SUMMARY

AND

CONCLUSION
Wood Apple (*Feronia limonia swhite*) is also known as elephant apple, monkey fruit, curd fruit, *kath bel* and other dialectal names in India. Wood Apple is a hardy fruit tree grown throughout the country for its edible sweet pulp. Wood Apple belongs to the family Rutaceae. It is a tropical deciduous species, native to India and Sri Lanka. It is commonly found in rural areas as a homestead tree. The fruit are very rich in iron, protein and minerals, especially calcium and phosphorus. The flesh is refreshing and, aromatic and tastes sour-sweet. The excellent flavor, nutritive value and medicinal characteristics of fruit indicate its good potentiality for processing into valuable products such as development of Wood Apple fruit bar and blended Wood Apple bar with Mango pulp, development of beverages includes Wood Apple nectar, blended beverages with orange flavour, Wood Apple based carbonated drink and development of powder treated with KMS and mixed with Ginger and Aonla powder.

1. For the extraction of Wood Apple pulp, flesh and water blends were prepared separately by manual mixing of flesh and water. The flesh and water in the ratio of 1:2 was easy for extraction. Wood Apple pulp was also treated with Enzyme (Tryzime) but no acceptable change was observed in the juice.

2. Proximate composition of Wood Apple pulp showed moisture percentage of 72.4 per cent. Percentage of protein was 7.2, fat 2.07, carbohydrate 15.13 and ash 3.20, respectively.

3. Wood Apple pulp was rich in ascorbic acid content (66.40 mg/100g) and also in calcium content (188.80 mg/100g) while phosphorus content was 98.80 mg/100g.

4. Acidity of Wood Apple pulp was 3.18 per cent. TSS and pH of Wood Apple pulp was 13.2°Brix and 3.4, respectively.

5. Oleoresin was extracted from Wood Apple seeds with the help of solvent (hexane). Wood Apple seeds contained about 13.2 per cent oleoresin.

6. Wood Apple fruit bar prepared with standardized amount of sugar (30 per cent) and heated at 80 to 90°C. For the development of blended Wood Apple bar.
Wood Apple pulp was blended with three different type of pulp i.e. Mango pulp, Ginger pulp and Papaya pulp in different ratios. Wood Apple and Mango pulp were mixed in 90:10, 70:30, 50:50 and 30:70 ratios, respectively. Wood Apple pulp and Ginger pulp were mixed in the ratio of 97:03, 95:05, 90:10 and 85:15 and Wood Apple and Papaya pulp were mixed in the ratio of 90:10, 70:30 and 50:50, respectively.

7. The sensory scores for overall acceptability of blended bar samples (Wood Apple Mango bar, Wood Apple Ginger bar and Wood Apple Papaya bar) were in the range of 6.94 to 7.62. The Wood Apple Mango bar with 50:50 (Wood Apple pulp: Mango pulp) ratio had highest sensory score of 7.62.

8. Studies showed that the moisture content of Wood Apple fruit bar and Wood Apple Mango bar decreased significantly (P ≤ 0.05) from 17.40 and 14.80 to 13.52 and 10.95 per cent, respectively after 6 months of storage at room temperature.

9. During storage, significant changes were observed in protein of Wood Apple fruit bar and Wood Apple Mango bar from 2.20 and 1.98 to 2.18 and 1.84 per cent, respectively after 6 months of storage. The carbohydrate content (by difference) in bar samples increased significantly (P ≤ 0.05) from 78.70 and 81.64 to 82.86 and 85.62 per cent, respectively.

10. During storage, significant (P ≤ 0.05) changes were observed in acidity, TSS and pH. Acidity in Wood Apple fruit bar and Wood Apple Mango bar was increased from 2.35 and 2.44 to 2.48 and 2.55 per cent, respectively while TSS content in bar samples increased from 78.90 and 78.10 to 79.16 and 78.90°Brix, respectively. However, the pH value in bar samples was decreased from 3.90 and 4.32 to 3.63 and 4.07, respectively.

11. Non significant changes were observed in fat, ash, calcium and phosphorus during 6 months of storage. Total sugar, reducing sugar and non reducing sugar showed significant difference during storage period.

12. Textual characteristics (adhesiveness and cuttingness) of the Wood Apple fruit bar and Wood Apple Mango bar was changed significantly (P ≤ 0.05). The adhesiveness of the bar samples were increased (-0.108 and -0.110 kg to -0.114 to -
0.116 kg) with increase in the storage period while cutting strength of the bar samples was decreased (2.80 and 3.04 kg to 2.16 and 2.12 kg) with increase in the storage period.

13. Sensory score for overall acceptability of Wood Apple fruit bar (control) and Wood Apple Mango bar was 7.79 and 8.29 at zero day and after 6 month decreased to 6.25 and 7.27, respectively. The acceptability of the bar was good after the 6 months of storage.

