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Studies in Properties of Animal Waxes : Bees and Shellac Waxes Using DSC, FT-IR and Conventional Methods of Testing

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ABSTRACT

The plant waxes are used in many different applications in the industries. The application of waxes for any particular industries depends on their properties. In this study the two plant waxes namely Carnauba and Candelilla waxes had been studied for their properties like melting point, needle penetration, drop melting point, flash point, viscosities and densities. The testing were carried out as per ASTM standards. These properties were correlated with the results obtained from the DSC and FT-IR data.

Keywords: Carnauba wax, Candelilla wax, FT-IR, DSC, Conventional properties.

I. INTRODUCTION

Natural waxes are unique mix of long-chain, linear and even-numbered aliphatic mono-esters. Partially varying amounts of linear hydrocarbons (candelilla), free wax alcohols respectivly polycosanoles (carnauba wax) and other ingredients like phytosterols, natural resins are also present.[1]Carnauba wax is used in the manufacture of polishes for floors, automobiles, furniture , shoes, etc.. It is used in candles to raise the melting point; in carbon paper; and in a variety of moulded products. Articles published by scientific men in technical and trade journal reveal a curious lack of accurate information about this wax in any stage of its production or in any form other than that in which it appears on the market. The actual production of carnauba wax is exceedingly crude. The original native methods of production have been little improved. The harvesters go forth into the farms armed with a sharp sickle-like knife fastened to the end of a long pole. With this long-handled knife they cut the desired number of leaves from the trees. Harvesting takes place from July to January; the time varies in different localities, depending primarily upon rainfall.[2,4]

Candelilla wax is a yellowish-brown hard, brittle, lustrous solid with an aromatic odour when heated. It consists primarily of odd-numbered saturated straight-chain hydrocarbons (C29 to C33), together with esters of acids and alcohols with even-numbered carbon chains (C28 to C34). The most abundant n-alkane, C31, comprises more than 80% of total n-alkanes. Free acids, free alcohols, sterols, neutral resins, and mineral matter (<1%) are also present.[3]

Candelilla wax may be obtained from several species of *Euphorbiacea*; the primary source is *Euphorbia antisyphilitica.* The plant grows as a bush or shrub in dense stands, principally in the Chihuahuan desert in north eastern Mexico. The plant consists of numerous slender, leafless, cylindrical stalks covered with a powdery wax that gives the plant a blue-green colour.[4]

The Candelilla wax is used in Textile industry, Leather industry, Casting, Precision electroplating and Automobile for coating. It is also used for manufacturing Greases, adhesive agents, Lipstick and chewing gum.

II. EXPERIMENTATION AND OBSERVATIONS:

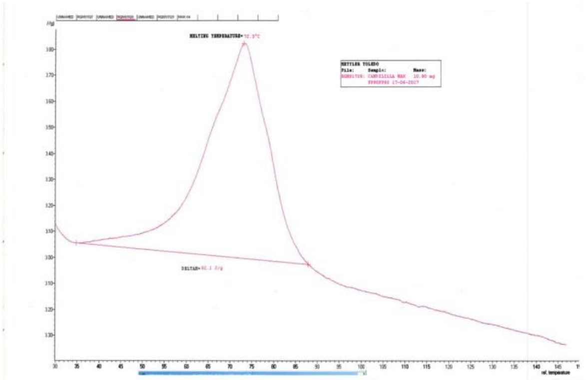
The DSC of Carnauba and Candelilla waxs were carried out using ASTM D 4419. The experiment has been done using aluminium container heated at a controlled rate of

5°C/Min in inert atmosphere. The drop melting point of the wax carried out using ASTM D 127, Needle penetration of the wax was carried out using ASTM D 1321 and the Flash point of the samples was done by ASTM D 92. The congealing point was done by ASTM D 938 – 05) and melting point was done by ASTM D87 - 09(2014).

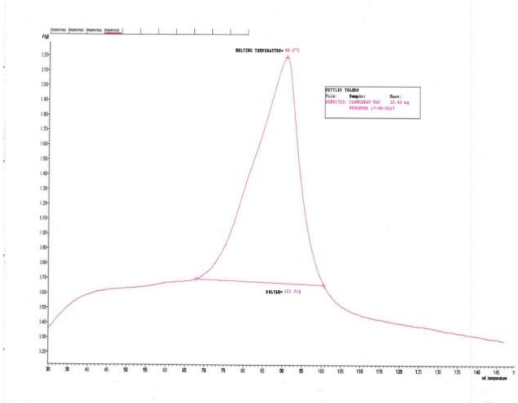
The observations have been tabulated in the following tables:

