



TOSHKENT TIBBIYOT AKADEMIYASI URGANCH FILIALI
JANUBIY OROLBO‘YI TIBBIYOT JURNALI
2 - TOM, MAXSUS SON-2. 2026
14.00.00 - TIBBIYOT FANLARI ISSN: 3093-8740

UDK: 616.311-616.314-092.9:613.3

**CLINICAL AND EXPERIMENTAL EVALUATION OF THE EFFECTS OF ENERGY
DRINKS ON THE ORAL MUCOSA AND DENTAL HARD TISSUES**



Scientific Supervisor: Rizayev Jasur Alimdjanovich

Samarkand State Medical University

sammu@sammu.uz

<https://orcid.org/0009-0000-5354-5491>



Scientific Supervisor: Oripov Firdavs Suratovich

Samarkand State Medical University

firdavs.oripov1809@gmail.com

<https://orcid.org/0000-0002-0615-0144>



Bobonazarov Dilshod Ilhom o'g'li

Samarkand State Medical University

drbobonazarov007@gmail.com

<https://orcid.org/0009-0008-9146-0892>



TOSHKENT TIBBIYOT AKADEMIYASI URGANCH FILIALI JANUBIY OROLBO'YI TIBBIYOT JURNALI

2 - TOM, MAXSUS SON-2. 2026

14.00.00 - TIBBIYOT FANLARI ISSN: 3093-8740

Abstract: Energy drinks have become increasingly popular worldwide, particularly among adolescents and young adults. Their high content of sugar, caffeine, and organic acids may adversely affect the oral mucosa and dental hard tissues. This study aimed to clinically and experimentally evaluate the effects of energy drinks on the oral mucosa and dental hard tissues. The findings demonstrated that regular consumption of energy drinks contributes to enamel demineralization, dental erosion, reduced salivary pH, and inflammatory changes in the oral mucosa. The study highlights the importance of preventive dental care and increasing public awareness to minimize the harmful effects of excessive energy drink consumption on oral health.

Keywords: Energy drinks, oral mucosa, dental enamel, dental hard tissues, dental erosion, salivary pH.

КЛИНИКО-ЭКСПЕРИМЕНТАЛЬНАЯ ОЦЕНКА ВЛИЯНИЯ ЭНЕРГЕТИЧЕСКИХ НАПИТКОВ НА СЛИЗИстую ОБОЛОЧКУ ПОЛОСТИ РТА И ТВЕРДЫЕ ТКАНИ ЗУБОВ

Аннотация: Энергетические напитки в последние годы получили широкое распространение, особенно среди молодежи. Высокое содержание сахара, кофеина и органических кислот может оказывать неблагоприятное влияние на слизистую оболочку полости рта и твердые ткани зубов. В данном исследовании проведена клиническая и экспериментальная оценка влияния энергетических напитков на слизистую оболочку полости рта и твердые ткани зубов. Полученные результаты показали, что регулярное употребление энергетических напитков способствует деминерализации и эрозии эмали, снижению pH слюны, а также развитию воспалительных изменений слизистой оболочки полости рта. Результаты исследования подчеркивают необходимость профилактических стоматологических мероприятий и повышения осведомленности населения о возможных рисках чрезмерного употребления энергетических напитков.

Ключевые слова: Энергетические напитки, полость рта, слизистая оболочка, эмаль зубов, твердые ткани зубов, эрозия, pH слюны.

ENERGETIK ICHIMLIKLARNING OG'IZ BO'SHLIG'I SHILLIQ QAVATI VA TISH QATTIQ TO'QIMALARIGA TA'SIRINI KLINIK VA EKSPERIMENTAL BAHOLASH

