



**COMPARATIVE ANALYSIS OF PHYSICAL PROPERTIES OF COMBINATIONS
OF MODELLING WAX WITH SOLIDUS WAX AT DIFFERENT RATIOS**

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ABSTRACT

Aim

To evaluate the dimensional accuracy, flow and melting points and setting temperatures of different combinations of modelling mixed with solidus wax in varied proportions

Materials and Method

Sheets of modelling (M) wax and solidus (S) wax were cut into samples of standardised dimensions of 4.5x4.5 cm and were divided into 5 groups. Waxes were heated and their melting point and their setting temperatures were recorded. The flow of waxes followed by evaluation of their dimensional stability was done.

Results

Performing this study showed that the shrinkage of 1M:2S combination of waxes is less on comparing with only Solidus wax which showed 1 mm of shrinkage.

Conclusion

It can be concluded that by incorporating modeling wax and solidus wax at a proportion of 1:2 into a mixture, one can obtain a material with the benefits of low shrinkage, adequate flow and good strength. Still further studies would be required to confirm the above results.

Keywords: Modelling Wax, Solidus Wax, Dimensional Accuracy, Flow, Melting Point

INTRODUCTION

Wax has been a valuable commodity for over 2000 years. In ancient times beeswax was used for softening skin, binding together reeds used for flutes, coating and preserving valuable objects, candle production, and making sculptures and statues of highly regarded public figures. Beeswax was derived from secretions that bees use to build honeycombs [1]. Although beeswax is still used today, modern waxes, such as those used to preserve furniture and automobile surfaces and those designed for dental procedures, are made from natural plant and animal sources; some types are derived synthetically from petroleum products and distillates. Synthetic waxes are typically composed of hydrogen, carbon, oxygen, and chlorine. Synthetic waxes are more uniform than natural waxes in their organic structure and more homogeneous in composition [2].

The major compositions of dentals waxes include paraffin wax, carnauba wax and beeswax. Modelling wax is simply a formulation of wax that is soft enough to be easily moulded by hand. They have a principle use in dentistry. They are used in the making occlusal rims, teeth setting etc [3]. Though they are widely used for the same, they have drawbacks such as post cooling shrinkage, warpage at cold

temperatures and also lesser dimensional stability [4, 5].

To overcome these drawbacks Solidus 84 has great stability which ensures they do not pull out of shape, even when fitting inside the mouth. It has good modelling features even though it is extremely hard. Solidus is also suitable as a bite wax. Solidus 84 is harder and the solidification point is at 84- 85 °C.

A wax that is best suited for dental purpose must have favourable handling characteristics and physical properties. It must have dimensional accuracy so as to have accuracy in the final prosthesis. At the same time, it must have adequate flow on melting. It must be able to melt and set within the desired temperature range that the procedure demands.

Hence the present study was conducted to develop a wax incorporating the properties of Modelling wax and Solidus wax so as to formulate a new wax with more favourable handling characteristics and dimensional stability.

The aim of the present study was to compare and evaluate the dimensional accuracy, flow, melting point and setting temperature of different ratios of Modelling wax with Solidus wax

The present study was conducted with the following objectives:

- 1) To compare and evaluate the dimensional accuracy of various combinations of Modelling wax and Solidus wax in different proportions.
- 2) To compare and evaluate the flow of various combinations of Modelling wax and Solidus wax in different proportions.
- 3) To compare and evaluate the melting point of various combinations of Modelling wax and Solidus wax in different proportions.
- 4) To compare and evaluate the setting temperature of various combinations of Modelling wax and Solidus wax in different proportions.
- 5) To come to a conclusion as to which combination of Modelling wax and Solidus has the most favourable handling characteristics and physical properties.

