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CLINICAL AND FUNCTIONAL RATIONALE FOR THE USE OF WHITENING AND DESENSITIZING TOOTHPASTES IN MIDDLE-AGED ADULTS

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Aesthetic and functional enamel parameters, such as colour stability and dentinal sensitivity, are key indicators of oral health and patient quality of life. Modern dentifrices often combine whitening, remineralizing, and desensitizing components, yet long-term comparative evaluation of their optical and electrofunctional effects remains limited. **Aim** – to assess changes in colour (saturation, brightness, whiteness, and yellowness indices) and electroodontometric parameters of permanent teeth in adults using toothpaste formulations with different ratios of whitening, remineralizing and desensitizing agents over short- and long-term periods.

Materials and methods. The study population comprised adults allocated into four groups, with each group assigned a toothpaste formulation differing in its predominant whitening, remineralizing or desensitizing effect. Optical enamel characteristics were measured by spectrocolourimetry, and pulp excitability was determined using electroodontometry at baseline and after 1, 3 and 6 months of product use.

Results. Toothpastes with predominant whitening–remineralizing action produced a significant reduction in colour saturation and yellowness with a stable increase in brightness and whiteness from the first month of use, maintaining the effect throughout the observation period. In contrast, formulations with a dominant desensitizing component provided moderate optical improvement but demonstrated a pronounced increase in pulp excitability, indicating activation of reparative tissue responses.

Conclusions. Dentifrices with varying combinations of whitening, remineralizing and desensitizing agents exert differential effects on enamel and pulpal tissues, supporting an individualized selection strategy depending on the intended clinical outcome – aesthetic enhancement or functional recovery.

Keywords: middle-aged adults, toothpaste, dentin hypersensitivity, spectrocolourimetry, electroodontometry.

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КЛІНІКО-ФУНКЦІОНАЛЬНЕ ОБҐРУНТУВАННЯ ЗАСТОСУВАННЯ ВИБІЛЮЮЧИХ ТА ДЕСЕНСИТАЙЗЕРНИХ ЗУБНИХ ПАСТ У ПАЦІЄНТІВ ЗРІЛОГО ВІКУ

Державна установа «Інститут стоматології та щелепно-лицевої хірургії Національної академії медичних наук України», Одеса, Україна

У статті наведено результати оцінки змін колірних та електрофункціональних показників твердих тканин зубів у пацієнтів зрілого віку у разі використання зубних паст з різною комбінацією вибілюючих, ремінералізуючих і десенситайзерних компонентів. Засоби із домінуючим оптичним ефектом забезпечили стійке зниження колірної насиченості і жовтизни емалі, тоді як пасти з переважною десенситайзерною дією сприяли підвищенню електрозбудженості пульпи. Отримані результати підтверджують доцільність індивідуального підбору засобів гігієни залежно від клінічного запиту – естетичної корекції або відновлення функціональної реактивності зубних тканин.

Ключові слова: зрілий вік, зубна паста, чутливість зубів, спектроколориметрія, електроодонтометрія.

Introduction

Aesthetic and functional characteristics of the hard dental tissues are important indicators of a modern patient's quality of life. Enamel colour, its brightness, and the level of optical homogeneity affect not only appearance but also the psycho-emotional state, social confidence, and motivation to maintain oral health. At the same time, dentinal sensitivity is a common complaint among adults, caused by dentine exposure, enamel demineralization, or impaired pulpal reactivity [1–4].

The pharmaceutical market offers a substantial number of home-care products that combine whitening components with remineralizing and desensitizing agents. The most common formulations are based on hydroxyapatite, fluorides, peroxide or abrasive systems, which can influence the colour, optical, and functional parameters of enamel. However, the duration of effect, the stability of optical changes after discontinuation, and the impact of such products on tooth-pulp excitability remain controversial [5–8].

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Стаття поширюється на умовах ліцензії

Most available studies focus on the short-term effects of whitening toothpastes, without accounting for the dynamics of parameters over longer periods and the relationship between optical changes and functional pulpal reactivity. In addition, it remains insufficiently studied whether whitening mechanisms coincide with remineralization processes or whether these effects are realized independently of one another [9; 10].

Accordingly, there is a need for a comprehensive analysis of colour, optical, and electrofunctional parameters of teeth when using modern toothpastes with whitening and desensitizing effects during long-term follow-up.

Aim – to assess the effect of toothpastes with different combinations of whitening, remineralizing, and desensitizing components on colour parameters of hard dental tissues (colour saturation, brightness, whiteness, and yellowness indices) and on electroodontometric parameters in adult patients.

Materials and Methods

The study was conducted at the Department of Epidemiology and Prevention of Major Dental Diseases, Paediatric Dentistry and Orthodontics, and at the Outpatient Consultation Department and the Biophysics Sector of the State Establishment "The Institute of Stomatology and Maxillo-Facial Surgery National Academy of Medical Sciences of Ukraine" (SE "ISMFS NAMS") (Odesa).

