International Journal of Research in Medical Sciences
Khan S et al. Int J Res Med Sci. 2025 Aug;13(8):3585-3589
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012
DOI: https://dx.doi.org/10.18203/2320-6012.ijrms20252441

Review Article

Role of khilṭ-i-Safrā in digestion: scientific exploration

Sajid Khan[1]*, Ashraf Imam[1], Qamrul Hasan Lari[2]

[1]Department of Manafeul A'ḍā (Physiology), State Unani Medical College and H.A.H.R.D.M. Hospital, Prayagraj, Uttar Pradesh, India
[2]Department of Kulliyat (Basic Principles of Unani Medicine), State Unani Medical College and H.A.H.R.D.M. Hospital, Prayagraj, Uttar Pradesh, India

Received: 29 April 2025
Revised: 07 June 2025
Accepted: 30 June 2025

***Correspondence:**
Dr. Sajid Khan,
E-mail: 77sajid92@gmail.com

ABSTRACT

The Unani system of medicine is based on the concept of *Akhlāt* (humors), which includes *khilṭ-i-Safrā* (yellow bile), a vital bodily fluid primarily produced by the liver and stored in the gallbladder. *Khilṭ-i-Safrā* plays a crucial role in digestion and overall physiological balance. It is characterized as hot and dry (*Ḥārr Yābis*) in temperament and is responsible for *tarqeeq dam* of blood, promoting circulation, and supporting the digestive process. *Khilṭ-i-Safrā* is known for its detersive (cleansing) action in the intestine also influences the enteric nervous system (ENS), stimulating peristaltic movements and enhancing gastrointestinal secretions. This function aligns with the concept of digestion in Unani system of the medicine, where balanced *khilṭ-i-Safrā* ensures smooth digestion and excretion. The study explores the classical Unani perspective of *khilṭ-i-Safrā* and its correlation with bile in modern physiology, highlighting its essential role in digestion. In modern medical terms, bile, a secretion of the liver stored in the gallbladder and released into the intestine, which is considered as a component of *khilṭ-i-Safrā* in Unani system of the medicine. Bile salts facilitate the digestion and absorption of fats by emulsifying fat globules and forming micelles, making them more accessible for enzymatic action. Additionally, bile acts as a natural laxative by stimulating intestinal peristalsis.

Keywords: Khilṭ-i-Safrā, Digestion, Bile, Unani system of medicine

INTRODUCTION

The literal meaning of *Akhlāt* is substances mixed together.[1] In Unani system of the medicine fluids which are enclosed in body cavities and provide *Badal ma tahalul* considered as *Akhlāt*.[2,3] Unani system of the medicine is based on the concept of *Akhlāt*. The concept of *Akhlāt* is introduced by one of all-time great Greek philosopher known as Hippocrates (Buqrat) (460-360BC). According to Hippocrates all body fluid classified into four broad categories based on colour: all red colour fluid is known as *khilṭ-i-Dam*, all white colour fluid is known as *khilṭ-i-Balgham*, all yellow colour flood is known as *khilṭ-i-Safrā*, and all black colour fluid is known as *khilṭ-i-Sawdā*.

In Unani system of medicine principally it is considered that balance in all four broad categories of fluid that is *khilṭ-i-Dam, khilṭ-i-Balgham, khilṭ-i-Safrā and khilṭ-i-Sawdā* quantitatively and qualitatively will leads to health and any qualitatively and quantitatively disproportion will lead to disease.[4]

METHODS

Classical Unani literature translated in Urdu and English. Modern books dealing with medical physiology of Indian and foreign writers were studied. Well known scientific search engine *viz.* PubMed, Medline, Google Scholar were used to preview outline literature.

KHILṬ-I-SAFRĀ IN UNANI SYSTEM OF MEDICINE

According to Hippocrates *Khilṭ-i-Safrā* is broad conceptual umbrella term comprises all fluids which are yellowish in colour. In Unani system of the medicine *Khilṭ-i-Safrā* considered as froth of blood (*Khoon ka Raghu*) produced by liver radish yellow in colour. As it is produced in liver. It is divided into two parts. A part of *khilṭ-i-Safrā* get mixed in blood and remaining get stored in gallbladder.[5] The part of *khilṭ-i-Safrā* that mixes with blood is known as *sareera* and part that is stored in gallbladder and poured into gastrointestinal tract is known as *jaheera*.

