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# Evaluation Effect of Oyster Shell Powder on The Surface Hardness and Compressive Strength of Dental Stone

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**Abstract**

Aim: This study measured the surface hardness and compressive strength of dental stone after adding oyster shell powder. Materials and methods: Forty-eight specimens of dental stone were prepared for four groups (12 specimens for each group). The dental stone specimens, without addition, were the control group, the powder of oyster shell was added to the dental stones in the three experimental groups at various weight ratios of 3%, 5%, and 7%. For each group, compressive strength and surface hardness measurements were performed. Results: the results show that an increased ratio of oyster shell powder led to a significant increase in surface hardness. There was no significant difference in compressive strength value between the control group and the two experimental groups (incorporation of 3% and 5% oyster shell powder), while the addition of 7% oyster shell powder to dental stone caused a significant decrease in compressive strength ($P< 0.05$). Conclusion: - increase in surface hardness by increasing the weight ratio of oyster shell powder to dental stone. However, increasing the load of oyster shell powder by more than 5% decreased the compressive strength of dental stones.

## Introduction:

Molds and models are necessary for prosthetic rehabilitation and connect the clinical and laboratory phases needed for the production of dental prostheses (1).

Dental stone materials are essential materials in the construction of dental prostheses, such as a complete or partial denture or removable orthodontic appliance in clinical dentistry (2) . For the gypsum product to be utilized as a dental model, it must have an excellent surface hardness to withstand abrasion and scratches during the wax pattern sculpture process (3). The material's potential to withstand crushing when compressive tension is expressed in compressive strength, and the strength of gypsum products, such as dental stones, is an essential factor in the working principles of dentistry (4). Many efforts have been made to improve the quality of gypsum products by adding chemical components (5). Oyster shells are one of the most widely used materials in the fabrication of calcium supplements because they primarily contain calcium carbonates at a concentration of around 95%, followed by materials such as copper, nickel, cobalt, and iron oxide (6, 7). The oyster shell powder was readily available, inexpensive, simple to prepare, and had good biocompatibility.

## Materials and Methods:

**Designing of specimens**

special silicone mould made to prepare 12 cylindrical specimens, the measurement of each cylinder 40 mm in height and 20 mm in diameter figure (1) according to the ISO standard ( ISO 6873/2013 Dental gypsum products)(8).

**Control and experimental groups:**

Forty-eight specimens were obtained: 12 specimens for the control group and 36 specimens for the three experimental groups, divided according to the amount of oyster shell powder being added.

Group A: control group (100% dental stone)

Group B: 97% dental stone + 3% oyster shell powder

Group C: 95%dental stone + 5% oyster shell powder

Group D: 93%dental stone + 7% oyster shell powder

**Mixing and pouring of dental stone**

Dental stone (type III, Zhermack / Italy) and oyster shell powder (4oz, Terravita, United States) were weighted on a digital scale (BEL Engineering, Italy) according to the weight ratio of control and experimental groups.

The mixing of powder with distilled water was based on the manufacturer's recommended ratio (100 g/30 ml). The mixing of oyster shell powder with distilled water was accomplished by using a magnetic stirrer machine ( JOANLAB,China) to ensure an equal and uniform distribution of oyster shell powder, and then the dental stone was added to the mixture (distilled water and oyster shell powder) and hand-mixed for 10 to 15 seconds, then mechanically mixed by using a vacuum mixer ( Mestra , Spain) for 30 seconds to get a homogenous and avoiding air bubbles, smooth mixture. The mix was poured into the silicon mould and the specimens separated from the silicon mould after 1 hour, and the same calibrated operator produced all specimens.

**Surface hardness measurement**

Shore D tester (Time Group Inc., China) with an accuracy of 0-100HD figure (2) was used to make three indentations on the surface of each specimen to measure the surface hardness. These indentations' average values were computed (9, 10).

**Compressive strength measurement**

The compressive strength tests were performed with the computer-controlled electronic universal testing machine ( Instron universal testing machine, laryee WDW-50, China ) at a loading rate of 5KN /min figure (3) (11). specimens were crushed ,and the compressive strength determined from the value was obtained digitally by the computer. Digitalized readings were registered in Newton/mm$^2$ (MPa).

## Result:

The collected data were sent to Excel for graphic presentation and computerized statistical analysis using SPSS, version 21.

