Charcoal-based mouthwashes: a literature review

John K. Brooks,¹ Nasir Bashirelahi,² Ru-ching Hsia³ and Mark A. Reynolds⁴ describe the emerging use of charcoal-based oral hygiene products and look at the lack of evidence supporting their use for therapeutic or cosmetic improvement.

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Abstract

The commercial marketplace has seen a rapid increase in the number of over-the-counter charcoal-containing mouthwashes. The purpose of this systemic review was to examine the clinical and laboratory evidence supporting therapeutic claims of efficacy and safety of use of charcoal-based mouthwashes. Secondly, the product labels and information of 36 commercially marketed charcoal mouthwashes were reviewed for active ingredients. Only 8% of charcoal mouthwashes contained an active ingredient, such as cetylpyridinium chloride or chlorhexidine. There is insufficient evidence to substantiate the therapeutic and cosmetic marketing claims of charcoal-based mouthwashes, including antimicrobial activity, anti-halitosis, tooth whitening, periodontal disease control, caries reduction and tooth remineralisation, among others. Moreover, there is no available information on charcoal particulate size or abrasivity of any of these products. Dental clinicians should advise their patients to exercise caution when using over-the-counter charcoal-containing mouthwashes because of the lack of evidence supporting therapeutic or cosmetic effectiveness as well as safety.

Introduction

Mouthwashes are classified by their chemical and antimicrobial properties and are designated as either

cosmetic or therapeutic. Cosmetic types are recognised for offering only temporary relief of halitosis.¹ The American Dental Association (ADA) Science Institute has validated the efficacy and documented the range of active ingredients to be included in therapeutic mouthwashes, such as cetylpyridinium chloride, chlorhexidine, essential oils (eucalyptol, menthol, methyl salicylate, thymol), and fluoride.²

With our increasingly health-conscious society, there has become a renewed interest in the potential merits of charcoal-containing products for personal hygiene, including skin and dental care. The most common oral product containing charcoal is toothpaste, reviewed by Brooks *et al.*,³ and less frequently found in mouthwash,

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manual and electric toothbrush bristles, dental floss and floss picks, tooth whitening strips, and chewing gum. As such, consumers may be faced with the challenge of making decisions whether to use charcoal mouthwashes based upon the advertised claims of product effectiveness and safety.

There is a paucity of clinical information concerning the effectiveness of over-the-counter charcoal mouthwash as an aid to oral hygiene (Fig. 1). The objective of this investigation was to substantiate whether there was clinical and laboratory evidence that the use of charcoal mouthwashes reduces gingival inflammation and promotes tooth whitening, as well as establishing any adverse effects. In this systematic review, we searched the literature for controlled clinical trials with a minimum follow-up of six months, evaluating the effect of charcoal-containing mouthwashes on therapeutic and cosmetic outcomes. In addition, we examined the product labels and information of commercially marketed charcoal-containing mouthwashes for recognised active ingredients.

Methods

Search strategy

We established comprehensive search strategies for identification of studies for inclusion in this review. We searched MEDLINE and Scopus databases for reports on the efficacy and safety of charcoal-containing oral rinses published in the English language literature through 15 June 2019, using the following four strategies and search terms: 1. charcoal OR charcoal-based OR activated charcoal OR soot; 2. rinse; OR oral rinse OR mouthwash OR antiseptic; 3. oral hygiene OR oral health OR teeth OR dental; and 4. 1, 2, and 3. We also screened reference lists of potential articles for relevant published studies.

Inclusion criteria of relevant studies

The inclusion strategy consisted of identification of randomised controlled clinical studies coincident with a follow-up assessment of at least six months, cohort studies, case reports and case series.

Assessment of validity and data extraction

We identified ten articles employing our literature search criteria. Two authors (J.B., M.R.) reviewed potentially eligible articles and independently screened titles, abstracts and full texts. Disagreements of references were resolved through discussion and achievement of a consensus. The aim of this investigation was to provide a comprehensive

Fig. 1 Photograph of charcoal mouthwash

There has become renewed interest in the potential merits of charcoal-containing products for personal hygiene, including skin and dental care'

review of the English language literature on the potential effectiveness and adverse sequelae with usage of charcoal mouthwash. Culled articles underwent extraction of the following data:

- Citation, authors and year of publication
- Methodology
- Study population, including city and country, and age of participants
- Oral hygiene comparisons
- Outcome measurements
- Source of investigation funding.

Product labelling

Search strategy

We performed an Internet search on Google and Amazon, utilising the key words 'charcoal mouthwash'. Thirty-six consecutive brands were found, and information from available advertising and product labelling was procured. Other oral charcoal-based

preparations and devices were excluded from this study.

