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Original Research Article

A systematic review of Indonesian traditional Jamu medicine

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Abstract

Purpose: *To systematically review the Indonesian Jamu reference book and summarize the available literature on commonly used formula for conditions like hypercholesterolemia, hypertension, skin diseases, arthritis, sexual disorders, and liver health. Gaps are highlighted and recommendations are made for future studies.*

Methods: *Relevant information was extracted from book chapters into predefined categories. PubMed and Scopus were searched systematically for clinical trials, animal studies, and in vitro experiments evaluating Jamu formula and ingredients described in the book. Thirty (30) eligible studies were analyzed regarding proposed mechanisms of action, safety and efficacy.*

Results: *Significant anti-hyperlipidemic, antihypertensive, hepatoprotective and other relevant bioactivities were demonstrated in animal models evaluating formulations containing Curcuma xanthorrhiza, Curcuma longa, Orthosiphon stamineus, celery, green tea and Caesalpinia sappan. Small pilot trials also showed beneficial effect, but clinical studies are limited regarding quality and sample sizes.*

Conclusion: *The findings provide preliminary pharmacological evidence largely supporting traditional Jamu use. However, well-designed randomized controlled trials in larger patient samples are needed to conclusively demonstrate therapeutic efficacy and clinical safety.*

Keywords: *Jamu, Medicinal plants, Traditional medicine, Clinical trials, Herbal safety, Standardization, Mechanism of action*

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INTRODUCTION

Traditional herbal medicines have been widely used for centuries around the world, relying largely on knowledge accumulated from their historical utilization [1]. In Indonesia, *Jamu* is a popular form of traditional multi-herb preparation consumed for various preventive and therapeutic health purposes [2]. The growing popularity of traditional remedies has led to increasing scientific interest in evaluating their pharmacological mechanisms, efficacy and safety through rigorous experiments and clinical trials [3]. Systematically reviewing this emerging evidence is vital in determining the current state of knowledge, analysis of the clinical relevance of traditional health claims, identification of gaps that need to be addressed and recommendations

to inform evidence-based therapeutic applications [4,5].

The present report systematically reviews proposed health benefits and mechanisms of action of certain multi-herb *Jamu* formulations. However, the validity and generalizability of these traditional preparations require more extensive investigation regarding real-world efficacy, safety, bioactive compounds, molecular mechanisms and underlying science explaining their purported medicinal use. This systematic assessment of up-to-date studies on the highlighted *Jamu* formula helps analyse the existing clinical evidence and pharmacological data supporting their traditional medical claims related to areas such as cardiovascular health, skin, inflammation, pain, infection and liver disease.

Evaluation of the literature also reveals significant gaps and limitations requiring well-designed studies to conclusively demonstrate safety, efficacy within therapeutic windows, quality control ability and pharmacological mechanisms that will unlock their medicinal potential to enrich traditional healing practices with modern scientific advancements [6–8].

METHODS

Data collection

This report followed the PRISMA guidelines for systematic reviews [5]. Relevant information was extracted from each book chapter into categories covering *Jamu* preparation's definition, formulation, proposed mechanisms of action and available scientific evidence. A comprehensive literature search was conducted on Scopus and PubMed to analyze existing clinical and experimental studies on the safety and efficacy of highlighted preparations. The following keywords were used to search the databases for relevant articles – (*Jamu* or Herbal medicine or Herbal preparation or Phytotherapy) and ("health condition"). Sources were screened based on pre-defined eligibility criteria viz: Articles published in the last 10 years; they are peer-reviewed; they are available in full-text; they contain relevant study designs including clinical trials, animal studies and *in vitro* experiments. Consequently, a total of 30 Scopus-indexed references meeting eligibility criteria were critically reviewed and cited to support the safety and efficacy discussion. Limitations related to clinical evidences, methodological quality and generalizability were highlighted.

