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Studies in Properties of Plant Waxes : Carnauba and Candelilla Waxes Using DSC, FT-IR and Conventional Methods of Testing

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ABSTRACT

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

Keywords: Bee wax, Shellac wax, FT-IR, DSC, Conventional properties.

I. INTRODUCTION

At one time the word wax meant only bees- wax and as the most important insect wax it has attracted the most attention. Beeswax generally refers to wax of the European bee, Apis mel/i/era, but Asiatic species A. dorsata, A. Jlona and A. indica are sometimes also commercial sources of wax. The wax scales are secreted by eight wax glands on the underside of the abdomen of the worker bee.[1,5]

The good quality of beeswax depends greatly on the production methods. There are two wax extraction methods: melting and chemical extraction. Melting is the most frequently used procedure. Wax can be melted by boiling water, by steam, or by electrical or solar power. Chemical extraction by solvents is feasible only in a laboratory, where small scale wax production is needed. Good wax solvents are gasoline and xylene.[3]

Beeswax components fall into the following chemical groups: esters (67%), hydrocarbons (14%), fatty acids (12%), and alcohols (1%). Among the hydrocarbons, the most numerous group are linear saturated hydrocarbons (n alkanes), accounting for ca. 67% of all hydrocarbons occurring in beeswax; branched alkanes occur in much smaller amounts (0.2%). Apart from saturated hydrocarbons, unsaturated hydrocarbons containing one double bond alkenes) can also be found in beeswax.[2,4] Some of the important uses of Beeswax are in Candles and ornaments, Lip balm. Medicinal cream in pharmaceutical firms. Water proofing shoes. Polishing the furniture and making soaps.

Shellac is the purified product of lac, a natural resinous oligomer (MW ≈ 1000 D) secreted by the parasitic insect Kerria lacca on various host trees in India, Thailand, and Myanmar. Shellac consists of polyesters of mainly aleuritic acid, shellolic acid, and a small amount of free aliphatic acids. The composition varies depending on the insect species as well as the host tree from which the raw material is obtained. After harvesting, the so-called “stick lac” is chopped and separated from wood and resin. A washing step extracts the water-soluble dye, laccaic acid, yielding the raw material “seed lac.” There are three different processes used for refining, resulting in different shellac qualities: The melting filtration process, where melted seed lac is filtered through a cotton hose, leads to wax containing shellac. Bleached shellac is obtained by treating the dissolved polymer with sodium hypochlorite. [4,5,6]

Shellac wax consists of long- chain esters of monovalent alcohols and acids. Typical for this wax is the content of more than 30% of free wax alcohols with a chain length

of C28–C32. [6]Some of the uses of Shellac Wax are Shining the articles made of wood. Moulded goods like surgical dye, sanitary articles, picture frames, and ornaments. In motor vehicle industries, Shellac wax used for tiers manufacturing also.

II. EXPERIMENTATION AND OBSERVATIONS

The DSC was carried out using ASTM D 4419. The experiment has been done using aluminium container heated at a controlled rate of 5oC/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).

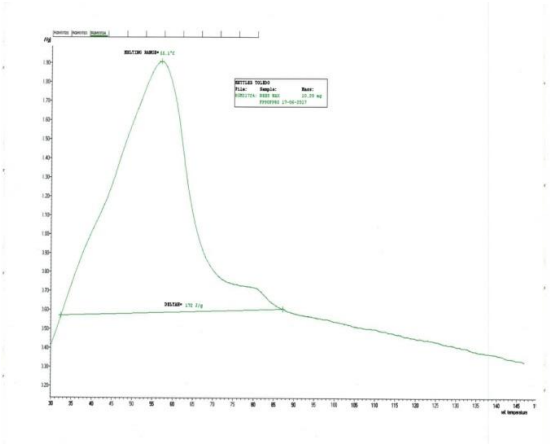
The observations have been tabulated in the following tables :

2.1 Observation Table

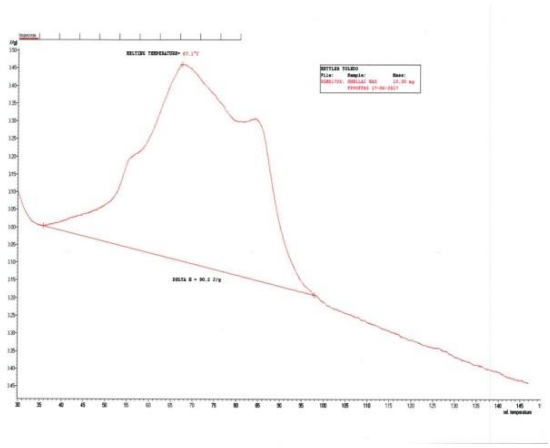
2.1.1 DSC Analysis

Sr. No.	Parameters	Bee Wax	Shellac Wax	ASTM Testing Method
1	Peak Value, ˚C	55.10	72.30	D 4419
2	DSC (j/g)	173	90.2	

