ISSN: 1812–1217

Preparation and modifying a new type of waxes

Nadira A Hatim
BDS, MSc (Assist Prof)

Amer A Taqa
BSc, MSc, PhD (Assist Prof)

Wafa M Abbas
BDS, MSc (Assist Lect)

Department of Prosthetic Dentistry
College of Dentistry, University of Mosul

Department of Basic Sciences
College of Dentistry, University of Mosul

Department of Chemistry
College of Science, University of Mosul

ABSTRACT

Aim: To prepare and modify different wax compositions in order to find out the most suitable formula that has almost the same properties of dental modeling wax used in dentistry. **Materials and Methods:** Three groups of waxes (220 samples) with different compositions regarding its origin (Al–Dora refinery waxes, natural bees wax–North of Iraq, and commercially available Iraqi waxes), additives such as starch, sodium–carboxyl methylcellulose (Na–CMC), rosin, or nylon, and coloring agents were prepared. The samples were tested for their melting range, 21 samples only had a melting range that nearly coincides with that of the dental waxes such as Major and Cavex. **Results:** The resultant 21 samples were tested for their softening, trimming, penetration, residue materials and solubility. Only 4 samples showed properties that are closely similar to that of Major and Cavex wax. The results of melting point ranged from 69–80^{o}C. Softening test showed that the samples which contain nylon, Na–CMC, or rosin were softened without adhering to the fingers. Trimming test showed that they were trimmed easily and clearly. Penetration test showed that, some samples had the similar measurements of Major and Cavex wax (0.6–0.9mm). Residue materials showed that all samples had no residue of wax materials on acrylic teeth after wax elimination procedure. All the prepared waxes were soluble in ether (acetone), and petroleum spirit (benzene). **Conclusion:** Six new modeling wax materials were prepared according to ADA specification No.24. Three of new wax materials consist of nylon (polystyrene 1.71–2.13%); the other two novel modeling waxes were fabricated by using additive materials (Na–CMC and rosin).

Key Words: Hard paraffin, natural pure beeswax, dental wax.

Hatim NA, Taqa AA, Abbas WM. Preparation and modifying a new type of waxes. *Al–Rafidain Dent J.* 2006; 6(1): 64-71.

Received: 1/8/2005 ***Sent to Referees:*** 11/9/2005 ***Accepted for Publication:*** 10/11/2005

INTRODUCTION

The major components of dental waxes may be of minerals, plants, animals, and insects. Waxes may be divided into two categories: Natural waxes (plant, insect and animal waxes), and synthetic waxes.[1]

Waxes are generally characterized by their thermal properties such as melting point and solid–solid transition temperature that is closely related to the softening temperature observed in practice.[2]

Previously, two types of wax were formulated in Iraq, boxing wax[3] and inlay dental wax[4] from the waxes purchased from Al–Dora Refinery Center, and that available in the Iraqi market

Another type of wax used in dentistry is modeling wax. It is used as a pattern material for the registration of jaw relationship, also for setting up of artificial teeth in the procedure for a full denture.[1]

Modeling waxes used for clinical procedures should show little or no dimensional changes when they are heated to mouth temperature.[5,6]

Few formulas are found in the literature for modeling wax. This wax may contain 70 to 80% paraffin–base waxes or commercial ceresin, with small quantities of other waxes, resins, and additives to develop the specific qualities desired in the wax.[7–11]

This research aimed to prepare wax, and test some of its properties to find the most suitable dental modeling wax formula in comparison with the commercial brands of modeling dental wax used in clinical prosthodontic applications, and to prepare other modeling wax using additive materials.

MATERIALS AND METHODS

The materials used to fabricate new modeling wax materials were listed in Tables (1) and (2).

There is no published information on the percentage, main composition, and additive materials of modeling wax with its properties.

A pilot study was done to fabricate a novel Iraqi modeling wax material. Two hundred and twenty samples from three groups of waxes with different compositions regarding its origin (Al–Dora refinery waxes, natural bees wax, and commercially available Iraqi waxes), additives such as starch, sodium–carboxyl methylcellulose (Na–CMC), rosin, or nylon, were prepared.

