

# Evaluation of Experimental Modelling Wax Manipulation Used in Constructing Maxillary Completely Edentulous Record Base

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## الخلاصة

**الأهداف:** تهدف الدراسة إلى تقييم التلاعب ودقة شموع العرض التجريبي المحضرة من شمع البارافين الصلب، بإضافة بعض المنتجات الطبيعية (شمع عسل طبيعي، نشا، وamaranth) وقورنث بالسيطرة (Polywax وشمع Major) ببناء قاعدة قياسية لفك علوي أورد كلياً. **المواد وطرائق العمل:** تم تحضير (36) عينة من شموع العرض التجريبيتين، ومقياس للمقابلة والتحقق (Polywax وشمع Major) وتقييمها بتحضير قالب خاص للقوس العلوي صنع من الجبس الصلب طبقاً لشكل العلامات التجارية المصنعة من شمع القاعدة الأساسية (شمع Major). كُتِل العينات (القاعدة العلوية القياسية) هُيئت وقيست بعد (1 hr، 24 hr، 48 hr). باستعمال برنامج Dimax. **النتائج:** أظهرت نتائج كُتِل شموع العرض التجريبي تحضيراً سهلاً، ماعدا العينة بالإضافة رقم 2 (90% شمع عسل + 10% نشا) التي أظهرت أقل تغييرات بعدية (0.17%) من الآخرين. **الاستنتاجات:** شمع العرض التجريبي رقم 1 (80% بارافين صلب + 20% شمع عسل) رقم 2 (90% شمع عسل + 10% نشا) كانت الأقرب في الصفات إلى مجموعة القياس لمنظمة أطباء الاسنان الأمريكية رقم 24 من الشموع الأخرى.

## ABSTRACT

**Aims:** The aims of this study were to evaluate the manipulation, and accuracy of the prepared experimental modeling waxes from hard paraffin wax, by adding some natural products (natural beeswax, starch, and amaranth) materials and compared with the control (Polywax and Major wax) by constructing maxillary completely edentulous record base. **Materials and Methods:** The manipulation of 36 samples of the two experimental modeling waxes and control (Polywax and Major wax) were evaluated by preparing a special mold of maxillary arch made of die stone according to the form of manufacturing trademarks of base plate wax (Major wax). All samples (maxillary arch record base) were prepared and measured after 1hr, 24hr, and 48hr. by using Dimax program. **Results:** the results of all new experimental modeling waxes showed easy manipulation, except the sample with additives { experimental modeling wax No. 2 (90% beeswax + 10% starch)} which showed less dimensional changes (0.17%) from others. **Conclusions:** the experimental modeling wax No. 1 (80% hard paraffin + 20% beeswax) and experimental modeling wax No. 2 (90% beeswax + 10% starch) were closest in properties to control and ADA specification No. 24 than other waxes.

**Key words:** Record base, Experimental wax, Starch, Beeswax Sulaiman JM. Comparison Study for the

Hatim NA, Alubaidi AW, TaqaAA. Evaluation of Experimental Modelling Wax Manipulation Used in Constructing Maxillary Completely Edentulous Record Base. *Al-Rafidain Dent J.* 2013; 13(3): 372-379.

**Received:** 20/1/2010

**Sent to Referees:** 11/2/2010

**Accepted for Publication:** 13/4/2010

## INTRODUCTION

Pattern waxes include casting waxes, base plate waxes, inlay waxes, <sup>(1-3)</sup> and polymerizable waxes.<sup>(4)</sup> All pattern waxes had two major qualities, thermal change in dimension and tendency to warp or distort on standing, which create serious problems in their use whether an inlay, crown, or a complete denture construction.<sup>(5)</sup>

