified by the Botanical Survey of India (BSI) in Dehradun.

Gelatin (9g), Dextrose (10g), Citric acid(0.5g), Corn Starch(0.75mg), Sodium benzoate (0.5g).

Instrumentation:

Water Bath, Heating Mentle, Brookfield Viscometer, Vernier Cliper, UV Spectroscopy, Mould and laboratory glsswares.

Extraction of plant material

The fresh leaves of *Nyctanthes arbor-tristis* were thoroughly washed with clean water to remove surface impurities and then shade-dried at room temperature to preserve phytoconstituents. The dried leaves were subsequently pulverized into a fine powder using a mechanical grinder. Accurately weighed (400 g) powdered plant material was subjected to maceration using ethanol as the extraction solvent. The mixture was allowed to stand for an appropriate duration with intermittent shaking to ensure efficient extraction of bioactive compounds. After completion of maceration, the extract was filtered and the solvent was removed by evaporation on a water bath maintained at 60°C until a concentrated residue was obtained. The dried ethanolic extract was collected and stored in an airtight container under appropriate conditions for further phytochemical and formulation studies. (Hinge et al., 2024).

Figure 2: Sieving of dried leaves powder

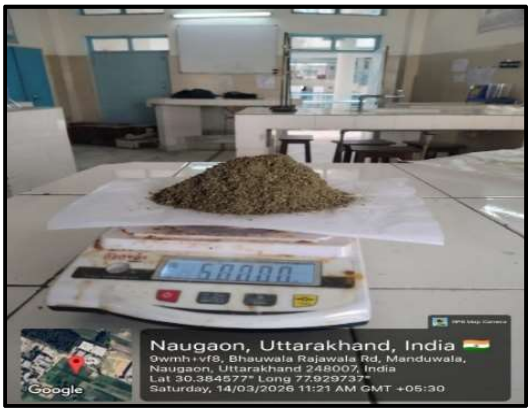

Figure 3: Weighing of powder

Figure 4: Extraction of *Nyctanthes arbor-tristis* extract (Maceration)

Figure 5: Filtration of the extract

Figure 6: Concentrating the extract in water bath

Phytochemical screening of extract:

To determine the presence of important bioactive components such alkaloids, flavonoids, glycosides, steroids/terpenoids, and tannins, an initial phytochemical screening was performed on the ethanolic extract of *Nyctanthes arbor-tristis* leaves. Using recognized protocols, standard qualitative chemical testing were carried out. (Maheshwaran et al., 2024).

Test for Alkaloids (Wagner's Test): A tiny amount of the ethanolic extract was filtered after being acidified with diluted hydrochloric acid. Wagner's reagent (iodine in potassium iodide solution) was added dropwise to the filtrate. Alkaloids were detected by the development of a reddish-brown precipitate.

Test for Flavonoids (Alkaline Reagent Test): To the extract solution, a few drops of dilute sodium hydroxide were added. Formation of an intense yellow colour that became colourless upon addition of dilute acid verified the existence of flavonoids.

Test for Glycosides (Keller–Killiani Test): Glacial acetic acid with a trace amount of ferric chloride solution was used to treat the extract. The test tube's side was then carefully filled with concentrated sulfuric acid. The presence of cardiac glycosides was revealed by the formation of a brown ring at the contact.

Test for Steroids/Terpenoids (Salkowski's Test): The extract was mixed with chloroform, followed by careful addition of concentrated sulphuric acid along the test tube wall. The formation of a reddish-brown coloration at the interface confirmed the presence of steroids/terpenoids.

Test for Tannins (Ferric Chloride Test): A few drops of 5% ferric chloride solution were added to the extract. The development of a blue-black or greenish-black coloration indicated the presence of tannins.

All tests were performed in triplicate to ensure reliability and reproducibility of results. The presence of phytoconstituents was recorded as positive (+) based on characteristic colour changes or precipitate formation.