MATERIAL AND METHODOLOGY

In the current study, sheets of modelling wax (Hindustan®) and solidus wax (Yeti®) were cut into samples of standardised dimensions of 4.5x4.5 cm (**Figure 1**). Samples were divided into 5 groups:

[Modelling wax (M) Solidus was (S)]

Group I: 1 M: 1 S

Group II: 1 M: 2 S

Group III: 2 M: 1 S

Group IV: 2 M

Group V: 2 S

Waxes were subjected to melting in wax heater (Denstar®) in the proportions as given above and the melting points and the setting temperatures were recorded with a lab thermometer. The flow of waxes was evaluated by allowing the waxes of all groups to flow on a sloped glass slab, the slope of which was standardised by stabilising the glass slab at a fixed position at an angle of 45 degrees (**Figure 3**).

Putty index mold of standard dimension 4.5x1.5 cm (**Figure 2**) was made in which waxes from all the 5 groups were melted and poured and allowed to set. Following which the dimensions of the set waxes were assessed after 60 minutes.

RESULTS

The present study revealed that the melting temperature of only modelling wax was 55 °C which was the lowest (**Table 1**). Melting point for the combination of Modelling wax and Solidus wax in the ratio 1:2 was 78 °C which was the highest. The initial setting temperature for only the modelling wax was 48 °C which was the lowest. The initial setting temperature for the combination of Modelling wax and Solidus wax in the ratio 1:2 was 58 °C which was the highest. The final setting temperature did not vary much

between the groups and was within the range of 44 to 49 °C. Flow was maximum for only the Modelling wax which was 2.8 mm and it was the lowest only the Solidus wax which was 1.8mm. It was observed that shrinkage was least for the combination of Modelling wax and Solidus wax in the ratio 1:2 and it was the highest for only the solidus wax (**Table 1**).

DISCUSSION

As per the conducted study it is seen that the Group 2(1M:2S) and Group 5 (2S) have the highest melting points upto 78 degrees and setting temperature upto 48 degrees compared to the other groups. Likewise, the flow of the waxes was least in group 5(2S)(1.8cm) followed by group 2(1M:2S)(2 cm) and was maximum for group 4(2M)(2.8cm) showing the dimensional stability of the former groups as better waxes. The test for shrinkage is also done which shows that the group 5 has the maximum and group 2 is almost zero showing a modification from group 5. Thus it was observed that Solidus wax contributed to the increase in melting point and setting temperatures but it reduced the flow. However, Modelling wax contributed to a decrease in melting point and setting temperatures and it increased the flow [6, 7]. Although Solidus wax had the highest shrinkage, it's combination with Modelling wax lead to a reduction in the shrinkage.

Modelling wax is a combination of paraffin wax (70-80%), bees wax (12%), Carnuaba wax (2.5), resins and synthetic waxes; with a melting range of 44 degree C to 62 °C [8-10]. Modelling wax is majorly used for laboratory purposes for which the wax must have adequate flow properties at a temperature that does not cause injury to the operator. Hence to mould the wax, at 45 degree C one would ideally require a plastic deformation of 60-70% [1]. But at the same time, it is necessary that the wax does not undergo dimensional changes on solidification. The current study infers that modeling wax has greater flow properties than solidus wax and also has minimum shrinkage [6]. The study also infers that the melting point of modeling wax is lower than that of solidus wax. When combining different proportions of the two waxes, it was observed that as the proportion of solidus wax increases the flow of the combination wax decreases and the melting point increases [2, 7]. A probable reason for reduced flow of the combination wax and its increase in melting point could be the incorporation of the properties of the solidus wax which could be acting as filler. In the study conducted by Taqa *et al* [11,12–14] it was concluded that addition of polymethylmethacrylate particles to bees and hard paraffin wax, reduced its flow and dimensional changes but increased its

melting point as compared to modeling wax [15]. Waxes expand when heated and contract on cooling. The present study inferred that solidus wax had the maximum shrinkage but at the ratio of 2:1 (solidus wax: modeling wax) no shrinkage was observed but it still had better flow properties than solidus wax alone as one part of modeling wax incorporated in it.

One of the possible limitations of the present study is the limited number of samples tested. Further investigations would be required to confirm the above results. Additional combination ratios can be included in future for comparative evaluation.

