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Abstract
Natural wine from Plums, Prunus salicina Linn. (cv. ‘Santa Rosa’) was prepared and standardized the preservation technique of low alcoholic wine. The wine was blended with sand pear juice at the rate of 20 and 30%. The blends were preserved with heat treatments i.e. by pasteurizing the wine at different temperatures for different intervals of time and by chemical preservatives using sodium benzoate (NaB) and sulphur dioxide @100 ppm each. In all the treatments, there was no change in TSS, acidity and alcohol concentration whereas when heating either at 70 or 80°C for 10 or 2 min, respectively was carried out in comparison to the control (without heating or any preservative), highest reduction in TSS, increase in alcohol concentration and acidity took place. The heat treatment given to the wine showed complete elimination of microorganisms hence can be used for preservation of low alcohol wine.

Key words: Low alcoholic wine, Plum wine, Prunus salicina, Preservation of wine, Fermentation, Preservatives.

IPC code; Int. cl.8—C12G 1/00.

Introduction
A large quantity of wines are produced and consumed all over the world1, Italy and France being the leading wine producing countries. Although production of wine is largely made by the fermentation of grape juice yet it has also been practiced widely from fruits such as apples, cherries, currants, peaches, plums, strawberries, etc2. In India, the total production of wine was 8.35 million bottles per year3, indicating a wide scope of production of wine from different fruits such as plum.

Plum, Prunus salicina Linn. (Hindi—Alubukhara) is a highly perishable fruit with a shelf-life of 3-4 days only at ambient temperature and 1-2 weeks in the cold storage. It can neither be easily transported to far off places nor it can be put in cold storage for long periods. Though the fruit could be utilized for the preparation of jams, jellies, etc. yet to accommodate the large quantities of the fruit produced during the glut periods, it becomes necessary to explore alternate commercial methods for its utilization. Production of alcoholic beverages from this fruit with attractive colour and high fermentability is one of the profitable alternative available to utilize the fruit1,4-6.

Wine especially with low alcohol content is gaining popularity among the consumers and generating a lot of interest for the production of such products to the manufacturer7,8. Different countries have different standards for defining the low alcoholic product as in Australia, product labelled as wine must contain more than 8% v/v ethanol, any product below it may be branded as wine product9. In United States of America, the Federal Alcohol Administration Act defines wine with an alcohol content of 7 and 24% (v/v). Wine with more than 15 % alcohol generally does not get spoiled microbiologically. But those with lesser quantity of alcohol are liable for spoilage.

To preserve low alcoholic wines, pasteurization (generally 62°C for 15 min) or use of chemicals are normally done1,10. To determine, whether there is need for additional amount of heat input sufficient to preserve the wine with low alcohol content such as those blended with 20 and 30% pear juice and that does not trigger any chemical change and hence, cause adverse effects on the wine quality, the effect of pasteurization or chemical preservation on quality of wine was studied. Only a limited work on low alcoholic wine from grapes is available and no work has been reported on low alcoholic plum wine. The preservation of

Evaluation of preservation methods of low alcoholic plum wine

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a low alcoholic wine was investigated and the results are discussed here.

Materials and Methods

Collection of fruits

Plum fruits of cv. ‘Santa rosa’ and sand pear fruits were procured from Dr YS Parmar University of Horticulture and Forestry, Orchard, Nauni, Solan, HP. The fruits were harvested at maturity. The yeasts i.e. Saccharomyces cerevisiae UCD 595 and Schizosaccharomyces pombe used in the study were procured from UCD California Davis and Indian Institute of Horticultural Research, Bangalore, India.

Preparation of wine

Plum wine was prepared with four different treatments, viz. T₁ conventional method (using Saccharomyces cerevisiae); T₂ using Saccharomyces cerevisiae but ameliorated with honey; T₃ conventional method but followed by distillation for removal of alcohol and T₄ deacidification with Schizosaccharomyces pombe followed by fermentation with Saccharomyces cerevisiae as described by other workers. To prepare wine, the fruits were converted into pulp. Preparation of pulp, must and fermentation, siphoning, etc., were the same as reported earlier.

Blending of wine

The low alcoholic plum wine was prepared by blending it with different proportions of sand pear juice at the rate of 10, 20, 30, 40 and 50 per cent. Out of these blending proportions, two best blending proportions of sand pear juice with plum wine were selected by the sensory evaluation.

Preservation of low alcoholic wine

The experiment on preservation of low alcoholic plum wine before maturation was laid out to determine the effect of preservation treatments. Each treatment with two blends was preserved with heat treatments i.e. by pasteurizing the wine at different temperature for different intervals (at 80°C for 2 min. or 70°C for 10 min. or at 60°C for 15 min.). Chemical preservatives, viz. sodium benzoate (NaB) and sulphur dioxide @100ppm each were added to the wines separately.

Physico-chemical analyses

Various physico-chemical characteristics of the treated wines were analysed at an interval of 48h till 14 days. Total soluble solids (%) were measured using a refractometer, titratable acidity and pH, were measured as per the AOAC method. Ethanol content was measured by the colourimetric procedure.