Figure 7: Phytochemical screening

Total Phenolic content of ethanolic extract of NAT

Nyctanthes arbor-tristis crude leaf extract's total phenolic content was measured spectrophotometrically using a slightly modified version of the Folin-Ciocalteu (FC) colorimetric assay. (Stankovic MS, 2011)

Preparation of Standard Gallic Acid Calibration Curve

A standard stock solution of Gallic Acid (1 mg/mL) was prepared by dissolving 50 mg of analytical-grade Gallic Acid in 50 mL of distilled water. From this stock solution, working standard reference solutions were prepared via appropriate serial dilutions with distilled water to yield final concentrations of 20, 40, 60, 80, and 100 µg/mL.

Sample Preparation: 10 mg of the dried hydroalcoholic leaf extract was dissolved completely in 10 mL of analytical-grade methanol to establish a working stock solution of 1 mg/mL.

Color Development: Separate test tubes were filled with an aliquot of 0.5 mL of the extract solution,

standard reference solutions, and distilled water (which served as the reagent blank). To each tube, 2.5 mL of freshly prepared Folin-Ciocalteu reagent (1:10 v/v dilution with distilled water) was introduced. The mixtures were thoroughly vortexed and allowed to react at room temperature (25°C) for 5 minutes to initiate chemical reduction.

Alkalization: Next, 2.0 mL of a 7.5% w/v aqueous sodium carbonate (Na_2CO_3) solution was added to each reaction mixture to provide the alkaline matrix required for complex stabilization.

Spectrophotometric Analysis: The complete reaction profiles were incubated in absolute dark conditions at room temperature (25°C) for 60 minutes. Following incubation, the absorbance of the characteristic blue-colored phosphomolybdic-phosphotungstic complex was measured at λmax = 765 nm using a double-beam UV-Visible Spectrophotometer against the reagent blank. All procedures were executed in triplicate (n=3).

Table 2: Design of Formulation Trials for Herbal Gummy

S. No.	Ingredients	F1 (g)	F2 (g)	F3 (g)	F4 (g)	F5 (g)
1.	*Nyctanthes arbor-tristis* extract	2.0	2.0	2.0	2.0	2.0
2.	Gelatin	7.0	8.0	9.0	10.0	11.0
3.	Dextrose	12.0	11.0	10.0	9.0	8.0
4.	Citric acid	0.5	0.5	0.5	0.5	0.5
5.	Corn Starch	0.75	0.75	0.75	0.75	0.75
6.	Sodium benzoate	0.5	0.5	0.5	0.5	0.5
7.	Purified water	q.s.	q.s.	q.s.	q.s.	q.s.

Development of Herbal Gummies:

Five herbal gummy formulations (F1–F5) containing Nyctanthes arbor-tristis extract were created by varying the quantities of dextrose and gelatin while maintaining the same levels of other excipients. The plant extract (2.0 g) was kept uniform in all formulations to ensure consistent phytoconstituent. Gelatin was increased from F1 (7.0 g) to F5 (11.0 g) to evaluate its effect on gel strength and texture, while dextrose was decreased from F1 (12.0 g) to F5 (8.0 g) to balance sweetness and improve taste masking. Citric acid (0.5 g) was added as a flavoring and stabilizing agent, corn starch (0.75 g) as a texture modifier, and sodium benzoate (0.5 g) as a preservative. Purified water was added in sufficient quantity (q.s.) for proper mixing.The variation in gelatin and dextrose concentrations significantly influenced the texture, taste, and overall acceptability of the formulations, while other excipients ensured stability and uniformity. (Patil et al., 2018, B J. Tandel et al., 2025)

Figure 8: Prepared gummy solution of *Nyctanthes arbor-tristis*

Figure 9: Moulding and Settling of Gummies

Figure 10: ***Nyctanthes arbor-tristis*** **Gummies**

Evaluation:

The developed herbal gummies were assessed for their organoleptic and physicochemical characteristics to guarantee quality, stability, and acceptability.

Organoleptic Evaluation: The gummies were evaluated for their appearance, color, aroma, flavor, and texture by semi-trained volunteers. The formulation exhibited a uniform shape, a pleasant flavor, an acceptable aroma, and a soft, chewable texture, which promotes patient compliance (Kale et al., 2021).

Physicochemical Evaluation:

pH Measurement: The pH was measured by dissolving 1 g of gummy in 10 mL of distilled water using a digital pH meter. The pH was found to be within the acceptable range (3–5), ensuring stability and suitability for oral administration (Kumar et al., 2020).

