2. REVIEW OF LITERATURE

The Nutritional, storage and value addition studies on raw and heat processed honey were carried out in the Department of Food Science and Nutrition, College of Home Science CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur. Honey, a delicious and viscous food, is prepared by bees from the nectar of flowers. It has high viscosity, high sweetness and range of colours. It is valued not only as a food but also for some of its therapeutic attributes. In India, however, very little work has been carried out on keeping quality of honey and no comparative studies on ripened and unripened honey have been reported so far. Therefore, in the present study various chemical, organoleptic and microbiological parameters of ripened, unripened processed honey samples and honey based food products were determined and compared. Available literature have been reviewed and presented under the following heads:

2.1 Chemical characteristics of honey
2.2 Processing of honey
2.3 Nutrient changes of honey during storage
2.4 Microbial characteristics of honey
2.5 Consumer’s acceptability of honey
2.6 Honey based value added products
2.7 Packaging materials

2.1 Chemical characteristics of honey

Proximate composition of honey has been reported by several workers. There has been much emphasis on moisture content, ash content, total soluble solids (TSS), acidity, pH, reducing, non-reducing and total sugars, fructose,
glucose, diastatic activity, energy, minerals, microbial characteristics and organoleptic evaluation in the analysis of honey.

2.1.1 Moisture

Moisture is one of the most important characteristics of honey, having profound influence on its keeping quality and granulation of honey. Ghoshdastidar and Chakrabarti (1992) determined the moisture content of nine samples of honey and values were present in the range of 17.4 to 19.4 percent. Horn (1993) reported the moisture content of honey of different samples and the values were present in the range of 15.10 to 21.60 per cent and 15.30 to 20.00 per cent of honey collected in 1989 and 1990, respectively. Liebig (1993) determined a slight increase in the values of moisture content was 18.40 per cent, 18.80 per cent and 19.20 per cent for the year 1989, 1990 and 1991, respectively. Tarboush et al. (1993) while studying the floral type identification and quality of honey reported that the values of moisture content of honey were present in the range of 15.5 to 18.2 per cent.

Vit et al. (1994) reported the moisture content of fresh honey as 39.8 per cent. Tilde and Payawal (1995) reported the values of moisture content present in honey in the range of 16.20 to 33.10 per cent. According to Gopalan et al. (1996) the moisture content of honey as 20.60 per cent. Kalpana and Ramanujan (1997) while analyzing different samples of honey, reported that the values of moisture content in different samples varied in the range of 21.00 to 21.50 per cent. According to Ihtishamulhaq and Khan (1998) the values of moisture content present in the range from 17.60 to 21.83 per cent. Kumari (1998) reported 18.20 per cent moisture in honey. Gulati and Kumari (2005) determined the moisture content of nine samples of honey, and reported a range of 22.8 to 25.0 per cent moisture in honey.

2.1.2 Ash

Minh et al. (1971) determined the ash content of eight samples of honey and the values present in the range of 0.061 to 0.316 per cent. As per the
Agmark, ISI, PFA Act as reported by Shamala and Jyothi (1999) and Abdulkar (2003) the honey should have ash content of 0.5 per cent. Gulati and Kumari (2005) determined the ash content of eight samples of honey and the values varied from 0.05 to 0.12 per cent.

2.1.3 Total Soluble Solids (TSS)

Kaushik (1988) and Kaushik et al. (1993) reported the TSS value of 80°Brix in honey. Singh (1994) determined the TSS of five different floral sources of honey in Punjab and values were in the range of 81.30 to 83.95° Brix. Kumari (1998) reported that the fresh honey contained TSS of 81° Brix.

2.1.4 pH

The determination of pH is important in honey in relation to darkening. As the pH increases the darkening of honey also increases. Kaushik (1988) reported pH value of 4.10 in fresh honey. Kaushik et al. (1993) reported that the pH of fresh honey was 4.1. As per PFA Act, Indian Standard, BIS and Codex Standards as reported by Manjunath and Tharanathan (2000) the honey would have pH in the range of 0.5 to 0.6. Cooper et al. (2002) determined the pH of 142 different samples of honey and values were present in the range of 0.36 to 3.4.

Anupama et al. (2003) determined the pH of eleven commercial samples of honey and reported the pH values in the range of 3.62 to 5.46. Sahinler et al. (2004) reported the pH value 4.12 of honeys produced in Turkey. Singh et al. (2006) determined the pH of two different samples of ripened and unripened honey and the values ranged from 4.1 to 5.0.

