ISSN: 2322 - 0902 (P)
ISSN: 2322 - 0910 (O)

International Journal of Ayurveda and Pharma Research

Review Article

DECODING THE *YAKRUT-MEDAS* AXIS: A CONTEMPORARY REVIEW OF METABOLIC DYSFUNCTION ASSOCIATED STEATOTIC LIVER DISEASE (MASLD) IN THE FRAMEWORK OF *MEDOVAHA SROTO-DUSHTI*

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Article info

Article History:
Received: 12-11-2025
Accepted: 20-12-2025
Published: 20-01-2026

KEYWORDS:
Agni, Medovaha Srotodushti, Metabolic Syndrome, Hepatic Steatosis.

ABSTRACT

The recent transition in nomenclature from Non-Alcoholic Fatty Liver Disease (NAFLD) to Metabolic Dysfunction-Associated Steatotic Liver Disease (MASLD) reflects a paradigm shift, emphasizing the multisystemic nature of hepatic steatosis linked to cardiometabolic risk factors. In Ayurveda, this metabolic derangement closely mirrors the pathology of *Medovaha Srotodushti* (vitiation of the adipose-carrying channels) and *Yakrut-Roga* (liver disorders) arising from *Santarpanajanya* (excessive nourishment) conditions. **Objectives*:*** This review aims to explore the pathophysiological "*Yakrut-Medas* Axis" by correlating the modern "Multiple-Hit Hypothesis" of MASLD with the Ayurvedic concepts of *Agni Vaigunya* (impaired metabolism) and *Srotorodha* (channel obstruction). **Methods:** A comprehensive literature review was conducted across classical Ayurvedic texts and modern medical databases, focusing on the updated 2023 MASLD diagnostic criteria and their intersection with Medas (adipose tissue) metabolism. **Results:** The study identifies a direct correlation between modern insulin resistance and the Ayurvedic concept of Ama (toxic metabolic by-products) resulting from *Jatharagni* and *Dhatvagni* dysfunction. The "*Yakrut-Medas* Axis" is elucidated as a functional unit where *Yakrut* (liver), as the *Moolasthana* (root) of *Raktavaha Srotas*, becomes the primary site for *Abaddhameda* (loose/unmetabolized fat) accumulation. This review highlights that *Srotorodha* in the *Medovaha Srotas* triggers a vicious cycle of *Vata* vitiation and further metabolic stagnation, mirroring the progression from simple steatosis to inflammatory fibrosis. **Conclusion:** Understanding MASLD through the framework of *Medovaha Srotos-dushti* provides an integrative diagnostic lens. This correlation suggests that therapeutic strategies targeting *Agnideepana (*metabolic stimulation) and *Sroto-shodhana* (channel purification) may offer synergistic benefits in managing the global burden of metabolic liver disease.

INTRODUCTION

Metabolic Dysfunction-Associated Steatotic Liver Disease (MASLD) has emerged as the most prevalent chronic liver condition globally, affecting nearly 30% of the adult population [1]. In 2023, global hepatology societies officially transitioned from the term NAFLD (Non-Alcoholic Fatty Liver Disease) to MASLD to more accurately reflect the disease's etiology: metabolic dysfunction [2]. It is defined by the presence of steatosis in >5% of hepatocytes in the presence of at least three of five cardiometabolic risk factors[3]. (Following medical conditions: Abdominal obesity, high blood pressure, high blood sugar, high serum triglycerides, and low serum HDL cholesterol.)

