



Medicinal Uses and Therapeutic Potential of Safed Musli (*Chlorophytum borivilianum*): A Review

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Abstract

Safed Musli (*Chlorophytum borivilianum*) is an important Indian medicinal plant traditionally used to promote vitality, reproductive health and recovery from weakness. Its tuberous roots contain steroidal saponins, polysaccharides, fructans, and other phytoconstituents that have attracted interest in pharmaceutical and nutraceutical research. This review paper critically examines its botanical identity, ethnomedicinal applications, phytochemical composition, pharmacological activities, clinical evidence, safety, standardization and conservation. Evidence for consistent testosterone enhancement and therapeutic benefits in diabetes, cancer, and inflammatory disorders remains insufficient. Variations in botanical authentication, extraction methods, chemical composition and dosage can alter the effect of the medicinal potential. Sustainable cultivation and conservation of genetic diversity are also essential for reliable sourcing. Overall, *C. borivilianum* represents a promising candidate for focused therapeutic investigation, but its clinical applications require stronger and reproducible evidence.

Keywords: Safed Musli; *Chlorophytum borivilianum*; phytochemistry; steroidal saponins; reproductive health; therapeutic potential.

Introduction

The assessment of medicinal plants lies at the meeting point of traditional usage, chemical variety and modern predictions of effect. Safed Musli sits quite comfortably at this juncture: its tuberous roots have a well-established reputation as a regenerator and sexual stimulant, but its commercial name often applies to a product more inclusive of the species than were utilized in this experiment. Khatun et al. (2024) Any helpful review must therefore consider both composition and demonstrated activity, including plant name, extraction method, formulation, dose and study group, as fundamental rather than ancillary considerations.

The formally accepted species *Chlorophytum borivilianum* Santapau and R.R. Fern is listed by Plants of the World Online as perennial of western India within the seasonally dry tropical biome (Royal Botanic Gardens, Kew, n.d.). Most traditional pharmacological reports historically identified it within the *Liliaceae*, while recent botanical references document the genus within the *Asparagaceae* (Patil et al., 2015). This is the reason for why taxonomic searches must include any previous nomenclature even if you do not consider it as another medicinal organism.

Broad reviews provide traditional uses for weakness, male sexual function, and other complaints, and refer to growing interest in nutraceutical development (Thakur et al., 2009). Such documents provide the justifications to the traditional usage and investigation. They do not: (a) define a range of effective therapeutic dose, or (b) guarantee that a commercially available capsule would match a traditional formula. This paper refers to the "therapeutic potential" as a research opportunity and the "clinical efficacy" as a relevant human measure.

Botanical Identity and Medicinal Raw Material

Physiological characteristics and Distribution

Safed Musli can be identified by its crown of very narrow leaves and cluster of fleshy underground roots. Used in the preparation of medicine are probably dried roots, root powder or extracts. A standardized plant name and authority are required with vernacular names, as musli is both a trade mark and Traditional knowledge term which may be used for more than one species. Kew's species record provides a taxonomic anchor but the location of the material must also be indicated (Royal Botanic Gardens, Kew n.d).

Genetic studies indicate the need to discriminate among similar species of *Chlorophytum*. Patil et al. (2015) employed amplified fragment length polymorphism markers to assess the relatedness of the Indian members of the genus. Their findings reinforce the importance of correlating taxonomic and molecular data in the discrimination of medicinal material. Nath (2025) A commercial designation alone cannot guarantee the powder is the same organism as reported in an experiment.

Identification of sample

Authenticity should be based on unbroken whole specimens, if available. The source plant should be recognized by a botanist and a voucher specimen deposited in a herbarium. Locality of collection, date of collection, portion of the plant collected, cultivated or gathered in the wild, and processing history should be specified. Darbar et al. (2023)

Any anomaly in results can be explained and a taxonomic determination reconfirmed based on this information. WHO's quality-control manual for herbal materials notes as the main procedures for examining herbal material identification and physicochemical properties (World Health Organization [WHO], 2011).