Total microbial analysis

The samples of wines were analyzed for the total microbial count as per the prescribed methods using standard plate count agar by pour plate technique. The total microbial count was expressed as CFU/ml.

Results and Discussion

Changes in TSS in different treatments

The trends (Figs.1 a-h) obtained on the changes in TSS (%) in different treatments during 14 days of storage showed that in all the treatments there was no change where heating either at 70 or 80°C for 10 or 2 min., respectively was carried out. In the control, highest reduction in TSS (showing fermentation) took place while in other treatments it remained more or less in between the heating and the control. In general, the pattern exhibited by all the treatments remained the same except in the treatments where alcohol was removed (the manifestation of TSS reduction started quite earlier). Pasteurization at 60°C for 15 min. inhibited the reduction of TSS better than NaB/KMS. It has been reported earlier that 0.8 mM level of SO₂ + DMDC (Dimethyl dichloride) and NaB + DMDC prevented fermentation in samples inoculated with 2 or 200 CFU/ml at 31ºC temperature. Comparison of TSS reduction in the blends (20 and 30% juice) of all the treatments revealed that addition of higher juice content led to higher reduction in TSS. It is apparent that reduction in TSS took place in almost all the treatments except in those, where heating was done at 80 or 70°C. Clearly, the fermentation started very early in treatment T₃ and reduction in TSS was observed more in control and in the treatment where sulphur dioxide was used because of the lack of alcohol (which was removed by the distillation method) as alcohol itself inhibits fermentation. The reduction in TSS shows that treatments other than those heated to 70°C/80°C were not preserved properly.

Alcohol content in different treatments

Results obtained (Figs. 2a-h) on the changes in alcohol content (%) in different treatments corroborated with the decrease in TSS as described earlier. Pasteurizing the wines at 70 or 80°C inhibited the increase in alcohol content.
It is also apparent that in the control (without heating or preservative), highest increase in alcohol content took place. In general, all the treatments maintained the same trend except where alcohol was removed. In these treatments the manifestation of increase in alcohol started quite earlier during 14 days of observation. Addition of more juice content (50%) led to the higher increase in alcohol than lower. Pasteurization at 60°C for 15 min. inhibited the increase of alcohol better than NaB/KMS preservatives. It corroborated with the reduction in TSS discussed earlier. Pasteurization showed no change in ethanol concentration and the heating inhibited the fermentation, hence, no increase in alcohol content took place.

**Acidity percentage in different treatments**

Changes in acidity (%) in different treatments are depicted in Figs 3a-h. Similar to change in alcohol there was no change in acidity in the treatments that were heated at 70 or 80°C. In the control highest increase in acidity was documented. The changes in acidity also reflect the microbial activity and in confirmation with increase in the microbial count (CFU/ml) with increase in storage time in control and in the treatments (discussed in subsequent section) which were preserved with SO₂ and NaB. On the other hand, the heat treatment given to the wine showed a complete elimination of microorganisms, hence preservation. Other observations were similar to those discussed for TSS and ethanol. In all the treatments the addition of 30% juice content led to the higher increase in acidity than 20%. Pasteurization at 60°C for 15 min. inhibited the increase of acidity better than NaB/KMS.

**Changes in pH**

Trends obtained on the changes in pH in different treatments depicted in Figs 4a-h, corroborated with increase of acidity as discussed earlier. Further, there was no change in pH in the treatment at 70 or 80°C. The data also illustrated that in the control highest decrease in pH took place. In general, the pattern exhibited by all the treatments remained the same except where alcohol was removed. Like TSS and acidity the manifestation of changes in pH started quite earlier in these treatments. Comparison of decrease in pH in the blends of 20 and 30% showed that addition of more juice content led to the higher decrease in pH than 20%. Pasteurization at 60°C for 15 min inhibited the decrease of pH better than NaB/KMS.

**Changes in microbial count**

The changes in microbial count (CFU/ml) in different treatments (Figs 5 a-h) showed no microbial/yeast count in the treatments that were pasteurized at 70 or 80°C. In the control highest count was noted. The increase in microbial count remained the same, except in the treatment, where alcohol was removed. Comparison of increase in microbial count in the juice blended wines of all the treatments like other parameters, addition of more juice content led to the high increase in microbial load than lower content. The difference in behaviour of the blended wine from that of normal wine is because of the fact that the wines had reduced level of alcohol and had more juice content used in blending that needed additional heat treatment to preserve than the wine with higher ethanol content. Pasteurization at 60°C for 15 min inhibited increase of microbial load. NaB gave better performance than KMS. The results on microbial/yeast count of various treatments clearly reflected that heating at 70/80°C has been the most effective treatment. It has been reported that heat treatment of less than 3 pasteurization units (PU) was sufficient to reduce 10⁶ cells/ml of Saccharomyces cerevisiae and Hansenula anomala added to Chenin Blanc juice to an undetectable level¹⁶. Neither heating at 60°C nor chemical additive equalled the heating treatment in preventing the changes in blended wine. It is attributed to survival of the wine yeast in the treatment where neither heating at a temperature lower than 70°C was applied nor any preservative was added. This is in confirmation to previous findings by Terrell et al¹⁵ who reported that Saccharomyces is capable of withstanding an amount of 100 ppm SO₂ in wine that is why in this study the treatments using these preservation techniques could not inhibit the spoilage as indicated by TSS decrease, increase in acidity, alteration of pH, increase in ethanol and microbial count. Yeast ascospores are considered more resistant than vegetative cells and further studies are indicated to determine the level of PUs required for their destruction in the products like wine.
Fig. 1(a): Effect of different preservation methods on TSS in 20% blended plum wine ($T_1$)

