



## **Effects of adding eggshell powder and medical mud powder on the mechanical Properties of type III of gypsum product**

Zahraa saad A. karkosh <sup>1</sup>, Mohammed. R. Abduljabbar <sup>2</sup>, Safa G. Dekan <sup>3</sup>, Nuha Agab Hamed <sup>4</sup>

zahraasaad282@yahoo.com

<sup>1</sup>College of dentistry, Ibn- Sina University of medical and pharmaceutical sciences, Iraq, Baghdad, clinical sciences department.

<sup>2</sup>College of Dentistry, Anbar University, Prosthodontics department.

<sup>3</sup>College of Dentistry, Ibn Sina University of Medical and Pharmaceutical Sciences, Iraq, Baghdad, Clinical sciences department.

<sup>4</sup>College of Dentistry, University of Anbar, Iraq, Department of Periodontics Dentistry.

### **ABSTRACT**

Since type III of gypsum product can also be susceptible to fracture by sudden blow, this can be prevented by adding reinforcing materials of eggshell powder with powder of medical mud. Furthermore, it can be used as a biocompatible reinforcing material due to the content of medical mud that has 34% alumina, 50% silica, as well as traces of iron oxide, magnesium, and lime material. Eggshell powder contains 95% calcium carbonate, 3% phosphorus, and 3% magnesium, along with traces of sodium, potassium, zinc, manganese, iron, and copper.

**Aim:** to determine the effect of in-cooperation of eggshell powder and medical mud powder to type III gypsum product.

**Subject and methods:** Forty samples were prepared by adding eggshell powder 2.5 % and 2.5 % of medical mud powder concentration to dental stone to measure impact strength and setting time.

**Results:** descriptive statistics used to interpret the data obtained in this search which showed an increase in the impact strength with decrease in setting time.

**Conclusion:** The addition of eggshell powder and medical mud powder to dental stone had a positive effect on some of the mechanical properties.

**Keywords:** dental stone, medical mud, impact, setting time.

### **INTRODUCTION**

Gypsum products classify as a natural, powdered white material known as calcium sulphate dihydrate with chemical formula  $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ , have many applications in dentistry. It could be

used as dental cast, die and investment material. However, it still has many drawbacks including the ability to fracture as it is considered a brittle material, especially by sudden blows like dropping from hands. [1]

Based on their characteristics and applications, the American Dental Association divides gypsum products into five types: impression plaster (type I), dental plaster (type II), dental stone (type III), enhanced stone (type IV), and high expansion improved stone (type V) (ADA 1985). [2]

These five types of gypsum products are produced according to how they are produced by manufacture which in turn changes the chemical composition of these products. [3-4]

A dental cast represents all details of patient mouth including teeth and associated structures.

The dental cast can be made from plaster or stone, however; the main difference between these two gypsum product types is the method of manufacturing rendering dental stones harder than dental plaster. [4-5]

It had been found that in-cooperation of eggshell powder in different fields of dentistry became increased for its high calcium content which helps in cases of bone defect regeneration, biocompatibility, also assist in the process of remineralization due to its high content of iron.[6]

Medical mud consists of a mixture of inorganic, organic, and water materials created by geological and biological processes under the influence of numerous physical and chemical variables. The organic content involved humic acid, fulvic acid, and acetic acid in addition to minerals like  $\text{Ca}^{2+}$ ,  $\text{Zn}^{2+}$ ,  $\text{Mg}^{2+}$ , and  $\text{Na}^{+}$ . [7]

### **Materials and methods:**

A total of 40 samples were prepared divided into two groups for each test. Ten samples as a control and ten samples had a mixture of 2.5% eggshell powder and 2.5% medical mud (modified samples) for measuring impact strength, and ten samples as control and ten modified samples for measuring initial and final setting time.

A pilot study was used to determine the most appropriate concentration for egg shell powder and medical mud powder, three different concentration were used (2.5mm, 5mm, 7.5mm), the results of impact strength showed decrease in impact strength as concentration increase, therefore; the 2.5mm concentration depended to be used in this study.