Results

Literature review

The conducted literary search yielded ten potentially qualified articles on charcoal as an ingredient in mouthwash or rinse for oral hygiene purposes; however, none of the publications met the inclusion criteria.^{4,5,6,7,8,9,10,11,12,13}

Product information

The inclusion of charcoal was the *sine qua non* for this investigation. With respect to therapeutic agents, fluoride was found in 13.9% (5/36) of the products, and 8.3% (3/36) of the brands contained cetylpyridinium chloride or chlorhexidine. Three mouthwashes contained alcohol. Numerous other organic compounds, such as limonene,

Fig. 2 Electron microscopic view of charcoal-based mouthwash (original magnification x6,500)

menthol, peppermint oil, tea tree leaf oil and thymol were included in the charcoal mouthwashes.

Discussion

To date, there are no clinical or laboratory published studies that have demonstrated therapeutic or cosmetic benefits of charcoal mouthwash usage. As of January 2020, the ADA Seal of Acceptance has not been granted to any of these products. A review of the literature regarding the efficacy and safety concerns of charcoal mouthwash has been provided. The brand names of the reviewed charcoal mouthwashes are listed in the Addendum.

Ingredients

Antimicrobial

There is some laboratory evidence that charcoal may offer some antibacterial properties. Ravasi *et al.*¹⁴ noted that powdered activated carbon reduced antibiotic-resistant microflora in wastewater with a 99.7% efficiency. Thamke *et al.*¹⁵ reported oral carriage reductions with charcoal, noting use of charcoal-bristled toothbrushes resulted in a near-75% reduction in colony-forming units than non-charcoal-bristled toothbrushes after washout at one week (38 versus 151, $P < 0.001$).

Anti-caries

Only five charcoal-containing oral rinses contained fluoride, a well-recognised cariogenic inhibitor. Some laboratory evidence has suggested that charcoal may reduce the concentration of available fluoride,^{16,17,18} raising concerns about whether fluoride-containing charcoal mouthwashes would offer caries protection. In fact, charcoal products have been utilised as a medium of defluoridation in community water supply systems to reduce endemic fluorosis.¹⁹ Measurements of available fluoride

ion concentrations in charcoal mouthwash would be of merit, as well as clinical trials, to determine whether there is any preventative benefit to their usage overall. Five other mouthwashes contained xylitol, which has generally been accepted to offer a modest reduction in caries incidence.²⁰

Anti-halitosis

Although there is limited evidence that systemic administration of charcoal has shown an ability to reduce oral malodour with trimethylaminuria (fish-like odour syndrome),²¹ there have not been any published clinical investigations to validate the effectiveness of charcoal-based mouthwash for management of halitosis. In fact, only 8.3% (3/36) charcoal mouthwashes contained cetylpyridinium chloride or

47.2% (17/36) of the charcoal mouthwashes, there have been no well-controlled clinical investigations corroborating its long-term lubrication to the oral mucosa. None of the charcoal mouthwashes contained pilocarpine or cevimeline, agents recognised to achieve longstanding xerostomia improvement.²³

Tooth whitening

Most charcoal mouthwashes offered cosmetic claims of tooth whitening, presumably attributed to the inclusion of charcoal acting as an abrasive agent to mechanically remove extrinsic organic stains. Although there are no investigations to substantiate that charcoal mouthwash may whiten teeth, an *in vitro* study involving bovine incisors found one brand of charcoal-based toothpaste resulted in some degree of loss of surface pigmentation.¹³ However, Greenwall *et al.*²⁴ suggested that charcoal particles may lead to marginal staining along the cavosurfaces of defective composite restorations. Only one brand of charcoal mouthwash contained hydrogen peroxide as an apparent chemical bleaching method to whiten teeth; none listed carbamide peroxide. The typical 30-second rinsing time for over-the-counter mouthwash usage would not likely achieve any significant degree of whitening as 20 to 30 minutes is usually needed for satisfactory results.²⁵ Furthermore, the inclusion of chlorhexidine in one other brand may inadvertently increase surface stain following extended periods of administration.²⁶

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chlorhexidine, agents recognised for halitosis management. Any persistent reduction in halitosis with charcoal mouthwash may more likely be attributed to the inclusion of the aforementioned therapeutic agents, and any temporary relief might be gained from the various flavouring agents.

