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Qualitative Characterization of the Abrasive Component of Charcoal-Containing Toothpastes and the Effect on Dentin Roughness

Caracterización Cualitativa del Componente Abrasivo de las Pastas Dentales que Contienen Carbón Vegetal y la Rugosidad de la Dentina

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ABSTRACT: This study investigated the effect of commercially available whitening toothpastes containing charcoal on dentin. Nine charcoal-containing toothpastes were compared with 3 whitening toothpastes (positive control) and distilled water (negative control). Periodontally hopeless molars were cleaned and washed and the occlusal table removed to expose dentin. The teeth were mounted in auto-polymerizing resin and exposed dentine surfaces polished with water-cooled decreasing grits of silica carbide paper up to 1500 grit. Baseline average roughness (Ra) measurements were taken. Specimens were then mounted in an automatic tooth-brushing machine and brushed for 5000 cycles. Repeat Ra measurements were taken. Specimens were brushed in 5000-cycle increments up to 25,000 cycles with Ra measurements being taken at each time point. Between abrasive challenges specimens were stored in distilled water. All toothpaste samples were sputter coated and examined under a scanning electron microscope to qualify the shape and size of the abrasive components of the formulations. Data were analyzed using a two-way analysis of variance with post hoc Bonferroni. The results demonstrated that the abrasive effect, in terms of increasing Ra, on dentin was noted as early as 5000 cycles for all the tested toothpastes ($p<0.05$). The effect of continued brushing showed an overall cumulative effect on dentine roughness up to 25000 cycles. When toothpastes were compared between groups at each time-point, dentin specimens brushed with Pursito were statistically similar to the control group. At 25,000 cycles all dentin samples were significantly rougher compared to Pursito and the control groups. It may be concluded that all the tested toothpastes have an abrasive effect on dentin surfaces.

KEY WORDS: charcoal containing toothpastes; whitening toothpastes, dentin abrasion.

INTRODUCTION

The appearance, including the color of teeth, in recent times has become a major concern for people from varied geographic locations and cultural backgrounds, with persons actively seeking out whitening treatments either professionally or with the use of over-the-counter products such as whitening toothpastes (Joiner & Luo, 2017).

The active ingredients in whitening toothpastes include enzymes such as proteases, polyphosphates, surfactants, and small amounts of peroxide (Hilgenberg *et al*., 2011). The mechanisms of action of whitening toothpastes are based on the active ingredients and vary from breaking down surface stains, replacing negatively charged macromolecules associated with

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surface pellicle or penetrating tooth structure to oxidize intrinsic stains (Baig *et al*., 2005; Joiner, 2010; Vertuan *et al*., 2020). The main mechanism of action of whitening toothpastes, however, includes substances that can abrade surface staining on teeth and tooth colored restorations (Wülknitz, 1997; Demarco *et al*., 2009).

The shape, size, and relative percentage of the abrasive particles found in toothpastes including whitening toothpastes can affect their abrasive potential (Mahmoud *et al*., 2009; Wiegand *et al*., 2009; Ashcroft & Joiner, 2010; Singh *et al*., 2016). The more abrasive the particle the better the extrinsic stain removal, however, this can be detrimental to tooth structure during brushing (Wiegand *et al*., 2009). Abrasivity of toothpastes is normally measured by the relative dentin abrasivity (RDA) and relative enamel abrasivity (REA), with higher rates of wear of dental hard tissues associated with toothpastes having high relative RDA and REA values (Philipotts *et al*., 2005).

Charcoal has recently been included in toothpaste formulations and marketed as whitening in nature possibly related to its abrasive potential. Secondly, some manufacturers have postulated a mechanism of action based on the ability of certain formulations containing activated charcoal to tightly bind surface stains which can then be brushed away (Greenwall *et al*., 2019). This second binding mechanism of action is a prominent feature for formulations containing diatomaceous earth, whose chemical structure is based on absorbent phyllosilicates, which have the property of absorbing protein molecules from aqueous solutions (Lutynski *et al*., 2019).

In research examining the abrasivity of traditional toothpastes; Singh *et al*. (2016) discussed the potential of excessive abrasion of dental hard tissue caused by the inclusion of charcoal in formulations of toothpaste. The charcoal which is normally in the form of a fine powder can come from a variety of sources and be derived from a number of production methods (Greenwall *et al*., 2019). Sources of oxidized carbon can include peat, nutshells, coconut shells, and bamboo (Greenwall *et al*., 2019). However, the source of the organic material and method of preparation can affect the abrasive potential of the final charcoal powder used in the toothpaste formulations (Lutynski *et al*., 2019).

There has been increased marketing of charcoal-containing whitening toothpastes on social media platforms, with little known about the abrasive potential of the various formulations on dental hard tissue. The aim of this study is to primarily quantify the abrasive effect of charcoal-containing toothpastes in terms of surface roughness on dentin by using contact profilometry. The null hypothesis stated that there would be no difference in average surface roughness (Ra) of dentin samples when brushed with any of the tested toothpastes. A secondary aim of this study was to ascertain if the surface roughness caused because of simulated brushing could be explained by the abrasive components of the respective toothpastes ascertained by the qualitative examination of charcoal-containing toothpastes using scanning electron microscopy.

MATERIAL AND METHOD

The toothpastes used in this study together with the listed abrasive components and manufacturers' details are shown in Table I. Distilled water was used as a negative control. Colgate with Baking Soda and Peroxide Whitening, Crest Complete with Scope Whitening, and Arm and Hammer Advance White were used as positive controls. An exemption from The University of the West Indies, St Augustine ethics committee was granted prior to the start of this study (CREC-SA.0181/02/2020). A power analysis determined the size of the total sample of 78 given an effect size of 0.25, 13 groups, and a power of 0.8.