Traditional and Ethnomedicinal Uses

Chemical Profiling and Standardization

Desirable characterization is = an extract yield, solvent, ratios of drug to extract, chromatographic fingerprint, and quantitative determination of specific components. ConPhyMP also centers on description of and chemical characterization of botanical medicine extracts used for pharmacological and toxicological research (Heinrich et al., 2022). This approach, for example, would enable researchers to assess whether two separate investigations of Safed Musli were based on similar extracts.

Qualitative phytochemical screening is adequate for initial investigations but does not allow determination of batch-to-batch equivalence. Gas chromatography-mass spectrometry library match yields probable identities and may require verification using authentic standards. A fingerprint is a useful adjunct to botanical verification and contaminant testing. Table 1 is an overview of the relationship of evidence from constituents to therapeutic reading.

Restorative and Reproductive Applications:

The conventional categorization of Safed Musli touches on rasayana, balya and vajikarana notions, generally linked with restoration, power and reproductive health. Rahth and Panja (2013) designed their clinical study using the root shukrala tradition. A link between these terms and modern targets is subjective: a traditional category might encompass multiple expressions of well-being rather than a unique biochemical pathway.

Khanam et al. (2013) reviewed botanical, ethnopharmacological and phytochemical literature and recorded regional use of Safed Musli within healthcare. While ethnopharmacological and phytochemical literature provide support for investigating culturally specific uses, local formulations, synergists and targets may differ. Nadesakanthan et al. (2023) If a claim is made for use of a preparation with milk or other ingredients, that claim is not necessarily made for a concentrated solvent extract, and studies must retain this distinction when reporting reasons for use.

a) Interpretation of Broader Claims

Metabolic, joint, digestive and postpartum uses are also listed in the classical and review literature (G. S. Thakur et al., 2009). These are to be taken as historical or reported uses. They are not to be used as evidence to transform that information into treatment prescriptions without research in the indicated population, formulation and outcome. Use in pregnancy or breast-feeding cannot be justified solely by the use during postpartum.

Ethnomedicinal research is most instructive when it lists the part, preparation, route, dose, frequency, duration, coingredients, and reasons for use. Absent this information, laboratory scientists may study a different chemical substance or compound and assume it provides validation for the traditional usage. The goal is mutual reinforcement; clinical and experimental research can delineate limits of use while traditional knowledge guides the questions asked.

Phytochemical Composition

a) Steroidal Saponins and Related Constituents

The most extensively studied constituents of *C. borivilianum* are the steroidal saponins. Acharya et al. (2008) identified the furostane saponins (referred to as borivilianosides A-D) present in the dried roots. Another study characterized the spirostane borivilianosides E-H and examined their cytotoxic activity (Acharya et al., 2009). These reports are based on such extensive structural details that have yet to be established by a color test indicating the presence of "saponins."

Deore and Khadabadi (2010) identified root constituents including the furostanol saponin Chlorophytoside-I and stigmasterol. A molecule is an analytical marker only if the molecule can be established as the active principle of the preparation. No single constituent was identified for any particular effect; activity-guided fractionation of the extract, quantitative analysis and reconstitution experiments are necessary to establish the activity of any single constituent.

The word "steroidal" refers to a specific chemical scaffold. It does not imply that any particular saponin resembles testosterone nor that any particular ingestion provides meaningful medically relevant androgen replacement. Furthermore, an assay of total saponin content is not a surrogate for proof of efficacy. Several glycosides may differ in activity, stability, absorption, and toxicity; total-content measurements may be useful for batch control, but they are an incomplete measure of pharmacological identity.

Polysaccharides, Fructans and the Extract Matrix

The root is also rich in carbohydrate substance. M. Thakur et al. (2011) tested a hot-water-extracted polysaccharide fraction, inulin-type fructans and acetylated mannans with immune-related testing, such as this work suggests that focus should not only be directed at saponins. Water extracts may be quite different from alcohol extracts or purified fractions, in terms of composition and of their biological effects.

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Different constituents in the extract matrix may also affect solubility, stability, intestinal absorption, and the outcome of assays. Synergy claims must therefore be verified, not made. Ashraf et al. (2013) observed the crude extract and a total saponin fraction react differently in antioxidant and cytotoxicity assays. Their results prevent us from assuming that the enrichment of one class of constituents has the desired effect on biological activity.

