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PREPARATION AND PHYSICOCHEMICAL ANALYSIS OF AJAMODADI VATAKA AND AJAMODADI VATAKA GRANULES: A COMPARATIVE PHARMACEUTICAL STUDY

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ABSTRACT

The present study was designed to prepare Ajamodadi Vataka as described in Bhaisajya Ratnavali (Amavata Rogadhikara) and its modified granule dosage form, and to evaluate their comparative physicochemical profiles. Ajamodadi Vataka was prepared using thirteen ingredients following the classical Vataka preparation method with jaggery as the binding agent. Ajamodadi Vataka Granules were developed as an alternative dosage form to enhance shelf life and reduce susceptibility to microbial contamination. Both formulations were subjected to physicochemical analysis including loss on drying, moisture content by Karl Fischer titration, pH, total ash, total sugar, and volatile oil estimation. Additionally, High Performance Thin Layer Chromatography (HPTLC) fingerprinting was performed using Toluene: Ethyl acetate: Glacial acetic acid (7:2:1 v/v) as the mobile phase. Results demonstrated that the granule form exhibited significantly lower moisture content (6.7%) compared to the classical Vataka (11.7%), indicating superior stability. HPTLC analysis revealed characteristic fingerprint profiles with prominent bands corresponding to terpenoids, phenolics, flavonoids, and essential oil fractions, confirming the retention of bioactive phytoconstituents in both formulations. The study concludes that the granule dosage form offers improved shelf stability while preserving the phytochemical integrity of the classical formulation.

KEYWORDS: Ajamodadi Vataka, Granules, HPTLC, Physicochemical analysis, Ayurvedic pharmaceutics, Bhaisajya Ratnavali

INTRODUCTION

Ayurveda, the traditional Indian system of medicine, has been employing polyherbal formulations for the management of various disorders since antiquity. Among the diverse dosage forms described in classical Ayurvedic texts, Vataka (tablet-like preparations) represents a significant category of solid oral formulations prepared by combining powdered herbs with binding agents such as jaggery or sugar (Shastri, 2014)[1]. These formulations have been extensively used owing to their ease of administration, precise dosing, and palatability.

Ajamodadi Vataka is a classical polyherbal formulation described in *Bhaisajya Ratnavali* (Amavata Rogadhikara) and is traditionally indicated in the management of *Amavata* (rheumatoid arthritis), *Agnimandya* (digestive impairment), *Adhmana* (flatulence), and allied *Vata-Kapha* dominant conditions (Mishra, 2007)[2]. The formulation comprises thirteen ingredients, with *Ajamoda* (*Apium graveolens* Linn.) as the principal drug, along with other potent *Deepana-Pachana* (digestive and carminative) herbs.

Despite the proven therapeutic efficacy of classical Vataka formulations, they present certain pharmaceutical challenges including limited shelf life, susceptibility to moisture absorption, microbial contamination, and inconsistent dosage uniformity (Lachman et al., 1986)[3]. The hygroscopic nature of jaggery-based preparations renders them vulnerable to fungal growth and insect infestation during storage, thereby compromising product quality and patient compliance.

Granulation technology, widely employed in modern pharmaceutical sciences, offers a viable approach to overcome these limitations. Granules provide improved flow properties, enhanced stability, reduced hygroscopicity, and better dose uniformity compared to conventional tablet or bolus forms (Aulton, 2013)[4]. The application of granulation techniques to Ayurvedic formulations represents a rational integration of traditional knowledge with contemporary pharmaceutical science, without compromising the therapeutic attributes of the original formulation.

Physicochemical standardization and chromatographic fingerprinting are essential quality control measures for ensuring the identity, purity, strength, and reproducibility of herbal formulations (WHO, 2011)[5]. High Performance Thin Layer Chromatography (HPTLC) has emerged as a valuable analytical tool for the standardization of polyherbal preparations due to its ability to generate characteristic fingerprint profiles (Reich and Schibli, 2007)[6].

In light of the above considerations, the present study was undertaken with the objectives of preparing Ajamodadi Vataka following the classical method, developing its granule dosage form as a modified pharmaceutical preparation, and conducting a comparative physicochemical and HPTLC fingerprint analysis of both formulations to evaluate their quality attributes and phytochemical profiles.

OBJECTIVES

1. To prepare Ajamodadi Vataka following the classical method described in Bhaisajya Ratnavali (Amavata Rogadhikara).
2. To develop Ajamodadi Vataka Granules as a modified pharmaceutical dosage form of the classical preparation.
3. To conduct a comparative physicochemical and HPTLC fingerprint analysis of both formulations to evaluate their quality attributes and phytochemical profiles.