Previously extracted periodontally hopeless upper and lower molars were used. The water-cooled diamond saw was used to remove the occlusal third of the tooth leaving dentin with a periphery of enamel. Resultant dentin surfaces were polished with water-cooled decreasing grits of 600, 800, 1000, and 1500 silica carbide paper (Dura Gold Premium, TCP Global, San Diego, CA, USA). Teeth were then mounted in (2.5 cm X 1.5 cm) polyvinyl chloride (PVC) cylinders using auto-polymerizing polymethylmethacrylate (Fas-Tray, Harry J Bosworth, Stokie, Il, USA). Six teeth were randomly allocated per group as shown in Table II and baseline average (Ra) roughness measurements were taken using profilometry using the Mahr Pocket Surf (Mahr Federal Inc, Providence, RI, USA) with a cutoff of 0.8 mm, a transverse length of 5.0 mm and an evaluation length of 4.0 mm. The probe had a transverse speed of 5.08 mm/second with a force of 15 mN. For each evaluated surface, 3 readings were taken to give a mean Ra for each specimen.

Table I. Tested toothpastes, ingredient list and manufactures' details.

Toothpaste	Listed Abrasive/Whitening Ingredients	Manufacturer
Active WOW Activated Charcoal Whitening Toothpaste	Diatomite Diatomaceous Earth, Baking Soda, Activated Charcoal	Active Wow Toronto, Ontario Canada
Arm & Hammer Advance White Stain Protection	Sodium Bicarbonate, Sodium Carbonate Peroxide, Silica	Church & Dwight Co., Inc Mississauga, Ontario, Canada
Crest 3D Whitening with Charcoal	Hydrated Silica, Charcoal Powder, Mica	Procter & Gamble Company Cincinnati, Ohio, USA
Curaprox Black is White Toothpaste	Hydrated Silica, Charcoal Powder, Mica	Curaden USA Inc Mesa, Arizona, USA
Colgate Essentials with Charcoal	Hydrated Silica, Charcoal Powder	Colgate-Palmolive Company New York, NY, USA
Crest Complete Multi-Benefit Whitening+ Scope Dualblast	Hydrated Silica	Procter & Gamble Company Cincinnati, Ohio, USA
Pursito Activated Charcoal Spearmint Toothpaste	Bamboo Charcoal Powder 1.2 %, Silicon Dioxide	Jarosa, Inc Boyne City, Michigan, USA
Colgate Baking Soda & Peroxide Whitening Toothpaste	Hydrated Silica, Sodium Bicarbonate	Colgate-Palmolive Company New York, NY, USA
FineVine Activated Coconut Charcoal Toothpaste	Diatomaceous Earth, Baking Soda, Charcoal	FineVine Organics Princeton, NJ, USA
Cali White Activated Charcoal & Organic Coconut Oil	Purify Water, Xylitol, Diatomaceous Earth, Baking Soda, Activated Charcoal	Caliwhite Santa Barbara, California, USA
Seven Minerals Activated Charcoal Whitening Toothpaste	Diatomaceous Earth, Sodium Bicarbonate (Baking Soda), Activated Charcoal	Seven Minerals Las Vegas, Nevada, USA
Moon Whitening Activated Charcoal Toothpaste	Silica, Mica, Activated Charcoal	Moon Oral Care El Segundo, California, USA

Table II. Mean Ra (μm) readings from Baseline to 25,000 cycles. Significances between toothpaste groups denoted by differences in the same common and capital superscript letters.

	Mean (S.D) Dentine Roughness (Ra)					
Toothpaste Brand	Baseline Readings	5 K	10 K	15 K	20 K	25 K
Distilled Water (negative control)	0.34 (0.06)^{a}	0.35 (0.08)^{b}	0.35 (0.08)^{c}	0.34 (0.09)^{f}	0.30 (0.11)^{h}	0.31 (0.05)^{k}
Active WOW	0.50 (0.30)^{a}	2.80 (2.11)^{B}	2.85 (1.04)^{C}	3.45 (1.11)^{F}	2.99 (1.19)^{iH}	3.22 (0.83)^{KL}
Arm and Hammer Advance White (positive control)	0.40 (0.22)^{a}	2.40 (1.41)^{b}	3.11 (1.20)^{C}	3.55 (1.17)^{F}	4.32 (0.85)^{HJ}	4.99 (1.04)^{KL}
Crest 3D Whitening with Charcoal	0.32 (0.09)^{a}	2.78 (1.61)^{b}	3.05 (1.72)^{C}	3.67 (1.84)^{F}	3.82 (1.56)^{H}	4.03 (1.66)^{KL}
Curaprox	0.37 (0.09)^{a}	2.57 (1.46)^{b}	3.42 (1.64)^{C}	4.32 (1.56)^{FG}	4.4 (1.30)HJ	4.86 (1.21)^{KL}
Colgate Essentials with Charcoal	0.37 (0.09)^{a}	2.02 (0.71)^{b}	2.59 (1.09)^{c}	3.39 (1.02)^{F}	3.47 (0.96)^{H}	4.13 (0.63)^{KL}
Crest Complete with Scope Whitening (positive control)	0.33 (0.07)^{a}	1.79 (0.31)^{b}	2.20 (0.60)^{cd}	2.48 (0.34)^{f}	3.2 (1.08)H	3.65 (1.06)^{KL}
Pursito	0.34 (0.07)^{a}	1.21 (0.24)^{b}	1.22 (0.37)^{ce}	1.87 (0.57)^{fg}	2.15 (0.85)^{hj}	1.76 (0.72)^{lk}
Colgate with Baking Soda & Peroxide Whitening (positive control)	0.42 (0.11)^{a}	2.82 (1.05)^{B}	3.76 (0.58)^{CE}	3.51 (1.25)^{f}	4.11 (0.68)^{H}	4.19 (0.93)^{KL}
FineVine Activated Coconut Charcoal	0.32 (0.08)^{a}	3.39 (1.85)^{B}	3.46 (1.91)^{C}	4.32 (1.50)^{FG}	4.69 (1.44)^{HJ}	4.78 (1.31)^{KL}
Cali White	0.28 (0.04)^{a}	3.63 (0.58)^{B}	4.67 (1.00)^{CDE}	4.69 (0.75)^{FG}	5.32 (0.41)^{HIJ}	5.40 (0.71)^{KL}
Seven Minerals	0.44 (0.10)^{a}	2.45 (0.98)^{b}	2.76 (0.85)^{C}	3.78 (0.89)^{F}	4.62 (0.80)^{HJ}	4.84 (0.80)^{KL}
Moon	0.45 (0.08)^{a}	2.44 (0.86)^{b}	3.10 (1.07)^{C}	3.98 (1.11)^{F}	4.51 (1.00)^{HJ}	5.19 (0.60)^{KL}

