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Original Research Article

Alginate Brand Comparison: A Study on Measurement and Hydration

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Abstract: Alginate, discovered in 1881 by British chemist E.C.C. Stanford, is a polysaccharide isolated from seaweed. Since its introduction into dentistry in 1940, it has been used as an impression material due to its hydrophilic and hydrophobic properties, which allow dimensional changes during impression and solidification. For optimal impression, type 3 plaster is recommended, which presents lower expansion and longer setting time, ensuring dimensional accuracy. In addition, the stability of the dental model is crucial, including mechanical and dimensional strength. Plastic and metal trays offer different advantages and disadvantages in impression taking. 126 plaster models made with 9 brands of alginates were reviewed: Super Gayz, Kromopan, Tulip, Cavex CA37, Alginoplast, Tropicalgin, Tulip Color Switch, Max Print Cyan and Biogel. The models were divided into three groups according to the type of tray: perforated plastic, perforated metal and smooth Rim Lock type. Each group was evaluated by gelation tests with room temperature water and cold water (4°C), using plaster types 2 and 3, and either removing the plaster immediately or after waiting 4 minutes. The distance between the central development groove of the lower left first molar and the central development groove of the lower right first molar was measured as 44.16 mm. When analyzing the perforated plastic trays with plaster types 2 and 3, the brands Super Gayz, Kromopan, Tulip, and others maintained an average of 44.15 mm with plaster type 2 and 44.15 mm with plaster type 3, showing consistent results in dimensional accuracy.

Keywords: Alginate, Dimensional Stability, Plaster Type 2, Plaster Type 3, Dental Spoon, Orthodontics.

INTRODUCTION

Alginate was discovered in 1881 by the British chemist ECC Stanford. He isolated alginate from seaweed and identified it as a polysaccharide. Since then, alginate has been found to be found in many species of seaweed, including red and green algae. (Don Sabores, 2024). These were adapted in 1940 to be used as a dental impression material belonging to the group of irreversible hydrocolloids, also called alginates. (Nicolás-De la Luz, I. G., & González-Medina, M. A., 2023). It has been recognized as a non-toxic, biodegradable and renewable biopolymer. But it has the quality of being hydrophilic and hydrophobic, which confers the possibility of having dimensional changes. (Hurtado, A., Selgas, R., & Serrano, A., 2020). These can occur during the printing and solidification phases of the material. The initial expansion occurs when the alginate absorbs water at the time of the union of the powder and water. The other moment is known as contraction, which occurs once the alginate has solidified and has been removed from the mouth, thus beginning a dehydration process.

Plasters for Impressions

In order to achieve the ideal impression, it is necessary to consider using the appropriate plaster. For irreversible hydrocolloids, type 3 plaster is considered to be the most suitable, as it has a longer setting time compared to other plasters, which is crucial to allow the alginate to solidify before pouring the plaster. It presents less expansion upon setting, which helps to maintain the dimensional accuracy of the dental model.

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Another type 2 plaster that is commonly used in orthodontics is when taking models with alginate as a diagnostic aid. As it contains hemihydrated calcium sulphate, it offers us adequate hardening and adequate precision of the teeth and oral tissues. However, when entering the initial expansion process, the plaster may expand slightly due to the crystallization of the hemihydrated calcium sulphate. Over time, the plaster may experience contraction due to the loss of water and the compaction of the crystals. (García, J. L., 2009).

Handling

Bazan-Collantes MJ, *et al*., report that all alginates expand and contract due to the phenomena of ambition and syneresis, since they are exposed to external factors such as room temperature, as well as they can be immersed in water. (Bazan-Collantes, M. J., & Guerrero-Vejarano, F. E., 2017). Torrecilla VR, *et al*., recommend that the gelation time of the alginate can be reduced if the hydrocolloid is exposed to a higher temperature, therefore it is recommended to cool the cup and the spatula at the time of mixing. (Torrecilla, V. R., Hierrezuelo, F. L., & Rodríguez, L. M., 2021) It has also been considered that the use of cold water when mixing can help to delay the gelation time, this is because the temperature affects the chemical reaction of the alginate with water.

