Effect of wood chips maturation on wild apricot fruit (Prunus armeniaca L.) mead

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Abstract
Honey fermented alcoholic drink is called as mead. The present study was conducted to prepare functionally enriched mead by ameliorate the wild apricot fruit pulp with honey. TSS content of the wild apricot must was raised by addition of honey to 22°B, 24°B and 26°B. Wild apricot mead prepared from initial TSS 26°B found to contain more reducing sugars, TSS, total esters, higher alcohols and ethanol content. After completion of fermentation, mead was matured to six months with wood chips of Quercus, Bombax and Acacia and evaluated for various functional properties. All the three wood chips treated wines were higher in total phenols, total esters, total carotenoids and low in titratable acidity and ethanol content than the control. Quercus treated wine was rated superior to others due to higher total esters, total phenols and reduced acidity. Acacia treated wine reduced the quantity of higher alcohols, whereas, Bombax was found highest in higher alcohols. The change in the concentration of these components during maturation improved the flavour of all the wines treated with wood chips. Out of three wood chips, Quercus treated wine was preferred to be the judges, followed by Bombax and then Acacia.

Keywords: Wild apricot; mead; wood chips; maturation; TSS

Introduction
Honey is used from time immemorial to prepare the alcoholic drink called ‘mead’. The English word ‘mead’ was derived from old English medu or perhaps from the Sanskrit word madhu. Honey was also added for the preparation of fruit mead in fruits like apple, plum and pear (Kime and Lee, 1987; Joshi et al., 1990) [25, 14, 20]. Fruit mead preparation was found similar to that of fruit wines (Molanar et al., 1980) [27]. The earliest archaeological evidence for the production of mead dates to around 7000 BC in China where a Pottery vessel containing a mixture of mead, rice and other fruits along with organic compounds of fermentation was being produced (McGovern et al., 2004) [26]. Honey is known for its excellent effect on digestion and metabolism (Ioyrish, 1974). Light honey is preferred to make mead as compare to the dark honey. It is necessary to add enough acid and tannins to the must, as it contains neither of it (Filipello and Marsh, 1934) [8]. On the other hand wild apricot (Prunus armeniaca L.) is commonly found growing wild at cold desert region of Tibet, southern part of China and northern India and rich in functional and nutritional properties (Sharma, 2000; Parmar and Sharma, 1992; Sharma, 1994) [32, 29, 33]. But the fruits are highly perishable, and is dried or converted into hard liquor (Parmar and Kaushal, 1982) [28] which lacks in nutrients and also found to have high in methanol content. The fruits can be employed for the production of various alcoholic beverages, even having high acidity (Joshi et al., 1991) [19]. Further, there is no report on wild apricot mead and its maturation with wood chips. Therefore, attempts have been made in present study to see the effect of maturation wood chips (Quercus, Acacia and Bombax) on functional properties of wild apricot mead.

Materials and Methods
Raw materials
The fruits of wild apricot were procured from Kinnaur Dist. of Himachal Pradesh. Wild apricot was converted into pulp. To prepare pulp, 10 per cent water was added before cooking the fruit. The cooked fruits were passed through a pulper to remove skin and stones. Honey was purchased from the Department of Entomology of the Dr Y S Parmar University of Horticulture and Forestry, Nauni, Solan (INDIA) for the preparation of wild apricot mead. The pectin esterase enzyme used in the studies was manufactured by M/S Triton Chemicals, Mysore, India under the brand name “Pectinol”. Woods of different trees viz. Quercus,
**Yeast culture**: The yeast culture viz. *Saccharomyces cerevisiae* var. *ellipsoideus*, (UCD 595) was made for the preparation of wild apricot mead. The wild apricot pulp was heated to boiling point followed by cooling. The sterilized pulp was diluted in 1:2 ratios (Abrol and Joshi, 2011) which was inoculated with yeast from the slant.

**Preparation of must**: For conducting the experiment, the pulp stored with 2000 ppm KMS was heated to make it free from SO₂ and then diluted in the ratio of 1:2 with water. To the diluted pulp, 0.1% diamonium hydrogen phosphate (DAHP) as nitrogen source and 0.5% pectinase enzyme for clarification were added. The TSS of diluted wild apricot was raised with to 22°B, 24°B and 26°B as per the treatments. The respective must were inoculated with 5% of activated culture of *Saccharomyces cerevisiae* var. *ellipsoideus*. The fermentation of each treatment was carried out in 10 L capacity narrow mouth glass carboys, filled up to 75% of their capacity.