Table (1): Materials used to fabricate new waxes

No.	Materials	Manufacturer	Product
1	Hard Paraffin Wax	Marketing Specifications of Iraqi Petroleum Products	The Republic of Iraq Ministry of Oil
2	Soft Paraffin Wax	Marketing Specifications of Iraqi Petroleum Products	The Republic of Iraq Ministry of Oil
3	Beeswax	Natural	North of Iraq
4	Commercial Wax	Iraqi Commercial Factory	
5	Modeling Wax	Major Prodtti Dentari	SPA, Italy
6	Modeling Wax	Cavex Product	Japan

Table (2): Additive materials used to fabricate new wax materials

No.	Product	Type	Manufacturer
1	Starch	Powder	Iraq
2	Sodium–Carboxy–Methylcellulose (Na–CMC)	Powder	Iraq
3	Rosin	Solid	Iraq (Conifer Trees)
4	Coloring Agent (Ferrous Oxide)	Powder	Iraq
5	Nylon (Polystyrene)	Used for Storage Fresh Food	

The samples were tested for their melting point. The results of the pilot study showed that 21 samples only had a melting point that nearly coincides with that of the dental waxes such as Major Prodtti Dentari SPA, Italy, and Cavex–Italy modeling wax. These tests were done first by mixing 85% of paraffin (hard and soft) wax and 15% additive material. Then novel modeling waxes were fabricated by fixing one

percentage of material and change the other components gradually (1% of paraffin and 0.01% of additives). The resultant 21 samples were tested for their softening, trimming, penetration, residue materials and solubility. The experimental design of novel modeling wax was done according to the following groups:

Group 1: The samples were fabricated from hard paraffin, soft paraffin, and bees wax (natural pure and impure–North of Iraq). These samples were compared with samples consist of additive materials [nylon (polystyrene), and ferrous oxide coloring agent].

Group 2: The samples were fabricated from commercially available wax materials, and pure bees wax. These samples were compared with samples consist of additive materials such as rosin, and coloring agent.[11, 12]

Group 3: The samples were fabricated from commercially available wax materials, pure beeswax, and additive materials either starch, or Na–CMC, or by adding 5–15% one brand of modeling wax (Major Prodtti Dentari SPA, Italy), and coloring agent.

The new modeling waxes were subjected to the following tests:

1. Melting point.
2. Softening test.
3. Trimming test.
4. Penetration test.
5. Residue material property.
6. Solubility test.

The samples were prepared by the following general methods:

The mixing of wax was done by mixing different percentages of paraffin wax, and other additives in shaking water bath unit (Kavo GmbH, West Germany) (Figure 1) at 45–50ºC for five minutes to obtain homogenous mixture liquid. Then the liquid mixture was poured in special mold according to the type of test and left to cool at room temperature (25 ± 2 ºC).

Bees wax used in this study was a natural wax either pure or impure. Pure bees wax was prepared by adding natural impure wax to boiling water, and then cooling the water to 5ºC to take the pure wax that floats on the water surface. The addition of coloring agent (ferrous oxide) at 43ºC before melting point was done with mixing.

1. **Melting point:** The mold used in this test was a cylinder of 2cm in diameter, and 2.5 cm in length to determine the melting point. The melting point was measured according to a method reported by Vogel[13] using Electro thermal melting point apparatus (CE, VWR. International) (Figure 2).

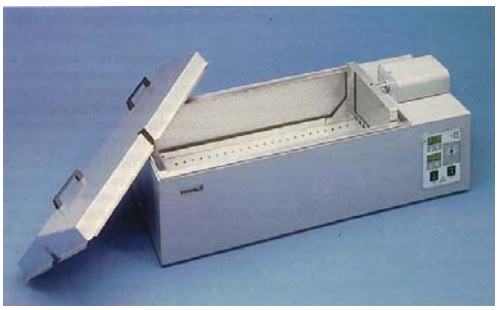

Figure (1): Shaking water bath unit

Figure (2): Electro thermal melting point apparatus.

