CHAPTER 7

Hive Products

7.1 HONEY

Honey is a natural sweet product of the bee hive, which has been treasured by man from ancient times. Due to its high medicinal and nutritional value, man derives great benefits from honey. The most common raw material for honey is nectar and other natural plant exudations. Nectar is a watery solution of sugars and originates in floral and extra-floral nectaries of plants. Bees also frequently make honey from honey dew which is a sweet secretion of insects.

The composition of honey determines its value as a nutritional and medicinal product. The major components of honey are the sugars. (about 80 per cent) and water (17 to 20 per cent) in which the sugars are dissolved. In addition, so far 181 different substances have been identified in honey and some of them are unique and do not exist anywhere else. These substances make up only a small part of the total components of honey. Important minor elements, are minerals, enzymes, lipids, amino acids, proteins, organic acids, etc. These minor components of honey determine its aroma, flavour and colour. Physico-chemical properties of honey are determined by major and minor elements. Several of these properties, viz. refractive index, density, viscosity, electric conductivity, surface tension, etc., are of great importance in the honey industry as they influence its keeping quality, granulation,. texture, etc.

Moisture content is the major factor which determines the keeping quality of honey. If the water content in honey is 20 per cent or more, it undergoes the process of fermentation and deteriorates in quality. Thus, fermentation, which is caused by a yeast, is the greatest enemy of honey. Due to fermentation, honey becomes sour and has a foamy layer on top. In advanced countries, honey fermentation is prevented by pasteurizing and storing it in sealed containers. However, such facilities are not available in the developing countries of South and Southeast Asia, and fermentation of honey is prevented by heating extracted honey for 30 minutes at 60°C and bottling it in airtight containers.

Honey also has a tendency to granulate during storage. This occurs because of its high glucose content which during prolonged storage undergoes a process of crystallization. Although, granulation does not affect the taste, such honey does not fetch good price in the market because consumers suspect that granulated honeys have been adulterated with the addition of table sugar, sucrose.

Granulation also accelerates the process of fermentation. Granulation can be controlled by heating honey to 77°C for five minutes and then cooling it rapidly to 57°C at which temperature it is bottled and immediately capped.

Honey should be stored at minimum possible temperatures to maintain its quality and texture. A detailed world-wide comprehensive review on honey has been compiled by Crane (1976).

7.1.1 Analytical Studies on Asian Honeys

Some analytical studies on Asian honeys made by different investigators are reviewed as follows:

1. *Physical characteristics*: One of the important optical properties of honey is its refractive index which provides an easy way of estimating the water or moisture content of honey, a value which determines whether and when honey will ferment at a given temperature. Latif et al. (1956) measured water content in honey samples from Pakistan, and it ranged from 14.3 to 18.6 per cent (average 16.4). In the Taiwan honeys, the water content varied from 20 to 24 per cent (Lin et al., 1977). Iwada et al. (1969) recommended that in Japanese honey, moisture content of 23 per cent for domestic and 21 per cent for imported honey was considered adequate. Aso et al. (1960) and Arai et al. (1960) reported moisture content in Japanese honey as 20.5 and 20.4, respectively. A number of investigators have reported the moisture content of Indian honeys, as 20.9 per cent in samples from all over India (Phadke, 1967a); 17.2–19.1 per cent in Mahabaleshwar honey (Phadke, 1962, 1967b); 19.2 per cent in Madras honey (Giri, 1938); 25.2–28.4 per cent in Travancore honey (Nair et al., 1950); 20.5 per cent in Calcutta honey (Mitra and Mathew, 1968) and 16.6–26.4 per cent in samples from all over India (Mallick, 1958). Narayana (1970) reported that Indian honeys have a higher moisture content and acidity than foreign honeys. Mahajan (1984) determined moisture content of 15 honey samples from the Shimla hills of Himachal Pradesh which ranged from 16.45 to 20.45 per cent (average 18.85 per cent). These values were lower than those observed from other parts of India. The average moisture contents in multifloral, *Plectranthus* and *Eucalyptus*

honeys were 18.33, 19.45 and 19.25 per cent, respectively (Table 7.1). Six samples of honey stored for one year did not show a significant increase in moisture content. The moisture content of summer samples (18.65 per cent) also did not differ significantly from those of autumn (18.57 per cent). However, Perti and Pandey (1967) reported average moisture content of summer and rainy season honeys from *Apis dorsata* colonies as 17.0 and 25.9 per cent, respectively.

Accordingly to Mahajan (1984), the average specific gravity, viscosity, surface tension and electrical conductivity at 30°C for honey samples of *Apis cerana* colonies from the Shimla hills were 1.425, 37.764, 106.219 and 0.219, respectively (Table 7.1). These physico-chemical characteristics did not show significant differences in their values for both major honey flow seasons (May–June and October–November). After a storage period of one year at room temperature (15–20°C), there was an increase in the moisture content, surface tension, electrical conductivity, and a decrease in refractive index, specific gravity and viscosity due to the hygroscopic nature of honey.

A correlation matrix worked out by Mahajan (1984) for the above honey samples revealed that some of these physico-chemical properties were positively or negatively correlated with each other (Table 7.2). For example, refractive index showed positive correlation with specific gravity ($r = 0.977$, $P < 0.01$); viscosity ($r = 0.807$, $P < 0.01$); surface tension ($r = 0.596$, $P < 0.01$). Similarly, specific gravity showed significant positive correlation with viscosity ($r = 0.725$, $P < 0.001$); surface tension ($r = 0.512$, $P < 0.01$). Electrical conductivity showed positive correlation with phosphate ($r = 0.516$, $P < 0.01$); potassium ($r = 0.642$, $P < 0.01$); magnesium ($r = 0.720$, $P < 0.01$); iron ($r = 0.827$, $P < 0.01$); and manganese content ($r = 0.653$, $P < 0.01$).

2. *Sugars, amino acids and vitamins*: Sugars constitute by far the largest portion of dry matter in honey and are responsible for such physical properties as viscosity, hygroscopicity and granulation.

Latif et al. (1956) investigated samples of Pakistan honey, which had sugar percentages as follows: reducing sugars (71.1–76.9), fructose (39.01–53.81), glucose (21.7–34.2) and sucrose (1.9–2.75). According to Mallick (1958) reducing sugars in Indian honeys varied from 53.9 to 78.4 per cent, and five samples, possibly from a sugar producing area, had more than 10 per cent sucrose. Fieh's test for invert sugar gave a positive result for two years. Kalimi and Schonie (1964) confirmed the increase of higher sugars and decrease of mono-saccharides during honey storage at 28 to 30°C for six to 12 months. These authors also reported that the total sugar content of unifloral honeys varied from 74.7 to 80 per cent and reducing sugars from 72 to 78 per cent of the total. Phadke (1967a, b) found the average value of non-reducing sugars,

Table 7.1: Physico-chemical analysis of honey samples of *Apis cerana* colonies from northern India