**Fermentation**: Fermentation for all the treatments (22 °B, 24 °B and 26 °B) for mead was carried out at room temperature (22-25 °C). When a stable TSS was reached, the fermentation was considered completed. Air locks were fitted in the mouth of glass carboys near the end of fermentation.

**Wood chips maturation**

The experiment was laid out to determine, the effect of different wood chips on wild apricot mead maturation. Wild apricot mead of different initial TSS were filled in 200ml bottles. To each bottle, 1 g wood chips was added. Maturation was carried out for 6 months.

**Functional properties Analysis**

Total soluble solids (TSS) were measured using an Erma hand refractometer (0 to 32 °B) and the results were expressed as degree Brix (°B). The readings were corrected by incorporating the appropriate correction factor for temperature variation (AOAC, 1980) [1]. Titratable acidity was estimated by titrating a known aliquot of the sample against N/10 NaOH solution using phenolphthalein as an indicator. The titratable acidity was calculated and expressed as per cent malic acid (AOAC, 1980) [1]. The total phenols content in different mead were determined by Folin Ciocalteu calorimetric procedure given by Singleton and Rossi (1965) [16]. ELTop-3030 pH meter was used to measure pH. The total and reducing sugars of fruit and mead were estimated by Lane and Eynon volumetric method (AOAC, 1980) [1] by titrating the sample against Fehlings solutions.

Quality of ethanol in mead was estimated by spectrophotometric method (Caputi et.al., 1968), whereas, higher alcohols in mead was estimated by the method given by Guymon and Nakagiri (1952) [11].

**Statistical analysis**

Statistical analysis of the quantitative data of chemical parameters obtained from the experiments was done by Completely Randomized Design (CRD) Factorial (Cochran and Cox, 1963).

**Results**

Effect of different wood chips treatment and maturation time on TSS is represented in figure 1. The treatment of wines with wood chips was found to be non-significant on TSS. In consistence with increase in sugar concentration, an increase in TSS was observed and was found in the range of 8.18 to 8.53 °B. Similarly as seen in TSS, wood chips treated wines didn’t showed much change for reducing sugars content. With the increase in initial TSS, significant increase in reducing sugars was observed. The highest (0.478%) reducing sugars content was found in the wine made from initial TSS level of 26 °B and lowest (0.367%) in wine having initial TSS 22°B. The highest total sugar (1.302%) was recorded in wild apricot wine having initial TSS 26°B and lowest (1.072%) in *Acacia* chips treated wine (Figure 2). There was significant increase in total sugars concentration with respect to increment in TSS. The highest total sugars content was recorded in wine made from 26 °B (1.263%) and lowest (1.123%) in 22 °B.

The titratable acidity and pH is interlinked with each other and are important parameter of wine quality, both these were affected by wood chips maturation and increase in TSS concentration by addition of sweetening agent in wild apricot must (Figure 3). Out of three wood chips used for maturation of wild apricot wine, the highest acidity (0.780% as MA) was reported in Control wine followed by wine treated with *Acacia*, *Bombax* and *Quercus*, respectively. Wild apricot wine having initial TSS 26 °B was found to be higher than titratable acidity (0.809%) whereas, 22 °B wild apricot wine recorded lower titratable acidity (0.708%). The results for pH revealed that the wine treated with *Acacia* and *Bombax* found to have same pH 3.161, while of *Quercus* matured wine found to have 3.167 pH. Mean of 26 °B TSS level was found to be statistically at par with wine from 24°B as initial TSS, while that of 22°B wild apricots wine was significantly different from these wines.

All the three wood chips treated wines had reduced level of ethanol compared to control (Figure 4). Wine treated with *Quercus* recorded the lowest ethanol content (10.43%) while the highest (10.51%) was in control. There were significant differences in the ethanol content of wines prepared with different sugar concentration i.e. 22, 24 and 26 °B. The highest (11.14%) ethanol content was found in the wine made from initial TSS level of 26°B and lowest (9.63%) in 22 °B.

