

Effects of dentifrices containing activated charcoal on dental enamel: a review of the literature

Efeitos de dentifrícios contendo carvão ativado no esmalte dental: uma revisão da literatura

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ABSTRACT

The increased demand for white teeth has intensified the commercialization of new bleaching products, particularly those that can be accessed easily, do not require the direct supervision of a dentist, and are affordable. Among these new products, several dentifrices publicized as bleaching products have been developed, most recent of them being the activated charcoal toothpaste, which entered the market promising to whiten teeth. While it is portrayed as a healthy and ecological product, there is a paucity of scientific evidence supporting its alleged benefits. Therefore, this literature review aimed to evaluate activated charcoal containing oral hygiene products on their bleaching ability and effects on enamel. After analyzing several

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in vitro studies on the subject, it can be concluded that these products do not have a bleaching effect per se, but act by removing the extrinsic pigments from the teeth. However, most of the products containing activated charcoal could have abrasive effects on the surface of the enamel. Therefore, it is suggested caution about the indication of these dentifrices, especially for individuals predisposed to dental wear, such as gingival recession, reduced salivary flow, and high risk of caries or dental erosion.

Indexing terms: Activated carbon. Tooth bleaching. Dentifrices.

RESUMO

A maior procura por dentes brancos tem impulsionado a comercialização de novos produtos clareadores, especialmente aqueles que possam ser de fácil acesso, que não precisem supervisão direta do dentista, e que tenham um custo acessível para o consumidor. Entre esses novos produtos diversos dentifrícios, denominados como branqueadores, têm sido comercializados. Destes o mais recente é o dentifrício a base de carvão ativado, que entrou no mercado prometendo clarear os dentes, enquanto que se apresenta como um produto saudável e ecológico, porém sem grande respaldo científico. Portanto, esta revisão da literatura teve o objetivo de avaliar a capacidade branqueadora e os efeitos no esmalte após o uso de produtos de higiene oral contendo carvão ativado. Após avaliar diversos artigos *in vitro* sobre o tema, pode-se concluir que estes produtos não tem um efeito clareador propriamente dito e sim agem como removedores de pigmentos extrínsecos. Porém, grande parte dos produtos contendo carvão ativado poderiam apresentar um efeito abrasivo sobre a superfície do esmalte, pelo que se sugere cautela sobre a indicação destes dentifrícios, especialmente para os pacientes sujeitos a maiores riscos de desgaste dental, como recessão gengival, fluxo salivar reduzido, alto risco de cárie ou erosão dentária.

Termos de indexação: Carvão ativado. Clareamento dental. Dentifrícios.

INTRODUCTION

Although the best teeth bleaching option is one that makes use of gels containing peroxides and is directly carried out or indicated for use under the supervision of a dentist, various toothpastes cited as bleaching have been made available on the market. Some contain hydrogen peroxide (HP) in low concentrations or abrasive agents that remove extrinsic stains from teeth [1]. Toothpastes that contain HP have a low peroxide content, which, combined with the low contact time during brushing, would be factors that prevent these products from acting as effective bleaching agents [2]. While abrasive agents such as hydrated silica, calcium carbonate, dicalcium phosphate dihydrate, calcium pyrophosphate, alumina, perlite or sodium bicarbonate can mechanically remove biofilm and chromophores from the tooth surface. However, due to their degree of abrasiveness, they should be used with caution [3].

Thus, given the search for new toothpastes or oral hygiene products with a bleaching effect, the more recent incorporation of activated charcoal into brushing products, whether in powder or toothpaste form, has had great appeal to the public. Particularly because it is a natural/organic compound, supposedly offers a bleaching effect, is economically advantageous, easy to access and use when compared to supervised treatments [4].

Charcoal is a very light hydrocarbon made of black carbon and ash residues, whose first uses in oral hygiene date back to ancient Greece. This product is obtained by a method called “slow pyrolysis”, which removes water and other volatile components from carbon-rich materials. In toothpastes, a fine powder of activated charcoal is incorporated, which has been previously oxidized by controlled reheating or chemical

means [4]. The activated charcoal acts by binding to all the deposits on the surface of the tooth, retaining biofilm so that brushing eventually leaves the tooth surface free of deposits [5].

The use of toothpastes with activated charcoal is becoming increasingly widespread, driven largely by the use of marketing and social networks, and their easy access in physical stores and online. However, more recent scientific evidence has questioned the effect of these products on changing tooth color, while evaluating their possible abrasive effects on the enamel surface [3, 6]. Therefore, the aim of this study was to evaluate, through a review of the literature, the bleaching capacity and effects on enamel following the use of oral hygiene products containing activated charcoal.

METHODS

To carry out this literature review, articles were searched for in the Pubmed database on 22.04.2023. The search words used were: “activated charcoal” OR “powder charcoal” OR “charcoal tooth paste” OR “charcoal based products”.