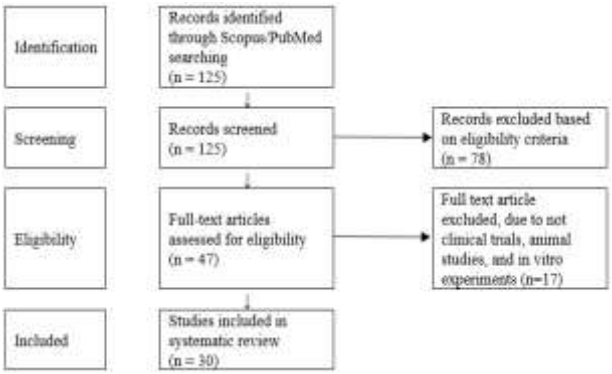

Figure 1: PRISMA flowchart depicting data collection for the systemic review

Systematic review followed the key steps outlined in PRISMA guidelines

Identification

A structured literature search was conducted using Scopus and PubMed databases to identify potentially relevant articles on *Jamu* preparations highlighted in book chapters. This initial search yielded 125 records.

Screening

Article titles and abstracts (n = 125) were screened based on predefined eligibility criteria - relevant populations/models, interventions reflecting *Jamu* preparations of interest, comparators, outcomes and study designs. Ineligible records (n = 78) were excluded at this stage.

Eligibility

Full texts of remaining records (n = 47) were assessed in detail. Additional records (n = 17) were excluded at this stage due to reasons such as unavailable full text, unrelated/insufficient interventions and outcomes, or unsuitable study designs.

Included

Finally, 30 studies that met all eligibility criteria were included for the systematic review to support *Jamu* preparations' discussion of safety, efficacy and mechanisms. The evidence base still has some limitations which have been highlighted.

RESULTS

The PRISMA flow diagram depicts the step-wise study screening and selection process that was followed to find the most relevant evidence for

this *Jamu* medicine review in accordance to systematic review guidelines.

Anti-hypercholesterolemia activity

Jamu is used to lower elevated blood cholesterol levels thereby reducing the risk of cardiovascular disease.

Formulations

Key ingredients mentioned were *Cassia angustifolia* (jati cina) leaves, *Guazuma ulmifolia* (jati belanda) leaves, *Sonchus arvensis* (tempuyung) leaves, *Camellia sinensis* (green tea) leaves, *Curcuma xanthorrhiza* (temulawak) rhizome*, Curcuma longa* (turmeric rhizome), and *Phyllanthus niruri* (meniran) herb.

Proposed mechanisms of action

Multiple potential mechanisms were described including inhibition of cholesterol absorption in the gut, increasing cholesterol breakdown and excretion through the hepatobiliary route, impeding endogenous cholesterol biosynthesis pathways via effect on HMG CoA reductase and other regulatory enzymes, anti-oxidative protection of LDL particles against atherogenic oxidative modifications and upregulating LDL-receptor expression for enhanced clearance of circulating cholesterol [9-12].

Evidence summary

Pre-clinical studies in hypercholesterolemic rat models showed hypolipidemic and antioxidant activity of *C. xanthorrhiza* extracts, significantly reducing serum total cholesterol, LDL-cholesterol, and triglycerides and elevating HDL-cholesterol levels compared to disease controls [13]. Another study demonstrated enhanced cholesterol catabolism and excretion following *C. longa* supplementation in high fat-diet fed hamsters [14]. Clinical investigations also showed beneficial effect such as decrease in serum total cholesterol by 13 % and 7 % in mild-moderate hypercholesterolemic adults after green tea extract intake over 12 weeks [15] and multi-herb *Jamu* formula consumption for 28 days [16] respectively.

However, clinical evidence has some limitations regarding sample size, lack of optimal control groups and dietary/physical activity control, undefined randomization protocols, and possible recall biases in post-hoc surveys [16]. Safety assessments were also lacking, along with head-to-head comparisons against mainstream cholesterol drugs such as statins. Nevertheless, findings provide preliminary support for traditional anti-hypercholesterolemic use. Proposed mechanisms of action have also been partly validated, but require more elaborate investigation regarding specific enzymatic pathways and molecular targets mediating therapeutic effect of different bioactive phytochemicals.

Overall, more rigorous, randomized, controlled trials in larger patient populations with robust blinding, randomization, dietary controls and defined safety evaluations are needed to conclusively demonstrate clinical efficacy and utility. Future studies should also focus on identifying optimal therapeutic concentrations and dosing regimens, pharmacokinetic characterizations, quality control ability using advanced chromatographic techniques, improved delivery systems and formulations for enhanced bioavailability, as well as potential nutraceutical or synergistic combinations with mainstream therapies against cardiovascular diseases.

