

Effect of Expiration Date on Flexural Strength of 3D-Printed Interim Resin Material

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Objective

The aim of this study was to evaluate the effect of expiration date and thermocycling on flexural strength of 3D-printed interim resin material.

Introduction

In the rapidly evolving field of 3D-printing, the quality and durability of printed materials play an essential role in their clinical applications. The use of 3D-printed interim resin restorations are increasing due to the expansion of intraoral scanners, simple dental computer-aided design (CAD) software, and improved 3D-printing speeds. Interim restorations have many functions ranging from the protection and healing of periodontal tissue to the testing of esthetics or occlusal schemes. These types of restorations usually have a limited life span in prosthetic therapy, however; certain situations can be associated with long-term use. It is important to understand how proper handling techniques of 3D-printed materials can have an effect on their mechanical properties. The effect of expiration date on the flexural strength of 3D-printed resin is an important factor to consider. It is common for dentists to have unused expired 3D-printable resin material in their office. Should this material be discarded or can it be used past the expiration date? This study evaluated the effect of expiration date on flexural strength of 3D-printed interim resin material. Half of the tested specimens were thermocycled in order to simulate the aging process of the material.

Materials and Methods

Forty-eight strips were designed (64×10×3.3 mm) and manufactured at a zero-degree orientation following ISO 20795-1; 24 using a one-year expired crown and bridge resin material (Ex) and 24 using an unexpired material (Uex) (Figure 1). Specimens were post-processed using a post-processing curing machine following the manufacturer's instructions (Table 1). Specimens were then polished using a polishing wheel at 15,000 RPM with medium pumice and a buffing agent. Twelve strips of each group were thermocycled (SD Mechatronik) for 1,000 cycles between 5° and 55° C with 15 second interval times (Figure 2). Strips were then subjected to a 3-point bend test using a universal testing machine (DILLON Quantrol; Dillon/Quality Plus) at a crosshead speed of 5.0 mm/minute (Figure 3).

Flexural strength (MPa) was calculated using the following formulas seen in Figure 4.

Material	Manufacturing Method	Post-processing
Resin (P Pro Temporary Crown & Bridge; Straumann Inc.) 	3D-printing Machine (P 30; Straumann Inc.) 	Post-processing Unit (P Wash, P Cure; Straumann Inc.) 