Xerostomia

Glycerin was an ingredient in seven charcoal mouthwashes. Use of glycerin for xerostomia management has resulted in only short-term success.²² Although coconut oil is present in

Potential safety concerns

Risk of oral mucosal neoplasia

Charcoal is composed of at least 15 polycyclic aromatic hydrocarbons,²⁷ of which four (naphthalene, benzo[a]pyrene, dibenz[a,h]anthracene and indeno[1,2,3cd]pyrene) are listed in the United States Department of Health and Human Services 2016 National Toxicology Program database²⁸ as ‘reasonably anticipated to be human carcinogens’. One concern is the lengthened mucosal contact of these substances, ranging from 5 to 20 minutes (as suggested by several charcoal mouthwash vendors), for

products that also contain oil for 'oil pulling'. Although there is some epidemiologic evidence of higher incidences of oral and pharyngeal carcinoma among cohorts with consumption of charcoal-grilled red meats,²⁹ a review of the extant literature conducted by the International Agency for Research on Cancer was unable to establish causality of exposure to any contained polycyclic aromatic hydrocarbons and carcinogenesis.³⁰ Nevertheless, the lack of clinical and laboratory investigations of chronic usage of charcoal-based mouthwash leaves unresolved whether these products confer any inherent risk of cellular alterations or neoplasia to the oral mucosa or other sites.

Three of the charcoal mouthwashes listed alcohol as an ingredient, two without specification of its chemical composition or concentration, and one contained <1% benzyl alcohol. Although there is convincing evidence of ethanol consumption and carcinogenesis (oropharyngeal, oesophagus, liver and breast),^{31,32,33,34} there is a lack of consensus in the literature regarding alcohol-containing mouthwashes and the risk of oral cancer.³⁵ Multiple investigations have linked salivary ethanol metabolites as aetiological factors in the development of oral mucosal keratinisation and dysplasia.^{36,37,38,39,40} It is unknown whether the combination of charcoal and alcohol provides any enhanced predisposition to oral mutagenesis. As a prudent guideline, patients with a history of alcohol abuse, xerostomia and premalignant or malignant oral lesions should avoid mouthwashes containing alcohol. Another study involving low doses of benzyl alcohol administration to F344/N rats was not correlated with an increased risk for carcinogenicity.⁴¹

Gingival health

There is no scientific evidence that charcoal mouthwash is an effective vehicle for the prevention of gingivitis or improvement in periodontal disease. It also remains unclear whether habitual rinsing with charcoal mouthwash leads to complete clearance of its charcoal particles or long-term residual accumulation within the gingival sulci, potentially having a negative periodontal impact.⁴²

Abrasivity

Another particular concern with the inclusion of charcoal in oral hygiene products is its hardness and potential damage to the aprismatic enamel (harder, less permeable and more stain-resistant outer mineralised layer)⁴³ and subsurface enamel, increasing the risks for surface roughness, caries susceptibility, tooth sensitivity and, ironically, could lead to

tooth discolouration despite the intention of tooth whitening. Yaacob *et al.*⁴⁴ described the practice of tooth cleansing via finger rubbing with charcoal in rural Malaysia, noting that its use led to the teeth appearing 'less white or even yellowish, as the enamel layer is removed to expose the dentine'.

There is recent evidence that toothpaste containing charcoal has led to increased enamel roughness.⁴⁵ None of the product labelling of charcoal mouthwashes included a relative dentine abrasivity score, and charcoal particulate size and its solubility in the delivery vehicle. Electron microscopy of one charcoal mouthwash revealed erose-shaped charcoal particles of variable sizes (Fig. 2). The maximum threshold of time to rinse with charcoal-based mouthwashes without risking enamel damage has not been provided to the consumer. Likewise, the rinsing times, ranging from 5 to 20 minutes, as advocated with charcoal mouthwashes intended for 'oil pulling', raise additional concerns about tooth wear. Two of the charcoal mouthwashes are explicitly advertised as being 'mildly abrasive' in order to achieve tooth whitening. One mouthwash contained silica, a mineral found in sandstone and quartz; it did not disclose the silica particulate size and its potential tooth structure injury.

Erosion

Other questions raised were regarding the pH of the charcoal mouthwashes containing various acids (citric, fulvic, salicylic, sorbic, lactic and humic) and whether use of these products had any effect on enamel health. Three of these mouthwashes concurrently included acidic and alkaline compounds and two contained alkaline agents. Principally, a lower pH oral environment may potentiate tooth structure dissolution and increase caries susceptibility consequent to acid production by *S. mutans*.

