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Influence of Coca-Cola® on Thermoplastic Degradation in Clear Orthodontic Aligners†

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Abstract

Clear orthodontic aligners, primarily composed of thermoplastic polymers, are increasingly popular but susceptible to degradation through thermal, chemical, and mechanical stress. This preliminary pilot study assessed the release of microplastics from two commercial aligner brands under simulated oral conditions. Aligners were exposed to daily cycles of Coca-Cola® or artificial saliva, with mechanical agitation replicating masticatory friction. Fourier-transform infrared spectroscopy confirmed microplastic release in both environments, with a notably higher particle count after Coca-Cola® exposure. These findings indicate the potential health and environmental risks linked to acidic beverage consumption during orthodontic treatment. Further comprehensive studies are required to validate and expand upon these results.

Keywords: microplastics; clear orthodontic aligners; Coca-Cola ®; FTIR spectroscopy

Materials and Methods

Two commercial aligner brands, Dentsply Sirona (Group A) and Invisalign (Group B), were selected for analysis. Each group of samples was subjected to a seven-day *in vitro* protocol designed to simulate oral conditions. Aligners were immersed for 5 h/day in either Coca-Cola® or artificial saliva and stirred to simulate the physiological friction produced by patient tooth movement. Following this period, the immersion medium was replaced with fresh artificial saliva and the samples were maintained at 37°C without stirring for the remaining 19 h/day. This cycle was repeated daily for seven days. All solutions in contact with each group of samples, including rinsing water, were collected and vacuum-filtered through 1.6 µm membranes. The retained particles were examined under a stereomicroscope and characterised by Fourier-transform infrared spectroscopy (FTIR). The spectra of the collected particles were compared with those of the original aligner materials to confirm the identity of the polymers.

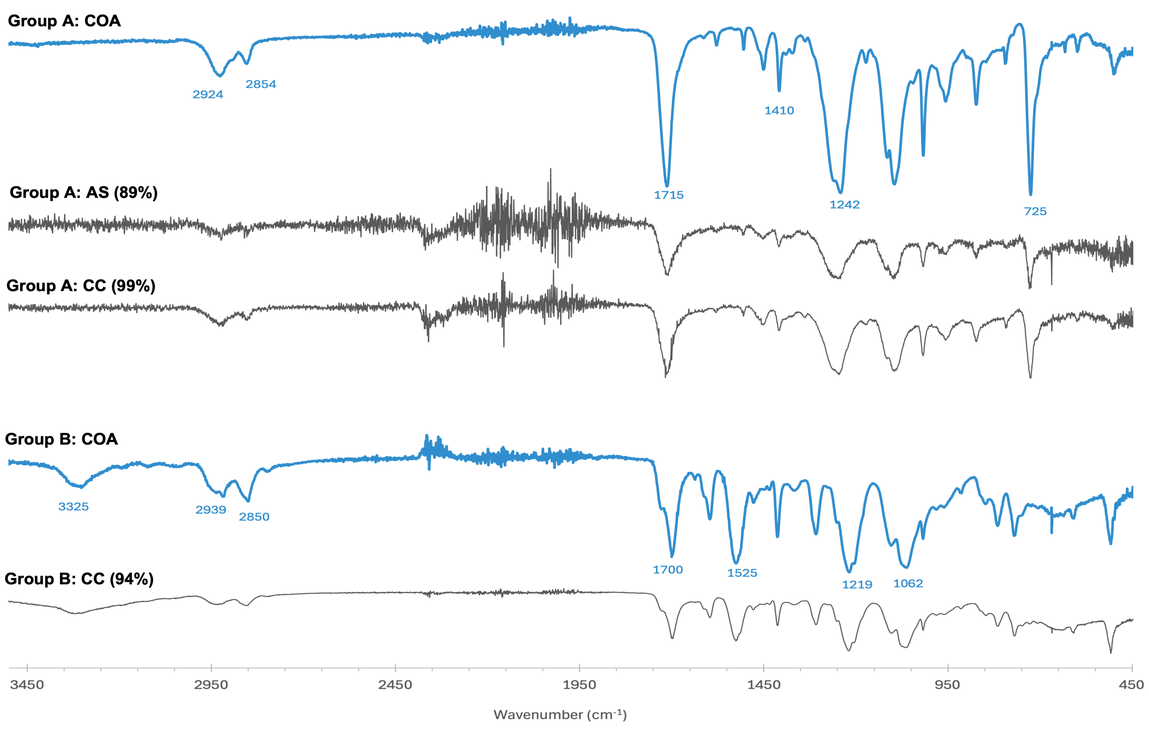

Figure 2. Comparison between the FTIR spectra of the as-received COA (in blue), with the characteristic molecular bands, and the FTIR spectra of the representative collected microparticles detached from the aligners (dark lines). The percentage value in brackets refers to the correlation with the original COA. AS, artificial saliva; CC, Coca-Cola.

