The effect of particles size distribution of gypsum powder on cast surface roughness

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ABSTRACT

The aim of this study was to determine effect of particle size distribution on surface roughness of stone cast poured from two gypsum products (ZETA and QD). Ten samples from each gypsum product were prepared. Measurements of surface roughness were carried out by profilometer. The analysis of particle size distribution of the gypsum products tested was performed with sieving machine.

Analysis of variance and Duncan's multiple range test used for data analysis.

The result showed that particles size distributions of the two gypsum products were significant affect the surface roughness of stone cast.

It was concluded that the smoothest surface of stone cast was obtained from ZETA dental stone were attributed to the distribution of different size of stone particles.

Key Words: Surface roughness, particle size, profilometer.

الخلاصة

إن الهدف من هذه الدراسة هو تحديد تأثير توزيع حجم الجزيئات لمسحوق الجبس على خشونة سطح القالب الجبسي من منتوجين مختلفين من الجبس (ZETA , QD). تم تحضير عشر عينات لكل منتوج من الجبس ، حيث تم الخلط حسب تعليمات المصنع. تم قياس خشونة السطح باستعمال جهاز قياس خشونة السطح (Profilometer). تم استخدام ماكنة النخل لتحليل توزيع الحجم الجزيئي لمسحوق الجبس. تم التحليل الاحصائي للبيانات المتحصل عليها باستخدام التصميم العشوائي الكامل واستخدام اختبار دنكن المتعدد المدى لاختبار الفروقات المعنوية بين المتوسطات تحت مستوى احتمال (٥%). تم تعريف حجم الجزيئات لمسحوق الجبس بمخطط بياني (المنحنى التكراري). اظهرت نتائج الدراسة ان هناك اختلاف معنوي بين قيم خشونة اسطح قوالب الجبس وهناك اختلاف في توزيع الحجم الجزيئي بين مادتي الجبس المختلفتين. دلت النتائج ان اقل قيمة لخشونة السطح ظهرت من خلال صب الجبس من نوع (ZETA) ويعزى ذلك الى توزيع الحجم الجزيئي لتلك المادة.

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INTRODUCTION

The precision fabrication of dental prosthesis is directly dependent on the quality of the working cast [1].

Surface roughness of the set materials is related to the particle size the finer powder particle size permits a much smooth surface [2, 3]. Since the difference in particles size distribution affect the amount of water required for mixing and thus affecting the characters of the final set mass, such as porosity, density, surface roughness and other physical properties [4]. The differences in size and shape of the crystals and the interference and dispersed of small crystals among Lange crystals affect the quality of water necessary for mixing and consequently the density and compression strength of the set material [5].

MATERIALS AND METHODS

Two different dental stones type III were used in this study (Table 1).

Table (1): Gypsum products used in the study with manufacturers recommended water / powder ratio

Gypsum Products Trade Name	Manufactures	Batch Number	W / P Ratio
QD kaffir D	Quayle Dental ENGLAND		30/100
ZETA	Selenor ITALY	GSGIA 0701	31/100

Ten samples from each dental stone were prepared, the contents of gypsum powder container was agitated before used to insure uniform distribution of all ingredients. Sample were prepared by mixing powder with distilled water according to the manufactures recommended water/powder ratio, mechanically spatulated under vacuum for thirty seconds, then the mix was gently vibrated into glass slab and let to set for one hour at ambient temperature (23$\pm$2 C°) and relative humidity of (50$\pm$10%) and kept for twenty four hours later [6]. The surface roughness was measured with profilometer (Perthometer S5P, Perther, West Germany). Six measurement were made on each sample, each measurement was made over tracing distance of (1.5) mm. The roughness average (Ra) was selected to describe the surface roughness of the sample (Ra: is the arithmatic mean deviation of the profile from a mean line through the profile curve).

For analysis of particles size distribution of dental stones sieving machine (LABC, Laboratory Supply Company, D-6360 Friedberg, Germany) was used. Sieving machine consist of set of test sieves, (200) mm diameter of different sizes. The sieving procedure was performed, (100) gm of the dried powder was weighed and placed on the upper most largest sieve which was (250) μm in size and the rest of sieves were fitted beneath it according to decreasing size as follow (250), (150), (90), (45) and less then (45) μm respectively. Fraction retained on each sieve was weighed and recorded, sieve loss was determined and recorded [7]. Sieving procedure was carried out three times for each stone sample used. The statistical analysis of the data was performed with ANOVA, followed by Duncan's multiple range test to compare average roughness value (Ra) at $p \leq 0.05$ level of significance. The mean and the weight percentage were calculated for the analysis of the particles size distribution and represented graphically by the form of frequency curve.

RESULTS

The results of the Ra value of the stone samples of the two dental stones used that poured against glass are represented in tables (2, 3).

Table (2): ANOVA for the Ra value of the gypsum product samples (ZETA and QD stone) poured against glass

S.O.V	DF	MS	F
Gypsum Products	1	1.40	83.99
Error	18	0.02	
Total	19		

** Means are highly significant different at $p \leq 0.01$.

Table (3): Duncan multiple range test for the Ra value of the gypsum products samples (ZETA and QD stone) poured against glass

Gypsum Products	Mean ± SD	No.	Grouping
ZETA Stone	0.35 ± 0.05	10	A
QD Stone	0.88 ± 0.18	10	B

Means with different letters are significantly different.

The Ra value of the ZETA stone samples was significantly different from the Ra value of QD stone samples. The ZETA stone samples had a lower value indicating the smooth surface.

The results of particles size distribution of the gypsum powder are represented in tables (4, 5) and represented diagrammatically as frequency distribution curve (Figure 1, A and B).