Specimens were mounted in an automatic tooth brushing machine (Toothbrushing Simulator MEV 4X-3D, Odeme Dental Research, Brazil) and brushed with a soft, circular bristled toothbrush (Colgate Extra-Clean Full Head, Colgate Palmolive Company, NY, USA) at 2 strokes per second with a load of 200 g for 5000 cycles. Mounted specimens were oriented in the tooth-brushing machine perpendicular to the direction in which baseline Ra readings were taken. The entire surface of each dentin specimen was exposed to toothbrush bristles and the specimens were kept wet with the toothpaste slurry at all times. All toothpastes were mixed with distilled water in a ratio of 1:1, by volume.

Specimens were washed with distilled water and lightly blotted and Ra readings quickly repeated on moist dentin surfaces. The samples were remounted in the toothbrushing machine and brushed up to 25,000 cycles with repeated Ra measurements taken at 5000 intervals to give cumulative readings at 10k, 15k, 20k, and 25k cycle time points.

Smears of the toothpaste samples were sputtered coated with gold (Denton Vacuum LLC, Moorestown, NJ, USA) and examined under SEM (Philips SEM 515, Philips, Eindhoven, Netherlands) to quantify the shape and size of the abrasive particles.

Data were analyzed with SPSS Version 24 (IBM Corporation, Chicago, Il, USA) firstly using Levene's test for homogeneity of variances and a Shapiro-Wilk to ascertain data were normally distributed. A two-way analysis of variance was then used to analyze differences in mean Ra values at different time points at a p-value of 0.05 within and between groups. Included factors were the toothpaste type, brushing time interval, and their interaction. Multiple comparisons were facilitated with post hoc Bonferroni tests.

RESULTS

Levene's test revealed that the data sets met the assumptions of variance required for the use of the two-way analysis of variance. The Shapiro-Wilk test ascertained the data was normally distributed. Results showed that both the main effects ($p<0.05$) and their interaction were significant ($p<0.01$). Mean dentin roughness values, together with associated standard deviations and significances between toothpastes groups are shown in Table II. When comparing groups, Active Wow Fine Vine and Cali White, both showed the earliest increases in roughness compared to all other tested charcoal toothpastes. At 5000 cycles, Colgate with Baking Sosa and Peroxide Whitening, a positive control, also showed statistically significant roughness compared to other tested toothpastes.

When statistical significances were examined within groups at different time points it was observed that the abrasive effect on dentin was noted as early as 5000 cycles for all the tested toothpastes. There was a gradual increase in the mean roughness as the brushing time increased, however, significances between time points were not as straightforward (Table III). The only exception was samples brushed with Arm and Hammer Advance White. Dentin samples brushed with Arm and Hammer toothpaste were significantly rougher at each time point compared to the previous time point.

Micrographs of the toothpastes showed large variations in the proportion, size and distribution of

Table III. Mean Ra(μm) readings from Baseline to 25,000 cycles. Significances within toothpaste groups denoted by differences in the same common and capital superscript letters.

