

# An *in vitro* assessment of the role of Tooth Mousse in preventing wine erosion

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## ABSTRACT

**Background:** The recommendation that Tooth Mousse (TM), an anticariogenic remineralizing agent, is effective for controlling dental erosion in professional wine tasters is not evidence-based. The aim of this *in vitro* study was to determine the effectiveness of TM in reducing erosion of coronal enamel and radicular dentine/cementum simulating a typical wine judging session.

**Methods:** Enamel and dentine/cementum from buccal halves (experimental sample) and palatal halves (control sample) of human maxillary premolar teeth were subjected to 1500 one-minute exposures (cycles) to white wine (pH = 3.5). TM was applied every 20 cycles to the experimental sample, but not to the control sample. Paired t-tests were used to determine whether there were significant differences in erosion depths between the experimental and control samples.

**Results:** Mean erosion depths were significantly shallower in the experimental sample than the control sample for both enamel (34.4  $\mu\text{m}$  versus 49.2  $\mu\text{m}$ , respectively) ( $p < 0.05$ ) and dentine/cementum (143.2  $\mu\text{m}$  versus 203.7  $\mu\text{m}$ , respectively) ( $p < 0.01$ ).

**Conclusions:** TM may have significant role in the management of wine erosion, which is under-recognized as an occupational hazard by the Australian wine industry. Future studies are needed to compare the relative benefits of TM and other remineralizing agents, when used individually or in combination, in preventing dental erosion.

**Key words:** Tooth wear, wine tasting, occupational hazard, demineralization, remineralization.

**Abbreviations and acronyms:** CPP-ACP = casein phosphopeptide-amorphous calcium phosphate; TM = Tooth Mousse.

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## INTRODUCTION

Wine erosion is an occupational hazard in professional wine tasters, particularly in wine judges who may taste up to 200 wines per day for four consecutive days.<sup>1</sup> Wine is acidic in nature (pH = 3.0–4.0) and contains organic acids with high erosive potential, such as tartaric, malic and lactic acids and smaller amounts of citric, succinic and acetic acids.<sup>2,3</sup> Furthermore, tooth structure eroded and softened by acids from extrinsic and intrinsic sources becomes susceptible to further wear by attrition and toothbrush abrasion.<sup>4,5</sup> Long periods of wine tasting can also overwhelm normal salivary protection of the oral environment, leading to extensive tooth wear and severe dentine hypersensitivity.<sup>2,6</sup>

Dental professionals have a responsibility to identify individuals at risk of erosion and to offer appropriate preventive measures.<sup>7,8</sup> Professional recommendations for prevention of erosion include use of fluoride

products, modification of toothbrushing habits and application of protective resin coating to teeth.<sup>9,10</sup> These preventive strategies provide some degree of protection against dental erosion, but improved strategies are needed to further diminish the risk of abrasive/erosive insult on teeth.<sup>10</sup>

Tooth Mousse (TM) (manufactured by the GC Corporation, Japan), contains a new anticariogenic remineralizing agent CPP-ACP (a casein phosphopeptide that stabilizes amorphous calcium phosphate nanocomplex) and has superior remineralizing properties compared with fluoride alone.<sup>11,12</sup> Recent evidence shows that a single application of TM can reduce enamel erosion against citric acid,<sup>13</sup> and that CPP-ACP can reduce erosive potential of an acidic soft drink.<sup>14</sup> Furthermore, TM has been found to reduce tooth wear from attrition in both acidic and near neutral environments.<sup>15</sup> Current recommendations for the management of wine erosion include using oral products containing CPP-ACP (e.g., TM and Recaldent chewing

gum) and fluoride,<sup>9,16</sup> although such recommendations are not evidence-based. Thus, more research is needed to better understand the role of TM in reducing wine erosion.

The aim of this *in vitro* study was to determine the effectiveness of TM in reducing erosion of coronal enamel and radicular dentine/cementum. It was hypothesized that TM would prevent wine erosion in both enamel and dentine/cementum.

## MATERIALS AND METHODS

Six intact extracted human maxillary premolar teeth were sectioned longitudinally along the mesiodistal axis and then painted with an acid resistant varnish, leaving two 3 × 3 mm windows on coronal and radicular surfaces. Buccal halves of teeth were treated as experimental samples (n = 6) and palatal halves were treated as control samples (n = 6). White Riesling wine (pH = 3.5 at 21.2°C) was chosen in this study because it is more erosive than champagne, claret style wine and red wine.<sup>17</sup> Both experimental and control samples were dipped in wine and artificial saliva alternately for one minute each using a dipping machine and this cycle was repeated 1500 times. The solutions were stirred continuously and maintained at an average room temperature of 21.3°C (ranging from 18.0°C to 24.2°C). One litre of artificial saliva (pH = 6.5 at 21.2°C) contained the following ingredients in deionized water: 4.766 g Hepes free acid buffer, 0.1225 g K<sub>2</sub>HPO<sub>4</sub>, 11 mg NaF and 1.5 mL Stock CaCl<sub>2</sub>. To ensure that the solutions did not become overly contaminated with extraneous chemicals, specimens were gently dried by using a desk fan for 30 seconds between dipping cycles. The solutions were also replaced every 200 cycles. The pH of the solutions remained consistent throughout the experiments, and the specimens were not desiccated during the drying stage.

In the experimental samples (n = 6), TM was applied every 20 cycles for four minutes and then washed off thoroughly for two minutes before the next cycle was continued. The experimental conditions are relevant to the sequence of wine exposure and Tooth Mousse application that might occur *in vivo*. In the control sample (n = 6 each), enamel and dentine/cementum

specimens were eroded using similar protocol but no TM was applied. One dentine/cementum specimen was excluded from this study because polarized light microscopy revealed marked hypercementosis in this specimen.