Properties of khilṭ-i-Safrā

In Unani system of the medicine *khilṭ-i-Safrā* considered as reddish yellow in colour, bitter in taste, *khilṭ* with *Har Yabis* temperament.[1] *Khilṭ-i-Safrā* is known for its *Tarqīq e dam* function. It means that *khilṭ-i-Safrā* acts as a viscosity modulating agent thus maintains the balanced viscosity of blood (*Mu'tadil qiwām of Dam*) which enable blood to flow through a small blood vessels and capillaries.[7] Blood (*dam*) which has a balanced amount of all four *Akhlāt* quantitatively and qualitatively. Blood vessels and capillaries get supplied to all *mufrad* and *murakkab A'ḍā* and all these *morakkab* and *mufrad A'ḍā* get proper nutrition from blood, hence *khilṭ-i-Safrā* play a vital role in growth and development of human body.

Part of *khilṭ-i-Safrā* stored in the gallbladder provides a nutritive function for the gallbladder and via biliary tree poured in the small intestine. In small intestine *khilṭ-i-Safrā* is known for its detersive action.[8] *Khilṭ-i-Safrā* due to its specific temperament vehemence, control the flora that is one of the important part of the digestive system which is required for digestion and absorption of food.

As we know, digestion is a process in which the combustion of food occurs, mediated by many chemical reactions. For these chemical reactions an optimum temperature is required and *Khilṭ-i-Safrā* provides that optimum temperature by virtue of its temperaments.

Effect of Khilṭ-i-Safrā on digestion in the Unani system of medicine

Khilṭ-i-Safrā is known as for its detersive action on intestine.[9] As per recent scientific medical studies the gastrointestinal tract has its own nervous system popularly known as enteric nervous system (ENS). *Khilṭ-i-Safrā* stimulate the enteric nervous system because it acts as detergent. The enteric nervous system comprises of two plexuses, Auerbach's and Meissner's plexus. As *Khilṭ-i-Safrā* stimulates Auerbach's plexus it increases the motor activity of intestine that is peristalsis and Meissner's plexus increase the secretion of gastrointestinal tract.[16] Secretion involved in digestion of different components of food and increased peristalsis play an important role for downward movement of undigested remanent food which ultimately leads to defecation.[11] As per the classical text and Unani physicians *Khilṭ-i-Safrā* is known for its *hararat and hiddat* (hotness and sharpness). The temperament of all foods which are cold get neutralised by *Khilṭ-i-Safrā* thus enabled all cold food to provide *badal ma tahallul* after digestion.

In Unani system of the medicine it is considered that the temperament of fat is barid while the temperament of *Khilṭ-i-Safrā* is hot, Hence *Khilṭ-i-Safrā* do tahaleel (Emulsification) of fat, thus help in digestion and absorption of fat. It is assumed in Unani system of the medicine that bile is as a component of *Khilṭ-i-Safrā*.[12] Initially hepatocytes secret major components of bile containing bile acids, cholesterol, and other constituents. Where these secretions pass through bile ducts under the influence of secretin watery solution of sodium and bicarbonate secreted by epithelial cells lining the ductules and ducts added with bile. Bile which is continuously secreted by liver cells are stored in the gallbladder. Gallbladder can hold about 50 ml bile. In order to store there is an active absorption of water, sodium, chloride occur through gallbladder epithelium, by this way bile is concentrated nearly by 10 folds.[13]

Correlation of bile with Khilṭ-i-Safrā

Khilṭ-i-Safrā is a concept dealing with all fluid in body predominantly yellowish in colour. In modern system of the medicine the specific secretion of liver which are stored in gallbladder and transported to small intestine via biliary tree are predominantly yellowish in colour popularly known as bile. Hence in Unani system of the medicine bile is considered as one of the fluid which comes under the broad category of *Khilṭ-i-Safrā*.

BILE

Bile consists of bile acids, bile pigments, and various other substances dissolved in an alkaline fluid similar to pancreatic juice.[14] Approximately between 600-1000 mL of bile is produced daily.[10] Some of its components are reabsorbed in the intestine and later re-excreted by the liver through the enterohepatic circulation.

Bile is continuously produced by liver cells and released into tiny channels called bile canaliculi. From there, it flows into the hepatic ducts, which merge with the cystic duct to form the common bile duct. During non-digestive periods, the sphincter of Oddi remains tightly closed, directing bile into the gallbladder through the cystic duct for storage and concentration. When food is taken in, the sphincter of Oddi relaxes. As the food reaches the upper small intestine, hormones like secretin and cholecystokinin-pancreozymin (CCK-PZ) are released by the duodenum, prompting the gallbladder to contract and release bile.[17]

Among its many roles, the liver produces bile, typically in amounts ranging from 600 to 1000 ml per day. Bile has two main functions.

