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# Acrylic Denture Basis' Long-Term Colour Stability

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## Abstract

**Objective**: This study investigated how staining solutions affected the acrylic denture bases' colour stability. **Materials and Methods**: Fifty-six samples of acrylic denture base (hot and cold) were submerged in distilled water for control and three staining solutions. A spectrophotometer was utilized to measure colour Before immersion, every sample's initial colour value was noted. Following a 24-hour, one-week, and two-week immersion period, colour change values were calculated. **Results**: Hot coffee was the most preferred beverage, showing strong significance over both time periods (P = 0.002 for 24 hours, P = 0.013 for 1 week). This indicates a consistent preference for hot coffee. Karak and hibiscus demonstrated increasing preference over time, especially in their hot forms (P = 0.001 for hot Karak, P = 0.006 for hot hibiscus). This suggests that these drinks become more favored as habits develop. Comparison between 24-hour and 1-week data showed that coffee remained stable in preference, while Karak and hibiscus became more preferred over time. **Conclusion**: The denture base's discoloration rose in direct proportion to the immersion time, and the instant coffee solution was discovered to be the most chromogenic staining solution. To maintain the color stability of acrylic dentures, users should adopt good oral hygiene practices and minimize prolonged exposure to these beverages.

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## Introduction

One of the most popular materials for creating a denture base is acrylic, also known as polymethyl methacrylate [1]. due to its superior mechanical and physical characteristics. Its drawbacks, however, include brittleness and liquid absorption with extended usage, which could damage its mechanical qualities [2]. The polar characteristics of resin molecules are the main cause of liquid absorption, which makes PMMA denture base materials more susceptible to food consumption, liquid exposure, and staining from denture cleaners [3]. The colour match and the material's colour stability over time are the primary factors that determine whether an aesthetic restorative material is successful or not. One crucial characteristic of many materials used in dentistry is colour stability, or the capacity of the material to maintain its original colour over time in a particular environment [4]. Over time, a number of internal and external factors that impact the mechanical and physical characteristics of acrylic resin can cause colour change [5]. Beverages, such as black tea, coffee, cola drinks, and fruit juices, have been shown to discolor denture surfaces. These beverages may also impact the surface finish of the dentures [6]. An annual herbaceous plant, hibiscus grows vertically and can reach a height of roughly two meters. The plant's branches have a reddish-green colour. The simple leaves have serrated edges and long petioles. Reddish-green leaves in the style of palms [7]. One of the most valuable plants for the culinary and pharmaceutical industries is Hibiscus sabdariffa, which is used as a pleasant beverage, particularly after being sweetened with sugar. After concentration, the extract is regarded as a colourful and enhanced material for the unique flavour [8]. Karak tea, a popular beverage in the Middle East, is known for its robust flavor from black tea, sugar, milk, and a mixture of spices, including cloves, cardamom, cinnamon, and ginger.

This aromatic concoction offers several health benefits, primarily attributed to its individual components. Karak tea combines the health-promoting properties of black tea and various spices, offering antioxidant, digestive, anti-inflammatory, and metabolic benefits. However, mindful preparation and consumption are essential to maximize its advantages while minimizing potential drawbacks [9].

One of the most consumed drinks in the world, coffee is prized for its deep flavour and invigorating properties.It is made from roasted coffee beans, which come from the Coffee plant. The drink contains caffeine, a natural stimulant that helps boost energy and alertness. Coffee is consumed in various forms, including espresso, cappuccino, and instant coffee, and can be served hot or cold. In many cultures, coffee is not just a drink but also a social tradition, often enjoyed with friends, family, or during work breaks [10].

## Materials and Methods

This study aimed to evaluate the colour stability of acrylic denture bases. that were heat-cured and cold-cured using three widely consumed beverages as staining agents and distilled water as a control. Fifty-six (56) specimens were prepared with wax, separated into two primary classes based on the type of denture base material after being conventionally converted to acrylic. 28 specimens were prepared with heat cured acrylic resin and 28 specimens with cold cure acrylic resin. Each group was split up into four smaller groups, each with seven samples, based on the kind of staining solution that was submerged in it. In total, 7 specimens immersion in coffee, 7 specimens immersion in Karak tea, 7 specimens immersion in hibiscus tea and 7 specimens immersion in distilled water only as control for 24 hours, one week and two weeks.

**Mold Preparation**

For this study, brass matrices were manufactured to standardize the dimensions of the specimens (50 mm length, 20 mm wide, 2 mm thick). The brass matrixes were invested in a denture flask with type II stone cast, to obtain molds, which were used to manufacture the standardized specimens.