RESULTS

After evaluating the available abstracts, 15 research articles were selected as relevant to the aim of this literature review. These were published between 2017 and 2023, of which four were literature reviews [4,5,7,8] and eleven were *in vitro* studies. All the laboratory research articles evaluated color after different bleaching/brushing strategies. Also, some evaluated the effects of exposure to activated charcoal on the surface of tooth enamel by analyzing roughness or microhardness [1,3,6,9-15]. While only one study directly determined the remineralizing effect of dentifrices containing activated charcoal through post-brushing acid challenge [16].

Main characteristics of activated charcoal-based products

Activated charcoal-based products for dental use have added inorganic components, flavoring agents and botanicals [5]. Around 8% of products contain fluoride, while 38% contain the abrasive agent bentonite clay [4]. Some of the commercial brands available, with their formulation, are described in Chart 1.

Before being incorporated, charcoal derived from different sources generally undergoes an oxidation process. For this reason, depending on its source and pulverization process, activated carbon powder has a very variable degree of abrasiveness [5]. According to a review study, only 28% of products have low abrasiveness [4].

Mechanism of action of activated carbon

Activated charcoal, together with the bentonite clay in some formulations, has the ability to “store” plaque, pigments and surface bacteria inside its pores, which are then rinsed out of the oral cavity [5], thus generating the desired cleanliness. The advertised bleaching effect has been associated with this ability to adsorb pigments and chromophores, which are responsible for dental pigmentation. Furthermore, recent

Chart 1. Commercial products based on activated charcoal and their composition.

| Commercial name | Presentation form | Company | Composition |
|-------------------------------------|-------------------|-----------|---|
| Whitemax | Powder | Dermavita | Activated carbon, aroma, kaolin, sweet orange essential peel oil (<i>citrus aurantium dulcis</i>). |
| Carvvo | Powder | Carvvo | Activated carbon, kaolin clay and orange essential oil [6]. |
| Natural Extracts Activated charcoal | Toothpaste | Colgate | Sorbitol, water, hydrated silica, sodium lauryl sulfate, PEG012 flavor, tetrasodium pyrophosphate (antitartar agent), cocamidopropyl betaine, cellulose gum, sodium saccharin, sodium fluoride, xanthan gum, CI 77891, mica, CI 77266 (mica, carbon CI 77266), benzyl alcohol [16]. |
| Luminous White Activated charcoal | Toothpaste | Colgate | Sodium fluoride 0.24% (0.15% w/v fluoride ion), water, hydrated silica, sorbitol, glycerin, PEG-12, pentasodium triphosphate, tetrapotassium pyrophosphate, sodium lauryl sulfate, flavor, Cellulose Gum, Cocamidopropyl Betaine, Sodium Saccharin, Xanthan Gum Sodium saccharin, xanthan gum, charcoal powder, sodium hydroxide, blue 1, red 40, titanium dioxide [12]. |
| Black is white | Toothpaste | Curaprox | Hydrated silica, charcoal powder, water, sorbitol, glycerin, aroma, decyl glucoside, cocamhydropyl betaine, sodium monofluorophosphate 950 ppm F, tocopherol, xanthan gum, maltodextrin, mica, hydroxylapatite. (nano), acesulfame potassium, titanium dioxide, microcrystalline cellulose, sodium chloride, citrus lemon peel oil, sodium hydroxide, Zea mays starch, amyloglucosidase, glucose oxidase, Urtica leaf extract, Urtica dioca leaf extract, potassium thiocyanate, cetearyl alcohol, hydrogenated lecithin, menthol lactate, methyl diisopropyl propionamide, ethyl menthol carboxamide, stearic acid, mannitol, sodium bisulfite, tin oxide, lactoperoxidase, limonene [16]. |
| Black and Polish | Toothpaste | Frezyderm | Deionized water, sorbitol, saccharin, sodium fluoride (0.32% - w/w), sodium benzoate, polyglycol 1500s, Blancoz 7M1F Pharm, Tixosil 73, Tixosil 43, Pearlwhite 19, Spearmint frost flavor EAB24297/00, biosol, citric acid, Speckare CAC3, sabosol L30. |
| Black and Polish Mouthwash | Mouthwash | Frezyderm | Deionized water, sodium saccharin, sodium monofluorophosphate (0.2%- w/w), sodium benzoate, Furdentyl, frost mint aroma EAB24297/00, biosol, sabowax ELH 40, glycerin, peroxidone K90, active carbon CA3, citric acid. |

evidence suggests that it is mainly the abrasive effect of this compound that is responsible for its ability to mechanically remove extrinsic pigments and generate an apparent “bleaching effect” [12,16].

Powdered activated carbon

Some *in vitro* studies have also analyzed the properties of products containing activated charcoal in powder form. Whitemax (Dermavita, Brusque, SC, Brazil) [9] showed a minimal effect of altering tooth color, which was associated with its effect of removing extrinsic pigmentation. This result was corroborated by other authors where the powder with activated charcoal was inferior to a conventional toothpaste with regard to color change [16], and even in one study its use generated changes in the enamel surface [6].

