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AGNI IN THE ERA OF ULTRA-PROCESSED FOODS (UPF): AN INTEGRATIVE PERSPECTIVE ON METABOLIC HEALTH AND LIFESTYLE DISORDERS

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ABSTRACT

The global rise in the consumption of **ultra-processed foods (UPFs)** has emerged as a major public health concern, contributing significantly to the increasing prevalence of non- communicable diseases such as obesity, metabolic syndrome, type 2 diabetes mellitus, cardiovascular diseases, non-alcoholic fatty liver disease, and other lifestyle disorders. While contemporary nutritional science attributes these adverse health outcomes to factors such as poor nutritional quality, chronic inflammation, gut microbiota dysbiosis, oxidative stress, and metabolic dysfunction, the concept of ***Agni*** provides a comprehensive physiological framework for understanding these effects from an Ayurvedic perspective. *Agni*, regarded as the fundamental principle governing digestion, metabolism, tissue transformation, and maintenance of homeostasis, plays a pivotal role in preserving health. This narrative review aims to explore the conceptual relationship between *Agni* and ultra-processed foods by integrating classical Ayurvedic principles with current scientific evidence. Relevant concepts were compiled from the **Charaka Samhita, Sushruta Samhita, Ashtanga Hridaya,** and **Ashtanga Sangraha**, while contemporary literature was retrieved from PubMed, Scopus, Google Scholar, ScienceDirect, and the Cochrane Library. The review suggests that the characteristics of ultra-processed foods—including excessive refinement, repeated thermal processing, incorporation of artificial additives, prolonged storage, and poor nutrient density—closely resemble dietary factors described as impairing *Agni*. Persistent consumption of these foods may lead to ***Agnimandya***, resulting in ***Ama*** formation, ***Srotorodha***, impaired tissue metabolism, and progressive development of lifestyle disorders. Furthermore, emerging evidence linking UPFs with gut dysbiosis, intestinal barrier dysfunction, oxidative stress, and mitochondrial impairment demonstrate notable conceptual parallels with the Ayurvedic understanding of *Agni* dysfunction. This integrative perspective highlights the enduring relevance of *Agni* in understanding modern dietary challenges and underscores the importance of preserving digestive and metabolic integrity through the consumption of fresh, minimally processed foods. Further interdisciplinary research is warranted to validate *Agni*-based concepts using contemporary biomedical markers and clinical outcomes.

KEYWORDS: *Agni*; Ultra-processed foods; *Ama*; Lifestyle disorders; Metabolism

INTRODUCTION

The modern world is witnessing an unprecedented nutritional paradox. Despite remarkable advances in food technology and an abundance of readily available food products, the prevalence of obesity, type 2 diabetes mellitus, cardiovascular diseases, non-alcoholic fatty liver disease (NAFLD), metabolic syndrome, and other lifestyle disorders continues to rise at an alarming rate. A significant contributor to this global health crisis is the increasing consumption of **ultra-processed foods (UPFs)**, which have gradually replaced traditional, freshly prepared meals with highly refined, industrially formulated products. These foods are designed for convenience, prolonged shelf life, and enhanced palatability; however, their regular consumption has been consistently associated with chronic inflammation, impaired gut health, metabolic dysregulation, and increased disease risk. This dietary transition has

prompted researchers to explore not only the nutritional composition of food but also its influence on the body's ability to digest, assimilate, and metabolize nutrients. In this context, the Ayurvedic concept of ***Agni*** offers a profound and holistic framework for understanding the relationship between diet and health.

Agni: The Fundamental Principle of Life and Metabolism

In Ayurvedic philosophy, health is considered a dynamic state of equilibrium characterized by the balanced functioning of *doshas*, *agni*, *dhatus*, and other bodily components, along with the proper regulation of physiological processes and the well-being of the mind, sense organs, and soul. Among all physiological concepts described in Ayurveda, ***Agni*** occupies the foremost position. *Agni* is regarded as the fundamental principle responsible for all transformative processes in the body. According to Ayurveda, *Agni* is classified into thirteen distinct types.[1] Among the thirteen types, *Jatharagni* is considered the chief digestive fire, playing a pivotal role in maintaining normal lifespan, physical strength, health, vitality, growth, complexion, luster, *ojas*, the proper functioning of other *Agnis*, and ultimately sustaining life itself.[2]