2.1 Observation Tables & Graphs:

2.1.1 DSC Graphs:



DSC graph of Candelilla Wax

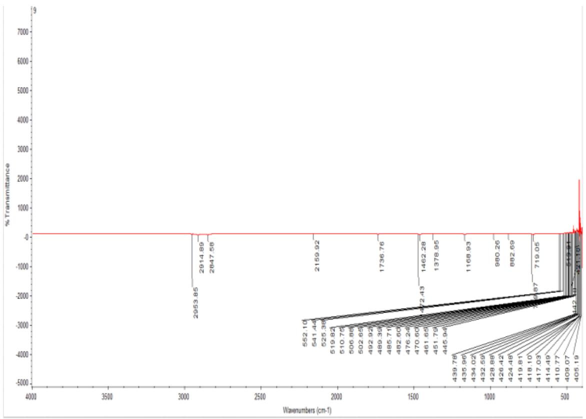


DSC graph of Carnauba Wax

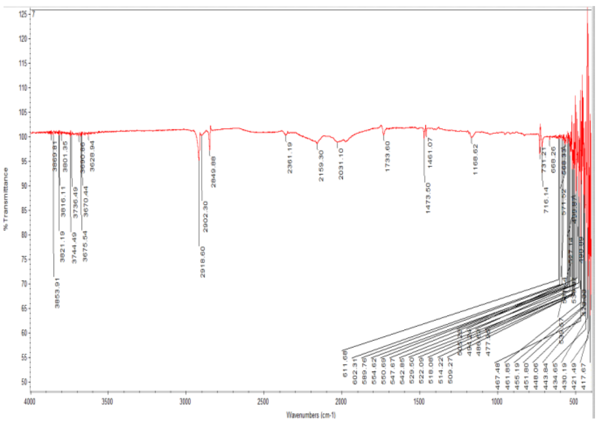
2.1.2 DSC Analysis of Carnauba and Candelilla Waxes:

Sr. No.	Parameters	Carnauba Wax	Candelilla Wax	ASTM Testing Method
1	Peak Value, ˚C	88.60	67.10	D 4419
2	DSC (j/g)	120	82.1	

2.1.3 FT-IR Graphs:



FT-IR graph of Candelilla Wax



FT-IR graph of Carnauba Wax

2.1.4 Conventional Method of testing for Carnauba and Candelilla Waxes:

Sr. No	Properties	Carnauba Wax	Candelilla Wax	ASTM Testing Method
1	R.I., @ 80 ˚C	1.448	1.451	D 1218
2	Congealing Point, ˚C	82	70	D 938
3	Melting Point, ˚C	83	72	D 87
4	Drop Melting Point, ˚C	84	73	D 127
5	Kinematic Viscosities @ 100˚C ,cSt	15.275	8.657	D 445
6	Penetration Index, @ 25 ˚C	7	9	D 1312
7	Flash Point (COC),˚C	280	240	D 92
8	Density @ 100˚C, gm/cc	0.940	0.941	D 1298

III. RESULTS & DISCUSSION

Analyzing the data in the table 2.1.4 we find that there is particularly two to three degree centigrade difference between the congealing point and melting point. These findings are in expected line because just before melting all the waxes which we have studied are in semi solid or solid state and one or two degree centigrade it starts melting. There is only one degree difference between melting point and drop melting point, drop melting point will always be higher than their melting point since it defiantly will take some more time for the drop to be detached and drop. In plant waxes namely Carnauba and Candelilla the difference in melting point and drop melting point is only one degree were as in case of animal waxes like bees wax the difference is of five degrees and in shellac it is three degrees centigrade between drop melting point and melting point. When we compare these findings of melting point with the data obtained from the DSC table 2.1.2 we find that there is around five degree difference in the values of melting point of the two waxes obtained from the conventional method of testing i.e. by cooling curve method. This is because waxes do not give sharp melting point because are mixture of hundreds and thousands of different hydrocarbons, these are not expected to give pin point sharp melting point. That's why when we tried to find out melting point with DSC, there is a temperature from where it starts melting and then we get a highest peak which gives the point where it melts completely.

The melt viscosities of the carnauba wax is higher than the candelilla waxes which indicates the presence of higher carbon number compounds which is also reflected by the flash point values of the two waxes i.e. the carnauba wax have higher flash point than the candelilla wax.

From the FT-IR data shows the presence of C=O (wave no. 980) group which indicates the presence of acidic group in the candelilla wax and the presence of hydroxyl group was found in the carnauba wax (wave no. 3628). The CH3 symmetric deformation (wave no. 1378) was found in the carnauba wax which in not detected in candelilla waxes. This shows the presence of more straight chain carbon in carnauba wax as compared to candelilla wax. These findings are also supported from the values of R.I., the R.I values of carnauba wax is less as compared to the candelilla wax. Also the density of the carnauba wax is less than that of the candelilla wax which indicates the presence of the high molecular weight aromatic compounds in it.

From the values of melt viscosities and the melting point the carnauba wax have the properties which matches with the microcrystalline waxes (values as given in literature) and the melt viscosities and the melting point of candelilla wax is matching with the values of semi refined paraffin waxes. Thus Carnauba and candelilla waxes can be used for modifying the properties of microcrystalline waxes and paraffin waxes respectively.

IV. CONCLUSION

Form the data generated using convention method and the DSC method. DSC is a convenient and rapid method for determining the temperature limits within which these wax under goes thermal transitions. The highest thermal transition is a solid-liquid transition associated with complete melting, which can guide the choice of wax storage and application temperatures. The solid-solid temperature transition can be related to the properties of the wax about its hardness and blocking temperature.

Also from the values of different properties obtained by the conventional methods and the values of DSC and FT-IR it can be said that Carnauba and candelilla waxes can be used for modifying the properties of microcrystalline waxes and paraffin waxes respectively.

The FT-IR can be used to determine the chemical composition of the waxes by find the wave numbers we can correlate them with the functional groups and compound present in the waxes.

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