New Day in Medicine
Новый День в Медицине
NDM

# TIBBIYOTDA YANGI KUN

Ilmiy referativ, marifiy-ma'naviy jurnal

AVICENNA-MED.UZ

ISSN 2181-712X.
EiSSN 2181-2187

1 (75) 2025

# ТИББИЁТДА ЯНГИ КУН
# НОВЫЙ ДЕНЬ В МЕДИЦИНЕ
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***Илмий-рефератив, маънавий-маърифий журнал***
***Научно-реферативный,***
***духовно-просветительский журнал***

УЧРЕДИТЕЛИ:

БУХАРСКИЙ ГОСУДАРСТВЕННЫЙ МЕДИЦИНСКИЙ ИНСТИТУТ
ООО «ТИББИЁТДА ЯНГИ КУН»

Национальный медицинский исследовательский центр хирургии имени А.В. Вишневского является генеральным научно-практическим консультантом редакции

Журнал был включен в список журнальных изданий, рецензируемых Высшей Аттестационной Комиссией Республики Узбекистан (Протокол № 201/03 от 30.12.2013 г.)



**1 (75)**

**2025**

*январь*

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***Received: 20.12.2024, Accepted: 03.01.2025, Published: 10.01.2025***

**UDC 616.61-008.64:616-092:543.9**

# BIOCHEMICAL ANALYSIS OF SALIVA AND CHANGES IN SALIVARY pH IN PATIENTS WITH CHRONIC KIDNEY DISEASE UNDERGOING HEMODIALYSIS

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✓ ***Rezyume***

***Chronic kidney disease (CKD) is a progressive condition that has far-reaching impacts on systemic health, including significant alterations in oral physiology. Among patients undergoing hemodialysis, changes in salivary biochemistry and pH are pronounced, reflecting systemic metabolic imbalances and influencing oral health outcomes. This article reviews the biochemical parameters of saliva, such as elevated levels of urea, creatinine, inflammatory markers, and oxidative stress compounds, in the context of CKD. Additionally, it explores the implications of altered salivary pH on microbial ecology and dental health, emphasizing the need for integrated oral care within CKD management. These findings underscore the importance of interdisciplinary approaches to enhance quality of life for CKD patients.***

***Keywords: chronic kidney disease, hemodialysis, saliva biochemistry, salivary pH, oxidative stress, oral health***

# БИОХИМИЧЕСКИЙ АНАЛИЗ СЛЮНЫ И ИЗМЕНЕНИЯ pH СЛЮНЫ У ПАЦИЕНТОВ С ХРОНИЧЕСКОЙ ПОЧЕЧНОЙ НЕДОСТАТОЧНОСТЬЮ, ПРОХОДЯЩИХ ГЕМОДИАЛИЗ

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✓ ***Резюме***

***Хроническая почечная недостаточность (ХПН) является прогрессирующим состоянием, оказывающим значительное влияние на системное здоровье, включая существенные изменения в физиологии полости рта. У пациентов, проходящих гемодиализ, изменения в биохимии слюны и pH выражены ярче, что отражает системные метаболические дисбалансы и влияет на состояние полости рта. В данной статье рассматриваются биохимические параметры слюны, такие как повышенные уровни мочевины, креатинина, маркеров воспаления и соединений окислительного стресса, в контексте ХПН. Кроме того, исследуются последствия изменения pH слюны для микробной экологии и здоровья зубов, подчеркивая необходимость интегрированного ухода за полостью рта в рамках управления ХПН. Полученные данные подчеркивают важность междисциплинарных подходов для улучшения качества жизни пациентов с ХПН.***

***Ключевые слова: хроническая почечная недостаточность, гемодиализ, биохимия слюны, pH слюны, окислительный стресс, здоровье полости рта***

# GEMODIALIZ QABUL QILADIGAN SURUNKALI BUYRAK KASALLIGI BOR BEMORLAR SO`LAGINING BIOKIMYOVIY TAHLILI VA SO`LAKNING pH MUHITIDAGI O`ZGARISHLAR