Annotatsiya: Energetik ichimliklar so'nggi yillarda, ayniqsa yoshlar orasida keng iste'mol qilinayotgan ichimliklardan biri hisoblanadi. Ularning tarkibidagi yuqori miqdordagi shakar, kofein va organik kislotalar og'iz bo'shlig'i shilliq qavati hamda tish qattiq to'qimalariga salbiy ta'sir ko'rsatishi mumkin. Ushbu tadqiqotda energetik ichimliklarning og'iz bo'shlig'i shilliq qavati va tish qattiq to'qimalariga ta'siri klinik va eksperimental jihatdan baholandi. Olingan natijalar energetik ichimliklarni muntazam iste'mol qilish tish emali demineralizatsiyasi, eroziyasi, so'lakning pH ko'rsatkichlarining pasayishi hamda og'iz bo'shlig'i shilliq qavatida yallig'lanish o'zgarishlarini yuzaga keltirishini ko'rsatdi. Tadqiqot natijalari og'iz bo'shlig'i kasalliklarini oldini olishda profilaktik stomatologik tadbirlarning muhimligini tasdiqlaydi.

Kalit so'zlar: Energetik ichimliklar, og'iz bo'shlig'i, shilliq qavat, tish emali, tish qattiq to'qimalari, eroziya, so'lak pH.

Introduction

The consumption of energy drinks has increased dramatically worldwide over the past decade, particularly among adolescents, university students, and young adults. These beverages are widely consumed to improve physical endurance, increase mental alertness, and reduce fatigue. However, energy drinks contain high concentrations of sugars, caffeine, taurine, and acidic compounds,



TOSHKENT TIBBIYOT AKADEMIYASI URGANCH FILIALI
JANUBIY OROLBO‘YI TIBBIYOT JURNALI
2 - TOM, MAXSUS SON-2. 2026
14.00.00 - TIBBIYOT FANLARI ISSN: 3093-8740

including citric and phosphoric acids, which may adversely affect oral health. Although numerous studies have investigated their systemic effects, their impact on the oral cavity, especially on the oral mucosa and dental hard tissues, remains an important area of scientific research. The acidic nature of energy drinks contributes to the demineralization of dental enamel, increasing the risk of dental erosion, hypersensitivity, and dental caries. Frequent consumption may also alter salivary pH, reduce the buffering capacity of saliva, and promote changes in the oral microbiome. Furthermore, prolonged exposure to acidic beverages may irritate the oral mucosa, leading to inflammatory changes and increasing susceptibility to oral diseases. These alterations may negatively affect both oral function and overall quality of life. Recent advances in preventive dentistry have emphasized the importance of evaluating dietary risk factors associated with oral diseases. Clinical and experimental studies play a crucial role in understanding the mechanisms by which energy drinks affect oral tissues and in developing effective preventive strategies. A comprehensive assessment of their effects on the oral mucosa and dental hard tissues may provide valuable evidence for improving oral health education and reducing the incidence of beverage-related dental disorders.

Relevance

The widespread consumption of energy drinks has become a significant public health concern due to their potential adverse effects on oral health. The high acidity and sugar content of these beverages may contribute to dental enamel erosion, demineralization, and alterations in the oral mucosa. Despite the growing popularity of energy drinks, limited clinical and experimental evidence is available regarding their long-term effects on oral tissues. Therefore, a comprehensive clinical and experimental evaluation of the effects of energy drinks on the oral mucosa and dental hard tissues is highly relevant for improving preventive dental care, reducing the risk of oral diseases, and promoting evidence-based recommendations for healthy beverage consumption.

Aim

The aim of this study was to clinically and experimentally evaluate the effects of energy drinks on the oral mucosa and dental hard tissues, to assess their influence on oral health, and to determine their role in the development of enamel erosion and other pathological changes in the oral cavity.

Main part

Energy drinks are among the most frequently consumed beverages worldwide, particularly among adolescents and young adults. These beverages typically contain caffeine, taurine, glucuronolactone, sugars, B-group vitamins, and various herbal extracts. In addition, they contain acidic components such as citric acid and phosphoric acid, which lower the pH of the beverage and increase its erosive potential. Caffeine is responsible for stimulating the central nervous system, whereas taurine plays a role in cellular metabolism and neuromuscular function. Although these ingredients may temporarily improve physical and cognitive performance, excessive and frequent consumption has been associated with several adverse health effects. The combination of high sugar concentration and acidic pH creates favorable conditions for the development of dental erosion and caries. Furthermore, repeated exposure of the oral cavity to acidic beverages may disturb the normal oral environment and reduce the protective function of saliva. Understanding the chemical composition and biological characteristics of energy drinks is essential for evaluating their effects on oral tissues and for developing preventive strategies in dental practice.

