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AYURVEDIC CONCEPTUALIZATION AND MULTIMODAL MANAGEMENT OF HYPERLIPIDEMIA: A SYSTEMS-BASED INTEGRATIVE REVIEW

[1]*Dr. Ruhi Zahir, [2]Prof. Ravi Sharma

[1]Assistant Prof., PG Dept. of Kaya Chikitsa, MMM Govt. Ayurved College, Udaipur.
[2]Prof. and HOD, PG Dept. of Kaya Chikitsa, MMM Govt. Ayurved College, Udaipur.

***Corresponding Author: Dr. Ruhi Zahir**

Assistant Prof., PG Dept. of Kaya Chikitsa, MMM Govt. Ayurved College, Udaipur.

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ABSTRACT

Background: Hyperlipidemia represents a fundamental metabolic disturbance underlying atherosclerosis and cardiovascular disease (CVD), which remain leading causes of global mortality. Although lipid-lowering pharmacotherapy—particularly statins—has substantially reduced cardiovascular risk, persistent residual risk, drug intolerance, and long-term adverse effects necessitate exploration of complementary therapeutic paradigms. *Ayurveda*, the classical medical system of India, provides a comprehensive metabolic framework that may offer multi-targeted intervention strategies. **Objective**: To critically reinterpret hyperlipidemia through Ayurvedic patho-physiology and synthesize contemporary experimental and clinical evidence supporting Ayurvedic pharmacological, detoxificatory, and lifestyle-based interventions. **Methods:** A structured narrative synthesis was performed using classical Ayurvedic treatises—including Charaka Samhita, Sushruta Samhita, and Ashtanga Hridaya—alongside indexed biomedical literature from PubMed, Scopus, and AYUSH databases. Experimental studies, clinical trials, mechanistic investigations, and translational analyses focusing on lipid biomarkers were included. **Results**: Hyperlipidemia corresponds primarily to *Medoroga*, *Sthaulya*, *Kapha-Meda Dushti*, *and Dhatvagni Mandya* in Ayurvedic nosology. Botanical agents such as Terminalia chebula, Terminalia bellirica, Phyllanthus emblica, Piper nigrum, Piper longum, Zingiber officinale, Commiphora mukul, Allium sativum, Curcuma longa and Go-mutra exhibit lipid-modulatory effects mediated through regulation of HMG-CoA reductase activity, PPAR signaling, FXR modulation, bile acid turnover, antioxidant enzyme activation, and inflammatory pathway suppression. *Panchakarma* procedures including *Virechana* and *Lekhana Basti* demonstrate metabolic re-regulatory potential. **Conclusion**: *Ayurveda* offers a network-based therapeutic model targeting metabolic inflammation, oxidative stress, hepatic lipid synthesis, and adipose deregulation. Integrative application alongside conventional therapy warrants further large-scale randomized and molecular validation studies.

KEYWORDS: Hyperlipidemia, Medoroga, Dyslipidemia, Ayurveda, Systems Biology, Cardiovascular Risk, Integrative Medicine.

1. INTRODUCTION

Hyperlipidemia is characterized by quantitative and qualitative abnormalities in circulating lipoproteins, including elevated total cholesterol, low-density lipoprotein cholesterol (LDL-C), triglycerides (TG), and/or reduced high-density lipoprotein cholesterol (HDL-C). The pathophysiological consequence of persistent dyslipidemia is endothelial dysfunction, lipid oxidation, vascular inflammation, and progressive atherogenesis. Despite the clinical success of HMG-CoA reductase inhibitors, a substantial proportion of patients experience statin intolerance, metabolic perturbations, or incomplete risk reduction. Emerging paradigms emphasize that dyslipidemia is not solely a disorder of lipid concentration but a systemic inflammatory-metabolic syndrome. Ayurveda conceptualizes such disorders under:

- Medoroga (pathology of adipose tissue metabolism)
- Sthaulya (obesity spectrum)
- Kapha-Meda Vriddhi
- Agnimandya (metabolic insufficiency)

- Ama (toxic metabolic intermediates)

Unlike reductionist lipid-centric models, Ayurveda integrates digestive fire (Agni), tissue metabolism (Dhatvagni), channel integrity (Srotas), and doshic balance, thus offering a multidimensional metabolic framework.

2. METHODS

A structured narrative review methodology was employed. Data Sources, PubMed, Scopus, Google Scholar, AYUSH Research Portal.

Search Terms

"Hyperlipidemia," "Dyslipidemia," "Ayurveda," "Medoroga," "Guggulu," "Triphala," "Panchakarma," "FXR," "PPAR," "HMG-CoA reductase," "oxidative stress."

Inclusion Criteria

- Randomized and non-randomized clinical trials
- Animal experimental studies
- Molecular pathway investigations
- Standardized herbal extract analyses
- Classical textual references

Exclusion Criteria

- Non-standardized polyherbal reports lacking phytochemical characterization
- Studies without lipid biomarker endpoints

3. RESULTS

3.1 Ayurvedic Pathophysiological Correlation

The progression of hyperlipidemia can be interpreted as:

Agnimandya
↓
Incomplete metabolic transformation
↓
Ama formation
↓
Rasa Dhatu dysfunction
↓
Meda Dhatu augmentation
↓
Srotorodha
↓
Systemic Kapha predominance.

