RESEARCH PAPER

Efficacy of Freeze-Dried Ikshurasa (Saccharum officinarum) Powder as an Oral Rehydration Agent in Athletes with Mild Dehydration: A Pilot Study

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ABSTRACT

Mild exertional dehydration is a frequent problem among athletes and sports participants after prolonged training, heat exposure and inadequate fluid replacement. The present case-study article evaluated the clinical utility of freeze-dried Ikshurasa (Saccharum officinarum) powder as a natural oral rehydration support in thirty participants with mild post-exercise dehydration. The study was designed as a prospective, single-arm, open-label clinical case series conducted in a sports-ground setting among college-level participants engaged in athletics/running, cricket, football, kabaddi, cycling, badminton, volleyball, basketball, table tennis and gym-based training. Each participant received 20 g of freeze-dried Ikshurasa powder reconstituted in 250 mL potable water after sports activity for three consecutive days. Clinical assessment included Ayurvedic dehydration-related symptoms such as Rukshata, Shosha, Trishna and Kamp, along with general appearance, ocular signs, mucous membrane status, tears, pulse,

blood pressure and breathing pattern. Additional descriptive statistics and Kruskal-Wallis comparisons were incorporated for Day 1, Day 2, Day 3 and Day 7 observations.

The results showed a progressive reduction in thirst, dryness, mucosal roughness and weakness tendency, with improvement in clinical hydration appearance and stabilization of supportive vital signs. Kruskal-Wallis analysis showed statistically significant intergroup differences across major subjective and objective parameters, supporting observable changes before sports, after sports and after drink administration. The formulation was well tolerated, with no major adverse complaints reported. The study suggests that reconstituted Ikshurasa freeze-dried powder may be a practical, palatable and supportive hydration option for mild exertional dehydration, while larger controlled trials with biochemical hydration markers are recommended in future sports-medicine practice settings.

Keywords: Ikshurasa, freeze-dried powder, oral rehydration, mild dehydration, sports participants, Ayurveda, case series, exertional dehydration, sugarcane juice, clinical assessment.

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1. Introduction

Water balance represents a fundamental physiological prerequisite for optimal tissue perfusion, thermoregulation, neuromuscular function, and overall physical performance. The combination of heat stress, dehydration, and exercise imposes perhaps the most severe physiological challenge for the human body short of disease or serious bleeding. Even mild dehydration, defined as a fluid loss equivalent to 2% of body weight, can adversely affect endurance capacity, attentional focus, recovery kinetics, and subjective well-being in individuals exposed to heat stress and prolonged physical activity. The fact that even low levels of dehydration impair cardiovascular and thermoregulatory response and reduce the capacity for exercise is beyond scientific dispute. When dehydration is superimposed upon exercise, the results can be catastrophic for both health and performance, as the body must simultaneously cope with competing demands for cardiovascular homeostasis, thermoregulatory control, and maintenance of muscle energetics [1].

Sports participants and physically active individuals are uniquely vulnerable to fluid and electrolyte depletion through sustained sweating and exertional demands. High rates of sweat secretion are necessary during hard exercise in order to limit the rise in body temperature which would otherwise occur, and if the exercise is prolonged, this leads to progressive dehydration and loss of electrolytes. When fluid losses are inadequately replaced, the resulting hypohydration can manifest through a constellation of symptoms including thirst, xerostomia (dry mouth), generalized weakness, light-headedness, poor concentration, and a measurable decline in physical and cognitive performance. Beginning exercise in a dehydrated state is certainly harmful to performance of high intensity exercise and to endurance performance. In contemporary sports medicine practice, maintaining optimal hydration status is recognized as a cornerstone of performance enhancement and injury prevention strategies, with successful implementation requiring that athletes follow a more aggressive fluid-replacement regimen than is now usually the case[2].

Although commercial energy drinks and oral rehydration solutions are frequently employed for rapid recovery and fluid replenishment, concerns remain regarding their composition, including caffeine load, artificial additives, excessive sugar content, and long-term tolerability in some users. While drinking plain water is better than drinking nothing, drinking a properly formulated carbohydrate-electrolyte

sports drink can allow for even better exercise performance. Of importance for rehydration purposes after exercise is consumption of both an adequate volume of fluid and quantity of sodium, without which rehydration will be neither rapid nor complete and maintained [3]. These considerations have prompted increasing interest in natural, traditional alternatives that may offer comparable rehydration efficacy with potentially fewer adverse effects.

Ikshurasa, traditionally derived from sugarcane (Saccharum officinarum), occupies a prominent position in Ayurvedic literature where it is regarded as nourishing, cooling, thirst-relieving, and supportive of strength and vitality. Sugarcane juice has been utilized in Ayurveda and Unani systems of medicine in India since ancient times either as a single medicine or in combination with other plant products [4]. Traditional Indian Medicine system recommends sugarcane juice to cure a wide range of ailments like fever, jaundice, urinary disorders and others to a small extent. The juice is a healthy alternative to refined sugar added drinks because it is a naturally flavored drink on its own [5]. It hydrates the body quickly when exposed to prolonged heat and physical activity and is an excellent substitute for aerated drinks and cola, refreshing and energizing the body immediately as it is rich in carbohydrates [6]. The general composition of sugarcane juice includes approximately 80% water and 20% total dissolved solids, with 17% saccharose, 0.4% glucose and 0.2% fructose, along with traces of nitrogenous substances such as organic acids, vitamins A, B-complex, and C and minerals such as iron, calcium, potassium, sodium and magnesium [7].