Honey type	Refractive index at 20°C	Moisture percentage at 20°C	Specific gravity at 30°C	Viscosity (poises) at 30°C	Surface tension (dynes/cm) at 30°C	Electrical conductivity (mho/cm × 10^{-4})	Ash percentage	Phosphate PO_4 (ppm)	Potassium K^+ (ppm)	Calcium Ca^{++} (ppm)	Magnesium Mg^{++} (ppm)	Iron Fe^{++} (ppm)	Manganese Mn^{++} (ppm)	Zinc Zn^+ (ppm)
1) *Multifloral*														
Range	1.486 –1.496	16.450 –20.450	1.409 –1.436	13.482 –111.807	98.899 –121.137	0.029 –0.328	0.08 –0.76	30 –262	519 –3125	37 –1376	9 –250	1.5 –11.3	0.50 –11.4	2.3 –103.0
Mean	1.491	18.330	1.425	37.764	106.219	0.219	0.44	118.50	1441.40	339.80	106.00	5.33	3.41	16.41
2) *Unifloral*														
A) *Plectranthus*														
Range	1.488 –1.489	19.250 –19.650	1.415 –1.419	15.076 –26.423	105.609 –107.917	0.016 –0.246	0.06 –0.66	44 –299	147 –2614	52 –250	11 –237	1.9 –6.8	0.20 –9.2	1.5 –3.8
Mean	1.488	19.450	1.417	20.749	106.763	0.131	0.36	136.50	1380.50	151.00	124.00	4.35	4.70	2.65
B) *Eucalyptus*														
Range	1.488 –1.490	18.850 –19.650	1.414 –1.419	27.712 –28.292	105.489 –105.849	0.043 –0.050	0.08 –0.46	34 –79	237 –1394	52 –74	5 –92	2.3 –4.8	0.45 –2.2	1.6 –2.7
Mean	1.489	19.250	1.416	28.00	105.669	0.047	0.27	56.50	815.50	63.00	48.50	3.55	1.33	2.15

Source: Mahajan, 1984.

Table 7.2: Correlation matrix of various physicochemical characterstics of honeys of Shimla Hills extracted from *Apis cerana* colonies

Honey type	Refractive index	Specific gravity	Viscosity (poises)	Surface tension (dynes/cm) at 30°C	Electrical conductivity (mho/cm × 10^{-4})	Phosphate PO_4 (ppm)	Potassium K (ppm)	Calcium Ca (ppm)	Magnesium Mg (ppm)	Iron Fe (ppm)	Manganese Mn (ppm)	Zinc Zn (ppm)
Refractive index		0.977**	0.807**	0.596**	−0.219	0.258	0.253	0.568**	0.105	-0.016	0.115	−0.326*
Specific gravity			0.725**	0.512**	−0.077	−0.369*	−0.362*	0.550**	0.249	0.146	0.241	−0.361*
Viscosity (poise)				0.804**	−0.313**	0.061	0.135	0.859**	−0.080	−0.234	−0.103	−0.162
Surface tension (dyne/cm)					−0.124	0.029	−0.300	0.012	−0.107	−0.246	−0.103	−0.034
Electrical Conductivity (mho/cm ×10^{-4})						0.516**	0.642**	0.013	0.720**	0.827**	0.653**	−0.049
Phosphate PO_4 (ppm)							0.951**	0.196	0.928**	0.708**	0.963**	−0.025
Potassium K (ppm)								0.290	0.938**	0.762**	0.923**	−0.031
Calcium Ca (ppm)									0.151	0.046	0.082	−0.081
Magnesium Mg (ppm)										0.748**	0.959**	−0.012
Iron Fe (ppm)											0.788**	−0.127
Manganese Mn (ppm)												−0.144
Zinc Zn (ppm)												

Source: Mahajan, 1984. *$p<0.05$ = Significant; **$p<0.01$ = Highly significant.

glucose, fructose as 70.2, 33.4 and 36.5 per cent, respectively in Indian multifloral honeys, whereas, in Mahabaleshwar (India), these percentage of glucose and fructose varied from 31.2 to 38.3 and 35.2 to 43.3, respectively (Phadke, 1967b). Other authors also analysed honey samples for their sugar contents from Calcutta (Mitra and Mathews, 1968), Travancore (Nair et al., 1950) and Madras (Giri, 1938). These authors showed regional differences in percentages of total sugars, glucose, fructose and sucrose, etc.

Latif et al. (1956) analysed five honey samples of *Apis dorsata* from Pakistan and showed that average percentages of reducing sugars, glucose, fructose and sucrose in these samples, were 69.2, 27.0, 42.2 and 1.43, respectively (Table 7.3). Phadke (1968) carried out such analyses on Indian honeys extracted from 20 nests of *Apis dorsata* and concluded that total reducing sugars averaged 69.5 per cent, whereas, the percentages of glucose, and fructose in these samples varied from 29.8 to 33.8 and 34.6 to 39.9, respectively. Similar sugar content analyses extracted from *Apis dorsata* colonies from Travancore and Calcutta were carried out by Mitra and Mathew (1968) and Nair et al. (1950) which represented interregional differences.

The total reducing sugars, glucose, and fructose in honey samples extracted from *Apis florea* nests in India averaged 71.2, 32.3 and 38.9 per cent, respectively. Latif et al. (1956) reported lower total reducing sugars but higher fructose content in *Apis florea* honey samples from Pakistan (Table 7.3). Giri (1938) studied 12 samples of Indian honeys for acid phosphatose activity and reported that this enzyme was effective over pH ranges from 3.5 to 6.5; and at a temperature of 35°C.

Deodikar and Phadke (1966) concluded that the Fieh test for presence of hydroxymethyl furfural (HMF) in honey should be regarded as quantitative rather than qualitative. According to HMF contents honeys may be graded as follows:

HMF contents µ gm/gm of honey	Grade
0–10	I
11–20	II
21–30	III

Phadke and Nair (1968) further suggested that 30 µ gm of 5-hydroxymethyl furfural per gramme would be reasonable value for honeys produced in tropical climate.

The amino acid composition of Indian honey from *Apis cerana* colonies revealed that lysine, arginine, proline, valine, methionine, isoleucine and leucine along with asparatic acid, glutamine, serine, glycine, histidine and alanine were present (Kalimi and Schonie, 1964).

Table 7.3: Composition of Pakistan honey

	Moisture per cent	Reducing sugar per cent	Levulose per cent	Dextrose per cent	Sucrose per cent	Ash per cent	Formic acid per cent
Honey Analysis of Government Sample							
Government Apiaries:-							
1. Lyallpur							
(a) Capped honey ...	16.6	71.1	40.5	33.8	2.04	0.220	0.115
(b) Uncapped honey ...	20.6	58.56	30.78	30.34	4.90	...	0.103
(c) Clover flow ...	15.6	76.0	48.85	27.20	2.75	...	0.138
(d) Blended honey ...	18.6	76.8	50.0	31.05	2.5	...	0.161
(e) Brassica flow ...	21.2	73.84	44.15	33.44	2.18	0.148	0.0977
2. Sialkot ...	14.3	76.90	41.4	34.2	2.0	0.268	0.138
3. Chattar ...	15.5	69.8	39.01	33.9	1.66	0.112	0.078
4. Hassanabdal ...	17.6	74.5	48.8	30.53	1.09	0.32	0.069
5. Murree ...	16.56	76.6	53.88	27.07	1.56	...	0.069
Honey Analysis of Three Species of Apis							
(1) *Apis florea* F. ...	17.4	62.92	40.38	28.26	1.8	0.183	
(2) *Apis dorsata* F. ...	16.2	69.23	42.23	27.00	1.43	0.158	
(3) *Apis indica* F. ...	16.4	73.53	42.8	32.5	2.12	0.113	

Source: Latif *et al.* 1956

The content of vitamins such as riboflavin, niacin, thiamine and ascorbic acid in Indian honeys from *Apis cerana* colonies varied from 12 to 54; 442 to 798, 8 to 22, 2000 to 3400 μ gm per 100 gm of honey. These authors also found that after storage of honey at 28–30°C for one year, 20 per cent of the vitamins were lost (Kalimi and Schonie, 1965).