Hypersensitivity

Some of the mouthwash ingredients, such as chlorhexidine, have the potential to induce immunologically-mediated reactions to the oral mucosa and perioral tissue. Chlorhexidine has been associated with an increased risk of anaphylaxis and isolated instances of death.⁴⁶ Cinnamic aldehyde, the allergenic compound found in cinnamon, may result in oral mucositis or glossodynia.⁴⁷ Lcarvone, a component in spearmint oil, has occasionally promoted angular cheilitis.⁴⁸ Many charcoal mouthwashes include other organic compounds that potentially induce hyperallergenic reactions, namely limonene, menthol, peppermint oil, tea tree leaf oil, thymol and tocopherol.^{49,50} Over

30% (11/36) of the charcoal mouthwashes contained so-called 'inactive' ingredients that have been classified as allergenic or potentially contain allergenic contaminants,⁵¹ such as sodium benzoate, saccharin, polyethylene castor oil, poloxamer, sesame oil, benzyl alcohol, polyethylene glycol, or vanilla. Five of these mouthwashes included two of these aforementioned allergens and one brand contained three allergens. Prior to the use of charcoal mouthwashes, individuals with known histories of contact dermatitis or increased hypersensitivity profiles should gain familiarity with the product ingredients and possible oral and systemic side effects. To avoid adverse incidents, mouthwash users should comply with the manufacturers' expressed instructions.^{52,53}

Summary

A review of the state of science has failed to substantiate any clinical investigations that have demonstrated reduction in caries, sustained improvement in halitosis, tooth whitening, oral detoxification, anti-periodontal/anti-inflammatory activity, oral palliation, or xerostomia management associated with usage of charcoal mouthwash. Approximately 10% of commercial charcoal-containing mouthwashes also contained active ingredients, such as cetylpyridinium chloride or chlorhexidine, with the potential recognised to reduce plaque and gingivitis. Dental healthcare providers are encouraged to inform their patients about the lack of clinical evidence of the effectiveness of, and potential safety concerns following chronic administration of, charcoal mouthwash to the teeth and oral mucosa. Moreover, such products may increase the risk of enamel damage due to the abrasiveness of charcoal particles and the risk of caries due to the lack of fluoride or, perhaps, charcoal-induced fluoride degradation. Consumers should be familiar with the active and so-called 'inactive' ingredients in charcoal mouthwashes and their possible side effects, particularly in hypersensitive individuals, and are urged to comply with the manufacturers' expressed rinsing instructions.

Disclosure of competing interests

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Addendum: List of reviewed charcoal mouthwashes

Activated Charcoal Infused Mouthwash (Avistar)
 Activated Charcoal Mouthwash (Fuss Free Naturals)
 Activated Charcoal Mouthwash (Pro Teeth Whitening Co.)
 Activated Coconut Charcoal (Lifetime)
 Advanced Formulation Mouthwash (Beauty Formulas)
 Black Edition Liquid (Diamondwhites)
 Black Magic Edition Swish & Swirl Oil Pulling Mouthwash (Lochside)
 Black Oil Mouthwash
 Brilliant Black Oil Pulling with Activated Charcoal (Terra & Co.)
 Carbon Coco Activated Alcohol Free Rinse
 Charbright Activated Charcoal Natural Mouthwash
 Charcoal Mouthwash (Pro Care)
 Charcoal Mouthwash (101 Lifestyle)
 Coco Black's Swish & Swirl Oil Pulling Mouthwash
 Coco Pull Coconut Oil Pulling Mouthwash
 Colgate Plax Bamboo Charcoal Mint (Colgate)
 Dr. Brite Mouthwash (Dr. Brite)
 Ecodenta Extra Whitening Mouthwash (Eco Natural Products)
 Evanelli Charcoal Coco Pulling
 Georganics Oil Pulling Mouthwash
 Hello Activated Charcoal Extra Freshening Mouthwash
 Ivismile Activated Charcoal Oil Pulling Mouthwash
 Keeko Coconut Oil Pulling Mouthwash with Activated Charcoal
 Kohle Charcoal & Coconut Whitening Mouthwash
 Les Coconut Oil/Charcoal Mouthwash
 Moon Alcohol-Free Activated Charcoal Whitening Mouth Rinse
 Morrisons Charcoal Mouthwash
 My Magic Mud Activated Charcoal Alcohol-Free Oral Rinse (My Magic Mud)
 OEM Chlorhexidine Bamboo Mouthwash
 OEM/ODM Oil Pulling Mouthwash
 Olivia Care Oil Pulling Mouthwash
 Perfect White Black Mouthwash (Beauty Hills Formula)
 Polished London Charcoal Mouthwash
 Pullin' Out (Wolf & Pine)
 White Glo Activated Charcoal Whitening Mouthwash
 XOC Activated Charcoal Whitening Mouthwash.

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