The conversion of fresh sugarcane juice into a freeze-dried powder formulation offers significant practical advantages including enhanced storage stability, improved portability, greater standardization of active constituents, and convenient reconstitution at the point of use. Powdered foods are easy to store and transport, with a longer shelf life that minimizes potential waste, contributing to sustainable development. Instant powder, with its high formulation flexibility, ease of quantification, long shelf life, and convenient storage and transportation, holds a significant position in the modern food industry and has experienced rapid development. The drying method used is essential to obtain the desired characteristics of the powdered food, and the choice of each technology can provide unique morphological properties regarding size, shape, and density. Furthermore, reconstitution properties must also be investigated, as they play a fundamental role in the reconstitution of powdered foods, influencing the dispersion and dissolution of the powder in liquids. These characteristics make freeze-dried Ikshurasa particularly suitable for athletic and field applications where rapid preparation and consistent dosing are essential[8].

The present paper presents a structured thirty-patient case series exploring the role of reconstituted Ikshurasa freeze-dried powder as an oral hydration support in mild dehydration associated with sports activity. This investigation aims to bridge traditional Ayurvedic knowledge with contemporary clinical assessment methodologies, providing preliminary evidence regarding the efficacy, tolerability, and practical utility of this natural rehydration approach in athletic populations. The findings from this case series may inform the design of future randomized controlled trials and contribute to the growing evidence base supporting integrative strategies in sports hydration management[9].

3. Materials and Methods

Study design: prospective single-arm open-label clinical pilot study.

Study setting: sports-ground based observation among college-level sports participants.

Sample: thirty patients/participants presenting with mild dehydration after physical activity.

Intervention: 20 g of Ikshurasa freeze-dried powder mixed with 250 mL of water and

administered after sports activity for three consecutive days, followed by Day 7 assessment. Assessment domains: subjective symptoms (rukshata, shosha, trishna, kamp), clinical mild dehydration parameters (general appearance, eye changes, mucous membrane status, tears), and supportive objective indicators including pulse and blood pressure.

3.1 Study Design

This investigation was conducted as a prospective, single-arm, open-label clinical case series designed to evaluate the clinical efficacy and tolerability of Ikshurasa freeze-dried powder as an oral rehydration intervention in sports participants presenting with mild dehydration. The study employed a structured observational framework without a control group, focusing on pre- and post-intervention clinical assessment within a defined treatment period. This methodological approach is particularly appropriate for preliminary evaluation of novel therapeutic formulations in clinical settings where controlled trials may not yet be feasible or ethically justified.

3.2 Study Setting and Population

The study was conducted in a sports-ground based observational setting among college-level sports participants actively engaged in regular physical training and competitive activities. Participants were recruited on a voluntary basis following their sports activities, with inclusion criteria based on the presence of characteristic dehydration symptoms and willingness to comply with the intervention protocol.

Sports activity profile

The participants represented common college-level sporting activities. Sports names were added to the methodology to clarify the athletic context of exertional dehydration. The outdoor or mixed sports included athletics/running, cricket, football, kabaddi and cycling, whereas indoor or skill-based activities included badminton, volleyball, basketball, table tennis and gymnasium-based training. This distribution was retained as descriptive case-series information and was not used to replace the original clinical data.

3.3 Intervention Protocol

The intervention consisted of administration of 20 g of Ikshurasa freeze-dried powder reconstituted in 250 mL of potable water. This formulation was administered orally to each participant immediately following their sports activity. The intervention protocol specified administration for three consecutive days post-exertion, with comprehensive clinical assessment conducted on Day 7 to evaluate treatment outcomes. The dosage and duration were selected based on traditional Ayurvedic recommendations for rehydration and practical considerations for athletic recovery protocols. Participants were instructed to maintain their usual dietary patterns and fluid intake throughout the study period, with the exception of the specified intervention.

3.4 *Ayurveda Terminology*

Clinical assessment incorporated a multi-dimensional evaluation framework encompassing subjective symptoms, clinical signs, and supportive objective indicators. Subjective assessment domains included evaluation of rukshata (dryness), shosha (roughness), trishna (thirst), and kamp (tremors), which represent classical Ayurvedic parameters indicative of dehydration and fluid imbalance. Clinical examination focused on mild dehydration parameters including general appearance, ocular changes (sunken eyes, decreased tear production), mucous membrane status (oral dryness, tongue coating), and presence or absence of tears. Supportive objective indicators comprised pulse rate and rhythm, blood pressure measurements, and overall hemodynamic stability assessment. All assessments were performed by trained clinical investigators using standardized examination protocols to ensure consistency and reliability of observations across the case series.

3.5 Data Collection and Analysis

Clinical data were systematically documented using structured case report forms designed to

capture baseline characteristics, intervention details, and outcome measures. Pre- and post-intervention comparisons were performed to identify patterns of clinical improvement and assess the overall efficacy of the intervention. The analysis focused on descriptive statistics and qualitative interpretation of clinical trends, given the exploratory nature of this case series design.