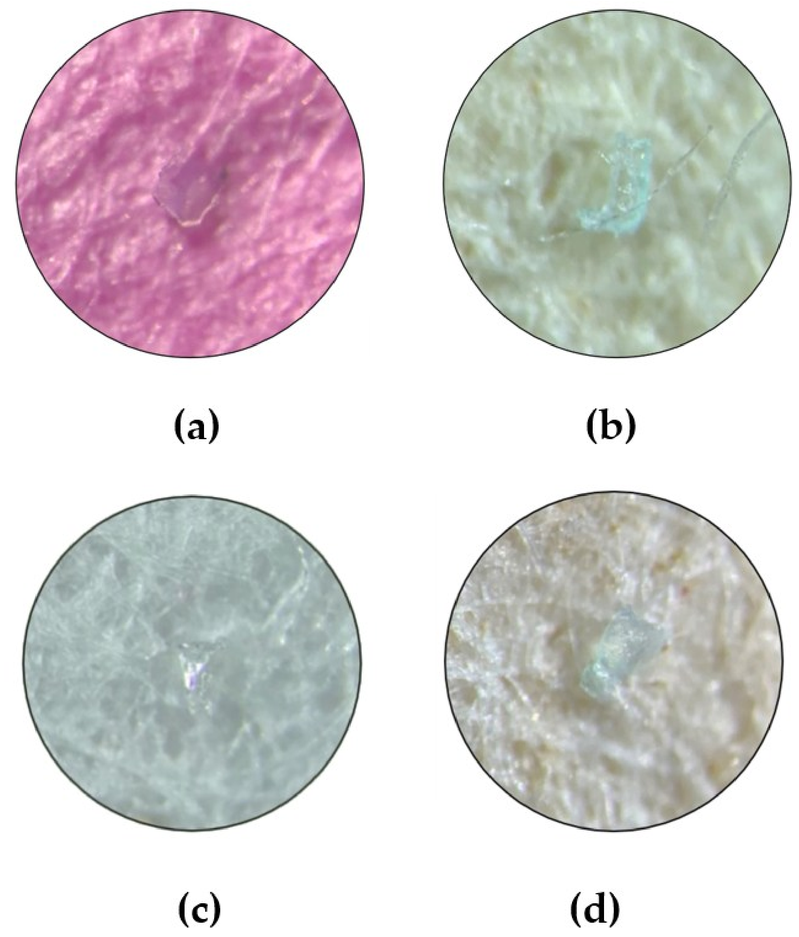

Figure 1. Stereomicroscope images of some particles obtained after filtration: Group A tested with (a) artificial saliva and with (b) Coca-Cola; Group B tested with (c) artificial saliva and with (d) Coca-Cola®.

Results and Discussion

Both aligner brands released microplastic particles under the tested conditions, the stereomicroscope images of some are shown in Figure 1. The number of particles released was visibly higher following exposure to Coca-Cola® compared to artificial saliva. The FTIR spectra of the as-received aligners (Figure 2, blue lines) showed the characteristic peaks for the presence of: polyethylene terephthalate (PET) for the Dentsply Sirona COA, Group A; polyurethane, PU, for the Invisalign COA, Group B. FTIR analysis of the particles collected after filtration (Figure 2, dark lines) and comparison of the spectra obtained with the original COA (by correlation percentages) confirmed the presence of microplastics. No evidence of extraneous contamination was detected. The amount of MP released in the test with Coca-Cola® was always higher than in the control, with artificial saliva. These results should be interpreted with caution due to the limited sample size. Broader investigations are necessary to confirm these trends and assess their clinical significance.

Conclusions

This pilot study demonstrates that artificial saliva alone can induce microplastic release from orthodontic aligners, with Coca-Cola® exposure significantly increasing this effect. The results highlight the potential influence of patient behaviour on material stability and microplastic exposure.

The acidic environment produced by Coca-Cola® appears to accelerate the degradation of thermoplastic polymers used in orthodontic aligners. Repeated acid exposure, combined with simulated mastication, likely increases material fatigue and surface erosion, promoting microplastic release. These findings, although based on a small sample and in vitro simulation, raise concerns considering the growing evidence that microplastics can cross epithelial barriers, accumulate in tissues, and elicit cellular stress responses. Chronic exposure has been linked to endocrine disruption and altered immune responses, which may have systemic implications, particularly for younger patients undergoing prolonged orthodontic treatment. As a pilot study, these results reinforce existing recommendations discouraging the consumption of acidic beverages while wearing aligners and underscore the importance of further research.

References

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