14. Total plate counts (TPC) in Wood Apple fruit bar (control) and Wood Apple Mango bar was nil at zero day and after 6 months storage TPC was $5.0 \times 10^2$ and $7 \times 10^2$ cfu/g, respectively. Yeast and mould counts in Wood Apple fruit bar (control) and Wood Apple Mango bar was nil at zero day and after 6 months this was $1.0 \times 10^2$ and $1.5 \times 10^2$ cfu/g, respectively. The bar remained safe microbiologically during storage and acceptable after 6 months of storage.

15. Wood Apple nectar was prepared by using 25 per cent Wood Apple pulp, 15 per cent sugar, 0.25 per cent citric acid and 0.03 per cent KMS (Pottassium metabisulphite).

16. Proximate composition of Wood Apple nectar changed significantly ($P \leq 0.05$) during 90 days of storage. Moisture content of Wood Apple nectar decreased significantly ($P \leq 0.05$) from 83.78 to 83.45 per cent, respectively during storage. Protein in Wood Apple nectar was 0.86 per cent at zero and after 90 days was decreased to 0.65 per cent. Ascorbic acid content in nectar decreased from 37.50 to 26.53 mg/100g, respectively during storage period. Acidity, pH and TSS content were also changed significantly ($P \leq 0.05$) from 0.53 to 0.55 per cent, 3.35 to 3.20 and 12.40 to 13.28°Brix, respectively during storage period.

17. Total sugar, reducing sugar and non reducing sugar in Wood Apple nectar was changed from 11.22 to 9.86 per cent, 4.78 to 5.32 per cent and 6.44 to 4.54 per cent, respectively after 90 days of storage.

18. During storage, non significant changes were observed in ash, calcium content and phosphorus content.
19. Sensory score for overall acceptability of Wood Apple nectar was 8.10 at zero day and decreased to 6.95 after 90 days of storage. The acceptability of the nectar was good after 90 days of storage. Microbiologically the nectar was safe to drink and no appreciable change was observed during 90 days of storage. Total plate count and yeast mould counts was nil at zero day and after 90 days the count was $7.5 \times 10^2$ and $1.5 \times 10^3$ cfu/ml, respectively.

20. Wood Apple pulp was used in the preparation of Wood Apple blended beverage (cocktail) at 25 per cent concentration. The standardized amount of sugar in blended beverage was 15 per cent and citric acid was 0.50 per cent. Flavored blended beverage was prepared by using orange flavour.

21. During storage, significant changes were observed in moisture, protein, ascorbic acid, acidity, pH, TSS, total sugar, reducing sugar and non reducing sugar while non significant changes were noticed in ash, calcium and phosphorus. Moisture content of blended beverage (control) and flavoured blended beverage was decreased significantly ($P \leq 0.05$) from 82.76 and 82.60 to 82.42 and 82.25 per cent, respectively. Protein in blended beverage (control) and flavoured blended beverage was 0.65 and 0.68 per cent at zero day and after 90 days was decreased to 0.40 and 0.48 per cent, respectively.

22. Ascorbic acid content in blended beverage (control) and flavoured blended beverage was decreased from 25.75 and 28.75 to 16.70 to 18.36 mg/100g, respectively during storage period. Acidity content in blended beverage (control) and flavoured blended beverage was 0.51 and 0.48 at zero day and after 90 days was increased to 0.55 and 0.53 per cent, respectively. The pH value of blended beverage (control) and flavoured blended beverage was decreased from 3.60 and 3.72 to 3.38 and 3.44, respectively while TSS content of blended beverage (control) and flavoured blended beverage was increased from 12.20 and 12.00 to 12.40 and 12.80, respectively.

23. During 6 month storage total sugar in blended beverage (control) and flavoured blended beverage was changed from 11.12 and 11.18 to 10.18 and 10.26 per cent, respectively while reducing sugar in blended beverage (control) and
flavoured blended beverage was increased from 4.94 and 4.70 to 5.30 and 5.08 per cent, respectively. The non reducing sugar in blended beverage (control) and flavoured blended beverage was 6.18 and 6.48 per cent at zero day and after 90 days was decreased to 4.88 and 5.18 per cent, respectively.

24. Sensory score for overall acceptability of blended beverage (control) and flavoured blended beverage was 8.02 and 8.19 at zero day and decreased to 6.43 and 6.61, respectively after 90 days storage period. The blended beverage was acceptable after 90 days of storage period. Microbiologically the beverage was safe to drink and no appreciable change was observed during 90 days of storage. Total plate counts in blended beverage (control) and flavoured blended beverage was nil at zero day and after 90 days was 8.0 x 10^2 and 9.0 x 10^2 cfu/ml, respectively while yeast and mould counts in blended beverage (control) and flavoured blended beverage was nil at zero day and after 90 days was 3.0 x 10^2 and 2.0 x 10^2 cfu/ml, respectively.

25. Wood Apple based carbonated drink was prepared by using 25 per cent Wood Apple pulp, 15 per cent sugar and the carbonation time was 3 min.