Table 1. Material, Fabrication, and Post-processing Techniques

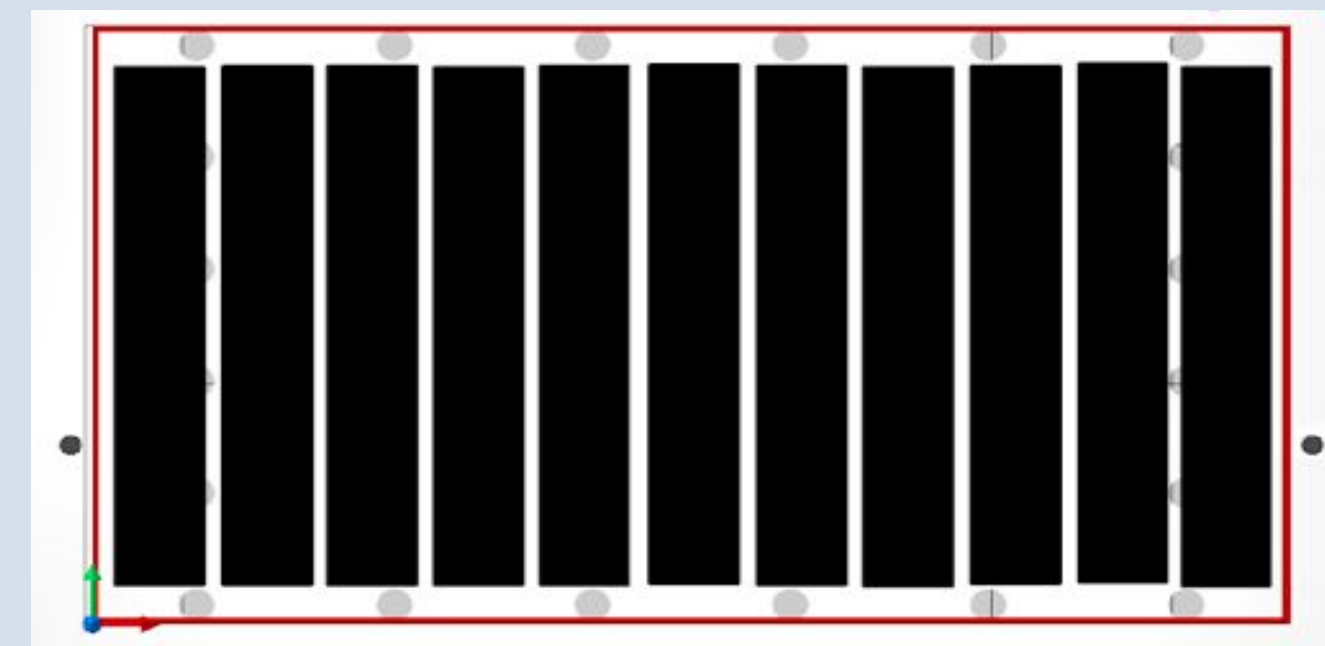


Figure 1. Orientation of specimens nested in Netfabb

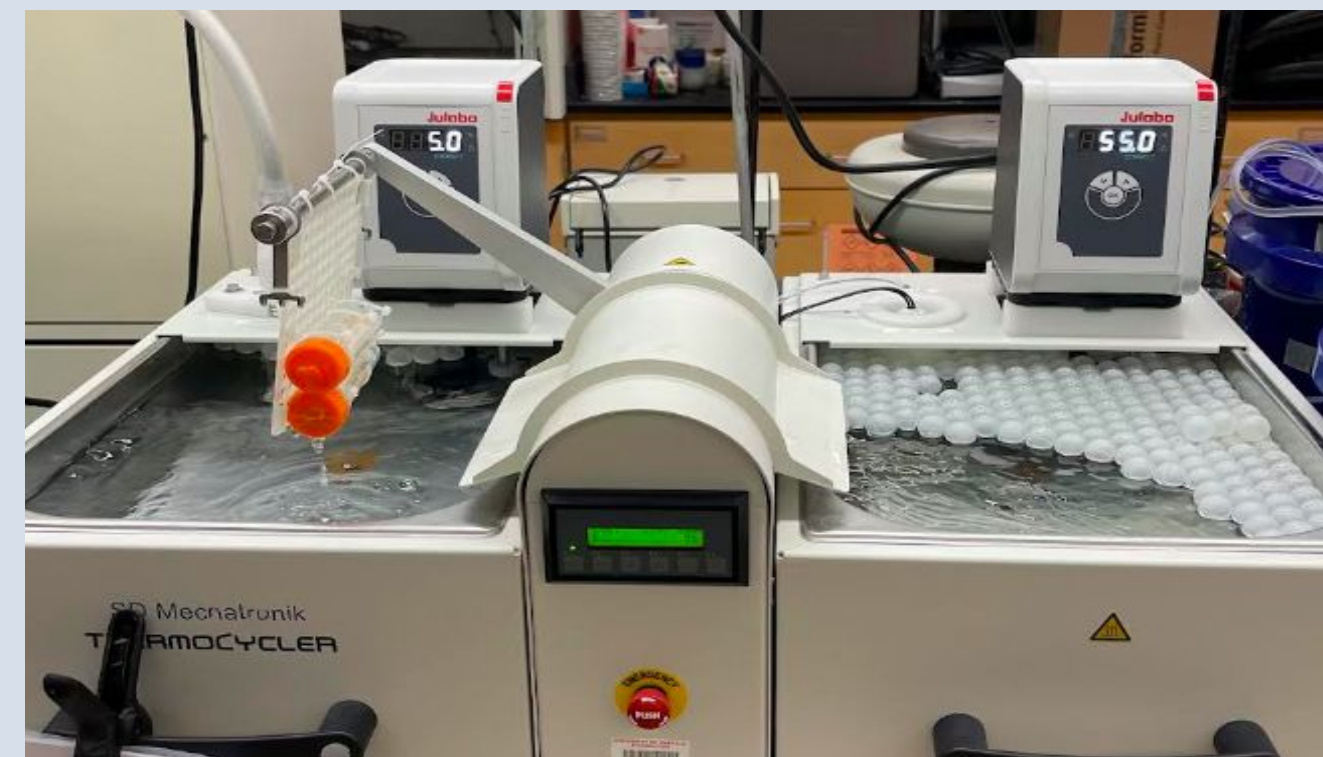


Figure 2. Thermocycling machine

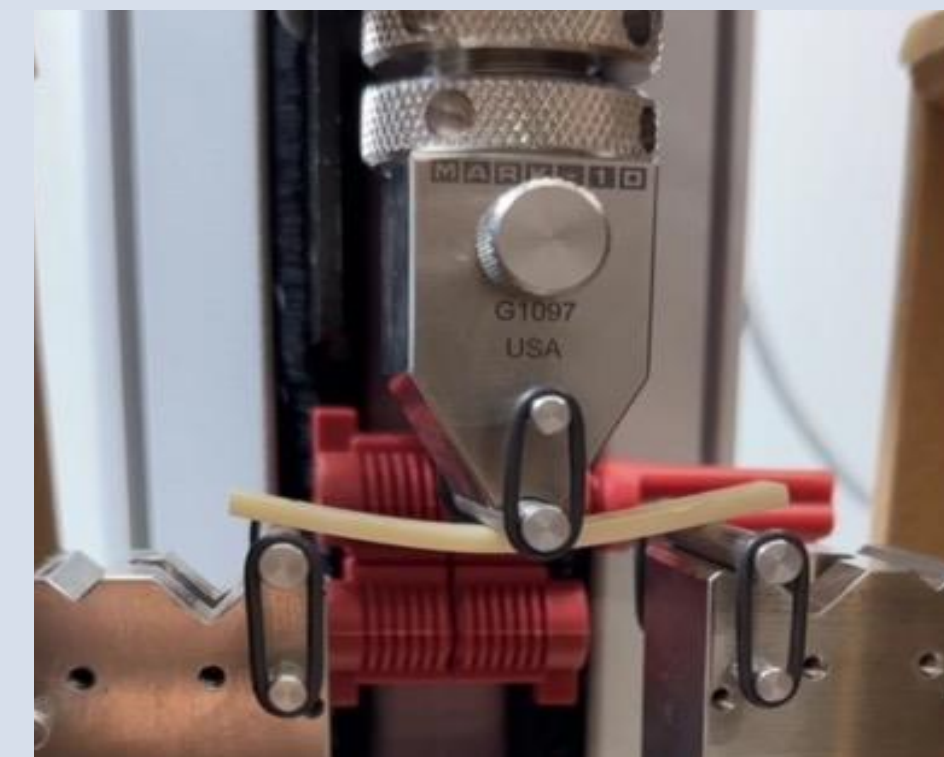


