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# UNIT 1 BEE'S WAX

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## 1.0 AIMS AND OBJECTIVES

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The aim of this unit is to make you familiar with the beewax and its uses. After going through this unit, you will be able to:

- comprehend about the composition and properties of beewax;
- assess the method of extraction and processing for obtaining the good quality beewax; and
- market the wax for income generation.

## 1.1 INTRODUCTION

In the previous units, we have learned about the products which are collected and transformed by honeybees. It includes honey, propolis and pollen. Here in this block, we shall be discussing about the products which are synthesized by the honeybees. These products are wax, royal jelly and bee venom. In the present unit, we shall deal with the wax.

Among the different by-products of the beekeeping, wax is an important by-product. Worker bees secrete wax when they are of 12-18 days old. The wax is secreted through four pairs of wax secreting epidermal glands present on the ventral side of fourth to seventh abdominal segment. The wax is liquid at the time of secretion, but solidifies when exposed to air. It further solidifies and gets deposited as scales. These scales are scraped off by the bee, chewed and masticated into pliable pieces with the addition of saliva and variety of enzymes and prepare a comb of hexagonal cells. To produce one part of wax, bees have to consume about 4-7 times more as they eat for the production of honey. Bee uses the wax for the assembling of pool tables to fill the screw holes and the seams between the slates in the hive. The wax of honeycomb is nearly white, but becomes progressively more yellow or brown by incorporation of pollen oils and propolis.

Let us discuss about the beeswax in detail.

## 1.2 BEEWAX COMPOSITION

Beewax is a complex mixture of several components consisting of mainly free fatty acids. The pure beewax from *Apis mellifera* consists of 284 different compounds. Quantitatively, the major compounds are saturated and unsaturated monoesters, esters, saturated and unsaturated hydrocarbons, free acids and hydroxyl polyesters.

There are 21 major compounds each making up more than 1% of the pure un-fractionated wax. Together they account for 56% of the wax. The other 44% is of diverse minor compounds probably accounts for beeswax's characteristic plasticity and low melting point (Tolloch, 1980).

Let us examine the composition of the beewax with the help of the following Table:

Table 1.1: Composition of Beeswax

Description of Constituents	Content (%)	Number of Components	
		Major	Minor
Hydrocarbons	14	10	66
Monoesters	35	10	10
Diesters	14	6	24
Triesters	3	5	20
Hydroxy monoesters	4	6	20
Hydroxy polyesters	8	5	20



Acid esters	1	7	20
Acid polyesters	2	5	20
Free acids	12	8	10
Free alcohols	1	5	?
Unidentified	6	7	?
<b>TOTAL</b>	<b>100</b>	<b>74</b>	<b>&gt; 210</b>

(Tulloch, 1980)

? Estimates

**The number of minor compounds, with less than 1% of the fraction, is only an estimate.**



**Fig.1.1: Newly constructed white comb in a traditional log hive. The white portion is wax**

*Source : Krell, R. (1996). Value Added Products from Beekeeping FAO Agricultural Services Bulletin No. 124, Food and Agriculture Organization of the United Nations Rome.*

### 1.3 BEEWAX PROPERTIES

The main raw material for wax formation is carbohydrates; primarily honey sugars fructose, glucose and sucrose. The ratio of sugar to wax can vary from 3 to 30:1, a ratio of 20:1 is typical for Central Europe (Weiss, K., 1965. Ueber den Zuckerverbrauch und die Beanspruchung der Bienen bei der Wachserzeugung. Sonderdruck Z.Bienenforsch. 8 (4): 106-124). Stronger the colony, smaller the ratio, the more economical wax production for the colony. One Langstroth frame containing only 100 g of wax can hold 2-4 kg of honey. Immediately after secretion, the beeswax gets elaborated and formed into comb and appears white in color. It becomes darker inside the hive as pollen and larval debris are inadvertently incorporated. The melting point of beeswax is not constant but ranges between 62 to 65°C. Its relative density

at 15°C is 0.958 -0.970 g/cm<sup>3</sup>. Beewax is insoluble in water and resistant to many acids but gets dissolved easily in most of the organic solvents such as ether, benzene, benzyl, chloroform and turpentine oil. It is also soluble in alcohol and fatty oils after little warming.

