

Research Article

The Effectiveness of Corn Starch Addition on the Dimensional Stability of Irreversible Hydrocolloid Impressions

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ABSTRACT

Introduction: Dental impression materials are classified as elastic and non-elastic, with irreversible hydrocolloid being one of the most widely used elastic types. It is favored for its ease of handling, patient comfort, ability to capture fine details, and hydrophilic nature that supports performance in moist conditions. However, ideal clinical procedures are not always feasible, and delays in processing may lead to dimensional changes. These alterations are mainly caused by imbibition and syneresis, which affect the material's stability. The addition of corn starch (*Zea mays*), containing amylose and amylopectin, may improve water absorption and reduce instability. This study aimed to assess the effect of corn starch incorporation on the dimensional stability of irreversible hydrocolloid impressions.

Materials and Methods: A laboratory experimental study with a post-test only control group design was conducted. Samples were divided into three groups: control (no starch), treatment with corn starch and 5-minute storage, and treatment with corn starch and 10-minute storage. Data was analyzed using ANOVA.

Results and Discussion: The findings indicated no statistically significant differences between the control and treatment groups in terms of dimensional stability. However, the addition of corn starch in appropriate proportions may improve the mechanical properties of the hydrocolloid gel, such as strength and hardness.

Conclusion: Corn starch addition contributes to maintaining dimensional stability after 5 and 10 minutes of storage, supporting better accuracy of the resulting diagnostic casts.

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INTRODUCTION

Dental impression materials are widely used in dental practice to produce negative replicas of teeth and surrounding tissues. To obtain accurate reproductions of intraoral and extraoral structures, the impression material must fulfill several criteria, including the ability to transition from a fluid to an elastic state within the oral cavity and to maintain dimensional stability until the casting process using gypsum material is performed. Based on elasticity characteristics and chemical composition, impression materials can be classified into elastic and non-elastic types. Among these, elastic impression materials of the irreversible hydrocolloid type are among the most commonly used by dentists in impression procedures.¹ Despite offering several advantages such as ease of use, affordability, and good surface detail reproduction, this material also has limitations that may affect the quality of the impression. One major drawback is its dimensional instability due to physicochemical properties. Irreversible hydrocolloid is highly sensitive to environmental conditions, particularly humidity and temperature. If the impression is not poured immediately with gypsum, dimensional changes may occur.²

Dimensional stability in irreversible hydrocolloid materials is influenced by syneresis and imbibition.³ Syneresis refers to the loss of water from the gel due to evaporation or exudation from the surface of the impression material, whereas imbibition is the absorption of water by the material. Irreversible hydrocolloid can function as a thickening or gel-forming agent through reactions with calcium ions.^{4,5} Irreversible hydrocolloid impression material contains alginate along with several other components. Literature studies indicate that alginic acid consists of L-guluronic acid and D-mannuronic acid, which play roles in regulating the strength,

elasticity, and stability of the impression material, thereby determining its physical characteristics.^{6,7} Impression materials are used to obtain negative reproductions of teeth and oral tissues. The resulting impressions are then cast with gypsum to produce working or study models that replicate the dentition.

One alternative material that can be used as an additive in irreversible hydrocolloid mixtures is corn starch. Natural materials such as starch or flour can be utilized as additives due to their similar characteristics, particularly their ability to form gels when reacting with water. Starch polysaccharides consist of two main components, amylose and amylopectin. These compounds play important roles in the gel formation mechanism through interactions with water, forming a gelatinized matrix structure.⁸

This mechanism underlies the use of starch as an additive component in modifying irreversible hydrocolloid impression materials, as it can influence the consistency and physical properties of the resulting gel. Such developments reflect ongoing efforts to improve the quality of impression results to meet the requirements for precision and reliability in clinical practice. This emphasizes that dental impression materials are not merely passive components in clinical procedures, but rather a continuously evolving field adapting to quality standards and sustainability principles in dental care.⁹

Previous studies have reported that both irreversible hydrocolloid and cassava starch contain polysaccharides composed of amylose and amylopectin chains.¹⁰ Furthermore, starch has been utilized as a thickening agent in sucmixtures.¹¹ The amylose and amylopectin content is approximately 17% in cassava starch, 20% in potato starch, 26% in sago starch, and 28% in corn starch.¹²

The high amylose and amylopectin content in corn starch enables its use as a mixture component in irreversible hydrocolloid, potentially minimizing dimensional changes in diagnostic models derived from such impressions. The ratio of amylose to amylopectin affects the degree of starch gelatinization; higher amylopectin content results in gels that are wetter, stickier, and tend to absorb less water.¹³

MATERIAL AND METHODS

This study employed a laboratory experimental design. The samples consisted of impressions produced from irreversible hydrocolloid and impressions made from irreversible hydrocolloid mixed with corn starch. Measurements were conducted at different time intervals (in minutes) to obtain mean values based on time variation, in order to determine whether the addition of corn starch influences the dimensional stability of irreversible hydrocolloid.

