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Comprehensive Physicochemical Characterization and Quality Assessment of a Herbo-mineral Ayurvedic Proprietary Formulation: TA Tablet

Author: Anju Antony[1]
Co Authors: Shari Sankar[2], Anagha Mariya[3], Alisha Shajan[4], Krishnavarna CK[5], Merin Babu[6] and Bijeshmon PP[7]

[1-7]Quality Control Department (Approved by Ministry of AYUSH), Sitaram Ayurveda (P) Limited, Nedupuzha PO, Thrissur, Kerala, India

ABSTRACT

Herbo-mineral formulations play an important role in Ayurvedic therapeutics, particularly for managing low haemoglobin levels and associated symptoms such as fatigue, pallor, dizziness, shortness of breath, and palpitations. Iron deficiency is one of the most widespread nutritional disorders globally and is highly prevalent in India, especially among women of reproductive age, due to dietary insufficiency, menstrual blood loss, and poor iron absorption. TA Tablet is a proprietary Ayurvedic formulation, developed by Sitaram Ayurveda, containing *Triphala*, *Annabhedi Sindoora*, and *Yashtimadhu*, designed to enhance iron levels, improve digestion, and promote overall vitality. Standardization through physicochemical and phytochemical evaluation is essential to ensure quality, safety, and therapeutic consistency. Aim: To evaluate the physicochemical, phytochemical, and analytical characteristics of TA Tablet. Materials and Methods: Physicochemical analysis of TA Tablet included organoleptic properties, average weight, thickness, diameter, hardness, friability, disintegration time, pH (1% w/v), loss on drying, ash values, and extractive values. Phytochemical screening, total phenolic content, flame photometric assay, and iron assay were performed using standard procedures. Results: TA Tablet complied with standard pharmacopoeial physical and physicochemical parameters. Phytochemical screening confirmed the presence of major secondary metabolites. Analytical evaluations indicated appropriate iron content and phenolic constituents relevant to its therapeutic function. Conclusion: TA Tablet meets essential quality-control parameters and contains key phytoconstituents and iron content consistent with haematinic activity. These findings support its suitability as a safe and effective supplement for managing anaemia-related conditions, particularly in populations vulnerable to iron deficiency, and for enhancing overall vitality.

Key Words *Herbo-mineral, TA Tablet, Physicochemical characterization, Iron content, Anaemia management, Haematinic*

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INTRODUCTION Ayurveda, the traditional medical system of India, employs a diverse range of formulations that include herbal, mineral, and herbo-mineral preparations. Among these, herbo-

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mineral medicines hold a unique position due to their enhanced potency, rapid action, stability, and high therapeutic value[1,2]. These formulations incorporate purified minerals and metals processed through specialized techniques such as *Shodhana* (purification), *Bhavana* (trituration), and *Marana* (incineration), resulting in fine, bioavailable, and safe medicinal preparations known as *Bhasma* or *Sindoora*[3]. Herbo-mineral preparations are widely used for chronic ailments, metabolic disorders, nutritional deficiencies, and conditions requiring sustained therapeutic support[4,5]. Iron deficiency remains a major global public-health concern and continues to be one of the most common nutritional deficiencies worldwide. In India, more than half of women of reproductive age are affected by iron-deficiency anaemia due to inadequate dietary intake, menstrual blood loss, and poor absorption[6]. This high disease burden highlights the need for safe, effective, and culturally accepted haematinic supplements such as Ayurvedic herbo-mineral preparations. However, despite their clinical significance, herbo-mineral medicines must undergo stringent quality control due to concerns related to raw material variability, heavy metal contamination, inconsistent processing, and lack of standardized manufacturing practices[7]. Establishing physicochemical and phytochemical profiles is essential to ensure identity, purity, safety, and therapeutic reliability of these formulations. Evaluations such as ash values, extractive values, loss on drying, hardness, friability, disintegration time, and phytochemical tests help in confirming formulation consistency, while analytical assays like total phenolic content, Flame photometry and iron estimation provide insights into the therapeutic constituents[8]. TA Tablet is a proprietary Ayurvedic herbo-mineral formulation designed to support haematinic activity and address symptoms associated with low haemoglobin levels, including fatigue, pallor, dizziness, shortness of breath, and menstrual irregularities. The formulation contains *Triphala*, *Annabhedi Sindoora*, and *Yashtimadhu*, which work synergistically to improve iron availability, enhance digestion, support liver function, and promote antioxidant activity. Annabhedi Sindoora - an Ayurvedic calx prepared using purified iron compounds serves as a potent haematinic agent known for its safety and bioavailability when prepared under classical guidelines[9]. Despite its therapeutic importance, the formulation lacks published scientific documentation on its standardization and quality attributes.