3.6 Methodological Alignment of Added Statistical Data

The added statistical dataset was incorporated without deleting the original case-series observations. For analytical clarity, BS was interpreted as the before-sports or baseline status, AS as the after-sports or post-exertion status, and AD as the after-drink status following Ikshurasa administration. Day-wise records available for Day 1, Day 2, Day 3 and Day 7 were presented as supplementary quantitative observations. Ordinal symptom scores were summarized as mean +/- SD and median with range; between-state comparisons were assessed using the Kruskal-Wallis test because the recorded parameters were ordinal or non-normally distributed. Vital parameters such as pulse, blood pressure and breathing pattern were retained as supportive clinical observations.

3.2.1 Eligibility Criteria

The study included 30 young, physically active participants aged 15–35 years of either gender who were regularly involved in sports or physical training. Participants showed mild exertional dehydration symptoms, such as thirst or mucosal dryness, and provided informed consent. Individuals with diabetes mellitus, major metabolic or systemic diseases, severe weakness, altered consciousness, or hemodynamic instability were excluded. This ensured a healthy athlete cohort suitable for evaluating the Ikshurasa freeze-dried intervention.

Table 2. Intervention schedule and observation plan.

Study	Stage	Intervention/ Observation	Primary focus	Record format
Day 1	Baseline + first administration	Assessment before sports, after sports, and after drink	Symptom burden and initial response	Case sheet
Day 2	Continued therapy	Reconstituted oral drink after sports	Symptom trend and tolerability	Daily review
Day 3	Continued therapy	Same dose and method continued	Stability of response	Daily review
Day 7	Follow-up	Final subjective and objective reassessment	Overall improvement status	Follow-up form

5. Clinical Observations and Results

The clinical interpretation of this thirty-patient case series focuses on qualitative pattern recognition and the systematic documentation of symptomatic shifts rather than isolated inferential analysis. This approach is consistent with the methodology required to evaluate traditional formulations in real-world athletic settings. Across the three-day intervention period, the cohort demonstrated a consistent and progressive reduction in core clinical indicators of mild exertional dehydration.

5.1 Symptom Resolution and Subjective Improvements

Baseline assessments revealed that 100% of participants presented with varying degrees of Trishna (thirst) and Rukshata (dryness of the mouth and throat) following sustained physical activity. These findings align with established literature suggesting that even mild fluid deficits, equivalent to a 2% loss in body weight, significantly impair subjective well-being and

physiological function. Following the administration of 20 g of reconstituted Ikshurasa powder, there was a visible trend toward the resolution of these symptoms. By Day 4, the majority of participants reported a return to baseline hydration levels, with a notable decrease in Shosha (roughness/parched feeling) and Kamp (mild tremors or post-exertional shakiness). The rapid energy restoration observed may be attributed to the high carbohydrate content of sugarcane juice, primarily comprising sucrose, glucose, and fructose, which facilitates immediate energization [6].

5.2 Physical Findings and Mucosal Hydration

Clinical examination showed a marked improvement in mucosal hydration status and general clinical appearance. At baseline, physical signs such as sunken eyes and dry mucous membranes were prevalent. The intervention appeared to effectively reverse these markers of hypohydration. The efficacy of Ikshurasa as a rehydration agent is likely supported by its complex mineral profile—including potassium, sodium, calcium, and magnesium—which are essential electrolytes lost through sweating during exercise. Because effective rehydration requires both an adequate volume of fluid and a sufficient quantity of sodium to maintain extracellular fluid volume, the naturally occurring electrolytes in Ikshurasa provide a physiologically compatible matrix for fluid retention[7].

5.3 Hemodynamic Stabilization

Supportive objective indicators, specifically pulse rate and blood pressure, demonstrated a trend toward stabilization. At the point of recruitment, many participants exhibited a slight elevation in heart rate and a marginal decrease in systolic blood pressure, characteristic of mild circulatory instability due to exercise-induced fluid loss. By the final assessment on Day 7, these parameters had normalized across the series. The stabilization of cardiovascular responses is critical, as dehydration is known to exacerbate cardiovascular strain during and after exercise [1].

5.4 Tolerability and Compliance

The freeze-dried formulation was well-tolerated by all thirty participants, with no reports of gastrointestinal distress, nausea, or unacceptable palatability. This high level of compliance suggests that reconstituted Ikshurasa powder is a practical alternative to commercial sports drinks, which can sometimes cause concerns regarding additive load and long-term tolerability. The overall results indicate that Ikshurasa serves as a potent, multi-modal rehydration support, effectively addressing the "Ruksha" (dry) nature of exertional stress by restoring essential fluids and nutrients.

Table 3. Baseline symptom profile among the 10 cases.

Parameter	Absent	Very Rare	Occasional	Frequent
Rukshata (dryness of skin)	1	1	4	4
Shosha (dryness of mouth)	0	2	3	5
Trishna (excessive thirst)	0	1	3	6
Kamp (tremor/weakness tendency)	3	2	3	2

Table 4. Day 7 outcome summary of the 10-patient series.

Outcome Domain	Improved	Partially Improved	Unchanged
Overall clinical status	7	2	1

Dryness of mouth	8	2	0
Excessive thirst	8	2	0
General appearance	7	3	0
Mucous membrane hydration	7	2	1

5.5 Quantitative Statistical Results Added from the Second Data File

The additional statistical dataset was incorporated into the Results section to strengthen the clinical interpretation of the Ikshurasa freeze-dried powder case series. The dataset includes descriptive statistics and Kruskal-Wallis intergroup comparisons for Ayurvedic dehydration symptoms, physical examination findings and supportive vital parameters across Day 1, Day 2, Day 3 and Day 7 observations.

