2075. *In Vitro* Dietary Stain Build-Up on Smooth and Roughened Teeth

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Introduction

Whitening toothpastes, aiming to remove extrinsic stains and thus improving the overall esthetic appearance of a tooth, have become increasingly popular in the last few decades. As there are numerous models and methodologies available to evaluate the potential of toothpaste formulations to remove extrinsic stain. However, there is little published data on the enamel surface finish after brushing and its consequences towards new stain build-up.

Extensive work on enamel surface finish post-brushing has been previously published [1-2]. Therefore, the present study was only concerned with the dietary stain build-up on enamel surfaces of different roughnesses.

Objectives

The aim of the present *in vitro* study was to investigate whether differences in enamel surface roughness impact the acquisition of dietary stain.

Methods

A recently developed *in vitro*, extrinsic, forced dietary stain model [3] which is based on an *in situ* model [4], to which good agreement has been shown, was used in the present study.

Mounted bovine teeth (n=28) were abraded using 320grit SiC abrasive discs to obtain a sufficiently large (approx. 1x1cm) and flat enamel surface area. 14 teeth were further polished to a mirror-like appearance using 1200grit and then 4000grit SiC discs.

All teeth were then measured for surface roughness (Ra) by non-contact profilometry (Proscan 2000, Scantron) and the following settings:

- Sensor: S5/03
- Sample rate: 300Hz
- Step size: 10µm
- Measurement area: 2x2mm
- Image processing: 1) autolevel; 2) surface filter: 12; 3) Ra(x) of entire measurement area recorded

All teeth were then subject to 16 forced dietary staining cycles [3] at room temperature consisting of:

- 1) 5min artificial saliva (as per [3])
- 2) 1min chlorhexidine (Corsodyl, 0.2% w/v chlorhexidine gluconate)
- 3) 1min tea (PG tips)

Artificial saliva and chlorhexidine were replaced every 4 cycles, tea after every cycle. Tea was prepared using 1 tea bag per 100ml boiling water with a brewing time of 5min.

After 8 and 16 cycles, all teeth were brushed with water under a load of 100g using a flatbed brushing machine using the following settings:

- speed: 5
- strokes: 50
- samples rotated by 90deg and brushed again as above

The colour of the teeth (L*, a*, b*) was measured using a calibrated Hunter LabScan XE spectrophotometer before cycling (=initial), after 4, 8, 12 and 16 cycles as well as after the brushing treatments after 8 and 16 cycles.

A one-way ANOVA at the 95% confidence level was employed for the present study (L* data). A multiple range test (Fisher's least significant difference procedure) at a 95% confidence level was performed to identify statistically homogeneous groups.

Results

Enamel Sample Roughness Measurements

The measured roughness of all teeth can be found in Table 1.

Table 1. Surface roughness of bovine teeth after surface preparation

	Ra [µm] (SD)
Roughened teeth	0.330 (0.091)
Smooth teeth	0.093 (0.012)

As expected, the extra polishing steps using up to 4000grit SiC abrasive discs produced a smoother enamel surface finish compared to the 320grit SiC abraded samples. Furthermore, there was also less variation in surface roughness for the smooth teeth.

Figure 1 shows surface images of roughened (left) and smooth enamel samples (right) acquired using the Proscan software. Differences in surface roughness between samples are clearly visible.

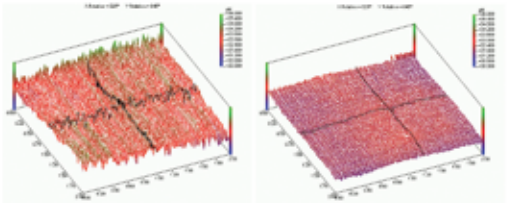

Figure 1. Surface images (2x2 mm, 6µm z range) of a roughened (left) and a smooth enamel sample (right). Differences in surface roughness between samples are clearly visible.

Dietary Stain Build-Up Measurements

Results for ΔL* are shown in Table 2 and graphically in Figure 2.

Table 2. Results for ΔL* as a function of bovine tooth preparation (roughened vs. smooth) and treatment step

	Mean change in L* (SD)					
	Number of stain cycles					
	4	8 (pre-brushing)	8 (post-brushing)	12	16 (pre-brushing)	16 (post-brushing)
Roughened teeth	-5.78 (1.13)	-10.40 (1.49)	-6.76 (1.37)	-10.88 (1.53)	-16.63 (1.87)	-7.63 (1.98)
Smooth teeth	-3.89 (1.08)	-7.81 (1.58)	-4.95 (1.32)	-9.54 (1.69)	-14.90 (1.68)	-5.81 (1.70)

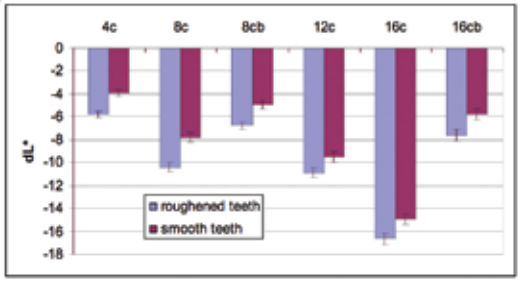

Figure 2. Results for ΔL* (SEM) as a function of bovine tooth preparation (roughened vs. smooth) and treatment step (e.g. 8cb = after 8 staining cycles, post brushing). Less stain build-up was seen for smooth compared to roughened bovine teeth at all measured time points ($p<0.05$).

It can be clearly seen in Figure 2 that smooth teeth acquired less stain compared to roughened teeth throughout the entire study. There was also a clear difference in overall stain build-up between 0 (initial), 4 and 8 as well as between 12 and 16 staining cycles.

Brushing removed equivalent amounts of stain on both sets of teeth.

Smooth teeth were statistically significantly less stained than roughened teeth at all time points ($p<0.05$).

There were no statistically significant differences in a*, b* and L*-2b* between smooth and roughened teeth at all time points (data not shown).

Conclusions

The previously presented *in vitro*, extrinsic, forced dietary stain model [3] has been successfully used to study the effects of enamel surface roughness on stain accumulation.

Under the conditions of the study, smooth teeth were found to acquire less stain than roughened ones.

References

1. Parry J, Harrington E, Rees GD, McNab R, Smith AJ. Control of brushing variables for the in vitro assessment of toothpaste abrasivity using a novel laboratory model. J Dent. 2008 Feb;36(2):117-24.
2. Creeth J, Parry J, McNab R, Smith AJ. Enamel Surface Finish after Brushing with Micronised Silicas in vitro. IADR/PEF 2006. abstract 0239.
3. Gordon J. In vitro method for evaluating extrinsic stain prevention and removal. IADR/PEF 2006. abstract 0092.
4. Claydon NC, Moran J, Bosma ML, Shirodaria S, Addy M, Newcombe R. Clinical study to compare the effectiveness of a test whitening toothpaste with a commercial whitening toothpaste at inhibiting dental stain. J Clin Periodontol. 2004 Dec;31(12):1088-91.