Received: 24 April. 2025 | Revised: 13 May. 2026 | Accepted: 5 June 2026

Review Article

AJDP
Nature has the Power to Heal

ISSN: 3048-5614

"EFFECT OF UPAVASA (INTERMITTENT FASTING) IN CORRECTING BLOOD SUGAR LEVELS IN INSULIN-RESISTANT SUBJECTS: A COMPREHENSIVE REVIEW"

Raghurama Bhatta[1]*, Ravi Rao S[2]*, Rajani B[3], Shubha M[4]

AFFLIATIONS:
1. Pro Vice Chancellor Health Sciences, Sanskriti University, Chhata, Mathura, Uttar Pradesh, India.
2. Principal, Professor, P P Savani Ayurvedic College and Hospital, Kosamba, Surat, Gujarat
3. Director, Sanskriti Ayurvedic Medical College and Hospital, Sanskriti University, Chhata, Mathura, Uttar Pradesh, India.
4. Samhita Siddhantha, Muniyal Institute of Ayurvedic Medical Sciences, Manipal, Karntaka, India.

CORRESPONDENCE:
Vd Ravi Rao S
EMAILID:
ravisorake@gmail.com

FUNDING INFORMATION
Not Applicable

How to cite this article:
Bhatta R, Rao R, Rajani B, Shubha M, "Effect of Upavasa (intermittent fasting) in correcting blood sugar levels in insulin-resistant subjects: A comprehensive review" Asian Journal of Dravyaguna and Pharmacology. 2026;3(2):10-21.

ABSTRACT:

Introduction: Insulin resistance is a pivotal pathological feature underlying type 2 diabetes mellitus (T2DM) and metabolic syndrome. Upavasa, a therapeutic fasting modality described in classical Ayurvedic texts as one of ten Langhana (depletion) therapies, shares conceptual and physiological parallels with modern intermittent fasting (IF). This review evaluates the effect of Upavasa and IF on correcting blood sugar levels and improving insulin sensitivity in insulin-resistant subjects.

Methods: A comprehensive literature search was conducted across PubMed, Scopus, Google Scholar, Cochrane Library, and AYUSH Research Portal for studies published between 2005 and 2025. Classical Ayurvedic texts were consulted for traditional context. Randomised controlled trials, systematic reviews, and meta-analyses investigating intermittent fasting effects on fasting blood glucose (FBG), HbA1c, HOMA-IR, and fasting insulin in insulin-resistant or T2DM subjects were included.

Results: Multiple meta-analyses demonstrated that IF significantly reduced FBG (SMD = −0.51; p = 0.001), fasting insulin (SMD = −0.21; p = 0.030), HOMA-IR (SMD = −0.39; p = 0.004), and HbA1c (SMD = −0.25; p = 0.034) compared to controls. Key molecular mechanisms included AMPK activation, mTOR suppression, enhanced autophagy, improved insulin signalling, and reduction of pro-inflammatory cytokines.

Discussion: The convergence of Ayurvedic Upavasa principles with modern IF evidence supports structured fasting for glycaemic correction in insulin-resistant subjects. However, standardised clinical protocols, long-term safety data, and Prakriti-based personalisation warrant further investigation through well-designed clinical trials.

Keywords: Agni; AMPK; Autophagy; Blood glucose; HbA1c; HOMA-IR; Insulin resistance; Intermittent fasting; Langhana; Prameha; Type 2 diabetes mellitus; Upavasa

This is an open access article, which permits use and distribution in anymedium, provided the original work is properly cited, the use is non-commercial and no modifications or adaptations are made.

INTRODUCTION

Insulin resistance, defined as a diminished cellular responsiveness to normal circulating concentrations of insulin, constitutes the central pathophysiological mechanism underlying type 2 diabetes mellitus (T2DM), metabolic syndrome, and a constellation of associated cardiometabolic disorders[1,2]. The global prevalence of diabetes has reached pandemic proportions, with an estimated 537 million adults affected in 2021 and a projected increase to 783 million by 2045, predominantly driven by insulin resistance and its metabolic sequelae[1]. Conventional pharmacological interventions, while effective, are often accompanied by adverse effects, treatment fatigue, and escalating healthcare costs, underscoring the need for evidence-based non-pharmacological strategies[2].