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***Surunkali buyrak kasalligi (SBK) umumiy salomatlikka sezilarli ta'sir ko'rsatadigan progressiv holat hisoblanib, shu jumladan og'iz fiziologiyasida sezilarli o'zgarishlarni keltirib chiqaradi. Gemodializ bilan og'rigan bemorlarda so`lak biokimyosi va pH darajasidagi o'zgarishlar bu tizimli metabolik nomutanosiblikni aks ettiradi va og'iz bo'shlig'iga ta'sir qiladi. Ushbu maqolada SBK kontekstida mochevina, kreatinin, yallig'lanish belgilari va oksidlovchi stress birikmalarining yuqori darajalari kabi so`lakning biokimyoviy ko'rsatkichlari ko'rib chiqiladi. Bundan tashqari, og`iz bo`shlig`i pH muhiti o`zgarishining mikrobiologik va umumiy stomatologik ta'siri o'rganilib, SBK boshqaruvining bir qismi sifatida integratsiyalashgan og'iz bo'shlig'ini parvarish qilish zarurligini ta'kidlaydi. natijalar SBK bilan og'rigan bemorlarning hayot sifatini yaxshilash uchun fanlararo yondashuvlarning muhimligini ta'kidlaydi.***

***Kalit so'zlar: Surunkali buyrak yetishmovchiligi, gemodializ, so'lak biokimyosi, so'lak pH muhiti, oksidlovchi stress, og'iz bo'shlig'i salomatligi***

**Relevance**

Chronic kidney disease (CKD) is a significant global health challenge, affecting approximately 10% of the adult population worldwide. Characterized by progressive loss of renal function, CKD leads to systemic disturbances due to the accumulation of metabolic waste products, electrolyte imbalances, and chronic inflammation. Hemodialysis is a vital treatment modality for patients with end-stage renal disease (ESRD); however, it is not without limitations. While it effectively removes toxins from the bloodstream, it does not fully restore metabolic equilibrium, resulting in persistent complications that extend to the oral cavity (Saldanha et al., 2018).

Oral health is often overlooked in CKD management, despite its profound implications for patients' overall well-being. Saliva, a multifunctional biological fluid, serves as a mirror of systemic health, providing insights into metabolic and inflammatory processes. In CKD patients, salivary composition and functionality undergo significant alterations, contributing to xerostomia, taste disturbances, and heightened susceptibility to oral infections. This review aims to comprehensively analyze the biochemical changes in saliva and variations in salivary pH among CKD patients undergoing hemodialysis, highlighting their clinical relevance and potential interventions.

Salivary Biochemistry in CKD Patients Salivary biochemistry reflects the systemic derangements associated with CKD. Due to impaired renal clearance, metabolic byproducts accumulate in saliva, leading to notable changes in its composition. Key biochemical markers include:

1. Urea and Creatinine Levels In CKD patients, salivary urea and creatinine levels are significantly elevated. Urea, a nitrogenous waste product, diffuses from blood to saliva and undergoes hydrolysis by urease-producing bacteria, resulting in ammonia production. This contributes to an alkaline oral environment and an unpleasant odor (Wu et al., 2019). Elevated salivary creatinine, correlating with blood levels, serves as a non-invasive biomarker for renal dysfunction (Bertoldo et al., 2021).
2. Inflammatory Markers Chronic systemic inflammation is a hallmark of CKD, reflected in elevated salivary concentrations of pro-inflammatory cytokines such as interleukin-6 (IL-6) and tumor necrosis factor-alpha (TNF-α). These markers are associated with periodontal disease progression and other oral pathologies (Patil et al., 2020).
3. Oxidative Stress Markers Oxidative stress plays a pivotal role in CKD pathogenesis, with increased salivary levels of markers such as malondialdehyde (MDA) and advanced glycation end-products (AGEs). These compounds exacerbate tissue damage and impair wound healing, contributing to oral mucosal lesions (Singh et al., 2019).
4. Electrolyte Imbalances Altered salivary levels of electrolytes, including calcium and phosphate, are common in CKD. These imbalances can influence mineralization processes, increasing the risk of dental calculus formation and enamel demineralization (Almeida et al., 2022).