2. **Softening test:** The samples were softened to 40–45 ºC by the thermostatically controlled water bath unit (Kavo GmbH, West Germany) and tested by finger according to the ADA Specification No. 24 to determine the adherence of soft wax material.
3. **Trimming test:** The samples were prepared with dimensions 10 mm diameter, and 6mm thickness (ADA Specification No. 24).[14] Trimming was done into 6µm cross sections by a microtome (Bright Co. Ltd, Huntingdon, England) at 23 ± 2 ºC.
4. **Penetration test:** The samples were prepared with dimensions 10mm diameter, and 6 mm thickness (ADA Specification No. 24), and softened to 40–45 ºC by

the thermostatically controlled water bath unit (Kavo GmbH, West Germany), and tested by a standard Vicat apparatus (Baustoff Pruf Toni Technik) at 25 ºC.

5. **Residue material:** A silicone putty material (ORMASIL, Major Prodotti Dentari SPA, Italy) was used to prepare a special rubber mold with 5 mm diameter and 2.5 mm thickness that represents the usual thickness of denture base (ADA Specification No. 12).[14]

The novel wax was melted in a thermostatically controlled water bath unit (Kavo GmbH, West Germany), and kept at a constant temperature of 60 ºC. The mold was adapted on a surveyor. The melting wax was poured into the mold and immediately a first premolar tooth was inserted in the softened wax.

Each tooth was mounted on the surveyor for easy insertion of the neck of the tooth in the softened wax, and left to cool at room temperature for 15 minutes to prepare the wax pattern.

Flasking was made in the conventional method: The flask was left on the bench for 2 hours at room temperature (23 ± 2 ºC) after the final set of the plaster. The wax was removed from the mold by immersion of the metal flask in boiling water for 4 minutes.[15] Then the flask was removed from boiling water, carefully opened and flushed by application of boiling solution of synthetic household detergent (1 tablespoon to 1 pint of water), and then rinsed with clean boiling water.

Each neck of tooth was tested by visual examination, and by using a reflecting microscope ×30 magnification) to detect the presence of residue on the neck of the tooth according to ADA Specification No. 24.[14]

6. **Solubility test:** This test was done to determine the weight of the samples before and after immersion. One gram of each novel of modeling wax material was immersed in 10 ml of solvent [acetone (ether), chloroform, benzene, methanol, or tetrachlorocarbon] for 10 minutes at room temperature. Filtrations were done and weight of the remaining material was measured by Electronic balance (Mettler PM460, Germany).

Descriptive and percentage statistical analysis tests were used in this study.

RESULTS AND DISCUSSION

On the basis of results from experimental preparation, the evaluation of dental composition of the prepared wax was studied. Twenty–one samples of 220 were selected to complete this study because the properties of these samples nearly coincide with the other brands of modeling wax.[9, 14, 16, 17]

This formulation is hard paraffin wax, soft paraffin wax, bees wax (pure and impure), and nylon (polystyrene) (Table 3). Hard paraffin is a mixture of purified solid saturated hydrocarbons, generally obtained from crude paraffin waxes during the production of petroleum oils.[18, 19] The other formulation showed nearly similar to the other brands of modeling wax consisting of commercial paraffin wax, bees wax, and rosin, or Na–CMC material (Table 4 and 5).

