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Review Article

Unani Concepts of Urine Formation and Micturition in Relation to Modern Renal Physiology: A Narrative Review

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Abstract

Background: Urine formation and micturition are essential physiological processes that maintain fluid, electrolyte, and acid-base balance. While contemporary medicine explains these processes through renal and lower urinary tract physiology and neural regulation, Unani medicine interprets them through the concepts of *Akhlāṭ* (humours), *Quwā* (faculties), and *Ṭabīʿat* (the governing principle of the body). **Objective:** To review the classical Unani concepts of urine formation and micturition and compare them with modern renal physiology through a functional correlation. **Methods:** A narrative review was conducted using classical Unani literature, including the works of Al-Razi, Raban Tabari, Ibn Sīnā Al-Jurjānī, along with modern textbooks and peer-reviewed articles on renal physiology. Relevant information was critically analyzed and interpreted to identify functional similarities and conceptual differences between the two systems. **Results:** Classical Unani literature describes urine as a waste product of hepatic digestion that undergoes further processing in the kidneys through the coordinated action of *Quwwat Jādhiba*, *Quwwat Māsika*, *Quwwat Hāḍima*, *Quwwat Mumayyiza*, and *Quwwat Dāfiʿa*. Micturition is explained as a coordinated process involving the kidneys, urinary bladder, urethral sphincter, abdominal muscles, and natural faculties. Functional comparison with modern physiology revealed meaningful parallels between selective separation of useful substances, urinary storage, and controlled voiding. However, differences remain in the theoretical basis of urine formation and the mechanisms regulating renal function. **Conclusion:** Despite their distinct conceptual frameworks, Unani medicine and contemporary renal physiology share several functional similarities in explaining urine formation and micturition. A functional interpretation of classical concepts provides a scientific basis for understanding Unani physiology while preserving its original principles. This integrative approach may support future interdisciplinary research and strengthen the scientific interpretation of Unani medicine.

Keywords: Urine formation; Micturition; Unani medicine; Renal physiology; *Quwā*; *Akhlāṭ*; Narrative review.

1. Introduction

The urinary system plays a pivotal role in maintaining internal homeostasis by regulating body fluid volume, electrolyte balance, acid–base equilibrium, and the excretion of metabolic waste products.[1] Among its principal physiological functions, urine formation and micturition constitute two closely coordinated processes that ensure the elimination of waste while preserving the internal milieu necessary for normal cellular function. Modern physiology explains urine formation through glomerular filtration, tubular reabsorption, and tubular secretion.[2,3] It has a complex interaction among the urinary bladder, urethral sphincters, and autonomic and somatic nervous systems that regulates micturition. Together, these mechanisms maintain water and electrolyte balance, blood pressure, and overall metabolic stability.[4]

Long before the advent of modern renal physiology, scholars of the Unani system of medicine described the formation, transportation, storage, and excretion of urine within a comprehensive physiological framework based on the principles of *Tabīʿat* (the innate governing power), *Akhlāṭ* (humours), *Quwā* (faculties), and *Aʿḍā'* (organs). Classical physicians such as Hippocrates, Galen, Al-Rāzī, Al-Majūsī, Ibn Sīnā, Ismāʿīl Jurjānī, and Nafīs ibn ʿIwaḍ Kirmānī recognized urine as an important physiological product and a valuable indicator of health and disease.[5-11] They described the kidneys (*Kulya*) as organs responsible for separating the aqueous portion of the blood from useful constituents, the ureters as channels conveying urine to the urinary bladder (*Mathāna*), and the bladder as the reservoir from which urine is expelled through the action of *Quwwat Dāfiʿa* (expulsive faculty).[5-11] These concepts, although expressed in the terminology of humoral

physiology, demonstrate a systematic understanding of urinary function.

Advances in nephrology and neurophysiology have clarified the mechanisms underlying renal filtration, tubular transport, and neural control of micturition. While Unani and modern medicine differ in their theoretical foundations, several classical descriptions show noteworthy conceptual parallels with contemporary physiology. However, these concepts remain scattered across classical texts and have not been comprehensively synthesized alongside current scientific knowledge. Therefore, this review critically explores the Unani concepts of urine formation and micturition and correlates them with modern renal and lower urinary tract physiology, aiming to provide an integrative understanding without implying direct equivalence.