Various characteristics of honey are influenced to some extent by its mineral composition. Ash represents the amount of dry matter present in honey. Latif et al. (1956) showed that the ash content in samples of Pakistan honey ranged from 0.11 to 0.32 per cent. In Indian honeys, the ash content ranged from 0.03 to 0.52, 0.014 to 0.048, 0.03 to 0.46 and 0.11 to 0.25 in *Apis cerana* honey samples from Calcutta, Mahableshwar, Madras and all India representative samples. According to Mahajan (1984), white or light coloured honey samples of *Apis cerana* from Shimla hills showed lower ash content (0.06–0.9 per cent), whereas, darker coloured honey samples were higher (0.33–0.76 per cent) in ash content (Table 7.1). The total ash content in *Apis dorsata* honeys from the Philippines, Pakistan and India averaged 0.17, 0.26 and 0.39 per cent, respectively (Minh et al., 1971; Latif et al., 1956; Phadke, 1968). In *Apis florea* honey samples, ash content varied from 0.48–0.54 with an average of 0.52 (Phadke, 1968).

Singh et al. (1975) determined the ash content in samples of Indian honeys by the cationic exchange method and also determined the quantity of acid liberated. The ash values calculated from this formula showed a close agreement with the sulphated ash content of samples determined by conventional methods. Kalimi and Schonie (1964) showed that the amount of sodium, phosphorous, iron and magnesium in ash extracted from Mahableshwar ranged from 18.2 to 45.4, 17.2 to 34.2, 169–389 and 47 to 122 ppm, respectively. Mahajan (1984) reported an average ash content of 0.04 per cent in *Apis cerana* honey samples from the Shimla hills. The average concentrations of phosphate, potassium, calcium, magnesium, iron and zinc in these samples were 118, 1432, 265, 109, 5–3, 3.71 and 11.9 ppm, respectively. She also found that electrical conductivity showed significant positive correlation with most of the minerals such as potassium, magnesium, iron and manganese content (Tables 7.1 and 7.2).

7.1.2 Honey Production and Marketing Strategies in China

There is an increasing demand for honey in the world market. This is because of the higher living standards and greater interest in natural foods particularly in developed countries. The world production of honey shows a decreasing trend particularly in the developed countries (Table 7.4). A shortage of hive products in the world market offers new sales opportunities for exports.

A honey market report prepared by International Trade Centre, UNCTAD/GATT (1986) revealed that world production of honey was estimated at over 997,157 MT in 1984, and only less than 20 per cent of this entered the world trade. There are at present fifteen countries in the world which account for 90 per cent of world honey exports. Among these, China is the only country in this region which is the biggest exporter of honey in the world (Table 7.6). Keeping in view the major role of China in world honey trade, past history and present policies of production and export in China are reviewed as follows:

Table 7.4: Honey production in China, Asia and World

Years	Honey production in China (MT)	Honey production in Asia (MT)	Honey production in World (MT)	Percentage of total Asian production in China	Percentage of total World production in China
1975	227609	26335	874808	84.79	26.01
1976	238481	23206	960465	84.35	24.82
1977	247316	25426	943903	85.16	26.20
1978	247313	20491	973023	84.17	25.41
1979	110495	43186	873738	68.74	12.64
1980	80764	51028	821965	62.89	9.82
1981	115600	62513	885302	65.06	13.05
1982	136605	69695	965557	68.19	14.14
1983	143605	56643	990862	70.28	14.49
1984	160605	48115	997157	73.38	16.10
1985	—	—	—	—	—
1986	—	—	—	—	—
1987	204000	—	—	—	—
1988	186500	—	—	—	—

Source: International Trade Centre UNCTAD/GATT. 1986
USDA Foreign Agricultural Service, 1988.

Significance of honey in Chinese history: In some Hindu Kush-Himalayan countries, honey was known as the earliest known sweetening food source. Surprisingly, this is not true for China, where honey came into use later than many other forms of sweet foods. The role of honey in Chinese history has been reviewed by Kellog, 1967 and Kellog and Tang, 1963. A brief description of their work is as follows:

Ancient writings (Chow Dynasty, 1122–205 BC) reveal that the earliest sweet food in China was maltose, extracted from fermented grains of rice and wheat. The use of the word "honey" in the Chinese language was mixed up with maltose. For example, old Chinese dic-

Table 7.5: Quality of Chinese honey

Honey Grade	Percentage of Total	Major Plant Sources
Superior and	—	Citrus and Pipa
I	20	Milkvetch, Acacia, Water melons, Lenden and Citrus
II	70	Rape-seed
III	10	Cotton, Palm tree

U.S.D.A. Foreign Agricultural Service, 1988.

Table 7.6: Honey production and export by China

Years	Honey production in (MT)	Honey export	Percentage of total domestic production exported	Percentage of total Asian exported	Percentage of total World production exported
1975	227609	26083	11.46	99.04	17.369
1976	238481	22117	9.27	95.30	12.106
1977	247316	25120	10.16	79.09	14.224
1978	247313	20111	8.13	98.14	10.98
1979	110495	42608	36.56	98.66	21.560
1980	80764	49296	61.03	96.60	23.541
1981	115600	60205	52.08	96.30	24.482
1982	136605	66256	48.50	95.06	26.289
1983	143605	53202	37.05	93.92	20.245
1984	160605	45059	28.05	93.64	16.725
1985	—	—			
1986	—	80589			
1987	204000	66381	39.94		
1988	—	70000 (projected)			
1989	over 200000	70000			

USDA Foreign Agricultural Service, 1988.
International Trade Centre UNCTADD/GATT, 1986.

tionaries describe honey as "sweet maltose produced by bees". They also termed honey as a "close" or "secret" valuable food because it was stored by bees in closely spaced combs of dark nests. It was only during the third century B.C. that honey was recognized as a separate distinct individual sweetening source and one can read in the literature statements like "this taste is not like maltose or honey".

In the fourth century B.C., Prince Yueh bartered honey for a piece of land and also presented it as a gift to the Prince of Wu. In 25 A.D., Emperor Kwan, while ascending the throne, gifted cattles and honey to one of his friends. These examples suggest that in olden times, honey was considered as a precious, luxurious and highly priced commodity in China. In the beginning of the first century A.D., one finds frequent examples in the literature about honey being imported into China from the West and being bartered for precious commodities like silk.