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## 1.4 USES OF WAX

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The majority of beeswax produced is consumed by beekeepers for making of comb foundation sheets. However, beeswax is also used in a variety of products and processes from packaging to processing, few of them as follows:

### 1.4.1 Candle Making

Making candle using the beeswax has a long history. As we know, the candles are used during many celebrations. This sector consumes large quantity of beeswax. Candles of beeswax were used by the ancient Egyptians, Ancient Greece and Rome and also in old China (Stefan Bogdanov, 2009).

### 1.4.2 Metal Casting and Modeling

This is another important area where the beeswax is being used extensively. You can prepare different designs and models on the metals using the beeswax. The sculptures of Madam Tussaud's Museums in London are primarily made of wax. Now in other countries museum, famous people are copied in wax and dressed as life-sized figures. A mixture of three parts beeswax and one part of a harder wax are used for making the sculptures (Sargant J., 1971).

### 1.4.3 In Cosmetics

The beeswax is an important ingredient in different cosmetics preparations. Since, its safety has already been proven and due to its shining and consistency, it is being used in different cosmetic preparations. Few prominent cosmetic preparations in which the beeswax is used are like lipsticks, cold creams, mascara, eye shadows, lotions, hair conditioners etc.

### 1.4.4 Food Processing

The beeswax is used for different purposes in the food processing. It is an authorised food preservative in the European Union under the name of E 901. Due to being water proof and glossy, it is coated over the fruits and vegetables to prevent the moisture loss and which enhance their shelf life. It is also used as preservative in various food items. The beeswax is mostly used in making of different staple products such as chocolates, chewing gum etc.

### 1.4.5 In Industrial Technology

There are about 120 industrial applications where the beeswax forms an integral component. It is a good insulator, used extensively in the electrical appliances. It is also used as a binding material.

### 1.4.6 In Textiles

The beeswax is greatly used in the textile industries for different purposes. While dyeing the cloth, you may put wax where you do not want to dye as it resists dye.



### 1.4.7 Varnishes and Polishes

Due to its being glossy and shining, it is extensively used in the varnishes and polishes. The beeswax adds the shining and glaze of the varnish and polish. After their painting, the objects shine and also remain intact for longer period of time as there will not be any impact of moisture.

### 1.4.8 Printing

Various types of inks used in pens, markers and even the carbon paper often contains small amount of beeswax.

### 1.4.9 In Medicines

The beeswax is antimicrobial in nature. As a coating agent for the drugs or pills, beeswax facilitates ingestion but retards dissolution of the enclosed compounds until they reach to the digestive tract. Beeswax can also be prepared as a mixture with the drug and then functions as a time-release mechanism (releasing the drug over a longer period of time).

### 1.4.10 Other Uses

Other products in which beeswax makes improvement and in which it is a traditional ingredient include grafting wax, crayons, floor and furniture polish, general purpose varnish, sealing wax, corrosion protective, car polishes and sewing thread etc. Large quantities of beeswax are also used in ammunition factories.

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#### Check Your Progress Exercise 1

**Note:** 1) Space is given below for answers.

2) Compare your answers with that given at the end of the unit.

1) How beeswax is formed? Write its composition.

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2) Write the uses of beeswax.

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## 1.5 WAX COLLECTION AND PROCESSING

The bees seal their hive honey wells using the wax. There are several ways of collecting beeswax from the bee hives. The beeswax can be obtained by removing the capping during honey extraction. This way, you will get a very

high quality light coloured wax. The light colour of the wax indicates its purity and any adulteration leads the darkening of the colour. If proper precaution is not taken at the time of extraction, the dead bodies of the bees or their excreta get mixed with the wax. Such mixings downgrade the quality of the wax. Similarly, the wax obtained from damaged, old and diseased combs is unfit for multifacet uses. You get good amount of beeswax from the hives of *Apis dorsata* because they usually build big hives. It has been observed that at the extraction of 100 kg honey, one gets roughly 2.0 to 2.5 kg of wax.

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## 1.6 METHODS OF BEEWAX EXTRACTION

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The wax is used in several applications even in the beekeeping itself. Thus, the extraction of beeswax has been as old as the extraction of the honey. The beeswax is isolated from the hives using different methodologies. The nature of extraction process depends upon the requirement (specific type), amount to be extracted and level of commercialization of the product. At the large scale, using machine to extract the wax ensures good recovery with better quality.