The materials used in this study included irreversible hydrocolloid (Hygedent) and corn starch (Maizenaku). The study consisted of three treatment groups: Group I (Control): Impressions made from irreversible hydrocolloid without the addition of corn starch. Group II: Impressions made from irreversible hydrocolloid with the addition of corn starch, stored at room temperature for 5 minutes. Group III: Impressions made from irreversible hydrocolloid with the addition of corn starch, stored at room temperature for 10 minutes.

After the impression procedures were completed, measurements were performed on the resulting impressions for each group. The data were then analyzed to determine the effect of corn starch addition on the dimensional stability of the impressions.

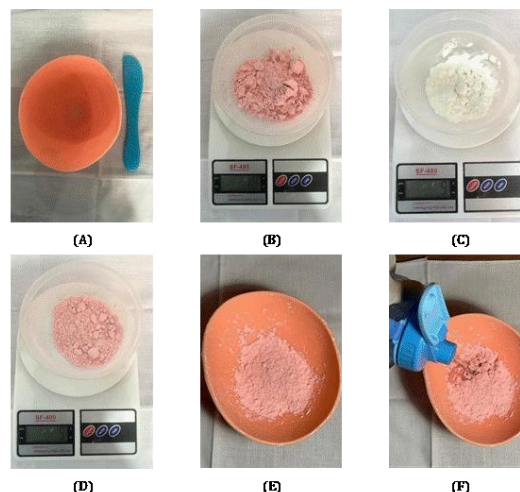


Figure 1. Preparation of Materials and Application of Powder-Liquid Components (A) Rubber bowl and spatula, (B) Irreversible hydrocolloid (18 g) for Group I, (C) Corn starch (9 g), (D) Irreversible hydrocolloid (9 g) (E) Mixed impression material: irreversible hydrocolloid and corn starch (18 g), (F) Application of Powder-Liquid Components

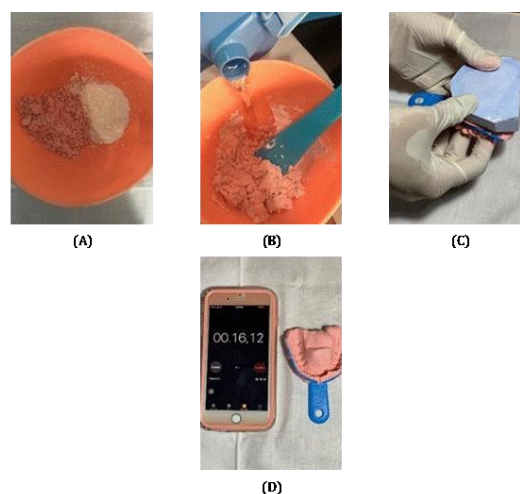


Figure 2. Impression Procedure and Time Measurement for Group II and III. (A) Mixing of irreversible hydrocolloid material and corn starch at a 1:1 ratio (9 g: 9 g), (B) Mixing of irreversible hydrocolloid material and corn starch at a 1:1 ratio (9 g: 9 g), (C) Impression of the master model using irreversible hydrocolloid material and corn starch at a 1:1 ratio (9 g: 9 g) (D) Time measurement using a stopwatch

The measurement of the impression results was performed to evaluate changes in dimensional stability by comparing the diameter of the master model using a digital caliper. This measurement

procedure was conducted on the impressions of teeth 16 and 26, and the mean value of both measurements was subsequently calculated to obtain representative data for the dimensional stability of the impressions.



Figure 3. Measurement of Impression Results Using a Digital Caliper

RESULTS AND DISCUSSIONS

The data obtained in this study were first subjected to a normality test using the Shapiro-Wilk test, which showed p -values > 0.05 ($p = 0.820; 0.763; 0.389$), indicating that the data were normally distributed. Furthermore, the homogeneity test yielded a p -value of 0.077 , which is greater than the significance level of 0.05 , indicating that the data had homogeneous variances. Subsequently, the data were analyzed using the One-Way ANOVA statistical test.

