5. SUMMARY AND CONCLUSIONS

The present investigation entitled “Nutritional, storage and value addition studies on raw and heat processed honey” was conducted in the Department of Food Science and Nutrition, CSK Himachal Pradesh Krishi Vishvavidyalaya Palampur. Honey is a sweet, viscous liquid made by honey bees using nectar from flowers and gets its sweetness from monosaccharides fructose and glucose and most microorganisms do not grow in honey. Because of its unique composition and chemical properties honey is suitable for long term storage. Regardless of preservation, honey may crystallize a period of time and this sometime effect colour and consumer’s acceptability. However, the colour, flavour and aroma are the important quality characteristics of honey from consumer’s point of view. Processing of honey is only practical method to obtain these desirable characteristics and prevent crystallization a period of time. The packaging material also play important role for long term storage with minimum changes in quality attributes. But the delicate aroma and fine flavour of honey are particularly vulnerable to heat and improper storage. Keeping in view the importance of honey, the present study was undertaken proposed with the aim to assess the nutritional attributes, storage stability of processed honey in relation to different packaging materials and utilization in preparation of various value added products.

In the present study, two types of honey viz ripened and unripened were procured from Nagrota Bagwan and from local market and processed at 60, 70 and 80°C for 12, 24, 36 and 48 hours. The processed honey was packaged in glass jars, plastic jars and polypack pouches and analyzed fresh and after every 3, 6, 9 and 12 months of storage intervals for physico-chemical, nutritional, microbiological and consumer’s acceptability. The various formulations for the preparation of value added products like RTS beverages, Squash, jam, biscuits and toffees were standardized and efforts were made to replace sugar with honey as sweetener in various foods and beverages. The results obtained during the investigation are summarized below:
1. The result of the present study revealed that the ripened honey had significant effect on its moisture content. Unripened honey contained higher value (17.56%) as compared to ripened honey (16.73%) packaged in glass jars. Processing temperature had significant effect on the moisture content. Honey processed at 60°C had higher moisture of (17.98%), followed by the honey processed at 70°C (17.06%) and 80°C (16.40%). The processing time had non-significant effect on the moisture content of honey packaged in glass jars, plastic jars and polypack pouches. The storage had significantly decreasing effect on the moisture content of honey.

2. In case of ripened honey, processing temperature, processing time and storage had significant effect on the ash content of honey. The ripened honey had higher values of ash content with the mean values of 0.32, 0.29 and 0.28 per cent of honey packaged in glass jars, plastic jars and polypack pouches, respectively. The ash content of honey significantly increased with increase in processing temperature as well as time used for heating of honey. However, storage showed significantly decreasing effect on the ash content of honey. The fresh honey had ash content of 0.30 percent which decreased to 0.23, 0.23 and 0.21 percent after 12 months of storage and packaged in glass jars, plastic jars and polypack pouches, respectively.

3. The TSS of ripened honey was significantly higher with the mean values of 82.31°B as compared to TSS of unripened honey (81.39°B). The TSS of honey processed at high temperature of 80°C was higher i.e. 82.90°B followed by honey processed at 70°C (81.86°B) and 60°C (80.78°B). Similar trend was observed in honey packaged in glass jars, plastic jars and polypack pouches. A slight increase in TSS was observed with storage and in fresh honey the mean value of TSS was 81.52°B which
increased to 82.11°B and 81.70°B after 12 months of storage of honey packaged in glass jars and polypack pouches, respectively.

4. The ripened honey had significant effect on pH of the honey and higher values were observed in ripened honey. The mean values of pH of ripened honey packaged in glass jars, plastic jars and polypack pouches were 5.50, 5.62 and 5.62 as compared to unripened honey with mean values of 4.44, 4.57 and 4.83, respectively. The pH of honey increased with increase in processing temperature as well as processing time. The mean value of pH of fresh honey was 5.41 which decreased to 4.62, 4.97 and 5.10 after 12 months of storage of honey packaged in glass jars, plastic jars and polypack pouches, respectively.

5. The acidity of honey was also affected significantly with ripening process, processing temperature, processing time and storage interval. The mean values of acidity of ripened and unripened honey were 0.33 and 0.40 per cent, respectively. The higher values of acidity 0.44% was observed in honey processed at 80°C followed by acidity 0.37% honey processed at 70°C and acidity 0.29% processed at 60°C. Similar trend was observed of honey packaged in plastic jars and polypack pouches. The storage of honey also had significantly increasing effect on the acidity content of honey. The mean values of fresh honey was 0.29 per cent which increased to 0.44, 0.42 and 0.40 per cent after 12 months of storage and packaged in glass jars, plastic jars and polypack pouches, respectively.

6. Processing temperatures of honey had significant effect on the reducing, non reducing and total sugars of ripened and unripened honey packaged in glass jars and plastic jars, whereas, ripened honey had non-significant effect on the total sugars of honey packaged in polypack pouches. Storage of honey had significant effect on the reducing, non reducing and total sugars of honey packaged in different packaging material.
7. The processing temperature had significant effect on the fructose content of honey. The fructose content of honey processed at 80°C was 35.15 per cent followed by 35.07 and 34.89 per cent in honey processed at 70°C and 60°C. Whereas, the processing time had non-significant effect on the fructose content of honey irrespective of different packaging materials. The fructose content of honey significantly decreased with storage.