#### **Preparation of eggshell powder:**

According to Patents (US 20060062857 A1) eggshell powder [8] procedure was followed to create a pure powder with a higher alkalinity which was devoid of pathogens. Twenty five chicken eggs washed with distilled water, and then their membrane had been removed after 10 min of boiling the egg shell in hot water at  $100^{\circ}\text{C}$  then baked in an oven to  $1200^{\circ}\text{C}$ , eggshells smashed with (silver crest, grinding degree 30-300 with rotating speed 28000 r/ min), ground into tiny powder.

The process of smashing repeated twice to be sure of producing fine powder.

#### **Preparation of medical mud powder:**

The medical mud powder is made from milling the medical mud rocks with silver crest mill then sift the powder and again milled to produce fine powder, this process repeated three times.

### Preparation of samples:

The control samples were prepared by adding water to rubber bowl then powder into water left powder for 30 sec to ensure complete wetting of powder then start manual mixing, the powder \water ratio was mixed according to manufacture instructions. For study samples, involved measuring 2.5 wt. % of medical mud powder and 2.5wt. % of eggshell powder by electrical scale then manually mixed with dental stone powder, then process of mixing was same as control group. After that, poured the fresh mix into impact strength test mold which was prepared according to ADA specification No. 25 for Metallic mold with dimensions 40 mm in diameter and 10 mm in height. While for the setting time test, according to ASTM C266-03, a Gillmore needle was used, for initial setting time evaluating the needle of 2.12-mm was used with 113.4 grams. And for final setting time, the needle of 1.06-mm was used with 453.6 grams. The process of penetration of needle repeated till needle could not penetrate the dental stone surface. [9]

### Statistical analysis:

For each group it had been used normality test, standard deviation, mean T- test and P- value values were calculated. IBM® SPSS® Statistics Version 20 for Windows was equipped for the statistical analysis, and  $P \leq 0.05$  was the indication for significance level.

### Results:

The results of this study showed highly significant differences between control group and study group for both impact and setting time test.

FTIR results showed there were some changes that happened to the new mixture as in control group there were single bond region as appeared in red square, in Yellow Square there is double bond region while for additive group, the yellow and green squares showed there were fingerprint region which represent complex absorption that could involve one of these bond (C-C, C-N, C-O, C-X) that refer to halogen and this region did not found in control group.

Table 1: Normality test of impact strength among groups.

| Groups        | Shapiro-Wilk |    |       |
|---------------|--------------|----|-------|
|               | Statistic    | Df | Sig.  |
| Stone         | 0.864        | 10 | 0.073 |
| Stone+egg+Mud | 0.849        | 10 | 0.057 |

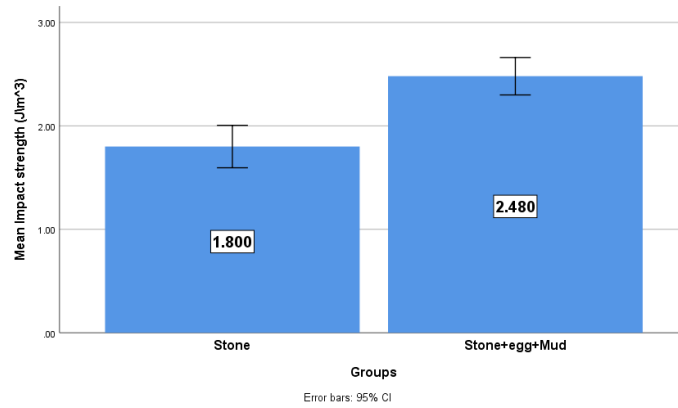


Figure (1): representing the meaning of impact strength between control and additive groups, the picture showed high difference between them.

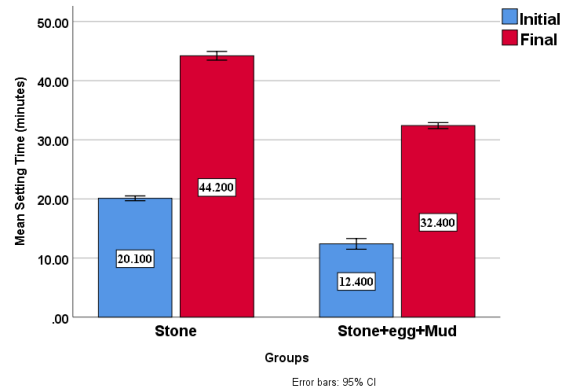


Figure (2): this picture represents the mean of setting time (initial and final setting time) that showed high significance between both groups.