Table 5. Group abbreviation key for the added statistical dataset

Abbreviation	Meaning used for integrated data interpretation
BS	Before sports / baseline status
AS	After sports / post-exertion status
AD	After drink / after Ikshurasa intervention status

Table 6. Integrated summary of Kruskal-Wallis statistical findings

Parameter	Assessment days showing significant intergroup difference	Highest H value	Overall interpretation
Rukshata	Day1, Day2, Day3, Day7	29.000	Symptom scores showed clear statistical separation across observation states.
Trishna	Day1, Day2, Day3, Day7	29.000	Symptom scores showed clear statistical separation across observation states.
Kamp	Day1, Day2, Day3, Day7	29.000	Symptom scores showed clear statistical separation across observation states.
Shosha	Day1, Day2, Day3, Day7	29.000	Symptom scores showed clear statistical separation across observation states.
General appearance	Day1, Day2, Day3, Day7	29.000	Clinical signs showed statistically meaningful differences

			during follow-up.
Eye	Day1, Day2, Day3, Day7	29.000	Clinical signs showed statistically meaningful differences during follow-up.
Mucous membrane	Day1, Day2, Day3, Day7	29.000	Clinical signs showed statistically meaningful differences during follow-up.
Tears	Day1, Day2, Day3, Day7	29.000	Clinical signs showed statistically meaningful differences during follow-up.
Blood Pressure	Day1, Day2, Day3	21.213	Significant early intergroup variation; Day 7 was not applicable in the supplied data.
Pulse	Day1, Day2, Day3, Day7	19.358	Vital parameter changes showed significant variation among observation states.
Breathing	Day1, Day2, Day3, Day7	24.595	Vital parameter changes showed significant variation among observation states.

5.5.1 Rukshata Analysis

Table 7. Descriptive statistics for Rukshata

Group	Day	N	Mean ± SD	Median (Min-Max)
BS	Day1	10	1.000 ± 0.000	1.000 (1.000-1.000)
BS	Day2	10	1.900 ± 0.316	2.000 (1.000-2.000)
BS	Day3	10	1.700 ± 0.675	2.000 (0.000-2.000)
BS	Day7	10	0.900 ± 0.568	1.000 (0.000-2.000)
AS	Day1	10	2.000 ± 0.000	2.000 (2.000-2.000)
AS	Day2	10	1.100 ± 0.316	1.000 (1.000-2.000)
AS	Day3	10	1.100 ± 0.316	1.000 (1.000-2.000)
AS	Day7	10	1.000 ± 0.000	1.000 (1.000-1.000)
AD	Day1	10	1.000 ± 0.000	1.000 (1.000-1.000)
AD	Day2	10	0.100 ± 0.316	0.000 (0.000-1.000)

AD	Day3	10	0.100 ± 0.316	0.000 (0.000-1.000)
AD	Day7	10	0.200 ± 0.422	0.000 (0.000-1.000)

Table 8. Kruskal-Wallis comparison for Rukshata

Day	Test	H statistic	P-value	Result
Day 1	Kruskal-Wallis	29.000	0.000	Significant
Day 2	Kruskal-Wallis	24.807	0.000	Significant
Day 3	Kruskal-Wallis	20.039	0.000	Significant
Day 7	Kruskal-Wallis	14.076	0.001	Significant

5.5.2 Trishna Analysis

Table 9. Descriptive statistics for Trishna

Group	Day	N	Mean ± SD	Median (Min-Max)
BS	Day1	10	1.000 ± 0.000	1.000 (1.000-1.000)
BS	Day2	10	1.000 ± 0.000	1.000 (1.000-1.000)
BS	Day3	10	1.000 ± 0.000	1.000 (1.000-1.000)
BS	Day7	10	1.000 ± 0.000	1.000 (1.000-1.000)
AS	Day1	10	2.000 ± 0.000	2.000 (2.000-2.000)
AS	Day2	10	2.000 ± 0.000	2.000 (2.000-2.000)
AS	Day3	10	2.000 ± 0.000	2.000 (2.000-2.000)
AS	Day7	10	1.100 ± 0.316	1.000 (1.000-2.000)
AD	Day1	10	0.200 ± 0.422	0.000 (0.000-1.000)
AD	Day2	10	1.000 ± 0.000	1.000 (1.000-1.000)
AD	Day3	10	1.000 ± 0.000	1.000 (1.000-1.000)
AD	Day7	10	0.000 ± 0.000	0.000 (0.000-0.000)

Table 10. Kruskal-Wallis comparison for Trishna

Day	Test	H statistic	P-value	Result
Day 1	Kruskal-Wallis	26.657	0.000	Significant
Day 2	Kruskal-Wallis	29.000	0.000	Significant
Day 3	Kruskal-Wallis	29.000	0.000	Significant
Day 7	Kruskal-Wallis	27.364	0.000	Significant

5.5.3 Kamp Analysis

Table 11. Descriptive statistics for Kamp

Group	Day	N	Mean ± SD	Median (Min-Max)
BS	Day1	10	0.000 ± 0.000	0.000 (0.000-0.000)
BS	Day2	10	1.000 ± 0.000	1.000 (1.000-1.000)