First, it is crucial in the digestion and absorption of fats—not because it contains digestive enzymes, but due to the action of bile acids. These acids: break down large fat globules into much smaller droplets (emulsification), increasing the surface area for pancreatic lipase enzymes to act upon, and assist in the absorption of the end products of fat digestion through the lining of the intestines.

Second, bile also helps the body eliminate waste products. It acts as a route for excreting substances such as bilirubin—a breakdown product of hemoglobin—and excess cholesterol from the blood.[18]

Table 1: Composition of bile.[10]

Components	Liver bile	Gallbladder bile
Water (g/dl)	97.5	92
Bile salts (g/dl)	1.1	6
Bilirubin (g/dl)	0.04	0.3
Cholesterol (g/dl)	0.1	0.3-0.9
Fatty acids (g/dl)	0.12	0.3-1.2
Lecithin (g/dl)	0.04	0.3
Na^+ (mEq/l)	145	130
K^+ (mEq/l)	5	12
Ca^{++} (mEq/l)	5	23
Cl^- (mEq/l)	100	25
HCO_3 (mEq/l)	28	10

Role of bile in digestion

Most of the bile from liver enters in to the gallbladder. It is stored in gallbladder. It is released from gallbladder into intestine and used where it is required. Bile Stored in gallbladder bladder, and undergoes to many changes in quality and quantity such as: decreased volume of bile due to absorption of larger amount of water and electrolytes; concentration of bile salts, bile pigments; cholesterol increased due to absorption of water and electrolytes in large quantities; and pH is decreased slightly.

The role of bile in digestion is mainly due to bile salts and bile pigments.[15]

BILE SALTS

Bile salts are sodium and potassium salts derived from bile acids, with a half-life of about 3 days. The liver synthesizes two main primary bile acids from cholesterol: cholic acid and chenodeoxycholic acid. In the colon, intestinal bacteria convert these into deoxycholic acid and lithocholic acid, known as secondary bile acids.

In the liver, bile acids undergo conjugation with either taurine or glycine. For example: cholic acid + taurine → taurocholic acid, and cholic acid + glycine → glycocholic acid.

These conjugated acids form sodium and potassium salts in the alkaline bile, collectively called bile salts. Their typical concentration ranges from 120–180 mg/dl (or 10–20 mEq/l).

At the alkaline pH of bile (7.8–8.6), bile salts exist in their anionic form and do not influence the osmotic pressure. Bile's osmotic pressure is equal to that of plasma, approximately 290 mosm/l.

Bile salts can form osmotically inactive aggregates with certain cations.

Around 90–95% of the bile salts that reach the duodenum are actively reabsorbed in the terminal ileum, returning to the liver via the portal vein in a cycle known as enterohepatic circulation. The remaining 5–10% enter the colon and are transformed into salts of deoxycholic and lithocholic acids. Lithocholate is poorly soluble and is mostly excreted in feces, whereas deoxycholate is reabsorbed.

Enterohepatic circulation is crucial because the body maintains only a limited reserve of bile salts. The liver produces about 0.2–0.4 grams of bile salts per day, while the total circulating bile salt pool is approximately 3.5 grams. Since an average meal requires 6–8 grams of bile salts for fat digestion and absorption, this pool must recirculate at least twice per meal, amounting to 6–8 cycles daily.

Administering bile salts intravenously strongly stimulates the secretion of bile.[17]

FUNCTIONS OF BILE SALTS

Hydrotropic action

Bile salts are amphipathic molecules, meaning they have both hydrophilic (water-attracting) and hydrophobic (lipid-attracting or water-repelling) sides. This unique structure allows them to lower the surface tension of water-based solutions, enabling the formation of stable emulsions of fats and other lipid substances.

Specifically, bile salts interact with lipids to form micelles, which are cylindrical, water-soluble structures. These micelles make it easier for the body to absorb lipids. By reducing surface tension, and in cooperation with phospholipids and monoglycerides, bile salts aid in the emulsification of dietary fats, a crucial step before their digestion and absorption in the small intestine.