Fig. 1(b): Effect of different preservation methods on TSS in 30% blended plum wine ($T_2$)

Fig. 1(c): Effect of different preservation methods on TSS in 20% blended plum wine ($T_2$)

Fig. 1(d): Effect of different preservation methods on TSS in 30% blended plum wine ($T_2$)
Fig. 1(e): Effect of different preservation methods on TSS in 20% blended plum wine (T$_3$)

Fig. 1(f): Effect of different preservation methods on TSS in 30% blended plum wine (T$_3$)

Fig. 1(g): Effect of different preservation methods on TSS in 20% blended plum wine (T$_4$)

Fig. 1(h): Effect of different preservation methods on TSS in 30% blended plum wine (T$_4$)
Fig. 2(a): Effect of different preservation methods on alcohol content in 20% blended plum wine ($T_1$)

Fig. 2(b): Effect of different preservation methods on alcohol content in 30% blended plum wine ($T_1$)

Fig. 2(c): Effect of different preservation methods on alcohol content in 20% blended plum wine ($T_2$)

Fig. 2(d): Effect of different preservation methods on alcohol content in 30% blended plum wine ($T_2$)
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<th>Sulphurdioxide</th>
<th>Control</th>
<th>60 degree celsius</th>
<th>80 degree celsius</th>
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Fig. 2(e): Effect of different preservation methods on alcohol content in 20% blended plum wine (T₁)

Fig. 2(f): Effect of different preservation methods on alcohol content in 30% blended plum wine (T₂)

Fig. 2(g): Effect of different preservation methods on alcohol content in 20% blended plum wine (T₄)

Fig. 2(h): Effect of different preservation methods on alcohol content in 30% blended plum wine (T₄)
Fig. 3(a): Effect of different preservation methods on titratable acidity in 20% blended plum wine ($T_1$)

Fig. 3(b): Effect of different preservation methods on titratable acidity in 30% blended plum wine ($T_2$)

Fig. 3(c): Effect of different preservation methods on titratable acidity in 20% blended plum wine ($T_2$)

Fig. 3(d): Effect of different preservation methods on titratable acidity in 30% blended plum wine ($T_2$)
Fig. 3(e): Effect of different preservation methods on titratable acidity in 20% blended plum wine (T_1)

Fig. 3(f): Effect of different preservation methods on titratable acidity in 30% blended plum wine (T_2)

Fig. 3(g): Effect of different preservation methods on titratable acidity in 20% blended plum wine (T_3)

Fig. 3(h): Effect of different preservation methods on titratable acidity in 30% blended plum wine (T_4)
Fig. 4(a): Effect of different preservation methods on pH in 20% blended plum wine (T1)

Fig. 4(b): Effect of different preservation methods on pH in 30% blended plum wine (T2)

Fig. 4(c): Effect of different preservation methods on pH in 20% blended plum wine (T2)

Fig. 4(d): Effect of different preservation methods on pH in 30% blended plum wine (T2)
Fig. 4(e): Effect of different preservation methods on pH in 20% blended plum wine (T_{3})

Fig. 4(f): Effect of different preservation methods on pH in 30% blended plum wine (T_{3})

Fig. 4(g): Effect of different preservation methods on pH in 20% blended plum wine (T_{4})

Fig. 4(h): Effect of different preservation methods on pH in 30% blended plum wine (T_{4})
Fig. 5(a): Effect of different preservation methods on total plate count in 20% blended plum wine (T₁)

Fig. 5(b): Effect of different preservation methods on total plate count in 30% blended plum wine (T₁)

Fig. 5(c): Effect of different preservation methods on total plate count in 20% blended plum wine (T₂)

Fig. 5(d): Effect of different preservation methods on total plate count in 30% blended plum wine (T₂)
Fig. 5(e): Effect of different preservation methods on total plate count in 20% blended plum wine (T₃)

Fig. 5(f): Effect of different preservation methods on total plate count in 30% blended plum wine (T₄)

Fig. 5(g): Effect of different preservation methods on total plate count in 20% blended plum wine (T₄)

Fig. 5(h): Effect of different preservation methods on total plate count in 30% blended plum wine (T₄)
Conclusion

Plum wine prepared with reduced content of alcohol or with more juice content (used to reduce the alcohol concentration) can be effectively pasteurized for 70°C for 5 min or 80°C for 2 minutes. The treatment did not allow reduction in TSS, increase in alcohol, acidity or reduction in pH. The microbial load, major criterion of successful pasteurization was also reduced appreciably by the pasteurization.

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