**Sample Preparation**

**Preparation of the heat cured acrylic samples**

The mold was prepared using the traditional flasking method for full dentures. Following the manufacturer's directions, all materials were combined and worked in each step, from packing and curing to finishing, polishing, and conditioning.

**Preparation of the cold cured acrylic samples**

Following the manufacturer's instructions, a 3:1 by volume mixture of polymer and monomer was used to create the necessary amount of self-cure acrylic resin (Italy).

**Preparing staining solutions**

According to the guidelines provided by the manufacturer, 250 mL of water was mixed with 5 g of coffee (Jordan), Karak tea (Jordan), and hibiscus tea (Saudi Arabia). The mixture was then put over a low heat and taken off before boiling. A paper filter was then used to filter the mixture. Every day, new solutions were made. Each time, the samples were carefully cleaned with soft toothbrush and water for 30 seconds to get rid of each debris from immersion [11].

**Spectrophotometer measurements**

Following polishing and finishing, the specimens were submerged in staining solutions and washed with room-temperature distilled water. As a control, untreated group specimens were employed. The colour change was measured with a spectrophotometer, after 24 hours, 1 week, and 2 weeks [12].

## Results (Tables 1-6 and Figures 1-3)

There was a statistically significant difference between cold and hot distilled water ($p = 0.041$).

The difference between hot and cold coffee was statistically significant ($p = 0.002$).

A difference between cold and hot hibiscus was observed ($p = 0.008$).

There was no statistically significant difference between cold and hot Karak ($p = 0.216$).

For distilled water, cold versus hot did not significantly affect consumption.

For coffee**,** karak, and hibiscus, the temperature did have a statistically significant effect, with cold drinks being preferred for Karak and hibiscus, and hot coffee being preferred over cold.

No significant difference was found between cold and hot variants for distilled water.

Hot coffee significantly differed from cold coffee, with hot coffee having a higher mean.

Hot Karak significantly differed from cold Karak, with hot Karak having a higher mean.

Hot hibiscus significantly differed from cold hibiscus, with hot hibiscus having a higher mean.

Hot beverages generally showed significant differences, except for distilled water (hot).

For cold beverages, distilled water showed the only significant difference for cold.

Karak and hibiscus showed differences for hot conditions.

Only cold coffee (cold), and hot and cold hibiscus showed statistically significant differences implying that time (24 hours versus 1 week) affected their consumption in meaningful ways.

Other beverages like distilled water and Karak did not show significant differences in either hot or cold conditions between 24 hours and 1 week.

There was a significant difference between cold and hot coffee, and hot Karak.

Hibiscus also showed significant differences for both cold and hot.

## Discussion

Since colour is regarded as a crucial component of any denture material, its stability during the course of the material's survival is seen as a key determinant of the success or failure of the prosthesis . All denture base materials were found to undergo colour changes, and these changes grew for every group during the immersion period. Denture base materials may change colour for a variety of reasons, which can be separated into intrinsic and extrinsic factors. These include the chemical makeup of the material, any remaining monomers, water absorption, the breakdown of intrinsic pigments, component leaching, stain accumulation, and surface roughness. Nevertheless, the types of food consumed are also important factors that contribute to colour stability over an extended length of time, in addition to polishing ability and material structure [13]. The base material used to make dentures is exposed to a variety of environments with fluctuating oral temperatures, salivary pH levels, and their constituents. It also has to come into contact with a number of foods, beverages, and drinks consumed at different temperatures, making it vulnerable to changes in its physical composition and appearance as a result of the absorption of various contaminants [14].

Colour stability is the ability of a material to hold onto its colour over time in a specific environment. It is thought to be an essential physical property of dental materials [15].

By forming micro cracks associated with absorption and hydrolytic degradation of the polymer, water molecules that are absorbed by acrylic resin function as plasticizers to weaken the material's mechanical resistance, causing linkage cleavage and the slow deterioration of its infrastructure [16].

Because coffee is typically utilized in vitro research, it was chosen as the staining material for this investigation. Because coffee is yellow-brown, tannic acid has been identified as the main staining agent [17].

The findings demonstrated that all denture material types utilized in this study had color changes after immersion in staining solution, depending on the length of time. This is likely since denture base materials collect deposits and stains in the same way as natural teeth, but that hard deposits and stains, like those from coffee, Karak, and hibiscus, are much harder to remove. The material's surface has a certain amount of porosity and surface roughness, as well as an organic mucin and inorganic.