As per Ayurveda, MASLD can be considered as a *Yakrit vikara* (disorder of liver), but the classical texts do not write about any liver conditions of fat in a clear manner. *Yakrit* (liver) and *Pleeha* (spleen) play vital roles in *Rakta Dhatu* formation (formation of blood) and *Raktavaha Srotas* (blood-carrying channels), while *Yakrit* is the primary site of *Ranjaka Pitta[4]*, Ayurvedic texts, like *Bhavaprakasha, Chakradutta,* and *Bhaishajyaratnavali*, outline liver disease under *Pleeha Yakrit Adhikara* in detail, such as

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https://doi.org/10.47070/ijapr.v13i12.3912

Pandu (anaemia), *Kamala* (Jaundice), and *Udara* [5,6](Ascites)

In Ayurveda, this metabolic derangement is not seen merely as a liver ailment but as a systemic failure of *Agni* (metabolic fire) and *Srotas* (micro-channels). The condition finds its closest clinical and pathophysiological parallel in *Medovaha Srotodushti*- a vitiation of the channels responsible for adipose tissue metabolism. This review explores the "*Yakrut-Medas* Axis," proposing that MASLD is the hepatic manifestation of a systemic failure in fat processing.

The *Yakrut-Medas* Axis: Conceptual Framework

The liver (*Yakrut*) and adipose tissue (*Medas*) are intrinsically linked in both modern and Ayurvedic physiology.

***Yakrut* (Liver):** Known as the *Moolasthana* (root) of *Raktavaha Srotas* [7] It is the seat of *Ranjaka Pitta*, responsible for converting *Rasa* into *Rakta* [8].

***Medas* (Adipose):** Regulated by the *Medovaha Srotas*, with its roots in *Vrukka* (kidneys) and *Vapavahana*[9] (omentum/peritoneum).

The Axis: In a healthy state, *Yakrut* processes the essence of food to nourish the *Dhatus*. However, when *Jatharagni* (digestive fire) is sluggish (*Mandagni*), it produces *Ama* (metabolic toxins). This *Ama* combines with *Medas* to form *Abaddha Medas* (non-compact, circulating fat), which then infiltrates the *Yakrut*, leading to what we modernly define as hepatic steatosis [10].

Ayurvedic perspective

The pathogenesis of MASLD through the Ayurvedic perspective involves multiple interconnected mechanisms. *Agni Vaishamya* (irregular digestive and metabolic fire) plays major role in this pathogenesis. The initial impairment of *Jatharagni* (digestive fire) and subsequent *Dhatwagnimandya* (tissue-level metabolic impairment) specifically affecting *Medodhatvagni* leads to improper formation and circulation of *Meda dhatu*. It causes for occurring *Srotovaigunya* (defect in microchannels). The vitiation of *Medovaha Srotas* creates susceptibility for fat accumulation in various organs. When this affects the *Yakrit* (liver), it manifests as fatty liver disease. Primarily *Kapha* and *Meda* accumulation, with secondary involvement of *Pitta* due to the liver is *Pitta*-predominant nature. As the disease progresses. *Vata* may also become involved, leading to more severe tissue damage and fibrosis[11].

Contemporary science perspective

The modern understanding of MASLD pathogenesis involves several key mechanisms. Lipotoxicity- Excessive free fatty acids overwhelm mitochondrial β-oxidation capacity, leading to toxic lipid species that promote cellular stress and apoptosis.

Insulin resistance-In adipose tissue, liver, and muscle, which promotes lipolysis and de novo lipogenesis while reducing fatty acid oxidation. Inflammatory activation- Recruitment of immune cells and release of pro-inflammatory cytokines that promote hepatocyte injury and fibrogenesis. And Gut-liver axis disruption- Altered gut microbiota composition and increased intestinal permeability which contributes to hepatic inflammation [12,13]

1. *Nidana* (Etiology/Root cause)

Nidana refers to the factors that provoke the disease. In MASLD, these are almost entirely *Santarpanajanya* (excessive nutrition). [14,15] These factors are categorized into dietary, lifestyle, and psychological components, which align remarkably with modern metabolic risk factors.

***Aharaja Nidana* (Dietary Causes):** Ayurvedic classics emphasize the consumption of foods that are *Guru* (heavy), *Snigdha* (unctuous/fatty), and *Madhura* (sweet), which directly increase *Kapha* and *Meda*. Resulting in Adipose tissue expansion and insulin resistance.