Anti-hypertensive activity

Jamu is used to lower elevated blood pressure.

Formulation

Major ingredients highlighted were *Apium graveolens* (celery) herb, *Centella asiatica* (pegagan) herb, *Orthosiphon stamineus* (kumis kucing) leaves, *Curcuma spp*. rhizomes, *Phyllanthus niruri* (meniran) herb, *Imperata cylindrical* (alang-alang) grass, and *Sonchus arvensis* (tempuyung) leaves.

Proposed mechanisms of action

Vasodilatory, diuretic, renin-angiotensin-aldosterone system inhibition, antioxidant, anti-inflammatory and calcium channel blockade mechanisms have been ascribed to various constituents.

Evidence summary

Animal studies demonstrated significant antihypertensive effect with *C. longa* [17], celery [18], pegagan [19], *O. stamineus* [20], alang-alang [21] and tempuyung [22], largely validating traditional usage. Small clinical trials also found modest blood pressure reductions after supplementation with celery extracts [23], pegagan tea [24] and multi-herb *Jamu* formula [25] in hypertensive subjects.

However, clinical evidence quality is generally preliminary; moderate sample sizes, lack of

optimal controls and blinding, inconsistent dietary counselling, reliance on subjective surveys and inadequate safety assessments were notable limitations [24,25]. Herb-drug interactions also remain unexplored, especially regarding warfarin, statins and calcium channel blockers commonly prescribed for hypertension. Therefore, well-designed, randomized, placebo-controlled trials with robust protocols are imperative to conclusively demonstrate therapeutic efficacy and safety of *Jamu* as an antihypertensive. Future pharmacodynamic studies should identify bioactive compounds and mechanisms mediating observed synergy among traditionally combined herbs. Investigating efficacy against specific hypertension subtypes, optimal dosing regimens, quality control techniques, improved delivery systems for enhanced oral bioavailability and patient compliance are other important aspects requiring focus.

Overall, findings provide preliminary pharmacological evidence largely supporting traditional medicinal use of plants like turmeric, celery and pegagan for hypertension. However, more rigorous clinical validation through high quality trials is still needed to unequivocally establish therapeutic utility and safety.

Skin disease

Jamu is used for treatment of various dermatological conditions like eczema, acne, psoriasis.

Formulations

Primary ingredients described were *Cassia alata* (jati cina) leaves, *Zingiber officinale* (ginger) rhizome, *Curcuma longa* (turmeric) rhizome, *Piper retrofractum* (cabe jawa) fruit, *Camellia sinensis* (green tea) leaves, *Oryza sativa* (rice) water, *Cucurbita pepo* (pumpkin) fruit, *Dioscorea hispida* (bengkoang) tuber, and *Theobroma cacao* (cocoa) powder.

Proposed mechanisms of action

Anti-inflammatory, antimicrobial, antioxidant, wound healing promotion, skin barrier enhancement and skin-lightening effect.

Evidence summary

Preclinical murine models demonstrated the anti-psoriatic effect of *C. longa* nanoemulsion gels [26], accelerated wound contraction with *Z. officinale* extracts [27] and antioxidant benefits of cocoa powder [28] when applied topically on skin. Early pilot studies in humans also indicate beneficial effect. Ginger poultice was comparable to betamethasone in reducing symptoms of atopic dermatitis [29], while dietary cocoa flavanols increased skin hydration and elasticity [30].

However, studies on highlighted *Jamu* preparations specifically for conditions like dermatitis, acne, and psoriasis are still lacking. Future studies should focus on standardized formulations, optimized extraction approaches, dosing/duration refinements and consistent safety monitoring. Testing combination formulas rather than individual herbs can help determine evidence underlying traditional multi-ingredient *Jamu* used for various skin disorders. Appropriate controls and objective skin assessments via biophysical tools are also vital to accurately demonstrate therapeutic utility [31].

Overall, findings provide preliminary support for the traditional use of plants like turmeric, ginger, green tea, cocoa and rice water for skin health. However, more rigorous clinical validation is still needed to confirm therapeutic efficacy and safety for specific dermatological applications.

Anti-hyperuricemia activity

Jamu is used in lowering elevated blood uric acid levels associated with gout and kidney stones.