The findings that demonstrated the surface characteristic, porosity that allows particles to accumulate and cause noticeable discoloration. This clarified the findings that

indicated notable distinctions between heat-cured and cold-cured acrylic resin.

The impact of solutions on the colour variations of denture base materials was found to be comparable in the current investigation. Coffee and hibiscus had the biggest colour change, whereas Karak showed the least. Compared to cold methyl methacrylate resin provisional materials, hot methyl methacrylate resin provisional materials were more colour stable [18].

## Conclusion

The following results were reached within the constraints of this investigation: 1. The denture base's discoloration rose in direct proportion to the immersion duration. 2. The instant coffee solution was determined to be the most chromogenic staining solution.

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Table 1. Results after 24 h.

| | | N | Mean | Standard Deviation | P-value |
|---|---|---|---|---|---|
| distilled water | Cold | 5 | 49.7840 | 4.48322 | 0.041 |
| | Hot | 5 | 38.3400 | 3.08086 | |
| coffee | Cold | 5 | 26.7760 | 6.21864 | 0.002 |
| | Hot | 5 | 56.7080 | 6.38243 | |
| Karak | Cold | 5 | 24.9640 | 3.65085 | 0.216 |
| | Hot | 5 | 26.1900 | 2.36219 | |
| Hibiscus | Cold | 5 | 29.1780 | 2.02280 | 0.008 |
| | Hot | 5 | 31.9700 | 1.41317 | |

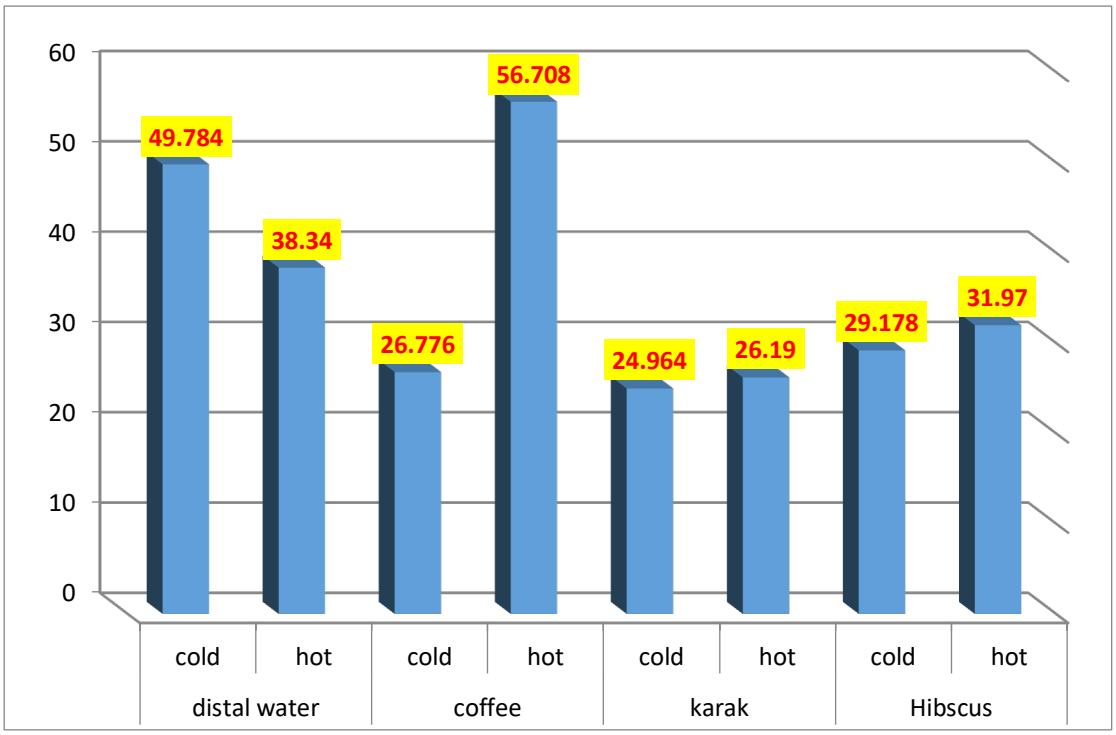


Figure 1. Average AE values that were acquired from samples that were immersed in various solutions for 24 h.