***Viharaja Nidana* (Lifestyle Causes):** The physical habits that lead to *Agni-Mandya* (metabolic slowing) are central to the pathogenesis of both *Medodushti* and MASLD: *Avyayama* (lack of physical exercise): The most common cause in both sciences. It leads to *Medo-Sanchaya* (fat accumulation) because the *Dhatvagni* is not stimulated, which ends up with weight gain, *Divaswapna* (daytime sleeping): Specifically prohibited in Ayurveda as it increases *Kapha* and *Meda* instantly by slowing down the metabolic rate. Modernly, this correlates with sedentary behaviour and disrupted circadian rhythms which are linked to insulin resistance. *Asya Sukham* and *Shayya Sukham*: The "comfort of sitting and sleeping." Modern medicine calls this sedentary lifestyle- the habit of sitting for prolonged hours without movement. Post-meal habits: Habits like sleeping immediately after a meal or taking a bath immediately after eating are cited as causes for *Ama* formation.

***Manasa Nidana* (Psychological Factors):** *Harshanityatva* (constant cheerfulness/contentment): While usually positive, in this context, it refers to a lack of mental or physical exertion and excessive indulgence in sensory pleasures. *Achintana* (lack of mental stress/mental laziness): The absence of mental work or worry is noted by Acharya Charaka as a factor that increases fat. modern science focuses on Chronic Stress causing high cortisol (which leads to visceral fat).

***Beeja Dosha* (Hereditary Factors):** *Acharya Charaka* mentions *Beeja Dosha* (heredity) as a cause for *Atisthoulya* (morbid obesity). Modern correlation: This matches the genetic predisposition to MASLD, where

certain gene variants (like PNPLA3) make individuals more susceptible to hepatic fat accumulation regardless of diet [16].

***Nidanarthakara Roga* (Secondary Causes):** In *Ayurveda*, one disease can cause another. Conditions like *Prameha* (diabetes/metabolic syndrome) and *Ajirna* (chronic indigestion) act as *Nidana* for *Medovaha Srotodushti.*

2. *Purvarupa*: (Prodromal Symptoms)

These are early warning signs before the full clinical manifestation of fatty liver.

Ayurvedic Indicators: *Alasya* (general lethargy), *Gaurava* (feeling of heaviness in the body), and *Mukha Madhurya* (sweet taste in the mouth).

Modern Comparison: Often asymptomatic, but may manifest as early insulin resistance signs, such as acanthosis nigricans (darkening of skin folds) or mild unexplained fatigue [17].

3. *Rupa*: (Clinical Features)

The full-blown signs and symptoms once the *Sroto-dushti* is established.

Ayurvedic *Rupa*: *Udaravriddhi* (increase in abdominal girth/visceral fat).

Daurgandhya (foul body odor due to disturbed fat metabolism).

Kshudrashwasa (shortness of breath on mild exertion).

Modern Rupa: Hepatomegaly (enlarged liver), elevated ALT/AST enzymes, and imaging showing bright liver (hyper echogenicity) on ultrasound [18].

4. *Upashaya/Anupashaya:* (Diagnostic Tests)

Upashaya (Relieving factors): Improvements seen with *Karshana* (depleting) treatments like *Triphala, Guggulu*, and exercise. This confirms the *Medas* (fat) involvement.

Anupashaya (Aggravating factors): Worsening of symptoms with *Brimhana* (nutritive) therapy or high-fat diets, confirming the metabolic nature of the blockage.

5. *Samprapti* (Pathogenesis)

***Samprapti* of *Medovahasroto Dushti* and the Modern "Multiple-Hit" Pathophysiology of MASLD.**

The comparative Pathogenesis [19,20,21]

The development of MASLD can be viewed as a five-stage journey where *Agni* fails, leading to the clogging of channels (*Srotas*) and structural changes in the liver (*Yakrut*).

Stage 1: The Initiation *(Agni Mandya* vs. Insulin Resistance)

Ayurvedic View: The process begins with *Mandagni* (low digestive fire) caused by *Atisampoorana* (over-nutrition). When the *Jatharagni* is weak, the nutrient essence (*Anna-Rasa*) is not fully processed, leading to the formation of *Ama* (unmetabolized metabolic waste).