In this context, a comprehensive physicochemical and phytochemical evaluation of TA Tablet is essential to establish scientific validation, support regulatory compliance, and ensure consistent therapeutic performance.

MATERIALS AND METHODS

Materials

TA Tablet (three different batches) was procured from the manufacturing unit of Sitaram Ayurveda (P) Ltd., Thrissur, Kerala. All chemicals and

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reagents used in the study were of analytical grade and were obtained from certified suppliers. Distilled water was used for all experimental procedures.

The instruments used for the physicochemical and analytical evaluations included a Vernier caliper (±0.02 mm accuracy), hardness tester, Friability apparatus, disintegration apparatus, pH meter, hot air oven, muffle furnace, electronic balance, UV–Visible spectrophotometer and flame photometer.

Authentication of Ingredients

Although TA Tablet is a proprietary medicine, the **ingredient verification and identity confirmation** were performed according to the standards described in the *Ayurvedic Pharmacopoeia of India (API)* and *Ayurvedic Formulary of India (AFI)*[10,11]. Raw material certificates and batch manufacturing records (BMR) were checked for compliance with classical standards applicable to Triphala, Yashtimadhu, and Annabhedi Sindoora.

Sample Preparation

For all analyses, tablets were randomly selected from each batch. Each tablet was powdered using a porcelain mortar and pestle, passed through a #60 mesh sieve, and used for physicochemical and preliminary phytochemical evaluations. For iron and phenolic content, accurately weighed portions of the powdered tablet were dissolved and extracted as per the specific analytical procedures.

Organoleptic Evaluation

Organoleptic characteristics including **appearance, colour, smell, and taste** were evaluated by trained QC analysts and Ayurvedic doctors following standard Ayurvedic guidelines documented in the Ayurvedic Pharmacopoeia of India.

Physical Evaluation

Average Weight

Ten tablets were individually weighed using a digital balance, and the mean weight, standard deviation, and percentage deviation were calculated as per USP guidelines[12].

Thickness and Diameter

Measured using a calibrated Vernier caliper by randomly selecting 10 tablets.

Hardness

Tablet hardness was determined using a hardness tester, and results were expressed in kg/cm².

Friability

Friability was tested using a Friability apparatus at 25 rpm for 4 minutes (total 100 revolutions). Percentage friability was calculated; values below 1% were considered acceptable.

Disintegration Time

Disintegration time was measured using a USP disintegration apparatus in distilled water maintained at 37 ± 0.5°C.

Physicochemical Evaluation

pH (1% w/v)

A 1% w/v aqueous solution of powdered sample was prepared and pH was measured using a calibrated digital pH meter.

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Loss on Drying (Moisture Content)

Approximately 4 g of powdered sample was dried at 105°C in a hot air oven until constant weight. Moisture content was calculated based on weight difference.

Total Ash

Two grams of sample were incinerated in a muffle furnace at 450–600°C until carbon-free ash was obtained. Results were expressed as % w/w.

Acid-Insoluble Ash

The ash obtained above was boiled with 25 mL of 2M HCl, filtered, washed, dried, ignited, and weighed.

Water-Soluble and Alcohol-Soluble Extractive Values

Extractive values were determined using maceration for 24 hours as per API procedures, using distilled water and 95% ethanol as solvents.