Bhutagni is responsible for transforming ingested substances of diverse *Panchamahabhuta* composition (*Vijatiya Panchabhautika Dravyas*) into forms that are compatible with the body's own elemental constitution (*Sajatiya Panchabhautika Dravyas*).[3] *Dhatvagni* governs the metabolic processes involved in the synthesis, nourishment, and catabolism of the body tissues (*Dhatus*).[4]

All the **thirteen types of *Agni***, comprising ***Jatharagni***, ***Bhutagni***, and ***Dhatvagni***, work in a coordinated manner to maintain physiological homeostasis. Proper functioning of these *Agnis* ensures the formation of healthy *Dhatus*, optimal *Ojas*, balanced *Doshas*, and efficient elimination of waste products. Conversely, disturbances in *Agni* lead to incomplete digestion, formation of ***Ama***, *Srotorodha* (obstruction of body channels), and subsequent disease manifestation.

Agni* and the Central Role of *Ahara

Aahara are the entities that are to be swallowed. Whatever is ingested or eaten with the mouth is called *Aahara*, which includes solid as well as liquid food items.[5] In Ayurveda, ***Ahara* (diet), *Nidra* (sleep), and *Brahmacharya* (regulated conduct or disciplined use of energy)** are regarded as the three subsidiary pillars (*Upastambhas*) that sustain and support the primary pillar, the human body.[6] Among these, *Ahara* is mentioned first, underscoring its fundamental importance in preserving health and maintaining physiological balance. The harmonious maintenance of *Ahara*, *Nidra*, and *Brahmacharya* forms the foundation for a healthy and balanced life according to Ayurvedic principles.

The quantity of food consumed should always be appropriate, as proper food intake plays a crucial role in preserving the efficiency of digestive power (*Agni*).[7] Consuming food in the right measure promotes physical strength, a healthy complexion, overall well-being, and longevity while maintaining physiological balance.[8] However, even wholesome food taken in the correct quantity may not be digested efficiently if an individual is affected by psychological disturbances such as anxiety, grief, fear, or anger, or if they have experienced inadequate or disturbed sleep or prolonged wakefulness.[9] Ayurveda recognizes negative emotional states, including envy, fear, and anger, as important causative factors for impaired digestion (*Ajirna*). Therefore, the functional state of *Agni* is influenced not only by the quality and quantity of food but also by the individual's mental and emotional well-being.

Dietary principles described in the traditional medical literature emphasize avoiding the frequent consumption of stale, preserved, repeatedly heated, incompatible, excessively heavy, and artificially modified foods, as these are believed to impair ***Agni*** and promote the formation of ***Ama***. These recommendations have gained renewed significance in the modern era, where industrial food processing has become an integral part of daily dietary practices and the consumption of highly processed convenience foods continues to increase.

Ultra-Processed Foods: A Modern Dietary Challenge

Almost all foods undergo some degree of processing, even if only for preservation, making the general classification of foods as simply "processed" of limited practical value. Consequently, several food classification systems have been developed that distinguish foods according to the nature and extent of processing rather than processing itself. A systematic review identified the NOVA classification as the most comprehensive, coherent, specific, clear, and practical system among the available food classification frameworks.[10] Ultra-processed foods represent the highest level of industrial food processing as classified by the NOVA food classification system.

These products are typically energy-dense while being deficient in dietary fibre, micronutrients, and bioactive phytochemicals. These have become a dominant component of dietary patterns across the globe, driven by rapid urbanization, changing lifestyles, and the increasing demand for convenience. Evidence from large population-based dietary surveys conducted in several countries indicates that these products constitute a significant proportion of daily energy intake, particularly among urban populations and younger age groups.[11,12,13]

Nutritionally, UPFs are characterized by a high energy density and typically contain excessive amounts of added sugars, unhealthy fats, and sodium, while being deficient in dietary fibre, high-quality proteins, vitamins, minerals, and other bioactive compounds essential for optimal

health.[14,15] Such an imbalanced nutritional profile contributes to poor overall diet quality despite adequate or excessive caloric intake.