In China, the Government encouraged beekeeping and honey production in as early as 300 A.D. At that time, the agriculture minister of the empire used honey to polish his pots and pans. During TS' dynasty (265–419 A.D.), a Government proclamation stated "Beekeepers can collect ten measures of honey as a maximum: if any persons can collect two pints more, he will be rewarded with ten bushels of rice."

In China, the first use of honey as medicine was mentioned in "Materia Medica of Shen men Shih" written during the period 25 to 110 A.D. Later, Dr. Chang Chi recommended the use of honey as a laxative in his medicinal book "Shang Lung". The role of honey in promoting long life has been advocated in the Chinese system of medicine since ancient times, and even today it is considered a valuable "drug of longevity".

In earlier times, honey was named as "ground honey", "wood honey", "bamboo honey" or "stone honey", depending upon whether the honey nest was located on the earth, tree or rocks, respectively.

Although China today is one of the top producers of honey in the world, but for a common man, it is still a luxury item which is scarcely available and highly priced. It is generally used for medicinal purposes and occasionally mixed with tea or taken as a refreshing drink on a hot day.

Recent trends in honey production in Peoples Republic of China

The present honey production policy in China has been reviewed by USDA, Foreign Agricultural Service, 1988; International Trade Centre, UNCTAD/GATT, 1986; Zhenming, (1990); Wongsiri et al. (1986); Xianshu, (1985); Schumacher, 1969, 1979, and 1980.

After the USSR, China is the second largest honey producer in the world. Tables 7.4 and 7.6 show the recent trends in honey production in China. According to a recent report published by USDA Foreign Agricultural Service (1988), China produced a total 204,000 MT of honey in 1987 from about 8,320,000 colonies. Out of this quantity, 166,200 MT was produced in modern commercial apiaries and the remaining 38,000 MT through traditional methods. In 1987, there were 6,820,000 bee colonies kept in modern bee hives for commercial honey production, and the average honey production per hive was 24.5 kg. There are about 24 species of plants (See chapter 9) which act as major sources of honey in China, and these occupy a total area of 22 million hectares which can provide good forage for over 30 million bee colonies. Projected commercial honey production in China by the year 1990 will be 1,86,500 MT from 7 to 9 millions bee colonies. Chinese honey is well known because of its good aroma and high dextrose content. But sometimes it contains sediments of loose-soil in the honey. Of the total honey produced in China, 20 per cent is classified as first grade, 70 per cent as second grade and the remaining 10 per cent as third grade honey (Table 7.5).

As in other parts of the world, honey production in China has fallen significantly in recent years as compared to the middle and late seventies when its production was maximum (Table 7.4). During the peak honey production years (1975–1979), China produced about 84–85 per cent of the total Asian production, and 25 per cent of the total world production. However, in recent years, these figures have come down to 60–70 per cent of the total Asian production and 13–14 per cent of the total world production (Table 7.4).

However, the Central Government and regional agencies in China are determined to promote beekeeping in China on a large scale. It plans to establish new commercial apiaries in Hubei, Sichuan, Heilongjiang, Hunan, Henan, Shaanxi, Zhejiang, Fujian, Jiangsu and Annui provinces with a total investment of 1.82 million US dollars, and has the target of increasing honey production by 13,000 MT per annum (USDA Foreign Agricultural Service, 1988). Unlike many developed countries of the world, where the new major thrust is on increasing the yield per hive, in China the policy is to increase the production by increasing the number of colonies.

China has both full-time commercial beekeeping enterprises and part-time small-scale beekeeping farmers. The majority of apiaries in China are household apiaries each with 50 to 80 bee colonies. The average size of an apiary in China is about 30 bee colonies. Whenever beekeeping is practised on a commercial scale, migratory beekeeping is very common. Bee hives are moved to good honey flow and suitable climatic zones either in trucks or by train. In China, honey production is primarily for export purposes, to increase the state income. For each ton of honey exported, it can import 3.5 tons of steel and 6 tons fertilizers (Svensson, 1977).

In 1987, 60 per cent of the total commercial honey produced in China was consumed in the domestic market in the following market segments:

Table honey	= 38 per cent
Chinese medicine	= 47 per cent
Food and beverage industries	= 15 per cent.

Honey export from China

China is the largest honey exporter in the world (Table 7.6). The Chinese have achieved this distinction because honey experts and economists in China are aware that:

i) There is a growing demand for honey in the developed countries of Europe, Japan and the USA, thus there exist a large, ready, and potential market for this hive product which can easily earn hard currency.

ii) Honey exported from China matches the international standards in quality, consistency and packing.

iii) Chinese honey meets standards of foreign food laws.

iv) Honey pricing policy is consistent and competitive.

In China, honey export is handled by provincial branches of the China Native Products Import/Export Corporation which is under the control of the central office in Beijing. This corporation has foreign offices in countries to which the major produce is exported such as to the USA, Japan, etc. After production, the quality is thoroughly checked by a state official, and an export certificate is furnished which accompanies the shipment. Honey is packed in new steel drums which are laquered green-red. These drums have the capacity of 640 litres net, and the smaller ones have a 200 litre capacity.

China's honey exports were maximum in 1986 when it exported 80,589 MT of honey, but in 1987 the export declined to 66,381 MT. A projected export quota for the year 1988 was marked about 70,000 MT. (Table 7.6).

The declining trend for China's export of honey may, due to more attractive domestic markets, as a result increase in the standard of living and can afford to pay higher prices. On the other hand, prices of honey in international markets are dropping and so is demand. For example, EEC now buys honey from the USSR at a very attractive competitive price, and similarly honey prices in the USA in recent years have fallen off, as a result, higher priced Chinese honey is in less demand. Japan is the only market for Chinese honey ready to pay top dollar prices.

7.1.3 Honey Production and Trade in the Hindu Kush-Himalayan Countries other than China

In the Indian subcontinent, honey has been referred as man's earliest food, and it has been valued throughout successive civilization. There are references to honey in the Vedas, the Ramayana, the Book of Proverbs, the Quoran and many other ancient books. In ancient times, it was common practice in this region to accept honey and beeswax by the ruling class for the payment of taxes and tributes. It has been considered as the most valued food at all important occasions including birth and death rites, and festivals. All ancient literature of the Hindu Kush-Himalayan region give details of honey as man's first food and the first available sweet. Information on honey production and trade in the Hindu Kush-Himalayan countries is reviewed in Table 7.7.