Interestingly, the therapeutic application of structured fasting is not a modern innovation but finds deep roots in the ancient Indian medical tradition of Ayurveda. The classical Ayurvedic texts describe Upavasa (fasting) as one of the ten forms of Langhana (depletion therapy), enumerated by Acharya Charaka in the Langhanabrimhaniya Adhyaya of Charaka Samhita Sutrasthana[3]. The Sanskrit term Upavasa is derived from 'Upa' (near) and 'Vasa' (to stay/reside), signifying 'staying near to the self or the divine' – reflecting both a spiritual and physiological dimension of the practice[7,32]. Ayurvedic pathogenesis of Prameha (a group of urinary disorders that encompasses Madhumeha/diabetes mellitus) attributes the disease to Kapha Dosha predominance, Medodhatvagni Mandya (impaired fat tissue metabolism), and Srotodushti (channel obstruction), conditions for which Langhana including Upavasa is specifically indicated[4,31].

In contemporary biomedical science, intermittent fasting (IF) has emerged as a widely investigated dietary strategy encompassing several protocols: time-restricted eating (TRE; 16:8, 14:10, or 12:12 hour fasting-to-feeding windows), alternate-day fasting (ADF), the 5:2 diet (five normal days with two days of marked caloric restriction), and periodic fasting[8,10]. A rapidly expanding body of clinical and preclinical evidence has demonstrated that IF improves insulin sensitivity, reduces fasting blood glucose (FBG), glycosylated haemoglobin (HbA1c), and homeostatic model assessment for insulin resistance (HOMA-IR), while also exerting favourable effects on body composition, lipid profiles, and systemic inflammation. [8,12,14,15]

The molecular mechanisms underpinning these metabolic benefits involve activation of the AMP-activated protein kinase (AMPK) pathway, suppression of the mechanistic target of rapamycin (mTOR) signalling, induction of autophagy, enhancement of mitochondrial biogenesis, and modulation of the insulin–insulin-like growth factor 1 (IGF-1) axis[8,9,20]. Notably, Yoshinori Ohsumi's 2016 Nobel Prize-winning research on autophagy provided a modern molecular framework that resonates with Ayurveda's ancient recognition that fasting promotes the digestion of Ama (metabolic

toxins), thereby restoring Agni (digestive and metabolic fire)[34,7].

Despite these converging lines of evidence, a comprehensive integrative review bridging the Ayurvedic concept of Upavasa with the modern evidence base on intermittent fasting and glycaemic correction in insulin-resistant populations remains lacking. This review aims to address this gap by systematically evaluating the available evidence, delineating molecular mechanisms, and proposing a framework for integrative clinical application.

METHODS

SEARCH STRATEGY AND DATABASES

A systematic literature search was conducted across PubMed/MEDLINE, Scopus, Cochrane Central Register of Controlled Trials (CENTRAL), Google Scholar, ScienceDirect, and the AYUSH Research Portal. The search employed combinations of the following Medical Subject Headings (MeSH) and free-text terms: "intermittent fasting," "time-restricted eating," "alternate-day fasting," "periodic fasting," "Upavasa," "Langhana," "insulin resistance," "type 2 diabetes mellitus," "blood glucose," "HbA1c," "HOMA-IR," "fasting insulin," and "metabolic syndrome." Boolean operators (AND, OR) and truncation were employed to optimise search sensitivity. Reference lists of included articles were hand-searched for additional relevant studies.

INCLUSION AND EXCLUSION CRITERIA

Studies published between January 2005 and December 2025 in the English language were included. Eligible study designs included randomised controlled trials (RCTs), quasi-experimental studies, systematic reviews, meta-analyses, and observational studies investigating the effects of any IF protocol on glycaemic parameters (FBG, HbA1c, HOMA-IR, fasting insulin) in adult subjects (≥18 years) with documented insulin resistance, prediabetes, T2DM, or metabolic syndrome. Classical Ayurvedic texts (Charaka Samhita, Sushruta Samhita, Ashtanga Hridaya, Ashtanga Sangraha) were consulted for traditional therapeutic context. Exclusion criteria included studies on type 1 diabetes, gestational diabetes, religious fasting without structured protocols, paediatric populations, animal-only studies without clinical correlates, and conference abstracts without full-text availability.

DATA EXTRACTION AND SYNTHESIS

Data were extracted independently and synthesised narratively, organised thematically by (a) Ayurvedic principles of Upavasa, (b) clinical evidence from IF trials on glycaemic parameters, (c) molecular mechanisms, and (d) translational implications. A total of 186 articles were initially identified, of which 50 met the inclusion criteria and form the evidence base of this review.