8. The ripened honey and processing time had non-significant effect on the glucose content of honey. The processing temperature had significant effect on the glucose content which slightly increased with increase in processing temperature of honey packaged in polypack pouches. The storage of honey had significant effect on the glucose content of honey packaged in plastic jars and polypack pouches. The mean value of glucose content of fresh honey was 32.62 per cent which increased to 32.83, 33.01 and 32.97 per cent after 12 months of storage irrespective of packaging material.

9. The ripened honey had significant effect on the protein content of honey and mean values of protein content of ripened and unripened honey were 0.33 and 0.29 per cent. The processing temperature had non-significant effect on the protein content of honey packaged in glass jars. The processing time used for processing of honey had significant effect on the protein content and mean values slightly increased with the increase in processing time. Protein content of honey packaged in glass jars, plastic jars and polypack pouches decreased significantly with the increase in storage period. The mean values of protein content of fresh honey was 0.32 per cent which decreased to 0.29, 0.28 and 0.27 per cent after 12 months of storage of honey packaged in glass jars, plastic jars and polypack pouches, respectively.
10. The ripened honey had significant effect on the diastatic activity of honey packaged in glass jars. The processing temperature had significant effect on the diastatic activity of honey packaged in plastic jars and polypack pouches. The diastatic activity of honey processed for 12 hours and packaged in plastic jars was 18.19 DN which increased to 18.39 DN after 48 hours of processing time, respectively. The values of diastatic activity of honey processed and packaged in glass jars and polypack pouches had non-significant effect.

11. The ripened honey had significant effect on the energy content and higher values were observed in honey packaged in plastic jars and polypack pouches with mean values of 326.68 and 326.12 Kcal/100g, respectively. The mean values of energy content of honey processed at 60°C packaged in glass jars, plastic jars and polythene pouches were 321.05, 312.38 and 312.33 Kcal/100g which increased to 327.60, 327.59 and 327.52 Kcal/100g of honey processed at 80°C, respectively. The processing time also had significant effect on the energy content and slightly increased in processing time. The storage of honey irrespective of different packaging materials had non-significant effect on the energy content.

12. The ripened honey had significant effect on the minerals content of honey. The mean values of sodium, potassium, calcium, magnesium, iron and zinc present in “ripened and unripened honey” were “1.90 and 2.10”, “290.00 and 310.00”, “7.00 and 9.00”, “21.00 and 16.00”, “1.00 and 2.00” and “4.00 and 5.00 mg/100g”, respectively.

13. Microbial growth in honey determined as standard plate count was higher in unripened honey as compared to ripened honey. Total microbial count of processed honey was lower as compared with unheated honey. The mean values of standard plate count of ripened and unripened honey packaged in glass jars were 2.4 and 2.7 X 10^2 CFU/g, in plastic jars were
2.6 and 2.9 \times 10^2 \text{ CFU/g} and in polypack pouches were 2.7 and 3.1 \times 10^2 \text{ CFU/g}, respectively.

14. The effect of the packaging materials on the sensory attributes of the processed honey was evaluated on the 9.0 point basis. The highest mean values for colour were recorded for honey processed at 60^\circ \text{C} for 12 hours and stored in glass jars (7.73 and 7.67) and the corresponding values for honey stored in plastic jars were 7.74 and 7.68 and those packed in polypack pouches were 7.73 and 7.67 respectively. Similarly the values for taste of honey stored in glass jars were 7.83 and 7.79 and those stored in plastic jars and polypack pouches were 7.83 and 7.79 and 7.82 and 7.78 respectively. Similarly the scores for consistency of honey stored in glass jars were 8.06 and 8.00, plastic jars 8.07 and 8.01 and polypack pouches 8.06 and 8.00 respectively.

15. Different products such as RTS, squash, jam, biscuits and toffee were formulated using mango and seabuckthorn pulp and honey, sugar and both as sweeteners. The prepared products were evaluated organoleptically for colour, taste and consistency. The products prepared by blending sugar with honey were considered better, followed by products prepared with sugar for overall acceptability.

16. The economics of the prepared products such as RTS, squash, jam, biscuits and toffee were also calculated. In case of products prepared from honey, it was observed that the cost was higher as compared to products prepared by blending sugar with honey.

Therefore, it can be concluded from the study that the honey processed at 60 and 70^\circ \text{C} was highly acceptable as compared to honey processed at 80^\circ \text{C} which produced slightly dark coloured honey. Among the different processing treatments, the overall acceptability of honey heated for 24 and 36 hour were more acceptable as compared to other
combinations. Among the various packaging materials glass jars were highly acceptable followed by plastic jars and polypack pouches. As per the formulations standardized for the preparation of different products viz. RTS, squash, jam, biscuits and toffees, the honey can be used as a substitute for sugar as sweetener for preparation of highly acceptable value added products. The processing of honey and its utilization in various products has commercial applications in Food Industry.