1. India

The FAO 1986 figures for total honey production in India is 18,000 MT. About half or more of this quantity of this total production is harvested from wild colonies of *Apis dorsata* and *Apis cerana* from forests and other areas. Keeping in view the total area of the country as well as the potential for beekeeping development in India, it has been estimated that there is enough bee forage in terms of cultivated crops and wild plants in India to support more than 5 million bee colonies (Thakar, 1976). This would mean substantial and reliable income to the tribal and rural population in the country. Most of the marketed honey in India is used for household purposes. Its use as table honey varies from 88 to 95 per cent of the total consumption. The remaining honey is used in bakery, confectionery and cereal foods. In India, it is also used in baby food, tobacco, pharmaceutical and cosmetic industries. In the past, (1977–1982), Malaysia, France, Nepal, the Netherlands, Singapore, Sri Lanka, Yeman and the Arab Republic have been the main importers of Indian honey. Among them Singapore had been a regular importer. However, the total amount of honey exported to these countries is almost negligible, i.e., about 3 tons per year (Joshi, 1982). Nepal had been importing honey from India earlier but now it is mainly China and Australia who export honey to Nepal.

In the past, traditional unhygienic methods of harvesting honey rendered the product unmarketable, even after a short period of time. The tropical and humid climate in many of the honey-producing areas was another serious constraint which affected the keeping quality of honey. However, in recent years, steps taken by the Government of India with regard to honey processing and marketing has removed these bottlenecks. The recent establishment of a separate ministry for processing food materials creates ways to facilitate processing and marketing of honey. The Government of India in 1988 removed the excise duty on equipment manufactured for use in the beekeeping industry. Honey-processing equipment and machinery would naturally be the major beneficiary of this policy (Tonapi, 1988). Himachal Pradesh is the only area in Southeast Asia which has announced support price for honey. The Indian Standard Institution (ISI) has laid down specifications for the different types of honey produced in India. These are summarized in Table 7.8.

2. Pakistan

In Pakistan, the annual production of honey from different species of honey bees is about 640 tons. About 14 to 18 per cent honey comes from domesticated hive bees *Apis mellifera* and *Apis cerana* kept in modern moveable frame bee hives, and the rest of the honey is harvested mainly from wild *Apis dorsata* colonies and also from *Apis cerana* colonies kept in traditional hives as well as those found in the wild state. The amount of honey harvested from wild *Apis florea* colonies is negligible but is of great medicinal value (Ahmad, 1990). The bulk of the honey in Pakistan from wild *Apis dorsata* colonies is harvested by using a very crude squeezing method. Such honey is very high in moisture content and it granulates and ferments very quickly. Sometimes, it is only a matter of few days, that the whole lot of such honey gets spoilt and becomes unfit for human consumption. The main reason for this poor standard of honey is ignorance. Honey hunters and traditional beekeepers have very little knowledge about the extraction and processing of honey. It has been estimated that through such crude methods of honey extraction, about 15 to 20 per cent of the total honey produced in Pakistan is lost (Ahmad, 1986). Some of the specifications for honey from Pakistan are given in Table 7.8.

3. Bangladesh

In Bangladesh, the average honey yield per colony of *Apis cerana* is quite low, i.e., 4 kg per colony. Honey is harvested quite frequently; sometimes, even every week. There are about 5,000 to 10,000 colonies of *Apis cerana* kept in different types of hives by about 8,000 beekeepers. The average number of bee colonies owned by a beekeeper is one or two. The Sunderbans in Bangladesh are major honey-producing areas and in these forests, concentration of *Apis dorsata* colonies is very high. More than 95 per cent honey in Bangladesh is consumed as table honey and the rest is used for medicinal and pharmaceutical purposes. Honey is stored and packed in plastic containers. This country also imports honey from Australia. Domestic honey is sold at prices between 3 and 4 US dollar per kilogramme (Svensson, 1988).

Table 7.7: Honey market situation in Hindu Kush-Himalayan region

	Bangladesh	*Bhutan*	*China*	*India*	*Nepal*	*Pakistan*
Consumers of honey	Local people + tourists + pharmaceutical	Local people + tourists	Local people	Local people + pharmaceutical	Local people + tourists + pharmaceutical	Local people + pharmaceutical
Price of honey per kg in US$	3.0	3.0	3.0	3.0	2.5–11.0	2.25
Trading system	Nil	Non-existent	Well developed	Honey co-operatives	Non-existent	A few honey co-operatives
Availability of honey	Scarce	Scarce	Scarce	Scarce	Scarce	Scarce
Consumer demand versus local supply	Demand is greater than supply	Demand is greater than supply	Demand is greater than supply	Demand is greater than supply	Demand is greater than supply	Demand is greater than supply
Honey import	Australia	Indian origin	Nil	Negligible Europe	China, Australia	–
Honey export	Negligible	Nil	Japan etc.	Negligible	Nil	Negligible
Honey containers	Plastic & glass bottles	Glass bottles	Glass or Plastic bottles	Glass or Plastic bottles	Glass or Plastic bottles	Glass or Plastic bottles
Annual honey production	30 tons	Negligible	204000 tons	18000 tons	26	640 tons

Average yield/ colony	4 kg with *Apis cerana*	3–5 kg with *Apis cerana*	24.5 kg with *Apis mellifera* 20–30 with *Apis cerana*	5–8 kg with *Apis cerana* 18 kg with *Apis mellifera* 30 kg with *Apis dorsata*	15 kg with *Apis cerana*	3–5 kg with *Apis cerana* 18 kg with *Apis mellifera*
Market segments:						
Table honey (%)	95	95	38	88–95	95	90–95
Pharma-ceutical (%)	5	5	47 5 food and beverage industries	5–12	5	5–10
Honey harvesting methods	Both by centrifugal extraction & squeezing	Both by centrifugal extraction & squeezing	Mainly by centrifugal extraction	Both by centrifugal extraction & squeezing	Both by centrifugal extraction & squeezing	Both by centrifugal extraction & squeezing

Source: Compiled from multiple sources.

Table 7.8: Specifications for different types on honey in India* and Pakistan**

Sr. No.	Characterstic	Indian Extracted Honey: Special grade	Indian Extracted Honey: A Grade	Indian Extracted Honey: Standard grade	Indian squeezed honey	Indian *Carvia callosa* honey	Pakistani honey	International standard
1.	Minimum specific gravity at 27°C	1.41	1.39	1.37	1.37	1.4	—	—
2.	Maximum moisture percent by mass	20	22	25	25	20	18.6	21
3.	Minimum total Reducing sugars percent by mass	70	65	65	65	60	71.1	65
4.	Maximum sucrose percent by mass	5.0	5.0	5.0	5.0	10	2.75	5
5.	Minimum fructose-glucose ratio	1.0	1.0	1.0	1.0	1.0	1.40	—
6.	Maximum ash percent by mass	0.5	0.5	0.5	0.5	0.5	0.32	0.6
7.	Maximum acidity expressed as formic acid present	0.2	02	0.2	0.2	0.2	0.69	—
8.	Fiehe's test	Negative	Negative	Negative	Negative	Negative	—	—

9.	Minimum Total count of pollens and plant element/gm honey	—	—	—	50000	50000	—	—
10.	Minimum Topical Density at 660nm	—	—	—	0.3	0.3	—	—

*Source: Indian Standard Institution, 1975a, 1977 a,b

**Latif *et al.*, (1956)

4. Nepal

In Nepal, local farmers harvest honey from traditional hives during spring (March–April), pre-monsoon (June–July) and autumn (October–November) seasons. In each of these honey-flow seasons, honey is harvested after every two or four weeks after the bees have occupied the hive in the lowland areas. In the highland areas, because of the temperate climate, beekeepers can harvest honey only once or twice a year. The quantity of honey harvested from traditional hives from both highland and lowland areas is quite low, 2 kg from *Apis cerana* hives. However, there are now progressive *Apis cerana* beekeepers in the Kathmandu valley of Nepal, who use modern moveable frame hives and the average honey yield from such *Apis cerana* hives is 15 kg per colony per year.