McCrorie<sup>(6)</sup> reported that the modelling and baseplate waxes are the most widely used dental materials. The easiness of manipulation, good sculpting properties and simplicity of wax pattern disposal, by boiling-out, probably account for modelling wax popularity as a pattern material.<sup>(7)</sup> Modelling waxes are used as a pattern material, for registration of jaw relationship

and in construction of dentures.<sup>(8)</sup> Heath *et al.*<sup>(9)</sup>, stated that the production of successful dentures necessitates the use of accurately fitted baseplate materials for recording of the jaw relationship and trial insertion of the waxed-up dentures. Starch is a versatile and cheap, and has many uses as thickener, water binder, emulsion stabilizer and gelling agent.<sup>(10)</sup> In a study made by Hatim *et al.*,<sup>(11)</sup> starch has been added to wax in order to prepare and modify different wax composition to find out the most suitable formula that has almost the same properties of dental modelling wax used in dentistry. The purposes of this study were to evaluate the manipulation, and accuracy of the prepared experimental

modeling waxes from hard paraffin wax, by adding some natural products (natural beeswax, starch, and amaranth) materials and compared with the control (Polywax and Major wax) by constructing maxillary completely edentulous record base.

### MATERIALS AND METHODS

In order to prepare the master stone model, a maxillary metal arch form (Model 41-45, Columbia Dentoform Corp, Long Island City, N.Y.) was used. Four reference marks were made in the metal model pyramid in shape in order to provide points for measurement (Figure 1).

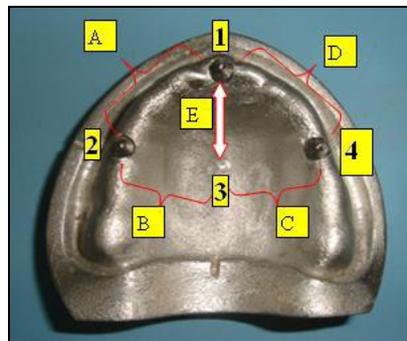


Figure (1): Maxillary metal arch with reference marks.

The reference marks located as follow:  
Reference mark (1): in the middle at the area of incisive papilla.  
Reference mark (2): in the area of the right second premolar.

Reference mark (3): in the center of hard palate at the mid palatine suture.  
Reference mark (4): in the left second premolar. The metal model is duplicated to stone model (Figure 2)



Figure(2): Impression and stone cast of metal model.

By taking an impression of metal model using perforated stock tray for maxillary arch. Polysiloxane impression material Type I (high and low viscosity) was

used to record the primary and secondary impression. The impression was allowed to polymerize at  $(20\pm 2)^\circ\text{C}$  and set for 1 hr at room temperature before pouring. The

impression then poured by dental stone and vibrated for 60 seconds and allowed to set in open air. After 2 hours, the stone model was removed from the impression and excess material trimmed off and become ready for use (36 samples).

To prepare mold for upper record base a rectangular frame of wax (16.5 x 10 x 2.5) cm. was made and used as a container. Vasaline was used as a separating medium before pouring the container with Elite stone, the powder liquid ratio of stone were mixed according to the manu-

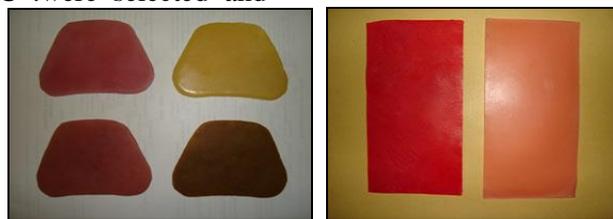
facture instructions, the frame was placed on vibrator and the mixing stone was gradually added to it, when the stone reached to the full length of container, a piece of commercial base plate wax (Major wax) of (1.5 mm) thickness was trimmed according to form of upper record base plate and placed in the center of the frame, then a glass slab of (15 x 7.5 x 0.5) cm was placed above it. After setting of stone (1 hr), the frame, glass slab and the piece of wax were removed and the stone mold ready for use<sup>(12)</sup> (Figure 3).



Figure(3): Stone mold.