Table 1: Constituent evidence and limits of therapeutic interpretation

Constituent group	Selected evidence	Interpretive limit	References
Furostane saponins	Structural isolation of borivilianosides A–D	Presence does not establish oral efficacy.	(Acharya et al., 2008)
Spirostane saponins	Isolation and cytotoxicity screening	Cell activity does not establish cancer treatment.	(Acharya et al., 2009)
Phytosterol and saponin	Stigmasterol and Chlorophytoside-I characterization	An analytical marker is not automatically an active ingredient.	(Deore & Khadabadi, 2010)
Polysaccharide fraction	Immune-related assays	Laboratory immune endpoints do not establish clinical benefit.	(Thakur et al., 2011)
Crude extract versus saponin fraction	Different activity across assays	Enrichment does not guarantee greater effectiveness.	(Ashraf et al., 2013)

Pharmacological Activities and Therapeutic Potential

i) Sexual Behavior and Male Reproductive Parameters

Kenjale et al. (2008) tested an aqueous root extract in male rats and measured changes in indices of sexual-behavior activity and sperm count. These two endpoints relate to reproductive endpoints, but do so in different biological domains: mounting behavior relates to sexual activity, and sperm count relates to reproductive function. Neither endpoint alone demonstrates treatment of a cause of human ED or infertility. Das et al. (2016) tested a standardized extract in male Wistar rats at 125 and 250 mg/kg for a 54-day dosing period.² The publication noted sperm count and motility as well as sexual behavior. It noted a modest increase in sperm abnormalities. In the synthesis, however, this publication can be viewed as preparation specific preclinical safety data, with relevant safety findings to bear on human use, and acknowledged, with an independent reproductive toxicology from third-party studies to follow.

Thakur et al. (2009) evaluated sexual dysfunction in male hyperglycemic rats and found improvement with an extract in that disease model. This takes research beyond healthy animals, but chemically induced hyperglycemia is no match for the vascular, neurological, psychological, and medication-related intricacies of human diabetic sexual dysfunction. Reproductive research should isolate sperm production, sperm function, hormonal effects, sexual desire, and erectile function, not treat all of these together in an undefined aphrodisiac.

ii) Antioxidant Activity and Oxidative Stress

Kenjale et al. (2007) provided antioxidant assay activity and biochemical stress-related end point changes in rats. Visavadiya et al. (2010) studied root extract in various in vitro systems of oxidation, some relevant to lipid oxidation. These three investigations indicate chemical and experimental biological activity. They do not demonstrate that an orally administered material reaches human tissues at the concentration in an assay.

Antioxidant results demand consideration of assay interference, solvent effects, reaction kinetics and exposure. A chemical may quench a lab reagent without any positive physiological action. Conversely, diminished tissue oxidative-stress parameters in an animal may be an indicator of disease amelioration, not radical quenching. For translation chemical assays must be supported by pertinent cell models, measured exposures and functional results. Antioxidant activity is better viewed as a mechanistic lead than a standalone clinical indication.

iii) Metabolic and Anti-diabetic Findings

Giribabu et al. (2014) dose 250 and 500 mg/kg/day of aqueous root extract for 28 days in streptozotocin (STZ)-induced diabetic male rats. They observed significant alterations of the parameters of glucose and insulin, HbA1c, lipids, histopathological and oxidative-stress parameters, in comparison with untreated diabetic rats. Glibenclamide comparator and botanical verification of the plant material were part of this experiment, which can be identified.

Though all of these we see in the model are encouraging, streptozotocin injures pancreatic beta cells and does not model the human disease state in total with common human type 2 diabetes. The multiple improvements seen in correlated measures of metabolism do not imply the existence of multiple separate therapeutic pathways. Investigations in humans would require pre-specified glycated outcomes, sufficient time, documentation of placebo background treatment, and careful recording of hypoglycemia. No definitive evidence of antidiabetes benefit can be extrapolated from this animal experiment.