Figure 3. Universal testing machine

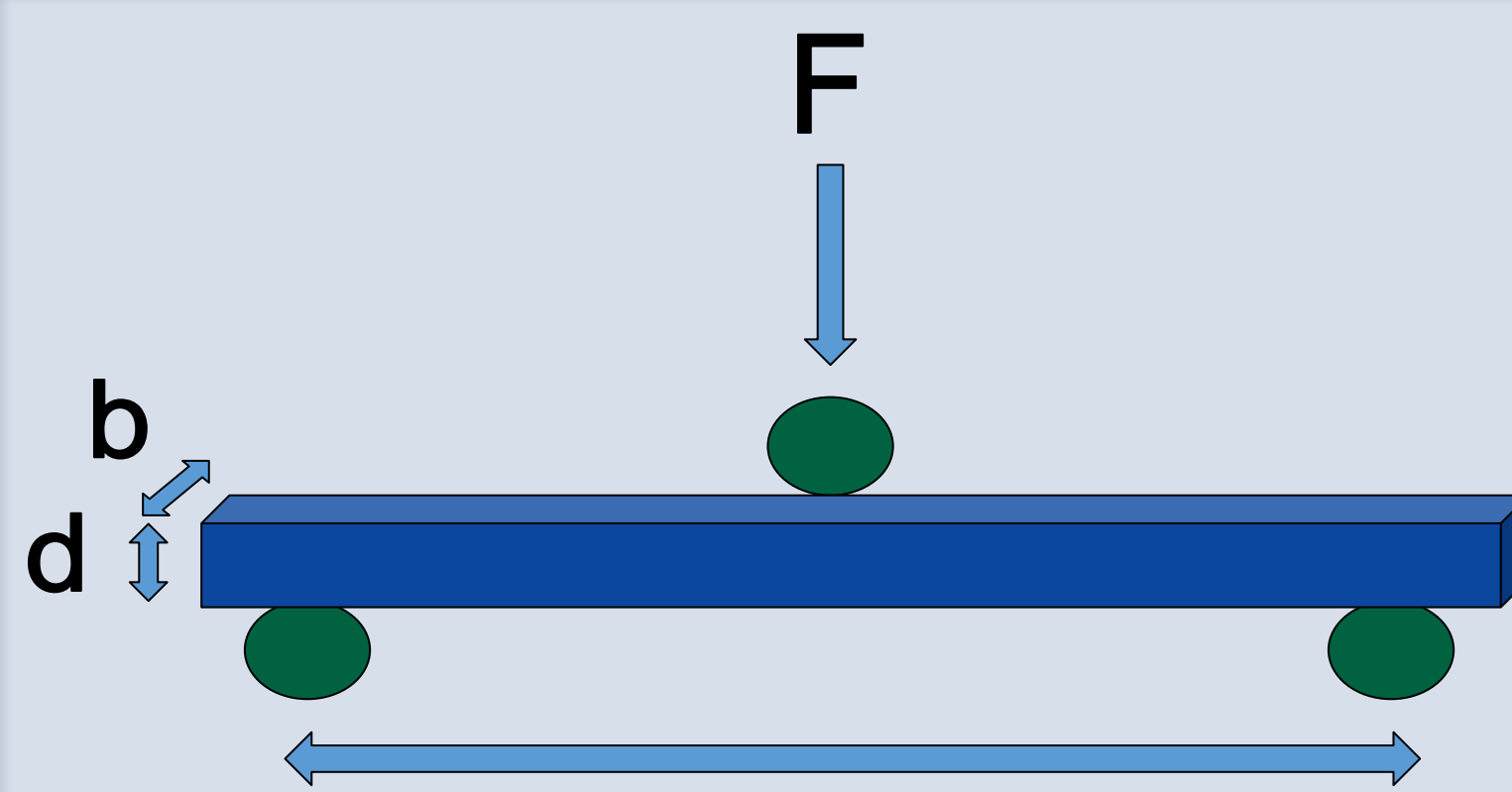


Figure 4. Schematic of 3-point flexural strength test

F = maximum force exerted on specimen
L = distance between specimen supports (50 mm)
b = specimen width (10 mm)
d = specimen thickness (3 mm)

$$FS = \frac{3FL}{2bd^2}$$



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Two-way ANOVA and Tukey's post hoc test were used to assess the impact of thermocycling and expiration date on the flexural strength of the material ($\alpha=0.05$).

