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Effect of maturation on wild apricot vermouth of different treatments

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ABSTRACT

Wild apricot vermouths (WAV) of different sugar levels (8, 10 and 12 °Brix), different alcohol levels (15, 17 and 19%) and spice levels (2.5 and 5%) were prepared. The product was matured for six months and evaluated for physico-chemical characteristics at 0, 3 and 6 months of maturation. In general, ethyl alcohol content decreased in wild apricot vermouth of all treatments during maturation for six months, in proportion to their initial values. The decrease in TSS was revealed with the advancement of the storage period of six months. A similar trend was observed for total sugars with the advancement of the ageing period. The amount of reducing sugars, however, increased with the prolongation of the maturation period. The total esters content in WAV increased with the advancement of the ageing period, irrespective of their alcohol content. However, the volatile acidity showed a very little increase during ageing but remained non-significant among the different treatments. Total phenols content in WAV decreased by both the ageing period of six months and an increase in alcohol level. A non-significant increase in the titratable acidity with an ageing period was observed in all the WAV having different alcohol levels. The effect of spice extract levels added in the preparation of WAV showed that with the advancement of storage period total esters increased from 246.8 to 272.8 mg/L and 252.8 to 280.6 mg/L for WAV having 2.5 and 5% spices content, respectively. In brief, an overview of the entire results revealed that there was an interactive effect of alcohol level, the sugar level and the spice extract during maturation of wild apricot vermouth. It can be concluded that the maturation of WAV exerted a favourable effect on physico-chemical properties of wild apricot vermouth and is thus, considered desirable.

Introduction*

Wild apricot (*Prunus armeniaca* L.) commonly found growing naturally in mid to the high Himalayas, is popularly known as *chulli, zardalu, sarha* (Himachal Pradesh); *chuari, zardalu* (Hindi); *gurdalu, cherkush* (Kashmir); *chuaru, chola, kushmaru* (Kumaon); *chult* (Laddakh); *zardalu* (Punjab) (Sharma et al., 2012; Sharma, 2000; Sharma, 1994; Parmar and Sharma, 1992; Joshi et al., 1990; Parmar and Kaushal, 1982). The fruit is a highly acidic drupe and is generally consumed after drying and or used for the preparation of different products by tribal people after the removal of seeds. Seed kernel of the fruit is an important source of oil and utilized for several purposes (Sharma et al., 2012). The fruit is also used to prepare an alcoholic drink by anorthodox method (Sharma et al., 2012; Joshi et al., 1990; Parmar and Kaushal, 1982). The drink contains high levels of methyl alcohol and completely lacks nutrients, and its consumption could result in various disorders as well as malnutrition (Joshi et al., 2005). Since the mid and higher Himalayas are also known as the home of various rare spices and herbs, these have been used to prepare vermouth. Efforts have been made to prepare vermouth, which is a fortified wine (alcohol 15–21%) flavoured with a unique mixture of herbs and

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spices (Amerine et al., 1980; Joshi et al., 2016) to impart an aromatic bitter flavour (Joshi et al., 2012). The word vermouth is derived from the German word 'wermut', in which 'wer' means 'man' and 'mut' means 'courage', spirit manhood or English word 'wormwood' which in Latin stands for *Artemisia absinthium* (Pilone, 1954). Method of preparation and quality characteristics of grape vermouth has been well established (Amerine et al., 1980; Wright, 1960). However, its preparation from other fruits and the effect of maturation is documented only for a few fruits (Panesar et al., 2009; Panesar et al., 2011; Joshi et al., 1991). This study aimed to investigate the effect of maturation on physico-chemical properties of wild apricot vermouth, which is rarely documented.

Materials and Methods

Raw materials

The fruits of wild apricot were procured from Kinnaur District of Himachal Pradesh and were converted into pulp. Cane sugar and di-ammonium hydrogen phosphate (DHAP) used to ameliorate the must for preparations of base wine were procured from the local market. The pectinase enzyme used was manufactured by M/S Triton Chemicals, Mysore, India, under the brand name of 'Pectinol'. Different spices and herbs for the preparation of vermouth were obtained from the Department of Forest Products, College of Forestry, Nauni, Solan (India).