Experimental studies further demonstrate that ultra-processed foods elicit rapid postprandial glycaemic responses and possess a low satiating capacity, thereby promoting overconsumption of calories.[16] In addition, emerging evidence suggests that several additives and ingredients commonly used during industrial food processing may alter the intestinal microbial ecosystem, creating a pro-inflammatory gut environment that adversely affects metabolic and immune homeostasis.[17]

Observational studies consistently report that a higher intake of ultra-processed foods is associated with deterioration in overall dietary quality[18,19] and an increased risk of numerous non-communicable diseases, including obesity.[20,21] hypertension.[22] dyslipidaemia,[23] metabolic syndrome,[24] cardiovascular diseases, gastrointestinal disorders,[25] and certain types of cancer.[26] These associations have been demonstrated across diverse populations, highlighting the widespread public health implications of excessive UPF consumption.

Recognizing these adverse health effects, several national dietary guidelines now advocate minimizing the intake of ultra-processed foods and encourage the consumption of fresh or minimally processed foods as part of a healthy dietary pattern.[27]

Rationale of the Present Review

Despite the rapidly growing body of evidence linking ultra-processed foods with lifestyle disorders, limited efforts have been made to interpret these findings through the lens of Ayurvedic physiology. Establishing a conceptual relationship between *Agni* and ultra-processed foods may provide a comprehensive understanding of the pathogenesis of modern metabolic diseases while reinforcing the timeless relevance of Ayurvedic dietary principles. The present review therefore aims to critically examine the impact of ultra-processed foods on *Agni* by integrating classical Ayurvedic concepts with contemporary scientific evidence, thereby highlighting the importance of preserving *Agni* as a cornerstone of preventive and promotive healthcare.

MATERIALS AND METHODS

The present study is a **narrative review** that integrates the fundamental concepts of **Agni** described in the Ayurvedic literature with contemporary scientific evidence on **ultra-processed foods (UPFs)** and their effects on human health. The review aims to establish a conceptual correlation between Agni and the physiological consequences of UPF consumption by critically analysing classical Ayurvedic principles alongside recent biomedical research.

Source of Data

Ayurvedic Literature

The conceptual framework of Agni, Ahara, Ama, Agnidushti, Viruddha Ahara, and the role of diet in health and disease was compiled through an extensive review of authoritative Ayurvedic texts, including the **Charaka Samhita**, **Sushruta Samhita**, **Ashtanga Hridaya**, and **Ashtanga Sangraha**, along with their standard commentaries. Relevant references pertaining to Jatharagni, Bhutagni, Dhatvagni, dietary regimens, food incompatibility, and the pathogenesis of disease were identified and critically interpreted in relation to the objectives of the review.

Modern Scientific Literature

Recent scientific evidence was retrieved from electronic databases including **PubMed**, **Google Scholar**, **Scopus**, **ScienceDirect**, and the **Cochrane Library**. A comprehensive literature search was performed using combinations of keywords such as *Agni*, *Ayurveda*, *ultra-processed foods*, *NOVA classification*, *processed foods*, *gut microbiota*, *gut dysbiosis*, *inflammation*, *oxidative stress*, *metabolic syndrome*, *obesity*, *type 2 diabetes*, *cardiovascular disease*, and *lifestyle disorders*. Original research articles, systematic reviews, meta-analyses, consensus statements, and review articles published primarily between **2015 and 2025** were considered. Landmark publications on the NOVA food classification system by **Monteiro et al.** and recent evidence evaluating the health effects of UPFs were also included. Relevant findings from both traditional and contemporary sources were synthesized to develop an evidence-informed discussion on the relationship between Agni dysfunction and the consumption of ultra-processed foods.

DISCUSSION

Conceptual Correlation between *Agni* and Ultra-Processed Foods

Agni is regarded as the fundamental principle responsible for all transformative processes occurring within the body. Although traditionally described in relation to digestion and metabolism, its functional significance extends beyond gastrointestinal digestion to encompass nutrient assimilation, tissue nourishment, cellular metabolism, immunity, and maintenance of physiological homeostasis. Contemporary biomedical science similarly recognizes that digestion is not merely the breakdown of food but an integrated process involving digestive enzymes, gastrointestinal hormones, intestinal microbiota, immune regulation, mitochondrial metabolism, and cellular bioenergetics. This multidimensional understanding closely parallels the functional attributes assigned to *Jatharagni*, *Bhutagni*, and *Dhatvagni*.

Ultra-processed foods differ substantially from their natural counterparts not only in nutritional composition but also in their structural integrity and biological properties. Repeated industrial processing, fractionation

of whole foods, chemical modification, incorporation of additives, and prolonged storage significantly alter the food matrix. Consequently, these products often possess characteristics that increase the digestive burden and reduce their compatibility with normal metabolic processes.