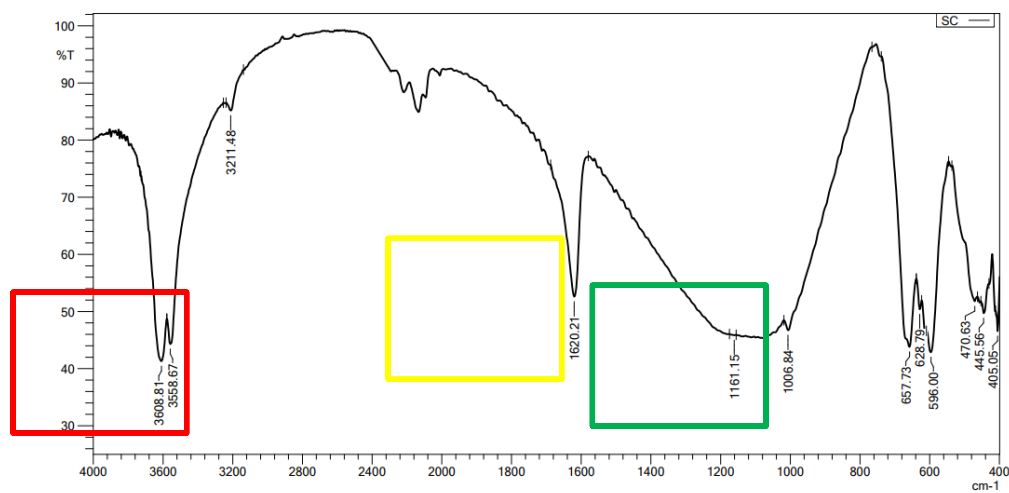


Figure (3): FTIR of control dental stone

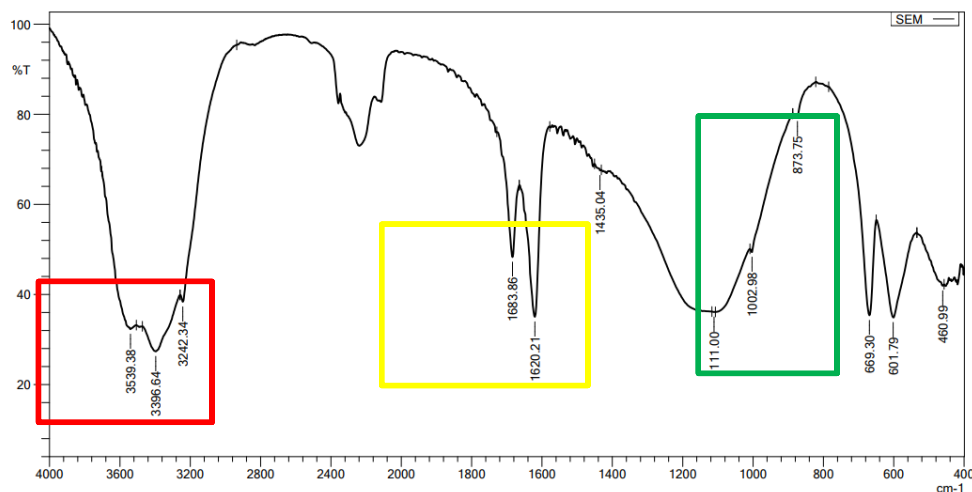


Figure (4): FTIR of additive stone sample

## Discussion:

One of the most important mechanical tests that are used to evaluate dental stone is surface hardness test. Harder stone means more resistance to wear and destruction during casting procedure, and consequently a finished dental pattern will be produced. [9] In this study the incorporation of medical mud and eggshell additives in dental stone resulted in statistically significant increase in impact strength of dental stone. This enhancement may be due to penetration of medical mud and eggshell additives in the space between calcium sulfate crystals of dental stone, and water absorption by them results in deposition of these particles in the existing space. This result agrees with L. De Cesero, et al., 2017. [9]

Also the addition of medical mud and egg shell powder results in reduction of water powder ratio by changing the adhesive force in contacting powder, which make the particles of powder more easily wetted by water and thus reducing the water requirement [10], and this reduction leads to the production of denser mass with improved impact strength. [11-12]