RESULTS

AYURVEDIC FRAMEWORK OF UPAVASA AND ITS APPLICATION IN PRAMEHA

Upavasa occupies a central position in the Ayurvedic therapeutic armamentarium as one of the ten Langhana therapies enumerated by Acharya

Charaka: Vamana (emesis), Virechana (purgation), Niruha Basti (decoction enema), Nasya (nasal instillation), Pipasa (thirst control), Maruta (wind exposure), Atapa (sunlight exposure), Pachana (digestive administration), Upavasa (fasting), and Vyayama (exercise) [3]. The foundational verse states: 'Chatushprakara Samshuddhi Pipasa Marutatapau | Pachananyu Upavasa cha Vyayamashcheti Langhanam' (Ch.Su.22/18)[3].

The pathogenesis of Prameha (diabetes) in Ayurveda is attributed to excessive consumption of Guru (heavy), Snigdha (unctuous), Madhura (sweet), and Shita (cold) Ahara (diet), combined with Avyayama (sedentary lifestyle), Divaswapna (daytime sleeping), and Adhyashana (eating before previous meal is digested)[4,31]. This leads to Kapha Dosha Prakopa (vitiation of Kapha), Medodhatvagni Mandya (impaired fat tissue metabolism), Srotorodha (channel obstruction), and Dhatuparimana Vriddhi (abnormal increase in tissue quantum), culminating in Prameha[4]. The concept of Ama – incompletely metabolised toxic residues resulting from impaired Agni – is particularly relevant, as Ama is considered the initiating factor in Srotorodha and subsequent Doshic vitiation[31].

Upavasa is indicated specifically in Sama conditions (conditions associated with Ama) and diseases of Kapha-Pitta predominance[3,5]. Acharya Charaka states that Langhana is the paramount therapy ('Langhanam Paramaushadham') and is indicated in conditions of Agnimandya (diminished digestive fire), Ama, Sthaulya (obesity), and Prameha [3,4]. The mechanism of Upavasa in Ayurvedic pharmacodynamics involves: (a) Agni Deepana – kindling of digestive and tissue-level metabolic fire, (b) Ama Pachana – digestion and elimination of metabolic toxins, (c) Srotovishodhana – clearance of obstructed tissue channels, and (d) Dosha Shamana – pacification of aggravated Doshas [3,7,45].

Importantly, Ayurveda prescribes Upavasa with clear contraindications and personalisation principles. Fasting is contraindicated in Balya (children), Vriddha (elderly), Krusha (emaciated), Garbhini (pregnant women), and those weakened by excessive exercise [3,5]. The duration and intensity of Upavasa are to be calibrated according to Prakriti (body constitution), Bala (strength), Agni (digestive capacity), Kala (season), and Vyadhi Avastha (disease stage)[3,6]. This personalised approach to fasting resonates with contemporary calls for individualised intermittent fasting prescriptions based on metabolic phenotype [8,10].

CLINICAL EVIDENCE: INTERMITTENT FASTING AND GLYCAEMIC PARAMETERS

A substantial and growing body of clinical evidence supports the efficacy of intermittent fasting in improving glycaemic parameters in insulin-resistant populations. The evidence is presented below, organised by glycaemic outcome.

Fasting Blood Glucose (FBG): Multiple meta-analyses have reported significant reductions in FBG following IF interventions. Yuan et al.[12], in a systematic review of RCTs in patients with impaired glucose and lipid metabolism, reported that IF

reduced FBG by 0.15 mmol/L (95% CI: −0.23 to −0.06). Khalafi et al. [15], in a GRADE-assessed meta-analysis of 10 RCTs in metabolic syndrome patients, demonstrated a larger effect size (SMD = −0.51; 95% CI: −0.81 to −0.20; p = 0.001) with high-quality evidence. Shu et al.[13], through a network meta-analysis comparing four IF regimens in T2DM patients, confirmed reductions in FBG across time-restricted eating, alternate-day fasting, and 5:2 protocols.

Glycosylated Haemoglobin (HbA1c): Reductions in HbA1c reflect sustained glycaemic improvement over 8-12 weeks. Yuan et al.[12] reported a mean HbA1c reduction of 0.08 (95% CI: −0.25 to −0.10) following IF. Khalafi et al. [15] demonstrated a significant reduction (SMD = −0.25; 95% CI: −0.49 to −0.02; p = 0.034) with GRADE-rated high-quality evidence. Carter et al.[16], in an RCT comparing intermittent energy restriction with continuous energy restriction in T2DM patients over 12 months, found non-inferior HbA1c reductions with IF, alongside greater patient adherence.