Modern Parallel: This corresponds to Insulin Resistance (IR). Chronic caloric excess leads to the desensitization of insulin receptors. Just as *Ama* is "undigested energy," IR prevents the body from "digesting" (utilizing) glucose and fats, leading to elevated circulating nutrients.

Stage 2: Adipose Dysfunction (*Medo-Dhatvagni Mandya* vs. Dyslipidemia)

Ayurvedic View: As *Ama* circulates, it specifically affects the *Medovaha Srotas*. *Medo-Dhatvagni* becomes impaired. This results in the production of *Abaddha Medas*- loose, poor-quality fat that cannot be properly integrated into stable adipose tissue.

Modern Parallel: This matches the dysregulation of peripheral lipolysis. Dysfunctional adipose tissue releases a flood of Free Fatty Acids (FFAs) into the bloodstream. These FFAs are "loose" and harmful, mirroring the description of *Abaddha Medas*.

Stage 3: The Hepatic Influx (*Srotas-Abhighata* vs. Ectopic Fat Deposition)

Ayurvedic View: The excess *Abaddha Medas* seeks a place for *Sthana-Samshraya* (localization). It invades the *Yakrut* (liver), which is the functional root of the blood-carrying channels (*Raktavaha Srotas*).

Modern Parallel: This is the First Hit: Hepatic Steatosis. The liver becomes an ectopic fat depot. FFAs are taken up by hepatocytes and esterified into triglycerides, visible as "fatty liver" on imaging.

Stage 4: Obstruction & toxicity (*Srotorodha* vs. Lipotoxicity)

Ayurvedic View: The accumulation of fat causes *Srotorodha*. This obstruction prevents the flow of other *Dhatus*, leading to *Vata* vitiation and further metabolic stagnation. The interaction between *Ama* and *Meda* creates *Amavisha*, a highly reactive toxic state.

Modern Parallel: This is Lipotoxicity & Oxidative Stress. Excessive lipid accumulation overwhelms the liver's capacity to export fat. This triggers mitochondrial dysfunction and the release of Reactive Oxygen Species (ROS), which damage cell membranes- a perfect match for the "tissue-cooking" nature of *Amavisha*.

Stage 5: Inflammation & structural change (*Dhatu Paka* vs. MASH/Fibrosis)

Ayurvedic View: Long-term *Srotorodha* and *Amavisha* lead to *Dhatu Paka* (tissue suppuration/inflammation) and eventually *Khavaigunya* (permanent structural weakness). This can lead to *Yakrut-Dalyudara* (liver enlargement and hardening).

Modern Parallel: This is the progression to MASH (Metabolic Dysfunction-Associated Steatohepatitis) and Fibrosis. Chronic inflammation activates hepatic stellate cells, leading to collagen deposition and scarring (Cirrhosis).

Samprapti Ghtaka* of *Medovahasrotodushti

Dosha	*Tridosha (Kapha Pradhan), Kapha-Kledaka* *Pitta-Pachaka* *Vata-Samana* and *Vyana*
Dushya	*Rasa dhatu, Rakta dhatu* and *Medo dhatu*
Srotas	*Rasa vaha, Raktavaha Medo vaha*
Adhisthana	*Vapavahana, Medodhara kala*
Srotodushti	*Sanga, Margavrodh, Vimargagamana*
Udbhava	*Amashaya*
Agni	*Jatharagni & Dhatvagni janit*
Vyadhisvabhava	*Daruna*
Sadhyasadhyata	*Krichhsadhya*

Management -An Integrative Approach

The management of MASLD aims to shift the liver from a state of *Sanchaya* (accumulation) to *Prashama* (equilibrium).

Stage 1: Clear *Ama* (Digestion of toxins)

Stage 2: Clear *Srotas* (Removing fat from liver channels)

Stage 3: Strengthen *Agni* (Preventing recurrence)

Management of MASLD is not just about "reducing fat" but is a comprehensive process of *Agni-Chikitsa* (metabolic correction). The goal is to transform the *Abaddha Meda* (unstable, ectopic fat) back into energy while clearing the *Srotorodha* (channel obstruction) in the liver.