Formulations

Key ingredients highlighted were *Piper retrofractum* (cabe jawa) fruit, *Plantago major* (daun sendok) leaves, celery herb, *Caesalpinia sappan* (secang) wood, *Stelechocarpus burahol* (kepel) leaves, *Curcuma* spp. rhizomes, *Phyllanthus niruri* (meniran) herb.

Proposed mechanisms of action

Xanthine oxidase (XO) inhibition, increased renal clearance of uric acid, anti-inflammatory, analgesic, antioxidant and immunomodulatory effect.

Evidence summary

Preclinical studies demonstrated significant hypouricemic effect of *P. niruri* [32] and *C. longa* [33] extracts in oxonate-induced hyperuricemic murine models. Active compounds like lupeol, rutin, curcumin and quercetin were inferred as the major bioactive mediating observed effect through mechanisms such as XO enzyme inhibition and antioxidant actions [32,33]. An *ex vivo* clinical study also showed improved anti-inflammatory cytokine profiles after oral

supplementation with *C. longa* extracts in gout patients [34].

However, studies are lacking regarding the effect of highlighted *Jamu* preparations specifically on key hyperuricemia endpoints, whether urate-lowering effect translate into reduced incidence of acute flares and resolution of tophi. Appropriately controlled trials are needed to evaluate therapeutic potential as monotherapy or adjuvant to standard urate-lowering drugs like allopurinol. Safety assessments also cannot be established from currently available data. Future studies should additionally focus on determining bioactive compounds from different *Jamu* herbs, evaluating synergistic combinations, appropriate standardization methods, dose-response characterizations and drug interaction potential. Overall, findings provide preliminary evidence largely supporting traditional consumption for preventive and therapeutic purposes. However, more rigorous clinical validation through appropriately designed trials is imperative to conclusively demonstrate therapeutic utility against asymptomatic hyperuricemia, gout flares and related arthritic conditions.

Aphrodisiac activity

Jamu is intended to stimulate sexual desire and enhance sexual performance.

Formulations

The key herbs described were *Curcuma spp*. rhizomes, *Talinum paniculatum* (ginseng jawa) herb, *Centella asiatica* (Pegagan) herb, *Anacyclus pyrethrum* (akar kucing) root, and honeyed pineapple juice.

Proposed mechanisms of action

Androgen modulation increased genital blood flow via nitric oxide dilation pathways, and the muscle relaxant effect facilitates performance.

Evidence summary

An animal study showed *C. xanthorrhiza* extracts stimulated male sexual behaviour and performance by increasing number of mounts and improving libido indices in normal and hypoactive rats [35]. A human pilot study indicated enhanced sexual desire and pleasure ratings in subjects consuming honeyed pineapple juice compared to sildenafil citrate tablets [36]. Effect were ascribed to nutritional agents like vitamin C, flavonoids, complex carbohydrates and boron compounds modulating sex hormone levels and nitric oxide pathways [37,38].

However, clinical evidence is currently negligible in terms of methodological quality and sample sizes to make definitive therapeutic claims. Optimal formulations, dosing strategies, shelf-life stability assessments, acceptance amongst different cultural groups, and safety profiles also remain unexplored for highlighted preparations. Well-designed, randomized, placebo-controlled trials are critically required using quantitative measures of desire such as questionnaires and surveys, objective performance indicators and hormonal level assessments.

Overall, preliminary data provides some pharmacological basis supporting traditional aphrodisiac utility. However, further rigorous investigation in clinical settings is imperative to conclusively demonstrate therapeutic efficacy.

Physical fitness

Jamu is intended to enhance physical performance, endurance, stamina and general wellness.

Formulations

Key ingredients mentioned were *Curcuma spp*. rhizomes, *Phyllanthus niruri* (meniran) herb, *Zingiber officinale* (ginger) rhizome, *Kaempferia galangal* (aromatic ginger) rhizome, *Cymbopogon citratus* (lemongrass) leaves, *Cinnamomum spp*. bark.

Proposed mechanisms of action

Anti-inflammatory and pain relief properties help to improve muscle function and reduce soreness associated with intense physical activity. Antioxidant effect combatting exercise-induced oxidative damage. Adaptogenic actions to modulate beneficial stress response during exertion.