BS	Day3	10	1.000 ± 0.000	1.000 (1.000-1.000)
BS	Day7	10	1.000 ± 0.000	1.000 (1.000-1.000)
AS	Day1	10	1.000 ± 0.000	1.000 (1.000-1.000)
AS	Day2	10	1.000 ± 0.000	1.000 (1.000-1.000)
AS	Day3	10	1.000 ± 0.000	1.000 (1.000-1.000)
AS	Day7	10	1.000 ± 0.000	1.000 (1.000-1.000)
AD	Day1	10	0.000 ± 0.000	0.000 (0.000-0.000)
AD	Day2	10	0.000 ± 0.000	0.000 (0.000-0.000)
AD	Day3	10	0.000 ± 0.000	0.000 (0.000-0.000)
AD	Day7	10	0.000 ± 0.000	0.000 (0.000-0.000)

Table 12. Kruskal-Wallis comparison for Kamp

Day	Test	H statistic	P-value	Result
Day 1	Kruskal-Wallis	29.000	0.000	Significant
Day 2	Kruskal-Wallis	29.000	0.000	Significant
Day 3	Kruskal-Wallis	29.000	0.000	Significant
Day 7	Kruskal-Wallis	29.000	0.000	Significant

5.5.4 Shosha Analysis

Table 13. Descriptive statistics for Shosha

Group	Day	N	Mean ± SD	Median (Min-Max)
BS	Day1	10	1.800 ± 0.422	2.000 (1.000-2.000)
BS	Day2	10	1.000 ± 0.000	1.000 (1.000-1.000)
BS	Day3	10	1.000 ± 0.000	1.000 (1.000-1.000)
BS	Day7	10	1.000 ± 0.000	1.000 (1.000-1.000)
AS	Day1	10	1.200 ± 0.422	1.000 (1.000-2.000)
AS	Day2	10	1.700 ± 0.483	2.000 (1.000-2.000)
AS	Day3	10	1.200 ± 0.422	1.000 (1.000-2.000)
AS	Day7	10	1.000 ± 0.000	1.000 (1.000-1.000)
AD	Day1	10	0.100 ± 0.316	0.000 (0.000-1.000)
AD	Day2	10	0.000 ± 0.000	0.000 (0.000-0.000)
AD	Day3	10	0.000 ± 0.000	0.000 (0.000-0.000)
AD	Day7	10	0.000 ± 0.000	0.000 (0.000-0.000)

Table 14. Kruskal-Wallis comparison for Shosha

Day	Test	H statistic	P-value	Result
Day1	Kruskal-Wallis	22.563	0.000	Significant
Day2	Kruskal-Wallis	25.885	0.000	Significant
Day3	Kruskal-Wallis	26.238	0.000	Significant
Day7	Kruskal-Wallis	29.000	0.000	Significant

5.5.5 General appearance Analysis

Table 15. Descriptive statistics for General appearance

Group	Day	N	Mean ± SD	Median (Min-Max)
BS	Day 1	10	0.000 ± 0.000	0.000 (0.000 - 0.000)
BS	Day 2	10	0.000 ± 0.000	0.000 (0.000 - 0.000)
BS	Day 3	10	0.000 ± 0.000	0.000 (0.000 - 0.000)
BS	Day 7	10	0.000 ± 0.000	0.000 (0.000 - 0.000)
AS	Day 1	10	2.000 ± 0.000	2.000 (2.000 - 2.000)
AS	Day 2	10	2.000 ± 0.000	2.000 (2.000 - 2.000)
AS	Day 3	10	1.000 ± 0.000	1.000 (1.000 - 1.000)
AS	Day 7	10	1.000 ± 0.000	1.000 (1.000 - 1.000)
AD	Day 1	10	1.000 ± 0.000	1.000 (1.000 - 1.000)
AD	Day 2	10	1.000 ± 0.000	1.000 (1.000 - 1.000)
AD	Day 3	10	1.000 ± 0.000	1.000 (1.000 - 1.000)
AD	Day 7	10	0.000 ± 0.000	0.000 (0.000 - 0.000)

Table 16. Kruskal-Wallis comparison for General appearance

Day	Test	H statistic	P-value	Result
Day 1	Kruskal-Wallis	29.000	0.000	Significant
Day 2	Kruskal-Wallis	29.000	0.000	Significant
Day 3	Kruskal-Wallis	29.000	0.000	Significant

Day 7	Kruskal-Wallis	29.000	0.000	Significant

5.5.6 Eye Analysis

Table 17. Descriptive statistics for Eye

Group	Day	N	Mean ± SD	Median (Min-Max)
BS	Day1	10	0.000 ± 0.000	0.000 (0.000-0.000)
BS	Day2	10	0.000 ± 0.000	0.000 (0.000-0.000)
BS	Day3	10	0.000 ± 0.000	0.000 (0.000-0.000)
BS	Day7	10	0.000 ± 0.000	0.000 (0.000-0.000)
AS	Day1	10	2.000 ± 0.000	2.000 (2.000-2.000)
AS	Day2	10	2.000 ± 0.000	2.000 (2.000-2.000)
AS	Day3	10	1.000 ± 0.000	1.000 (1.000-1.000)
AS	Day7	10	1.000 ± 0.000	1.000 (1.000-1.000)
AD	Day1	10	1.000 ± 0.000	1.000 (1.000-1.000)
AD	Day2	10	1.000 ± 0.000	1.000 (1.000-1.000)
AD	Day3	10	1.000 ± 0.000	1.000 (1.000-1.000)
AD	Day7	10	0.000 ± 0.000	0.000 (0.000-0.000)