2.1.5 Acidity

Kaushik et al. (1993) reported that honey contained 0.25 per cent acidity. Singh (1994) determined the acidity of five different floral sources in Punjab and reported values of acidity in the range of 0.55 to 0.12 per cent. Kumari (1998) determined titratable acidity of honey and acidity of fresh honey was reported as
0.16 per cent. According to Bogdanov et al. (2000) the acidity in honey was 0.005 per cent.

Abdulkadar (2003) determined the acid content of liquid honey and reported a range of 0.002 to 0.005 per cent acidity. Anupama et al. (2003) determined the acidity of eleven commercial samples of honey and recorded acidity values in the range of 0.03 to 0.15 per cent. Sahinler et al. (2004) reported the titratable acidity of 0.004 per cent in honey produced in Turkey. Gulati and Kumari (2005) analysed eight samples of honey and reported that the acidity content in different samples ranged from 0.17 to 0.64 per cent.

### 2.1.6 Sugars

Honey is mainly a solution of glucose and fructose with some minor constituents. There are great variations in the sugar composition of honey. Doner (1977) determined the glucose and fructose contents present in floral, honey dew and honey and reported that the values ranged from 31.80 to 37.10 per cent and 26.08 to 33.70 per cent, respectively. Kaushik (1988) determined the reducing sugars, total sugar and non-reducing sugars present in honey and the values were 68.33, 80.70 and 12.37 per cent, respectively. Among the different sugars, the values of glucose and fructose in honey were 32.43 and 35.90 percent, respectively.

Kalpana and Ramanujan (1997) determined the sugars of honey and the values of total sugars and sucrose were recorded as 70 and 2.5 percent, respectively. Kumari (1998) determined the reducing and total sugar content present in honey and values were 57.99 and 77.75 per cent. Shamala and Jyothi (1999) reported the glucose and fructose content of honey as 31.28 and 38.19 per cent, respectively. Manjunath and Tharanathan (2000) determined the reducing sugars and fructose of honey and values were in the range of 60 to 70 per cent.

Gulati and Kumari (2005) determined the glucose content of commercial *Apis mellifera* honey and the values of glucose and fructose contents were in the range of 22.4 to 32.2 per cent and 26.6 to 36.6 per cent, respectively. Maulny et
al. (2005) reported the fructose and glucose contents in the range of 0.27 to 1.24 per cent and 0.32 to 1.13 per cent, respectively. Dimins et al. (2006) determined the reducing sugars and reported the values in the range of 73.7 to 82.8 per cent.

Singh et al. (2006) determined reducing and total sugars in ripened honey and values varied in the range of 60.6 to 60.9 and 68.7 to 69.5 per cent, respectively. Among different sugars, values of glucose and fructose were 32.8 to 33.7 and 39.6 to 39.9 per cent respectively. The unripened honey had lower values of reducing sugars, total sugars, glucose and fructose, compared to ripened honey which were 58.6 to 58.9, 67.6 to 67.8 per cent, 30.1 to 31.0 and 38.6 to 39.5 per cent respectively.

2.1.7 Protein

Singh et al. (1988) reported the protein content of honey as 0.169 per cent. Whereas, Gopalan et al. (1996) reported as 0.3 per cent. Sahinler et al. (2004) reported that the protein content of fifty samples of honey produced in the Hatay region of Turkey was 0.76 per cent.

2.1.8 Diastatic activity

Enzyme diastase (amylases) breaks down starch into simple sugars. It is very sensitive to heat and hence its activity is an indicator of improper heating. Therefore proper heating and storage is of utmost importance to retain the market value of honey. Kaushik (1988) reported that the diastatic activity was 21.56 diastase number. Huidobro et al. (1995) determined the diastase activity of honey and values reported in the range of 11.3 to 34.5 diastase number. Vit and Pulcini (1996) reported diastatic activity of Melipnini and Trigonini honeys and the values ranged from 2.6 to 35.6 diastase number. Sahinler et al. (2004) determined diastatic activity of honey produced in Turkey and reported a value of 10.31 diastase number.

2.1.9 Minerals
Minerals whether micro or macro reflect amount of ash present in a particular food. According to Gopalan et al. (1996) reported values of calcium (0.5 mg/100g), phosphorous (16 mg/100g) and iron (0.696 mg/100g) present in honey. Kumari (1998) estimated phosphorous, magnesium, iron, calcium, potassium and sodium contents present in honey and reported that honey contained 20, 5.60, 0.76, 7.50, 75.40 and 7.10 mg/100g of these minerals respectively. Gyan and Marfo (1998) determined the calcium, phosphorous, magnesium, potassium and copper and the values reported in the range of 5.01 to 20.23, 4.03 to 37.26, 7.57 to 28.91, 40.92 to 266.48, 0.05 to 2.76, 0.006 to 1.20 and 0.32 to 0.56 mg/100g respectively.