Visavadiya and Narasimhacharya (2007) studied root powder in hyperlipidemic rats and observed, "deviation in lipid metabolism, including chole sterol excretion," (p. 1344), but their subsequent study of herbal combinations does not tease out any unique contribution of *C. borivilianum* (Visavadiya & Narasimhacharya, 2011). Root powder, aqueous extract and combination formulation must be considered separate interventions. No experiment demonstrates the prevention of cardiovascular events.

iv) Immunomodulatory Activity

The documented immune active effects of root preparations in experimental models (M. Thakur et al., 2007) contrasted with the subsequent assessment of a polysaccharide fraction in natural-killer-cell activity in vitro and humoral-response assays in rats (M. Thakur et al., 2011). This pair of studies helps sustain interest in immune-active ingredients, although the clinical implications are unclear. Enhanced immune laboratory parameters may not equate to enhanced health.

Biological plausibility and comparative research Evidence from nonhuman models was also presented. Giri et al. (2015) studied a noni-style polysaccharide fraction in *Labeo rohita* as well as immune function and resistance to *Aeromonas hydrophila*. Kaur and Kaur (2020) tested the ethanolic root extract in murine visceral leishmaniasis and studied host-response modification. These two experiments both relates to biological plausibility and comparative research but do not specify any benefit for immune supplement use in treating infection. Immune activation could be beneficial, neutral, or deleterious, depending on the disease and pathway. Further work should clarify the clinical problem to be addressed, quantify functional responses, and define excess inflammation. This is especially important before generalizing to autoimmune disease, transplant patients or individuals on immunomodulatory drugs.

v) Anti-inflammatory and Dermatological Potential

Razzaq et al. (2026) published topical test of root extract and dichloromethane fraction on chemically induced atopic dermatitis in mice. Publisher summary:

vi) "Roots extract and dichloromethane fraction exhibited improvement of the dermatitis parameters including inflammatory cytokine expression and oxidative-stress biomarkers. These results expand the species-specific literature of the product beyond oral restorative usages, providing a potential insight into a route-specific avenue for research." A mouse dermatitis model does not prove efficacy or tolerability in humans, and systemic use of root powder does not guarantee topical activity of a fraction. Product identities attributed by GC-MS should be analytically verified. Commercial development would need to establish formulation stability, test for skin irritation and sensitization, conduct a clinical trial under controlled conditions, and compare to an adequate standard-of-care intervention. Claims of specific signalling pathways should identify the correlation as opposed to proven causation.

vii) Cytotoxicity and Anticancer Claims

Certain cancer cell lines were also tested by using of various isolated saponins (Acharya et al. 2009) and comparison of crude extract and saponin fractions (Ashraf et al. 2013). A cytotoxicity reducing agent may nonspecific mode of action and active dose *in vitro* may not be possible to obtain safely after oral administration.

In anticancer development, data on selectivity, reproducible target engagement, pharmacokinetics, tolerability, and activity in relevant *in vivo* models should be available before any clinical testing of the substance. The authors consider cytotoxicity to be a lead for a discovery. Please do not describe Safed Musli as a proven treatment for cancer based on single-cell experiments. The same evidentiary standard applies to the broad antimicrobial claims found in secondary literature: organism-specific testing and feasible exposure levels before drawing any therapeutic conclusions.

Human Clinical Evidence

a) Semen Parameters and Testosterone

Rath and Panja (2013) also worked on a small, randomized, double blind, placebo controlled trial on apparently healthy males 20-40 years old. 30 subjects were randomized into 2 groups of 15. In this study, water soluble root extract was given at a dose of 500mg twice daily for 12 weeks. While the authors claimed to have observed an increase in measures of semen quantity and quality they did not report a statistically significant effect on serum testosterone.

