EFFECTS OF CARBOXYLIC ACID ADDITION ON THE SETTING TIME AND COMPRESSIVE STRENGTH OF GLASS-IONOMER CEMENTS

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Introduction

Glass-ionomer cements are created through the curing process of compositions made of two components: glass powder and a bonding liquid — an aqueous solution of polyalkenoic acids. Cement setting is based on an acid-base reaction; when ions of metal elements released from the glass surface bond with polyanions derived from the polyacid. Since the reaction is very fast, various compounds are added to the bonding liquids to extend the composition setting time. These are most often carboxylic hydroxyacids capable of complexing ions released from the glass [1-3]. Moreover the kinetics of the glass-ionomer cement curing process may also depends on other factors like pH or structure [4,5].

Materials and Methods

For the purposes of the study, the following components were used:
- G-J CHEMADENT powder (calcium-fluoroalumino-silicate glass) and G-J CHEMADENT liquid (aqueous solutions of acrylic and itaconic acid (AA-IA) copolymer) synthesised in accordance with the patent description "Dental glass-ionomer composition" [6] as cement components for dental fillings and restoration in the Department of Ceramic Technology of ICiMB;
- carboxylic hydroxyacids: tartaric acid (Avantor), citric acid (Avantor), malic acid (Fluka), and dicarboxylic acid
- oxalic acid (Avantor).

Bonding liquids were obtained on the basis of the solution of AA-IA copolymer, water and the above listed carboxylic acids. Glass-ionomer composition samples were made on the basis of powder component and the obtained bonding liquids in quantitative ratio 2,4g:1ml, in the way and conditions determined by a standard PN-EN ISO 9917-1. Properties of the glass-ionomer compositions were determined through the setting time measurement, while the properties of the cured cements were determined on the basis of compressive strength.

Results and Discussion

The addition of carboxylic hydroxyacids to AA-IA copolymer solution caused reduction of their viscosity and had positive influence on the mixing process of the glass-ionomer compositions through reduction of setting time. The highest increase in the composition setting time was observed for the addition of malic acid to the bonding liquids (FIG. 1).

The addition of carboxylic hydroxyacids to bonding liquids had negative influence on the strength of the cements obtained (FIG. 2). Test results showed that cements containing bonding liquids with added malic acid of 5% and 10% demonstrated the highest compressive strength, but higher content of this acid caused the higher reduction in cement strength to values below 100 MPa, which does not meet the requirements of the above mentioned standard.

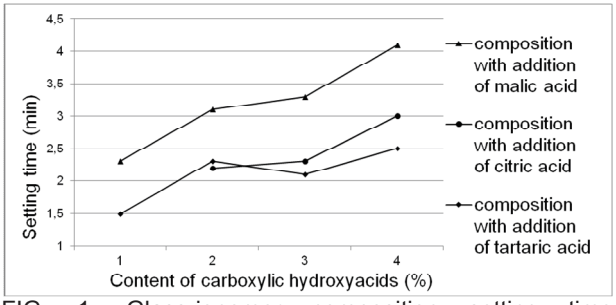

FIG. 1. Glass-ionomer composition setting time depending on the type and content of carboxylic hydroxyacids.

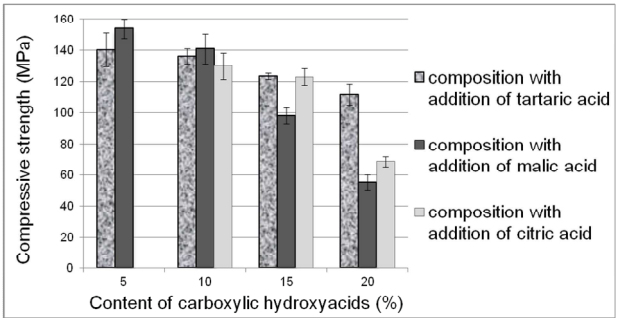

FIG. 2. Glass-ionomer cement compressive strengths depending on the type and content of carboxylic hydroxyacids.

It is known from the literature, that oxalic acid may function in glass-ionomer compositions as a setting reaction modifier [5]. Tests of compositions containing oxalic acid demonstrated that small additions of this acid (0,5 wt% and 1 wt%) affect the most setting time values. Depending on the type of additives and their percentage content in the bonding liquid, the composition setting time may be reduced or extended.

Strength test results of cements based on bonding liquids containing oxalic acid don't demonstrate a considerable influence of oxalic acid on the compressive strength of cements that contain it.

Conclusions

Test results indicate that the addition of carboxylic hydroxyacids, especially malic acid, reduces the bonding liquid viscosity, extends the glass-ionomer composition setting time, and facilitates cement mixing, but unfortunately reduces their compressive strength. The addition of oxalic acid to the bonding liquid may modify the setting time of glass-ionomer composition, without changing the strength properties of the cements.

Test results indicate that there may be several factors that simultaneously affect the glass-ionomer composition setting process, which may be of significance in developing materials for new applications.

Acknowledgments

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