Examination of the particle's shape, size and distribution of the commercial dental gypsum products

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ABSTRACT

Gypsum products used in dentistry are in the form of α and β calcium sulfate hemihydrate as dental stone and plaster.

The aim of the study is examination of the particle's shape, size and distribution of the different commercial dental gypsum products. The particle's shape was examined microscopically with transmitted light microscope instead of reflected light microscope or electron microscope. Analysis of the particle's size distribution and the measurement of the powder particle's fineness was performed by sieving procedure using sieving machine. The data was collected and calculated and then compared with the ADA Specification No. 25 for gypsum products.

The results showed that the microscopical examination with transmitted light microscope give clear accurate and precise image about the different shapes of the stone and plaster. The results of the analysis for particle's size distribution showed that there is a difference in the distribution between the different tested commercial dental gypsum products and also showed that all products have particle's size larger than the ADA Specification No. 25.

Key Words: Gypsum products, microscopical examination, particle's size.

الخلاصة

هناك نوعان من الجبس المستعمل في طب الأسنان: نوعα ونوع β واللذان يسميان بـ "الستون" و "البلاستر" السني.

هدف البحث هو دراسة شكل وحجم وكذلك توزيع حجم الجزيئات لمسحوق الجبس لأنواع تجارية مختلفة. لقد تمت دراسة شكل الجزيئات باستخدام مجهر الضوء الاعتيادي بدلا من مجهر الضوء المنعكس أو المجهر الإلكتروني ولقد تم إجراء تحليل توزيع حجم الجزيئات وقياس نعومة المسحوق باستخدام ماكنة النخل، وبعد احتساب النتائج تمت مقارنتها مع المقاييس المعتمدة عالمياً (ADA Specification No. 25).

أظهرت النتائج دقة ووضوح الصور لشكل الجزيئات المختلف لنوعي الجبس "الستون" و "البلاستر" بواسطة مجهر الضوء الاعتيادي؛ وأظهرت نتائج تحليل توزيع حجم الجزيئات أن هناك فرق في التوزيع للأنواع التجارية لمادة الجبس السني والتي تم فحصها في هذه الدراسة وكذلك أظهرت النتائج أن جميع الأنواع تمتلك حجم جزيئات أكبر من المواصفات المعتمدة والمحددة عالمياً (ADA Specification No. 25).

INTRODUCTION

Gypsum products used in dentistry are based chemically upon calcium sulfate hemihydrate.[1–3] Depending on the method of dehydration from natural occurring calcium sulfate dihydrate, different forms of hemihydrate can be obtained which are α– and β– forms. β–hemi-hydrate forms known as dental plaster is irregular, porous and spongy; while α– form known as

dental stone is more regular and denser than β– form. Both products are subsequently modified by grinding.[4–6]

The differences in the particle's shape, size and distribution affect the water/ powder ratio thus affect the physical properties of set material.[7–9]

Various types of the gypsum products with their recommended particles size or fineness according to ADA Specification No. 25 for gypsum products are listed in Table (1).

The aims of the study were microscopical examination of the particle's shape of the α– and β– hemihydrate (stone and plaster) with transmitted light microscope instead of reflected light microscope or electron microscope; analysis of the particle's size distribution of the commercial dental gypsum products by sieving procedure and determination of the fineness of the gypsum products.

Table (1): Types of gypsum product according to ADA Specification No. 25[3, 6]

Types of Gypsum	Fineness Passes Sieve 150 μm (Weight %)
I. Plaster, Impression	98
II. Plaster, Model	98
III. Dental Stone	98
IV. Dental Stone, High Strength	98
V. Dental Stone, High Strength, High Expansion	98

MATERIALS AND METHODS

Microscopical Examination

Dental stone (ZETA, Italy) and dental plaster (AL–AHLEIA, Iraq) were tested microscopically in this study. The specimens were prepared by mixing 1 mg of dried powder with drop of "Taha Indicator" (which is a transparent fluid oil, used as a lubricant for sewing machine. Chemically is one of saturated cyclic hydrocarbones known as alkanes or cycloalkanes which is relatively inert, ordinarily do not react with most common acids, bases or oxidizing or reducing agents) on glass slide, then covered with coverslip, then examined under transmitted light microscope at (X 400).[10] The specimens were examined and photographed with (Olympus BH_2, Microphotograph, Japan).

Sieving Procedure

Sieving procedure was performed to investigate the particle's size distribution and fineness of the different commercial dental gypsum products which were two dental plasters (AL–AHLEIA, Iraq) and (AL–MALIGE, Iraq) and six different stones (ZETA, Italy), (QD, England), (KAFFIRE, England), (MEHECO, China), (FUJI ROCK, Japan) and die stone (SILKY ROCK, USA).

Sieving procedure was performed using sieving machine (LABC, Germany) that consists of set of sieves of different sizes.

One hundred gram of dried powder for each product was placed on the upper most largest sieve and the rest of the sieves were fitted beneath it as follow: 250 μm, 150 μm, 90 μm, 45 μm and less than 45 μm, respectively. Fraction retained on each sieve was weighted and recorded.[9, 11]

Sieving procedure was carried out three times for each product. Weight means and weight percentages were calculated and recorded to be compared with ADA Specification No. 25.