Sahinler et al. (2004) determined the mineral content of honey and reported a range of 150 to 320 mg/100g. Wilczynska (2004) determined 176 samples of nine different honey and value of iron ranged from 0.627 to 0.936 mg/100g.

2.2 Processing of honey

Processing is the only practical means for preventing granulation and fermentation. Treatment in a closed system minimizes losses of volatile aroma during the heating period, and immediate cooling minimizes heat induced color and flavor changes and allows higher temperature to be used for shorter period. Processing of honey can be done by flash method which does not allow changes in the nutrients of honey. Kaushik (1988) reported that honey processed and total sugars, non-reducing sugars, fructose and pH decreased with the increase in storage intervals. Assil et al. (1991) reported that glucose content of processed honey were 33.0 and 36.1 per cent which increased to 34.9 and 39.1 per cent after four months of storage.

Hebbar et al. (2003) determined yeast reduction and lower hydroxymethylfurfural value and higher diastase activity in processed honey and
values were 3.8 mg/K and 12.0 diastase numbers, respectively. Subramanian et al. (2007) determined different methods of processing of honey and reported that microwave heating reduced level of yeast with less thermal damage.

2.3 Nutrient changes of honey during storage

Honey is no longer a seasonal commodity; modern merchandising requires year round availability which increases the importance of proper storage. Kaushik (1988) reported that TSS, reducing sugars, glucose and fructose were 81.5\(^0\)Brix, 68.33, 32.43, 35.90 per cent, in fresh honey which increased to 82.33\(^0\)Brix, 70.35, 34.14, and 36.15 per cent with increase in storage period, respectively. However, total sugars, non-reducing sugars, pH and diastase activity of honey were 80.70, 12.37, 4.10 and 21.56 DN which decreased to 78.82, 8.47 per cent, 3.25 and 18.42 DN after storage.

Ghazali and Sin (1986) determined the effect of storage of honey at room temperature 28±2\(^0\)C and at 50±2\(^0\)C and reported that glucose and fructose content were 31.50 and 30.25 per cent and decreased to 27.61 and 24.40 per cent after eighteen months of storage.

Thrasyvoulou (1986) reported the moisture, pH and ash contents of fresh honey as 18 per cent, 4.3 and 0.27 per cent that decreased to 16.3 per cent, 4.2 and 0.25 after four months of storage. However, the glucose, fructose and total acids of fresh honey were 32.0, 39.5 and 2.19 per cent which increased to 35.8, 38.7 and 2.81 per cent after four months of storage.

Gupta et al. (1992) studied the effect of storage on colour of honey stored at 40\(^0\)C which resulted in deterioration of colour which increase with the increase in storage period and also reported that addition of potassium metabisulphite reduced the darkening of honey stored at room temperature.

Kaushik et al. (1993) reported that total soluble solids of honey increased from 81.5 to 82.26 per cent, whereas acidity increased from 2.47 to 3.05 meq/100g and pH declined from 4.1 to 3.7 after 6 months of storage.
2.4 Microbial characteristics of honey

One of the most serious concerns of the apiculturists is honey fermentation. Kaushik (1988) reported that standard plate count (CFU/g) was $6.50 \times 10^2$ CFU/g in fresh sample of honey. Kaushik et al. (1993) while studying “Microbial content in Turkish honeys” reported that the values of standard plate counts of unheated and heated fresh honey and stored at $5^0\text{C}$ were $6.5 \times 10^2$ and $4.45 \times 10^2$ CFU/g, respectively. The standard plate counts decreased with storage.

Ceyhan and Ugur (2002) reported that the microbial count in monofloral honey samples ranged from $1.0 \times 10^3$ to $8.9 \times 10^4$ CFU/g and also reported the total plate count, total coliform bacteria, thermophilic bacteria, yeasts and moulds and osmophilic yeasts in 54 samples of monofloral honey and 30 samples of multifloral honey. Schneider et al. (2003) analysed four samples of fermented honey for microbiological parameters and reported twenty yeast strains in honey samples.

2.5 Consumer’s acceptability of honey

The aroma and flavour of honey are its most important characteristics from the bee keeper’s and consumer’s point of view. Ghazali and Sin (1986) determined effects of storage of honey at room temperature $28\pm2^0\text{C}$ and at $50\pm2^0\text{C}$ and reported that darkening of honey increased with increase in storage period.