Let us discuss some processes which are being used to extract the wax from hives.

### 1.6.1 Traditional Method

This method has been in practice since many years. It does not require any specific machine or instrument for extraction of wax. Simple steps are adopted to extract the wax from the hives. Let us explore this methodology in detail.

**Materials Required:** Pieces of honey comb, clean water, pan for wax melting, loosely woven cloth bag, fine mesh muslin cloth, soap and steel, enamel nickel or aluminum bowl.

#### Procedure

- 1) First remove the honey from the comb. To do it, soften the combs by putting it in the warm water. Repeat this step at least three times (pollen and honey are completely soluble in the water). After removal of all the honey and pollen, wash the comb with the clean water.
- 2) After washing, break the combs into small pieces.
- 3) Place the broken pieces of combs in a pan and add clean water to the level of combs.
- 4) Heat the mixture gently by stirring the contents continuously. Since the wax is flammable, it should not be heated directly. Always heat in water (heating above 85°C will result in wax discoloration). After sufficient heating, the wax will melt completely.
- 5) Pour the mixture into a long bag made of heavy cloth and squeeze the material along the sides with two sticks so that the wax passes into a pan held below. The liquid wax and water will ooze out from the cloth and impurities and extraneous matter are retained in the cloth bag.
- 6) Leave the water and wax mixture to cool by placing it in the cool room. Cooling should be done dust free.



- 7) When the wax is completely cooled, remove and remelt it in another pan with equal volume of water. This time use fine mesh muslin cloth to filter and remove the impurities. Collect wax mixture in an enamel bowl of 2 kg capacity smeared with a thin film of soap water. Cool it for overnight and then the moulds of beewax can be taken out with ease.

### Precautions

While using this technique to extract the wax, you have to adhere to some precautions to avoid the contamination in the product. They are as follows:

- 1) Mixing of dark honey combs with light honey combs should be avoided.
- 2) Always use clean water.
- 3) Only stainless steel or enamel or aluminum or nickel vessels should be used.
- 4) Do not use zinc or galvanized iron or iron vessels as wax acids react with zinc and impart dull colour.

### 1.6.2 Solar Wax Extraction

Here we need to fabricate a device called **Solar Wax Extractor**. This is a simple device and can be made locally. It consists of a melter, a pan and a filter. The melter is made of wood lined with a galvanized plate and has a glass cover. The melter is painted with black paint to absorb heat. On the inside of the extractor, there is a metallic pan that slants over a container. Pan is provided with wire mesh to serve as filter. The extractor is set in at inclined position facing the sun. During the sunny days, it is kept at the open place to get direct sunlight. It is capable of generating a temperature of about 68 to 70°C, which is enough to melt the comb pieces. The melted wax slowly flows and accumulates in the receptacle, half filled with water. The combs should be washed thoroughly before keeping in the extractor.

However, it consumes more time to melt the wax and the recovery is only 50-75% particularly with old combs because in old combs, the mass of cocoon waste from successive brood act as a sponge and soaks up the wax, thus reducing its flow.

It has other limitations such as the pan has to be turned towards the sun regularly and in cloudy weather or weak sunlight, there is no yield at all.

### 1.6.3 Hot Water Bath Extraction

Wax cannot be removed from old dark coloured wax combs by solar wax extractor as they are tough due to pupal carcasses left by generations of honeybees. Hot water bath method can be used in such cases. It is an efficient process and can be used for large scale wax extraction. In this method, the comb is broken into pieces after soaking it in the water for 24 hours. The comb pieces are filled in a sack and boiled in a container with water. When the temperature reaches at 59°C, the wax begins to melt and a waxy scum begins to form on top of the water. Wax starts floating on the surface. Keep overnight to cool it properly. Then floating wax can be collected.

### 1.6.4 Metal Foil Extraction

This is very simple method of wax extraction. Take a small piece of comb and wrap it in an aluminum foil. Then place it in the sunshine. Due to heating of the sunshine, the wax starts melting and flows out through small openings made in the wrapper. This liquid wax is collected into a container. After cooling, the wax solidifies.