Local beekeepers sell domestic honey at different prices depending upon the demand for honey in a particular region. For example, in mountainous parts and in the western region, where the demand exceeds supply, honey is more expensive as compared to the Terai and eastern regions, where villagers grow sugar cane. Honey is consumed by the beekeepers as well professional honey hunters themselves as a food or for other purposes. Most of the villagers in Nepal chew honey along with the comb, whereas other honey consumers, who must buy honey directly from beekeepers or the market, use it for medicinal and religious purposes and seldom for table consumption.

In Nepal, the prices of honey vary considerably, 2 to 20 US$ per kilogramme. Nepal imports honey from China, Europe and Australia and the price of exported honey is the highest, 20 US$ per kilogramme. Keeping up with this trend, some progressive beekeepers in the Kathmandu valley also sell their domestic *Apis cerana* honey at a rate which is competitive with foreign honey. However, squeezed honey from wild colonies is sold at a very low price of about 2 US$ per kilogramme (Wadhi, 1961, Crane 1984, Strickland, 1982 and Nakamura, 1989).

5. Bhutan

In Bhutan, the local people and tourists are the main consumers of honey. Demand is much greater than supply, and Bhutan imports honey from India. The price of honey in Bhutan is about 50 Nu (3 US$ per kilogramme). There is no trading system for honey in Bhutan.

7.1.4 Suggestions for Improvements of Honey Processing and Marketing

Except for China, there is hardly any policy being adopted in other countries of the Hindu Kush-Himalaya for the scientific processing and marketing of honey. With the introduction of the European honeybee, *Apis mellifera*, into some of the countries of the Hindu Kush-Himalayan region, honey production is likely to increase tremendously, and the processing and marketing problems are likely to become more serious. It is time that the different Governments take up these problems so that the beekeeping industry in the region can develop on scientific lines in a planned way. Some of the suggestions for the improvements of honey processing and marketing are:

1. There is a need to recognize that centrifugally extracted apiary honey is distinct from the honey collected by traditional squeezing methods. The former should be processed and marketed as "table or medicine honey", whereas squeezed honey should be used for industrial purposes.
2. There should be different price policies for table and squeezed honey.
3. Honey should be recognized as a natural and primary food product like fruits, vegetable, etc. There is a need to increase honey consumption as a nutrient food than as medicine. For this purpose, wide publicity through the media is required to popularize honey to different categories of consumers.
4. Since quality is one of the major considerations of the importers, it is essential that the honey be pure, clean and uniform. Consequently, all producing countries should lay major emphasis on quality control which is at present lacking in the Hindu Kush-Himalayan countries.
5. While exporting honey, it should be kept in mind that the developed countries are potential markets for honey export, and in these countries they prefer fresh, light coloured, liquid and unifloral honey.
6. In the Hindu Kush-Himalayan countries, honey is still packed in an odd assortment of glass bottles. In a country like India, high density polymers, which meet the requirements for international honey markets, are now available and should be used for packing honey.
7. New suppliers and smaller exporting countries as is the case in the countries of this region, should establish regular trade channels through reliable agents/importers or packers in the target markets.
8. National honey boards in individual countries of the Hindu Kush-Himalayan region should be established on a pattern similar to the United States National Honey Board to look after all aspects of honey handling from hive to market.

9. Smaller countries of the Hindu Kush-Himalayan region should also follow the example of China and India, where specifications for quality control of honey in terms of its physico-chemical properties have been laid out.
10. Marketing strategies for honey should be planned in such a way that soon after it is harvested, the storage and transport time is reduced to an absolute minimum. This problem has specific relevance in marketing of honey in the mountain region where the honey is produced at a considerable distance from the consumer market.
11. Honey cooperatives for the processing and sale of honey and other hive products should be formed because it is too expensive for an individual beekeeper to purchase and install honey-processing equipment and machinery.

7.2 BEESWAX

Beeswax has been widely used for several commercial purposes for many centuries. Egyptians were the first to use beeswax for the preservation of their dead. Romans made extensive use of beeswax for writing, modeling, candles, and in the preparation of salves and medicines (Eckert and Shaw, 1976). One early example is its presence in a Ninth Century Viking ship found at Oseberg (Sebelien, 1913).

Beeswax is secreted by the four pairs of wax glands of the worker bees located on the ventral side of their abdomen, and it is synthesized in their body from the reducing sugar. It is generally secreted in the form of wax scales, and it has been estimated that about 1.5 million wax scales are required to produce one kilogramme of wax (Coggshall, 1949; Snodgrass, 1925; Phadke et al., 1969). There are contradictory reports in the literature regarding the amount of honey actually consumed by bees during wax production. According to Eckert and Shaw (1976), for the production of 1 kg of beeswax about 34 kg of honey is consumed. However, Phadke et al. (1969, 1971) reported that only 10 to 15 kg of honey is needed. Whitcomb (1946) reported that 7.5 to 10 kg of honey is consumed.

In the Hindu Kush-Himalayan region, wax is extracted by melting the combs in hot water. Wax accumulates on the water surfaces, and is then strained or filtered to remove the gross impurities, and allowed to solidify in tins or moulds. This traditional method of wax extraction, however, is gradually being replaced by modern solar extraction methods, wherever modern beekeeping with moveable frame hives is practised. Solar wax extractors are now commonly available and it is a cheaper and better method of wax extraction. Indian Standard Institution (1977c) has laid down the specifications for solar beeswax extractors.

According to an FAO (1986) report, China is the largest producer of beeswax in the world. In 1982, it produced 12,800 MT of beeswax, whereas, the world total production was 43,400 MT beeswax during this year. However, there were no net import and export figures available for this country. At present, India is producing about 15 to 20 MT of beeswax. Earlier, India used to export wax to the USA, the Federal Republic of Germany, the UK, France and Japan. However, most of the beeswax now produced is utilized in domestic markets. At present, Nepal and Bhutan export beeswax to India (Joshi, 1982).

In the Hindu Kush-Himalayan region, beeswax is produced from *Apis cerana* and *Apis dorsata / laboriosa*. It has been estimated (Phadke et al., 1969) for *Apis dorsata* colonies that on an average a commercial honey yield of 100 kg corresponds to a wax production of 1 to 2 kg. The yield from *Apis cerana* is rather small. The beeswax collected from the Hindu Kush-Himalayan bees is different in physico-chemical properties as compared to *Apis mellifera* beeswax. It is not acceptable to the European export market mainly because the largest user of bees wax is the cosmetic industry which uses formulae that have been designed from *Apis mellifera* beeswax. In this region, beeswax is mainly used for comb foundation sheets, in the batik industry and in casting bronze. Now, the cosmetic industries in Asian countries, especially Japan and India, use formulations designed for the wax produced by native bees. (FAO, 1986). Specifications for different types of beeswax produced in India are given in Table 7.9.