2.1.2 DSC Graphs

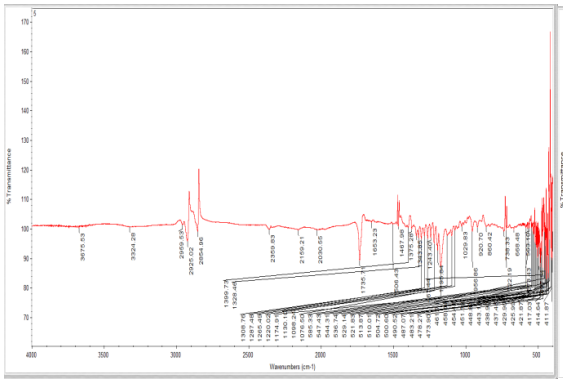


DSC graph of Bee Wax

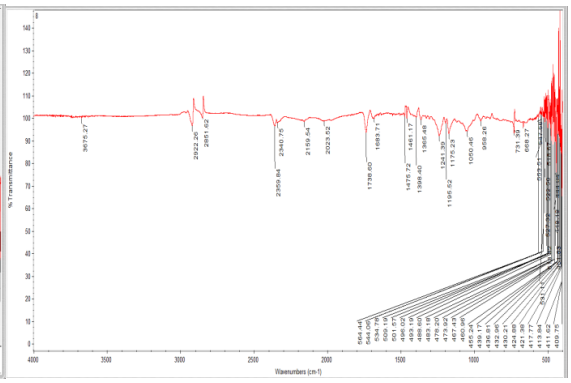


DSC graph of Shellac Wax

2.1.3 FT-IR Graphs:



FT-IR graph of Bee Wax



FT-IR graph of Shellac Wax

2.1.4 Conventional Method of testing:

Sr. No	Properties	Bee Wax	Shellac Wax	ASTM Testing Method
1	R.I., @ 80 ˚C	1.434	1.439	D 1218
2	Congealing Point, ˚C	66	79	D 938
3	Melting Point, ˚C	68	80	D 87
4	Drop Melting Point, ˚C	73	82	D 127
5	Kinematic Viscosities @ 100˚C ,cSt	5.25	9.292	D 445
6	Penetration Index, @ 25 ˚C	1.0	0.8	D 1312
7	Flash Point (COC),˚C	230	235	D 92
8	Density @ 100˚C, gm/cc	0.905	0.920	D 1298

III. RESULTS & DISCUSSION

Form the observation table we find that there is two degree centigrade difference between the congealing point and melting point .These 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 before it was in solid state and after heating it starts melting. There is five degree temperature difference between melting point and drop melting point in the case of bees wax and two degree difference in the case of shellac wax. The high difference in the melting point and drop melting point in the case of bees wax indicate the presence of some rubbery material in it which takes longer time to detach from the thermometer bulb. When we compare these findings with the data obtained from the DSC we find that there is around 13 degree difference in the values of melting point of the bee wax and 8 degree difference in the melting point of shellac wax obtained from the conventional method of testing i.e. by cooling curve method.

The melt viscosities of the Shellac wax is higher than the Bees 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 Shellac have higher flash point than the Bees wax. The R.I. values of Shellac wax is also higher than the Bees wax and same is the case with the densities of these two waxes. Which also give indications about the presence of higher carbon no in the case of shellac wax.

From the values of melt viscosities, melting point, flash point and R.I the Bees wax have the properties which matches with the paraffin waxes (values as given in literature) and the shellac wax properties matches with the semi refined microcrystalline waxes (values as given in literature) . Thus Bee and Shellac waxes can be used to modify the properties of paraffin waxes and semi refined microcrystalline wax respectively.

From the FT-IR data shows the presence of C=O (wave no. 3324) group which indicates the presence of carbonyl group in the bees wax and the presence of triglycerides were found in the Shellac wax (wave no. 1175), the presence of triglycerides indicates the presence of alcoholic group in the shellac wax which is not detected in the Bees wax. The CH3 symmetric deformation (wave no. 1375) was found in the Bees wax which in not detected in Shellac waxes which gives the indication about the presence of straight chain hydrocarbons.

IV. CONCLUSION

From the values of different properties obtained by the conventional methods and the values of DSC and FT-IR it can be said that Bee and Shellac waxes can be used for modifying the properties of paraffin waxes and microcrystalline waxes respectively.

The FT-IR can be used to determine the chemical composition of the waxes by finding the wave numbers we can correlate them with the functional groups and compound present in the waxes which also gives the brief idea about the structure if wax.

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