2. Materials and Methods

This narrative review was undertaken to examine the classical Unani concepts of urine formation and micturition and to interpret them in the light of contemporary renal physiology.

The review was primarily based on authentic classical Unani literature. The principal sources included *Kitāb al-Ḥāwī* (Al-Razi), *Al-Qānūn fi'l Ṭibb* (Ibn Sina), *Dhakhīra Khwarizm Shāhī* (Jurjani), *Kāmil al-Ṣanā'a al-Ṭibbiyya* (Majusi), *Kitāb al-Kulliyyāt* (Ibn Rushd), *Kulliyyāt Nafīsī* (Kabiruddin), *Kitāb al-Mukhtārāt fi'l Ṭibb* (Ibn Hubal al-Baghdadi), *Iksīr-i-A'ẓam* (Azam Khan), and *Firdaws al-Ḥikmat* (Rabban Ṭabarī), along with their authentic translations. These texts were reviewed to collect information related to the Unani concepts of urine formation, micturition, and the physiological role of the kidneys and urinary bladder.

To correlate these concepts with current scientific knowledge, standard medical textbooks, including *Guyton and Hall Textbook of Medical Physiology*, *Campbell-Walsh Urology*, *Smith's General Urology*, *Gray's Anatomy*, and *Harrison's Manual of Medicine*, were consulted. In addition, published literature, including peer-reviewed research articles, review papers, dissertations, conference proceedings, and institutional reports, was examined. Electronic databases such as PubMed, Google Scholar, Internet Archive, and the WHO database were searched to identify relevant literature on urine formation, micturition, and renal physiology.

The retrieved literature was critically analysed and organized according to the major themes of the review. Classical Unani concepts were interpreted alongside contemporary physiological evidence to identify areas of functional correlation and conceptual differences. The findings were then synthesized to provide an integrated understanding of urine formation and micturition while preserving the original principles of the Unani system.

3. Observations

Historical Background of Urine Examination:

Urine has been used as a valuable source of clinical information since ancient times. It is among the earliest body fluids examined for the diagnosis and prognosis of disease. In ancient civilizations, especially among the Babylonians and Egyptians, physicians considered urine a reflection of the body's internal condition. It was often described as a "window to the body" because changes in its appearance were believed to indicate disease.[12,13,14] The practice of examining urine dates back nearly 6000 years. Physical examination of urine is known as uroscopy. The term uroscopy is derived from the Greek words *ouron*, meaning urine, and *skopeo*, meaning to observe or examine.[12,13,14] The earliest systematic description of uroscopy is attributed to Hippocrates (460–377 BC). He proposed that urine was a filtrate of blood and reflected the condition of the body's humours. Later, Galen (AD 129–200) associated urine with the liver's functional state, which he considered the site of blood formation.[15] Over time, this practice evolved into modern urinalysis, which remains an essential laboratory investigation.

According to the Unani system of medicine, urine is the waste product formed during *Haḍm Kabidī* (hepatic digestion) and *Haḍm Uruqi* (vascular digestion). Raban Tabari described urine as the watery portion of the blood that is separated in the liver and carried to the kidneys for elimination.[16,17]

Unani Physiology of Urine Formation:

Urine is composed of two main components: a fluid portion called *Mā'iyat* and a solid residue known as *Rasūb.*[16,18,19] According to Unani philosophy, food undergoes a series of four digestive processes, termed *Huḍūm Arba'a* (gastric, hepatic, vascular, and cellular digestion), each producing specific waste products.[19,20] Since no food is completely nutritive, some portion always remains unassimilable. During gastric digestion, a semi-fluid mass called *Kaylūs* (chyme), resembling thick barley water, is formed.[5,6,17,20,21]

This *Kaylūs* moves to the liver via the mesenteric vessels for further transformation into *Akhlāṭ* (humours), assisted by the presence of excess water that facilitates its transport.[5,6,16-20]