**Descriptive Statistics of surface hardness and compressive strength for all groups**

**In Table (1), figure (4) and figure (5)**, the results showed the mean and standard deviation of the surface hardness and compressive strength values of all groups. All specimen hardness test results were expressed in Shore D, the highest mean value of surface hardness was obtained in group D (79.66± 1.07).and the lowest mean value in group A(62.33±1.10).

While all specimen compressive test results were presented in Mpa, the highest mean value was (61.23±1.329) for group A, and the lowest mean value was (54.26±0.816) for group D

**Inferential statistic by Tukey – HSD test for studied groups**

**a- for surface hardness test**

**In Table (2),** further analysis was done by using the Tukey –HSD test .The result in the table showed that the differences in surface hardness among all groups were significant ($P< 0.05$).

**b- for compressive strength test**

**in Table (3),** The result shows a non-significant difference in compressive strength value among the groups (A and B groups, A and C groups, B and C groups), while the difference among the other groups was significant ($P< 0.05$).

## Discussion

**The effect of oyster shell powder on surface hardness**

Surface hardness testing is an important part of dental stone evaluation. A majority of individuals agree that during the shaping and finishing of the pattern or casting, the harder the stone, the stronger its resistance to wear and destruction (12).

Multiple studies have been performed to determine if these characteristics may be optimized by enhancing the cast or by adding other types of substances to the stone (11).

In the present study, adding Oyster shell powder with different concentrations (3%, 5%, and 7%) caused to increase in surface hardness; this may because about 95% of the oyster shells are made of calcium carbonates, with the remaining materials being copper, nickel, cobalt, and iron oxide (6). The fact that these calcium carbonate particles are porous increases their surface area, allowing for more crystallization space on the free surface (7).

**The effect of oyster shell powder on compressive strength**

Compressive strength plays a significant role in dentistry's working principles. One of the most crucial characteristics of dental stone castings is their adequate compressive strength, which enables them to sufficiently withstand applied forces during prosthetic laboratory processes and is influenced by additives (13-15).

According to the results, the oyster shell powder don't effect compressive mean value in low ratio of oyster powder 3% and 5%, but the soon negative effect when the ratios increase to 7%.

It's probable that the increase in the rate of additive powder may have caused the compression strength to decrease (the amount of gypsum crystals will decrease because of the higher concentration of additives in a given volume of gypsum material) so that a few of the hemihydrate crystals do not hydrate and become dehydrated crystals ( decrease inter crystallization cohesion), Consequently, the components ultimately contain more unreacted hemihydrates, which results in a weaker final product (16).

## Conclusion

In the present study, the addition of oyster shell powder to the dental stone in a weight ratio of 3%, 5%, and 7% led to an increase in the surface hardness of the dental stone. The addition of 3% and 5% does not affect compressive strength, while the addition of oyster shell powder to the dental stone in a weight ratio of 7% leads to a decrease in compressive strength.