Evidence summary

Animal studies indicate anti-fatigue [39], muscle protection [40] and ergogenic effect [41] of ginger and turmeric that could translate into improved physical performance in humans. However, clinical evidence is currently very minimal with one study demonstrating faster recovery and reduced muscle injury biomarkers with a multi-herb *Jamu* formula [42]. No clinical investigations are available that specifically assess endurance enhancement, physical performance or actual exercise capacity improvement in humans following supplementation with highlighted *Jamu* preparations.

Future randomized controlled trials should investigate the impact of *Jamu* formulation on parameters like cardiovascular efficiency, oxygen utilization, lactate levels, muscle strength and exercise duration/capacity in both athletes and general populations using standardized physical activity protocols. Effect on muscle glycogen sparing, recovery after intense training, prevention of oxidative damage, inflammation modulation and associated pain also deserve focus. Dose-response studies are important to establish optimal intakes for intended benefits.

Overall, preclinical data provides pharmacological evidence largely supporting traditional consumption to augment fitness and overall wellness. Studies to translate purported benefits into measurable physical performance enhancement and muscle health improvement in active individuals as well as patients during rehabilitation.

Hepatoprotective activity

Jamu is used to protect liver health and support recovery from hepatic conditions like viral hepatitis, autoimmune disorders and fatty liver disease.

Formulations

Curcuma xanthorrhiza (Temulawak) rhizome was primarily described. Other herbs like *Phyllanthus niruri* (Meniran) may also be relevant.

Proposed mechanisms of action

Anti-inflammatory, antioxidant, antifibrotic, immunomodulatory, and regenerative effect to protect hepatocytes and improve liver structure/function. Stimulation of bile production and elimination of bilirubin/toxins.

Evidence summary

Animal studies demonstrated the pronounced hepatoprotective effect of *C. xanthorrhiza* against chemically-induced liver injury from paracetamol overdose [43], lead poisoning [44], alcohol toxicity, carbon tetrachloride [45], and hepatic carcinoma [35]. Bioactive curcuminoids like curcumin and xanthorrhizol attenuated liver enzyme leakage, morphological damage, inflammatory infiltration and oxidative lesions while bolstering endogenous antioxidant defenses. However, clinical reports on their activity against viral, autoimmune, metabolic, and neoplastic diseases of the liver are still lacking.

Future patient-centered studies with defined diagnostic criteria are imperative to translate preclinical promise into therapeutic potential against various etiologies underlying liver health deterioration. Impact on hard clinical endpoints like disease progression, complications, quality of life and mortality need evaluation. Dose refinement, formulation enhancements for bioavailability, synergy assessments with mainstream agents like silibinin and glucocorticoids, and pharmacovigilance regarding long-term safety require focus as well.

Overall, findings provide pharmacological evidence from animal models supporting traditional consumption for hepatic protection and recovery. However, studies are still needed to conclusively demonstrate therapeutic utility against liver diseases in human subjects.

CONCLUDING REMARKS

This systematic review highlights preclinical and early clinical evidence supporting various traditional *Jamu* preparations for conditions like hypercholesterolemia, hypertension, skin diseases, hyperuricemia, sexual disorders, physical tiredness and liver health. Studies are still preliminary and limited in terms of the quality of clinical evidence and generalizability. Well-designed randomized, controlled trials in larger patient groups to better demonstrate the therapeutic efficacy and safety of traditional *Jamu* formula are being advocated. Dose-response studies and head-to-head comparisons with standard pharmacological treatments are also recommended. Attention must focus on identifying bioactive compounds, elucidating mechanisms of action, pharmacokinetic profiling, and quality control of active ingredients, optimal formulation approaches for enhanced delivery and stability, as well as herb-drug interaction assessments. Government and industry initiatives promoting scientific validation of *Jamu* medicine integrated with biotechnology advancements will lead to economical and standardized phytopharmaceuticals that enrich traditional healing practices with modern evidence-based therapy.

DECLARATIONS

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Ethical approval

None provided.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Conflict of Interest

No conflict of interest associated with this work.

Contribution of Authors

The authors declare that this work was done by the authors named in this article and all liabilities pertaining to claims relating to the content of this article will be borne by the authors. Rani Rubiyanti made a substantial contribution to writing the manuscript and compilation of data. Yusmaniar and Fatwa Hasbi contributed significantly to the design and preparation of the manuscript. All authors read and approved the final draft of the manuscript for publication.

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