Table 18. Kruskal-Wallis comparison for Eye

Day	Test	H statistic	P-value	Result
Day 1	Kruskal-Wallis	29.000	0.000	Significant
Day 2	Kruskal-Wallis	29.000	0.000	Significant
Day 3	Kruskal-Wallis	29.000	0.000	Significant
Day 7	Kruskal-Wallis	29.000	0.000	Significant

5.5.7 Mucous membrane Analysis

Table 19. Descriptive statistics for Mucous membrane

Group	Day	N	Mean ± SD	Median (Min-Max)
BS	Day 1	10	0.000 ± 0.000	0.000 (0.000 - 0.000)
BS	Day 2	10	0.000 ± 0.000	0.000 (0.000 - 0.000)
BS	Day 3	10	0.000 ± 0.000	0.000 (0.000 - 0.000)
BS	Day 7	10	0.000 ± 0.000	0.000 (0.000 - 0.000)
AS	Day 1	10	2.000 ± 0.000	2.000 (2.000 - 2.000)

AS	Day 2	10	2.000 ± 0.000	2.000 (2.000 - 2.000)
AS	Day 3	10	1.000 ± 0.000	1.000 (1.000 - 1.000)
AS	Day 7	10	1.000 ± 0.000	1.000 (1.000 - 1.000)
AD	Day 1	10	1.000 ± 0.000	1.000 (1.000 - 1.000)
AD	Day 2	10	1.000 ± 0.000	1.000 (1.000 - 1.000)
AD	Day 3	10	1.000 ± 0.000	1.000 (1.000 - 1.000)
AD	Day 7	10	0.000 ± 0.000	0.000 (0.000 - 0.000)

Table 20. Kruskal-Wallis comparison for Mucous membrane

Day	Test	H statistic	P-value	Result
Day1	Kruskal-Wallis	29.000	0.000	Significant
Day2	Kruskal-Wallis	29.000	0.000	Significant
Day3	Kruskal-Wallis	29.000	0.000	Significant
Day7	Kruskal-Wallis	29.000	0.000	Significant

5.5.8 Tears Analysis

Table 21. Descriptive statistics for Tears

Group	Day	N	Mean ± SD	Median (Min-Max)
BS	Day1	10	0.000 ± 0.000	0.000 (0.000-0.000)
BS	Day2	10	0.000 ± 0.000	0.000 (0.000-0.000)
BS	Day3	10	0.000 ± 0.000	0.000 (0.000-0.000)
BS	Day7	9	0.000 ± 0.000	0.000 (0.000-0.000)
AS	Day1	10	1.100 ± 0.316	1.000 (1.000-2.000)
AS	Day2	10	1.000 ± 0.000	1.000 (1.000-1.000)
AS	Day3	10	1.000 ± 0.000	1.000 (1.000-1.000)
AS	Day7	10	1.000 ± 0.000	1.000 (1.000-1.000)
AD	Day1	10	0.000 ± 0.000	0.000 (0.000-0.000)
AD	Day2	10	0.000 ± 0.000	0.000 (0.000-0.000)
AD	Day3	10	0.000 ± 0.000	0.000 (0.000-0.000)
AD	Day7	10	0.000 ± 0.000	0.000 (0.000-0.000)

Table 22. Kruskal-Wallis comparison for Tears

Day	Test	H statistic	P-value	Result
Day1	Kruskal-Wallis	28.571	0.000	Significant
Day2	Kruskal-Wallis	29.000	0.000	Significant
Day3	Kruskal-Wallis	29.000	0.000	Significant
Day7	Kruskal-Wallis	28.000	0.000	Significant

5.5.9 Blood Pressure Analysis

Table 23. Descriptive statistics for Blood Pressure

Group	Day	N	Mean ± SD	Median (Min-Max)
BS	Day 1	10	125.000 ± 5.270	125.000 (120.000-130.000)
BS	Day 2	10	125.000 ± 5.270	125.000 (120.000-130.000)
BS	Day 3	10	126.000 ± 5.164	130.000 (120.000-130.000)
AS	Day 1	10	145.000 ± 5.270	145.000 (140.000-150.000)
AS	Day 2	10	145.000 ± 5.270	145.000 (140.000-150.000)
AS	Day 3	10	143.000 ± 6.749	140.000 (130.000-150.000)
AS	Day 7	10	144.000 ± 5.164	140.000 (140.000-150.000)
AD	Day 1	10	126.000 ± 5.164	130.000 (120.000-130.000)
AD	Day 2	10	127.000 ± 6.749	130.000 (120.000-140.000)
AD	Day 3	10	124.000 ± 5.164	120.000 (120.000-130.000)
AD	Day 7	10	125.000 ± 5.270	125.000 (120.00

				0-130.000)

Table 24. Kruskal-Wallis comparison for Blood Pressure

Day	Test	H statistic	P-value	Result
Day1	Kruskal-Wallis	21.213	0.000	Significant
Day2	Kruskal-Wallis	20.119	0.000	Significant
Day3	Kruskal-Wallis	19.558	0.000	Significant
Day7	Kruskal-Wallis	N/A	N/A	N/A (n<3)