Homeostatic Model Assessment for Insulin Resistance (HOMA-IR): HOMA-IR, a composite index of fasting glucose and insulin reflecting hepatic insulin sensitivity, showed consistent improvement with IF protocols. Khalafi et al.[15] reported a significant reduction (SMD = −0.39; 95% CI: −0.65 to −0.12; p = 0.004). Patikorn et al. [14], in an umbrella review of systematic reviews and meta-analyses, identified high-quality evidence for IF-mediated reduction in fasting insulin (SMD = −0.21; 95% CI: −0.40 to −0.02; p = 0.030) in adults with overweight or obesity. Sutton et al.[11], in a landmark crossover RCT, demonstrated that early time-restricted feeding (eTRF; 6-hour eating window) improved insulin sensitivity, beta-cell responsiveness, and oxidative stress markers even without weight loss in men with prediabetes.

Fasting Insulin: Yuan et al.[12] reported significant reductions in fasting insulin levels (mean reduction 13.25 μUI; 95% CI: −16.69 to −9.82) following IF interventions. Stekovic et al.[38], studying alternate-day fasting in healthy non-obese adults over four weeks, observed significant reductions in fasting insulin and improvements in the soluble intercellular adhesion molecule-1 (sICAM-1), a marker of endothelial function.

Comparative Efficacy of IF Protocols: The network meta-analysis by Shu et al.[13] compared TRE, ADF, 5:2 fasting, and modified ADF in T2DM patients and found that TRE (particularly 16:8 protocols) demonstrated the most favourable profile for FBG reduction, while ADF showed greater effects on body weight and insulin levels. Wilkinson et al.[44] demonstrated that 10-hour TRE in metabolic syndrome patients reduced body weight, blood pressure, and atherogenic lipids alongside glycaemic improvements. Liu et al.[48], in a large RCT published in the New England Journal of Medicine, found that calorie restriction with TRE was not significantly superior to calorie restriction alone for weight loss, but TRE showed trends toward greater insulin sensitivity improvement.

Table 1: Summary of key clinical studies on intermittent fasting and glycaemic outcomes in insulin-resistant populations

Study	Design	Population	IF Protocol	Duration	Key Glycaemic Outcomes
Sutton et al., 2018[11]	Crossover RCT	Men with prediabetes (n=8)	eTRF (6-h window)	5 weeks	Improved insulin sensitivity, ↓ BP, ↓ oxidative stress; weight-independent
Carter et al., 2018[16]	RCT	T2DM patients (n=137)	5:2 diet vs CER	12 months	Non-inferior HbA1c reduction; greater adherence with IF
Yuan et al., 2022[12]	SR & MA	Impaired glucose/lipid metabolism	Various IF	Variable	FBG ↓ 0.15 mmol/L; insulin ↓ 13.25 μUI; HOMA-IR ↓ 0.31
Pavlou et al., 2023[17]	RCT	T2DM adults (n=75)	TRE (8-h window)	6 months	Significant weight loss and HbA1c reduction vs controls
Patikorn et al., 2024[14]	Umbrella review	Overweight/obese adults	ADF, TRE, TWF	1–3 months	Fasting insulin SMD = −0.21 (high-quality evidence)

Abbreviations: ADF, alternate-day fasting; BP, blood pressure; CER, continuous energy restriction; eTRF, early time-restricted feeding; FBG, fasting blood glucose; GRADE, Grading of Recommendations Assessment, Development and Evaluation; HbA1c, glycosylated haemoglobin; HOMA-IR, homeostatic model assessment for insulin resistance; IF, intermittent fasting; MA, meta-analysis; RCT, randomised controlled trial; SMD, standardised mean difference; SR, systematic review; T2DM, type 2 diabetes mellitus; TRE, time-restricted eating; TWF, twice-per-week fasting.

MOLECULAR MECHANISMS OF GLYCAEMIC IMPROVEMENT

The glycaemic benefits of intermittent fasting are mediated through a network of interconnected molecular pathways that collectively enhance insulin signalling, promote cellular quality control, and reduce metabolic inflammation.

AMPK Activation and Metabolic Switching: During fasting periods exceeding 10-14 hours, hepatic glycogen stores are depleted and the metabolic switch from glucose-based to fatty acid-based energy production is activated[8,9]. The increased AMP:ATP ratio activates AMPK, a central energy sensor and metabolic regulator[23]. AMPK activation promotes glucose uptake in skeletal muscle via GLUT4 translocation, enhances fatty acid oxidation, suppresses hepatic gluconeogenesis, and inhibits lipogenesis, collectively improving whole-body insulin sensitivity[9,20].

mTOR Suppression and Autophagy Induction: The mechanistic target of rapamycin (mTOR), particularly mTORC1, functions as a nutrient sensor that promotes

anabolic processes during fed states while inhibiting autophagy[23]. During fasting, reduced insulin and amino acid availability, combined with AMPK-mediated TSC1/2 complex activation, suppress mTORC1 activity[23,34]. This derepresses autophagy – the cellular self-degradation and recycling process elucidated by Ohsumi's Nobel Prize-winning research[34]. Enhanced autophagy clears damaged organelles, misfolded proteins, and dysfunctional mitochondria, improving cellular function in insulin-target tissues including hepatocytes, skeletal myocytes, and adipocytes[22,35].