MATERIALS AND METHODS

Collection and authentication of raw materials

All the herbal raw materials were procured from the pharmacy attached to the institution and authenticated by the Department of Dravyaguna (Pharmacognosy). The raw materials used in the formulation are enlisted in Table 1. The quantities were calculated based on the classical reference from *Bhaisajya Ratnavali*, Amavata Rogadhikara, where 1 Pala is equivalent to approximately 48 g (Anonymous, 2003)[7].

Preparation of Ajamodadi Vataka

The classical method of Vataka preparation was followed. All herbal ingredients (Sl. No. 1 to 12, Table 1) were individually cleaned, dried, and pulverized into fine powder (mesh size 80). The individual powders were weighed in the prescribed proportions and blended uniformly in a mass mixer. The required quantity of jaggery (Guda) was heated and melted to obtain a semi-solid mass. The herbal powder blend was gradually added to the molten jaggery and the mixture was triturated thoroughly in a Khalva Yantra (mortar and pestle) until a homogeneous mass of suitable consistency was obtained. The mass was then rolled into uniform Vatakas of approximately 4 g each. The prepared Vatakas were air-dried and stored in airtight containers.

Preparation of Ajamodadi Vataka Granules

Equal parts of Ajamoda, Maricha, Pippali, Vidanga, Suradaru, Chitraka, Shatapushpa, and Pippalimoola were taken and individually pulverized to obtain fine powder passing through sieve number 140. Shunti and Vriddhadaru were taken in ten parts each and powdered. Similarly, five parts of Haritaki were processed. All the powders were transferred to a mass mixer and homogenized thoroughly.

Seventeen parts of jaggery were taken and heated to prepare a three-thread consistency sugar syrup (Gudapaka). The homogenized herbal powder mixture along with one part of Saindhava Lavana was added to the Gudapaka and mixed uniformly. The resultant mass was passed through a granulator to obtain uniform granules. The granules were dried and stored in airtight containers under controlled conditions.

Paka process

Sieving

Drying of Granules

Figure 2b: Granulation process — sieving of Ajamodadi Vataka Granules

Physicochemical analysis

Both formulations were subjected to the following physicochemical parameters as per standard protocols described in the Ayurvedic Pharmacopoeia of India (Anonymous, 2003)[7] and the Indian Pharmacopoeia (IP, 2014)[8]: loss on drying at 105°C, moisture content determination by Karl Fischer titration, pH of 1% aqueous solution, total ash value, total sugar content estimation, and volatile oil content by Clevenger apparatus method.

HPTLC fingerprint analysis

Preparation of test solution: Approximately 2.5 g of each sample was weighed and dissolved in 25 mL of methanol in a conical flask. The solution was refluxed for 30 minutes and subsequently filtered through Whatman filter paper No. 1. The filtrate thus obtained was used as the test solution for HPTLC analysis.

Preparation of spray reagent (Anisaldehyde–sulphuric acid reagent): The derivatization reagent was prepared by mixing 0.5 mL of anisaldehyde with 10 mL of glacial acetic acid, followed by 85 mL of methanol and 5 mL of concentrated sulphuric acid (98%).

The chromatographic conditions employed in the study are presented in Table 3.

Table 1: Ingredients of Ajamodadi Vataka (Bhaisajya Ratnavali, Amavata Rogadhikara)

Sl. No.	Sanskrit Name	Botanical Name / Identity	Part Used	Quantity
1	Ajamoda	*Apium graveolens Linn.*	Seed	1 Pala (48 g)
2	Maricha	*Piper nigrum Linn.*	Fruit	1 Pala (48 g)
3	Pippali	*Piper longum Linn.*	Fruit	1 Pala (48 g)
4	Vidanga	*Embelia ribes Burm.f.*	Fruit	1 Pala (48 g)
5	Suradaru	*Cedrus deodara (Roxb. ex D.Don) G.Don*	Heartwood	1 Pala (48 g)
6	Chitraka	*Plumbago zeylanica Linn.*	Root	1 Pala (48 g)
7	Shatapushpa	*Anethum graveolens Linn.*	Seed	1 Pala (48 g)
8	Saindhava Lavana	Rock salt	–	1 Pala (48 g)
9	Pippalimoola	*Piper longum Linn.*	Root	1 Pala (48 g)
10	Shunti	*Zingiber officinale Roscoe*	Rhizome	10 Pala (480 g)
11	Vriddhadaru	*Argyreia speciosa (Burm.f.) Boj.*	Root	10 Pala (480 g)
12	Haritaki	*Terminalia chebula Retz.*	Fruit rind	5 Pala (240 g)
13	Guda (Jaggery)	–	–	Q.S.