**Figure (1): The silicon mould.**

. **Figure (2): The hardness test of the** specimen

**Figure (3): Compressive strength test.**

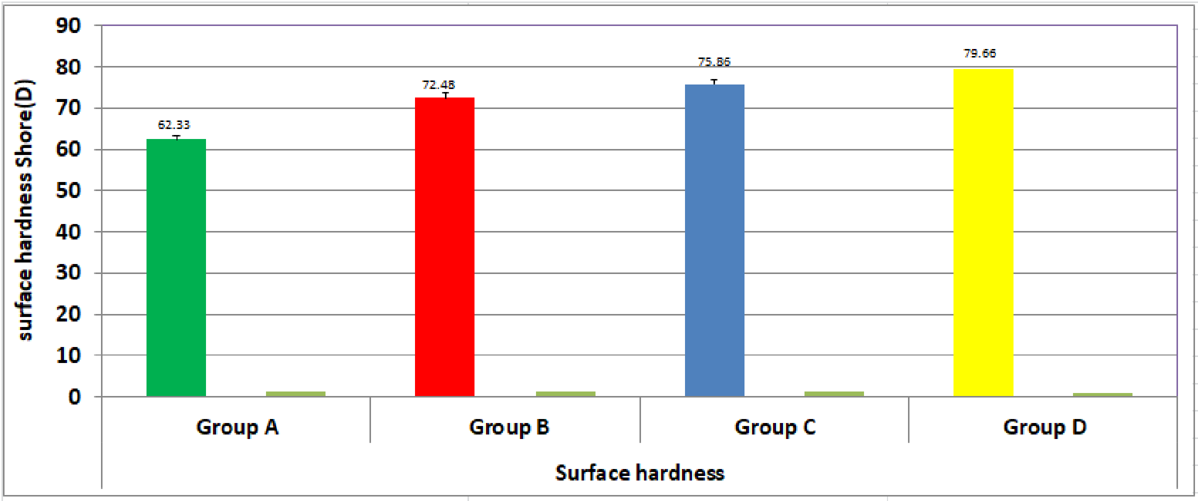


Figure (4): Bar –chart showing the mean values of surface hardness of all groups.

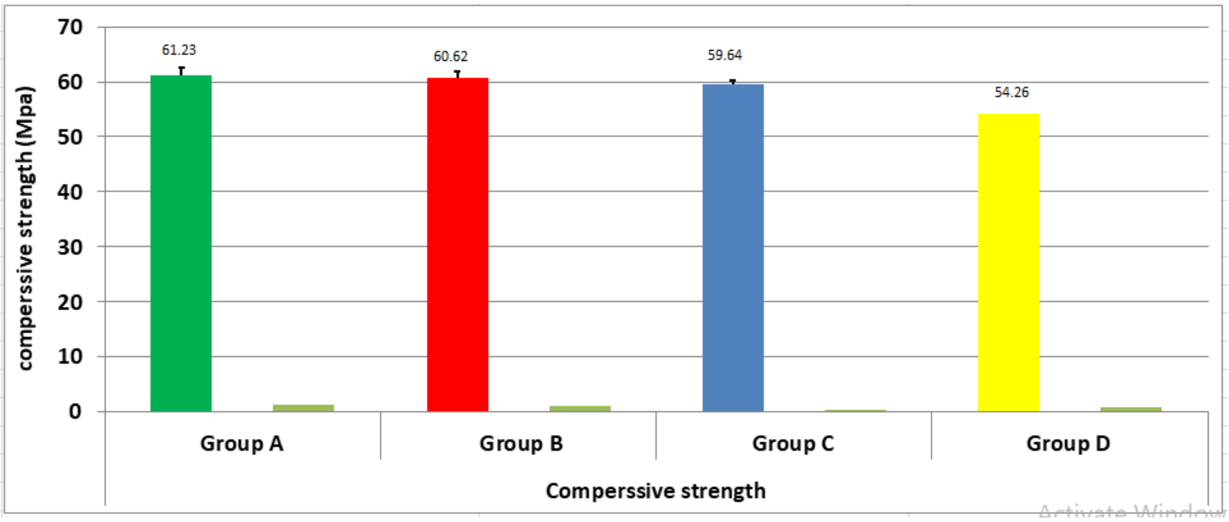


Figure (5): Bar –chart showing the mean values of compressive strength of all groups.

Table (1): Descriptive Statistics of surface hardness and compressive strength for all groups

| **Groups** | Surface hardness Shore (D) | | | Compressive strength ( Mpa) | | |
|---|---|---|---|---|---|---|
| | N | Mean | ±Std | N | Mean | ±Std |
| **A** | 12 | 62.33 | 1.10 | 12 | 61.23 | 1.329 |
| **B** | 12 | 72.48 | 1.15 | 12 | 60.62 | 1.224 |
| **C** | 12 | 75.86 | 1.15 | 12 | 59.64 | 0.516 |
| **D** | 12 | 79.66 | 1.07 | 12 | 54.26 | 0.816 |

Table (2): Inferential statistic by Tukey – HSD test for studied groups for surface hardness

| (I) Groups | (J) Groups | Mean Difference (I-J) | Std. Error | P-Value | Sig. |
|---|---|---|---|---|---|
| A | B | -10.15* | .50130 | .000 | S |
| | C | -13.53* | .50130 | .000 | S |
| | D | -17.33* | .50130 | .000 | S |
| B | C | -3.38* | .50130 | .000 | S |
| | D | -7.18* | .50130 | .000 | S |
| C | D | -3.80* | .50130 | .000 | S |