Once the transformation into humours is complete in the liver, the excess water becomes redundant and is regarded as waste. The liver directs this waste fluid toward the kidneys for excretion.[6,16,22]

The *Quwwat Jādhiba* (receptive faculty) of the kidneys absorbs this fluid, while *Quwwat Māsika* (retentive faculty) holds it temporarily for further processing by the *Quwwat Hāḍima* (digestive faculty) and *Quwwat Mumayyiza* (discriminative faculty).[10,23]

Through these faculties, the kidneys separate useful nutrients from waste, nourishing themselves while expelling the remaining watery content as urine by the action of *Quwwat Dāfi'a*. Thus, urine is ultimately considered a waste product of hepatic digestion.[6,10,11,16,22,24]

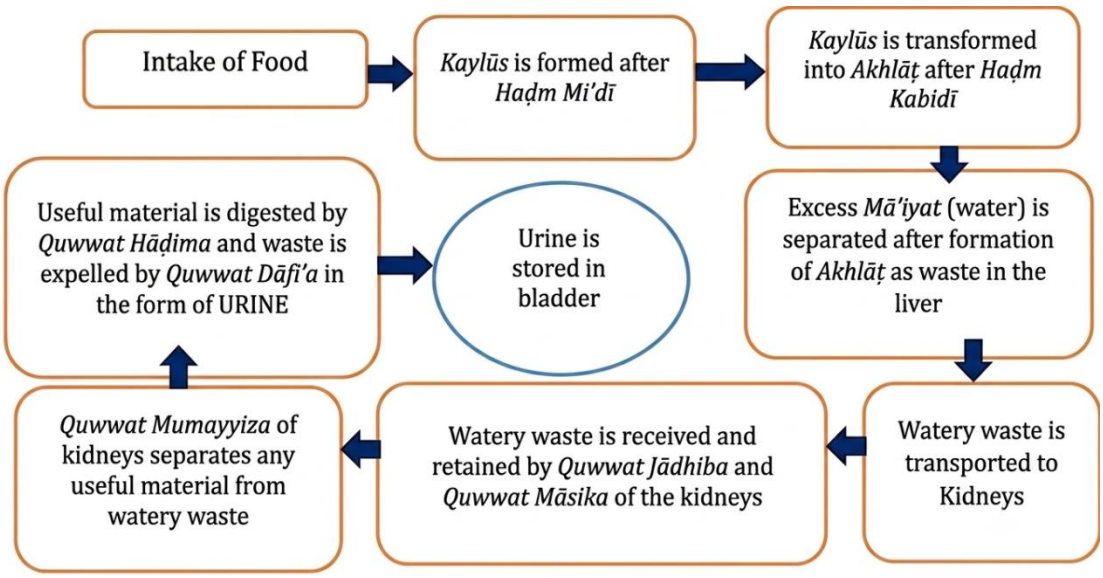

Fig.1 Sequential process of urine formation from the Unani perspective.

Modern Physiological Perspective:

In modern physiology, the kidneys are the primary organs of excretion, though the skin, lungs, liver, salivary glands, and gastrointestinal tract also assist in waste elimination. Among these, the kidneys play a dominant role by filtering approximately 1300 ml of blood per cardiac cycle, which constitutes around 26% of the resting cardiac output. This filtration process facilitates the removal of metabolic waste and excess water from the bloodstream in the form of urine.[25,26]

The formation and excretion of urine are essential kidney functions for maintaining homeostasis, thereby ensuring optimal conditions for cellular activity.[27,28]

Urine formation is vital for maintaining homeostasis and consists of three main processes:

A. Glomerular filtration
B. Tubular reabsorption
C. Tubular secretion

Among these, filtration is carried out by the glomerulus, while reabsorption and secretion occur within the tubular parts of the nephron.

A. Glomerular Filtration:
Glomerular filtration is the initial and essential step in the process of urine formation, wherein blood is filtered through a specialized filtration barrier as it flows through the glomerular capillaries.