The results of the One-Way ANOVA test showed a p -value > 0.05 ($p = 0.259$), indicating that there was no statistically significant difference between the control group and the groups with the addition of corn starch in terms of dimensional stability changes of the alginate impression material.

Nevertheless, the addition of corn starch tended to improve the dimensional stability of the alginate impressions.¹⁴ The incorporation of starch in optimal proportions can enhance the strength and hardness of the irreversible hydrocolloid gel, produce a more homogeneous texture, and form a dense and stable gel surface.¹⁵ Therefore, the

addition of corn starch as a mixture component is considered effective in maintaining the dimensional stability of irreversible hydrocolloid impression results.

Table 1. Measurement Results of the Effect of Corn Starch on the Dimensional Stability of Irreversible Hydrocolloid Impressions

Group	Treatment Description	Mean \pm SD (mm)	p -value (ANOVA)
I (Control)	Without corn starch addition	10.975 \pm 0.052	0.259
II	With corn starch, stored 5 min	11.200 \pm 0.245	
III	With corn starch, stored 10 min	11.200 \pm 0.308	

Note: SD: standard deviation. Impressions were stored at room temperature under open conditions. No statistically significant difference was observed among groups ($p > 0.05$).

In this study, it was found that the addition of corn starch did not produce a statistically significant effect on the dimensional stability of irreversible hydrocolloid impressions. When irreversible hydrocolloid impressions are exposed to air at room temperature, shrinkage occurs due to syneresis. These findings are consistent with previous research by Ningsih, which reported that irreversible hydrocolloid undergoes dimensional changes because of both syneresis and imbibition processes. Furthermore, this study indicates that the addition of corn flour (*Zea mays*) to irreversible hydrocolloid may reduce and slow down the water absorption process.¹⁶ This occurs because corn flour contains amylose, which has a relatively low degree of gelatinization.

The incorporation of corn flour (*Zea mays*) into irreversible hydrocolloid impression material can influence the hydration process of the material, particularly its water absorption capacity within the colloidal system. Corn starch consists primarily of two components, amylose and amylopectin. Amylose is a linear polysaccharide with a lower tendency for gelatinization and granule swelling

compared to amylopectin.¹⁷ This characteristic results in starch granules with high amylose content having lower water absorption capacity and forming a more compact gel structure. Such conditions can inhibit water diffusion into the colloidal system, thereby slowing the water absorption process. Therefore, the addition of corn flour to irreversible hydrocolloid impression material has the potential to reduce the rate of water absorption and influence the physical properties of the material, including dimensional stability and the dynamics of the setting time. The increase in gel strength and hardness is associated with the high starch content. The addition of starch enhances resistance to deformation due to the formation of intermolecular polymer bonds.

This statement is consistent with findings reported by Noerdin et al., which demonstrated that polysaccharides in cassava flour can inhibit the hydration process of irreversible hydrocolloid. These polysaccharides, composed of amylose and amylopectin chains, were shown to improve dimensional stability over a longer period compared to irreversible hydrocolloid without the addition of cassava flour. High amylose content in starch is associated with significant water interaction capacity and contributes to the observed effects. The addition of fillers in appropriate proportions can enhance the strength and hardness of irreversible hydrocolloid gel, resulting in a smoother texture and ensuring a dense and stable gel surface. The role of such fillers is also to improve handling characteristics. Without fillers, the mixture tends to be excessively soft. Additionally, the formation of a sol system is influenced by the homogeneous dispersion of particles in an aqueous medium, forming a colloidal system. Additives present in corn starch function as thickening agents.¹⁸

In the pharmaceutical industry, corn starch is widely utilized in products such as cosmetics and

medicinal formulations. Based on the results of this study, no significant changes in dimensional stability were observed in irreversible hydrocolloid impression materials with the addition of corn starch across the tested groups. However, it can be concluded that the addition of corn starch (*Zea mays*) contributes to improved dimensional stability by slowing the processes of imbibition and syneresis in irreversible hydrocolloid impression materials.¹⁹

CONCLUSION

The addition of corn starch to irreversible hydrocolloid impressions was shown to influence dimensional stability after storage for 5 and 10 minutes. Modification of the impression material with corn starch was able to maintain dimensional stability at both observation intervals, thereby potentially improving the precision and accuracy of the resulting impressions.

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