Difference is significant at the 0.05 level

Table (3) Inferential statistic by Tukey – HSD test for studied groups for compressive strength

| (I) Groups | (J) Groups | Mean Difference (I-J) | Std. Error | P-Value | Sig. |
|---|---|---|---|---|---|
| A | B | 0.605 | 0.59161 | 0.678 | NS |
| | C | 1.589 | 0.59161 | 0.085 | NS |
| | D | 6.963* | 0.59161 | 0.000 | S |
| B | C | 0.984 | 0.59161 | 0.509 | NS |
| | D | 6.358* | 0.5916 | 0.000 | S |
| C | D | 5.374* | 0.59161 | 0.000 | S |

Difference is significant at the 0.05 level

## References


1.Dias SC, Moysés MR, Agnelli JAM, Ávila GB, Ribeiro JCR, Pereira LJ. Impact fracture strength is applied to dental modeling materials.Brazilian Journal of Oral Scince.2016;6(21):1349-1352

2. Zarakani H, Karimi N, Sadriya S, and Fayaz A. Comparison of Setting Time, Setting Expansion, and Compressive Strength of Gypsum Casts Produced by Mixing Gypsum Powder with Distilled Water or 0.05% Sodium Hypochlorite. Journal of Dental School, Shahid Beheshti University of Medical Sciences. 2013;31(2):89-96.

3. Lindquist TJ, Stanford CM, Mostafavi H, and Xie X-J. Abrasion resistance of a resin-impregnated type IV gypsum in comparison to conventional products. The Journal of Prosthetic Dentistry. 2002;87(3):319-322.

4. De Cesero L, Mota EG, Burnett Jr LH, and Spohr AM. The influence of postpouring time on the roughness, compressive strength, and diametric tensile strength of dental stones The Journal of Prosthetic Dentistry. 2014;112(6):1573–1577.

5. Taqa AA, Mohammed NZ, and Bash TYK. The effect of adding some chemical materials on the compressive strength and surface hardness of dental stone Eastern Academic Journal. 2015, 4:104–110.

6. Young R. Mineral Supplements, Copper, Nickel, and Cobalt Content of Oyster Shells. Journal of Agricultural and Food Chemistry. 1960;8(6):485-486.

7. Yuzhi C, Shu L. Analysis of components in Os draconis and oyster shells. Journal of Fujian Medical College. 1999;33(4):432-434.

8. Hatim NA, Al-Khayat IK, Abdulla MA. Modification of gypsum products (Part II): the effect of drying methods on the compressive strength and surface hardness of modified gypsum products. Al-Rafidain Dental Journal. 2009;9(2):162-167.

9. Alraziqi ZNR. Water Temperature Effect on Hardness and Flexural Strength of (PMMA/TiO2 NPs) for Dental Applications. Baghdad Science Journal. 2022;19(4):922-931

10. Alwaeli WAA, Alsegar MAS. Influence of Different Disinfectants on Surface Hardness of Heat-Polymerized Acrylic Resins utilized for Orthodontic Appliance. Journal of Techniques. 2021;3(1):61-65.

11. Urapepon S, Sinavarat P, Suchatlampong C. Effect of die lubricants on the compressive strength and surface hardness of a die stone. M Dent J. 2015;35:111-116.

12. Anaraki MR, Moslehifard E, Bahari M, Mahboubi S. Effect of repeated microwave disinfection on surface hardness and dimensional accuracy of two dental stone materials. Advances in Bioscience and Clinical Medicine. 2015;3(1):17-24.

13. Abd Kati F, Yassin IN, Razak WA. Effect of adding some additives and drying method on compressive strength of gypsum products. TJDS. 2017;5(2):25-32.

14. Silva MABd, Vitti RP, Consani S, Sinhoreti MAC, Mesquita MF, and Consani RLX. Linear dimensional change, compressive strength, and detail reproduction in type IV dental stone dried at room temperature and in a microwave oven. Journal of Applied Oral Science, 2012, 20:588–593.

15. Salah A, Alnori AK, Elias MZ. Compressive strength of type IV dental stone with Ag nanoparticles. Al-Rafidain Dental Journal. 2019;19(1):60-69.

16. Lucas MG, Arioli-Filho JN, Nogueira SS, Batista AUD, Pereira RDP. Effect of incorporation of disinfectant solutions on setting time, linear dimensional stability, and detail reproduction in dental stone casts. Journal of Prosthodontics: Implant, Esthetic, and Reconstructive Dentistry. 2009;18(6):521-526.