The Erosive Potential of Different Malt Drinks: An *in vitro* and *in situ* study

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Objectives: *Whereas the potential effect of acidic drinks in the etiology of dental erosion is well recognized the role of malt drinks is unclear. The primary aim of the present study was to compare the in vitro erosive effect on enamel produced by different aromated malt drinks. A secondary objective was to compare their erosive effects in situ with those determined in vitro.*

Materials and methods: *To select the malt drink for the study in situ, six commercially available malt drinks were examined for erosive potential in vitro. The study in situ was a single centre, 2-period, 2-treatment crossover study to compare the erosive effect of a commercially available malt drink (Test), with that of natural spring water (Control), over 10 day periods on 10 healthy volunteers. Subjects wore upper removable appliances containing two human enamel specimens from 9 a.m. to 4 p.m. The regimen of intake of the drinks was 250 ml at midday. Measurements of enamel loss were made on samples after 5 and 10 days by profilometry.*

Results: *The in situ study showed a statistically significant difference in erosive potential between the test and control beverages. No specimen exposed to the control beverage displayed appreciable erosion. Erosion occurred with the test drink, but to a variable degree between subjects.*

Conclusions: *Malt drinks should be considered as potentially erosive as the results for enamel specimens exposed to the test beverage in the clinical study showed a degree of erosion that varied greatly between different participants. It is likely that under these conditions an increase in the degree of erosion would be observed in children and young people who consume malt drinks.*

Keywords: *dental erosion, malt drink, tooth wear*

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INTRODUCTION

The consumption of soft drinks such as acidic fruit juices, fruit drinks, carbonated beverages are the risk factors most significantly related to dental hard tissue defect.[1-6] Case report data[7-8] together with studies in vitro[9-10] support the contention that acidic soft drinks contribute to dental erosion. However, excessive tooth wear appears to have a multifactor etiology since the archeological ages, in which intrinsic and extrinsic erosive agents, abrasion and attrition may all contribute to a greater or lesser degree.[11] Today, consumption of carbonated, sports and malt drinks is increasing among Istanbulian teenagers.

Malt drinks are non-alcoholic beverages of malt extract origin having high nutritional value containing essential vital amino acids, vitamins and trace elements.[12] and are popular today among youngsters. Recently, from a group of Istanbul children who regularly consumed carbonated beverages, 40% exhibited dental erosion.[13] However there are currently no data regarding the erosive potential of consuming malt drinks.

The primary aim of this study was to compare the erosion of enamel *in vitro* produced by the different aromated malt drinks. A secondary aim was to compare the erosive effects *in situ* with those determined *in vitro*.

MATERIALS AND METHODS

The selection of the malt drink for the *in situ* study was based on an *in vitro* study.Commercially available malt drinks investigated were pineapple, lemon, apple and pomegranate produced by Ritmix® (Efes Pilsen, Istanbul, Turkey); apple and peach by F5® (Tuborg, Istanbul, Turkey). All of these are available in markets of many EU countries. The pH was measured with a calibrated pH meter utilizing a glass bodied, combination pH reference electrode. Preparation of

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the human enamel samples for the study *in vitro* employed the method described by West *et al* [9] and Hunter *et al*.[13] Extracted, unerupted human third molars teeth were sterilized by soaking for 48 h in 1:20,000 parts per million (ppm) sodium hypochlorite. Distribution of the samples was random and there was no attempt in this study to determine details of the origin of the extracted teeth or the site of sectioning of the enamel used. These were polished on 1200 grit abrasive paper to expose a window of enamel with a surface profile of ± 0.3 μm measured on a profilometer (Mahr GmbH®, Göttingen, Germany). Seven enamel samples were prepared for each of the drink formulations and samples were placed in 250 ml of the selected beverage and agitated with an automatic stirrer. After 1 h the surface profile of each sample was measured twice using profilometry to establish the mean surface loss across a 2 mm window of exposed enamel. Seven samples were subjected to each beverage with the beverage refreshed each hour. Hourly profilometry tracings were taken until the samples had been immersed for a total of 4 h.

The clinical study was a single centre, single blind, 2-period, 2-treatment crossover study to compare the erosive effect of a commercially available malt drink, (Ritmix® Pineapple) (Test) with that of natural spring water, Kardelen® (Kardelen Su Ltd, Istanbul, Turkey) (Control) over 10 day periods with an overnight washout period of 17 h. Simple randomization was used to allocate the treatment order for each subject. The pHs of the control were 8.0 and those of the test are documented in Table 1. Pineapple aromated malt drink was chosen as it was the most erosive sports drink in the in vitro investigation. Ten healthy adult volunteers consented to take part in the study; four female and six males, age range 21–23 years. The study was approved by the Yeditepe University School of Dentistry Ethical Committee and was designed, conducted and reported in accordance with the guidelines for Yeditepe University School of Dentistry Hard Tissue Laboratory. Subjects were given verbal and written information about the study and gave signed and witnessed consent to participate. The participants wore an intraoral appliance between 9 a.m. and 4 p.m., which contained two enamel samples sited in the palate (one sample anterior to the other) as described by Hunter and co-workers.[13] The appliance was removed for a 1 h lunch period daily and for the duration of any tea, coffee or water consumption. Other beverages, food and/or acidic medication were not permitted. There was no restriction on food intake during the lunch break. Volunteers were supervised drinking 250 ml of the malt drink per day for 10 working days. On completion of days 5 and 10, the enamel samples were assessed for tissue loss by profilometry. Two tracings were taken of each specimen and the mean of the two depths recorded was used for analysis. To disinfect specimens the enamel samples were placed in 0.5% chlorhexidine in a 70% spirit base for 20 min before and after the profilometry readings. The first period was followed by a two days wash-out. The study was then repeated for another 10 days with the control beverage and fresh enamel samples in the appliances.