Thin layer of separating medium (separating film for acrylic resin) placed over the entire mold to prevent the adhesion of record base to stone mold. Eighteenth samples of the two experimental modelling waxes were prepared in concentrations {80% hard paraffin + 20% beeswax(experimental modelling wax No.1)}, and {90% beeswax + 10% starch(experimental modelling wax No. 2)}<sup>(13)</sup>, and according to ADA<sup>(5)</sup>, and ADA Specification No. 24 and ISO 1561<sup>(14)</sup> coloring agent Amaranth have been added to wax mixtures in proportion of 0.02 % at 40°C .were selected and

melted in a metal pouring pan by using the water bath until become fluid and reach (75 ± 5) °C, at this temperature the fluid wax was poured in prepared stone mould. A glass slab (15 x 7.5 x 0.5) cm was placed over the mould and 5kg weight placed over it for 30 min, after that the glass slab and the weight were removed. The excess wax was trimmed off and the record base removed from the mold by chilling in tap water. The record base is stored at room temperature (20 ± 2) °C for 24 hours before testing its accuracy, (Figure 4).



Figure(4): A-Experimental modelling waxes.  
B- Commercial modelling waxes.

**Measuring maxillary record base accuracy:** Thin layer of separating medium (separating film for acrylic resin) placed over the entire (36) stone models. Thirty

six base plate waxes (Two experimental modeling waxes No. 1, and 2, and control Polywax and Major wax) were heated in a controlled water bath for 10 min at 45°C

in order to obtain uniform heating.<sup>(6,9)</sup> After that, the base plate waxes were removed from the water bath and adapted by finger pressure on stone model. Three long pins (3mm) prepared from 0.914 mm thick wire inserted perpendicularly by using dental surveyor in the record base at the reference marks of stone model. After that, the rec-

ord base separated from the stone model and became ready for measuring its accuracy. A stand held digital camera was placed (15 cm) away from the record base. A ruler (30 cm) long placed at (1 cm) distance from the record base was used as a reference point and to detect the accuracy of measurements (Figure 5, and 6).



Figure(5): Record base 15 cm away from camera.



Figure(6): Record base 1 cm away from ruler.

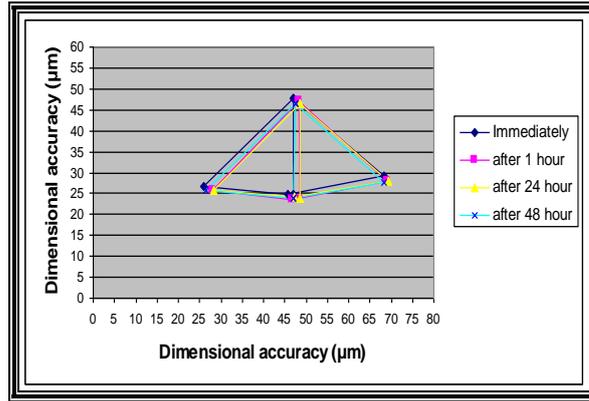
The lens of digital camera was vertical to the floor, and the pictures were taken for record base immediately after separation from the model, after 1 hr, after 24 hr and after 48 hr. The change in position of pins by the effect of time is measured by using Dimax program. The record base immediately after separation from the model was used as a control and the change in position of pins after 1 hr, 24 hr, and 48 hr was measured in accordance to the record base immediately after separation. The dimensional changes of the five

areas of record base (A, B, C, D and E) in Figure (1) were measured for each record base and for each time (1hr, 24hr and 48 hr) and the mean of five areas was measured as a percentage change for each record base.

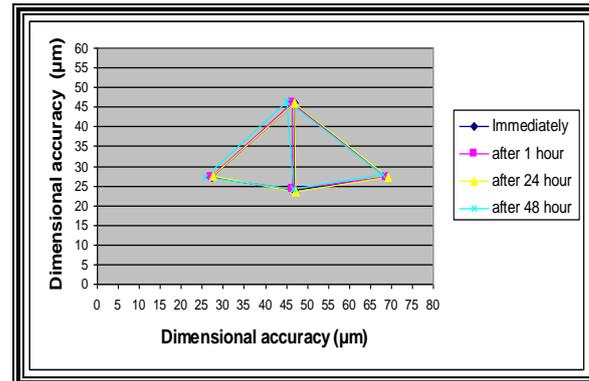
## RESULTS

The results of dimensional accuracy of thirty six maxillary completely edentulous record bases were obtained by using Dimax program as shown in Figure (7).