Insulin–IGF-1 Signalling Axis Modulation: IF reduces circulating levels of insulin and IGF-1, decreasing tonic activation of the PI3K/Akt/mTOR pathway[8,41]. This periodic reduction in insulin signalling prevents the chronic hyperinsulinaemia-driven downregulation of insulin receptors, a key mechanism underlying insulin resistance[2,20]. Halberg et al.[24] demonstrated that 20-hour intermittent fasting in healthy men increased insulin-mediated whole-body glucose uptake, accompanied by increased adipose tissue lipolysis.

Reduction of Oxidative Stress and Inflammation: Insulin resistance is both a consequence and driver of chronic low-grade inflammation characterised by elevated pro-inflammatory cytokines including TNF-α, IL-6, and C-reactive protein (CRP)[2]. Meta-analytic evidence demonstrates that IF significantly reduces IL-6 levels (SMD = −0.30; 95% CI: −0.57 to −0.03; p = 0.029) in metabolic syndrome patients[15]. IF-mediated AMPK activation and mTOR suppression converge to inhibit NF-κB signalling, a master regulator of inflammatory gene expression[20,36]. Additionally, fasting upregulates endogenous antioxidant defences including superoxide dismutase (SOD), catalase, and glutathione peroxidase.[37,38]

Circadian Rhythm Alignment and Beta-Cell Function: Emerging evidence highlights that the timing of fasting – not merely its duration – critically modulates glycaemic outcomes[11,21]. Early time-restricted eating (eTRF), which aligns the eating window with daytime circadian rhythms, has demonstrated superior improvements in insulin sensitivity, beta-cell function, blood pressure, and oxidative stress compared to isocaloric feeding spread throughout the day [11,37]. Jamshed et al.[37] demonstrated that eTRF improved 24-hour glucose levels and positively influenced circadian clock gene expression, ageing markers, and autophagy in humans, supporting the Ayurvedic emphasis on eating within the active solar period[6,32].

Convergence with Ayurvedic Ama-Agni-Srotas Framework: The molecular pathways activated by intermittent fasting demonstrate a striking correspondence with the Ayurvedic conceptual framework of Upavasa's therapeutic mechanism[7,33]. The autophagy-mediated clearance of damaged cellular components parallels the Ayurvedic concept of Ama Pachana (digestion of metabolic toxins). AMPK activation and metabolic switching correspond to Agni Deepana (kindling of metabolic fire). The improvement in insulin receptor sensitivity and tissue glucose uptake mirrors Srotovishodhana (clearance of obstructed channels). The reduction of inflammatory mediators aligns with Dosha Shamana (pacification of aggravated Doshas)[7,33,45]. This convergence provides a molecular basis for the therapeutic rationality of classical Ayurvedic fasting prescriptions.

DISCUSSION

The evidence reviewed in this article establishes a compelling case for the therapeutic application of structured fasting – conceptualised as Upavasa in

Ayurveda and operationalised as intermittent fasting in modern medicine – for correcting blood sugar levels and improving insulin sensitivity in insulin-resistant subjects. The consistency of glycaemic improvements across multiple meta-analyses [12,14,15], diverse IF protocols [13], and varied patient populations [11,17,18] provides robust evidence for clinical relevance.

A particularly noteworthy finding is the weight-independent improvement in insulin sensitivity demonstrated by Sutton et al.[11], suggesting that the metabolic benefits of IF are not merely secondary to caloric deficit but involve intrinsic molecular reprogramming through AMPK activation, autophagy induction, and circadian realignment. This mechanistic depth strengthens the case for IF as a distinct therapeutic modality rather than a simple caloric restriction strategy.

The Ayurvedic framework of Upavasa enriches the modern understanding by providing a personalisation paradigm based on Prakriti (constitutional type), Bala (individual strength), Agni (metabolic capacity), and Kala (seasonal and diurnal timing)[3,6]. This is particularly relevant given contemporary recognition that IF responses exhibit significant inter-individual variability, potentially linked to genetic, metabolic, and chronobiological factors [8,10]. Integrating Prakriti-based assessment into IF prescription could enhance therapeutic precision and patient outcomes.