From the perspective of *Agni*, the quality of food is as important as its nutrient content. Foods that are excessively heavy, chemically modified, repeatedly heated, preserved for prolonged periods, or consumed in incompatible combinations are described as factors capable of disturbing *Agni*.

Ultra-Processed Foods as *Agnidushtikara Ahara*

The pathogenesis of many diseases begins with impairment of *Agni*. The dietary properties attributed to ultra-processed foods exhibit remarkable similarities to several forms of ***Agnidushtikara Ahara***.

Most ultra-processed foods are rich in refined carbohydrates, saturated fats, trans fats, emulsifiers, stabilizers, artificial sweeteners, preservatives, flavour enhancers, and colouring agents while being deficient in fibre and naturally occurring micronutrients. These characteristics make them difficult to digest and metabolically demanding.

Repeated heating during manufacturing, prolonged storage, and the use of chemical preservatives alters the natural qualities of food. Such modifications reduce freshness and biological vitality while increasing dependence on artificial ingredients to maintain texture and palatability. Frequent consumption of these foods may therefore place continuous stress on digestive and metabolic functions.

Many commercially available products also contain combinations of ingredients that are rarely encountered in natural diets, including refined sugars with saturated fats, synthetic additives with dairy products, artificial flavours combined with acidic regulators, and multiple chemically modified ingredients within a single formulation. Such complex formulations may challenge normal digestive processes and contribute to metabolic imbalance.

Furthermore, their high palatability often promotes overeating, frequent snacking, and irregular meal timing, all of which are recognized contributors to impaired digestive efficiency. Together, these characteristics suggest that ultra-processed foods possess several properties capable of progressively disturbing *Agni* when consumed regularly over prolonged periods.

Formation of *Ama*: The Central Link between Ultra-Processed Foods and Disease

The concept of ***Ama*** occupies a central position in the pathogenesis of disease. *Ama* is formed when digestion remains incomplete because of impaired *Agni*, resulting in improperly processed nutritional material that accumulates within the body and obstructs physiological functions.

Although *Ama* has no direct equivalent in modern medicine, several contemporary mechanisms exhibit striking conceptual similarities. Chronic low-grade inflammation, increased intestinal permeability, metabolic endotoxemia, oxidative stress, accumulation of advanced glycation end products, and persistent immune activation collectively represent states in which incompletely processed metabolic products adversely influence systemic physiology.

Ultra-processed foods contribute to these processes through multiple mechanisms. Their high glycaemic load induces repeated postprandial hyperglycaemia and hyperinsulinemia, while excessive saturated fats promote lipid accumulation and oxidative stress. Food additives such as emulsifiers and artificial sweeteners have also been shown to impair intestinal barrier integrity and alter immune responses. Together, these changes create a chronic pro-inflammatory environment that resembles the systemic consequences attributed to *Ama*.

Gut Microbiota, Intestinal Barrier and *Agni*

Recent advances in microbiome research have transformed the understanding of digestive physiology. The intestinal microbiota is now recognized as an essential determinant of digestion, nutrient metabolism, immune modulation, neurotransmitter synthesis, and maintenance of intestinal barrier integrity.

Several experimental and clinical studies demonstrate that diets rich in ultra-processed foods reduce microbial diversity while favouring the proliferation of pro-inflammatory bacterial species. Artificial sweeteners, emulsifiers, preservatives, and inadequate dietary fibre collectively contribute to gut microbial dysbiosis and increased intestinal permeability.

The resulting translocation of bacterial endotoxins into the circulation stimulates chronic inflammation and metabolic dysfunction.

Efficient digestion, proper absorption, normal elimination, and freedom from *Ama* are all dependent upon the integrity of digestive function. Therefore, disturbances in gut microbial ecology may be viewed as one of the contemporary biological expressions of impaired *Agni.*

Ultra-Processed Foods and *Dhatvagni* Dysfunction

The effects of ultra-processed foods extend beyond gastrointestinal digestion and influence tissue metabolism at multiple levels. Following initial digestion by *Jatharagni*, nutrients undergo successive metabolic transformations governed by *Bhutagni* and *Dhatvagni* before contributing to tissue nourishment.

Experimental studies have demonstrated that ultra-processed foods promote mitochondrial dysfunction, oxidative stress, insulin resistance, altered lipid metabolism, and impaired cellular energy production. Persistent metabolic stress affects normal synthesis, maintenance, and regeneration of body tissues.