26. Proximate composition of Wood Apple carbonated drink was changed significantly (P≤ 0.05) during 90 days of storage. Moisture content of Wood Apple based carbonated drink was decreased significantly (P≤ 0.05) from 86.16 to 85.85 per cent, respectively during storage. Protein in Wood Apple carbonated drink was 0.79 per cent at zero and after 90 days was decreased to 0.66 per cent. Ascorbic acid content in carbonated drink was decreased from 22.54 to 16.93 mg/100g, respectively during storage period. Acidity, pH and TSS content were also changed significantly (P≤ 0.05) from 0.28 to 0.33 per cent, 3.44 to 3.18 and 12.20 to 13.20°Brix, respectively during storage period.

27. Total sugar, reducing sugar and non reducing sugar in Wood Apple carbonated drink was changed from 5.68 to 7.86 per cent, 3.48 to 4.24 per cent and 2.20 to 3.62 per cent, respectively after 90 days of storage.

28. During storage, non significant changes were observed in ash, calcium content and phosphorus content.
29. Sensory score for overall acceptability of Wood Apple carbonated drink was 7.86 at zero day and decreased to 6.41 after 90 days of storage. The acceptability of the Wood Apple based carbonated drink was good after 90 days of storage. Microbiologically the Wood Apple carbonated drink was safe to drink and no appreciable change was observed during 90 days of storage. Total plate counts and yeast mould counts was nil at zero day and after 90 days was $7.0 \times 10^2$ and $1.5 \times 10^5$ cfu/ml, respectively.

30. Wood Apple pulp was used in the preparation of powder. Pulp dried at 60°C was found to get highest sensory score (7.48). Chemically treated Wood Apple powder was prepared by mixing of 0.3 per cent KMS. For mixed powder, chemically treated Wood Apple powder mixed with Aonla powder and Ginger powder. The best ratio for Wood Apple powder and Aonla powder was 80:20 ratio, scored highest sensory score (7.61) while the best ratio for Wood Apple powder and Ginger powder was 90:10, scored highest sensory score (7.81).

31. During storage, significant changes were observed in moisture, carbohydrate and ascorbic acid while non significant changes were noticed in fat, protein, ash, calcium and phosphorus. Moisture content of control sample (variation I) and chemically treated Wood Apple powder (variation II) was increased significantly ($P \leq 0.05$) from 3.22 and 2.48 to 4.55 and 4.75 per cent, respectively after 6 months of storage storage.

32. Carbohydrate content in variation I and variation II was 85.76 and 87.02 per cent, respectively at zero day and after 6 months was decreased to 84.45 and 84.77 per cent, respectively. The ascorbic acid content in variation I and variation II was decreased from 37.90 and 44.80 to 25.14 and 41.26 mg/100g, respectively after 6 month of storage, respectively.

33. Sensory score for overall acceptability of control sample (variation I) and chemically treated Wood Apple powder (variation II) was 7.42 and 7.39 at zero day and decreased to 6.89 and 6.84, respectively after 6 months of storage period. There was no acceptable changes were observed during storage.
34. Significant changes were noticed in moisture, carbohydrate and ascorbic acid while non significant changes were noticed in fat, protein, ash, calcium and phosphorus. Moisture content of Wood Apple Aonla powder (variation II) and Wood Apple Ginger powder (variation IV) was increased significantly (\(P \leq 0.05\)) from 4.00 and 3.86 to 4.70 and 4.80 per cent, respectively after 6 months of storage.

35. Carbohydrate content in variation II and variation IV was 85.48 and 85.35 per cent, respectively at zero day and after 6 months was decreased to 84.80 and 84.44 per cent. The ascorbic acid content in variation II and variation IV was decreased from 55.86 and 42.48 to 47.12 and 40.28 mg/100g, respectively after 6 month of storage.

36. Sensory score for overall acceptability of Wood Apple Aonla powder (variation II) and Wood Apple Ginger powder (variation IV) was 7.26 and 7.36 at zero day and decreased to 6.76 and 6.78, respectively after 6 months of storage period. No acceptable changes were observed during storage.

37. The total plate count, yeast and mould count and coliform count in variation I (control sample), variation II (treated Wood Apple powder), variation III (Wood Apple Aonla powder) and variation IV (Wood Apple Ginger powder) was found to be nil throughout the storage period at room temperature. This indicated that the product remained safe microbiologically during storage and acceptable after 6 months of storage and no appreciable change was observed.

It can be concluded that Wood Apple pulp has all the essential nutrients and thus can be recommended for regular use in daily diet to contribute various nutrients. Further, Wood Apple bar, Wood Apple nectar, blended beverage, Wood Apple based carbonated drink and Wood Apple powder are well accepted also as they are good in nutrient content, hence can be recommended for household consumption. Since these products can be easily prepared with locally available ingredients, tribal population may be trained and motivated to use this fruit for commercial use.