RESULTS

Physicochemical parameters

The results of physicochemical analysis of Ajamodadi Vataka and Ajamodadi Vataka Granules are presented in Table 2. The loss on drying values for Vataka and Granules were 11.7% and 6.7%, respectively. Moisture analysis by Karl Fischer titration yielded values of 12.0% for Vataka and 6.3% for Granules. The pH of 1% aqueous solution was 5.6 for Vataka and 4.7 for Granules. Total ash values were 8.6% and 4.7% for Vataka and Granules, respectively. Total sugar content was 41.0% in Vataka and

67.8% in Granules. The volatile oil content was 0.2% in Vataka and 0.5% in Granules.

Table 2: Comparative physicochemical parameters of Ajamodadi Vataka and Ajamodadi Vataka Granules

Sl. No.	Parameters	Ajamodadi Vataka	Ajamodadi Vataka Granules
1	Loss on Drying (%w/w)	11.7	6.7
2	Moisture Content (Karl Fischer) (%w/w)	12.0	6.3
3	pH (1% aqueous solution)	5.6	4.7
4	Total Ash (%w/w)	8.6	4.7
5	Total Sugar (%w/w)	41.0	67.8
6	Volatile Oil (%v/w)	0.2	0.5

HPTLC fingerprint profile

The HPTLC analysis of Ajamodadi Vataka Granules revealed a characteristic chromatographic fingerprint. At 254 nm, eight distinct spots were observed with Rf values ranging from 0.11 to 0.76. At 366 nm, nine spots were detected with Rf values from 0.16 to 0.86, indicating enhanced visualization of fluorescent secondary metabolites. Post-derivatization scanning at 540 nm revealed five spots with Rf values from 0.27 to 0.76. The detailed Rf values, detection wavelengths, and probable phytochemical identities are summarized in Table 4.

Table 3: HPTLC chromatographic conditions

Parameter	Specification
Application mode	CAMAG Linomat 5 Applicator
Stationary phase	Merck HPTLC Silica gel 60 F254 on aluminium sheets
Mobile phase	Toluene : Ethyl acetate : Glacial acetic acid (7:2:1 v/v)
Sample application volume	10 µL
Application start position (Y axis)	10 mm
Development end position	80 mm from plate base
Distance between tracks	17.5 mm
Development chamber	CAMAG TLC Twin Trough Chamber
Chamber saturation time	30 minutes
Visualization	UV 254 nm, UV 366 nm, 540 nm (post-derivatization)
Spray reagent	5% Sulphuric acid in methanol
Derivatization mode	CAMAG dip tank, 1 minute
Drying	TLC plate heater at 100 ± 5°C for 3 minutes

Table 4: HPTLC fingerprint profile of Ajamodadi Vataka Granules

Rf Value	Detection (nm)	Probable Phytochemicals
0.11	254	Sugars, glycosides
0.16	366	Phenolic acids, tannins
0.23	366	Flavonoid glycosides
0.27	540	Sugars, reducing sugars

0.34	254, 366	Flavonoids, coumarins
0.41	366, 540	Terpenoids, phenolics
0.45	254, 366	Alkaloids / flavonoids
0.50	254	Essential oil fractions
0.56	366	Coumarins, volatile components
0.60	254, 366, 540	Thymol-like compounds, terpenoids
0.65	254	Volatile oils
0.71	254, 366, 540	Terpenoids, sterols
0.76	254, 540	Lipophilic compounds
0.86	366	Sesquiterpenes, hydrocarbons

DISCUSSION

The comparative physicochemical evaluation of Ajamodadi Vataka and its granule dosage form provides valuable insights into the quality attributes, stability potential, and pharmaceutical rationality of the modified formulation.

The loss on drying and Karl Fischer moisture values of the granule form (6.7% and 6.3%, respectively) were notably lower than those of the classical Vataka (11.7% and 12.0%). This reduction in moisture content is pharmaceutically significant as it directly correlates with improved shelf stability, reduced susceptibility to microbial proliferation, and enhanced resistance to physical degradation during storage (Aulton, 2013). The moisture content of the granules falls within the acceptable limits prescribed for granulated herbal formulations, suggesting adequate processing and drying protocols were employed.