The oral mucosa serves as the first biological barrier exposed to energy drinks during consumption. Continuous contact with acidic beverages may alter the physiological integrity of the oral epithelium and increase tissue permeability. Organic acids contained in energy drinks may cause irritation of the oral mucosa, resulting in inflammatory reactions and epithelial damage. In addition, high concentrations of caffeine and other bioactive substances may influence local blood circulation and cellular metabolism within the oral tissues. Long-term consumption has been associated with symptoms such as burning sensation, mucosal dryness, and increased susceptibility to traumatic injuries. Changes in salivary composition induced by energy drinks may further impair the protective



TOSHKENT TIBBIYOT AKADEMIYASI URGANCH FILIALI
JANUBIY OROLBO‘YI TIBBIYOT JURNALI
2 - TOM, MAXSUS SON-2. 2026
14.00.00 - TIBBIYOT FANLARI ISSN: 3093-8740

functions of the oral mucosa and promote the development of opportunistic infections. Clinical and experimental investigations have demonstrated that repeated exposure to acidic beverages may contribute to structural and functional alterations of the oral mucosal surface

Dental enamel is the hardest tissue in the human body; however, it is highly susceptible to acidic dissolution. The low pH and high titratable acidity of energy drinks promote enamel demineralization by dissolving hydroxyapatite crystals. Continuous consumption of these beverages increases the risk of dental erosion, enamel surface roughness, dentin hypersensitivity, and dental caries. Clinical studies have shown that the erosive potential of many energy drinks is greater than that of conventional carbonated soft drinks. Repeated acid exposure weakens the enamel surface and accelerates mechanical wear during mastication and tooth brushing. In addition, the high sugar content of these beverages supports bacterial growth and acid production, further increasing the risk of carious lesions. Experimental investigations have demonstrated measurable reductions in enamel microhardness after repeated immersion in energy drinks. These findings emphasize the importance of limiting energy drink consumption and implementing preventive measures to preserve dental hard tissues and maintain long-term oral health.

Saliva plays a fundamental role in maintaining oral homeostasis by regulating pH, buffering acids, lubricating oral tissues, and promoting the remineralization of dental enamel. Frequent consumption of energy drinks may alter the physicochemical properties of saliva, including its pH, buffering capacity, and flow rate. The acidic components of these beverages create a favorable environment for the growth of acidogenic and aciduric microorganisms while suppressing beneficial oral bacteria. Such microbial imbalance may increase the risk of dental caries, periodontal diseases, and oral mucosal disorders. In addition, high sugar concentrations provide an energy source for cariogenic bacteria, leading to increased acid production and enhanced enamel demineralization. Clinical studies have reported that regular consumption of energy drinks is associated with reduced salivary buffering capacity and significant changes in the composition of the oral microbiome. Therefore, evaluating the effects of energy drinks on saliva and oral microbiota is essential for understanding the mechanisms underlying beverage-related oral diseases and for developing effective preventive strategies.

Clinical and experimental studies are essential for assessing the impact of energy drinks on oral tissues. Clinical evaluation includes examination of the oral mucosa, assessment of dental erosion, measurement of salivary pH, and determination of oral hygiene status. Experimental investigations are commonly performed using extracted human teeth or enamel specimens exposed to different energy drinks under controlled laboratory conditions. Changes in enamel microhardness, surface roughness, mineral loss, and structural integrity are evaluated using modern analytical techniques. Histological and microscopic examinations may also be used to identify alterations in oral soft tissues following prolonged exposure to acidic beverages. The combination of clinical observations and laboratory findings provides comprehensive information regarding the biological effects of energy drinks and contributes to evidence-based recommendations for dental practice. Such studies are important for identifying individuals at increased risk of oral diseases and for improving preventive and therapeutic strategies.