Table (3): New prepared modeling wax group 1

Prepared Samples	Hard Paraffin Wax%	Soft Paraffin Wax%	Beeswax%	Nylon Polystyrene%
No.1	85	15	–	–
No.2	80.21	17.65	2.14 (Impure)	–
No.3	61.7	29.27	6.9	2.13
No.4	58.14	37.21	4.65(Pure)	–
No.5	53.42	40.6	4.27	1.71
No.6	65.84	27.57	4.88 (Pure)	1.71

No.: Number of sample

Table (4): New prepared modeling wax group 2

Prepared Samples	Commercially Wax %	Additives %	Beeswax %
No.7	60	–	40
No.8	70	–	30
No.9	60	5 P + 5 St	30
No.10	65	15 P + 5 St	15
No.11	65	10 P + 10 St	15
No.12	60	10 P + 10 Na–CMC	20
No.13	60	10 P + 10 St	20
No.14	65	10 P + 10 Na–CMC	15
No.15	65	15 P + 5 Na–CMC	15

No.: Number of sample, P: Paraffin Major modeling wax, St: Starch, Na–CMC: Sodium–Carboxyl Methylcellulose.

Table (5): New prepared modeling wax group 3

Prepared Samples	Commercially Wax %	Additives %	Beeswax %
No.16	55	10R	35
No.17	60	20R	20
No.18	65	10R	25
No.19	65	20R	15
No.20	75	10R	15
No.21	60	20R	20

No.: Number of sample, R: Rosin material.

1. **Melting point:** The results of this study showed that the melting point of sample no. 4 of group 1 was nearly the same as for the Major Prodtti Dentari SPA, Italy brand of modeling wax ranged between 63–75 ºC (Table 6). The results of other samples (No.1–3) showed the same melting point of Cavex modeling wax range 69–80 ºC. While the results of groups 2 and 3 which involves samples containing (Na–CMC, or rosin) showed nearly the same melting point (59–65º C) of Major type of modeling wax (Table 7). These results were agreed with other studies.[1, 9] This is because modeling wax is largely a paraffin wax with some additions. The melting point was approximately 58 ºC and the transition temperature was approximately 50 ºC. Thus, all manipulation of modeling wax should be carried out above the latter temperature to minimize stress relief. [1, 10]
2. **Softening test:** The results of this study showed that wax samples containing additive materials (nylon, or (Na–CMC), or rosin) were softened without adhering to the fingers (Tables 6 and 7) (ADA Specification No.24).[14]
3. **Trimming test:** The samples of new prepared modeling wax that fulfill the properties of commercial brands of wax were trimmed easily and clearly especially samples no. 3, 5, 14, 17, and 18 (ADA Specification No.24).[14]
4. **Penetration test:** The new prepared modeling wax (samples No. 3, 5, and 6) showed nearly the same measurements of Major Prodtti Dentari SPA, Italy and Cavex modeling wax range between 0.6–0.9 mm (Table 6).[17]
5. **Residue material:** The results of this test showed completely no residue of wax material on acrylic teeth after wax elimination procedure especially for the samples no. 3, 5, 6, 14, 17 and 18 (Table 6 and 7).[14]

Table (6): Some properties of the prepared modeling wax samples of group 1

Prepared Samples	Melting Point (°C)	Penetration (mm)	Softening Adherence to (Finger)	Residue Material (Clean Completely)
Major	63–72	0.6	None	None
Cavex	68–75.5	0.9	None	None
No.1	69–75	1.9	Yes	Yes
No.2	75–81	1.6	Yes	Yes
No.3	70–80	0.9	None	None
No.4	63–75	1.7	None	Yes
No.5	65–76	0.6	None	None
No.6	65–74	0.7	None	None

No.: Number of sample.

Table (7): Some properties of the prepared modeling wax Samples of group 2 and 3

Prepared Samples	Melting Point (°C)	Softening (Adherence to Finger)	Residue Material (Clean Completely)
No.7	50–52	Yes	Yes
No.8	–	Yes	Yes
No.9	50–54	Yes	Yes
No.10	58–60	Yes	Yes
No.11	52–56	Yes	Yes
No.12	–	None	None
No.13	–	Yes	Yes
No.14	60–65	None	None
No.15	59–65	None	None
No.16	47–57	Yes	Yes
No.17	50–60	None	None
No.18	50–60	None	None
No.19	48–58	None	None
No.20	45–55	Yes	Yes
No.21	–	Yes	Yes

No.: Number of sample.