Beeswax from *Apis mellifera* has been a subject of intensive investigation. It consists of a mixture of different classes of components and each of these classes is itself a mixture of a series of compounds. The major constituents of *Apis mellifera* beeswax are

Hydrocarbons	=	14%
Monoesters	=	35%
Diesters	=	14%
Triesters	=	3%
Hydroxy monoesters	=	4%
Hydroxy polyesters	=	8%
Free acids	=	12%
Acid polyesters	=	2%
Free alcohols	=	1%
Unidentified	=	6%

More than 300 individual components of beeswax have been identified. Among these, the predominant are: C_{40} (6%), C_{46} (8%),

Table 7.9: Specifications for Indian beeswax

	Apis mellifera	*Apis cerana*	*Apis dorsata*	*Apis florea*	*Apis sp.* mixed
Colour	–	–	–	–	Dark yellow brown
Specific gravity at 22.2°C	0.9520	0.9659	0.9541	0.9461	0.960–0.980
Melting point 0°C	62.5	64.8	59.6–66.7	63.0	61–65
Refractive index at 72°C	1.4398–1.4451	1.4431	1.4409	1.4417	–
Saponification cloud point	—	85–105	62.1	—	85–105
Specific heat (cel gm)	—	—	—	—	0.484
Conductivity (... $cm^{-1} \times 10^6$)	—	1.36	1.66	1.37	—
Specific resistance ... $cm^{-1} \times 10^6$	—	0.73	0.60	—	—
Dielectric constant K at 1000 cycles	—	1.43	1.76	1.26	—
Maximum iodine value	—	10.00	—	—	10.00
Maximum acid value	—	8.0	—	—	10.0
Maximum ash percent	—	0.2	—	—	0.5
Maximum total volatile matter percent by mass	—	0.75	—	—	0.75
Maximum insoluble matter in benzene per cent by mass	—	1.0	—	—	—
Maximum matter soluble in water per cent by mass	—	0.5	—	—	—

Source: Phadke *et al.* 1969
Latif *et al.* 1960
Indian Standard Institution, 1975b.

C_{48} (6%), monoesters and C_{24} acid (6%). All these exceed 5 per cent of the total (Tulloch, 1980).

The comparative composition of beeswax extracted from different species of honey bees is given in Table 7.10.

Table 7.10: Partial composition of single samples of Asiatic beeswaxes, determined by GLC relative to internal standards

Components	*Apis dorsata*	*Apis cerana*	*Apis florea*
Hydrocarbons	9	11	15
Monoesters	23	28	31
Free acids	2	3	3
Hydroxy monoesters	12	?	?
Total volatile	46	42	49

Source: Tulloch, 1980

Commercially beeswax is important for the cosmetic, industrial beekeeping purposes. The major part of world beeswax production is consumed by the cosmetic industry. It is mainly *Apis mellifera* beeswax which is used for the manufacture of cold creams, lipsticks, lip pomades and various lotions.

Beeswax has several other industrial uses. For example, it is exclusively used for the manufacture of church candles and it is also an important ingredient in polishes, engraving materials, castings, dental equipment, ornaments and confectioneries (Poncini, 1987).

In the Hindu Kush-Himalayan region, it is only India, China and Pakistan which use extracted beeswax for the manufacture of comb foundation sheets. In addition, it has value as an ingredient of folk medicines in the pharmaceutical industry. In this region, beeswax production from *Apis dorsata / laboriosa* offers great untapped potentials. It is mainly the ignorance of the producer of beeswax that at present only insignificant quantities are being collected and sold in the local market. Beeswax production technology is simple to follow. The investment for collection, refining, grading and packing are comparatively low and finished products fetch a good price. Thus, it is an important income-generating activity. Market information on beeswax is not available for the correct assessment of its production and various commercial uses. There is also a need to check adulteration of beeswax with other artificial ingredients.

7.3 POLLEN

At present, China is the only country in the Hindu Kush-Himalayan region which produces about 1,000 MT of pollen per annum. Commercial production of pollen in China started in 1983 (Guanhuang, 1990). The Hindu Kush-Himalayan region, because of its diversity and richness of natural flora, offers great potential for harvesting pollen as a surplus hive product. It is almost a free resource and can be collected with minimum investment. It will go waste in nature if not utilized.

Honeybees are the most efficient micro-manipulators of pollen in nature. Pollen can easily be harvested by putting a pollen trap at the entrance of the hive. A pollen trap is a single or double grid device through which the bees entering the hive must scramble, and in this way pollen pellets from their hind legs get knocked off and fall into a tray. It has been estimated that one colony of *Apis mellifera* uses about 50 kg of pollen in a year as a source of proteins, fats, minerals and other substances. Proteins are essential for honeybees in the build up and repair of body tissues, egg production and brood rearing. During a good pollen flow season, it is possible to harvest about 0.5 to 1 kg of pollen per day from one hive of *Apis mellifera*. However, the pollen collection behaviour of *Apis cerana* has been studied in less detail.

Pollen collected by honeybees has many commercial uses which have not been fully exploited in this region. In ancient times, pollen was used for human consumption by the Greeks, Egyptians, Persians and Chinese. Maximum use of pollen is more for feeding the bees during slack seasons when it is not available from the flowering plants. For bees feed it is blended with soybean flour or sugar. It is also used as a dietary supplement for domestic animals. Pollen is now becoming popular for human consumption as nutritional and therapeutic dietary supplements. It is used for treating human sterility because of the presence of gonadotrophic harmones (Ridi et al., 1969). Pollen is also recommended for the proper functioning of human prostrate glands (Traub, 1973). Keeping in view the growing demand for vegetarian food both in the developing and developed countries, the use of pollen as a protein supplement in the human diet will become more important. Pollen is also used for desensitizing persons affected with pollen allergy.

Currently, several experiments are being conducted for the use of pollen in controlled orchard pollination. It may be applied by brush, duster, gun, blower, aircraft or honeybees, and as a result of this practice, the fruit or seed set is enhanced significantly. A device called "pollen insert" has been specially designed for controlled pollination of fruit orchards where sufficient pollinizer varieties are lacking (Jaycox, 1969). Air-dried pollen can be stored for a year at ordinary room temperature but it gradually loses its palatability and nutritive value. In the Hindu Kush-Himalayan region, it has been noticed that many temperate fruit orchards, do not bear sufficient fruit because of inadequate pollination. In such orchards, the use of pollen under controlled conditions as explained above will greatly help in solving the problem of insufficient pollination.

7.4 ROYAL JELLY

Royal jelly is a milky white secretion which is produced from the hypopharyngeal glands of young worker bees. It is secreted exclusively to feed the queen bee throughout her larval and adult life, and also young worker and drone larvae. According to Witherell (1979), the chemical composition of royal jelly as compiled from different sources is:

Moisture	= 66%
Protein	= 12.34%
Total lipid (fat)	= 5.46%
Total reducing substance	= 12.49%
Ash (mineral)	= 0.82%

It is very rich in vitamins B and C, and is lacking in vitamin E. Royal jelly contains 10-hydroxy decanoic acid which has an antibiotic and anti-tumour activity.