The treatment protocol follows a specific sequence: *Nidana Parivarjana* (removing causes), *Shodhana* (purification), and *Shamana* (pacification).

1. *Shodhana* vs. Detoxification (Macro-Cleansing)

The goal here is to remove the primary bulk of "metabolic sludge" from the system.

Ayurvedic Approach[22] (*Virechana*[23]): Purgation therapy is the most effective for liver and fat disorders. It targets the *Moolasthana* of the *Raktavaha Srotas*. By inducing controlled purgation, it eliminates excess *Pitta* and *Medas*, reducing the hepatic fat load and improving the *Agni* at the liver level.

Lekhana type of *Basti* [24]: it scrapes away excess *Meda* and *Kapha*. And clears the obstruction of *Vata* so *Vata* can move normally, thereby regulating the appetite and metabolism. It is used in the management of *Sthaulya* and *Medoroga.*

Modern Science (Weight Loss & Bariatric Surgery): The primary recommendation for MASLD is a reduction in body weight (ideally >7-10%). In severe cases, bariatric surgery is utilized to physically restrict intake and alter gut hormones, which mirrors the intense metabolic "reset" of *Shodhana*.

2. *Shamana* vs. Pharmacotherapy (Micro-Correction)

Focusing on cellular repair and the scraping of localized fat.

Ayurvedic Herbs (*Lekhana & Deepana*):

Katuki [25] (*Picrorhiza kurroa*): Acts as a potent hepatoprotective and *Bhedana* (piercing) herb that stimulates bile flow (cholagogue).

Bhumyamalaki[26] (Phyllanthus niruri): Clinically proven to reduce liver enzymes and oxidative stress in hepatocytes.

Guggulu [27] (*Commiphora mukul*): Used for its *Lekhana* (scraping) property; it modulates lipid metabolism via FXR receptor pathways.

Modern Pharmacotherapy [28]

Resmetirom: Recently FDA-approved specifically for MASH; it targets thyroid hormone receptors in the liver to reduce fat.

Pioglitazone/GLP-1 Agonists: Focus on improving insulin sensitivity and reducing inflammation.

Vitamin E: Used as an antioxidant to combat the "Multiple Hit" oxidative stress.

3. *Pathya-Apathya* vs. Lifestyle & Diet

Both sciences agree that without behavioural change, medicine is ineffective.

***Pathya* (To Do)**

Grains: *Yava* (Barley) is the best grain for fat metabolism, Vegetables: Bitter gourd (*Karavellaka*), Patola, and Garlic, Water: *Ushnodaka* (Warm water) or water boiled with Musta.

***Apathya* (To Avoid)**

Sweets: All refined sugars and excess fruits (high fructose), lifestyle: *Divaswapna* (daytime sleep) is strictly prohibited as it slows down *Medodhatvagni* immediately.

DISCUSSION

The clinical transition from NAFLD to MASLD marks a significant milestone in modern hepatology, moving away from a diagnosis of exclusion (non-alcoholic) toward a diagnosis of inclusion (metabolic dysfunction). This shift brings modern medicine closer to the Ayurvedic ethos, which has always viewed liver health as a byproduct of systemic metabolic integrity.

1. The Metabolic Nexus: *Agni* and Insulin Resistance

In MASLD, the primary driver is insulin resistance, which leads to an overflow of free fatty acids (FFAs) into the liver. In the framework of *Medovaha Srotodushti*, this is a classic manifestation of *Agni Mandya* (weakened metabolic fire).

When *Jatharagni* is impaired, it results in the production of *Ama* (unprocessed metabolic waste). This *Ama* is not just a gastrointestinal concept; at a cellular level, it represents the "metabolic sludge" caused by over-nutrition. The liver, being the primary site of *Ranjaka Pitta* and a key player in *Dhatvagni* (tissue metabolism), becomes overwhelmed by this "unburnt" fuel, leading to *Medo-Sanchaya* (fatty infiltration).