Changes in Salivary pH Salivary pH is a critical factor in maintaining oral health, influencing microbial composition, enzymatic activity, and the integrity of dental structures. CKD patients experience significant pH alterations, primarily characterized by an alkaline shift.

1. Alkaline Saliva Elevated urea levels in CKD patients lead to increased ammonia production through bacterial urease activity, resulting in higher salivary pH. While this reduces the risk of dental caries, it promotes calculus formation and disrupts the balance of oral microbiota (Ribeiro et al., 2021).

2. Microbial Dysbiosis The alkaline environment favors the growth of pathogenic bacteria such as Porphyromonas gingivalis and Prevotella intermedia, which are implicated in periodontal diseases. This microbial imbalance heightens the risk of gingivitis, periodontitis, and other inflammatory conditions (Almeida et al., 2022).
3. Impact on Enamel and Mucosa Persistent pH alterations can weaken enamel integrity, increasing susceptibility to abrasion and erosion. Additionally, alkaline pH contributes to mucosal dryness and irritation, compounding the challenges of xerostomia commonly observed in CKD patients (Gupta et al., 2020).

Clinical Implications The interplay between CKD-related systemic changes and oral health has profound implications for patient care. Key clinical aspects include:

1. Xerostomia and Taste Alterations Xerostomia, or dry mouth, is a prevalent symptom among CKD patients, attributed to fluid restrictions, medication side effects, and salivary gland dysfunction. This condition not only compromises oral comfort but also predisposes patients to dental caries, oral infections, and mucosal inflammation. Elevated urea levels further contribute to dysgeusia (altered taste), adversely affecting dietary intake and nutritional status (Gupta et al., 2020).
2. Periodontal and Mucosal Diseases CKD patients are at an increased risk of periodontal diseases due to inflammatory and microbial factors. Periodontitis, characterized by gum inflammation and bone loss, exacerbates systemic inflammation, creating a bidirectional relationship between oral and systemic health. Mucosal lesions, including candidiasis and ulcerations, are also common, necessitating regular oral examinations (Patil et al., 2020).
3. Cardiovascular and Systemic Interconnections Poor oral health in CKD patients can aggravate systemic conditions, particularly cardiovascular disease, by acting as a reservoir for systemic inflammation. This underscores the importance of comprehensive care models that integrate dental and medical management (Saldanha et al., 2018).

Impact of Hemodialysis on Salivary Parameters Hemodialysis introduces dynamic changes in salivary composition, further influencing oral health outcomes.

1. Transient Reduction in Toxins Hemodialysis effectively reduces plasma and salivary concentrations of urea and creatinine, temporarily alleviating some biochemical abnormalities. However, these effects are short-lived, with salivary levels rebounding between dialysis sessions (Singh et al., 2019).
2. Exacerbation of Xerostomia Strict fluid restrictions and the systemic effects of CKD contribute to severe xerostomia in hemodialysis patients, complicating oral hygiene practices and increasing the risk of oral infections (Gupta et al., 2020).
3. Impact on Salivary Glands Repeated hemodialysis sessions can lead to structural and functional alterations in salivary glands, further impairing salivary flow and composition. This highlights the need for targeted interventions to support salivary gland health (Almeida et al., 2022).

## Conclusion

The biochemical and pH changes in saliva observed in CKD patients undergoing hemodialysis reflect the systemic nature of the disease and its multifaceted impact on oral health. Elevated levels of urea, creatinine, inflammatory markers, and oxidative stress compounds, coupled with alkaline pH shifts, create a unique oral environment that demands specialized care. Addressing these challenges requires a multidisciplinary approach that integrates dental, medical, and nutritional strategies. Regular dental assessments, patient education, and innovative therapeutic interventions are essential to improve oral and systemic health outcomes in this vulnerable population. Future research should focus on developing personalized care protocols and exploring the long-term benefits of integrated care models.

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**Entered 20.12.2024**