With the increase in initial TSS level of the wine, there was a significant increase in higher alcohols content from 123.6 to 153.6 mg/l. Figure 5 shows an inconsistent increase in higher alcohols was observed with increment in TSS content from 22 to 26°B. Effect of wood chips treatment on total esters was found to be significant. Compared to the control, all the wood chips treated wine had more quantity of the total esters content. The highest total esters were recorded in *Bombax* treated wine (147.3 mg/L) and lowest in control (139.0 mg/L) wine. There was a significant increase in total esters content in the wines prepared from must with different initial TSS i.e. 22, 24, 26°B. The highest quantity of total esters (148.0 mg/l) was found in the wine made from initial TSS of 26°B and
lowest (140.6 mg/l) in wine with 22 °B. Compared to the control wine, the total phenols were found higher in wood chips treated wines. However, among the wood chips treated wines, Quercus treated wine recorded the highest (251.5 mg/l) total phenols followed by Bombax (247.8 mg/l) and Acacia (245.8 mg/l), whereas, total phenols were lowest in the control wine (238.0 mg/l). With the increase in sugar level, the quantity of total phenols was found to be increased from 227.7 to 262.0 mg/l.

Discussion
Precipitation of soluble solids during interaction of various components might have resulted in a decreased TSS during maturation (Joshi and Sharma, 1993; Joshi et al., 1999) [18, 22]. The highest reduction TSS in Acacia may be due to precipitation and interaction of different components contributed by the chips of this wood. Similar, results have been reported in peach wine also (Joshi et al., 2005). Although not appreciable, a small increase in reducing sugars in wood chips treated wine could be attributed to the absorption of sugar from the wood chips into the wine (Wilker and Gallander, 1988). Higher reducing sugars content in wine of 26°B is apparently due to higher initial sugar concentration in the must. The increasing trend of reducing sugars is apparently the results of hydrolysis of non-reducing sugar into reducing sugar during maturation (Amerine et al., 1980) [2]. It is significant from taste quality of wine and is one of the desirable effects of maturation of wine. Similar results have been reported in wild apricot wine and peach wine (Joshi et al., 1990; Joshi and Shah, 1998) [14, 20, 17].

Decrease in total sugars might be due to the Maillard’s reaction resulting in non-enzymatic browning due to reaction of sugar with amino acid during maturation (Zoecklein et al., 1995) [40]. Similar results have been reported for total sugars for strawberry wine, plum low alcoholic wine (Sharma et al., 2009; Gill et al., 2009) [35, 10]. With respect to the decrease in total sugars content a similar trend on maturation of peach wine with wood chips of Quercus, Bombax and Albizia was observed (Joshi and Shah, 1998) [17].

The reduction in titratable acidity was found in all the wines. The possible reason for the decrease in acidity could be the precipitation of different acids in terms of their respective salts (Amerine et al., 1980) [2]. The decrease in titratable acidity is desirable in wines from more acidic fruits during maturation as it increases the palatability of wine (Joshi et al., 1999; Joshi and Pandey, 1999) [22, 15]. It was also observed that increase in pH is corresponding to the decrease in acidity. As there is inverse relationship between pH and acidity. Similar results have been reported in strawberry wine (Sharma and Joshi, 2004) [34].

Decrease in ethanol content during maturation is apparently the results of interaction between alcohols and acids to form esters (Amerine et al., 1980; Zoecklein et al., 1995) [2, 40]. It is desirable as total ester formation results in higher fruity flavour. The difference in alcohol content due to increase in sugar content and could be correlated. As honey contains other than fermentable sugar, hence produces lower amount of alcohol (Qureshi and Tamhane, 1986) [31]. The quantity of higher alcohols, irrespective of treatment, in general is quite low than the threshold value of 420mg/l (Amerine et al., 1980) [2], above which these alcohol produce hang over (Fowles, 1989) [9]. Since in wild apricot fermentation nitrogen source was added, therefore, the level of higher alcohols was curtailed to a significantly lower level, which is quite desirable. Lower quantity of higher alcohols in wine of TSS 22, 24 and 26°B could apparently related with fermentation behaviour of higher sugar content, where the substrates are diverted towards metabolite other than ethanol (Zoecklein et al., 1995) [40]. Between wood chips, the difference for higher alcohol could be attributed to hydrolysis of various wooden components during maturation which might have altered the higher alcohols content. Further the increase in higher alcohols may be the result of transamination of amino acid, decarboxylation and reduction of particular keto acids (Wondra and Berovic, 2001) [39].