Table 2. Results after 1 week.

| | | N | Mean | Standard Deviation | P-value |
|---|---|---|---|---|---|
| distilled water | cold | 5 | 38.526 | 3.284 | 0.176 |
| | hot | 5 | 40.126 | 3.65267 | |
| coffee | cold | 5 | 32.75 | 2.64833 | 0.023 |
| | hot | 5 | 38.352 | 3.27629 | |
| Karak | cold | 5 | 19.112 | 3.60012 | 0.048 |
| | hot | 5 | 14.662 | 3.1038 | |
| Hibiscus | cold | 5 | 15.022 | 1.76379 | 0.047 |
| | hot | 5 | 21.25 | 4.64618 | |

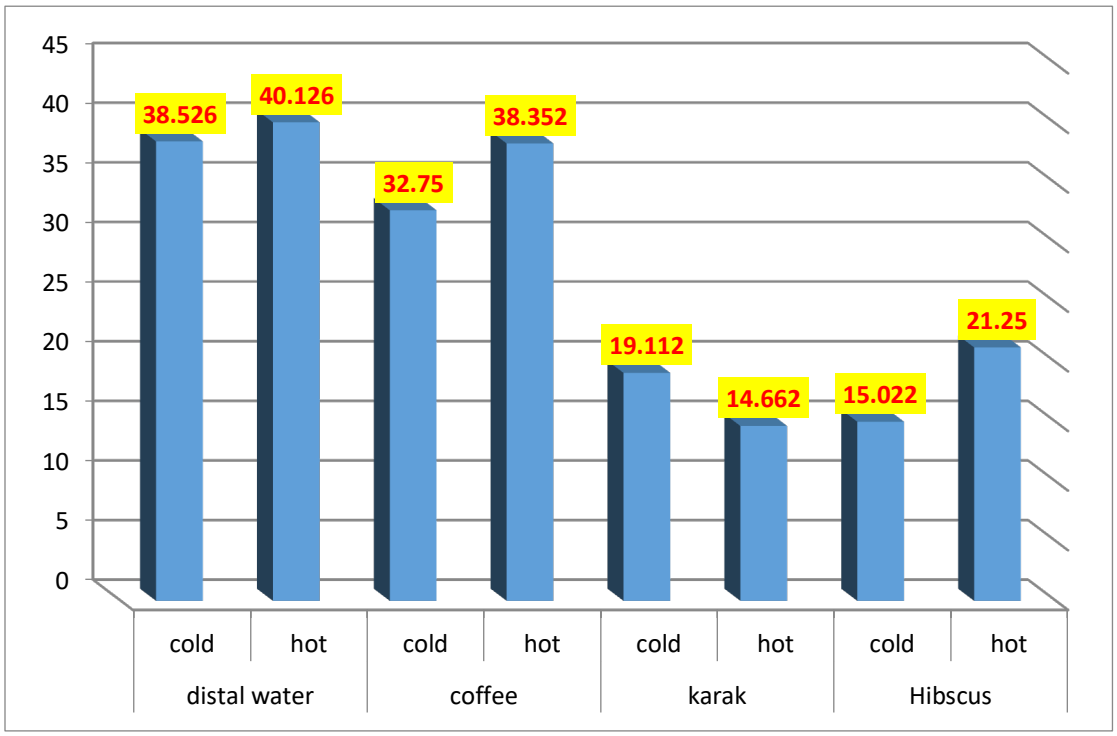


Figure 2. Average AE values derived from samples that were immersed in various solutions one week.

Table 3. Results after 2 weeks.

| | | N | Mean | Standard Deviation | P-value |
|---|---|---|---|---|---|
| distilled water | cold | 5 | 26.622 | 36.48096 | 0.324 |
| | hot | 5 | 27.282 | 37.3602 | |
| coffee | cold | 5 | 41.726 | 3.43239 | 0.000 |
| | hot | 5 | 57.896 | 3.49028 | |
| Karak | cold | 5 | 21.95 | 1.98813 | 0.045 |
| | hot | 5 | 24.384 | 2.0034 | |
| hibiscus | cold | 5 | 36.706 | 5.66449 | 0.005 |
| | hot | 5 | 55.08 | 3.71653 | |