	Mean (S.D) Dentine Roughness (Ra)					
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Active WOW	0.50 (0.30)^{b}	2.80 (2.11)^{cB}	2.85 (1.04)^{cd}	3.45 (1.11)^{de}	2.99 (1.19)^{ef}	3.22 (0.83)^{f}
Arm and Hammer Advance White (positive control)	0.40 (0.22)^{b}	2.40 (1.41)^{cB}	3.11 (1.20)^{Cd}	3.55 (1.17)^{eD}	4.32 (0.85)^{Ef}	4.99 (1.04)^{F}
Crest 3D Whitening with Charcoal	0.32 (0.09)^{b}	2.78 (1.61)^{cB}	3.05 (1.72)^{cd}	3.67 (1.84)^{de}	3.82 (1.56)^{ef}	4.03 (1.66)^{f}
Curaprox	0.37 (0.09)^{b}	2.57 (1.46)^{cB}	3.42 (1.64)^{cd}	4.32 (1.56)^{de}	4.4 (1.30)^{ef}	4.86 (1.21)^{F}
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Colgate with Baking Soda & Peroxide Whitening (positive control)	0.42 (0.11)^{b}	2.82 (1.05)^{cB}	3.76 (0.58)^{cd}	3.51 (1.25)^{de}	4.11 (0.68)^{ef}	4.19 (0.93)^{f}
FineVine Activated Coconut Charcoal	0.32 (0.08)^{b}	3.39 (1.85)^{cB}	3.46 (1.91)^{cd}	4.32 (1.50)^{de}	4.69 (1.44)^{ef}	4.78 (1.31)^{f}
Cali White	0.28 (0.04)^{b}	3.63 (0.58)^{cB}	4.67 (1.00)^{Cd}	4.69 (0.75)^{de}	5.32 (0.41)^{ef}	5.40 (0.71)^{f}
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Moon	0.45 (0.08)^{b}	2.44 (0.86)^{cB}	3.10 (1.07)^{Cd}	3.98 (1.11)^{De}	4.51 (1.00)^{ef}	5.19 (0.60)^{F}

the two main abrasives listed by the various manufacturers. Active Wow (Fig. 1), Fine Vine (Fig. 2), Cali White (Fig. 3), and Seven Minerals (Fig. 4) showed a preponderance of silicon dioxide abrasive particles. These toothpastes, also showed different degrees of agglomeration of silicon dioxide particles.

The rounder particles of sodium bicarbonate were apparent in Arm and Hammer Advanced White (Fig. 5) and Colgate with Baking Soda and Peroxide Whitening (Fig. 6). Even though silica is listed as an ingredient in both of these formulations such particles were rarely observed in the micrographs of this toothpaste. Noteworthy was the higher proportion of rounder sodium bicarbonate particles noted in the formulation (Fig. 5).

Micrographs of Pursito toothpaste (Fig. 7) showed an amorphous formulation with no significant proportions of abrasive particles. Curaprox (Fig. 8)

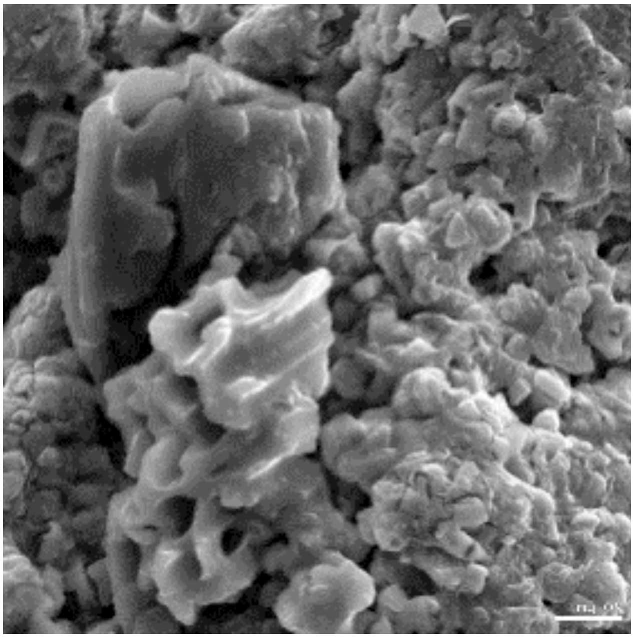

Fig. 1. Active Wow (Magnification X625).

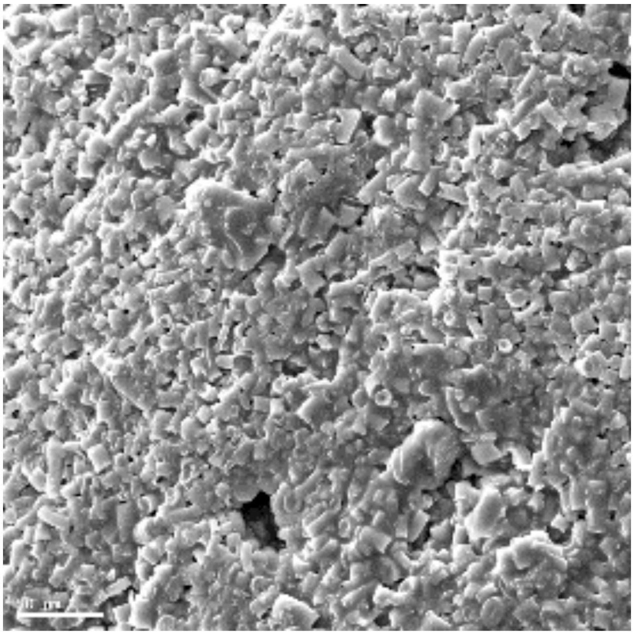

Fig. 3. Cali White (Magnification X326).

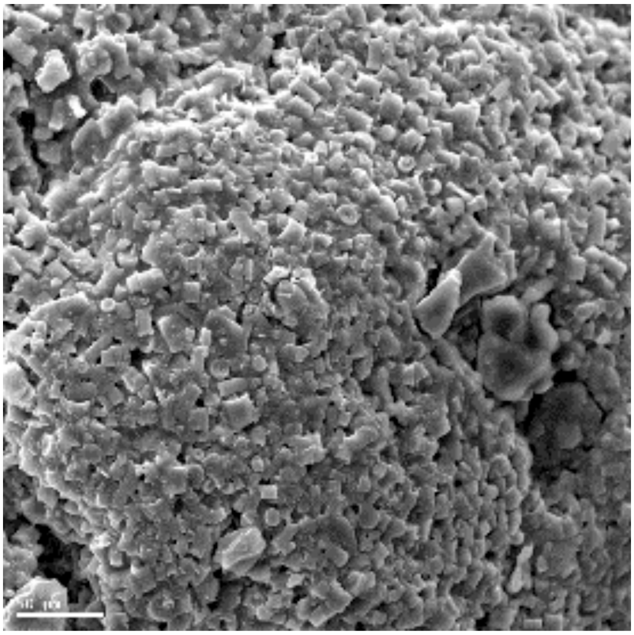

Fig. 2. Fine Vine (Magnification X326).