Preliminary Phytochemical Screening

Preliminary phytochemical screening was carried out on both aqueous and hydro-alcoholic (70:30 v/v; distilled water: methanol) extracts of the sample. Standard qualitative tests were performed to detect major phytochemical groups including alkaloids, tannins, phenolics, flavonoids, saponins, glycosides, and terpenoids using established procedures described by Harborne[13].

Total Phenolic Content

Total phenolic content was estimated using the **Folin–Ciocalteu method.** A known quantity of extract was mixed with Folin–Ciocalteu reagent and saturated sodium carbonate. After incubation at room temperature, absorbance was measured at 765 nm using a UV–Vis spectrophotometer. Results were expressed as mg gallic acid equivalent (GAE)/g extract[14].

Iron Assay

Iron content in TA Tablet was estimated by an iodometric titration method as per the Indian Pharmacopoeia[15,16]. The sample was digested with concentrated HCl, oxidized using hydrogen peroxide, and the liberated iodine (after reaction with potassium iodide) was titrated against standardized 0.1 N sodium thiosulphate using starch indicator. The iron content was calculated based on the titration factor, and results were expressed as % w/w of elemental iron.

Elemental assay by Flame photometer

Sodium, potassium, and calcium were estimated using a Systronics Flame Photometer 1027. Analytical-grade stock solutions of Na^+, K^+, and Ca^{2+} were prepared and diluted to obtain a series of calibration standards. The instrument was switched on, stabilized, and calibrated by aspirating the blank followed by each standard to generate individual calibration curves. TA Tablet powder was digested with dilute HCl, filtered, and the volume was made up to 50 mL. The sample solution was aspirated into the flame, and the emission intensities at the element-specific channels of the instrument were recorded. Concentrations of sodium, potassium, and calcium in the sample were obtained from the respective calibration curves and expressed as mg/g of the tablet[17,18].

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RESULTS AND DISCUSSION

The TA Tablet exhibited organoleptic and physical characteristics consistent with Ayurvedic compressed herbal formulations (Table No.1).

Table 1 Organoleptic Characteristics of TA Tablet

Parameter	Observation
Appearance	11 mm biconvex round shaped uncoated tablets
Colour	Brownish black
Odour	Characteristic
Taste	Astringent

The tablets showed a uniform **brownish-black appearance, characteristic odour**, and **astringent taste**, aligning with the presence of tannins and phenolic constituents. Physical quality parameters (Table No.2) including **average weight (613 mg), hardness (3 kg/cm²), friability (0.22%)**, and **disintegration time (10 minutes)**—were within acceptable pharmacopoeial limits, indicating good mechanical integrity and suitability for oral administration.

Table 2 Physical Parameters of TA Tablet

Parameter	Specification	Result
Average weight	600 mg ± 5%	613 mg
Thickness	6.10 mm± 0.2	6.9 mm
Diameter	11.32 ± 0.05 mm	11.33 mm
Hardness	2.0 - 4.0 kg/cm²	3 kg/cm²
Friability	Not More Than 1 %	0.22 %
Disintegration time (minutes)	Not More Than 30 minutes	10 minutes

Table 3 Physicochemical Parameters of TA Tablet

Parameter	Batch - 1	Batch - 2	Batch -3	Mean ± SD
pH (1% w/v)	3.01	2.98	3.02	3.00 ± 0.02
Loss on drying @ 105 °C (%)	2.93	2.96	2.94	2.94 ± 0.02
Total ash (%)	23.28	23.35	23.27	23.30 ± 0.04
Acid-insoluble ash (%)	0.62	0.64	0.63	0.63 ± 0.01
Water-soluble extractive (%)	32.40	32.46	32.42	32.43 ± 0.03
Alcohol-soluble extractive (%)	20.58	20.63	20.59	20.60 ± 0.03