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## 1.7 BEEWAX STORAGE

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Beewax should be stored in its clean form. It has been observed that if the wax is not cleaned properly it will be attacked by wax moth quickly which may destroy the wax. Clean wax in large blocks is not attacked by wax moth. Storage should be done in cool dry place and never done with pesticide. Wax will slowly crystallize over the time and become harder, but this process is reversible without any damage. Wax can be stored for very long period of time without losing its characteristics.

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### Check Your Progress Exercise 2

**Note:** 1) Space is given below for answers.

2) Compare your answers with that given at the end of the unit.

1) Write the sources of beewax and enlist the different methods of wax extraction.

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2) How will you store the beewax?

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## 1.8. LET US SUM UP

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Beewax is an important by-product of beekeeping besides honey. It is used in diverse applications. We studied many aspects of the beewax above. The beewax is secreted as liquid. It solidifies when exposed to air and scales are formed after hardening. Pure wax consists of at least 284 different compounds. The majority of locally produced beeswax is consumed by beekeepers for making of wax foundation sheets. The other uses include making candles, metal casting and modeling, cosmetics, food processing, industrial uses, textile making, varnishes and polishes, printings and preparing of various medicines. There are several methods of wax extraction from the combs. The wax should be extracted in pure form then only it can be stored for longer period of time.



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## 1.9 KEY WORDS

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- Abdomen** : The segmented posterior region of the body of a bee.
- Beeswax** : A complex mixture of organic compounds secreted by special glands located on the ventral side of the workers bee's abdomen.
- Capping** : The thin wax covering of cell full of honey; the cell coverings after they are sliced from the surface of a honey-filled combs.
- Comb** : A mass of six-sided cells made of wax by honeybees in which brood is reared and honey and pollen are stored; composed of two layers united at their base.
- Comb Foundation** : A commercially made structure consisting of a thin sheet of beeswax with the cell bases of worker cells embossed on the both sides in the same manner as they are produced naturally by honeybees.
- Frame** : Four pieces of wood (top bar, a bottom bar and two end bars) designed to hold foundation/drawn comb.
- Rendering Wax** : The process of melting combs and capping and removing refuse from the wax.
- Solar Wax Extractor** : A glass- covered insulated box used to melt wax from comb and cappings using the heat of the sun.
- Wax Gland** : The eight glands that secrete beeswax; located in pairs on the last four visible ventral abdominal segments of worker bees.
- Wax Moth** : Larvae of the moth *Galleria mellonella*, which seriously damages brood and empty combs.

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## 1.10 FURTHER REFERENCES

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The following references have been compiled for further reading on the subject.

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## 1.11 MODEL ANSWERS

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### Check Your Progress Exercise 1

- 1) Worker bees secreted wax as liquid but it solidifies when exposed to air and scales are formed. Worker bees have eight wax producing glands located on the inner sides of the sternites of abdominal segments 4 to 7. They are at their largest when the bee is about 12 days old and decline steadily from 18th days onwards, until the end of its life. It is a complex substance and contains 284 compounds. At least 48 compounds were found to contribute to the aroma of beewax. Quantitatively, the major compounds are saturated and unsaturated monoesters, diesters, saturated and unsaturated hydrocarbons, free acids hydroxyl polyesters etc. Density of beewax is 0.95 and melting point is 62-64°C
- 2) It has many uses like preparation of comb foundation sheet, in cosmetics (face creams lipsticks etc.) in pharmaceutical industries. It is also used in making shoes and floor polishes, water proofing, wax models. Candles, ink, carbon paper, adhesive tapes, insulating tapes and making toffees, chewing gum etc. In all beewax has over 120 industrial uses.

### Check Your Progress Exercise 2

- 1) Rock bees *Apis dorsata* is the main sources of wax production. It is also obtained from cappings collected during honey extraction and from damaged and old combs which become unfit for use. Extraction of wax is done by different methods like, traditional method, solar wax extraction, hot water bath extraction and metal foil method.
- 2) Beewax should only be stored in its rendered, clean form. Clean wax in large blocks in not attacked by wax moth. Storage of wax should be done in cool dry places and never in the same room with any kind of pesticides. Wax can be stored for very long periods of time without losing its major characteristics.