Importance of Model Stability

The stability of a dental model is an important property to ensure its accuracy and usefulness. (Zhermack, 2024).

1. **Accuracy and Precision**:

The plaster must faithfully replicate the patient's intraoral condition without distortion. This is essential for accurately fitting fixed prostheses, such as bridges or crowns, to the prosthetic stumps.

2. **Dimensional Stability**: After setting, the plaster must maintain its properties of accuracy and precision over time. This is crucial to avoid deformations.

3. **Mechanical Resistance**: The plaster must be strong enough to withstand manipulations and applications of force during the manufacture of prostheses.

4. **Wear Resistance**: The model must maintain its integrity even after multiple uses and manipulations.

5. **Compatibility with Printing Materials**: It should work well with the printing materials used to obtain the negative mold.

6. **Model Completion Time**: An efficient process is essential for dental laboratory productivity.

7. **Color**: Although it does not directly affect stability, the colour of the plaster can influence the aesthetic appearance of the model.

Impression trays allow for the creation of a replica of the anatomical structures of the teeth and tissues of the mouth. They are available in a variety of materials, including plastic, perforated metal, and rim lock. There are significant differences between them. Metal trays are more rigid and stable due to the nature of the material, which is typically stainless steel or other metals. This can help maintain the shape during impression taking, minimizing accidental deformation and bending. Unlike plastic trays, which are more flexible, this can be advantageous in situations where the tray needs to be adapted to the patient's anatomy in a smoother and more comfortable manner. However, flexibility can result in less stability during impression taking. This can result in impression models that may not be as dimensionally accurate as those obtained with metal trays. (Fuenmayor-Vinueza, O. A., & Moya-Vaca, K. E., 2020) (Godoy, V. J., & Quintero, J. J., 2015) (Reyes López, C. F., 2001) (Torrecilla, V. R., Hierrezuelo, F. L., & Rodríguez, L. M., 2021).

MATERIALS AND METHODS

Type of Study:

descriptive, quantitative, longitudinal, risk-free. Study universe: sample size: 10 brands of dental alginates, divided into 2 irrigation groups, one at room temperature and one at 4°C, 3 dental spoon groups and 2 plaster groups and two plaster run groups at 4 min and immediately after. Giving a total of 120 plaster models studied. Inclusion criteria: All alginate brands available in Mexico were included. Exclusion criteria: Alginate brands not available in Mexico. Elimination criteria: Alginate brands with expiration dates approaching or expired. Alginates were compared in spoons made of various materials.

