

Raman Spectroscopy for Evaluating the Effect of a Paste Based on Allogeneic Hydroxyapatite on the Enamel of Bovine Molars

*N.R. Valieva¹, P.I. Pyataeva¹, E.V. Pisareva¹, E.V. Timchenko^{1,2},
M.Yu. Vlasov^{1,2}, P.E. Timchenko¹, L.T. Volova^{1,2}*



¹Samara National Research University, 34 Moskovskoye shosse, Samara, 443086, Russia

²Samara State Medical University, 89 Chapayevskaya Street, Samara, 443099, Russia



Objective of the work

To evaluate the applicability of Raman spectroscopy for assessing the effect of a paste based on allogeneic hydroxyapatite (HAP) on the enamel of bovine molars.

The materials of the study

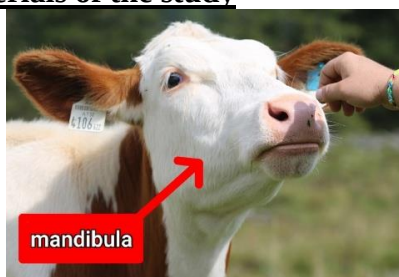


Figure 1 – Bovine molars located on the mandible.

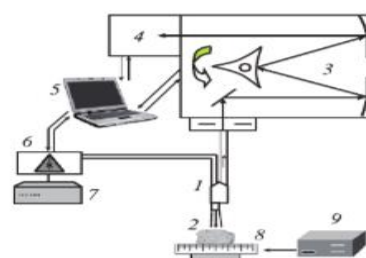


Figure 2 – Experimental setup: 1 – Raman probe; 2 – object; 3 – spectrometer; 4 – digital camera; 5 – computer; 6 – laser module; 7 – laser module power supply.

Experimental results

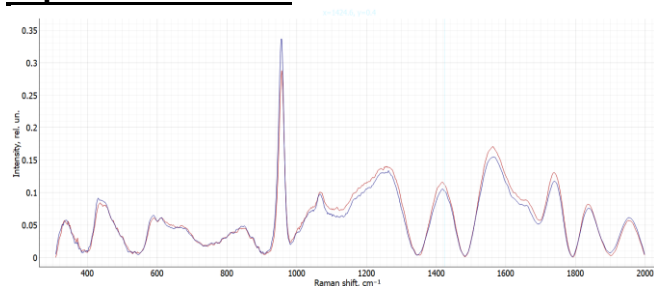


Figure 3 – Averaged Raman spectra of bovine enamel before (red) and after (blue) HAP paste treatment.

Mineral components: Intensity increased ~15% at **428 cm⁻¹** and **960 cm⁻¹** (ν_2 , ν_1 PO₄³⁻). This indicates B-type substitution and crystalline HAP growth [14].

Organic components: Decreased intensity at **620, 850, 1250, 1560, 1660 cm⁻¹**. This is associated with the restoration of enamel microcracks by the HAP paste.

Conclusion

The performed spectral analysis using chemometric approaches made it possible to identify spectral changes in bovine tooth enamel after application of the remineralizing toothpaste based on allogeneic HAP, which manifest themselves in changes in both mineral components (~428 cm⁻¹, ~960 cm⁻¹), associated with B-type substitution in hydroxyapatite, and organic components present in the tooth enamel (620 cm⁻¹, 850 cm⁻¹, 1250 cm⁻¹, 1560 cm⁻¹, 1660 cm⁻¹). These changes are due to remineralization and restoration of enamel microcracks when using the HAP-based paste.

The obtained results demonstrate the possibility of using Raman spectroscopy for preclinical trials of a new HAP-based paste using human teeth.

It has been shown that Raman spectroscopy can be further applied to evaluate the effectiveness of tooth remineralization in preclinical dental studies.

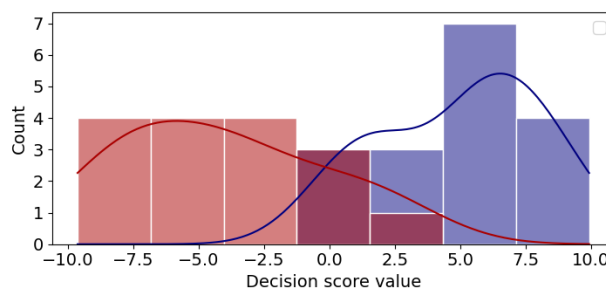


Figure 4 – Distribution of LDA decision scores.

The LDA model reliably separates intact enamel from treated enamel.

The highest contribution to group separation comes from Raman bands at **960 cm⁻¹** (mineral) and **1250 cm⁻¹** (organic components).