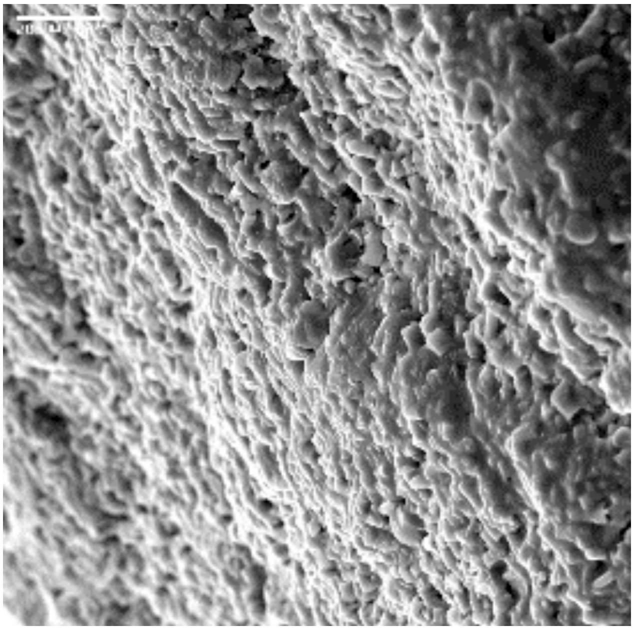

Fig. 4. Seven Minerals (Magnification X326).

and Moon (Fig. 9) had similar appearances, however, there was evidence of more abrasive particles compared to Pursito, with Moon having the largest amount of abrasive particles noted of these three toothpastes.

Crest 3D Whitening with Charcoal (Fig. 10), Colgate Essentials with Charcoal (Fig. 11), and Crest Complete with Scope Whitening (Fig. 12) all showed formulations with varying amounts of silicon dioxide with some evidence of agglomeration of these abrasive particles.

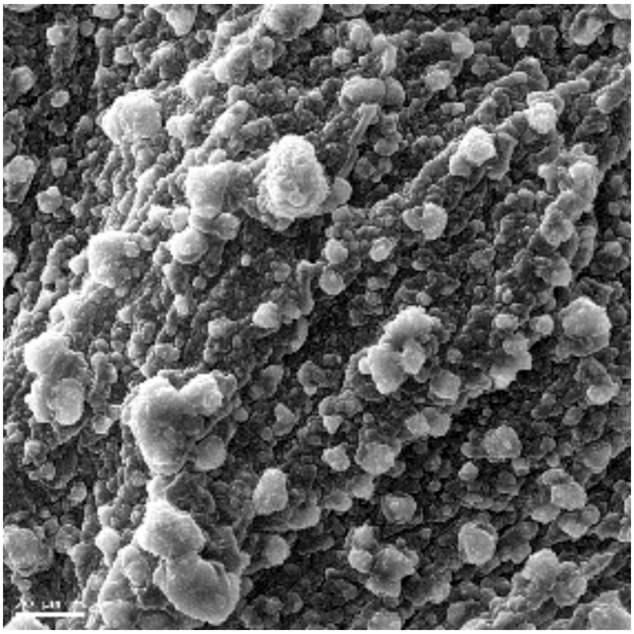

Fig. 5. Arm and Hammer (Magnification X655).

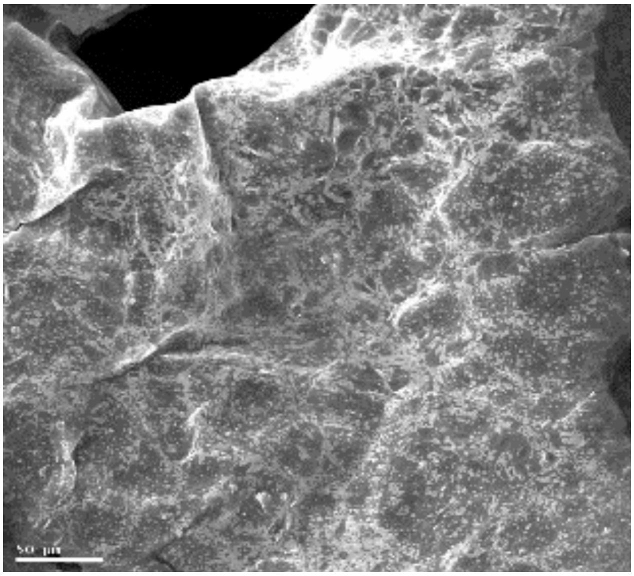

Fig. 6. Colgate with Baking Soda and Peroxide Whitening (Magnification X326).