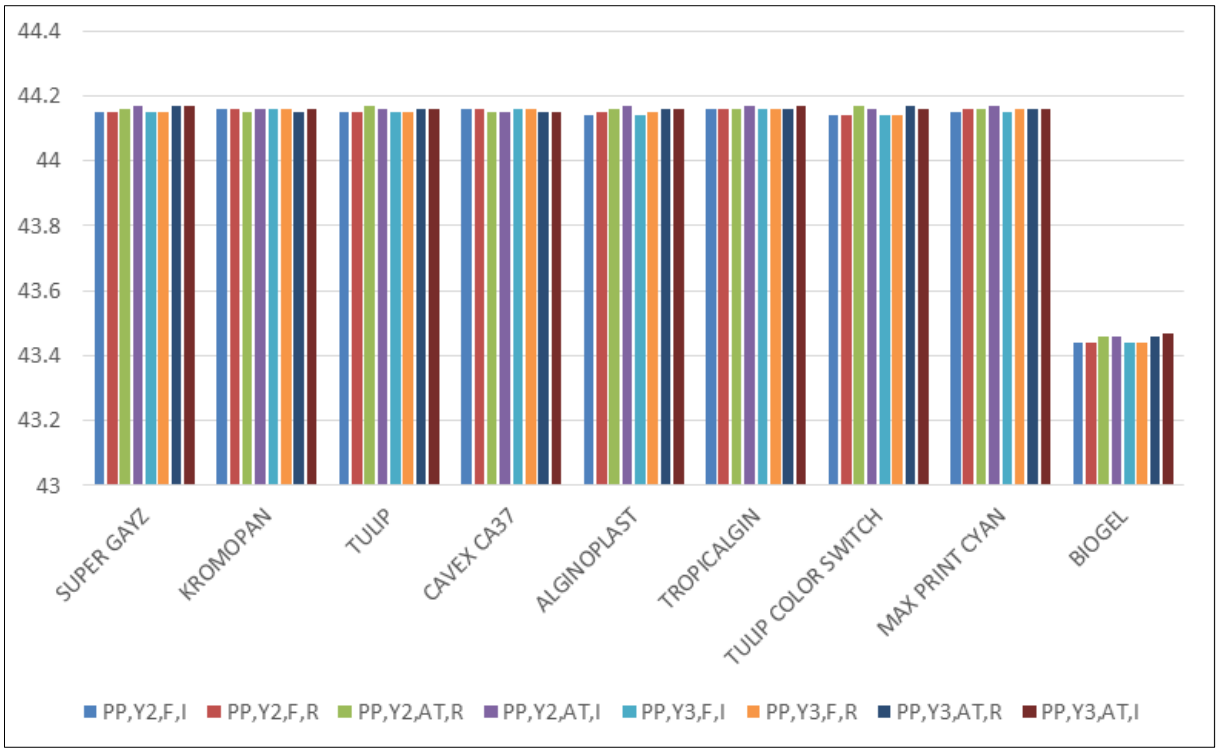
RESULTS

A total of 126 plaster models were reviewed using 9 commercial brands of alginates: super gayz, kromopan, tulip, cavex ca37, alginoplast, tropicalgin, tulip color switch, max print cyan and biogel, which were divided into 3 groups, the first taking impressions in perforated plastic trays, the second in perforated metal trays and the third using smooth Rim Lock type trays. Each group was evaluated by being subjected to different tests that included performing the gelation process using water at room temperature, cold water 4 ° C, being run in type 2 and type 3 plaster,and finally add the plaster immediately vs. waiting 4 minutes after taking the impression. Maintaining an average of 44.15 mm, measured from the central development groove of the first lower left molar to the central development groove of the first lower right molar, figure 1, figure 2.

Figure 1: Actual measurement taken on the patient, of the central development groove of the lower right first molar and the central development groove of the lower left first molar

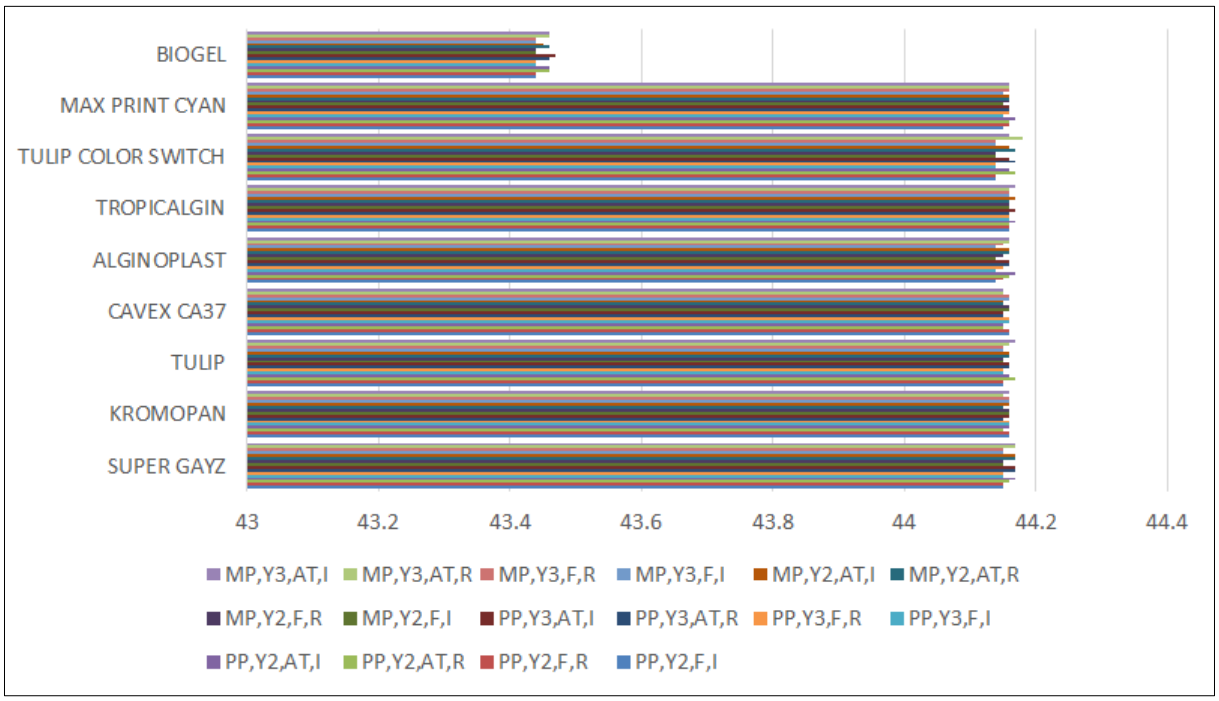
Figure 2: Measurement taken in type 2 plaster, of the central development groove of the lower right first molar and the central development groove of the lower left first molar