The mildly acidic pH observed in both formulations (5.6 and 4.7 for Vataka and Granules, respectively) can be attributed to the presence of organic acids and volatile principles inherent in the constituent herbs, particularly *Ajamoda* and associated *Deepana-Pachana* drugs. The acidic milieu may contribute to the *Deepana-Pachana* (appetizer and digestive) pharmacological activity of the formulation, consistent with its classical therapeutic indications in *Amavata* and *Agnimandya* (Mishra, 2007). Furthermore, the acidic pH imparts inherent antimicrobial resistance, contributing to product stability (Lachman *et al.*, 1986).

The total ash value of 4.7% in the granule formulation, compared to 8.6% in the Vataka, indicates relatively lower inorganic residue content. The values remain within pharmacopoeial limits, suggesting minimal contamination with extraneous matter and adherence to good manufacturing practices during raw material processing (Anonymous, 2003).

The higher total sugar content in the granule form (67.8%) compared to the Vataka (41.0%) is attributable to the increased proportion of jaggery employed in the three-thread Gudapaka process, which serves as the granulating agent. While this enhances organoleptic acceptability, granule formation, and binding properties, it necessitates appropriate cautionary labelling for patients with metabolic disorders such as Prameha (diabetes mellitus).

The volatile oil content of 0.5% in the granules compared to 0.2% in the Vataka is a notable finding, suggesting superior retention of thermolabile aromatic phytoconstituents in the granule dosage form. This may be attributed to the rapid granulation process, which minimizes prolonged exposure to atmospheric conditions, thereby preserving the volatile oil fraction responsible for the carminative, anti-flatulent, and digestive stimulant activities of the formulation. The retention of volatile oils, particularly from *Ajamoda* and *Shatapushpa*, is crucial for the therapeutic efficacy of the preparation (Kokate *et al.*, 2005)[9].

The HPTLC fingerprint profile of Ajamodadi Vataka Granules demonstrated a rich and diverse chromatographic pattern across all three visualization wavelengths. The presence of fourteen distinct bands spanning Rf values from 0.11 to 0.86 confirms the multi-component nature of this polyherbal formulation. The lower Rf bands (0.11 to 0.34) correspond to polar constituents including sugars, glycosides, phenolic acids, tannins, and flavonoid glycosides. The mid-range Rf bands (0.41 to 0.60) are indicative of moderately polar compounds such as terpenoids, phenolics, coumarins, and essential oil fractions. The higher Rf bands (0.65 to 0.86) correspond to non-polar constituents including volatile oils, terpenoids, sterols, sesquiterpenes, and lipophilic compounds.

The selective visualization at 540 nm following anisaldehyde-sulphuric acid derivatization revealed five prominent spots, with bands at Rf 0.41, 0.60, and 0.71 serving as potential marker compounds for future standardization studies. This derivatization-specific profile is particularly valuable for detecting terpenoids, sugars, and steroidal compounds that may not be adequately visualized under UV alone (Reich and Schibli, 2007).

The comprehensive chromatographic profile validates that the granulation process preserves the phytochemical integrity of the classical formulation, demonstrating that the modified dosage form retains the bioactive constituents essential for therapeutic activity. These HPTLC fingerprints can serve as reference standards for batch-to-batch quality control and authentication of the formulation.

CONCLUSION

The present study demonstrates that Ajamodadi Vataka Granules, developed as a modified dosage form of the classical Ajamodadi Vataka described in Bhaisajya Ratnavali, exhibit superior physicochemical stability parameters compared to the traditional Vataka form. The granule formulation showed significantly reduced moisture content, lower total ash, and enhanced volatile oil retention, indicating improved shelf stability and preservation of therapeutically relevant phytoconstituents. The HPTLC fingerprint analysis confirmed the presence of diverse phytochemical classes including terpenoids, phenolics, flavonoids, glycosides, and essential oil fractions in the granule formulation. The study concludes that the granulation approach offers a pharmaceutically rational modification of the classical Vataka dosage form, ensuring improved quality, stability, and reproducibility while maintaining the phytochemical fingerprint of the original preparation. Further studies involving accelerated stability testing, microbiological evaluation, and clinical assessment are warranted to establish the granule formulation as a viable alternative to the classical Vataka.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

ETHICAL STATEMENT

The present study is a pharmaceutical and analytical investigation. No animal or human subjects were involved; hence, ethical committee approval was not applicable.

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