Results

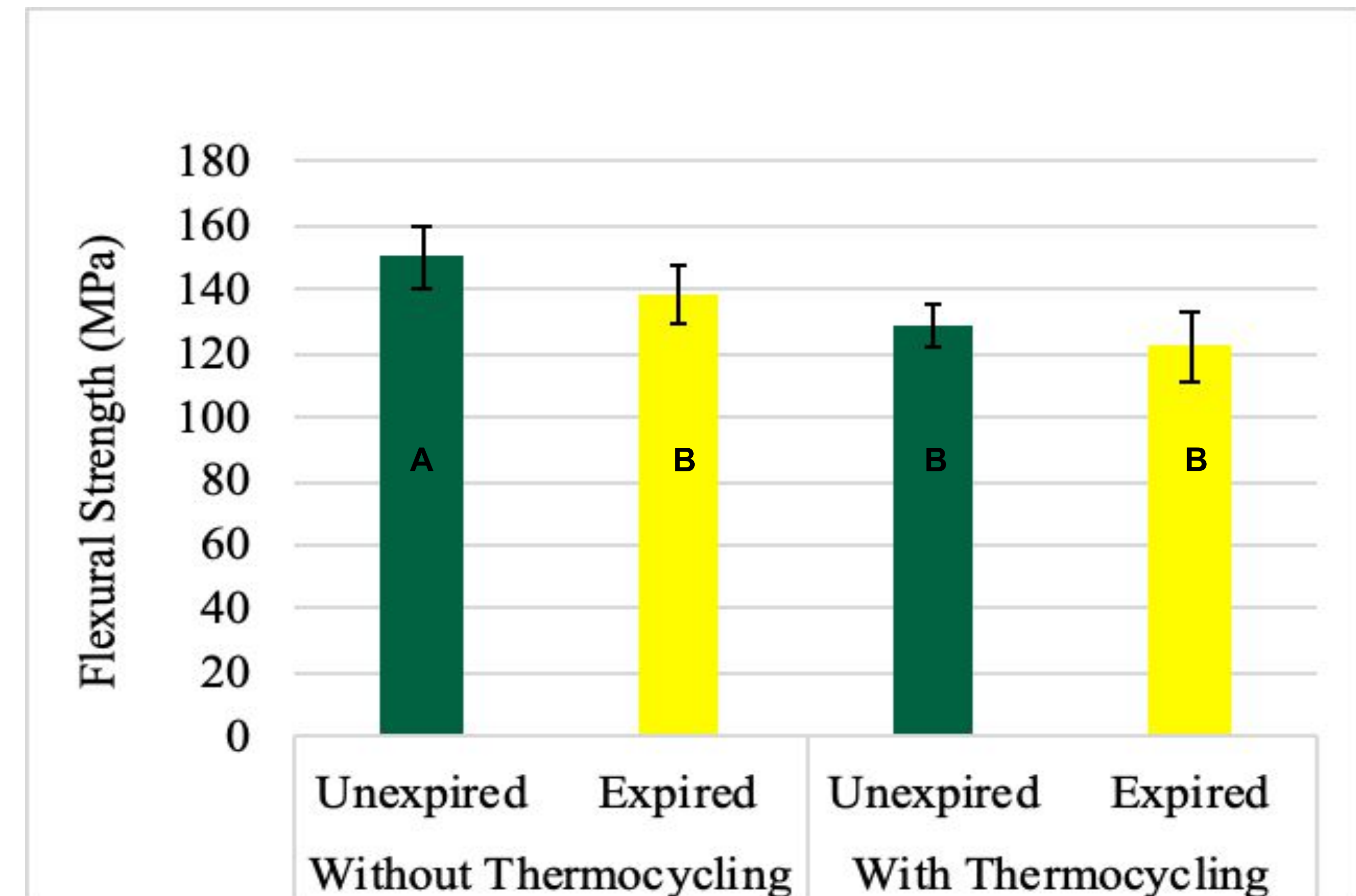


Figure 5. Flexural strength of tested groups. Same letter means non-significant ($P<0.05$) difference.

Conclusions

Within Limitations of the current study:

1. Expiration date significantly ($P<0.05$) impacts the flexural strength of 3D-printed resin material without thermocycling
2. The expiration date does not significantly impact ($P>0.05$) the flexural strength of 3D-printed resin material with thermocycling

References

1. Gad MM, Fouda SM. Factors affecting flexural strength of 3D-printed resins: A systematic review. J Prosthodont. 2023 Apr;32(S1):96-110. doi: 10.1111/jopr.13640.
2. Pantea M, Ciocoiu RC, Greabu M, Ripszky Totan A, Imre M, Țăncu AMC, Sfeatu R, Spînu TC, Ilinca R, Petre AE. Compressive and Flexural Strength of 3D-Printed and Conventional Resins Designated for Interim Fixed Dental Prostheses: An In Vitro Comparison. Materials (Basel). 2022 Apr 23;15(9):3075.