Base wine and brandy preparation

To prepare the base wine, must of 24 °Brix was prepared by diluting the wild apricot pulp in 1:2 ratio with water. In addition, 200 ppm SO_2, DAHP 0.1 % and 0.5 % pectinase enzyme were added. A 24 hrs old activated yeast culture (*Saccharomyces cerevisiae* var. *ellipsoideus* strain UCD 595) was prepared and used for fermentation. After completion of fermentation, siphoning/racking operation followed, and the product was labelled as base wine. A part of the base wine was distilled into brandy as per the standard procedure (Amerine et al., 1980; Joshi, 1997). First 1/10th of expected distillate called "head" was discarded. Similarly, the last 1/10th of distillate was also not taken. Only the middle portion, which is often called "heart" of the distillate, was collected and further double distilled to raise the strength of brandy to the required level.

Preparation of spices extract

Different spices and herbs, namely fruits of black paper (*Piper nigrum* L.) 0.75 g/L and clove (*Syzygium aromaticum* L.) 0.25 g/L; seeds of coriander (*Coriander sativum* L.) 0.70 g/L, cumin (*Cuminum cyaninum* L.) 0.50 g/L, large cardamom (*Amomum subulatum* Roxb.) 0.50g/L, nutmeg (*Myristica fragrans*) 0.25 g/L and poppy seed (*Papaver somniferum* L.) 1.00 g/L; flower of saffron (*Crocus sativus* L.) 0.01 g/L, woodfordia (*Woodfordia floribunda*) 0.25 g/L and rosemary (*Rosmarinus officinalis*) 0.10 g/L; roots of ginger (*Zingiber officinale* Rosc.) 1.00 g/L and withania (*Withania somnifera*) 0.20 g/L; leaves of asparagus (*Asparagus sp.*) 0.10 g/L and adhatoda (*Adhatoda* sp.) 0.25 g/L; bark of cinnamon (*Cinnamomum zeylanicum* Beryn) 0.25 g/L were used to prepare the extract for use in wild apricot vermouth production. Spices and herbs were immersed in wine and brandy mixture of 1:1 ratio and gently heated at 50–60 °C for 10 minutes for ten days continuously in a closed container (Joshi et al., 2012). The extract was kept at low temperature (4–5 °C) for two days for precipitation. The supernatant was separated by filtration and used in the vermouth preparation.

Preparation of vermouth

Wild apricot vermouths of different treatments viz., different ethanol concentrations (15, 17 and 19%), sugar concentrations (8, 10 and 12%) and concentrations of spices extract (2.5 and 5.0%) were prepared. The products were left to mature for six months and evaluated for various physico-chemical properties at an interval of three months.

Physico-chemical evaluation

Total soluble solids (TSS) were measured using an Erma hand refractometer (0 to 32°Brix), and the results were expressed as degree Brix (°Brix). The readings were corrected by incorporating the appropriate correction factor for temperature variation (AOAC, 2000). Titratable acidity was estimated by titrating a known aliquot of the sample against 0.1 M NaOH solution using phenolphthalein as an indicator. The titratable acidity was calculated and expressed as % malic acid (AOAC, 2000). The total phenols (mg/L as gallic acid) content in different wines was determined by Folin-Ciocalteu procedure given by Singleton and Rossi (1965). The total and reducing sugars of fruit and vermouth were estimated by Lane and Eynon's volumetric method by titrating the sample against Fehling's solutions (AOAC, 2000). Volatile acidity (% acetic acid) of wild apricot vermouth was estimated by the standard method (Amerine et al., 1980). The quantity of ethanol in wine/vermouth was estimated by spectrophotometric method (Caputi et al., 1968) while that of brandy was determined by alcohol-meter (Amerine et al., 1980) and expressed as % v/v. Total esters (mg/L as ethyl acetate) were estimated as per the method of Liberaty (1961).

Statistical analysis

Statistical analysis of the quantitative data of chemical parameters obtained from the experiments was done by Completely Randomized Design (CRD) factorial as per standard method (Cockrane and Cox, 1963). The critical differences were calculated. In the tables, data with no statistical difference have the same letters while those with differences have a different letter. Where analysis of variance has not been performed, the means ± Standard Deviation (S.D.) has been given.

Results

Characteristics of the wild apricot base wine

The base wine had low TSS (8.20 ± 0.07 °Brix), medium titratable acidity (0.76 ± 0.02 %MA) and a low pH (3.15 ± 0.02 pH), respectively. The alcohol content (10.64 ± 0.09 %v/v) was that of table wine, whereas, it had a very low quantity of reducing (0.34 ± 0.01 %) and total sugars (1.11 ± 0.02 %). Volatile acidity 0.025 ± 0.002 (%AA), total phenols 253.6 ± 0.8 mg/L, higher alcohols 141.40 ± 1.52 mg/L and total esters 135.40 ± 0.55 mg/L were documented.