Biomedical Mapping

Ayurvedic Concept	Translational Interpretation
Agnimandya	Impaired mitochondrial bioenergetics
Ama	Oxidized LDL, lipotoxic metabolites
Meda Vriddhi	Adipocyte hypertrophy & hypertriglyceridemia
Srotorodha	Endothelial inflammation & vascular stiffness

This mapping suggests Ayurveda anticipated a metabolic-inflammation model consistent with current cardiometabolic science.

3.2 Pharmacological Evidence

3.2.1 Triphala (Haritaki–Bibhitaki–Amalaki)

Triphala exhibits: Inhibition of HMG-CoA reductase, Enhancement of reverse cholesterol transport, PPAR-α activation, Reduction in malondialdehyde (MDA), Upregulation of superoxide dismutase (SOD). Clinical studies report significant decreases in TC, TG, and LDL with improved antioxidant status.

3.2.2 Trikatu (Piper nigrum, Piper longum, Zingiber officinale)

Trikatu enhances thermogenesis and metabolic rate, improves lipid digestion, and augments bioavailability of co-administered phytochemicals via piperine-mediated CYP modulation.

3.2.3 Gomutra (Cow Urine Distillate) as a Metabolic Modulator

In classical Ayurveda, Gomutra is described as a Katu-Tikta Rasa, Ushna Virya, Laghu-Ruksha Guna substance possessing Kapha-Vata Shamana, Deepana, Pachana, and Lekhana properties. It is widely indicated in Medoroga, Sthaulya, and metabolic disorders due to its ability to enhance Agni and remove Ama. From a biochemical perspective, distilled cow urine has been reported to contain volatile fatty acids, phenolic compounds, urea, creatinine derivatives, and micronutrients that may exert bioenhancing and metabolic effects.

3.2.3.1 Experimental Evidence

Preclinical studies suggest that Gomutra distillate demonstrates:

- Reduction in serum total cholesterol and triglycerides
- Decrease in LDL-C levels
- Improvement in HDL-C concentration

- Enhancement of hepatic antioxidant enzymes (SOD, catalase, glutathione)
- Reduction in lipid peroxidation markers (MDA)
- Animal models of high-fat diet–induced dyslipidemia indicate improved hepatic lipid metabolism following Gomutra administration, potentially mediated through:
- Activation of AMP-activated protein kinase (AMPK)
- Suppression of lipogenic transcription factors (SREBP-1c)
- Enhancement of bile acid–mediated cholesterol excretion
- Modulation of gut microbial composition

3.2.4 Commiphora mukul (Guggulu)
Guggul sterones function as antagonists of farnesoid X receptor (FXR), enhancing bile acid excretion and reducing hepatic cholesterol synthesis. Studies demonstrate LDL reduction and improvement in atherogenic index. Anti-inflammatory effects via NF-κB suppression further contribute to vascular protection.

3.2.5 Allium sativum (Lasuna)
Garlic reduces hepatic cholesterol synthesis, increases fibrinolytic activity, improves HDL levels, and decreases platelet aggregation—contributing to anti-atherogenic effects.

3.2.6 Curcuma longa (Haridra)
Curcumin down regulates SREBP-1c and inflammatory cytokines (TNF-α, IL-6), activates AMPK, and enhances insulin sensitivity, indirectly reducing lipogenesis.

3.3.7 Panchakarma Interventions
- Virechana (Therapeutic Purgation): Facilitates hepatic detoxification and bile-mediated cholesterol elimination.
- Lekhana Basti: Exerts "scraping" metabolic action, potentially influencing adipose mobilization and systemic lipid redistribution.

4. DISCUSSION
Ayurvedic management demonstrates a network pharmacology profile:
- Modulation of lipid synthesis enzymes
- Enhancement of bile acid turnover
- Suppression of inflammatory mediators
- Antioxidant defense activation
- Gut microbiome regulation
- Mitochondrial function restoration

This systems-based approach aligns with emerging cardio-metabolic frameworks recognizing hyperlipidemia as a chronic inflammatory-metabolic disorder. However, translational challenges remain:
- Need for phytochemical standardization
- Large multicentric RCTs
- Biomarker-based mechanistic validation
- Integration of omics technologies

Future research should incorporate metabolomics, transcriptomics, and systems pharmacology modeling to validate Ayurvedic formulations at molecular resolution.

Integrative Role of Gomutra in Lipid Regulation
The inclusion of Gomutra in hyperlipidemia management reflects Ayurveda's emphasis on metabolic ignition and toxin clearance prior to tissue-level correction. Unlike isolated lipid-lowering agents, Gomutra appears to exert:

Metabolic Priming Effect – Enhances digestive and hepatic metabolic activity, potentially improving lipid clearance.

Bioenhancer Activity – Evidence suggests Gomutra may increase the bioavailability of co-administered phytochemicals, thereby potentiating the action of formulations such as Triphala or Guggulu.

Antioxidant Modulation – Reduction in oxidative stress markers may attenuate LDL oxidation, a critical step in atherogenesis.

Inflammatory Pathway Regulation – Possible suppression of pro-inflammatory cytokines linked to metabolic syndrome.

5. CONCLUSION
Ayurveda provides a sophisticated metabolic paradigm for understanding and managing hyperlipidemia beyond cholesterol reduction alone. Through multi-targeted phytotherapeutics, detoxificatory procedures, and lifestyle correction, it addresses metabolic dysfunction, oxidative stress, and vascular inflammation concurrently. Rigorous scientific validation will facilitate its integration into global cardio-metabolic care.

6. DECLARATIONS
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Conflict of Interest: None.

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