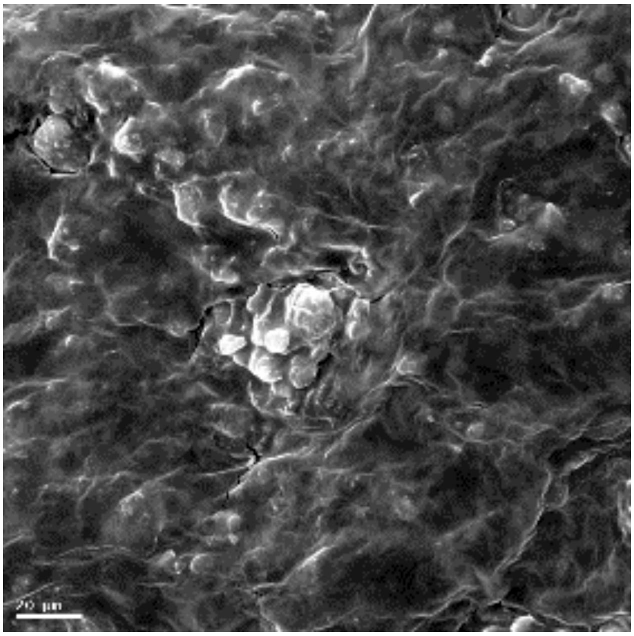

Fig. 7. Pursito (Magnification X 625).

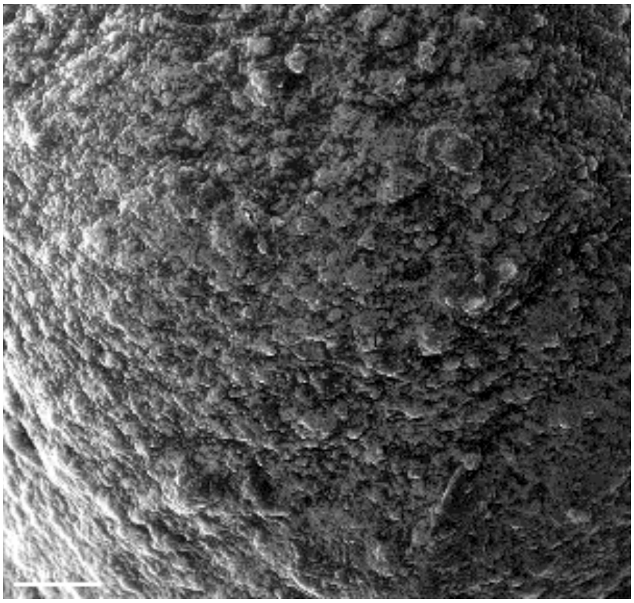

Fig. 8. Curaprox (Magnification X326).

DISCUSSION

Abrasives are integral to the formulations of whitening toothpastes and improve toothbrushing efficiency by abrading away surface stains. This 3-body abrasive effect occurs when abrasive particles move between surfaces in relative motion with the toothpaste acting between the tooth structure and the bristles of the toothbrush (Mair & Padipatvuthikul,

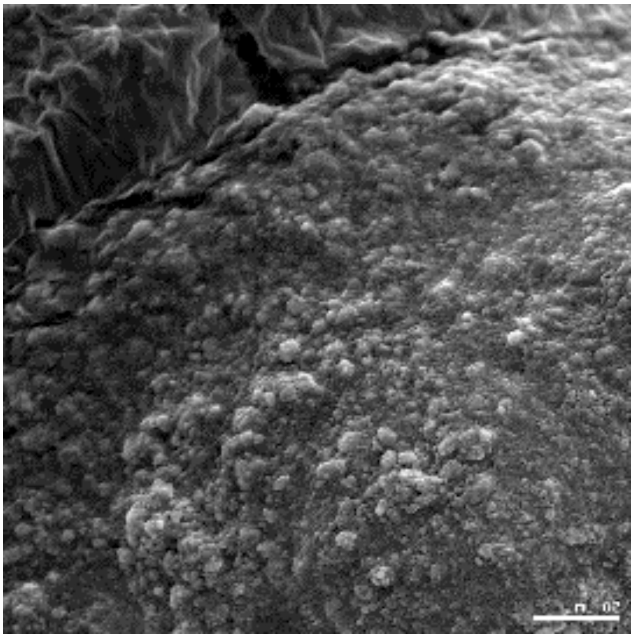

Fig. 9. Moon with Charcoal (Magnification X326).

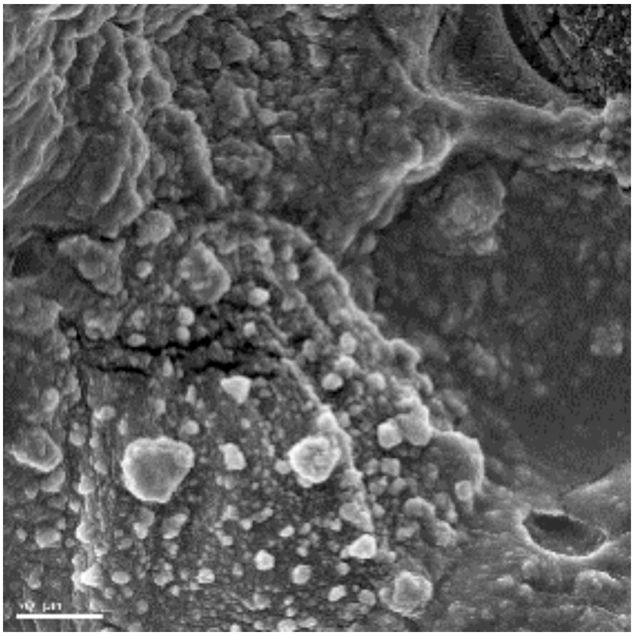

Fig. 11. Colgate Essentials with Charcoal (MagnificationX326).