The research was carried out within the framework of the scientific research work of the SE "ISMFS NAMS": "Improving the provision of dental care to the elderly in wartime conditions" (Code NAMS 115.24, state registration No. 0123U103245).

The study materials were approved by the Bioethics Committee of the SE "ISMFS NAMS" on November 17, 2025 (Protocol No. 1028).

The study included 61 volunteer patients aged 40–57 years who provided written informed consent. The participants were divided into four groups according to the predominant action of the toothpastes and the composition of their active ingredients, which were used for a period of one month:

Group 1 (15 patients) – toothpaste with a combined whitening, remineralizing and anti-inflammatory effect (enzyme systems, calcium, fluorides, anti-inflammatory and antiseptic components);

Group 2 (15 patients) – toothpaste with whitening, remineralizing and desensitizing effects (hydroxyapatite, arginine, potassium salts, fluorides, enzymes);

Group 3 (14 patients) – toothpaste with a predominantly desensitizing and anti-inflammatory effect (fluorides, calcium, enzyme systems, anti-inflammatory components);

Group 4 (17 patients) – toothpaste with a pronounced desensitizing and pulp-oriented effect (potassium and strontium salts in combination with fluorides).

After completion of the one-month course of the investigated products, all patients were recommended to use a neutral oral hygiene toothpaste with a mild remineralizing effect (Natusana Bio Calendula).

All participants used the toothpaste twice daily (in the morning and in the evening) throughout the entire observation period. Tooth brushing was performed using a medium-bristle manual toothbrush. These parameters were identical for all study participants in order to standardize the conditions of oral hygiene exposure.

Patients were examined at baseline and at 1, 3, and 6 months.

To assess the state of hard dental tissues, an optical express method was used: spectrocolourimetric determination of the aperture light-reflection coefficient in the 380–720 nm range with automatic calculation of digital and colour parameters (colour saturation, brightness, whiteness, and yellowness indices), allowing in vivo detection of minimal changes in enamel/dentine mineralization, remineralization, or demineralization [11].

Pulp excitability was assessed using the electroodontometer "Pulptester PT-1" (Lumen, Lithuania). Device parameters complied with TU 3204048-03-97 standards and general medical device safety rules IEC 601-1.

Data were processed by variance-statistical analysis using STATISTICA 6.1 and Student's t-test [12].

Research results and their discussion

Table 1 presents the changes in colour and optical parameters of dental hard tissues in mature adult patients using different toothpastes.

Table 1

Mean colour and optical parameters of hard dental tissues in adult patients during toothpaste use (relative units)

Group / Timepoint	Colour saturation, S	Brightness, Y	Whiteness index, B	Yellowness index, Yel
1	2	3	4	5
Hydroxyapatite (reference sample)	7.3±0.6	75.7±6.9	87.1±7.3	14.5±1.2
Toothpaste with a combined whitening, remineralizing and anti-inflammatory effect – Baseline	12.1±1.4	35.1±3.6	44.7±5.2	47.9±5.5
After 1 month	9.3±0.5 (p<0.001)	44.1±4.1 (p<0.001)	67.3±6.1 (p<0.001)	23.5±4.3 (p<0.001)
After 3 months	9.5±0.3 (p<0.001)	43.3±4.0 (p<0.01)	65.4±7.2 (p<0.001)	26.3±3.9 (p<0.001)
After 6 months	9.6±0.6 (p<0.001)	43.1±3.9 (p<0.01)	62.5±7.1 (p<0.001)	29.7±4.0 (p<0.001)
Toothpaste with whitening, remineralizing and desensitizing properties – Baseline	12.7±1.2	34.9±3.5	43.9±7.2	48.2±4.9
After 1 month	8.9±0.8 (p<0.001)	44.9±4.8 (p<0.001)	68.7±6.4 (p>0.1)	25.5±4.1 (p<0.001)
After 3 months	9.1±0.7 (p<0.001)	43.4±3.9 (p<0.001)	66.5±7.1 (p>0.1)	28.8±2.9 (p<0.001)

Table 1 (Continued)

1	2	3	4	5
After 6 months	9.5±1.1 (p<0.001)	43.1±4.4 (p<0.001)	61.5±7.6 (p>0.1)	29.1±3.5 (p>0.05)
Toothpaste with a predominantly desensitizing and anti-inflammatory effect – Baseline	11.3±1.3	35.4±3.5	45.1±7.2	48.5±6.7
After 1 month	10.0±1.2 (p>0.1)	40.3±4.1 (p>0.05)	51.5±5.4 (p>0.1)	35.4±3.4 (p<0.001)
After 3 months	10.3±0.9 (p>0.1)	39.9±3.8 (p>0.1)	50.7±4.3 (p>0.1)	36.5±3.9 (p<0.001)
After 6 months	10.5±0.8 (p>0.1)	39.4±4.2 (p>0.1)	50.1±5.2 (p>0.1)	37.0±4.3 (p<0.001)
Toothpaste with a pronounced desensitizing and pulp-oriented effect – Baseline	12.3±1.1	35.7±3.5	44.2±7.2	48.3±5.5
After 1 month	9.9±1.2 (p<0.01)	39.1±4.1 (p>0.1)	51.2±5.5 (p>0.1)	39.2±4.2 (p<0.001)
After 3 months	10.1±0.6 (p<0.01)	38.9±3.5 (p>0.1)	50.1±5.4 (p>0.1)	40.7±3.0 (p<0.001)
After 6 months	10.4±0.7 (p>0.05)	38.6±3.4 (p>0.1)	49.6±4.5 (p>0.1)	41.3±3.7 (p>0.05)

Note: p indicates the significance of differences from baseline.