The alignment of eating windows with circadian rhythms, as emphasised in eTRF research [11,37], finds a parallel in the Ayurvedic dietary principle of consuming the main meal during the Pitta Kala (mid-day solar period) when Agni is at its zenith [6,32]. This temporal alignment between traditional Ayurvedic dietetics and circadian medicine represents a fertile area for integrative research.

However, several limitations must be acknowledged. First, many IF trials have relatively short durations (4-24 weeks), and long-term glycaemic outcomes beyond 12 months remain inadequately studied[14,27]. Second, heterogeneity in IF protocols, outcome measures, and study populations complicates direct comparisons and definitive protocol recommendations. Third, safety concerns in specific populations, including patients on sulfonylureas or insulin (hypoglycaemia risk), those with eating disorders, pregnant women, and elderly individuals, necessitate careful clinical supervision and Ayurvedic contraindication awareness [3,8]. Fourth, while the Ayurvedic-modern convergence is conceptually compelling, rigorous clinical trials directly evaluating Prakriti-guided Upavasa protocols with biomarker endpoints are needed to validate this integrative approach.

CONCLUSION

This review demonstrates that Upavasa (Ayurvedic therapeutic fasting) and its modern counterpart, intermittent fasting, exert clinically significant effects in correcting blood sugar levels and ameliorating insulin resistance. High-quality evidence from multiple meta-analyses confirms reductions in fasting blood glucose, HbA1c, HOMA-IR, and fasting insulin across diverse IF protocols and insulin-resistant populations. These benefits are mediated through AMPK activation, mTOR suppression, autophagy induction, circadian rhythm alignment, reduction of metabolic inflammation, and restoration of insulin receptor sensitivity.

The convergence of Ayurvedic Upavasa principles – Agni Deepana, Ama Pachana, Srotovishodhana, and Dosha Shamana – with modern molecular mechanisms of intermittent fasting validates the timeless therapeutic wisdom of classical Ayurvedic Langhana therapy. Future research should prioritise well-powered, long-term

randomised controlled trials evaluating Prakriti-guided, standardised Upavasa protocols with glycaemic biomarker endpoints in insulin-resistant subjects. Such studies will be essential for translating the promising preclinical and clinical evidence into personalised, evidence-based, integrative therapeutic guidelines for diabetes prevention and management.

REFERENCES

1. International Diabetes Federation. IDF Diabetes Atlas. 10th ed. Brussels: International Diabetes Federation; 2021.
2. DeFronzo RA, Ferrannini E, Groop L, Henry RR, Herman WH, Holst JJ, et al. Type 2 diabetes mellitus. Nat Rev Dis Primers. 2015;1:15019.
3. Charaka Samhita. Sutrasthana, Chapter 22 (Langhanabrimhaniya Adhyaya), Verses 18-36. Varanasi: Chaukhambha Bharati Academy; 201
4. Charaka Samhita. Chikitsa Sthana, Chapter 6 (Prameha Chikitsa). Varanasi: Chaukhambha Bharati Academy; 2011.
5. Sushrrzuta Samhita. Sutrasthana, Chapter 46, Verses 472-475. Edited by Jadavaji Trikamji Acharya. 8th ed. Varanasi: Chaukhambha Orientalia; 2005.
6. Vagbhata. Ashtanga Hridaya. Sutrasthana, Chapter 14 (Doshabhediya Adhyaya). Varanasi: Chaukhambha Surbharati Prakashan; 2002.
7. Shirke S, Kolarkar R. Evaluation of therapeutic role of Upavasa in Ayurved. Int J Appl Ayurved Res. 2020;4(10):1552-8.
8. de Cabo R, Mattson MP. Effects of intermittent fasting on health, aging, and disease. N Engl J Med. 2019;381(26):2541-51.
9. Anton SD, Moehl K, Donahoo WT, Marosi K, Lee SA, Mainous AG 3rd, et al. Flipping the metabolic switch: understanding and applying the health benefits of fasting. Obesity (Silver Spring). 2018;26(2):254-68.
10. Patterson RE, Laughlin GA, LaCroix AZ, Hartman SJ, Natarajan L, Senger CM, et al. Intermittent fasting and human metabolic health. J Acad Nutr Diet. 2015;115(8):1203-12.
11. Sutton EF, Beyl R, Early KS, Cefalu WT, Ravussin E, Peterson CM. Early time-restricted feeding improves insulin sensitivity, blood pressure, and oxidative stress even without weight loss in men with prediabetes. Cell Metab. 2018;27(6):1212-21.e3.
12. Yuan X, Wang J, Yang S, Gao M, Cao L, Li X, et al. Effect of intermittent fasting diet on glucose and lipid metabolism and insulin resistance in patients with impaired glucose and lipid metabolism: a systematic review and meta-analysis. Int J Endocrinol. 2022;2022:6999907.
13. Shu Y, Huang Y, Dong W, Fan X, Sun Y, Chen G, et al. The effects of different intermittent fasting regimens in people with type 2 diabetes: a network meta-analysis. Front Nutr. 2024;11:1325894.
14. Patikorn C, Roubal K, Veettil SK, Chandran V, Pham T, Lee YY, et al. Intermittent fasting and health outcomes: an umbrella review of systematic reviews and meta-analyses of randomised controlled trials. EClinicalMedicine. 2024;70:102482.
15. Khalafi M, Symonds ME, Alipour S, Rosenkranz SK, Pourvaghar MJ, Faridnia M, et al. Intermittent fasting improves metabolic outcomes in metabolic syndrome: a systematic review and meta-analysis with GRADE evaluation. Nutr