China is the only country in the Hindu Kush-Himalayan region which had developed the technology for the production of royal jelly. Total royal jelly production in this country is 800 MT per year. Before 1957, royal jelly in China was produced from queenless colonies on a small scale. Commercial production of royal jelly from queenright colonies started in 1959. A relatively strong colony of *Apis mellifera* in southern China at present produces 0.5 to 1 kg of royal jelly (maximum 2 kg), whereas, in northern China 0.3 to 0.5 kg of royal jelly per colony is produced. This difference in the yield of royal jelly per colony is due to the longer bee activity period (six months). Thus royal jelly production in China is now one of the important components of the beekeeping industry, (Guanhuang, 1990). The wholesale price of royal jelly was about US$ 100 per kilogramme in 1985.

7.4.1 Production Technology

Royal jelly production technology in China as described by Guanhuang (1990) is as follows: A queenright colony is separated into brood chamber and production (Super) chamber by means of the queen excluder. The brood chamber contains the queen, sealed brood and some empty combs, whereas, the production chamber is provided with one to two frames of unsealed larval brood, sealed brood and the combs with honey and pollen stores. For royal jelly production, a large number of nurse bees are needed, and this is achieved by transferring sealed brood combs to the brood chamber. One royal jelly-producing frame with 80 to 100 cups is placed in the production chamber at a time. After 60 to 72 hours of grafting, about 300 mg royal jelly is produced in each queen cell cup. These queen cell cups are regrafted for the production of more royal jelly. Chinese bee scientists have developed special plastic grafting needles and plastic queen cell cups for the production of royal jelly. Beekeepers in rural areas often use sterile brushes to collect royal jelly in a clean bottle and then store it in a refrigerator. However, in big commercial bee farms, royal jelly is collected from the cups by electrical suction.

In China experiments are also being conducted to collect royal jelly from *Apis cerana* colonies. However, the amount of royal jelly produced by this native bee species is much lower than *Apis mellifera*. This difference may be due to the smaller size and activity of the hypopharyngeal glands of individual worker bees, smaller colony size, as well as a concentration of more nurse bees in the brood chamber than in the production chamber in *Apis cerana* as compared to *Apis mellifera*. Since royal jelly gets spoilt with time, it cannot be stored for an indefinite period. In order to overcome this problem, markets for royal.jelly are being developed near the production unit so that it can readily be sold while it is fresh. Further, royal jelly is now mixed with medicine, tonics, beverages, and cosmetic products without any chance of changes in its chemical composition. "Beijing Royal Jelly" extract has now become famous all over the world as a tonic.

7.5 BEE VENOM

Bee venom is stored in the poison sac of the sting apparatus and is injected into the skin of the victim by a pair of barbed lancets. A bee sting on the human body should always be scraped away and never pulled out, because through the latter process, more venom is pumped into the wound. After stinging, a worker bee usually dies on the same day or soon after. A honeybee sting is more poisonous than a wasp's (Benton and Heckman, 1969). For hypersensitive persons, even a single sting can cause death if they are not given timely medical treatment. Under normal circumstances, it may require 500 stings over a short period of time to cause death by direct toxicity.

Bee venom is acidic in nature and its specific gravity is 1.1313 (Beck, 1935). It contains a complex array of chemically and pharmacologically active substances. Among them the major ones are: histamine, dopamine, melittin, apamin, mast-cell destroying (MCD)-peptide, minimine, and the enzymes phospholipase A and hyaluronidase (Hodgson, 1955; Beard, 1963; Habermann, 1972; Munjal and Elliott, 1971). A comparison of venom composition of *Apis cerana japonica* and *Apis mellifera* is given in Tables 7.11 and 7.12.

Table 7.11: Peptide contents in the venom sac of *Apis mellifera* and *Apis cerana japonica**

Species	No. bees	Melittin	Apamin	MCD-peptide
Apis mellifera	21	310 ± 59	6.8 ± 1.5	5.5 ± 1.2
Apis cerana japonica	26	108 ± 34	1.6 ± 0.6	—

* Contents are expressed as μg/sac (mean ± SD)
Source: Inoue, H. and Nakajima, T. 1985.

Table 7.12: Amine contents in the Venom Sac of Bumble Bees and Honeybees*

Species		DOPA	Nad	DA	His	SHT
*Apis mellifera**	21	—	388 ± 168	643 ± 375	1425 ± 431	12 ± 5
Apis cerana japonica	12	—	154 ± 60	142 ± 69	24 ± 20 (7)	—
*Bombus diversus**	7	215 ± 151 (6)	344 ± 182	352 ± 169	16 (2)	—
*Bombus ardens**	6	547 ± 351 (5)	298 ± 94	1126 ± 704	637 ± 295	41 ± 38

* Contents are expressed as ng/sac (mean ± SD). Figures in the parentheses are number of bees examined.

Source: Inoue, H. and Nakajima, T. 1985.

In order to extract sufficient bee venom for scientific and medical uses, a special electrical grid which elicits the stinging response is placed near the entrance of the hive. This grid produces a mild electrical shock, and the bees who land on it react by stinging a sheet of nylon taffeta below this grid. The venom is collected on the glass plate located below the taffeta where it dries and is removed after scraping with a blade. In India and China, indigenous electric venom collectors have been designed, and through them it is possible to collect pure venom without causing injury to the bees.

Bee venom has several medical uses. It can cure rheumatoid arthritis, and is also used for the desensitization of patients allergic to bee stings. In recent years, bee acupuncture therapy for the treatment of various human disorders has come into wide use.

7.6 PROPOLIS

Pro and Polis are two Greek words which mean before and city, respectively. Propolis is a resinous substance collected by forager bees to seal the hive crevices and reduce its entrance point. It is gathered from the sticky and gummy exudations of trees and buds such as alders, poplars and some conifers. Propolis is collected mainly by *Apis mellifera* and not by *Apis cerana*. Because of its sticky nature, it contaminates beeswax and causes difficulty in removing frames at the time of honey harvesting or during inspection of the hive. However, recent discoveries have shown that this product is quite valuable because of its anti-bacterial and anti-fungal properties. These anti-microbial properties are due to the presence of flavones and related compounds. Many of these flavonic components have already been identified (Popravko, 1969). In addition, propolis also contain 30 per cent waxes, 55 per cent resins and balsams, 10 per cent etheral oils and 5 per cent pollen (Cizmark and Matel, 1970, 1973).

In China, research work is in progress for the commercial production of propolis. It is recovered from the hive by direct scrubbing. In Japan, total yield from a hive is about 50 g. In China, it is mainly an export item, and a very small quantity is used for medicinal purposes (Guanhuang, 1990).

One of the commercial products under trial in China is "Propolis soap" because of its anti-microbial properties. However, western bee scientists believe that pharmaceutical uses of propolis needs further investigation.