2. *Srotorodha*: The Pathology of Obstruction

Modern pathophysiology describes MASLD as a state of chronic low-grade inflammation. Ayurveda explains this through *Srotorodha* (obstruction of micro-channels).

As *Abaddha Medas* (loose fat) accumulates in the *Yakrut*, it blocks the *Srotas*.

This blockage prevents the proper nourishment of subsequent tissues (*Uttara Dhatus*), explaining why many MASLD patients feel fatigued despite having high energy (fat) stores. This obstruction leads to *Vata-Vaigunya* (functional disturbances), which can manifest as the progression from simple steatosis to MASH (Metabolic Dysfunction-Associated Steatohepatitis), where cellular damage and fibrosis begin.

3. Therapeutic Synergy: Clearing the *Yakrut-Medas* Axis

The discussion of management must bridge the gap between "weight loss" and "metabolic correction."

Lekhana and *Medohara* Properties: Herbs like *Guggulu* (Commiphora mukul) and *Vacha* (Acorus calamus) possess *Lekhana* [29] (scraping) qualities. Modern studies show Guggulsterones act as ligands for the Farnesoid X Receptor (FXR), which plays a critical role in bile acid and lipid metabolism [30]- directly addressing the *Srotorodha* in the liver.

Hepatoprotection: *Bhumyamalaki* (Phyllanthus niruri) and *Katuki* (Picrorhiza kurroa) are potent *Pitta-Rechaka* (bile stimulants). They enhance the flow of bile [31], which is essentially the physical clearance of the *Medovaha Srotas* at the hepatic level.

The Role of *Shodhana*: *Virechana* (therapeutic purgation) is not merely a purification; it is a systemic reset of the *Pitta-Medas* balance. By clearing the *Moolasthana* (root) of the *Raktavaha Srotas*, it reduces the hepatic fat load and improves insulin sensitivity.

4. Lifestyle as Medicine: *Santarpana* vs. *Apatarpana*

MASLD is the quintessential *Santarpanajanya Vyadhi* (disease of over-nourishment). Modern medicine recommends a Mediterranean diet and exercise; Ayurveda recommends *Apatarpana* (depletion therapy) and *Rukshana* [32] (drying treatments).

Udwarthana[33] (dry powder massage) is a unique Ayurvedic tool that stimulates *Medovaha Srotas* from the periphery, aiding in the mobilization of deep-seated fat.

Incorporating *Yava* (barley) and honey- substances categorized as *Lekhana*- provides a dietary framework that aligns with low-glycaemic, fibre-rich modern dietary protocols.

CONCLUSION

The "*Yakrut-Medas* Axis" serves as a profound conceptual bridge between the ancient wisdom of *Medovahasrotodushti* and the contemporary metabolic challenges of MASLD. The correlation between MASLD and *Medovaha Srotodushti* is more than linguistic; it is deeply functional. The "*Yakrut-Medas* Axis" provides a comprehensive map for understanding how lifestyle-induced *Agni-mandya* leads to structural liver damage. By integrating Ayurvedic diagnostic markers like *Gaurava* (heaviness) and *Alasya* (lethargy) with modern fibro scans and lipid profiles, clinicians can offer a truly holistic and preventative approach to this global epidemic. This correlation suggests that therapeutic strategies targeting *Agnideepana (*metabolic stimulation) and *Sroto-shodhana* (channel purification) may offer synergistic benefits in managing the global burden of metabolic liver disease.

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Cite this article as:
Patel Hiral, Tank Neha. Decoding the Yakrut-Medas Axis: A Contemporary Review of Metabolic Dysfunction Associated Steatotic Liver Disease (MASLD) in the Framework of Medovaha Sroto-Dushti. International Journal of Ayurveda and Pharma Research. 2025;13(12):129-135.
https://doi.org/10.47070/ijapr.v13i12.3912
Source of support: Nil, Conflict of interest: None Declared

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