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"*SANDHANA KALPANA* (*ASAVA* AND *ARISHTA*): A CRITICAL REVIEW OF FERMENTATION MICROBIOLOGY, SELF-GENERATED ALCOHOL AND QUALITY ISSUES"

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ABSTRACT

Background: *Asava* and *Arishta* are fermented liquid dosage forms of Ayurveda, prepared from herbal juices or decoctions with jaggery or sugar and a fermentation initiator, usually *Dhataki* (*Woodfordia fruticosa*) flowers. Their self-generated alcohol acts as a solvent and preservative, and they are among the most widely sold Ayurvedic products. **Objective:** To review the microbiology and biochemistry of *Sandhana kalpana*, the factors that govern alcohol content and product quality, and the quality and regulatory issues that arise. **Methods:** A critical narrative review of microbiological, biochemical, phytochemical and quality-assessment studies of *Asava* and *Arishta*. **Results:** *Dhataki* flowers carry wild yeasts, mainly *Saccharomyces cerevisiae*, together with other yeasts and *Bacillus* species, which drive a spontaneous mixed fermentation. During about 30–35 days, pH falls from about 5.5 to 3.5, sugars are consumed and ethanol rises; final ethanol of 6.5% and 9.3% v/v was reported in *Balarishta* and *Chandanasava*, and 4–9.2% in *Mustakarishta* made with different *Dhataki* treatments. GC-MS shows that many compounds disappear and new ones form during fermentation. Studies of marketed brands show wide variation in physicochemical parameters. Methanol, aflatoxins and heavy metals were absent in the products tested in one study, but routine testing is not universal. **Conclusion:** *Sandhana kalpana* is a controllable biotechnological process. Defined starter cultures, monitoring of ethanol, sugar and pH, and chemical fingerprinting would improve consistency, while clear labelling of alcohol content is needed for patient safety.

KEYWORDS: *Sandhana kalpana*; *Asava*; *Arishta*; Fermentation; *Woodfordia fruticosa*; Self-generated alcohol; Quality control

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INTRODUCTION

Sandhana kalpana is the group of Ayurvedic preparations made by fermentation. The two main medicinal forms are *Asava*, prepared from fresh juices or infusions without boiling, and *Arishta*, prepared from decoctions. Both use jaggery, sugar or honey as the fermentable substrate, and most use flowers of *Dhataki* (*Woodfordia fruticosa*) to start fermentation. The mixture is kept in a closed vessel for a prescribed period, traditionally about a month, until fermentation ceases, then filtered and stored[1,2]. Classical sources regard these preparations as potent, palatable and long-lasting, and their self-generated alcohol as a means of extracting and preserving active constituents[3].

Asava and *Arishta* are now produced on a large industrial scale. This raises scientific and regulatory questions: what organisms carry out the fermentation, how alcohol content is controlled, how the chemical composition changes, and how quality can be assured from batch to batch.

METHODS OF THE REVIEW

This is a critical narrative review. Studies were identified through PubMed, PubMed Central, DOAJ, Crossref-indexed records and journal archives using the terms *Sandhana kalpana*, *Asava*, *Arishta*, fermentation, *Woodfordia fruticosa*, *Dhataki*, yeast, alcohol and standardisation. Microbiological, biochemical, phytochemical and quality-assessment studies were included.

FERMENTATION MICROBIOLOGY

1. The role of *Dhataki*

Dhataki flowers are used in almost all *Arishtas*; one analysis found them in 17 of 18 *Arishtas* described in an official monograph[4]. The flowers are rich in tannins and other constituents and have numerous traditional uses[5], but their principal role in fermentation is to supply microorganisms. Crushed fresh flowers plated on Sabouraud agar yielded about 7.7×10^2 colony-forming units of yeast per gram[6]. *Dhataki* flowers also influence the immunomodulatory activity and the alcohol and sugar contents of the final product, as shown for *Nimba Arishta*[7].

2. Organisms involved

Molecular identification has clarified the microbial community. In *Balarishta* and *Chandanasava* prepared under factory conditions, the yeasts *Saccharomyces cerevisiae* and *Schizosaccharomyces pombe* were identified by 18S rDNA sequencing, together with several *Bacillus* species and related genera by 16S rDNA sequencing. Yeast counts peaked at about 2.6×10^7 CFU/mL in *Balarishta*, filamentous fungi disappeared within the first 5–10 days, and in *Chandanasava* yeasts disappeared after day 25[8]. In *Kutajarishta*, the microbial community changed between fermentation stages[9]. A defined yeast consortium isolated from *Woodfordia* flowers has been used to prepare *Ashwagandharishta* with preserved hepatoprotective activity in rats[10]. *Sandhana kalpana* is therefore a spontaneous mixed fermentation dominated by yeasts, with a succession of organisms over time.