This filtration membrane is composed of three distinct layers:

1. The endothelium of the glomerular capillaries

2. The basement membrane

3. The visceral epithelium of Bowman's capsule (formed by podocytes)

During this process, plasma is filtered into Bowman's capsule, yielding a fluid known as glomerular filtrate. This filtrate includes all components of plasma except for plasma proteins, which are excluded due to their relatively large molecular size. The fenestrations in the capillary endothelium and the narrow filtration slits between podocyte foot processes are insufficiently large to permit the passage of protein molecules. Hence, glomerular filtration is often referred to as ultrafiltration, as it allows even the smallest solutes to pass through while restricting macromolecules like proteins.

B. Tubular Reabsorption:
Tubular reabsorption is the process by which water and solutes are reclaimed from the renal tubular fluid and returned to the bloodstream. As the glomerular filtrate progresses through the tubular segments of the nephron, it undergoes substantial changes in both volume and composition. The epithelial cells lining the renal tubules reabsorb more than 99% of water, along with essential electrolytes and other biologically important substances. These reabsorbed substances initially diffuse into the interstitial fluid of the renal medulla and subsequently enter the peritubular capillaries, thereby rejoining the systemic circulation.

This process is described as selective reabsorption, as tubular cells selectively reabsorb only those substances required by the body, such as glucose, amino acids, and vitamins, while allowing waste products to be excreted.

C. Tubular Secretion:
Tubular secretion, also referred to as tubular excretion, involves the active transport of certain substances from the peritubular capillaries into the lumen of the renal tubules. In addition to reabsorbing useful substances, the nephron also eliminates excess or harmful substances through secretion by the tubular epithelial cells.

Various substances are secreted in specific segments of the nephron as follows:

1. Potassium ions are actively secreted via the sodium-potassium pump in the proximal and distal convoluted tubules, as well as in the collecting ducts.

2. Ammonia is secreted primarily in the proximal convoluted tubule.

3. Hydrogen ions are secreted in both the proximal and distal convoluted tubules, with the majority being secreted in the proximal tubule.

4. Urea is secreted in the loop of Henle.

Hence, the complete process of urine formation within the nephron comprises three coordinated physiological mechanisms: glomerular filtration, selective tubular reabsorption, and tubular secretion. [25,27-30]

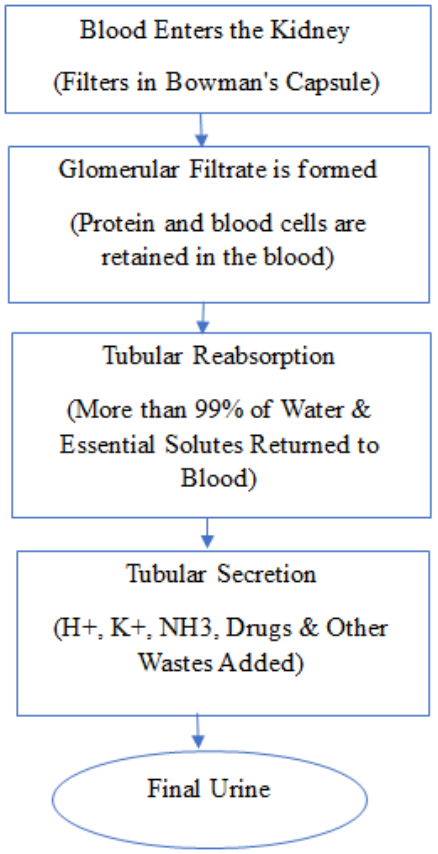

Fig.2. Physiological process of urine formation in Modern Medicine

ʿAmal Tabawwul (the act of micturition):

In Unani medicine, *ʿAmal Tabawwul* (the act of micturition) is described as a complex but naturally regulated physiological process that depends on the coordinated activity of the urinary bladder, the urethral sphincter situated at its outlet, and the abdominal muscles.[5,7] This process is governed by the *Quwwat Ṭabīʿiyya* (natural faculties), particularly the *Quwwat Dāfiʿa* (expulsive faculty) and the *Quwwat Māsika* (retentive faculty).[5–7,9]