Kaushik (1988) while studying the “Effect of storage conditions on the quality of honey” stored at $40\pm1^0\text{C}$, at room temperature and at $5\pm1^0\text{C}$ and reported that maximum deterioration in colour occured in honey stored at $40\pm1^0\text{C}$, followed by honey stored at room temperature and at $5\pm1^0\text{C}$.

Gupta et al. (1992) reported that storage of honey at $40^0\text{C}$ resulted in deterioration of colour and found that addition of potassium metabisulphite
reduced the darkening effect in honey stored at room temperature. Unheated honey stored at $5^\circ\text{C}$ was found to be the best.

### 2.6 Honey based value added products

Honey is the nectar and saccharin exudation of plants, gathered, modified and stored in the combs by honey bees. In India, the consumption of honey is mainly restricted for medicinal purposes though it has been used in a number of preparations elsewhere. Apart from the food value, it is also known for its medicinal value in burns, infections, wounds and its antimicrobial properties (Singh et al. 1988). The use of honey in beverage and baked food industry can be given impetus by determining suitability for use in products already being produced and developing newer honey products. According to FDA standards, of identity honey is the optimum sweetening agent for fruit butters, jellies, jams and preserves providing it either to be the sole ingredient or represent 20 per cent of solid mixtures with certain other optional sweetness. It is unlikely that any appreciable amount of honey is presently in such use (Singh et al. 1988). Steinsholt (1985) made an attempt to utilize honey in ice cream and illustrated that ice-cream made with honey had better flavour than those without it, although a honey content of more than 7.50 per cent produced significantly softer product. According to Singh et al. (1988) the increased production of honey has to be supported by the better uses in foods.

Kumari (1998) prepared fruit nectars by utilizing honey and reported that honey can be used as a substitute for sugar. These products can provide an added alternative of raw material and a variety in the spectrum of sugar based products. It was found that the nectar utilizing honey as a substitute of sugar was a viable alternative for opening up new vistas for surplus honey utilization.

Sood (2000) prepared IMF products from honey, which has therapeutic importance, despite being somewhat odd in flavour. The use of honey and sorbitol as humactancts further increased the therapeutic value and shelf life of
the products. There is a need to develop/standardized foods based on raw/processed honey. The author suggested that further studies on the utilization of honey in processed foods will provide basic and applied data for better application of honey.

2.6.1 Squash

Aparna and Rajlakshmi (1995) prepared acceptable quality beverage based on lemon and orange by adding honey. Roy et al. (1997) utilized ripe Dushehari Mangoes for the preparation of pulp, squash, nectar and ready-to-serve beverage. It was found that consistency and acceptability of the beverages were improved and stored at 4°C±2°C, 28°C±2°C and 38°C±2°C for 30 days to ensure maximum retention of chemical and sensory characteristics.

Chauhan et al. (1998) prepared protein-rich mango beverage by blending mango pulp with soy protein isolate and products were analysed for physico-chemical and sensory characteristics and found that higher protein and fat contents having good flavour, taste, body and overall quality.

Mandhyan et al. (2000) prepared guava squash using different proportions of guava pulp and water and the best organoleptic properties were found in sample having 1:4 (pulp:water) ratio.

Srivastava and Kumari (2002) prepared squash from fruit beverage containing 25 per cent fruit juice and 40 to 50 per cent total soluble solids. Whereas, Juan (2008) prepared beverages with high caloric content and limited health benefits from fruit juices, whole milk and fruit smoothies with sugar or honey; and alcoholic and sport drinks based on honey.

Silva and Alves (2008) developed different formulation of ready-to-drink cashew apple juice sweetened with honey as a substitute for sucrose and evaluated its chemical, physico-chemical, sensory and microbiological stability during 180 days storage at a temperature of 28°C and found that best accepted formulation contained 20 per cent cashew apple juice of 11°Brix.
2.6.2 Jam  

Kumar and Singh (1998) prepared jam from four papaya varieties viz pusa dwarf, pusa giant reported that the Co4 variety was best for jam making. Manivasagar et al. (2004) prepared jam from two types of karonda fruit stored and observed that the TSS, ascorbic acid and organoleptic rating decreased continuously irrespective of the type of karonda used for the preparation of jam and also reported that browning and acidity increased with the increase in storage period.

Sarvana et al. (2004) prepared papaya jam and observed an increase in total soluble solids, total sugars and reducing sugars whereas the acidity, ascorbic acid, total carotenoids and non-reducing sugars decreased with the increase in storage period.

