Flexural Strength of Heat Cure Denture Base Resin incorporated with Curcumin: An In-Vitro Study

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ABSTRACT

Introduction: Acrylic resin when used for fabrication of denture is susceptible for microbial colonization. Many antimicrobial agents have proven effective against the microbial colonization when they were incorporated into the acrylic resin but adding anything into the acrylic resin can alter its mechanical properties resulting into unacceptable intraoral use. This study was done to evaluate if adding an antimicrobial agent, Curcumin, alters the flexural strength of acrylic agent.

Methods: 172 acrylic strips were fabricated. They were divided equally into 4 groups depending upon concentration of curcumin as Control, T1: 1% curcumin, T2: 3% curcumin and T4: 5% curcumin. Flexural strength was tested using 3-point bend test using Universal Testing Machine.

Results: There was no significant difference in values of mean flexural strength for control, 1% and 3% curcumin groups. There was significant difference in the mean value between control and 5% curcumin group.

Conclusion: 1% and 3% curcumin can be incorporated into acrylic resin without significantly altering its mechanical properties.

Key words: Acrylic, Candida albicans, Curcumin, Denture, Flexural Strength

INTRODUCTION

Despite being developed in 1936, Polymethyl methacrylate (PMMA) is still the preferred foundation material for fabrication of dentures.[1,2] PMMA resin material raises a number of issues, particularly its high porosity, surface hydrophobicity and roughness,[3,4] which results in its significant potential for the growth of microbial plaque since food particles can lodge in the porosities. Accumulation of microbial plaque can cause gingival inflammation, decalcification and caries in tooth structure.[5] Inflammation of the oral mucosa is also a result of improper denture hygiene. *Candida albicans* is the most frequently linked organism to mucosal inflammation in people wearing dentures leading to denture stomatitis.[5] There are various mechanical and chemical methods to remove microbial plaque to stop microbial accumulation, but they heavily rely on the cooperation of the patient and may fail in cases when the patient is uncooperative. Therefore, it may be wise to directly incorporate antibacterial agents into acrylic to prevent denture stomatitis.[6] Several nanoparticles such as silver, silicon dioxide, titanium dioxide, zinc and platinum have been successfully added to the acrylic resin to confer antimicrobial activity.[7-10] However, the majority of the previously mentioned

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additives are mineral ions, which raises some biological questions. So, in order to combat microorganisms, researchers are searching for organic products with the best antimicrobial properties.

Among the organic products, a study showed that incorporating 0.5%, 1% and 2% Curcumin into acrylic resin was effective against the *Candida albicans*, reducing their growth.[11] A denture in an intraoral environment is subjected to a variety of forces during use, which can result in flexural and impact stresses which causes it to break because acrylic resin has less flexural strength.[12] Moreover, any additive to the acrylic resin may impact the mechanical properties reducing their flexural strength.[13] Thus, this study is designed to evaluate the effect of curcumin on the flexural strength of acrylic resin at different concentrations.

METHODS

This quantitative observational study was conducted in department of Prosthodontics and Maxillofacial Prosthesis, Universal college of Medical Sciences. The ethical clearance was obtained from Institutional Review Committee of UCMS before conducting the study (UCMS/IRC/051/20). The dutation of the study was 6 months (August 2020 - January 2021). 172 acrylic strips were prepared of PMMA-based heat polymerizing denture base resin (Coltene/Whaledent GmbH & Co KG) by conventional compression molding technique using metal strips of 65mmX10mmX2.5mm dimension (according to ADA Specification no. 12 for denture base polymers at room temperature) for preparation of split mold. The total specimens were divided into 4 groups of 43 samples each out of which the first group was used as control prepared with only polymer and monomer and the remaining groups were prepared with incorporation of different concentrations of antifungal agent, Curcumin in the acrylic resin mixture during the packing stage (Table 1). Curcumin sample was prepared from the curcumin roots by grinding them followed by drying.

PREPARATION OF SPECIMENS

For the control group 20 gm polymer was mixed with 10 gm monomer. The required amount of Curcumin was weighed and immersed in 10 gm of predetermined weight of monomer. Then the required mass of polymer was added to the mix to obtain 2:1 ratio by weight.

For T1, 1% by weight (0.2 gram) was mixed with 19.8 gm of polymer.

For T2, 3% by weight (0.6 gram) was added to 19.4 gm of polymer.

For T3, 5% by weight (1gram) was added to 18 gm of polymer.

FINISHING OF THE ACRYLIC STRIPS

The plaster traces and excess resin was removed with tungsten carbide bur and stone bur. The specimens were stored in distilled water at 37^0 C for 48 hours (according to ADA specification no 12/ISO: 1567-1981(ISO 6887-1986) for denture base polymers at room temperature).

Testing of flexural strength

The specimens underwent surface treatment and were subsequently stored in distilled water at a temperature of 37°C for a week prior to testing. Flexural strength was determined using a bench 3-point bend test using a universal testing machine with a span length of 50 mm and a crosshead speed of 5 mm/min (as per ISO 20795-1 guidelines for denture base polymer. The specimens were marked at a midline that corresponded to the spot where the testing machine's striker would make contact with the samples.