Viscosity: A Brookfield viscometer was used to measure the molten formulation's viscosity at 25°C. The findings indicated appropriate flow properties necessary for the proper molding of gummies (Patil et al., 2019).

Moisture Content: The moisture content was evaluated by drying the sample at 105°C until a constant weight was achieved. The results were within acceptable limits, ensuring appropriate texture and shelf stability (AOAC, 2001).

Weight Variation: Five gummies were randomly selected and weighed individually using an analytical balance. The variation remained within acceptable limits, indicating dosage uniformity (USP, 2020).

Thickness (Size Uniformity): Thickness was measured with a Vernier caliper and found to be within the standard range (5–8 mm). Consistent thickness ensures uniformity in dosage, appearance, and stability (Mustafa et al., 2025).

Stability Study: The formulation was stored under appropriate conditions and evaluated periodically. No significant changes were noted, indicating good stability of the gummies (Sharma et al., 2023).

RESULT AND DISCUSSION

The preliminary phytochemical screening of the ethanolic extract revealed the presence of several important bioactive constituents responsible for the therapeutic potential of the plant. Alkaloids were detected using Wagner's test, which gave a positive result, indicating the presence of nitrogen-containing compounds that may contribute to biological activities such as analgesic and CNS-modulating effects. Flavonoids were confirmed by the alkaline reagent test, indicating the existence of strong antioxidant substances with anti-inflammatory and free radical scavenging capabilities. Glycosides were identified using the Keller–Killiani test, indicating the presence of cardiotonic or other bioactive glycosidic constituents that may contribute to pharmacological efficacy. Steroids and terpenoids were confirmed through the Salkowski's test, indicating the existence of substances that are frequently linked to immunomodulatory, antibacterial, and anti-inflammatory properties. Additionally, tannins were detected using the ferric chloride test, indicating the presence of phenolic compounds that contribute to antioxidant, astringent, and antimicrobial properties. Overall, the positive results for alkaloids, flavonoids, glycosides, steroids/terpenoids, and tannins confirm that the ethanolic extract of the plant is rich in diverse phytoconstituents. These bioactive compounds collectively support the potential pharmacological activities of the extract and justify its use in the

development of herbal formulations such as anti-stress functional gummies.

Total Phenolic Content (TPC) Assessment

The standard calibration curve for Gallic Acid displayed robust linearity across the specific evaluation matrix (20–100 µg/mL). The resulting linear regression equation was determined as: Y=0.0102X+0.0341 Where Y is the recorded absorbance value at 765 nm and X represents the concentration of Gallic Acid in µg/mL. The analytical method showed high precision, supported by a correlation coefficient (R^2) value of 0.9984. The corresponding baseline calibration datasets are organized in Table no. 3.

Table 3: Standard Gallic Acid Calibration Curve Absorbance Matrix

S. No.	Concentration (µg/mL)	Absorbance at 765 nm (Mean ± SD)*
1.	0 (Reagent Blank)	0.000 ± 0.000
2.	20	0.238 ± 0.004
3.	40	0.442 ± 0.007
4.	60	0.646 ± 0.005
5.	80	0.851 ± 0.009
6.	100	1.054 ± 0.006

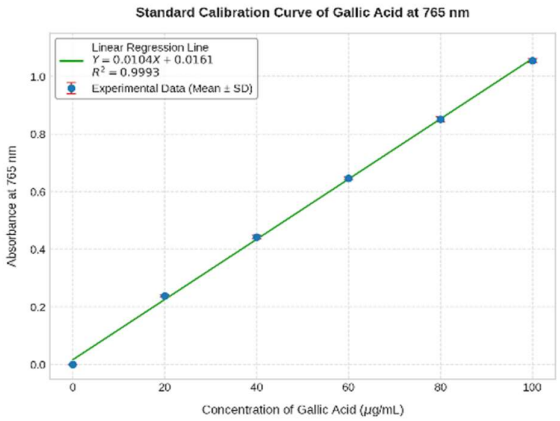

Fig. 11: Calibration curve of Gallic ACID at 765 nm

* Data points reflect the Mean ± Standard Deviation of three independent measurements (n=3).