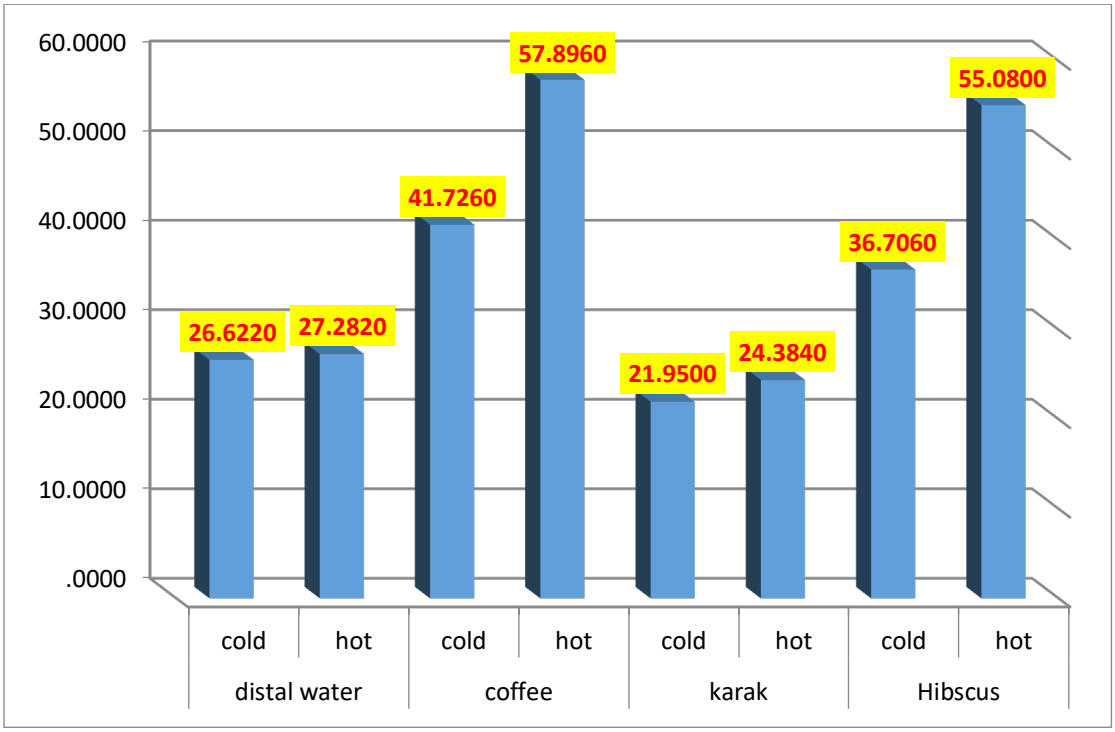


Figure 3. Mean AE values obtained from the samples soaked in different solution for two weeks.

Table 4. Comparison between 24 hours and 1 week.

| | | T | P-value |
|---|---|---|---|
| distilled water | 24hr-1 week (cold) | 2.335 | 0.047 |
| | 24hr-1 week (hot) | -1.589 | 0.187 |
| Coffee | 24hr-1 week (cold) | -2.342 | 0.049 |
| | 24hr-1 week (hot) | 4.306 | 0.013 |
| Karak | 24hr-1 week (cold) | 2.077 | 0.106 |
| | 24hr-1 week (hot) | 7.775 | 0.001 |
| Hibiscus | 24hr-1 week(cold) | 9.572 | 0.001 |
| | 24hr-1 week (hot) | 5.344 | 0.006 |

| Table 5. Comparison between 24 hours and 2 weeks. | | | |
|---|---|---|---|
| | | t | P-value |
| distilled water | 24hr -2 weeks (cold) | 1.568 | 0.192 |
| | 24hr -2 weeks (hot) | 0.894 | 0.422 |
| Coffee | 24hr-2 weeks (cold) | -4.283 | 0.013 |
| | 24hr-2 weeks (hot) | -0.327 | 0.76 |
| Karak | 24hr-2 weeks (cold) | 1.582 | 0.189 |
| | 24hr-2 weeks (hot) | 1.49 | 0.21 |
| Hibiscus | 24hr-2 weeks(cold) | -2.36 | 0.048 |
| | 24hr-1 week (hot) | -14.31 | 0.000 |

| Table 6. Comparison between 1 week and 2 weeks. | | | |
|---|---|---|---|
| | | t | P-value |
| distilled water | 1 week-2 weeks (cold) | 0.903 | 0.418 |
| | 1 week-2 weeks (hot) | 0.956 | 0.393 |
| Coffee | 1 week-2 weeks (cold) | -8.282 | 0.001 |
| | 1 week-2 weeks (hot) | -10.443 | 0.000 |
| Karak | 1 week-2 weeks (cold) | -1.225 | 0.288 |
| | 1 week-2 weeks (hot) | -6.905 | 0.002 |
| Hibiscus | 1 week-2 weeks (cold) | -10.852 | 0.000 |
| | 1 week-2 weeks (hot) | -9.541 | 0.001 |