Diabetes. 2025;15:26.

16. Carter S, Clifton PM, Keogh JB. Effect of intermittent compared with continuous energy restricted diet on glycemic control in patients with type 2 diabetes: a randomized noninferiority trial. JAMA Netw Open. 2018;1(3):e180756.
17. Pavlou V, Cienfuegos S, Lin S, Ezpeleta M, Ready K, Corapi S, et al. Effect of time-restricted eating on weight loss in adults with type 2 diabetes: a randomized clinical trial. JAMA Netw Open. 2023;6(10):e2339337.
18. Manoogian ENC, Wilkinson MJ, O'Neal ML, Laing K, Nguyen VD, et al. Time-restricted eating in adults with metabolic syndrome: a randomized controlled trial. Ann Intern Med. 2024;177(11):1462-70.
19. Suthutvoravut U, Anothaisintawee T, Boonmanunt S, Pramyothin P, Siririyotin S, Attia J, et al. Efficacy of time-restricted eating and behavioral economic intervention in reducing fasting plasma glucose, HbA1c, and cardiometabolic risk factors in patients with impaired fasting glucose: a randomized controlled trial. Nutrients. 2023;15(18):4233.
20. Mattson MP, Longo VD, Harvie M. Impact of intermittent fasting on health and disease processes. Ageing Res Rev. 2017;39:46-58.
21. Longo VD, Panda S. Fasting, circadian rhythms, and time-restricted feeding in healthy lifespan. Cell Metab. 2016;23(6):1048-59.
22. Shabkhizan R, Haiaty S, Moslehian MS, Bazmani A, Sadeghsoltani F, Saghaei Bagheri H, et al. The beneficial and adverse effects of autophagic response to caloric restriction and fasting. Adv Nutr. 2023;14(5):1211-25.
23. Kim J, Kundu M, Viollet B, Guan KL. AMPK and mTOR regulate autophagy through direct phosphorylation of Ulk1. Nat Cell Biol. 2011;13(2):132-41.
24. Halberg N, Henriksen M, Söderhamn N, Stallknecht B, Ploug T, Schjerling P, et al. Effect of intermittent fasting and refeeding on insulin action in healthy men. J Appl Physiol. 2005;99(6):2128-36.
25. Barnosky AR, Hoddy KK, Unterman TG, Varady KA. Intermittent fasting vs daily calorie restriction for type 2 diabetes prevention: a review of human findings. Transl Res. 2014;164(4):302-11.
26. Harvie MN, Pegington M, Mattson MP, Frystyk J, Dillon B, Evans G, et al. The effects of intermittent or continuous energy restriction on weight loss and metabolic disease risk markers: a randomized trial in young overweight women. Int J Obes (Lond). 2011;35(5):714-27.
27. Varady KA, Cienfuegos S, Ezpeleta M, Gabel K. Cardiometabolic benefits of intermittent fasting. Annu Rev Nutr. 2021;41:333-61.
28. Cho Y, Hong N, Kim KW, Cho SJ, Lee M, Lee YH, et al. The effectiveness of intermittent fasting to reduce body mass index and glucose metabolism: a systematic review and meta-analysis. J Clin Med. 2019;8(10):1645.
29. Rajani A, Vyas MK, Vyas HA. Comparative study of Upavasa and Upavasa with Pachana in the management of Agnisada. Ayu. 2010;31(3):351-4.
30. Singh N, Bhalla M, de Jager P, Gilca M. An overview on Ashwagandha: a Rasayana (rejuvenator) of Ayurveda. Afr J Tradit