Table 4 Preliminary Phytochemical Screening of TA Tablet

Phytochemical constituents	Name of the test Conducted	Aqueous extract	Hydro-Alcoholic extract
Carbohydrate	Molisch's test	+v	+
Sugar	Benedict test	+	+
Reducing sugar	Fehlings's test	+	+
Ketose	Seliwanoff's test	-	-
Amino acid	Ninhydrin test	-	-
Protein	Biuret test	+	+
Starch	K I test	-	-
Quinone	H_2SO_4	-	-
Glycoside	Keller killani	-	-
	Liebermann's test	-	-
	Salkowski test	-	-
Steroid	-	-	-
Terpenoid	-	-	-
Flavonoid	Alkaline reagent	+	+
Phenol	Phenol reagent test	+	+
Saponin	Foam test	-	-

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Alkaloid	Wagner reagent	-	-
Tannin	Ferric chloride test	-	-
Coumarin	NaOH	-	+

"+" Present, " - " Absent

Physicochemical evaluation of TA Tablet (Table No.3) confirmed its acidic nature with a pH of 3.00. All analyses were performed in triplicate and expressed as Mean ± SD. The formulation exhibited low moisture content (2.94 ± 0.02%), indicating favourable stability and reduced susceptibility to microbial growth. The total ash value was high (23.30 ± 0.04%), reflecting the herbo-mineral composition of the tablet, while the acid-insoluble ash remained low (0.63 ± 0.01%), suggesting minimal siliceous contamination. Extractive values showed higher water-soluble extractive content (32.43 ± 0.03%) compared to alcohol-soluble extractive (20.60 ± 0.03%), demonstrating the predominance of polar soluble constituents in the formulation.

Preliminary phytochemical screening (Table No.4) of both aqueous and hydro alcoholic extracts indicated the presence of **carbohydrates, reducing sugars, proteins, flavonoids, and phenolics**, which are known to contribute to antioxidant, immunomodulatory, and therapeutic properties. The detection of coumarins in the hydro-alcoholic extract further supports the presence of bioactive secondary metabolites. The absence of alkaloids, saponins, terpenoids, and glycosides suggests that these classes do not significantly contribute to the formulation's activity profile.

Analytical estimation (Table No. 5) showed a **total phenolic content of 3.35 mg GAE/g**, confirming the presence of moderate phenolic compounds that may contribute to antioxidant and protective effects. The **iron content (11.58% w/w)** was comparatively high, which is characteristic of herbo-mineral preparations and supports the traditional indications of TA Tablet for conditions requiring iron supplementation.

Table 5 Analytical Estimation of TA Tablet

Parameters Tested	Result (Mean of 3 batches)
Total phenolic content (mg GAE/g)	3.35 %
Iron content (% w/w)	11.58 %

Table 6 Elemental analysis by Flame photometer of TA Tablet

Element Tested	Result (Mean of 3 batches)
Calcium	5413.04 ppm
Potassium	7324.11 ppm
Sodium	6444.60 ppm

Although flame photometry (Table No.6) detected calcium (5413.04 ppm), potassium (7324.11 ppm), and sodium (6444.66 ppm) in TA Tablet, their per-tablet contributions (3.25 mg Ca, 4.39 mg K, 3.87 mg Na) are nutritionally minimal. However, the presence of trace Ca, K, and Na ions may contribute to digestive enzyme activation, gastrointestinal motility, and metabolic regulation, offering a supportive physicochemical correlation to digestion-related indications while serving as measurable elemental markers for quality characterization.

Overall, the results confirm that the TA Tablet meets standard physicochemical and quality

parameters and contains bioactive constituents that support its traditional therapeutic claims.

CONCLUSION

The TA Tablet complied with standard organoleptic, physical, physicochemical, and phytochemical quality parameters. The formulation exhibited appreciable levels of phenolics, flavonoids, essential minerals, and notably high iron content, supporting its traditional use as a haematinic and its potential role in improving iron deficiency. The presence of water-soluble bioactive compounds and favourable tablet characteristics further indicate good stability, quality, and suitability for consumption.

The study establishes baseline quality standards for TA Tablet that can serve as reference specifications for routine quality control, standardization, and regulatory compliance. The findings also reinforce the importance of integrating modern analytical tools with traditional Ayurvedic formulations to ensure safety, efficacy, and consistency.

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