The results showed that there were differences in the particle size distribution between the two different dental stone used. The particles that retained in sieve (150) um have the highest percentage for both dental stones. In addition to that ZETA stone sample had the high weight percentage of the particles retained in sieve sized (150) µm than that of QD dental stone.

Table (4): Particle size distribution of ZETA dental stone

ZETA Stone (100 gm*)		
Sieve size µm	Means weight retained (gm)	weight %
250	1.082	1.10
150	66.527	67.10
90	16.203	16.33
45	13.676	13.78
-45**	1.680	1.69
Total	99.168	100.00

* Original sample weight = 100 gm

** Sieves size less than 45µm

Table (5): Particle size distribution of QD dental stone

QD Stone (100 gm*)		
Sieve Size µm	Means Weight Retained (gm)	Weight %
250	0.842	0.85
150	53.718	54.00
90	5.701	5.73
45	27.427	27.57
-45**	11.783	11.85
Total	99.471	100.00

* Original sample weight = 100 gm

** Sieves size less than 45µm

DISCUSSION

The frequency curves of the particles size distribution that represented in figure (1 A and B) were skewed to the right indicated that most abundant size particles in the sample was large.

The results in this study showed that sample poured from ZETA stone have smoother surface than QD stone. It seems from the results that the differences in the particles size distribution could explain the differences between the surface roughness of the stone casts, since the differences in the particles size distribution affect the amount of water required for mixing and this may affect the physical property of the final mass such as porosity, density and surface roughness [4, 8, 9].

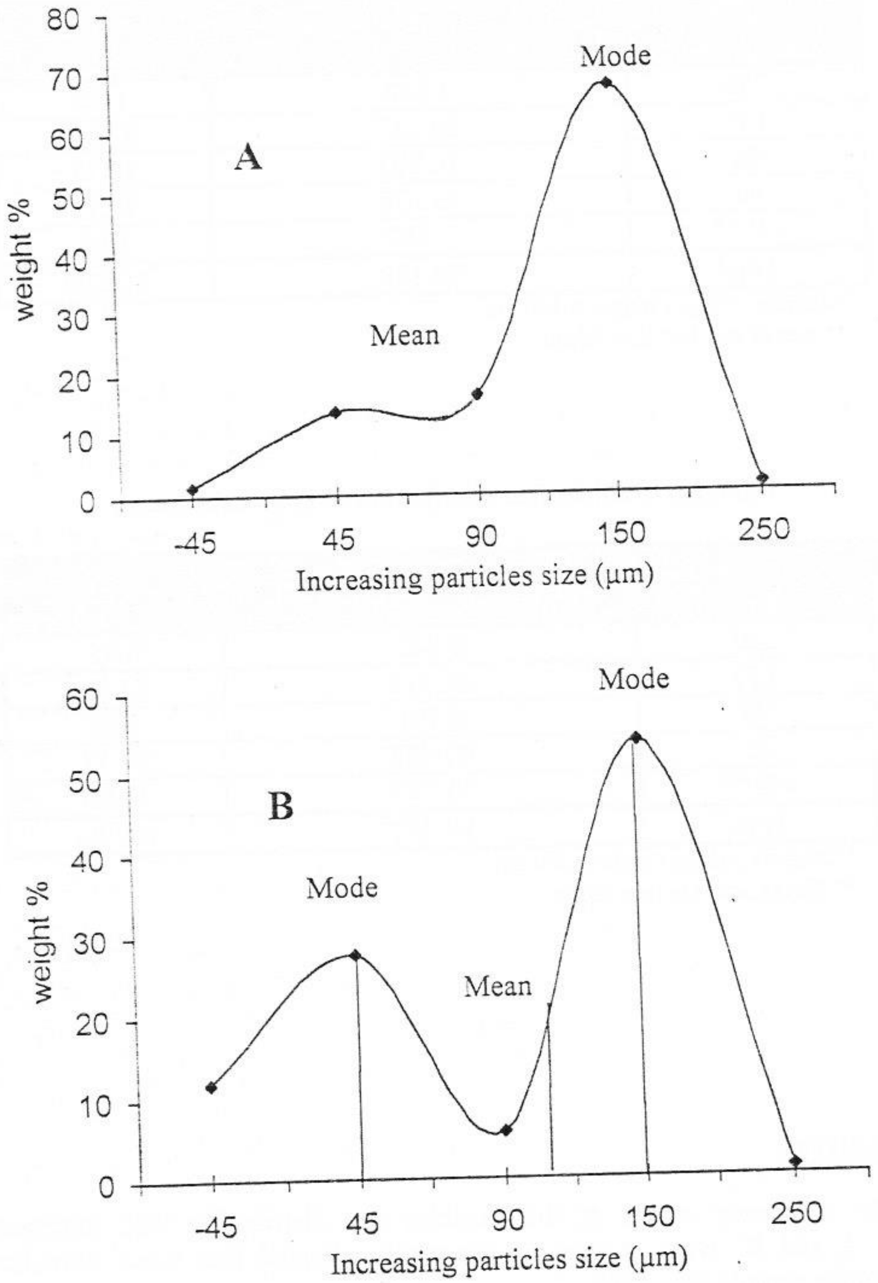

Figure (1): Frequency distribution curves
(A): Frequency distribution curve of ZETA stone.
(B): Frequency distribution curve of QD stone.

CONCLUSION

It was concluded that stone casts poured from ZETA dental stone were smoother than those poured from QD dental stone and the differences in particles size distribution could explain the differences in behavior between various commercial gypsum products.

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