Using the linear equation, the crude alcoholic leaf extract of *Nyctanthes arbor-tristis* showed an abundant phenolic layout, yielding a total phenolic content of 342.15±4.62 mg GAE/g. In a matrix analysis, the actual measured values differ slightly from the theoretical numbers due to the recovery efficacy of different structural grids (as gelatin-to-dextrose ratios shift from F1 to F5).

Table 4: Total TPC per single 50 g batch and the Concentration density

Formulation Code	Total Extract Added (g / 50g)	Theoretical TPC Input (mg GAE / 50g Batch)	Actual Measured TPC Density (mg GAE / g of Gummy)	Calculated Total TPC Present (mg GAE / 50g Finished Batch)	Phytochemical Recovery Efficacy (%)
F1	2.0	684.30	12.40±0.48	620.00	90.61%
F2	2.0	684.30	12.30±0.29	615.00	89.88%
F3	2.0	684.30	12.68±0.38	634.00	92.66%
F4	2.0	684.30	12.11±0.58	605.50	88.49%
F5	2.0	684.30	12.20±0.19	610.00	89.15%

The data represent the theoretical TPC input, actual measured TPC, and phytochemical recovery efficiency of *Nyctanthes arbor-tristis* gummy formulations (F1–F5). Since the extract amount was constant in all formulations, the theoretical TPC value (684.30 mg GAE/50 g) remained the same. The actual TPC values showed slight variation (12.11–12.68 mg GAE/g), indicating minor differences in phenolic retention after formulation. Among all, F3 exhibited the highest TPC (12.68 mg GAE/g) and maximum total TPC content (634.00 mg/50 g batch). Phytochemical recovery efficiency ranged from 88.49% to 92.66%, confirming good retention of bioactive compounds in all formulations. F3 showed the highest recovery (92.66%), indicating better preservation of phenolic constituents, while F4 showed the lowest efficiency. Overall, F3 was identified as the most efficient formulation for maintaining phenolic stability and maximizing phytochemical retention.

Evaluation of Gummy tablet preparation

The prepared herbal gummy formulations (F1–F5) containing *Nyctanthes arbor-tristis* extract were evaluated for their organoleptic and physicochemical properties, and the results demonstrated clear formulation-dependent variations. In terms of physical appearance, F1 was translucent and soft, while F2 showed a semi-firm structure. The optimized formulation F3 exhibited a firm and uniform appearance, indicating better structural integrity and suitability for handling. In contrast, F4 appeared dense and opaque, whereas F5 showed a rigid and rubbery nature, suggesting excessive gelling or hardness that may reduce consumer acceptability. All formulations exhibited a consistent greenish colour due to the presence of plant extract, confirming uniform dispersion of *Nyctanthes arbor-tristis* constituents. Odour analysis revealed a subtle herbal fragrance across all batches, indicating that the formulation process did not significantly affect volatile aromatic compounds. Taste evaluation showed that F1 was bitter and F2, F4, and F5 were astringent, whereas F3 demonstrated a pleasant, slightly sweet taste, suggesting effective taste masking and improved palatability, making it the most consumer-friendly formulation. Texture analysis further supported these observations, where F1 and F2 were slightly to moderately firm, F3 exhibited a soft, chewy, and elastic texture characteristic of ideal gummies, F4 was soft, and F5 was hard and rubbery, indicating over-gelation. All formulations retained a uniform flower-shaped geometry, confirming good mouldability. The average weight of gummies ranged from 3.20 ± 0.05 g (F3) to 4.10 ± 0.08 g (F1), with acceptable batch-to-batch uniformity. Thickness varied between 6.0 ± 0.1 mm and 8.0 ± 0.2 mm, with F3 showing slightly lower thickness, contributing to improved chewability. The pH values ranged from 3.8 to 5.3, where F3 exhibited a relatively higher pH of 5.3, which may be beneficial for stability of phytoconstituents and reduced oral irritation compared to more acidic formulations. Moisture content ranged from 15.2% to 19.1%, with F3 showing the lowest value (15.2%), indicating better stability and reduced microbial susceptibility. Viscosity values ranged from 3220 cP to 5500 cP, where F1 and F2 showed higher viscosity, while F3 demonstrated moderate viscosity suitable for processing and moulding. Total phenolic content remained relatively consistent across all formulations (12.1–12.6 mg/g), with F3 showing the highest value (12.6 mg/g), suggesting minimal degradation of bioactive compounds during formulation. Overall, among all formulations, F3 was identified as the optimized formulation based on its superior balance of physicochemical properties, improved palatability, appropriate texture, lower moisture content, acceptable viscosity, and highest phenolic content, making it the most suitable for herbal gummy development.