When checking the alginate brands using a perforated plastic spoon (PP), the plaster type 2 (Y2) and plaster type 3 (Y3) models were measured, being subjected to a gelation process with water at room temperature (AT) and water at cold temperature (F). Running the plaster immediately (I) and the recommended time of 4min (R). Demonstrating that the commercial brands Super Gayz, Kromopan, Tulip and Cavex CA37, Alginoplast, Tropicalgin, Tulip color switch and Max print cyan maintained an average of 44.15 mm, when measured with plaster type 2. While plaster type 3 demonstrated an average of 44.15 mm. On the other hand, Biogel alginate demonstrated to be the one that presented the lowest dimensional capacity by demonstrating results of 43.44 mm with a standard deviation of 0.3 mm. Graph 1.



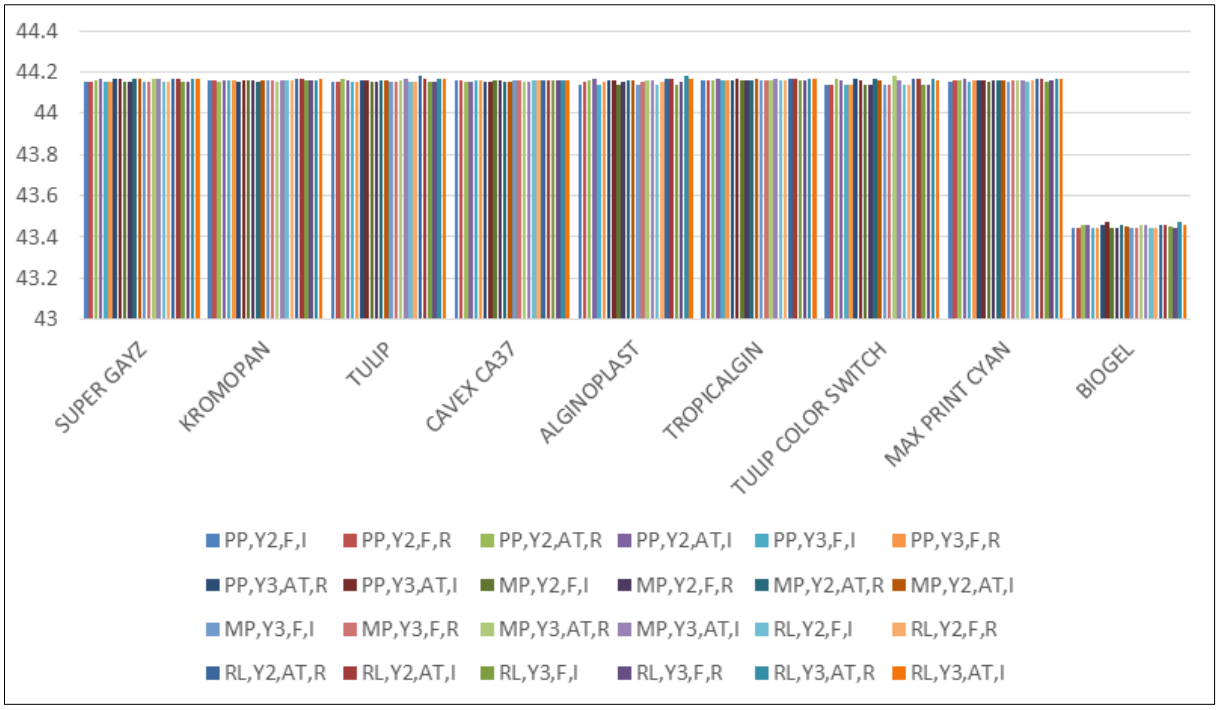
Graph 1: A comparison of alginates using a perforated plastic spoon is presented.