BIOCHEMISTRY AND SELF-GENERATED ALCOHOL

Table 1. Selected biochemical findings during fermentation of *Asava* and *Arishta*

Product	Conditions	Main findings
Balarishta and *Chandanasava*	Factory fermentation; monitored every 5 days for 35 days	pH fell from 5.5 to 3.5 (*Balarishta*) and 4.7 to 3.7 (*Chandanasava*); sugars declined as ethanol rose; final ethanol 6.5% and 9.3% v/v; acetic acid 0.3–0.4%; methanol, aflatoxins, Pb, Cd and Hg absent
Mustakarishta	Fresh *Dhataki*, dried *Dhataki*, or no *Dhataki*	Alcohol 4%, 9.2% and 6.4%; pH 3.65, 4.84 and 4.6 respectively
Balarishta and *Chandanasava*	GC-MS before and after fermentation	*Balarishta*: 19 compounds retained, 18 lost, 23 formed; *Chandanasava*: 14 retained, 30 lost, 32 formed
Abhayarishta	HPLC-DAD during fermentation	Chemical changes during fermentation used for standardisation
Nimba Arishta	With and without *Dhataki*	*Dhataki* affected alcohol and sugar contents and immunomodulatory activity

Several *Asava* and *Arishta*	Liquid chromatography	Naturally produced water-soluble vitamins quantified

1. Course of fermentation

The biochemical course of fermentation is consistent across studies. In the first days, pH falls rapidly, from about 5.5 to 3.5 in *Balarishta*, as organic acids are produced. Sugars are converted to ethanol over the following weeks, and fermentation slows as sugars are exhausted and ethanol accumulates[11]. Classical texts judge completion by cessation of effervescence, clarity and characteristic aroma; the duration of fermentation and of storage both influence the product, as shown in early studies of *Chandanasava*[14].

2. Determinants of alcohol content

Self-generated alcohol varies with the substrate concentration, the fermentation initiator, temperature and container. In *Mustakarishta*, using dried rather than fresh *Dhataki* flowers raised alcohol from 4% to 9.2%[6], and the type of container and method affected the preparation of *Kutajarishta*[15]. Final ethanol of 6.5–9.3% v/v has been reported in factory products[11]. These figures are within the range of light wines, which has implications for patients who must avoid alcohol and for regulation.

3. Chemical transformation

Fermentation is not simply extraction. GC-MS showed that, in *Chandanasava*, 30 compounds present before fermentation disappeared and 32 new compounds appeared[8]. Chemical changes during fermentation have been characterised by HPLC in *Abhayarishta*[12], naturally produced water-soluble vitamins have been quantified[13], and preparations made by traditional and non-traditional fermentation processes differed in antioxidant potential[16]. These findings support the classical view that fermentation adds value, but they also mean that the marker compounds used for standardisation must be chosen with the fermented product, not the raw herbs, in mind.

QUALITY ISSUES

1. Variation between brands

Studies comparing marketed brands of the same *Arishta* have found substantial differences in physicochemical parameters, including alcohol, total solids and sugar, for example in *Dashamoolarishta* and *Ashokarishta*[17,18]. Such variation can arise from raw material differences, spontaneous fermentation, and differences in duration and storage.

2. Safety parameters

Potential contaminants include methanol from pectin-rich substrates, mycotoxins from mouldy raw materials or jaggery, and heavy metals. In one study of *Balarishta* and *Chandanasava*, methanol, aflatoxins B1, B2, G1 and G2, and lead, cadmium and mercury were all absent[11]. This is reassuring, but such testing is not yet routine across the industry. Microbial contamination after fermentation, and the possibility of continued fermentation in the bottle, are further concerns for products with residual sugar.

3. Alcohol and regulation

Because *Asava* and *Arishta* contain alcohol, their status as medicines rather than alcoholic beverages depends on the alcohol being self-generated during the classical process and on their therapeutic presentation and dosage. Addition of external alcohol is not consistent with the classical process. For patients, the relevant facts are that typical doses of 15–30 mL taken two or more times daily deliver a small but real amount of ethanol, which matters for children, pregnant women, people with liver disease or alcohol dependence, and those taking interacting medicines. Alcohol content should therefore be stated on the label.

TOWARD STANDARDISATION

Table 2. Proposed control points for *Sandhana kalpana*

Stage	Control point	Measurement
Raw materials	Identity, contaminants, jaggery quality	Pharmacognostic tests; aflatoxin and metal testing
Initiator	*Dhataki* quality or defined starter culture	Yeast count; species identification
Fermentation	Temperature, duration, completion	pH, total and reducing sugar, ethanol, specific gravity at fixed intervals
End-point	Completion of fermentation	Stable sugar and ethanol over consecutive measurements

Finished product	Composition and safety	Ethanol (% v/v), methanol, total solids, marker compounds, microbial limits
Labelling	Patient information	Ethanol content per dose

RESEARCH GAPS

Important gaps include: comparisons of spontaneous and defined-culture fermentation for therapeutic activity; identification of active compounds formed during fermentation; stability studies of alcohol and actives during storage; systematic surveys of methanol and contaminants in marketed products; and clinical data on the pharmacological contribution of the alcohol itself.

CONCLUSION

Asava and *Arishta* are produced by a spontaneous mixed fermentation driven mainly by yeasts carried on *Dhataki* flowers, during which pH falls, sugars are converted to ethanol of roughly 4–9% v/v, and the chemical profile of the product is substantially transformed. Marketed products vary widely in composition. Defined starter cultures, objective monitoring of fermentation, chemical fingerprinting of the finished product and clear labelling of alcohol content would make *Sandhana kalpana* more consistent and safer while preserving its traditional character.

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