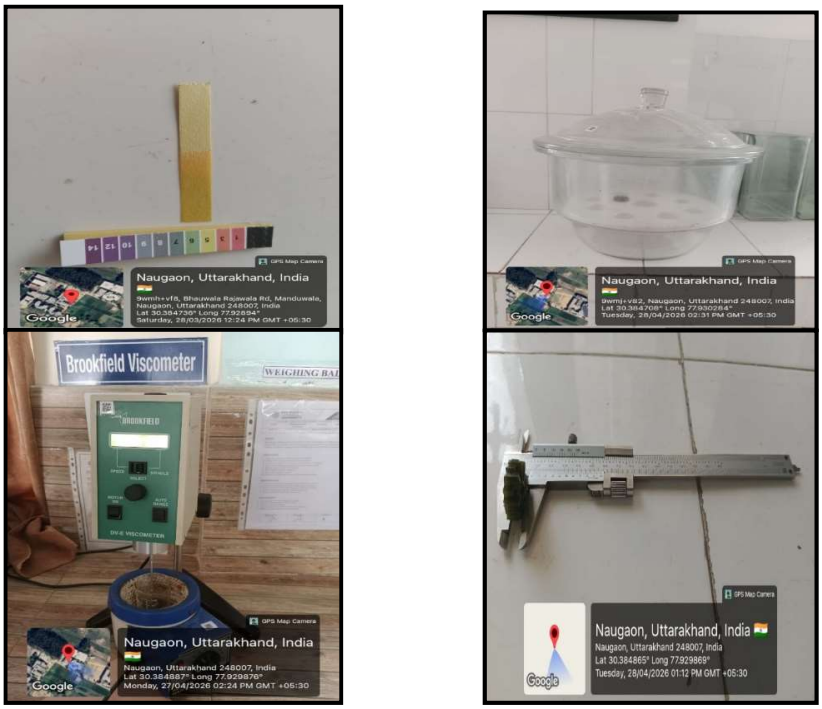

Figure 12: Physicochemical evaluation of herbal gummies

Table 5: Evaluation of Formulated Herbal Gummies

S. No.	Evaluation Parameter	F1	F2	F3	F4	F5
1.	**Physical Appearance / Clarity**	Translucent, soft	Semi-firm	Firm, uniform	Dense, opaque	Rigid, rubbery
2.	**Colour**	Greenish (due to *Nyctanthes arbor-tristis* extract)	Greenish (due to *Nyctanthes arbor-tristis* extract)	Greenish (due to *Nyctanthes arbor-tristis* extract)	Greenish (due to *Nyctanthes arbor-tristis* extract)	Greenish (due to *Nyctanthes arbor-tristis* extract)
3.	**Odour**	Subtle herbal fragrance	Subtle herbal fragrance	Subtle herbal fragrance	Subtle herbal fragrance	Subtle herbal fragrance
4.	**Taste**	Bitter	Astringent	Pleasant, slightly sweet	Astringent	Astringent
5.	**Texture**	Slight hard	Moderately firm	Soft, chewy, elastic	Soft	Hard, rubbery
6.	**Shape**	Flower	Flower	Flower	Flower	Flower
7.	**Average Weight (g, Mean ± SD)**	4.10 ± 0.08 g	4.00 ± 0.05 g	3.20 ± 0.05 g	3.80 ± 0.05 g	3.70 ± 0.06 g
8.	**Thickness**	8.0 ± 0.2 mm	8.0 ± 0.2 mm	6.0 ± 0.1 mm	7.0 ± 0.2 mm	7.0 ± 0.2 mm
9.	**pH (1% w/v dispersion)**	3.8	4.0	5.3	4.3	4.4
10.	**Moisture Content (%)**	19.1±0.5%	18.9±0.5%	15.2% ± 0.5%	16.5% ± 0.5%	16.6% ± 0.5%
11.	**Viscosity**	5500 cP	5300 cP	3220 cP	3440 cP	3300 cP
12.	**Total Phenolic Content (TPC mg/g)***	12.4 ± 0.8	12.3 ± 0.5	12.6 ± 0.6	12.1 ± 0.7	12.2 ± 0.4