Effect of maturation on physico-chemical characteristics of wild apricot vermouth

A decrease in TSS in wild apricot vermouth was revealed with the advancement of the storage period of six months (Table 1). The highest TSS content of 17.67 °Brix was observed in WAV having 19% alcohol level at the initial month of vermouth maturation, while the lowest TSS content of 6.93 °Brix was in WAV having 15% alcohol after maturation of 6 months. The amount of reducing sugars increased with the prolongation of the maturation period but decreased when subjected to an increase in alcohol level. With the increase in alcohol level, i.e. 15, 17 and 19%, a significant decrease in total sugars was recorded, and similarly, a decreasing trend was there with the advancement of the ageing period. The highest value of total sugars 10.67% was recorded in WAV having 15% alcohol level after the initial month and also contained the highest total sugars level 10.46% when compared to different alcohol levels after six months of storage. On the other hand, the lowest total sugars content was observed in WAV having 19% alcohol during maturation. By examining the effect of the addition of different alcohol level in WAV against the storage period of six months on titratable acidity and pH value, a *vice-versa* trend was observed. The titratable acidity decreased with the increase in alcohol level in WAV. However, a non-significant increase with an ageing period was observed in all the WAV having different alcohol levels.

The ethanol content decreased in all treatments with the advancement of storage period: from 15.27 to 14.95%v/v in WAV having 15% alcohol, 17.32 to 16.95%v/v in WAV having 17% alcohol and 19.22 to 18.91%v/v in WAV having 19% alcohol. The soundness of vermouth is generally determined by volatile content, which is found non-significant in all treatments and with the storage period.

The total esters content in WAV increased with the advancement of the ageing period, irrespective of their alcohol content. The WAV of different ethanol contents increased total esters content. The highest total esters content observed was 287.1 mg/L in 19% alcohol level WAV after six months of maturation, while the lowest content 247.0 mg/L was observed in WAV having 15% alcohol content after the initial month. Total phenols content in WAV decreased by both the ageing period of six months and an increase in alcohol level in the wild apricot vermouth. The total phenols content ranged from 432.9 mg/L to 468.4 mg/L.

The results given in Table 2 show the effect of the ageing period on physico-chemical properties of WAV having three different sugar levels. In general, the increase in sugar level resulted in an increase of TSS level in all treatments during the initial period of storage, which was expected. However, TSS level decreased with the advancement of the ageing period for six months. The highest TSS level was documented in WAV with 12% sugar added, and the lowest was in WAV with 8% sugar addition. Changes in the level of reducing sugars during maturation were negligible and non-significant, but the addition of different sugar levels (8, 10, 12 %) influenced the level of reducing sugars. The effect of the sugar addition on the total sugars content was found to be similar to the impact of sugar addition on TSS level. Titratable acidity slightly increased, while pH decreased with the prolongation of the maturation period.

Table 1. Effect of ethanol level on physico-chemical characteristics of WAV during maturation

	Alcohol level (%v/v)								
	15.0			**17.0**			**19.0**		
Characteristics	0 month	3 months	6 months	0 month	3 Months	6 months	0 month	3 months	6 months
TSS (°Brix)	17.30^{aa}	17.03^{ab}	16.93^{ab}	17.45^{ba}	17.17^{bb}	17.07^{bc}	17.67^{ca}	17.42^{cb}	17.27^{cc}
Reducing sugars (%)	5.51^{aa}	5.55^{aa}	5.59^{aa}	5.41^{aa}	5.46^{aa}	5.49^{aa}	5.32^{aa}	5.38^{aa}	5.43^{aa}
Total sugars (%)	10.67^{aa}	10.37^{ab}	10.20^{ac}	10.46^{ba}	10.08^{bb}	9.93^{bc}	10.25^{ca}	9.92^{cb}	9.72^{cc}
Titratable acidity (%MA)	0.82^{aa}	0.85^{aa}	0.88^{aa}	0.75^{ba}	0.79^{ba}	0.80^{aa}	0.73^{ba}	0.77^{ba}	0.80^{aa}
pH	3.283^{aa}	3.273^{ab}	3.263^{ac}	3.336^{ba}	3.318^{bb}	3.308^{bc}	3.381^{ca}	3.341^{cb}	3.314^{cc}
Ethanol (%v/v)	15.27^{aa}	15.05^{ab}	14.95^{ac}	17.32^{ba}	17.03^{bb}	16.95^{bc}	19.22^{ca}	19.01^{cb}	18.91^{cc}
Volatile acidity (%AA)	0.025^{aa}	0.026^{aa}	0.028^{aa}	0.026^{aa}	0.028^{aa}	0.030^{aa}	0.027^{aa}	0.029^{aa}	0.031^{aa}
Total esters (mg/L)	247.0^{aa}	262.0^{ab}	273.5^{ac}	249.8^{ba}	263.4^{bb}	274.9^{bc}	252.6^{ca}	267.9^{cb}	281.7^{cc}
Total phenols (mg/L)	468.4^{aa}	455.4^{ab}	439.4^{ac}	465.3^{ba}	451.6^{bb}	437.9^{bc}	460.3^{ca}	446.8^{cb}	432.9^{cc}