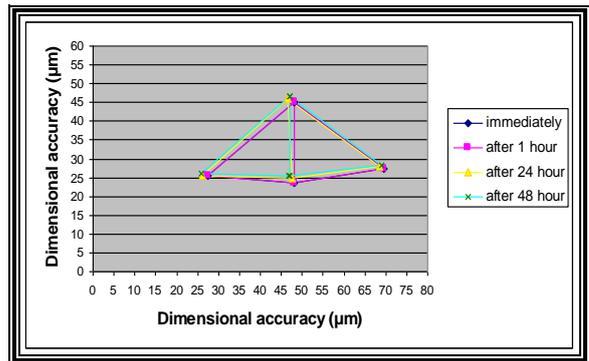
Manipulation of the Prepared Experimental Modelling Waxes



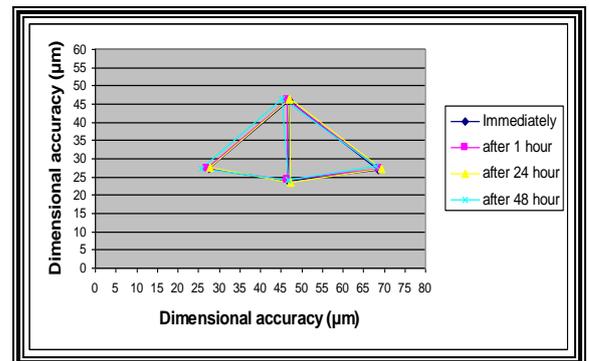
Polywax (Control 1)



Major wax (Control 2)



Experimental modelling wax (1).



Experimental modeling wax (2)

Figure (7): Dimensional accuracy of record base made from Control and experimental modelling waxes No.1 and 2.

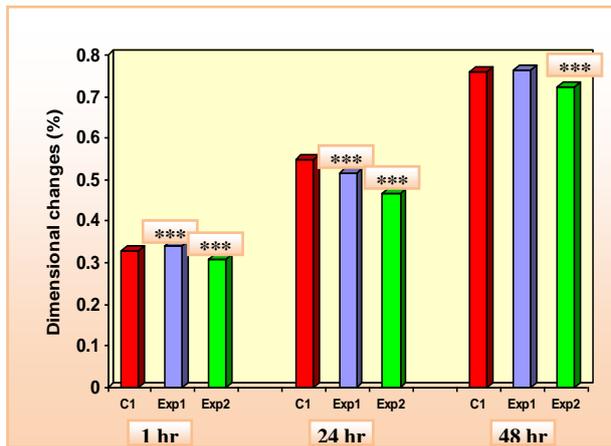
Number of samples, mean, and standard deviation of tested samples of accuracy after 1 hr, 24 hr and 48 hr of maxillary edentulous record base of control and ex-

perimental modelling wax No. 1 (80% hp + 20% bw) and No. 2 (90% bw + 10% starch) are listed in Table (1). Unpaired t-test, Figure (8).

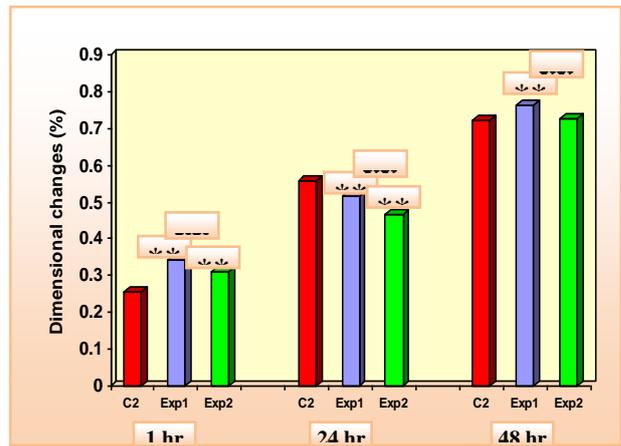
Table (1): Descriptive statistic for accuracy of maxillary edentulous record base after 1hr, 24hr and 48hr for control and experimental modelling waxes (No.1 and 2).