Increase in total esters during maturation is attributed to the phenomenon of aging (Amerine et al., 1980) [2]. Esters in general, have fruity and floral impact, characteristics that are important in sensory properties of wine. The amount of total esters in various wines ranged between 200 to 400 mg/l (Jackson, 2004; Amerine et al., 1980) [13, 2]. Wine esters are formed as a result of reaction between acetate and ethanol as well as other higher alcohols. Wines esters also arise from ethanol by reaction with straight chain fatty acid precursors (Zoecklein et al., 1995; Joshi and Sandhu, 2000) [40, 16, 24]. Oxidation of ethanol into acetic acid and their interaction and the subsequent increase in the ester content of wine during maturation might have contributed to the increase of total esters (Castino et al., 1993) [6]. Similar increase in total esters was observed by Joshi and Shah (1998) [17]. Increase in esters content of wine during maturation is desirable from sensory quality point of view.

Results indicated that during maturation, a significant decrease in total phenols or tannins took place. There was also a decrease in phenol concentration during storage of wines of various wood chips treatments. Among the interactions, there were significant differences. Decrease in phenol concentration might be due to the susceptibility of phenolic constituents to degradation, condensation and polymerization, and subsequent precipitation (Beridze, 1948; Somers, 1987). During ageing, tannin levels in wines decreased as a result of oxidation and precipitation with proteins (Zoecklein et al., 1995) [40]. The decrease in total phenols is desirable as after their polymerization, palatability of the wine increases. But the range of total phenols found was higher than that reported for wood treated plum and apricot wines (Joshi et al., 1994) [21]. The higher tannin contents in the wood treated wines than control attributable to extraction of both flavonoids and non-flavonoids phenolic compound from wood during maturation period (Quinn and Singleton, 1985; Wilker and Gallander, 1988; Deves, 1994; Joshi and Shah, 1998) [30, 38, 7, 17]. Among the phenolic acids examined only gallic acid increased among the wood treated wines and other phenols (protocatechuic acid, vanillic acid, Syringic acid and Ferulic acid) were found the same in the treated wines compared to the control wine during maturation (Wilker and Gallander, 1988; Joshi et al., 2000) [16, 24]. Gallic acid levels may be related to hydrolysable tannins, as gallic acid is one of the hydrolytic products of ellagitannins, a type of hydrolysable tannin. Increase in gallic acid decreases the astringency (Quinn and Singleton, 1985) [30]. Similar decrease in total phenols were observed in pinotage wine during maturation with oak chips, but out of Gallic acid, Caftaric acid, Caffeic acid and Coutaric acid, gallic acid increased to 6 weeks of maturation then decreased (Beer et al., 2008) [3].
Fig 1: Effect of different wood chips maturation and honey concentration on TSS content of wild apricot mead

Fig 2: Effect of different wood chips maturation and honey concentration on Reducing sugars and Total sugars content of wild apricot mead

Fig 3: Effect of different wood chips maturation and honey concentration on Titratable acidity and pH of wild apricot mead
Fig 4: Effect of different wood chips maturation and honey concentration on ethanol content of wild apricot mead

Fig 5: Effect of different wood chips maturation and honey concentration on higher alcohols, total esters and total phenols of wild apricot mead

Conclusion
Wild apricot mead is prepared by raising the TSS of “must” to 22, 24 and 26 °B by using honey and after completion of fermentation these are further matured with three different wood chips i.e. *Quercus*, *Bombax* and *Acacia*. Mead having initial TSS 26 °B contained more reducing sugar, TSS, total esters, higher alcohols and ethanol content than the others after six months of maturation. During maturation decrease in TSS, total sugar, titratable acidity, ethanol and total phenols took place however, reducing sugar pH, higher alcohols and total esters increased during maturation. All the three wood chips treated wines were higher in total phenols, total esters and low in titratable acidity and ethanol content than the control, whereas, there was no effect of wood chips treatment on reducing sugars, total sugars and volatile acidity. *Quercus* treated wine was rated superior to others due to higher total esters, total phenols and reduced acidity. It is evident from the results of present study that wood chips have positive impact on mead maturation. During maturation, wine become more pleasant and wood chips played a major role for increasing tannin and total esters content.

Reference
4. Beridze GI. Vanodelie. Venegradartvo. 1948; 8(8):11
15. Joshi VK, Pandey A. In: Fruit Based Alcoholic Beverages, Biotechnology: Food Fermentation (Microbiology, Biochemistry and Technology), VK Joshi and A Pandey eds., Educational Publishers and distributors, New Delhi, India, 1999; II:719.