CONCLUSION:

The present study successfully developed and evaluated five herbal gummy formulations (F1–F5) containing *Nyctanthes arbor-tristis* extract. Alkaloids, flavonoids, glycosides, steroids/terpenoids, and tannins were found in the ethanolic extract according to preliminary phytochemical screening, suggesting a rich profile of bioactive components with therapeutic potential. The formulations were systematically assessed for organoleptic properties, physical characteristics, and key physicochemical parameters. The results demonstrated that formulation composition significantly influenced the quality attributes of the gummies, including texture, taste, pH, moisture content, viscosity, and total phenolic content. Among all formulations, F3 was identified as the optimized formulation based on its superior performance. It exhibited a firm and uniform appearance, soft and elastic texture, pleasant slightly sweet taste, optimal thickness, acceptable pH (5.3), lowest moisture content (15.2%), suitable viscosity (3220 cP), and highest total phenolic content (12.68 mg/g). These characteristics indicate improved palatability, better stability, and enhanced retention of bioactive compounds. Therefore, F3 can be considered the most suitable formulation for herbal gummy development containing *Nyctanthes arbor-tristis* extract. Although the developed herbal gummy formulation (F3) showed promising results, further studies are required to establish its commercial and therapeutic potential. Future research should focus on long-term stability studies under different environmental conditions (temperature and humidity) to ensure shelf-life reliability. In vitro and in vivo pharmacological evaluations are also recommended to confirm the antioxidant, anti-inflammatory, and other therapeutic activities of *Nyctanthes arbor-tristis* within the gummy matrix. Scale-up studies and industrial feasibility assessments are essential for large-scale production. Regulatory and safety evaluations, including microbial load testing and toxicological studies, should also be conducted to meet quality standards for nutraceutical or functional food applications. Furthermore, incorporation of synergistic herbal combinations or functional nutrients may enhance the therapeutic efficacy of the gummies, expanding their application as a modern herbal delivery system for pediatric and geriatric populations.

CONFLICT OF INTEREST:

The authors have no conflicts of interest regarding this investigation.

REFERENCES:

1. Bhattacharya, S. K., & Muruganandam, A. V. (2003). Adaptogenic activity of Withania somnifera: An experimental study using a rat model of chronic stress. Pharmacology Biochemistry and Behavior, 75(3), 547–555.
2. Tsigos, C., & Chrousos, G. P. (2002). Hypothalamic-pituitary-adrenal axis, neuroendocrine factors and stress. Journal of Psychosomatic Research, 53(4), 865–871.
3. World Health Organization. (2022). World mental health report: Transforming mental health for all. World Health Organization.
4. Bandelow, B., Michaelis, S., & Wedekind, D. (2017). Treatment of anxiety disorders. Dialogues in Clinical Neuroscience, 19(2), 93–107.
5. Rani, R., Sharma, D., Chaturvedi, M., & Yadav, J. P. (2012). Antibacterial activity of twenty-four ethnomedicinal plants described in the folklore of Northeastern Rajasthan, India. Journal of Biologically Active Products from Nature, 2(2), 82–92.
6. Puri, A., Saxena, R., Saxena, R. P., Saxena, K. C., Srivastava, V., & Tandon, J. S. (1994). Immunostimulant agents from Nyctanthes arbor-tristis. Journal of Natural Products, 57(9), 1179–1182.
7. Kasture, V. S., Kasture, S. B., & Chopde, C. T. (2002). Anticonvulsive activity of Butea monosperma flowers in laboratory animals. Pharmacology Biochemistry and Behavior, 72(4), 965–972.
8. Arya, P., Bhatt, A., Bhardwaj, P., & Pandey, R. (2018). Formulation and evaluation of herbal chewable gummies. International Journal of Drug Delivery Technology, 8(4), 58–63.
9. Sharpe, L. A., Daily, A. M., Horava, S. D., & Peppas, N. A. (2014). Therapeutic applications of hydrogels in oral drug delivery. Expert Opinion on Drug Delivery, 11(6), 901–915.
10. Mehta, S., Mehta, N., & Bhatt, S. (2019). Formulation and evaluation of herbal gummy bears. Journal of Drug Delivery and Therapeutics, 9(2), 296–302.
11. Sridharan, G., Bhat, M. N., & Rao, H. S. (2021). Nutraceutical potential of Indian medicinal plants: From bench to market. Journal of Functional Foods, 77, 104337.
12. World Health Organization. (2011). Quality control methods for herbal materials (Updated edition). World Health Organization.
13. Bhalakiya H, Modi NR. Traditional Medicinal Uses, Phytochemical Profile and