In addition to their emulsifying role, bile salts also help activate lipase enzymes in the intestine, enhancing the digestion of fats.[17]

Enterohepatic circulation of bile salts

Approximately 94% of bile salts are reabsorbed into the bloodstream from the small intestine. Roughly half of this reabsorption occurs through passive diffusion in the upper small intestine, while the remaining portion is absorbed via active transport in the distal ileum. Once reabsorbed, bile salts enter the portal circulation and return to the liver. As the blood passes through the liver's venous sinusoids, most of the bile salts are taken up by liver cells and secreted again into bile.[18]

This cycle results in around 94% of bile salts being reused, allowing each bile salt molecule to complete the enterohepatic circulation around 17 times before eventually being excreted in the feces. The liver continuously synthesizes small amounts of new bile salts to replace those lost in the stool.

The volume of bile secreted daily by the liver largely depends on the amount of bile salts available in circulation. A higher concentration of bile salts in the enterohepatic cycle—typically about 2.5 grams—leads to greater bile production. In fact, taking extra bile salts can boost bile output by several hundred milliliters per day.[18]

Bile salts perform several vital functions.[14] They lower surface tension and, along with phospholipids and monoglycerides, aid in emulsifying fats—making them easier to digest and absorb in the small intestine. Being amphipathic, bile salts have both water-attracting (hydrophilic) and water-repelling (hydrophobic) parts. The hydrophilic side contains polar peptide bonds, carboxyl, and hydroxyl groups, while the hydrophobic side lacks these features. Due to this structure, bile salts naturally organize into disk-like formations called micelles, with their hydrophilic sides facing outward and hydrophobic sides inward.

When the bile salt concentration exceeds a specific threshold—known as the critical micelle concentration—they form micelles. These micelles trap lipids: cholesterol occupies the central hydrophobic core, while phospholipids and monoglycerides arrange with their hydrophilic ends outward and hydrophobic parts inward. Micelles help maintain lipid solubility and transport these fats to the intestinal lining for absorption.

About 90–95% of bile salts are absorbed in the small intestine. After being deconjugated, some are absorbed by passive diffusion, but most are taken up in their conjugated form in the terminal ileum through a sodium-dependent co-transport mechanism, driven by the Na^+/K^+-ATPase pump. The rest (5–10%) passes into the colon, where some are transformed into deoxycholic acid and lithocholic acid salts. Lithocholate is largely excreted because of its low solubility, while deoxycholate is reabsorbed.

Once absorbed, bile salts return to the liver through the portal vein and are secreted again in bile—a process called enterohepatic circulation. Any bile salts lost in stool are replenished by liver synthesis at a rate of 0.2–0.4 g/day. The body maintains a circulating pool of about 3.5 grams, which is reused multiple times daily—roughly two times per meal and 6–8 times each day.

If bile cannot enter the intestine, up to half of the dietary fat is lost in feces, leading to fat malabsorption and poor absorption of fat-soluble vitamins. Similarly, diseases or surgical removal of the terminal ileum can disrupt bile salt reabsorption, increasing fat loss in stools. The liver, in such cases, cannot compensate for the loss by producing sufficient bile salts.

ROLE OF BILE SALTS IN DIGESTION

Digestion of fats

Bile salts help in digestion and absorption of fats in intestine. Bile salt acts on fat globules and brake down into minute droplets, forming a milky fluid called an emulsion in the small intestine.[15]

They act like detergents on dietary fats, lowering surface tension and making it easier for intestinal movements to break large fat globules into smaller droplets. This process is known as the emulsification function of bile salts.[18]

Fat is insoluble in water due to surface tension, the lipolytic enzymes of the gastrointestinal (GI) tract cannot digest them directly. Bile salts act as detergents, lowering surface tension and emulsify the fat.

Absorption of fats

Bile salts aid in the absorption of digested fats from the intestine into the blood stream. They combine with fats to form complexes known as micelles which Facilitate the easy absorption.

More importantly, bile salts assist in the absorption of fats, including fatty acids, monoglycerides, cholesterol, and other lipids. They achieve this by forming micelles—tiny, electrically charged complexes that can dissolve partially in chyme.

These micelles transport lipids to the intestinal lining, where absorption into the bloodstream occurs.[18]

Laxative action

Bile salts function as laxative by stimulating the peristaltic movements of the intestine.