Activated charcoal in toothpastes

Several *in vitro* studies using toothpastes containing activated charcoal have not observed a significant bleaching effect. Furthermore, when associated with hydrated silica, which is an abrasive particle, it would have a greater capacity to alter the roughness of the enamel [12,16]. On the other hand, products containing sodium bicarbonate, an abrasive with lower hardness, would be less aggressive to the enamel surface than those containing silica. The difference in results could be related to the number, shape and size of the activated carbon used [16].

Although it has been suggested that the combination of activated charcoal and fluoride would make dentifrice safer for clinical use, studies evaluating this type of formulation have not shown a superior effect due to the incorporation of fluoride, which could be explained by the charcoal’s ability to absorb fluoride ions, which would reduce its availability in the oral environment [16].

DISCUSSION

This literature review evaluated the bleaching capacity and effects on enamel after using oral hygiene products containing activated charcoal. It was observed that as far as the bleaching effect is concerned, activated charcoal-based toothpastes or powders did not show bleaching efficacy when compared to home bleaching with 10 or 16% carbamide peroxide (CP) [6,9]. Even when compared to other toothpastes containing microspheres and optimized abrasives or blue covarine, activated charcoal was inferior in terms of bleaching [3]. Patients should therefore be made aware of the fact that in-office or at-home peroxide-based bleaching products remain the ideal treatments for achieving an effective and predictable result. Although the media promotes the use of activated charcoal-based products as bleaching agents, there is currently no scientific evidence to support this indication.

The abrasive effect associated with products containing activated charcoal is a major concern, particularly considering how widespread these products are. According to Palandi et al. [6], when enamel was bleached with CP and then brushed with a product containing activated charcoal, the roughness was higher compared to enamel brushed with a fluoride-containing toothpaste, indicating a compromise of enamel integrity. Furthermore, the association of abrasives, commonly present in toothpastes, with activated charcoal in some formulations led to surface alterations, which serves as a warning, especially considering the prolonged use of these products.

From the results of this review, the studies that evaluated toothpastes containing activated charcoal concluded that they would generate abrasion on the surface of dental enamel [1,6,9,12]. In addition, Franco et al. [9] reported no substantial differences in the surface roughness of enamel brushed with regular toothpaste (1450 ppm F) or activated charcoal-based tooth powder after 14 days. Palandi et al. [6] observed slight changes in enamel surfaces after brushing with activated charcoal powder and regular toothpaste. Similarly, Pertiwi et al. [17] described an increase in surface roughness after 1 and 3 months of brushing with a charcoal dentifrice. However, brushing force and technique, as well as the type of toothbrush, are issues to be considered when translating laboratory results into the clinical setting.

Regarding the presence or absence of fluoride in products containing activated charcoal. Charcoal, due to its high absorption power, has previously been used, to extract fluoride from drinking water in communities with water supplies with excessive fluoride content [5]. The ability of fluoride toothpastes to act on the processes of tooth re- and demineralization is well established in the literature, and is considered a relevant agent for controlling the development of caries lesions. However, associated with their fluoride inactivation effect, toothpastes with activated charcoal and fluoride did not show remineralizing potential [16]. This indicates that dentifrices with activated charcoal and fluoride may have a limited capacity to enhance mineral recovery, or even to reduce the effects of demineralization, as is the case with caries and erosive wear.

An important fact is the evaluation time of the studies carried out so far. Most of them have only evaluated the use of this toothpaste for 14 days, which is the time indicated by the manufacturers to notice a change in tooth color. However, it is understood that patients will generally use the product until it runs out, demonstrating that studies with a longer evaluation time and which simulate other conditions and challenges present in the oral cavity, such as erosion, are still needed. Thus, caution is suggested in view of the current gaps in the effects of long-term use of products containing activated charcoal.

CONCLUSION

Considering the frequent questioning from patients about whether or not to use toothpastes containing activated charcoal, this literature review summarizes that these products are not bleaching agents, but act by removing extrinsic pigmentation, and although there may be a change in color, the effect ends up being clinically imperceptible. Most of these products do not have a remineralizing capacity, and even the fluoride, when present, can be inactivated. Because of this and their abrasive effect on the enamel surface, caution is suggested regarding the indication of these toothpastes, especially for patients at greater risk, such as those with gingival recession, reduced salivary flow, high risk of caries or dental erosion. The studies carried out so far with these products show that they do not have a bleaching effect, but rather an abrasive effect.

Collaborators

CP Maturrano Castillo, conceptualization, methodology, research, writing – original draft, writing – revision and editing. MI Guanipa Ortiz, methodology, research, validation, writing – review and editing. WF Vieira Junior, supervision, writing – review and editing, project administration. FH Baggio Aguiar, supervision, writing – review and editing, project administration. DAN Leite Lima, conceptualization, supervision, writing – proofreading and editing, project administration.

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