According to Ibn Sina, during *Haḍm Kabidī* (hepatic digestion), a watery residue separates from the digested material and is directed toward the kidneys, where it is transformed into urine. This urine travels through the ureters and accumulates in the bladder, which serves as a temporary receptacle until the act of expulsion occurs (Ibn Sina). He further notes that at the opening of the bladder there is a muscular structure (sphincter) that prevents the outflow of urine; its closing and opening actions depend on the *Quwwat Māsika* for retention and the *Quwwat Dāfiʿa* for expulsion.[5] He adds that when voiding arises, the *ʿAḍala al-Mathāna* (muscle of the bladder), the sphincter at its opening, and the *ʿAḍal al-Baṭn* (muscles of the abdomen) work together under the influence of *Quwwat Dāfiʿa* to expel the urine.[5]

Razi, in *Kitāb al-Ḥāwī fiʾl Ṭibb*, describes that as the bladder fills, it stretches, and this distension is perceived by the *Quwwat Ḥissiyya* (sensory faculty), and the *Quwwat Dāfiʿa* initiates urination.[7]

Al-Jurjani further elaborates that when the bladder becomes distended, the sensation of fullness activates the *Quwwat Dāfiʿa*, which contracts the bladder and allows urine to pass through the urinary passage.[6]

Thus, Unani scholars consider *ʿAmal Tabawwul* to be a finely balanced act that involves the formation of urine in the kidneys, its storage in the bladder under the control of *Quwwat Māsika*, and its expulsion through the joint effort of the bladder, urethral sphincter, and abdominal muscles. This activity proceeds under the influence of *Quwwat Dāfiʿa*, aided by *Irādah* (will) and the perceptive response arising from the *Aʿṣābi Ṭabaqa* (sensitive layer) of the bladder, ensuring a natural and coordinated act of micturition within the Unani physiological framework.

Micturition

Micturition is the process by which urine is voided from the urinary bladder. It is primarily a reflex mechanism; however, in older children and adults, it can be voluntarily controlled to some extent. A comprehensive understanding of the bladder's anatomical structure and its neural control mechanisms is crucial for elucidating the micturition process.[25]

Filling of Urinary Bladder:

Urine Filling Process:

Urine is continuously produced by the nephrons and transported to the urinary bladder in small amounts via the ureters. As urine gathers in the renal pelvis, it triggers contractions that are propagated along the ureter as peristaltic waves, eventually reaching the bladder's trigone region. These waves typically move at a speed of about 3 cm per second and occur 1 to 5 times per minute, helping to propel urine into the bladder.

After exiting the kidney, the ureter initially travels downward and outward, then curves horizontally before entering the bladder. At the junction where the ureter meets the bladder, a valve-like mechanism is present. This valve opens in response to the peristaltic wave, allowing urine to enter the bladder. The anatomical arrangement of the ureter and this valve system help prevent urine from flowing backward when the bladder's detrusor muscle contracts. As a result, urine accumulates gradually in the bladder, which can store a significant amount without causing discomfort or a major rise in internal bladder pressure (intravesical pressure).

Micturition Reflex:

The micturition reflex is the neural mechanism responsible for the act of urination. It is triggered when stretch receptors located in the walls of the urinary bladder and urethra are stimulated. This occurs as the bladder fills with urine, typically around 300 to 400 mL, leading to an increase in internal bladder (intravesical) pressure. The rising pressure causes the bladder walls to stretch, activating the receptors and initiating sensory nerve impulses.

Pathway of the Micturition Reflex:

The sensory (afferent) signals generated by these receptors travel through the pelvic nerve (parasympathetic pathway) to reach the sacral region of the spinal cord. In response, the spinal cord sends motor (efferent) signals back through the same pelvic nerve to the bladder and internal urethral sphincter. These impulses stimulate the detrusor muscle to contract and cause the internal sphincter to relax, allowing urine to pass into the urethra. As urine enters the urethra, additional stretch receptors in the urethral wall are activated. They send more sensory signals back to the spinal cord, which then suppresses the activity of the pudendal nerve (the nerve responsible for keeping the external urethral sphincter contracted). This inhibition leads to relaxation of the external sphincter, allowing urination to occur.