Prevention remains the most effective strategy for reducing the harmful effects of energy drinks on oral health. Dental professionals should educate patients, particularly adolescents and young adults, about the potential risks associated with excessive energy drink consumption. Limiting the frequency of intake, avoiding prolonged contact of beverages with the teeth, and rinsing the mouth with water immediately after consumption may reduce acid exposure. The regular use of fluoride-containing toothpaste and professional fluoride applications can enhance enamel remineralization and improve resistance to acid erosion. Maintaining good oral hygiene and attending regular dental examinations are also important preventive measures. Recent advances in preventive dentistry, including biomimetic remineralization agents, calcium-phosphate technologies, and minimally



TOSHKENT TIBBIYOT AKADEMIYASI URGANCH FILIALI
JANUBIY OROLBO‘YI TIBBIYOT JURNALI
2 - TOM, MAXSUS SON-2. 2026
14.00.00 - TIBBIYOT FANLARI ISSN: 3093-8740

invasive treatment approaches, provide new opportunities for protecting dental hard tissues from erosive damage. A multidisciplinary approach combining patient education, dietary counseling, and preventive dental care is essential for preserving oral health and minimizing the adverse effects of energy drinks.

Results

A total of 80 participants were included in this clinical and experimental study. The participants were divided into a study group consisting of regular energy drink consumers and a control group comprising individuals who consumed energy drinks rarely or not at all. Clinical examination demonstrated that regular consumers exhibited more pronounced oral alterations than the control group. The most common findings included early dental enamel erosion, increased tooth hypersensitivity, reduced enamel surface gloss, gingival irritation, and complaints of oral dryness. Assessment of oral health parameters revealed that frequent consumption of energy drinks was associated with unfavorable changes in the oral environment. Salivary analysis demonstrated a decrease in salivary pH and buffering capacity after the intake of energy drinks, creating conditions that favored enamel demineralization. In addition, regular consumers showed greater dental plaque accumulation and poorer oral hygiene status compared with the control group, indicating an increased risk of dental caries and periodontal disorders.

The experimental investigation confirmed the clinical findings. Enamel specimens repeatedly immersed in energy drinks exhibited progressive structural alterations. Microscopic evaluation revealed partial enamel demineralization, increased surface porosity, irregular surface morphology, and a noticeable reduction in enamel microhardness. The severity of these changes increased proportionally with the duration and frequency of exposure, indicating a direct erosive effect of energy drinks on dental hard tissues. Furthermore, mild inflammatory changes of the oral mucosa were observed following prolonged exposure to acidic beverages. These alterations were characterized by slight erythema, mucosal irritation, and reduced tissue resistance, suggesting that continuous consumption of energy drinks may adversely affect the physiological condition of the oral mucosa. The clinical and experimental findings indicate that regular consumption of energy drinks has a detrimental effect on both the oral mucosa and dental hard tissues. The acidic composition and high sugar content of these beverages appear to accelerate enamel erosion, alter salivary properties, and disturb the normal oral environment. These findings highlight the importance of preventive dental care, patient education, and reducing excessive consumption of energy drinks to preserve oral health.

Discussion

The findings of the present study indicate that regular consumption of energy drinks may have adverse effects on both the oral mucosa and dental hard tissues. Clinical observations demonstrated that individuals with frequent energy drink intake exhibited a higher prevalence of enamel erosion, tooth hypersensitivity, and mild inflammatory changes of the oral mucosa. These findings are consistent with previous studies, which have reported that the acidic composition and high sugar content of energy drinks contribute significantly to the development of dental erosion and other oral disorders. The reduction in salivary pH and buffering capacity observed after energy drink consumption suggests that these beverages disturb the natural protective mechanisms of the oral cavity. Saliva plays an essential role in maintaining enamel integrity through remineralization and acid neutralization. Therefore, prolonged exposure to acidic drinks may accelerate enamel demineralization and increase susceptibility to dental caries. Similar findings have been reported in recent international studies evaluating the erosive potential of commercially available energy drinks.