At hr	Group	Dimensional Changes (%)		
		N	Mean	SD
1hr	Polywax	3	0.327	0.0006
	Major	3	0.254	0.0004
	Experimental 1	3	0.341	0.0005
	Experimental 2	3	0.310	0.0025
24 hr	Polywax	3	0.55	0.0013
	Major	3	0.559	0.0026
	Experimental 1	3	0.516	0.0007
	Experimental 2	3	0.466	0.0031
48 hr	Polywax	3	0.759	0.0037
	Major	3	0.722	0.0028
	Experimental 1	3	0.763	0.0036
	Experimental 2	3	0.725	0.0047

SD: standard deviation N: number of samples



Control (1) and (Experimental 1)



Control (2) and (Experimental 2)

Figure (8): Unpaired t-test of accuracy of maxillary edentulous record base of control (1), and (2), and experimental modelling waxes No.1 and 2.

\*\*\* Significant difference from control 1, and 2 at  $p \leq 0.001$ ; xxx :significant difference from Exp1 at  $p \leq 0.001$  and xx at  $p \leq 0.01$ ; C1: control 1 (Polywax) C2: control 2 (Major) Exp1: Experimental modelling wax (1) Exp2: Experimental modelling wax (2)

Showed that there was a significant difference in dimensional changes of record base after 1hr and 24hr of experimental modelling waxes (No. 1 and 2) compared with control (Polywax and Major wax). There was a significant difference in dimensional changes of record base after 48 hr of experimental modelling wax No.2 compared with control (Polywax) and No.1 from control (Major wax). There was no significant difference in dimensional changes of record base after 48 hr of experimental modelling wax No.1 from control (Polywax) and No.2 from control (Major wax). Dimensional changes of experimental modelling wax No.2 after 1 hr, 24 hr and 48 hr were less than that of experimental modelling wax No.1 and control (Polywax).

### DISCUSSION

Table (1) and Figure (7) showed that the dimensional changes of experimental modelling waxes No.1 (80% hp + 20% bw) and No.2 (90% bw + 10% starch) were increased with increasing storage time. This can be explained as the waxes following molding are allowed to cool. During this cooling period, they may undergo potentially significant contraction due to high values of coefficient of expansion exhibited by these products. The thermal contraction may not fully exhibit immediately after cooling. The low thermal conductivity values of the materials result in solidification of surface layer of the wax well before the bulk becomes rigid. This reduces the magnitude of thermal contraction and produce significant internal stresses. Dimensional changes may occur due to relief of stresses.<sup>(15)</sup> Vieira<sup>(16)</sup> reported that the position of teeth is often changed, during the construction of denture bases, resulting in a modification of previously established occlusion and this may be due to the distortion of wax and base plate during storage on the model. Diwan *et al.*<sup>(17)</sup>, stated that the wax pattern should be started and completed in 1 hr or less in order to reduce the amount of distortion that occur with time. Figures (7 and 8) showed that the dimensional changes of experimental modelling wax No.2 were less than that of experimental modelling wax No.1. This may be due to

the effect of high percentage of beeswax in the composition of experimental modelling wax No.2 (90% beeswax + 10% starch). This is due to high melting point beeswax which makes the mixture flow less at room temperature, and due to the presence of strong secondary valence forces between the crystals of beeswax which required higher temperature to overcome these forces.<sup>(18)</sup>

Amaranth was used as coloring agent because of matching the colour of the control, and due to its source a plant with an upright growth habit cultivated for both its seeds which are used as a grain and its leaves which are used as a vegetable.<sup>(19)</sup> The anthocyanin (reddish) pigments in amaranth flour and vegetation appear to have great potential for competing with sugar beets as a source of natural, non-toxic red dyes. These pigments are used in food industry.<sup>(20)</sup>

### CONCLUSION

It was concluded that the experimental modelling waxes No.1 (80% hard paraffin + 20% beeswax) and No.2 (90% beeswax + 10% starch) were closest in properties to control and ADA specification No. 24.

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