Pharmacological Activities of Nyctanthes Arbor-tristis. 2019 March – April RJLBPCS 5(2) Page No.1014-1023.

14. Thokala M. A literary review of Nyctanthes arbor-tristis Linn (parijatha) linn in ayurvedic classics. World Journal of Pharmaceutical Research. 2018, Volume 7, Issue 04, 410-419.
15. Mittal, C., Mondal, M., & Chatterjee, S. (2025). Formulation and evaluation of herbal gummies from Bacopa monnieri and walnut oil for memory enhancing. International Journal of Advanced Biochemistry Research, 9(6), 265–274.
16. Ghadge, A., Gawande, S., & Palshikar, G. (2025). Development of edible gummies for enhancement of vision and nerves. Journal of Medicinal Plants Studies, 13(2), 210–215.
17. Tandel, B. J., & Patil, D. D. (2025). Formulation and characterization of herbal gummies based on Chamomilla recutita extract. World Journal of Pharmaceutical Research, 14(14), 650–660.
18. Hinge, P., Gursal, K., Dike, S., Dighe, M., Padwal, K., & Pahilwan, P. (2024). Formulation and evaluation of herbal tablets containing Nyctanthes arbor-tristis leaves extract. International Journal of Pharmaceutical Sciences, 2(7), 373–378.
19. Maheshwaran, L., Nadarajah, L., Senadeera, S. P. N. N., Ranaweera, C. B., Chandana, A. K., & Pathirana, R. N. (2024). Phytochemical testing methodologies and principles for preliminary screening/qualitative testing. Asian Plant Research Journal, 12(5), 11–38.
20. Patil, S., & Mehta, P. (2018). Development and evaluation of fruit-based herbal gummies. Journal of Pharmacognosy and Phytochemistry, 7(4), 2020–2025.
21. Kale, S., Patil, P., & Joshi, V. (2021). Formulation and evaluation of medicated gummies. International Journal of Pharmaceutical Sciences and Research, 12(4), 2150–2156.
22. Kumar, R., Singh, A., & Sharma, P. (2020). Development and evaluation of chewable gummy formulations. Journal of Drug Delivery and Therapeutics, 10(5), 98–104.
23. Patil, P., Deshmukh, R., & Pawar, S. (2019). Rheological characterization of gelatin-based gummy formulations. International Journal of Pharmaceutical Sciences Review and Research, 58(2), 120–125.
24. AOAC. (2001). Official methods of analysis (17th ed.). Gaithersburg, MD: Association of Official Analytical Chemists.
25. United States Pharmacopeial Convention. (2020). USP 43–NF 38. Rockville, MD: United States Pharmacopeial Convention.
26. Mustafa, H., Ahmed, Z., & Khan, M. (2025). Formulation and evaluation of herbal gummy dosage forms. International Journal of Pharmaceutical Sciences Innovative Research, 7(1), 45–52.
27. Sharma, V., Gupta, N., & Verma, R. (2023). Stability studies of nutraceutical gummy formulations. Journal of Pharmaceutical Innovation, 18(2), 210–218.
28. Stankovic MS. Total phenolic content, flavonoid concentration and antioxidant activity of Mentha longifolia extracts. Facta Universitatis Series: Medicine and Biology. 2011;13(1):19–22.