The second test to discuss is the setting time of dental stone. Adding medical mud and egg shell powder significantly reduced the initial and final setting time of modified dental stone, this can be explained by the fact that; during the setting reaction of dental stone a molecular bond is formed between calcium  $\text{Ca}^{2+}$  and sulfate ( $\text{SO}_4^-$ ) ions, which called the a nucleation process. After adding medical mud and eggshell powder, additional nucleus of crystallization will be created, therefore the modified dental stone will harden faster because of faster formation of dihydrated crystals by the increased number of crystallization nuclei. [12]

## CONCLUSION

The process of adding reinforcing material like eggshell and medical mud powders can improve mechanical properties of dental stone.

## SUGGESTIONS

As the number of samples was only 40 samples, it has been suggested to future study to increase sample size and involve other different mechanical tests.

## REFERENCES

- 1- Singh R, Singh K, Agrawal KK. A comparative study of physical properties of gypsums manufactured in India. *J Indian Prosthodont* 2013, SocDec;13(4):531-5. doi: 10.1007/s13191-012-0163-4. Epub 2012 Jul 29. PMID: 24431787; PMCID: PMC3792298.
- 2- Razak WA, Yassin IN, Kati FA, Effect of adding some additives and drying method on compressive strength of gypsum products. *Tikrit J Dent Sci* 2017. 5(2073–1213):25–32
- 3- Hamdy, T.M., Abdelnabi, A. & Abdelraouf, R.M. Reinforced dental plaster with low setting expansion and enhanced microhardness. *Bull Natl Res Cent* (2020) **44**, 78. <https://doi.org/10.1186/s42269-020-00334-8>
- 4- Abdulateef, M., Alfahdawi, I., Yaseen, A. 'Effect of Dental Stone Fluidity Properties, Compatibility with Impression Materials, and Detail Reproduction after Incorporation of 0.2% Chlorhexidine Solution', *Ain Shams Dental Journal* 2024, 34(2), pp. 49-56. doi: 10.21608/asdj.2024.272800.1219
- 5- Haghgoo R, Mehran M, Ahmadand M, Ahmadvand MJ Remineralization effect of eggshell versus nano-hydroxyapatite on caries-like lesions in permanent teeth (In vitro). *J Int Oral Health* 2016, 8(4):435–439.
- 6- Property of mud and its application in cosmetic and medical fields: a review. *Environmental Geochemistry and Health* 2022, 44 (11).
- 7- Moharam, L.M., Hassan, S.N. Effect of eggshell powder application on the shear bond strength of bulk-fill resin composite to bleached enamel. *Bull Natl Res Cent* 2021, **45**, 221 <https://doi.org/10.1186/s42269-021-00682-z>
- 8- Darmawan I, Willy O, Budiman JA. Setting time of construction gypsum, dental plaster, and white orthodontic gypsum. *J Dent Res Dent Clin Dent Prospects* 2021. Summer;14(3):167-170. doi: 10.34172/joddd.2020.036. Epub 2020 Sep 21. PMID: 33408821; PMCID: PMC7770402.
- 9- De Cesero L, de Oliveira EMN, Burnett Junior LH, Papaléo RM, Mota EG. The addition of silica nanoparticles on the mechanical properties of dental stone. *J Prosthet Dent* 2017. 118(4):535–539
- 10- Al-Hadad, A.S., Al-Huwaizi, A.F. and Al-Huwaizi, R.F. The Surface Hardness Measurement of Stone and Improved Die Stone After the Addition of a Mixture of Chemical Additives with Different Proportion. *Journal of baghdad college of dentistry* 2018, 30(1), pp.1-4
- 11- Manappallil JJ. Dental laboratory and processes. In: Manappallil, editor. Basic dental materials 2016. New Delhi: Jaypee Brothers Medical Publishers; 312-323
- 12- Taqa, A.A., Mohammed, N.Z. and Bash, T.Y., the effect of adding some chemical materials on the water powder ratio of dental stone running title: the effect of chemical materials on the dental stone. In International conference on multidisciplinary science 2024 (Vol. 2, No. 2, pp. 6-11).