For the statistical analysis; GraphPad Prism V.3® was used to study the effect of the erosion of malt drinks. As the aim of the *in vitro* study was to determine which product was the most erosive, the mean data were appraised observationally without formal statistical analysis. Repeated appraisals were carried out by Friedman's test while intergroup measures were completed using Kruskal –Wallis test. Dunn's and Mann-Whitney-U tests were also applied for the *in situ* part of the study. The significance level for all tests was set at 0.05.

RESULTS

Table 1 summarizes the results of the *in vitro* analysis of acidity and enamel loss and erosive potential of six malt drinks on enamel samples. Baseline measurements were all well within the surface profile tolerance of ± 0.3 μm. Pineapple malt drink, which did not have the lowest pH, caused the greatest erosion at the end of 4 h.

All 10 subjects completed the study satisfactorily and a complete data set was available for analysis. The main analyses of the difference in erosion between test and control bev-

Table 1. pH and enamel erosion *in vitro* of the malt drinks

Malt drink	pH		erosion in μm at baseline	erosion in μm after 1 h	erosion in μm after 2 h	erosion in μm after 3 h	erosion in μm after 4 h	p
Pineapple		Mean±SD	0,201±0,033	0,177±0,035	0,199±0,069	0,41±0,185	0,811±0,374	0,0001
Ritmix®)	4,33	Median	0,200	0,170	0,170	0,370	0,750	
Apple		Mean±SD	0,161±0,047	0,16±0,035	0,264±0,06	0,443±0,117	0,624±0,154	0,0001
(Ritmix®)	3,79	Median	0,160	0,160	0,260	0,390	0,660	
Lemon		Mean±SD	0,124±0,039	0,136±0,049	0,44±0,475	0,571±0,496	0,591±0,211	0,0001
(Ritmix®)	4,16	Median	0,110	0,120	0,350	0,390	0,560	
Pommeradge		Mean±SD	0,097±0,058	0,107±0,055	0,291±0,196	0,353±0,179	0,654±0,289	0,0001
(Ritmix®)	4,80	Median	0,090	0,090	0,220	0,290	0,680	
Apple		Mean±SD	0,089±0,079	0,109±0,066	0,514±0,402	0,544±0,178	0,631±0,342	0,0001
(F5®)	3,63	Median	0,060	0,090	0,370	0,550	0,560	
Peach		Mean±SD	0,067±0,019	0,08±0,029	0,333±0,26	0,449±0,173	0,454±0,146	0,0001
(F5®)	3,80	Median	0,070	0,080	0,220	0,460	0,480	

Table 2. Mean loss of material (μm) from in situ enamel specimens at 5 and 10 days on test and control beverages.

		Test	Control	P
Baseline	Mean (μm)±SD	0,138±0,025	0,143±0,031	0,583
	Median	0,135	0,140	
Day 5	Mean (μm)±SD	0,535±0,203	0,231±0,052	0,0001
	Median	0,495	0,240	
Day 10	Mean (μm)±SD	0,591±0,287	0,256±0,065	0,0001
	Median	0,515	0,260	
p		0,0001	0,0001	

erages are shown in Table 2, where differences between test and control drinks at days 5 and 10 were statistically significant ($p<0.01$).

DISCUSSION

The *in vitro* study was performed to ensure selection of an appropriate malt drink that showed sufficient erosive potential to produce enamel loss in the clinical trial piloting methodology specific to aspects of consumption of malt drinks. In the event the product chosen (pineapple malt drink) was, in mean terms, appropriately 16% more erosive after 4 h than the next most erosive product.

Regarding the *in situ* study; while pineapple malt drink was the test beverage, natural spring water was considered a negative control because of the expected and previously demonstrated[9,14] lack of effect on enamel in situ and in vitro. The *in situ* results again showed a difference between participants in erosion compared to the test drink. Thus, the enamel samples from two subjects exhibited very little erosion whilst the enamel samples from another two subjects displayed gross erosion. The present difference could arise from the individual susceptibly to erosion. The considerable individual differences in erosion between subjects during the in situ study could be differences in drinking patterns.

The present study showed differences between specimens eroded under identical conditions, which can be appraised from the standard deviations (Table 1). Assuming that individual susceptibility was constant throughout the present study and specimen position in the appliance was not a factor, biological variation was apparent from the differences in erosion between pairs of specimens in the same mouths.

CONCLUSION

Malt drinks should be considered as potentially erosive as the results for enamel specimens exposed to the test beverage in the clinical study showed a degree of erosion that varied greatly between different participants. It is likely that under these conditions an increase in the degree of erosion would be observed in children and young people who consume malt drinks.

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