INTRODUCTION

For many years, polymethyl methacrylate (PMMA) was commonly used as denture base material. Properties that contributed to the success of these materials as a denture base are excellent appearance, ease of processing, and ease of repair. However, an inherent disadvantage is the liability of heat-cured acrylic resin denture to break during service, color instability, water sorption, and surface roughness.

PMMA resin surfaces are prone to indentation by different hard objects, which increase the abrasiveness and wear of acrylic base material. These phenomena provide a favorable environment for fungal and bacterial colonization which is associated with several oral and general diseases. Several studies of denture base materials have demonstrated a direct link between acrylic surface abrasion, plaque buildup, and Candida albicans adherence.

At present, a new line of thermoplastic acetal, acrylic, nylon, and polycarbonate materials has been introduced. Thermoplastic dentures are excellent alternatives to conventionally used methyl methacrylate dentures; they provide excellent aesthetics and comfort and also adapt to the constant movement and flexibility in partially edentulous patients.

The therapeutic use of thermoplastic materials has increased drastically in the late decade. A new procedure, during which...
a fully polymerized basic material is softened by heat (without chemical changes) and injected afterward, has opened up a new chapter in making dentures.\[5\]

Thermoplastic acetal also known as polyoxymethylene (POM) derived from formaldehyde. These materials are presented as low molecular weighed (about 150,000) grains having low plasticizing temperature and higher rigidity.\[6\] The homopolymer, POM is a chain of alternating methyl groups linked by an oxygen molecule. Acetal resins are hard, tough, and rigid materials, which show a low coefficient of friction and have high resistance to fatigue. In industry, they are used at sites where wear of components is a problem.\[7,8\]

Acetal resins (POM-based materials) used in dentistry exhibits high flexibility, physical strength, heat and chemical resistance, and the exceedingly rare allergy response. Acetal resins show limited water sorption, exhibit lower creep, and superior abrasion resistance with higher surface luster than nylons. The higher stiffness of acetal resin supports conventional clasp designs, connectors, and other components with some compensation required.\[9\]

Acetal resin or POM is being used for esthetic purpose for denture base and clasps material and especially in individuals who are allergic to Co-Cr alloys as it has a property of biocompatibility.\[9,10\]

The material has been shown to have good biocompatibility, and this has fostered its use in total hip replacement and as an artificial heart valve prosthesis.\[7\]

The choice of thermoplastic acetal resin in the case is backed by its several advantageous mechanical properties, namely strength, resistance against warpage and fractures, and inherent flexibility.\[11-13\]

It is reported to have a sufficiently high resilience and modulus of elasticity, high impact strength, and resistance to organic solvents, oils, and hot and cold water,\[14\] which allows its use in the manufacture of retentive clasps, connectors, and support elements for removable partial dentures.\[15\]

Exploratory studies in the past have also highlighted the advantages of acetal resins over metal alloys which compared the modulus of elasticity of acetal resin (2.9–3.5 kN/mm\(^2\)) with that of Cr-Co alloy (22.43 kN/mm\(^2\)). His study suggested that acetal resin has superior flexibility, which allows its use in larger retentive undercuts such as in interproximal area.\[15-19\]

However, few disadvantages of acetal resin are needed to be accounted as well. One such disadvantage is to include a greater thickness of material required compared to metal clasps due to its lowered flexural modulus, which can cause plaque accumulation and affect gingival and periodontal health; hence, patient should be encouraged for hygiene maintenance.\[20,21\]

Many researches\[2,3,22-25\] had been carried out to study the properties of resins, however, until now there are little data available regarding the wearing resistance of the heat-cured acryic resin denture base material and acetal resin materials; therefore, this study is aimed to compare the wear resistance of heat-cured acrylic resin denture base material and acetal resin material.

**MATERIALS AND METHODS**

Two different resin materials were used for this study, namely heat-cured acrylic denture base and acetal flexible resin material. Using G power 3.1 statistical program, the number of samples required for this study was seven specimens for each test depending on acceptable level of statistical significance \(P < 0.05\). The power of the study will be equal 0.8 and effect size equal 0.5.

**Samples grouping**

- **Group I:** Seven specimens of acrylic resin material (Vertex TM, Netherlands) were fabricated with dimensions (15 mm in diameter × 2 mm thickness) according to ISO standard number 14569/2 [Figure 1a].
- **Group II:** Seven specimens of acetal flexible resin material (Biocetal, Roko, Poland) were fabricated with dimensions (15 mm in diameter × 2 mm thickness) according to ISO standard number 14569/2 [Figure 1b].

**Wear test**

The two-body wear testing will be performed using a programmable logic-controlled equipment using the newly developed four stations multimodal Dual-axis ROBOTA chewing simulator. The device allows simulation of the vertical and horizontal movements simultaneously in the thermodynamic condition. The chewing simulator has four chambers, each chamber consists of an upper Jacob’s chuck as antagonist holder and a lower Teflon sample holder. All the samples will be tested under standard conditions. A weight of 700 g which is comparable to 7N of chewing force will be exerted. Samples will be subjected to a revolution of 10,000 cycles, which run approximately 54 min. After

**Figure 1:** (a) Acrylic resin specimens. (b) Acetal resin specimens
10,000 cycles, the samples will be removed from the holder, cleaned with running water, and followed by cleaning in ultrasonic cleaner for 2 min to remove any abraded particles from the surface of the samples before measuring. The weight will be checked to calculate the loss. Table 1 demonstrates the wear test parameters of the ROBOTA chewing simulator device.