When checking the alginate brands using a perforated metal spoon (MP), the plaster type 2 (Y2) and plaster type 3 (Y3) models were measured, being subjected to a gelation process with water at room temperature (AT) and water at cold temperature (F). Running the plaster immediately (I) and the recommended time of 4 min (R). Demonstrating that the commercial brands Super Gayz, Kromopan, Tulip and Cavex CA37, Alginoplast, Tropicalgin, Tulip color switch and Max print cyan maintained an average of 44.15 mm, when measured with plaster type 2. While plaster type 3 demonstrated an average of 44.15 mm. On the other hand, Biogel alginate demonstrated to be the one with the lowest dimensional capacity by demonstrating results of 43.45 mm with a standard deviation of 10 mm. Graph 2.



Graph 2: A comparison of alginates using a perforated metal spoon is presented.

When checking the alginate brands using a smooth Rim Lock spoon (RL), the plaster type 2 (Y2) and plaster type 3 (Y3) models were measured, being subjected to a gelation process with water at room temperature (AT) and water at cold temperature (F). Running the plaster immediately (I) and the recommended time of 4 min (R). Demonstrating that the commercial brands Super Gayz, Kromopan, Tulip and Cavex CA37, Alginoplast, Tropicalgin, Tulip color switch and Max print cyan maintained an average of 44.16 mm, when measured with plaster type 2. While plaster type 3 demonstrated an average of 44.16 mm. On the other hand, Biogel alginate demonstrated to be the one with the lowest dimensional capacity by demonstrating results of 43.45 mm with a standard deviation of 0.2 mm. Graph 3.



Graph 3: A comparison of alginates using a smooth Rim Lock spoon is presented.

DISCUSSION

The study carried out by Navarro Quispe CF shows that there are greater dimensional changes when working at a temperature of 30c than at 10c. where the distance from canine to molar was measured where the nanometric discrepancy of contraction of 0.12 mm was measured, however, it was recognized that a standard measurement cannot be established between the groups since the samples are variables that cannot be controlled when changing the sample depending on the storage time, water temperature, etc. (Navarro Quispe, C. F., & Gonzales Sena, M. F., 2022). Bazan-Collantes MJ mentions that it is unknown which chromatic alginate remains longer without modifying its dimensional stability as offered by the manufacturer. (Bazan-Collantes, M. J., 2017).

García A, *et al.*, compared the dimensional stability of impressions taken with alginate using the conventional casting technique, showing that dimensional variations ranged from 0.24 to 0.91% at 0.24 and 96 hours. Two brands showed a smaller decrease in dimensional variations compared to 4 brands. (García, A., Mederos, M., De León, E., Vázquez, P., De los Ángeles, G. M., Suiffert, G., Pérez, S., Goinheix, R., & Grazioli, G., 2023).

CONCLUSION

The dimensional stability offered by the various brands of alginates available in Mexico allows us to establish a minimum discrepancy of 0.2-0.3 mm; however, we can determine that the BIO-GEL brand is not within the standardized average. Considering that all the commercial brands were analyzed and compared in plastic, perforated metal and Rim Lock type spoons with various hydrolysis methods at room temperature vs. cold hydration at 4°C, it demonstrates that the material maintains a constant stability, prolonging the gelation time during the manipulation of the material.

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