*n = 3, Means with different levels; different letters indicate significant differences between groups

Table 2. Effect of sugar level on physico-chemical characteristics of WAV during maturation

	Sugar level (%)								
	8.0			**10.0**			**12.0**		
Characteristics	0 month	3 months	6 months	0 month	3 Months	6 months	0 month	3 months	6 months
TSS (°Brix)	15.10^{aa}	14.83^{ab}	14.70^{ac}	17.63^{ba}	17.33^{bb}	17.20^{bc}	19.68^{ca}	19.45^{cb}	19.37^{cc}
Reducing sugars (%)	4.93^{aa}	4.99^{aa}	5.01^{aa}	5.38^{bb}	5.41^{bb}	5.46^{bb}	5.92^{cc}	5.99^{cc}	6.04^{cc}
Total sugars (%)	8.87^{aa}	8.72^{ab}	8.37^{ac}	10.25^{ba}	9.95^{bb}	9.78^{bc}	12.41^{ca}	12.05^{cb}	11.87^{cc}
Titratable acidity (%MA)	0.76^{aa}	0.78^{aa}	0.82^{aa}	0.79^{aa}	0.83^{ba}	0.84^{ba}	0.73^{aa}	0.76^{aa}	0.80^{aa}
pH	3.325^{aa}	3.294^{ab}	3.262^{ac}	3.355^{ba}	3.321^{bb}	3.301^{bc}	3.401^{ca}	3.364^{ac}	3.355^{ba}
Ethanol (%v/v)	17.33^{aa}	17.05^{aa}	16.93^{aa}	17.28^{aa}	17.04^{aa}	16.93^{aa}	17.19^{aa}	16.99^{aa}	16.94^{aa}
Volatile acidity (%AA)	0.027^{aa}	0.029^{aa}	0.031^{aa}	0.026^{aa}	0.027^{aa}	0.029^{aa}	0.025^{aa}	0.027^{aa}	0.028^{aa}
Total esters (mg/L)	216.4^{aa}	234.8^{ab}	248.0^{ac}	245.3^{ba}	256.8^{bb}	267.6^{bc}	287.7^{ca}	301.7^{cb}	314.5^{cc}
Total phenols (mg/L)	472.2^{aa}	455.3^{ab}	441.5^{ac}	465.9^{ba}	455.3^{bb}	443.5^{bc}	455.8^{ca}	443.1^{cb}	425.2^{cc}

*n = 3, Means with different levels; different letters indicate significant differences between groups

Table 3. Effect of spices level on physico-chemical characteristics of WAV during maturation.

	Spices level (%)					
	2.5			**5.0**		
Characteristics	0 month	3 months	6 months	0 month	3 months	6 months
TSS (°B)	17.35^{aa}	17.09^{ab}	16.95^{ac}	17.59^{ba}	17.32^{aa}	17.22^{bb}
Reducing sugars (%)	5.43^{aa}	5.49^{aa}	5.54^{aa}	5.39^{aa}	5.44^{aa}	5.46^{aa}
Total sugars (%)	10.30^{aa}	10.00^{ab}	9.81^{ac}	10.62^{ba}	10.24^{aa}	10.09^{ab}
Titratable acidity (%MA)	0.75^{aa}	0.79^{ab}	0.81^{ab}	0.78^{ab}	0.82^{ab}	0.84^{ab}
pH	3.373^{aa}	3.339^{ab}	3.308^{ac}	3.348^{ba}	3.314^{bb}	3.303^{bc}
Ethanol (%v/v)	17.33^{aa}	17.06^{ab}	16.96^{ac}	17.21^{ba}	17.00^{bb}	16.92^{bc}
Volatile acidity (%AA)	0.025^{aa}	0.027^{aa}	0.029^{aa}	0.027^{aa}	0.029^{aa}	0.030^{aa}
Total esters (mg/L)	246.8^{aa}	261.9^{ab}	272.8^{ac}	252.8^{ba}	266.9^{bb}	280.6^{bc}
Total phenols (mg/L)	462.6^{aa}	450.2^{ab}	436.1^{ac}	466.7^{ba}	452.3^{bb}	437.4^{bc}