The micturition reflex is self-reinforcing: initial bladder contraction further stimulates stretch receptors, increasing sensory input and enhancing bladder contraction. This positive feedback loop continues until bladder pressure peaks and the urine is completely expelled.

During urination, voluntary contraction of abdominal muscles also increases abdominal pressure, helping to empty the bladder more efficiently.

Higher Centers for Micturition:

Although the basic micturition reflex is mediated by the spinal cord, it is under the regulation of higher brain centers:

- **Inhibitory centers:** located in the midbrain and cerebral cortex, suppress the reflex by inhibiting the spinal micturition centers, thereby enabling voluntary control over urination.

- **Facilitatory centers:** Particularly in the pons, and to some extent in the cerebral cortex, enhance the reflex by promoting the activity of the spinal centers, thus supporting the process of urination when appropriate.[25]

4. Discussion

Urine formation and micturition have been described in both Unani medicine and modern physiology, although each system explains these processes through a different conceptual framework. Modern medicine interprets urinary function in terms of anatomy, cellular physiology, and neural regulation. In contrast, Unani medicine explains the same functions through the concepts of *Akhlāṭ* (humours), *Quwā* (faculties), and *Ṭabīʿat* (the governing principle of the body). Despite these differences, several functional similarities can be identified.

A notable point of convergence is the close relationship between the liver and kidneys in maintaining internal balance. According to Unani scholars, the liver completes the transformation of *Kaylūs* into *Akhlāṭ* and separates the excess watery component, which is then transported to the kidneys for elimination as urine. Modern physiology also recognizes a functional connection between these organs. The liver performs numerous metabolic reactions and generates water-soluble waste products such as urea, while the kidneys remove these substances from the circulation through urine. Thus, although the mechanism differs, both systems recognize that metabolic processing in the liver is closely linked to renal excretion. The Unani description may therefore represent an early physiological understanding of this liver-kidney axis.

The concept of waste separation described in Unani medicine also shows an interesting functional resemblance to nephron physiology. Classical texts state that the kidneys receive the watery residue and separate beneficial substances from waste through the coordinated actions of *Quwwat Jādhiba*, *Quwwat Māsika*, *Quwwat Hāḍima*, and *Quwwat Mumayyiza*. Although these faculties are not anatomical structures, their combined function resembles the integrated activities of the nephron. *Quwwat Jādhiba* may be viewed as representing the kidney's ability to receive fluid from the circulation. *Quwwat Māsika* reflects temporary retention of the filtrate, allowing further processing. *Quwwat Mumayyiza* appears comparable to the selective discrimination performed by the renal tubules, where useful substances are conserved while waste is retained in the tubular fluid. Likewise, the action of *Quwwat Dāfiʿa*, which expels the remaining waste as urine, resembles the final elimination of urine after completion of tubular processing. These comparisons should be understood as functional analogies rather than direct anatomical equivalents.

The Unani description of urine as consisting of *Māʾiyat* and *Rasūb* also has a meaningful parallel in modern medicine. *Māʾiyat* represents the liquid component of urine, whereas *Rasūb* refers to the material that settles after standing. Similarly, modern urinalysis distinguishes between the liquid phase and the urinary sediment, which contains cells, crystals, casts, and other microscopic elements. Although the composition of *Rasūb* was not characterized at the cellular level in classical literature, the observation that urine contains both fluid and sediment demonstrate a remarkable degree of clinical insight.

Even stronger similarities become evident in the process of micturition. Unani scholars described the urinary bladder as a temporary reservoir that stores urine until expulsion occurs. They emphasized that normal voiding depends on the balanced actions of *Quwwat Māsika*, which retains urine, and *Quwwat Dāfiʿa*, which expels it. This concept closely resembles the modern understanding of bladder physiology. During the storage

phase, sympathetic activity and the external urethral sphincter maintain continence. During voiding, parasympathetic stimulation contracts the detrusor muscle and relaxes the sphincters, allowing urine to pass. Although the regulatory mechanisms are explained differently, both systems recognize that successful micturition depends on a balance between retention and expulsion.