Cholesterol solubility

The high cholesterol content in bile is kept dissolved by incorporation into micelles, which prevents its crystallization and enables smooth transport through the biliary system into the intestine.[17]

Excretory function

Bile serves as a route for the elimination of waste substances, including certain drugs, steroid hormones (like those from the adrenal cortex), toxins, bile pigments, and various inorganic elements such as copper, zinc, and mercury.[17]

Acid neutralization

Bile acts as an alkaline buffer, helping to neutralize the acidic chyme that enters the small intestine from the stomach.[17]

CONCLUSION

The Unani system of medicine emphasizes the significance of *Akhlāt* (humors) in maintaining physiological balance and health. Among these, *khilṭ-i-Safrā* (yellow bile) holds a pivotal role in digestion and overall bodily functions. This study elucidates the classical Unani perspective of *khilṭ-i-Safrā*, highlighting its properties, functions, and its correlation with bile in modern physiology. *Khilṭ-i-Safrā*, characterized by its hot and dry (*Ḥārr Yābis*) temperament, is essential for modulating blood viscosity, promoting circulation, and supporting the digestive process. It is known for its detersive action in the gastrointestinal tract which stimulates the enteric nervous system (ENS) and enhances gastrointestinal secretions, aligns closely with the modern understanding of bile's role in digestion.

Khilṭ-i-Safrā is known for its *hararat* and *hiddat*. With the help of *hararat* and *hiddat,* khilṭ-i-Safrā converts fat into very small fat globules, then into micelles, and overall helps in the digestion of fat. Hence, we can say that *khilṭ-i-Safrā* plays a vital role in the emulsification of fat.

The integration of classical Unani concepts with modern physiological insights provides a comprehensive understanding of the vital role of *khilṭ-i-Safrā* in digestion and health. This study bridges the gap between traditional and modern medical systems, offering a holistic perspective on the importance of balanced bodily fluids in maintaining health. Further research should be continued in order to explore such interdisciplinary correlations to enrich both traditional and contemporary medical concepts and practices which ultimately leads to benefiting global healthcare.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: Not required

REFERENCES

1. Ahmad SI. Kulliyat-e-Asri. Volume 1. 1983;220-28.
2. Masihi AS. Kitab ul Miyat. Volume 1. Urdu translation by CCRUM. 2014;101-
3. Kabiruddin, H. Tarjuma wa Sharah Kulliyat-e Qanoon Part-I. 2015;44.
4. Greekmedicine.net. The four humors. Available at: http://www.greekmedicine.net/b_p/Four_Humors.html. Accessed on 12 May 2025.
5. Sina I. Al-Qanun fi al-Tibb. Volume 1. Urdu Translation by Ghulam Hasnain Kanturi Idara Kitabul-Shifa Delhi. 2010;30.
6. Ibn al-Quff A. Kitab Umda fi'l-Jarahat. Volume 1. Urdu translation by CCRUM Literary Research Unit Lucknow. 2024;22.
7. Baghdadi MAA. Kitab al-Mukhtarāt fi al-Tibb. Volume 1. Urdu translation, CCRUM. Ministry of Health & Family Welfare, Government of India, New Delhi. 2005;29.
8. Ibn-e-Rushad M. Kitab-Al-Kulliyat Urdu Translation by CCRUM. 1987;42-9.
9. Kabiruddin HM. Tarjama wa Sharh Kulliyat Nafisi Tarjuma wa Sharah. Idara Kitabul-Shifa. Volume 1. 2012;69.
10. Hall JE, Hall ME, Guyton and Hall Textbook of Medical Physiology. 3rd South Asia Edition. Elsevier Health Science. 2020.
11. Jurjani I. Zakhira Khwarizam Shahi Vol-1 (Urdu translation by Hadi Hassan Khan). Matba Nami Nawal Kishore. 1902;26-7.
12. Zafar T, Firdaus S, Ahmad HI. Review on Functions of Khilte Safra. J Integ Comm Health. 2021;10(1):35-40.
13. John NA, Singh SH. CC Chatterjee's Human Physiology. 12th edition. Volume 1. CBS Publishers & Distributors Pvt Ltd. 2018.
14. Barrett, K, Brooks H, Boitano S, Barman S, Ganong's Review of Medical Physiology. 23rd edition. McGraw Hill. 2010;438.
15. Sembulingam K, Sembulingam P. Essentials of Medical Physiology. 6th Edition. Jaypee Brothers Medical Publishers (P) Ltd. 2019;252-3.
16. Koeppen BM, Stanton BA, editors. Berne & Levy Physiology. 8th edition. Philadelphia: Elsevier. 2023;512-3.
17. Jain AK. Textbook of Physiology. Volume I. 6th edition. New Delhi: Avichal Publishing Company. 2023;237-41.
18. Hall JE. Guyton and Hall Textbook of Medical Physiology. 12th edition. Saunders Elsevier. 2011;783-5.

Cite this article as: Khan S, Imam A, Lari QH. Role of khilṭ-i-Safrā in digestion: scientific exploration. Int J Res Med Sci 2025;13:3585-9.