6. Solubility test: The novel wax was practically insoluble in water, soluble in chloroform, in ether, and in benzene (boiling range 40–60°C) the solutions sometimes showed a slight opalescence practically insoluble in ethanol (96%) (Table 8).

Table (8): Solubility of prepared modeling wax (groups 1, 2 and 3)

Solvent	Acetone (Ether)	Chloroform	Benzene	Methanol	Tetra-chloroCarbon
Solubility	Insoluble	Slowly	Slightly soluble in room temperature and good soluble at 50 °C	Insoluble	Similar to benzene solvent
Mean Weight Loss (gm)	0.0	0.1–0.2	0.1–0.5	0.0	0.1–0.5

CONCLUSION

Six recommended modeling wax material samples (no. 3, 5, 14, 17 and 18) were prepared. Three of them consisted of nylon (polystyrene 1.71–2.13%). The other two novel modeling waxes were fabricated by using additive materials (Na-CMC, and rosin) with the following properties according to ADA Specification No. 24: Melting point ranged between 63–75 ^{o}C, which was similar to other brands of modeling wax (Major and Cavex Wax).

Softening, penetration, trimming, and residue material properties showed that 6 samples of the 220 had nearly the same properties of other brands of modeling wax materials. Solubility of the prepared materials showed the same results as the commercial products.

REFERENCES

1. Ray NJ. Dental Materials Science. 3rd ed. Noel Ray. Wilton. Cork. Treland. 2001; Pp: 65-71.
2. McCabe JF. Anderson's Applied Dental Materials. 6th ed. Blackwell scientific publication. Oxford. London. 1985; p: 33.
3. Al–Azzawi WH, Al–Jassim G, Said MA. Iraqi boxing wax formulation. *Iraqi Dent J*. 1997; 20: 73-79.
4. Al–Jassim G. Iraqi dental wax formulation. *Iraqi Dent J*. 1997; 21: 5-16.
5. Bezzon OL, Orsil A. An interocclusal record made of a combination of wax and acrylic resin. *J Prosthet Dent*. 1994; 72: 334-336.
6. Bissasu M. Method for determining the proper vertical height of the wax occlusion rim in the laboratory. *J Prosthet Dent*.1995; 74: 549-550.
7. Ali LH. The oil origin, composition, and technology. MSc thesis. College of Science. University of Mosul.1986.
8. Aldubooni EA. An Introduction into Petrochemicals. 1st ed. Mosul Publisher University. Iraq. 1991; p: 16.
9. Craig RG, Ward ML. Restorative Dental Materials. 10th ed. Mosby Co. St Louis. 1996; Pp: 376-378.
10. Craig RG, Powers JM. Restorative Dental Materials. 11th ed. Mosby Co. London. 2002; Pp: 424-436.
11. Kotsiomiti E, McCabe JF. Experimental wax mixtures for dental use. *J oral Rehabil*. 1997; 24: 517-521.
12. Kotsiomiti E, McCabe JF. Waxes for functional impressions. *J Oral Rehabil*. 1996; 23: 114-20.
13. Vogel I. Textbook of Practical Organic Chemistry. 3rd ed. DiSc. London. 1972; p: 1028.
14. American Dental Association Specifications. Guide to Dental Materials and Devices. 7th ed. East Chicago Avenue. USA. 1975; Pp: 83-84, 251-255.
15. Anusavice KJ. Phillip's Science of Dental Materials. 10th ed. WB Saunders Co. Philadelphia. 1996; Pp: 468-469.
16. Hobson GD, Pohl W. Modern Petroleum Technology. 1st ed. Applied Science, Barking Essex. UK. 1963; Pp: 41-50.
17. Speight JG: The Chemistry and Technology of Petroleum. 1st ed. Marcel Decker Inc. New York. 1981; Pp: 35-79.
18. Louis F, Williamson KL. Organic Experiments. 5th ed. 1983; Pp: 34-38.
19. British Pharmacopoeia 1034. Volume I of the European Pharmacopoeia 3rd ed. As Amended by Supplement Crown Copyright. 2000.