Erosion depths were measured on cross-sections of erosion lesions by using a Leica MZ16 FA stereomicroscope (Heerbrugg, Switzerland) for enamel (x25.0) and by using an Olympus BX51 transmission polarized light microscope (Olympus Corporation, Tokyo, Japan) for dentine (x8.0) as described previously.<sup>17,18</sup>

## Statistical analysis

Paired t-tests were used to determine whether there were significant differences in erosion depths for enamel and dentine/cementum between the experimental and control samples. Statistical significance was set at the 0.05 probability level. These tests were analysed using the statistical package SPSSX (version 13.0, SPSS Inc, Chicago, USA).

## RESULTS

Mean erosion depth for enamel in the experimental sample (34.4 ± 3.65 µm, mean ± SE) was significantly less than that in the control sample (49.2 ± 4.57 µm) (p < 0.05). Mean erosion depth for dentine/cementum in the experimental sample (143.2 ± 13.63 µm) was also significantly less than that in the control sample (203.7 ± 10.09 µm) (p < 0.01). Overall, erosion depths in dentine/cementum specimens were four times greater than those in enamel specimens, and TM reduced erosion depths in both enamel and dentine/cementum by around 30 per cent (Table 1).

## DISCUSSION

Our data show that dentine is more susceptible to wine erosion than enamel, supporting the premise that erosion proceeds at a faster rate once dentine is exposed.<sup>19</sup> Enamel erosion predominantly involves loss of surface volume, with the formation of only a shallow subsurface layer of approximately 1 µm depth in most situations.<sup>20</sup> In contrast, dentine/cementum erosion is characterized by minimal surface loss and a thick zone

**Table 1. Comparison of erosion depths (µm) between experimental and control samples in enamel and dentine/cementum**

Enamel			Dentine		
n	Experimental sample, mean ± SE	Control sample, mean ± SE	n	Experimental sample, mean ± SE	Control sample, mean ± SE
6	34.4* ± 3.65	49.2* ± 4.57	5	143.2** ± 13.63	203.7** ± 10.09

Paired t-tests show significant difference in erosion depths between experimental and control samples at p < 0.05\* and p < 0.01\*\*.

of demineralized organic dentine matrix having similar histological appearance to that of root caries.<sup>18</sup> Despite these physical differences in the outcomes of erosive demineralization between enamel and dentine/cementum, the present study showed that TM was equally effective in reducing wine erosion in both hard tissues (Table 1). Our findings along with those of other erosion preventive studies<sup>13,14</sup> point to the need for more comprehensive, well-designed clinical trials to determine the effectiveness of TM in the prevention of dental erosion. Further studies are also needed to determine the optimum frequency and mode of application of TM for preventing wine erosion.

Current recommendations for self-application of TM for wine tasters include application of TM after wine tasting sessions, or on the morning of the tasting event.<sup>16</sup> Wine tasting involves a very detailed evaluation of the aroma, bouquet, taste, flavour, body and astringency of wine,<sup>3</sup> and it is important that anti-erosive products do not alter the taste. Ramalingam *et al.*<sup>14</sup> reported that the addition of CPP-ACP did not alter the taste of an acidic sports drink. Our preliminary survey of eight professional wine tasters (unpublished data) also indicated that TM did not affect the taste one to two hours after initial application, but a detailed investigation is needed to confirm this.

The mechanism by which TM reduces erosion is unclear, although its anticariogenic properties, involving prevention of demineralization and enhancement of remineralization, are well-documented.<sup>6,12</sup> By maintaining saturation levels of calcium and phosphate at the tooth surface, CPP-ACP provides a reservoir of neutral ion pair ( $\text{CaHPO}_4^0$ ) that inhibits enamel demineralization and promotes formation of hydroxyapatite crystals inside carious lesions.<sup>12</sup> It is hypothesized that, in addition to the prevention of erosive demineralization, TM also remineralizes (repairs) eroded enamel and dentine crystals. This hypothesis is supported by an observation that superficial granular structures, probably representing remineralized enamel crystals, formed on the enamel surface after treatment with a sports drink containing CPP-ACP.<sup>14</sup>

The present study did not compare the erosion-inhibiting effect of TM with that of fluoride as it is difficult to make direct comparisons between our findings and those for fluoride<sup>21</sup> due to methodological differences. Recent reports have indicated that frequent application of fluoride protects enamel against erosion by wine<sup>17</sup> and soft drinks.<sup>22</sup> Intensive application of fluoride has also been shown to reduce enamel and dentine erosion by strong acids,<sup>23</sup> even under conditions simulating gastric reflux.<sup>24</sup> Future studies are needed to compare the relative benefits of CPP-ACP and fluoride, when used individually or in combination, in preventing dental erosion.

Extensive erosion as a result of wine tasting may have dento-legal implications.<sup>25</sup> In Sweden, identification of wine tasting as an occupational hazard led to the provision of free preventive dental treatment by the state-owned company 'Systembolaget' to its employees.<sup>26</sup> This occupational hazard is under-recognized by the Australian wine industry. Further epidemiological studies are needed to investigate the prevalence of dental erosion in Australian wine tasters and to widely disseminate evidence-based measures to minimize erosive damage to their teeth.

## CONCLUSION

Within the limitation of the present *in vitro* study, it is concluded that TM is effective in reducing wine erosion in both enamel and dentine/cementum. These findings have positive implications in the control and prevention of occupational hazard caused by wine erosion in professional wine tasters. Further studies are needed to compare the relative benefits of TM and fluoride, when used individually or in combination, in preventing dental erosion.

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