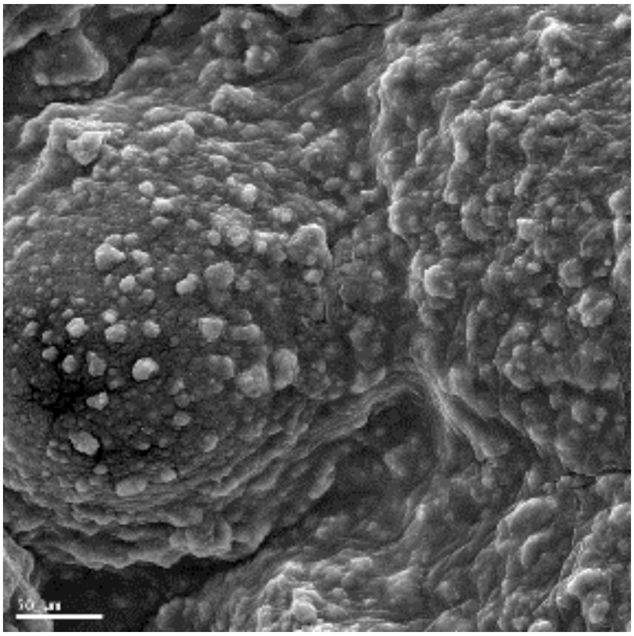

Fig. 10. Crest 3D Whitening with Charcoal (Magnification X326).

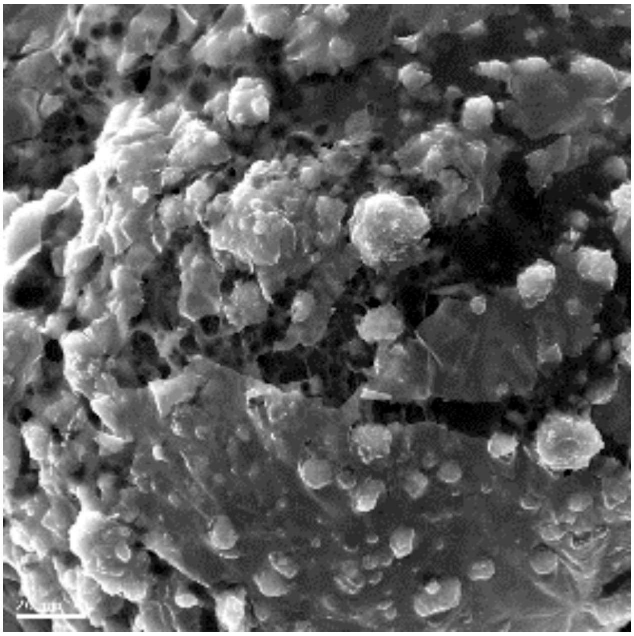

Fig. 12. Crest Complete with Scope Whitening (X655).

2010). This mechanism which is useful in abrading surface stains also has a deleterious effect on dentin if it has been exposed. Abrasion of dental hard tissue by toothpastes depends on the proportions of added abrasives and their associated hardness values (Greenwall *et al*., 2019). Clinicians frequently refer to guides of relative (radioactive) dentin abrasivity (RDA) in recommending toothpastes that may have the desired effect of surface stain removal while being safe in terms of tooth abrasion (ISO Standard, 2017). However, no such guide exists for charcoal-containing toothpastes. Charcoal-containing toothpastes are recent additions to the oral health care marketplace and there are many varieties that are manufactured by lesser-known manufacturing entities.

The results of this study clearly demonstrated the role of toothpastes in the role of dentin abrasion, since the control group that was brushed with distilled water only, showed no statistically appreciable change in mean Ra values from baseline to 25,000 cycles. This is in keeping with the work of Moore & Addy (2005) who demonstrated only removal of the dentin smear layer when brushed with distilled water and Manly *et al*. (1965), who concluded that brushing without a dentifrice produced negligible abrasion of enamel and dentin. Lippert *et al*. (2017), in an in-vitro study of the development of erosion/abrasion lesions, concluded that the interplay of toothpaste abrasivity and filament stiffness was more important for dentin than it was for enamel.

All of the toothpastes investigated were bi-abrasive in nature i.e. having more than one type of abrasive particle in its formulation, assuming charcoal also has an abrasive effect. Known abrasive particles included silicon dioxide in the form of either synthetic precipitated hydrated silica or diatomaceous earth and sodium bicarbonate. The micrographs of many of the lesser-known brands of toothpaste showed a preponderance of the angular silica particles that are known to abrade surface stain more effectively however can also cause significant damage to exposed dentin surfaces since the tribological mechanisms for abrading staining from the surface of teeth are also similar for abrasion of tooth structure (Wülknitz, 1997; Wiegand *et al*., 2009).

Sodium bicarbonate-containing toothpastes have been shown to have lower dentin abrasivity when used alone due to its smaller size, softer rounder abrasive particles, and possibly due to the fact that the particle shows mild dissolution once in the oral cavity, making the abrasive particle smaller during use (Newbrun, 1997). This study produced contrasting results. There was no difference in the abrasive potential of Arm and Hammer toothpaste compared with all other tested toothpastes at 25,000 cycles. In fact, the abrasive effect of Arm and Hammer is noted as early as 5,000 cycles, and at 10,000 cycles was notably more abrasive than Crest Complete with Scope Whitening, Colgate Essentials with Charcoal, and Pursito.