Each specimen was positioned on the support beams. A load cell was applied to the center of the specimens using the upper anvil assembly of a universal testing machine at a crosshead speed of 5 mm/min until fracture. The maximum load before fracture which was displayed on the screen was recorded as fracture load (F) in Newtons. Flexural strength (Fs) were then calculated from the following equations

Flexural strength (MPa)=$3PL/2bd^2$

where P=maximum load (N), b=specimen width (10 mm), L=span length (65 mm), d=specimen thickness (3 mm)

The mean value of the flexural strength of all the groups was computed. Statistical software (IBM SPSS Statistics, v25.0; IBM Corp.) was used to analyze the data. One-way analysis of variance (ANOVA) was used to evaluate differences in the flexural strength of the specimen groups.

RESULTS

Table 2 shows that the flexural strength has decreased in the test groups with increase in the percentage of curcumin as compared with the control group. However, the decrease in flexural strength of T1 and T2 was not significant with p-value 0.946 and 0.073 respectively. (Table 3) There was significant difference (p-value<0.01) in the mean strength values only with T3.

Table 1: Grouping of samples

Groups	Concentration
Control	Standard polymer and monomer ratio (2:1 by weight)
Turmeric	T1: 1% (0.2gm by weight)
	T2: 3% (0.6gm by weight)
	T3: 5% (1gm by weight)

Table 2: Mean and standard deviation of all groups in Megapascal (Mpa)

Sample groups	Mean	Standard deviation
Control	94.442	3.12
T1	93.937	5.57
T2	92.205	3.48
T3	84.333	4.41

Table 3: Tukey's HSD poc host test for comparison of mean difference of all groups

Sample groups		Mean difference	Significance (p-value)
Control	T1	0.504	0.946
	T2	2.237	0.073
	T3	10.109	<0.01*
T1	T2	1.732	0.236
	T3	9.604	<0.01*
T2	T3	7.872	<0.01*

*level of significance at p-value <0.05

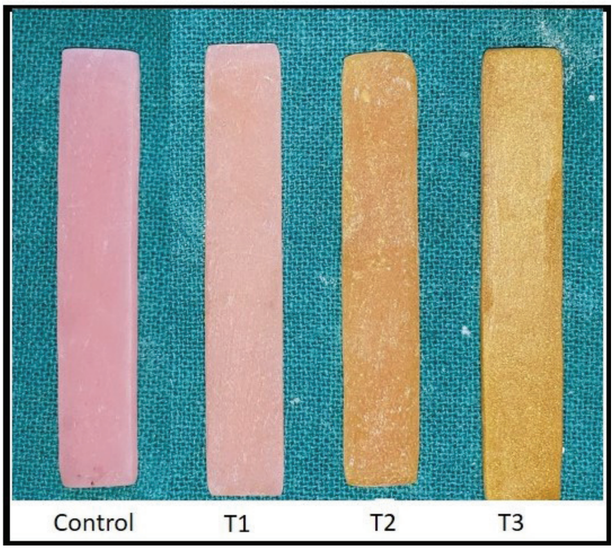

Figure 1: *Sample groups*

DISCUSSION

Curcumin has been successfully added into acrylic resin in different concentrations as an anti-fungal agent against *Candida albicans* in many studies.[11,14] Although these studies proved the biological efficacy, addition of any agent in the acrylic resin may bring change in the mechanical properties due to which its use for intraoral function may not be acceptable. As there are limited studies regarding the strength of acrylic resin with curcumin incorporated as an anti-fungal additive, this study was done to evaluate the flexural strength of acrylic resin incorporated with different curcumin concentrations.

In the present study, 1%, 3% and 5% of curcumin was added to the acrylic resin as the antifungal agent. Similar concentrations of turmeric were taken in a study by Khamooshi et al[11] (0.5, 1 and 2%) and Pourhaji Bagher et al [15](1, 2 and 5%).

According to ISO 1565, flexural strength of acrylic resin, processed and cured with any method, should be no less than 65 MPa. All the concentrations used in the current study showed the mean flexural strength value greater than 65 MPa indicating their acceptable use intra-orally. When the concentrations were compared with the control and also between the groups, the differences were not significant for all.

The mean of 1% curcumin and 3% curcumin was not significantly different from control. Study done by Pourhaji Bagher et al[15] showed similar findings where there was no difference in flexural strength between the normal acrylic resin and those containing curcumin 1 and 2%. However, that study also showed no significant difference with 5%, which is in contrast with the current study where there was significant difference. This contrast in the result may be due to difference in the forms of curcumin used and the different sizes of the specimens.

The limitations of the study are that the forces in the intraoral environment are complex and dynamic while the test uses a static load and the extraction of curcumin was not done.

CONCLUSION

Within the limitations of the study, it can be concluded that the incorporation of 1% and 3% curcumin (wt/wt) in the acrylic resin did not decrease the strength significantly, while 5% addition decreased it. Thus, 1% and 3% curcumin can be added effectively without altering the mechanical properties of the acrylic resin.

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