The experimental results further support the clinical observations. Repeated exposure of enamel specimens to energy drinks resulted in progressive surface demineralization, increased porosity, and reduced enamel microhardness. These structural alterations confirm the erosive effect of acidic beverages and demonstrate that both the duration and frequency of exposure influence the severity of enamel damage.



TOSHKENT TIBBIYOT AKADEMIYASI URGANCH FILIALI
JANUBIY OROLBO‘YI TIBBIYOT JURNALI
2 - TOM, MAXSUS SON-2. 2026
14.00.00 - TIBBIYOT FANLARI ISSN: 3093-8740

In addition to dental hard tissue changes, mild inflammatory alterations of the oral mucosa were identified among regular energy drink consumers. Continuous exposure to acidic components may impair epithelial integrity and reduce the protective capacity of the oral mucosa, increasing its susceptibility to irritation and inflammation. These findings emphasize that the harmful effects of energy drinks extend beyond enamel erosion and involve multiple oral tissues. Despite these findings, the present study has several limitations. The sample size was relatively limited, and longer follow-up periods would provide more comprehensive information regarding the long-term effects of energy drink consumption on oral health. Future multicenter studies involving larger populations and advanced laboratory investigations are recommended to further clarify the biological mechanisms responsible for beverage-induced oral tissue damage. The present findings support the growing body of evidence indicating that excessive consumption of energy drinks is an important risk factor for oral diseases. Increasing public awareness, promoting healthy dietary habits, and implementing preventive dental measures may help reduce the negative impact of these beverages on oral health.

Conclusion

The present clinical and experimental evaluation demonstrates that regular consumption of energy drinks may have harmful effects on both the oral mucosa and dental hard tissues. Frequent exposure to these beverages contributes to dental enamel demineralization, increased tooth hypersensitivity, alterations in salivary pH and buffering capacity, and mild inflammatory changes of the oral mucosa. The experimental findings further confirm the erosive potential of energy drinks by demonstrating progressive structural damage and reduced enamel microhardness following repeated exposure. These findings emphasize that the acidic composition and high sugar content of energy drinks are important risk factors for the development of oral diseases. Therefore, limiting the consumption of energy drinks, maintaining proper oral hygiene, and implementing preventive dental measures are essential for preserving oral health. Further large-scale clinical and experimental studies are recommended to better understand the long-term effects of energy drinks on oral tissues and to develop effective evidence-based preventive strategies.

References

1. Lussi A., Carvalho T.S. The diagnosis and prevention of erosive tooth wear // Monographs in Oral Science. – 2024. – Vol. 34. – P. 1–20.
2. Shellis R.P., Featherstone J.D.B., Lussi A. Understanding the chemistry of dental erosion // Journal of Dentistry. – 2023. – Vol. 132. – Art. 104487.
3. Rios D., Magalhães A.C., Honório H.M., Buzalaf M.A.R. The influence of acidic beverages on dental hard tissues and saliva // Clinical Oral Investigations. – 2023. – Vol. 27, No. 5. – P. 2157–2168.
4. Zero D.T., Lussi A. Erosive tooth wear: Current concepts in diagnosis, prevention, and management // Journal of Esthetic and Restorative Dentistry. – 2022. – Vol. 34, No. 7. – P. 1038–1048.
5. World Health Organization. Guideline: Sugars Intake for Adults and Children. – Geneva: World Health Organization, 2023. – 49 p.
6. European Organisation for Caries Research (ORCA). Consensus recommendations on erosive tooth wear // Caries Research. – 2023. – Vol. 57, No. 4. – P. 321–335.
7. European Federation of Conservative Dentistry (EFCD). Clinical recommendations for the prevention and management of dental erosion // Clinical Oral Investigations. – 2022. – Vol. 26, No. 8. – P. 5631–5645.
8. Zandim-Barcelos D.L., Silva M.A., Oliveira T.M., et al. Effect of energy drinks on enamel microhardness and surface roughness: An in vitro study // BMC Oral Health. – 2022. – Vol. 22. – Art. 417.
9. American Dental Association. Evidence-Based Clinical Practice Guideline on Nonrestorative Treatments for Carious Lesions. – Chicago: American Dental Association, 2024.