Impairment of *Dhatvagni* results in defective nourishment of successive *Dhatus*, leading to either tissue depletion or pathological accumulation. Such disturbances closely resemble the metabolic abnormalities observed in obesity, dyslipidaemia, fatty liver disease, and metabolic syndrome, where altered tissue metabolism rather than simple caloric excess underlies disease progression.

Thus, prolonged consumption of ultra-processed foods may adversely influence not only *Jatharagni* but also *Bhutagni* and *Dhatvagni*, resulting in widespread metabolic disturbances.

Ultra-Processed Foods, *Agni* Dysfunction and Lifestyle Disorders

An increasing body of epidemiological evidence consistently associates high consumption of ultra-processed foods with obesity, type 2 diabetes mellitus, cardiovascular disease, hypertension, metabolic syndrome, inflammatory bowel disorders, depression, and several malignancies.

While modern biomedical science attributes these disorders to chronic inflammation, oxidative stress, endocrine dysregulation, gut microbial alterations, and mitochondrial dysfunction, these mechanisms collectively correspond to the consequences of persistent *Agni* impairment described in Ayurveda.

Impaired *Agni* leads to incomplete digestion, accumulation of *Ama*, obstruction of body channels, imbalance of *Doshas*, defective tissue metabolism, and gradual manifestation of disease. The remarkable convergence between these traditional concepts and contemporary biomedical findings suggests that *Agni* provides an integrative physiological framework for understanding the systemic consequences of diets dominated by ultra-processed foods.

Implications for Preventive Healthcare

The increasing burden of lifestyle disorders underscores the importance of preventive dietary strategies. Current public health recommendations encourage reducing the consumption of ultra-processed foods and replacing them with minimally processed, nutrient-rich alternatives. These recommendations closely align with traditional dietary principles emphasizing freshly prepared foods, appropriate meal timing, moderation in quantity, and consumption according to digestive capacity.

Preservation of *Agni* may therefore represent a practical preventive approach that extends beyond nutrient counting to encompass food quality, digestibility, compatibility, freshness, and individual metabolic capacity. Integrating these principles with evidence-based nutritional guidelines may enhance strategies aimed at reducing the incidence of chronic metabolic diseases.

CONCLUSION

The growing consumption of ultra-processed foods represents one of the most significant dietary shifts of the modern era and is increasingly recognized as a major contributor to the global burden of lifestyle disorders. While contemporary research attributes their detrimental effects to excessive energy density, poor nutritional quality, chronic inflammation, gut microbiota dysbiosis, oxidative stress, mitochondrial dysfunction, and metabolic disturbances, the concept of ***Agni*** offers a comprehensive physiological framework for interpreting these changes. Rather than viewing digestion solely as a mechanical or biochemical process, *Agni* encompasses the body's entire capacity for digestion, absorption, assimilation, tissue transformation, and maintenance of metabolic homeostasis.

The characteristics of ultra-processed foods—including excessive refinement, prolonged industrial processing, repeated thermal treatment, incorporation of artificial additives, and poor nutrient density—closely resemble dietary factors traditionally described as impairing *Agni*. Persistent consumption of such foods may lead to ***Agnimandya***, resulting in the formation of ***Ama***, ***Srotorodha***(obstruction of physiological channels), impairment of ***Bhutagni*** and ***Dhatvagni***, and subsequent disturbance of tissue metabolism. These pathological events exhibit notable conceptual parallels with contemporary mechanisms underlying obesity, metabolic syndrome, type 2 diabetes mellitus, cardiovascular diseases, non-alcoholic fatty liver disease, and other chronic non-communicable diseases.

The present review highlights the remarkable convergence between traditional concepts of *Agni* and current scientific understanding of metabolic health. This integrative perspective reinforces the continuing relevance of Ayurvedic dietary principles in addressing present-day nutritional challenges. Encouraging the consumption of fresh, minimally processed foods, maintaining appropriate meal timing and quantity, and preserving the functional integrity of *Agni* may complement existing public health strategies aimed at preventing lifestyle disorders.

Future interdisciplinary research should focus on validating the physiological correlates of *Agni* using contemporary biomarkers of digestive function, gut microbiota composition, inflammation, oxidative stress, and metabolic regulation. Such evidence may facilitate the integration of Ayurvedic principles with modern nutritional science and contribute to the development of

holistic, evidence-based approaches for promoting health and preventing disease.

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