In all groups of examined patients, baseline colour and optical parameters of the hard dental tissues did not differ significantly from each other. As early as one month after the use of toothpastes with a combined whitening and remineralizing effect, as well as toothpastes with whitening, remineralizing and desensitizing properties, a pronounced and statistically significant effect was observed (p<0.001). In these groups, the colour saturation index decreased by 1.3-fold and 1.42-fold, respectively, while the yellowness index decreased by 2.03-fold and 1.89-fold, respectively. At the same time, the brightness index increased by 1.25-fold and 1.28-fold, and the whiteness index increased by 1.5-fold and 1.56-fold, respectively. The achieved changes remained stable at 3 and 6 months of follow-up, indicating a pronounced and prolonged whitening effect of the investigated products.

In the groups of patients who used toothpastes with a predominantly desensitizing and anti-inflammatory effect, as well as toothpastes with a pronounced desensitizing and pulp-oriented effect, a slight whitening effect was also observed one month after the beginning of the study. However, after discontinuation of toothpaste use, at 6 months of observation, the values of the analyzed parameters tended to approach baseline levels without fully reaching them. Toothpastes with different ratios of whitening and desensitizing components demonstrate a whitening effect that stabilizes over a certain period of time. However, these effects may be temporary when the use of the products is discontinued, indicating the need for their regular use to maintain the achieved results.

Table 2 presents the results for the electroodontometry index (pulp excitability) in the examined adult patients over the course of toothpaste use.

Analysis of EOM data showed that toothpaste with a pronounced desensitizing and pulp-oriented effect most effectively promoted recovery and enhancement of pulp-related functional responses, which participates in

Table 2

Electroodontometry (EOM) in middle-aged adults during toothpaste use (μA)

Group / Timepoint	EOM, μA
Toothpaste with a combined whitening, remineralizing and anti-inflammatory effect – Baseline	6.75±0.45
After the first use	6.88±0.62 (p>0.05)
After 1 month	8.93±0.50 (p<0.001)
After 3 months	8.01±0.60 (p>0.05)
After 6 months	7.73±0.65 (p>0.05)
Toothpaste with whitening, remineralizing and desensitizing properties – Baseline	7.23±0.40
After first use	7.37±0.48 (p>0.05)
After 1 month	9.84±0.55 (p<0.001)
After 3 months	9.12±0.60 (p<0.001)
After 6 months	8.72±0.60 (p<0.001)
Toothpaste with a predominantly desensitizing and anti-inflammatory effect – Baseline	7.34±0.55
After first use	7.41±0.54 (p>0.05)
After 1 month	9.77±0.60 (p<0.001)
After 3 months	9.48±0.45 (p<0.001)
After 6 months	8.86±0.60 (p<0.001)
Toothpaste with a pronounced desensitizing and pulp-oriented effect – Baseline	7.06±0.65
After first use	7.75±0.42 (p>0.05)
After 1 month	10.81±0.40 (p<0.001)
After 3 months	10.54±0.35 (p<0.001)
After 6 months	10.07±0.50 (p<0.001)

Note: p indicates the significance of differences from baseline.

dentinogenesis and remineralization of superficial enamel layers. These findings indicate a favourable effect of the toothpaste on these processes, with potential relevance for improving enamel condition and overall oral health. Notably, this toothpaste showed the greatest effect already after the first use compared with the others.

Conclusions

Toothpastes with combined whitening and remineralizing action provided the most pronounced improvement in enamel colour characteristics within one month, manifested by decreased colour saturation and yellowness and increased brightness and whiteness.

The optical changes persisted over a prolonged period (up to six months), indicating the formation of a stable remineralizing effect in superficial enamel layers.

Products with a predominant desensitizing effect produced less pronounced enamel lightening but positively affected pulp excitability, indicating activation of functional tissue-recovery mechanisms.

The dynamics of electroodontometric indices suggest that toothpastes with a pronounced desensitizing component can improve pulpal functional reactivity after the first application, with subsequent stabilization over the long term.

Toothpastes with different combinations of whitening, remineralizing, and desensitizing agents may be recommended with regard to the patient's clinical needs: formulations with a predominantly optical effect for rapid aesthetic improvement, and those with a pronounced effect on the pulp for restoring functional activity of dental hard tissues.

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