Complement Altern Med. 2011;8(5 Suppl):208-13

31. Tripathi B. Charaka Samhita. Nidana Sthana, Chapter 4 (Prameha Nidana). Varanasi: Chaukhamba Surbharati Prakashan; 2009.
32. Frawley D. Ayurveda and the Mind: The Healing of Consciousness. Delhi: Motilal Banarsidass Publishers; 1997.
33. Patwardhan B, Vaidya ADB, Chorghade M. Ayurveda and natural products drug discovery. Curr Sci. 2004;86(6):789-99.
34. Ohsumi Y. Historical landmarks of autophagy research. Cell Res. 2014;24(1):9-23.
35. Klionsky DJ, Abdel-Aziz AK, Abdelfatah S, Abdellatif M, Abdoli A, Abel S, et al. Guidelines for the use and interpretation of assays for monitoring autophagy (4th edition). Autophagy. 2021;17(1):1-382.
36. Madeo F, Carmona-Gutierrez D, Hofer SJ, Kroemer G. Caloric restriction mimetics against age-associated disease: targets, mechanisms, and therapeutic potential. Cell Metab. 2019;29(3):592-610.
37. Jamshed H, Beyl RA, Della Manna DL, Yang ES, Ravussin E, Peterson CM. Early time-restricted feeding improves 24-hour glucose levels and affects markers of the circadian clock, aging, and autophagy in humans. Nutrients. 2019;11(6):1234.
38. Stekovic S, Hofer SJ, Tripolt N, Aon MA, Royer P, Pein L, et al. Alternate day fasting improves physiological and molecular markers of aging in healthy, non-obese humans. Cell Metab. 2019;30(3):462-76.e6.
39. Harvie M, Wright C, Pegington M, McMullan D, Mitchell E, Martin B, et al. The effect of intermittent energy and carbohydrate restriction v. daily energy restriction on weight loss and metabolic disease risk markers in overweight women. Br J Nutr. 2013;110(8):1534-47.
40. Wei M, Brandhorst S, Shelehchi M, Mirzaei H, Cheng CW, Budniak J, et al. Fasting-mimicking diet and markers/risk factors for aging, diabetes, cancer, and cardiovascular disease. Sci Transl Med. 2017;9(377):eaai8700.
41. Longo VD, Mattson MP. Fasting: molecular mechanisms and clinical applications. Cell Metab. 2014;19(2):181-92.
42. Tinsley GM, La Bounty PM. Effects of intermittent fasting on body composition and clinical health markers in humans. Nutr Rev. 2015;73(10):661-74.
43. Adrienne RB, Hoddy KK, Unterman TG, Varady KA. Intermittent fasting vs daily calorie restriction for type 2 diabetes prevention: a review of human findings. Transl Res. 2014;164(4):302-11.
44. Wilkinson MJ, Manoogian ENC, Zadourian A, Lo H, Fakhouri S, Shoghi A, et al. Ten-hour time-restricted eating reduces weight, blood pressure, and atherogenic lipids in patients with metabolic syndrome. Cell Metab. 2020;31(1):92-104.e5.
45. Tripathi S, Kumari S. Langhanam Paramaushadham – a conceptual review on the principles of therapeutic fasting in Ayurveda. J Ayurveda Integr Med Sci. 2019;4(5):234-40.
46. Sadashiv M, Patil S. A literature review of Upavasa in PCOD w.r.t. intermittent fasting. J Ayurveda Integr Med Sci. 2023;8(11):140-6.

47. Cienfuegos S, Gabel K, Kalam F, Ezpeleta M, Wiseman E, Pavlou V, et al. Effects of 4- and 6-h time-restricted feeding on weight and cardiometabolic health: a randomized controlled trial in adults with obesity. Cell Metab. 2020;32(3):366-78.e3.
48. Liu D, Huang Y, Huang C, Yang S, Wei X, Zhang P, et al. Calorie restriction with or without time-restricted eating in weight loss. N Engl J Med. 2022;386(16):1495-504.
49. Gabel K, Hoddy KK, Haggerty N, Song J, Kroeger CM, Trepanowski JF, et al. Effects of 8-hour time restricted feeding on body weight and metabolic disease risk factors in obese adults: a pilot study. Nutr Healthy Aging. 2018;4(4):345-53.
50. Shetty P, Dinesh S, Halappa NG, Rajany T. Role of Langhana (therapeutic fasting) in Ayurveda – a critical review. J Ayurveda Integr