Table 1: Evaluation of the Properties of Various Combinations of Modelling Wax and Solidus Wax

Properties	Group One (1M:1S)	Group Two (1M:2S)	Group Three (2M:1S)	Group Four (2M)	Group Five (2S)
Melting temperature (degree C)	60	78	63	55	74
Initial Setting temperature	50	58	54	48	52
Final setting temperature	46	48	48	44	49
Flow (cm)	2.2 cm	2.0 cm	2.5 cm	2.8 cm	1.8 cm
Shrinkage(mm)	0.5 mm	0	0.5 mm	0.5 mm	1 mm



Figure 1: Samples of wax sheets cut in 3*3 cm dimension

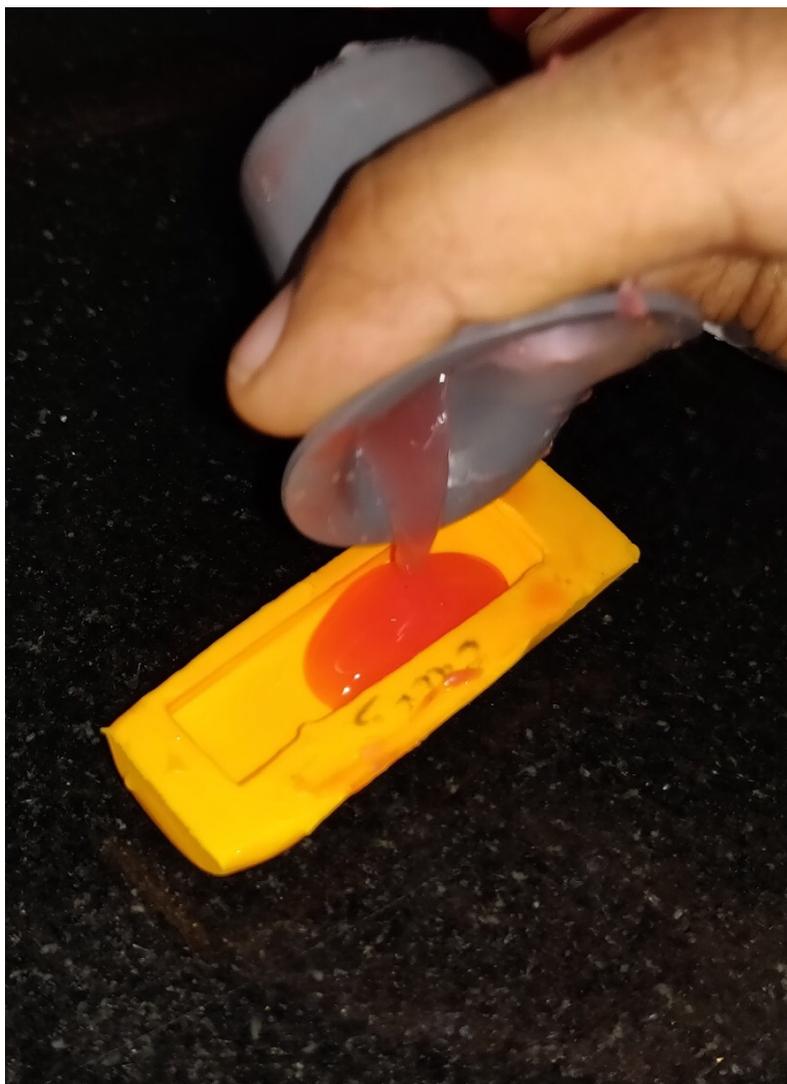


Figure 2: All the waxes are poured in a standardized index to measure the shrinkage



Figure 3: Flow of the waxes measured using a glass plate and scale

CONCLUSION

From the present study, it can be inferred that melting point and initial setting temperature is directly proportional to the quantity of Solidus wax present in the combination. The quantity of Solidus wax present in the combination is inversely proportional to the flow. At the same time modelling wax lead to a decrease in melting point and setting temperature. However, Modelling wax lead to an increase in flow. From the results of various combination rations in the present study it can be concluded that by incorporating modeling wax and solidus wax at a proportion of 1:2 into a mixture, one can obtain a material with the benefits of low shrinkage, adequate flow and good strength. Still further studies would be required to confirm the above results.

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