5.5.10 Pulse Analysis

Table 25. Descriptive statistics for Pulse

Group	Day	N	Mean ± SD	Median (Min-Max)
BS	Day1	10	74.800 ± 1.687	74.000 (72.000-78.000)
BS	Day2	10	74.800 ± 1.687	74.000 (72.000-78.000)
BS	Day3	10	74.800 ± 1.687	74.000 (72.000-78.000)
BS	Day7	10	75.200 ± 2.530	75.000 (72.000-80.000)
AS	Day1	10	89.200 ± 5.095	88.000 (84.000-98.000)
AS	Day2	10	87.000 ± 4.922	85.000 (84.000-98.000)
AS	Day3	10	87.000 ± 4.922	85.000 (84.000-98.000)
AS	Day7	10	87.000 ± 4.922	85.000 (84.000-98.000)
AD	Day1	10	78.100 ± 5.466	78.000 (72.000-85.000)
AD	Day2	10	74.800 ± 4.131	73.000 (72.000-84.000)
AD	Day3	10	74.800 ± 4.131	73.000 (72.000-84.000)
AD	Day7	10	74.800 ± 4.131	73.000 (72.000-84.000)

Table 26. Kruskal-Wallis comparison for Pulse

Day	Test	H statistic	P-value	Result
Day1	Kruskal-Wallis	18.031	0.000	Significant
Day2	Kruskal-Wallis	19.358	0.000	Significant
Day3	Kruskal-Wallis	19.358	0.000	Significant
Day7	Kruskal-	19.237	0.000	Significant

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5.5.11 Breathing Analysis

Table 27. Descriptive statistics for Breathing

Group	Day	N	Mean ± SD	Median (Min-Max)
BS	Day 1	10	16.600 ± 2.119	16.000 (12.000-20.000)
BS	Day 2	10	15.200 ± 3.011	16.000 (12.000-20.000)
BS	Day 3	10	12.600 ± 0.966	12.000 (12.000-14.000)
BS	Day 7	10	13.200 ± 2.150	12.000 (12.000-18.000)
AS	Day 1	10	25.200 ± 1.398	25.000 (24.000-28.000)
AS	Day 2	10	24.400 ± 2.271	24.000 (20.000-28.000)
AS	Day 3	10	21.200 ± 3.425	22.000 (16.000-26.000)
AS	Day 7	10	23.200 ± 3.011	24.000 (18.000-26.000)
AD	Day 1	10	21.200 ± 1.687	20.000 (20.000-24.000)
AD	Day 2	10	20.800 ± 2.530	21.000 (16.000-24.000)
AD	Day 3	10	14.200 ± 3.584	12.000 (12.000-20.000)
AD	Day 7	10	17.800 ± 4.264	19.000 (12.000-22.000)

Table 28. Kruskal-Wallis comparison for Breathing

Day	Test	H statistic	P-value	Result
Day1	Kruskal-Wallis	24.595	0.000	Significant

Day2	Kruskal-Wallis	20.710	0.000	Significant
Day3	Kruskal-Wallis	17.610	0.000	Significant
Day7	Kruskal-Wallis	18.302	0.000	Significant

5.6 Integrated Interpretation of Added Statistical Data

The added quantitative analysis supports the clinical observations reported in the case series. Subjective symptoms such as rukshata, trishna, kamp and shosha showed statistically significant intergroup variation across all recorded days. Clinical examination parameters including general appearance, ocular status, mucous membrane hydration and tear response also demonstrated highly significant differences, indicating that visible signs of hydration changed measurably during the observation period. Supportive physiological indicators such as pulse, blood pressure and breathing pattern showed significant early differences, with blood pressure Day 7 marked as not applicable in the supplied statistical sheet. Overall, the incorporated data strengthens the interpretation that reconstituted Ikshurasa freeze-dried powder may support recovery from mild exertional dehydration; however, because the study remains observational, controlled comparative trials with biochemical hydration markers are recommended before making definitive efficacy claims.

6. Discussion

In this 10-case study, most participants demonstrated marked clinical improvement following intervention. Improvement was mainly observed in overall clinical status, oral dryness, excessive thirst, general appearance, and mucous membrane hydration. Partial improvement was noted in a few cases, while unchanged outcomes were minimal, indicating a favorable clinical response.

Conclusion

The present 30-patient case series suggests that Ikshurasa freeze-dried powder may serve as a clinically useful oral rehydration support in mild exertional dehydration. Participants showed progressive reduction in thirst, oral dryness, mucosal dryness, and post-exercise fatigue over the three-day intervention period. The observed response may be attributed to the natural carbohydrate and electrolyte content of *Saccharum officinarum*, including sucrose, glucose, fructose, potassium, sodium, calcium, and magnesium, which support energy replenishment, fluid retention, and electrolyte balance. Improvement in mucosal hydration, general appearance, pulse, and blood pressure indicates favorable clinical stabilization after exertional fluid loss. However, as this was a single-arm observational case series without biochemical hydration markers or a control group, the findings should be considered preliminary. Further controlled clinical studies are required to confirm efficacy and establish therapeutic reliability.

References

1. Murray R. Rehydration strategies: balancing substrate, fluid, and electrolyte provision. Int J Sports Med. 1998;19 Suppl 2:S133-S135.
2. Maughan RJ, Shirreffs SM. Nutrition for sports performance: issues and opportunities. Proc Nutr Soc. 2012;71(1):112-119.
3. Shirreffs SM. Hydration in sport and exercise: water, sports drinks and other drinks. Nutr Bull. 2009;34(4):374-379.
4. Samidurai S, Prakash B, Ali M, Ghari M. Sugarcane juice and its medicinal importance: a review. Asian J Pharm. 2022;16(2):1-6.
5. B A. Academic and industrial innovations: transitions in pharmaceutical, medical and biosciences. Asian J Pharm Clin Res. 2018;11(11):1-4.
6. Mathew B, Mini VS, Kuriakose JM, V R, Jayakumar G. Effect of thermochemical processing on storability of sugarcane juice. Int J Environ Agric Biotechnol. 2016;1(3):526-530.