Weight loss measurement will be done by weighing samples in the electronic analytical balance (Sartorius, Biopharmaceutical, and Laboratories, Germany) with an accuracy of 0.0001 g to show the difference in weight before and after wear test. As this electronic balance had a fully automated calibration technology and a micro weighing scale, values of all the mounted discs and antagonist samples will be accurately measured. Each mounted sample will be cleaned and dried with tissue paper before weighing. To ensure accuracy, the balance will be kept on a free-standing table at all times away from vibrations and weighed the samples with the glass doors of the balance closed to avoid the effect of air drafts [Figure 2]. The collected data were statistically analyzed using SPSS software V20 for windows.

**RESULTS**

The mean values and standard deviations for weight measured in grams recorded on all materials before and after 4 months wear simulation cycles summarized in Table 2 and graphically represented in Figure 3. Weight recorded for the antagonistic enamel cusp is also shown.

For acrylic group, it was found that the weight mean value before wear was \( (0.155833 \pm 0.008 \text{ g}) \) while after wear simulation, the mean value was \( (0.154983 \pm 0.008 \text{ g}) \) with weight change mean value \( (0.00085 \pm 0.0002 \text{ g}) \) as shown in Table 2. The change in weight was statistically significant as validated by paired \( t \)-test \( (P \leq 0.0001 < 0.05) \).

For acetal group, it was found that the weight mean value before wear was \( (0.145658 \pm 0.005 \text{ g}) \) while after wear simulation, the mean value was \( (0.14495 \pm 0.0058 \text{ g}) \) with weight change mean value \( (0.000708 \pm 0.0002 \text{ g}) \) as shown in Table 2. The change in weight was statistically significant as validated by paired \( t \)-test \( (P \leq 0.0001 < 0.05) \).

The difference between weight changes recorded for groups was statistically non-significant as indicated by \( t \)-test \( (P = 0.0861 > 0.05) \).

**DISCUSSION**

For long decades, PMMA has dominated the field of denture base materials, but flexible dentures have emerged as a major competitor to PMMA dentures.\(^{[18]}\)

### Table 1: Wear test parameters of ROBOTA chewing simulator machine

<table>
<thead>
<tr>
<th>Wear test parameters</th>
<th>Vertical movement: 1 mm</th>
<th>Horizontal movement: 5 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rising speed: 90 mm/s</td>
<td>Forward speed: 90 mm/s</td>
<td></td>
</tr>
<tr>
<td>Descending speed: 40 mm/s</td>
<td>Backward speed: 40 mm/s</td>
<td></td>
</tr>
<tr>
<td>Cycle frequency 1.6 Hz</td>
<td>Weight per sample: From 700 g</td>
<td></td>
</tr>
<tr>
<td>Torque: 2.4 N.m</td>
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</table>

![Figure 2: Multimodal dual-axis ROBOTA chewing simulator](image)

![Figure 3: Weight mean values for all materials before and after 4 months wear simulation cycles](image)

Flexible dentures have got various advantages over the traditional rigid denture bases regarding esthetics, translucency, absence of clasp visibility in partial dentures, and flexibility which allow it to act as stress breaker and biocompatibility.\(^{[2,19,23]}\)

A systematic review of 143 articles shows that the thermoplastic material is an attractive modern material to use in prosthodontics due to its favorable chemical, mechanical, and physical properties.\(^{[2,3,23]}\)

PMMA resin surfaces are prone to indentation by different hard objects, which increase the abrasiveness and wear of
acrylic base material. These phenomena provide a favorable environment for fungal and bacterial colonization which is associated with several oral and general diseases. Several studies of denture base materials have demonstrated a direct link between acrylic surface abrasion, plaque buildup, and C. albicans adherence. Furthermore, surface roughness facilitates the adhesion of microorganisms to the restoration and tooth structure.

This in vitro study compared the amount of wear which occurred under same laboratory conditions between acrylic resin and acetal resin materials using a two-body wear testing machine.

Although this contact between the maxillary and mandibular dentures does not occur significantly during mastication of food, it normally occurs during swallowing and parafunctional habits that lead to wear of denture teeth. Therefore, the two-body wear test was selected in this study. As the oral cavity displays masticatory cycles ranging 5000–30,000 cycles in a month, to simulate this condition a wear cycle of 10,000 was selected. This was in accordance with study done by Hirano et al.

There was a statistically significant loss in the weight for the specimens of Group I (heat-cured acrylic resin group) \( (P < 0.05) \). Furthermore, there was a statistically significant loss in the weight for the specimens of Group II (acetal resin group) \( (P < 0.05) \).

However, there was no statistically significant difference in the weight loss between Group I and Group II \( (P > 0.05) \).

On the other hand, the results of the present study were not in accord with Hamanaka et al. who found that wear depth of PMMA conventional heat-polymerized denture-based polymer was significantly higher than that of other injection-molded thermoplastic denture base resins.

Based on the results of the present study, the acetal resin can be used as an alternative material to conventional heat-cured acrylic resin.

Little is known about the wear resistance of injection-molded thermoplastic denture base resins. An evaluation of the hardness and wear resistance of denture base resins is beneficial for clinical purposes because surface roughness has an effect on microbial adhesion to the surface. High surface roughness is caused by adhesive dental plaque and dental calculus among others.

Hence, this study recommended the surface roughness of injection-molded thermoplastic denture base resins for future work.

**CONCLUSIONS**

Within the limitation of the study, it was concluded that there was no statistically significant difference between the two groups regarding wear resistance so that the acetal resin can be used as alternative material to conventional heat-cured acrylic resin.

**REFERENCES**