The Unani explanation of bladder filling also demonstrates a close functional agreement with current knowledge. Al-Razi and Al-Jurjānī observed that distension of the urinary bladder produces a sensation of fullness, which activates *Quwwat Dāfiʿa* and initiates urination. Modern physiology explains the same phenomenon through stretch receptors located in the bladder wall. These receptors transmit sensory impulses to the sacral spinal cord, where the micturition reflex is initiated. Although classical scholars could not describe neural pathways, their clinical observations accurately recognized that bladder distension is the primary trigger for urination.

Another interesting similarity is the role of abdominal muscles during voiding. Ibn Sina stated that the bladder muscles, urethral sphincter, and abdominal muscles act together during micturition under the influence of *Quwwat Dāfiʿa*. Modern physiology similarly acknowledges that voluntary contraction of the abdominal muscles increases intra-abdominal pressure and assists bladder emptying, particularly during forceful micturition; this represents a striking agreement between classical observation and present-day physiology.

Nevertheless, some concepts cannot be correlated directly. The Unani faculties (*Quwwat Jādhiba*, *Māsika*, *Hāḍima*, *Mumayyiza*, and *Dāfiʿa*) describe physiological functions in a holistic manner rather than discrete anatomical structures. Modern physiology, in contrast, attributes these functions to specialized nephron segments, membrane transporters, hormones, and neural pathways. Therefore, these faculties should not be interpreted as direct equivalents of specific renal structures. Instead, they may be regarded as functional concepts that collectively explain processes now understood through molecular and cellular mechanisms.

Similarly, the Unani view that urine is primarily a waste product of hepatic digestion differs from the modern concept that urine originates through glomerular filtration of plasma. However, this difference should not be viewed as a contradiction alone. Rather, it reflects the distinct explanatory models adopted by the two systems. Classical physicians emphasized the origin of waste following metabolism, whereas modern physiology focuses on the site where filtration and modification occur. Both perspectives ultimately acknowledge that urine serves as the principal route for eliminating metabolic waste and preserving internal balance.

Beyond the physiological comparison, understanding these concepts has practical importance in Unani medicine. The selection of drugs and therapeutic interventions is guided by the principles of *Mizāj* and the functional state of *Quwā*. Treatment aims not only to remove the cause of disease but also to restore the normal temperament and strengthen the affected organ. Therefore, a clear understanding of urine formation and micturition from the Unani perspective provides a stronger physiological basis for the rational use of Unani therapies. Interpreting these concepts alongside contemporary renal physiology may also improve their scientific understanding while preserving the originality of the classical framework.

Overall, the comparison indicates that many classical Unani concepts retain physiological relevance when interpreted functionally instead of literally. The ideas of selective separation, temporary retention, waste elimination, bladder storage, and coordinated voiding correspond closely with established principles of renal physiology. While the underlying explanations differ, the fundamental physiological purpose described by both systems remains remarkably similar. This functional convergence provides a meaningful basis for integrating classical Unani concepts with contemporary renal physiology without overlooking the distinct theoretical foundations of each system.

5. Conclusion

The present review highlights that Unani medicine offers a coherent and systematic explanation of urine formation and micturition based on the concepts of *Akhlāṭ*, *Quwā*, and *Ṭabīʿat*. Although its theoretical framework differs from contemporary renal physiology, several functional similarities can be recognized. The Unani concepts of selective separation, retention, and expulsion of urine show meaningful parallels with the physiological processes of filtration, tubular processing, storage, and voiding described in modern medicine. At the same time, certain concepts, particularly the hepatic origin of urine and the faculty-based explanation of renal function, remain unique to the Unani system and cannot be directly equated with modern anatomical and molecular mechanisms.

Rather than viewing these differences as contradictory, they should be understood as distinct approaches to explaining the same physiological phenomenon. A functional interpretation allows meaningful integration while preserving the originality of both systems. Such an approach not only improves the scientific understanding of classical Unani concepts but also provides a foundation for future interdisciplinary and translational research in renal physiology.

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