RESULTS AND DISCUSSION

Microcsopical Examination

The results of microscopical examination with transmitted light microscope by

using "Taha Indicator" of AL–AHLEIA plaster show the irregular, fibrous, porous particles that represent the β- form of calcium sulfate hemihydrate as shown in Figure (1), while the results of microscopical examination of ZETA stone show the more regular and denser prism–like particles which represent the α- form hemihydrate (Figure 2). This finding comes in agreement with the findings of other studies.[3, 4, 6, 12] The differences in the particle's shape affect the surface area per unit weight, so the α– hemihydrate have lower surface area per unit weight than β– hemihydrate and this permits the use of a lower water / powder ratio and so result in less porous, harder and stronger set mass for the dental stones.

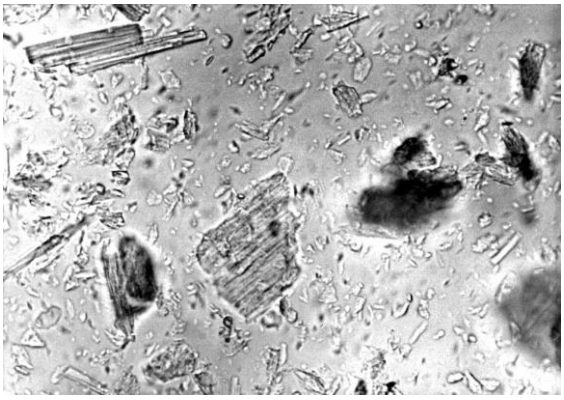

Figure (1): Microscopical examination of AL–AHLEIA plaster (Particles are irregular, fibrous and porous)

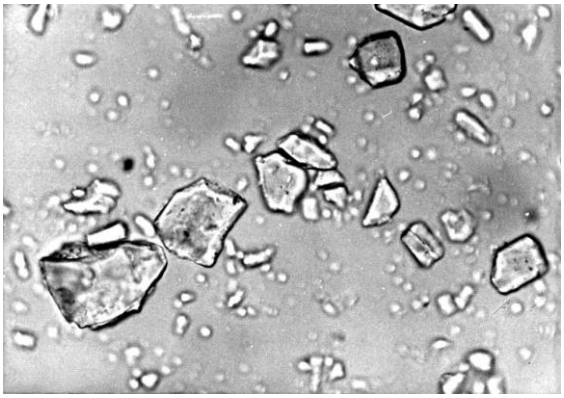

Figure (2): Microscopical examination of ZETA stone (Particles are regular, dense and prism–like)

The results of microscopical examination of the dried powder with transmitted light microscope by using "Taha Indicator" indicated that this simple and easy method give accurate, clear and precise images about particle's shape and could be of great benefit in the process of evaluation, comparison and differentiation between the different types of gypsum products and discovering the industrial deceit without needing to perform other tests to evaluate other physical properties of the material like setting time, setting expansion, compressive strength and so on. So it helps to save effort, time and cost, and also could be depend on it as a useful method in the studies and researches for evaluation, comparison and differ-entiation of the other dried powdered materials.

Particle's Size, Distribution and Fineness

The fineness and particle's size distribution of the tested materials are listed in Tables (2) and (3).

The results in Table (2) show that all tested products have weight percentage for fineness less than 98% of the ADA Specification that mean they have larger particle's size than required. Dental plasters have the lower values than of the stones; while AL–MALIGE has the lowest value.

The results in Table (3) appeared the differences in the particle's size distribution between the tested products; also showed that most of the particles of the two dental plasters and some of the dental stones which were ZETA, QD and KAFFIRE stones are large in size, while most of the particles of the other rest

tested stones are small in size.

Table (2): Fineness of the tested commercial dental gypsum products

Gypsum Products	Fineness Passes Sieve 150 µm (Weight %)
AL–MALIGE Plaster	11.94
AL–AHLEIA Plaster	24.43
ZETA Stone	31.8
QD Stone	45.15
KAFFIRE Stone	69.25
FUJI ROCK Stone	77.44
SILKY ROCK Die Stone	78.58
MEHECO Stone	93.24

Table (3): Particles size distribution of the tested commercial dental gypsum products

Sieve Size (µm)	Gypsum Products Weight Retained (%)							
	AL–MALIGE*	AL–AHLEIA*	ZETA*	QD*	KAFFIRE*	FUJI ROCK**	SILKY ROCK**	MEHECO**
250	0.33	0.36	1.1	0.85	0.84	0.43	1.11	0.32
150	87.73	75.21	67.1	54.0	29.91	22.13	20.31	6.44
90	7.47	14.78	16.33	5.73	15.25	26.41	26.5	18.91
45	4.2	9.51	13.78	27.57	50.19	36.12	35.87	42.97
–45* **	0.27	0.14	1.69	11.85	3.81	14.91	16.21	31.36
Total	100	100	100	100	100	100	100	100

* Most of the particles of the large size; ** Most of the particles of the small size;
*** Sieve size less than 45 µm.

From the results we could have the conclusion that the manufacturers that produce gypsum products can depend on the particle's size distribution through the interlocking or spreading of the small particles among the large one in such away that the total surface area can be regulated to control and reach the recommended required water / powder ratio, but fine particles are required to ensure accurate production of details in an impression;[3,7,13] so that the particle's shape, size and distribution must be put in attention considerably to produce material with physical properties within the accepted recommended values.

CONCLUSIONS

Microscopical examination of the dried gypsum powder with transmitted light microscope give accurate, clear and precise image of the different forms of α– and β– hemihydrate particles.

The fineness of the tested commercial gypsum products not agreed with ADA Specification No. 25. All products have larger particle's size.

There is a difference in the particle's size distribution between the different tested products.

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