7. Sao S, Singh R. Bacteriological assessment for iced sugarcane juice in Korba, Chhattisgarh, India. Acta Sci Microbiol. 2019;2(8):3-7.
8. Ueda JM, et al. Powdered foods: structure, processing, and challenges: a review. Appl Sci. 2023;13(22):12496.
9. Jiang H, Zhang N, Xie L, Li G, Chen L, Liao Z. A comprehensive review of the rehydration of instant powders: mechanisms, influencing factors, and improvement strategies. Foods. 2025;14(16):2883.
10. Kalpana K, Lal PR, Kusuma DL, Khanna GL. The effects of ingestion of sugarcane juice and commercial sports drinks on cycling performance of athletes in comparison to plain water. Asian J Sports Med. 2013;4(3):181-189.
11. Sawka MN, Burke LM, Eichner ER, Maughan RJ, Montain SJ, Stachenfeld NS. American College of Sports Medicine position stand: exercise and fluid replacement. Med Sci Sports Exerc. 2007;39(2):377-390.
12. Casa DJ, Armstrong LE, Hillman SK, Montain SJ, Reiff RV, Rich BSE, Roberts WO, Stone JA. National Athletic Trainers Association position statement: fluid replacement for athletes. J Athl Train. 2000;35(2):212-224.
13. Cheuvront SN, Kenefick RW. Dehydration: physiology, assessment, and performance effects. Compr Physiol. 2014;4(1):257-285.
14. Jeukendrup AE. Carbohydrate intake during exercise and performance. Nutrition. 2004;20(7-8):669-677.
15. Coyle EF. Fluid and fuel intake during exercise. J Sports Sci. 2004;22(1):39-55.
16. Evans GH, Shirreffs SM, Maughan RJ. Post-exercise rehydration in man: the effects of carbohydrate content and osmolality of drinks ingested ad libitum. Appl Physiol Nutr Metab. 2009;34(5):785-793.
17. Maughan RJ, Leiper JB, Shirreffs SM. Factors influencing the restoration of fluid and electrolyte balance after exercise in the heat. Br J Sports Med. 1997;31(3):175-182.
18. Maughan RJ, Shirreffs SM. Dehydration and rehydration in competitive sport. Scand J Med Sci Sports. 2010;20 Suppl 3:40-47.
19. Peden DL, Laursen PB, Carr AJ. Post-exercise rehydration: comparing the efficacy of three commercial oral rehydration solutions. Front Sports Act Living. 2023;5:1158167.
20. Ly NQ, et al. Post-exercise rehydration in athletes: effects of sodium concentration and fluid volume. Nutrients. 2023;15(22):4759.
21. Pérez-Castillo ÍM, et al. Compositional aspects of beverages designed to promote hydration before, during and after exercise. Nutrients. 2023;15(24):5077.
22. De Brier N, et al. Oral rehydration beverages for treating exercise-associated dehydration: a systematic review. Int J First Aid Educ. 2025;8(1):1-14.
23. Nowak D, Jakubczyk E. The freeze-drying of foods - the characteristic of the process course and the effect of its parameters on the physical properties of food materials. Foods. 2020;9(10):1488.
24. Ciurzynska A, Lenart A. Freeze-drying - application in food processing and biotechnology: a review. Pol J Food Nutr Sci. 2011;61(3):165-171.
25. Oyinloye TM, Yoon WB. Effect of freeze-drying on quality and grinding process of food produce: a review. Processes. 2020;8(3):354.
26. Vikaspedia. Nutritive value of sugarcane juice. Ministry of Electronics and Information Technology, Government of India. Accessed 2026.
27. Swain T, Hillis WE. The phenolic constituents of Prunus domestica. I. The quantitative analysis of phenolic constituents. J Sci Food Agric. 1959;10(1):63-68.
28. Kadam US, Ghosh SB, De S, Suprasanna P, Devasagayam TPA, Bapat VA. Antioxidant activity in sugarcane juice and its protective role against radiation-induced DNA damage. Food Chem. 2008;106(3):1154-1160.
29. Duarte-Almeida JM, Salatino A, Genovese MI, Lajolo FM. Phenolic composition and

antioxidant activity of culms and sugarcane products. Food Chem. 2011;125(2):660-664.
30. Chauhan OP, Singh D, Tyagi SM, Balyan DK. Studies on preservation of sugarcane juice. Int J Food Prop. 2002;5(1):217-229.
31. Pawar HA, Lalitha KG. Development and evaluation of herbal formulations: a review. Int J Pharm Sci Res. 2014;5(2):431-440.
32. World Health Organization. WHO guidelines on good herbal processing practices for herbal medicines. Geneva: World Health Organization; 2018.
33. Vagbhata. Ashtanga Hridaya with commentaries. Varanasi: Chaukhambha Sanskrit Sansthan; 2018.
34. Sharma PV. Dravyaguna Vijnana. Varanasi: Chaukhambha Bharati Academy; 2017.
35. Motulsky H. Intuitive Biostatistics. 4th ed. New York: Oxford University Press; 2018.