This distinction matters because commercial claims of fertility and testosterone are often blurred. An alteration in a semen parameter does not indicate endocrine replacement and successful-volunteer results cannot prove treatment of diagnosed infertility. Pregnancy, live-birth, time to conception, and validated sexual function outcomes were not proven. Collection of repeated semen samples under controlled conditions and quality control of laboratory procedures are critical, as per the WHO semen manual (WHO, 2021).

b) Physical Performance and Adaptogenic Claims

Tripathi et al. (2019), 60 healthy volunteers received standardized root powder or placebo (3 g/day) for 60 days. Walking, cycle-ergometer work, cardiovascular responses and handgrip strength were measured. Favorable between-group differences for some of the performance parameters studied were observed. Within-group improvements in handgrip strength were noted in Safed Musli but they were not significantly superior to placebo.

Sleep and Multi-ingredient Supplements

McCarthy et al. (2012) studied a blend of *C. borivilianum* with velvet bean. The uncontrolled study reported increased quality of sleep. The proprietary blend and the absence of a control group means the effect cannot be attributed to Safed Musli in isolation. Expectation, placebo response, seasonal effects and a co-nutrient are other potential confounds. In order to attribute effects to a single ingredient, an appropriate factorial or component-comparison design needs to be employed. Variation in subjective sleep scores needs confirmation with longer follow-up and, if possible, objective sleep measures. Table 2 compares the main human investigations and their limitations.

Table 2: Human studies: intervention, findings and limitations

Sr. No.	Study and design	Preparation and exposure	Main interpretation	References
1	Small randomized placebo-controlled trial; 30 men	Water-soluble root extract; 500 mg twice daily; 12 weeks	Reported semen changes; no established significant testosterone effect; fertility outcomes unproven.	Rath and Panja (2013)
2	Randomized placebo-controlled pilot; 60 adults	Standardized root powder; 3 g/day; 60 days	Selected performance findings; handgrip superiority over placebo not significant; independent replication needed.	Tripathi et al. (2019)
3	Uncontrolled supplement study	Proprietary blend with velvet bean	Subjective sleep findings; no placebo comparison and no ingredient-specific attribution.	McCarthy et al. (2012)

Safety, Toxicity and Herb-Drug Interactions

There is not any obvious acute toxicity has been noted with the aqueous extract at the high dose tested in mice by Giribabu et al. (2014). Reproductive observations were studied on repeated treatment with a standardized extract by Das et al. (2016) in male rats. These reports give information on safety for the specific preparation used under the specific experimental conditions. These do not confirm the safety of all powders, extracts, enriched saponin products or mixtures with the Safed Musli designation.

Unlike repeated exposure, acute tests pose a different question. A distinction can be seen in the OECD acute toxic class method and repeated-dose 28-day guideline (Organization for Economic Co-operation and Development [OECD], 2002, 2025). Depending on application, a development program can include studies that last much longer, genotoxicity tests, and reproductive and developmental tests. Being able to survive a once dose is not sufficient to be able to recommend use over a longer period of time.

Vulnerable Populations and Interactions

Safety data are inadequate to classify routine use in pregnancy, breastfeeding, childhood, or major hepatic or renal disease. Possible interactions should be explored in vitro. Metabolic and immune effects provide grounds for investigating combinations with relevant drugs, but do not establish the occurrence of an interaction. Reviews should separate a theoretical pharmacodynamic issue from a confirmed clinical interaction.

Trials should actively seek adverse events and not depend on report. The dose of the product, dates of exposure, batch, other medicines taken and available relevant laboratory tests must be documented. The WHO recommendations on herbal pharmacovigilance highlight the need to identify the product and to exclude other alternative explanations when looking for the suspected reaction (WHO 2004). Identification becomes even more critical for multi-ingredient supplements.

Contaminants and Product-related Risks

Herbal safety is also driven by cultivation, processing and manufacturing. Microbial contamination, pesticide residues, toxic trace elements, residual solvents or undeclared ingredients may introduce hazards that are not related to the authentic plant chemistry. WHO Guides on contaminants and residues offer a model for incorporating such quality assessment (WHO, 2007). An active extract must not proceed to clinical evaluation without suitable product-quality controls.