Generally, it is accepted that increasing the concentration of the abrasive particles within a toothpaste formulation increases both its cleaning and abrasive potential up to a critical point due to the saturation of the abrasive at the bristle-tooth interface (Wright, 1969). This is true mainly for large-sized abrasive particles. The tested Arm and Hammer toothpaste, with its smaller, relatively high percentage of sodium bicarbonate of 50-60 % is also formulated with hydrated silica (Hara &Turssi, 2017). This mix of particle sizes could contribute to an increased saturation at the bristle dentin interface leading to the results noted in this study.

Pursito when compared with the other commercial brands of toothpastes produced a significantly lower abrasive effect on dentin surfaces. This; the authors ascribed to the amorphous appearance of the toothpaste under SEM. The manufacturer's information listed both abrasive particles however the characteristic angular particles of silicon dioxide or smaller rounded sodium bicarbonate particles were not observed. The authors assumed that the amorphous appearance on micrograph could be attributed to a high percentage of activated charcoal. This lead the authors to the conclusion that charcoal-containing toothpastes with higher relative percentages of charcoal may be less abrasive compared to their counterparts with higher percentages of abrasives such as sodium bicarbonate or silicon dioxide.

The micrographs of several of the tested toothpastes showed agglomeration of silica particles to produce abrasive particles that were irregular in shape and in some instances as large as 50µm in diameter. While some researchers seem to speculate that larger particles do not worsen the abrasive potential of toothpastes due to the fact that such particles cannot easily roll between the toothbrush bristles and the tooth surface, others seem to conclude that larger particles will cause larger scratches on tooth structure (Ashcroft & Joiner, 2010; Hara & Turssi, 2017). While the former explanation may be the case for sound enamel, exposed dentin, with its higher organic content, may be more susceptible to bulk tissue loss caused by larger particles (Ganss *et al*., 2016).

All the tested toothpastes caused statistically significant increases in mean Ra from as early as 5000 cycles, with these values increasing until maximum Ra values were reached at 25,000 cycles. Early significant increases in Ra values lend support to the conclusion that all of the tested toothpastes were aggressive in terms of their abrasive potential on exposed dentin. These findings may be clinically relevant for patients with exposed dentin surfaces. Whitening toothpastes; with and without charcoal should not be recommended due to their associated abrasive effect, which is cumulative with continued use. Additionally, *in vitro* studies of tooth-brushing abrasion have demonstrated that the abrasive effect of tooth-brushing is cumulative with time, as noted in this study (Lippert *et al*., 2017).

Further research would include an assessment of the abrasive potential of charcoal powder alone used in combination with water on dentin surfaces. Since it was unclear from this research if the abrasive effects noted were from the charcoal, added abrasives, or a synergistic effect of both.

CONCLUSIONS

Within the limitations of this study the following conclusions may be drawn:

a) All the tested toothpastes caused significant early increases in Ra values of dentin.
b) With increasing brushing cycles there was a concomitant increase in Ra values on dentin surfaces at each time point, with endpoint Ra values being significantly different from baseline measurements.
c) When the abrasive potential of the toothpastes was compared, Pursito with the lowest percentage of abrasive particles demonstrated the least abrasive effect.

MARCHAN, S.; RAJHBEHARRYSINGH, A.; BASCOMBE, K. & SMITH, W. Caracterización cualitativa del componente abrasivo de las pastas dentales que contienen carbón vegetal y la rugosidad de la dentina. *Int. J. Odontostomat., 17(3)*:346-355, 2023.

RESUMEN: Este estudio investigó el efecto sobre la dentina de las pastas dentales blanqueadoras disponibles en el mercado que contienen carbón vegetal. Se compararon nueve dentífricos que contenían carbón vegetal con 3 dentífricos blanqueadores (control positivo) y agua destilada (control negativo). Los molares sin material periodontal se limpiaron y lavaron y se retiró la tabla oclusal para exponer la dentina. Los dientes se montaron en resina autopolimerizable y las superficies expuestas de la dentina se pulieron con papel de carburo de sílice de grano decreciente enfriado con agua hasta grano 1500. Se tomaron medidas de rugosidad promedio (Ra) de referencia. Luego, las muestras se montaron en una máquina automática de cepillado de dientes y se cepillaron durante 5000 ciclos. Se tomaron medidas repetidas de Ra. Las muestras se cepillaron en incrementos de 5000 ciclos hasta 25 000 ciclos y se tomaron medidas de Ra en cada punto de tiempo. Entre periodos abrasivos, las muestras se almacenaron en agua destilada. Todas las muestras de pasta de dientes se recubrieron por pulverización catódica y se examinaron bajo un microscopio electrónico de barrido para calificar la forma y el tamaño de los componentes abrasivos de las formulaciones. Los datos se analizaron utilizando un análisis de varianza de dos vías de Bonferroni post hoc. Los resultados demostraron que el efecto abrasivo, en términos de aumento de Ra, sobre la dentina se notó ya en 5000 ciclos para todas las pastas dentales probadas ($p<0,05$). El efecto del cepillado continuo mostró un efecto acumulativo general sobre la rugosidad de la dentina hasta 25.000 ciclos. Cuando se compararon las pastas dentales entre los grupos en cada momento, las muestras de dentina cepilladas con Pursito fueron estadísticamente similares al grupo de control. A los 25.000 ciclos, todas las muestras de dentina eran significativamente más ásperas en comparación con Pursito y los grupos controles. Se puede concluir que todas las pastas dentales probadas tienen un efecto abrasivo sobre las superficies dentinarias.

PALABRAS CLAVE: dentífricos que contienen carbón vegetal; pastas dentales blanqueadoras, abrasión de la dentina.

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