2.6.3 Biscuits  

Singh et al. (1998) prepared soy-biscuits containing various levels of fat (20, 25, 30 and 35 per cent) and sugar (28, 31, 34, 37, 40 and 43 per cent). It was found that increased levels of fat and sugar, increased attributes such as weight, diameter, spread ratio and per cent spread factor of biscuits, whereas thickness and hardness of the product decreased irrespective of soy flour incorporation.

Singh et al. (1998) prepared soy biscuits using baking powder at 0.5, 0.8, 1.1 and 1.4 per cent and skim milk powder at 0.8, 1.6, 2.3 and 3.1 per cent levels and reported that baking powder at 0.8 per cent level and skim milk powder at 1.6 per cent level were the best. The spread ratio and overall acceptability increased, whereas hardness of the product decreased with increased levels of SSL or GMS, irrespective of fat levels.

Onweluzo and Iwezu (1998) prepared biscuits from different blends of wheat-soybean and cassava soybean flours and reported that cassava-soybean
flour biscuits had twice the protein value of the wheat flour biscuits, and higher calorific value. However, biscuits containing more than 50 per cent fermented soybean flour showed low texture and flavour scores.

Awasthi and Yadav (2000) prepared three biscuit samples i) 15 per cent defatted soy flour ii) 15 per cent and 75 per cent channa whey and iii) 15 per cent defatted soy flour and 50 per cent skim milk separately and reported that biscuits prepared with 15 per cent defatted soy flour with 75 per cent channa whey and 15 per cent defatted soy flour (DSF) with 50 per cent skimmilk had higher amounts of proteins.

Conforti and Lupano (2004) studied the effect of two different whey protein concentrates on the structural and functional properties of honey based biscuits and reported that honey increased the adhesiveness of dough, mainly in samples with the WPC of lower protein content and tended to decrease dough relaxation time and lightness. However, addition of lemon juice reduce these effects.

Ostyn et al. (2006) reported that raw and unheated honey is sterilized by ozonizing it by using an ozone generator and biscuits were prepared from honey and food fibres, by-products of food-fibres and ozonized food fibres. Gall (2009) prepared wholemeal based biscuits by adding honey and egg.

2.6.4 Toffees

Sharma (1997) prepared toffees from plum-soya mixture. The TSS, acidity, sugar increased and sensory quality decreased after six months of storage. Sharma (2000) prepared toffee by using apple pomace and evaluated organoleptically for taste. Higher acceptability scores were given with the mean values of 8.4 (on the basis of 10.0). Vaidya (2002) prepared fruit toffees with skimmed milk powder, sugar, citric acid and papaya pulp that were acceptable and had a shelf life of three months when wrapped in butter paper and stored in plastic container.

2.7 Packaging materials
Packaging materials prevent the physico-chemical changes in the products. The products can be safely stored for months and the products can be better processed easily under aseptic processing condition. Kaushik (1988) reported the effect of different treatments and storage periods on honey and found that TSS, non-reducing sugars, fructose, diastase and amino acids decreased whereas reducing sugars, glucose and total acid contents increased when stored in glass containers for six months.

Sethi (1995) determined that mango pulp could be stored for 7-10 months in PVC bottles and 9-12 months in glass bottles. Physico-chemical changes were minimum in pulps stored in glass bottles. The combination of two preservatives increased storage life of pulp in PVC bottles at ambient temperature as compared to the use of single preservative.

Kumari (1998) determined the quantitative and qualitative parameters associated with the honey based fruit nectar. The fruit nectars were prepared from peach, pear and apricot fruits by using sucrose and honey as sweetening agents and the products were filled in glass bottles, cans and polythene pouches and stored for 90 days. Among packaging materials the better results were obtained for fruit nectars stored in glass bottles followed by cans, polythene pouches although HDPE pouches were cheapest modes of packaging.

Dogra (2002) found that the addition of various humectants viz sorbitol, manitol and glycerol altered the deep-fat-frying characteristics of doughnuts and reported that the addition of humectants shortened the processing time and increased the shelf-life when stored in craft paper, plastic jars and polyethylene bags.

Prabha (2002) reported the results of nutritional quality evaluation of the papaya based value added products viz jam, pickle, squash, jelly, ready to serve, pomace, kofta, chutney and sauce stored in plastic and glass jars and found that jelly packed in glass jars scored higher as far as the organoleptic evaluation was concerned and could be stored safely for six months.
Vaidya (2002) prepared products of kiwi fruit viz jam, butter, leather, candy and toffees. The products were packed in different packaging materials like wooden box, corrugated fiber box and left open on counters control and observed that products hot glass pack samples behaved better under the aseptic processing condition.