Preparation, Formulation and Quality Assurance

The included literature comprised root powders, aqueous extracts, ethanolic extracts, solvent fractions, and combinations. Preparations are not interchangeable. Methods of extraction, extract yield, constituent levels, excipients, dosing regimens, and stability must all be described in trials. The herbal CONSORT extension focuses on the intervention (intervention description) that provides the information for understanding and replicating clinical research (Gagnier et al., 2006).

Manufacturers and investigators need to separate 'a marker' from a validated active ingredient. The marker can be an indicator of identity or batch consistency but does not have to relate to efficacy. Conversely, a total-saponin claim may hide differences in contents of individual saponins. Release specifications therefore need to include botanical identity, chemical fingerprinting, quantitative markers, moisture or stability index, and limits on contaminants (WHO 2011).

Molecular Authentication and their Limits

DNA techniques provide additional means of identification for raw plant materials CBOL Plant Working Group (2009) introduced a proposed core land-plant barcode, and Chen et al (2010) investigated ITS2 for Medicinal-Plant authentication. Such non-specific work provides a good basis for the use of molecular authentication, but a method should be verified using suitable species of Chlorophytum and known authentic material prior to being used routinely.

DNA testing does not quantify the level of a pharmacologically active ingredient nor demonstrate that a finished extract has the expected chemical profile. The absence of extract DNA in a highly processed product may be an indication of degradation. For these reasons, a layered approach is preferable: visual/botanical/microscopic evaluation prior to extraction, molecular analysis where informative, and chemical analysis of the actual study preparation. Each method addresses a different source of uncertainty.

Micropropagation and Production Technologies

Ashraf et al. (2014) examined cytokinin stimulation of in vitro shoot proliferation, and Rizvi and Kukreja (2014) looked into propagation by bioreactor. These types of technical researches underpin practice for multiplying planting material. Their successes are no guarantee of performance in the field, nor of the commercial economics of the rooted production, nor of the chemical comparability with conventionally-grown roots.

Propagation programmes must therefore check that the genetics are faithful, that the plants are well acclimatised, well grown and that the harvested roots and their profile have not changed. Growing, sourcing and analytical information should be connected using batch records. This links conservation with clinical reproducibility: a source of consistent, authentic material enables a replicate trial to be completed and reduces the harvest pressure.

Priorities for Clinical Translation

Clinical development can be limited to several likely well-described indications. In reproductive research, eligibility criteria will stratify healthy subjects from men with known abnormality, and outcomes should stratify semen parameters, hormone levels, sexual function and fertility. For physical performance, there needs to be a prespecified functional outcome and standardization of activity conditions. Product characterization needs to precede publication such that findings can be independently replicated (Gagnier et al, 2006).

Trials should be registered prospectively, have sufficient sample size, and be analysed using appropriate between-group analysis. Effect sizes and confidence intervals are more informative than mere significance statements. Follow-up should be sufficient to show the proposed benefit and duration of treatment. Monitoring of adverse events, compliance, concomitant treatment, and missing data should be reported transparently.

Integrating Traditional Knowledge and Product Development

Use should guide the research question and the preparation and not replace validation. A translational pathway can be helpful: the documented practice, validated plant, identified product, mechanistic proof, safety and clinically relevant results. At each stage the claim should be commensurate with the evidence; this preserves the gift of healing traditions whilst explicitly testing for uncertainties.

Conclusion

Safed Musli is a chemical complex medicine with a long history, large ethnobotanical literature, and a relatively large experimental data set. -Laboratory studies confirm species presence of steroidal saponins and a conserved presence of polysaccharides and demonstrate a preclinical effect on reproductive, metabolic, immunomodulation, oxidative stress, and inflammatory pathways. -Clinical human studies are limited in size but provide initial results for semen quality and select physical-performance measurements. They do not demonstrate consistent clinical efficacy for the treated condition, a consistent testosterone effect, or treatment of broad medical conditions.

The key is linking a specified plant preparation with reproducible biological activity, achievable exposures, a tolerable safety profile and relevant patient benefit. Authentication, chemical analysis, tight clinical design and reliable sourcing are all parts of assessing therapeutic possibilities. While these chains are being built, we would do well to maintain the modest stance that *C. borivilianum* is a potential candidate for focused study, with an evidence-based cap.

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