*n = 3, Means with different levels; different letters indicate significant differences between groups

The ethanol content as such is not influenced by the addition of sugar content in WAV but slightly decreased during storage. However, the volatile acidity showed a slight increase during ageing but it remained non-significant among the different treatments. The total esters content increased from 216.4 to 248.0 mg/L, 245.3 to 267.6 mg/L and 287.7 to 314.5 mg/L in WAV with the 8%, 10% and 12% sugar addition, respectively. The total phenols were reduced in wild apricot vermouth by both the addition of sugar and ageing time (six months).

Addition of 2.5% and 5% spices extract in WAV increased TSS as well as total sugars (Table 3). However, the prolongation of maturation period decreased the TSS content from 17.35 to 16.95 °Brix and 17.59 to 17.22 °Brix, and total sugars content from 10.30 to 9.81°Brix and 10.62 to 10.09 °Brix for WAV having 2.5% and 5% spices content took place, respectively. Similarly, the titratable acidity increased up to three months of storage and then, the increase was non-significant, irrespective of the addition of the spices extract level. With the increase in spice extract levels, a significant decrease in pH was observed.

The effect of different levels of spice extracts added in the preparation of WAV summarizes that with the advancement of the storage period the total esters increased from 246.8 to 272.8 mg/L and 252.8 to 280.6 mg/L for WAV having 2.5 and 5% spice content, respectively. The effect of the addition of spices and herbs was similar to that of the effect of the addition of alcohol level and sugars in WAV preparation.

Discussion

Wild apricot base wine

Characteristics of the prepared wild apricot base wine were quite comparable to the earlier studies of sand pear vermouth base wine, plum vermouth base wine and apple vermouth base wine (Joshi et al., 1991; Attri et al., 1994; Joshi and Sandhu, 2000). The recorded TSS of the wild apricot base wine was 8.2 °Brix, whereas acidity and pH were 0.764 and 3.152, respectively. The low volatile acidity of 0.025%, shows the soundness of fermentation, and it was within the limits of the legal standards (0.040%) recommended (Amerine and Ough, 1979). Higher alcohols, total phenols and added sugar were found to be within recommended limits of a base wine suitable for conversion into vermouth. In brief, the results showed that the base wine was a sound medium alcoholic beverage, suitable for conversion into vermouth.

Effect of maturation on physico-chemical characteristics of wild apricot vermouth

The total sugars decreased with the increase of maturation time. The decrease in total sugars might be due to the Maillard's reactions, resulting in non-enzymatic browning (due to the reaction of sugar with amino acid) (Zoeckleinet al.,1995), and the same is reflected in the enhancement of colour due to browning as documented earlier (Joshi et al., 1991; Panesar et al., 2011, Zoecklein et al., 1995). The titratable acidity increased with the increase of maturation period due to the extraction of organic acids from the spices extract or production of organic acids by oxidation of ethanol during maturation, which is correlated with an increase in volatile acidity. Similar results of titratable acidity have been reported for the plum vermouth and *mahua* vermouth (Joshi et al., 1991; Yadav et al., 2012; Ruth et al., 2014). There were significant differences among the wild apricot vermouth of various treatments. As in the case of titratable acidity, pH value of the vermouth prepared from different fruits was also found to be different (Amerine et al., 1980; Joshi et al., 1991). Nevertheless, the pH remained sufficiently acidic to prevent the occurrence of spoilage. The high acidity of wild apricot vermouth is correlated with the high acid contents of wild apricot fruits. Similar results have been reported in sand pear vermouth, plum vermouth and apple vermouth (Panesar et al., 2009; Joshi et al., 1991; Attri et al., 1994; Joshi and Sandhu, 2000).

A significant but small decrease in alcohol concentration during maturation was attributed to the changes occurring during the maturation process *i.e.* the interaction between the acid and ethyl alcohol resulting in the production of ethyl acetate and consequently, the reduction of ethanol. Similarly, the oxidation of ethanol to acetic acid took place. Similar results have been reported in sand pear vermouth (Attri et al., 1994), apple vermouth (Joshi and Sandhu, 2000) and plum vermouth (Joshi et al., 1991). The difference in alcohol content with different sugar level could be explained by the dilution of ethanol by the addition of sugar syrup to raise sugar level. The alcohol content of grape vermouth ranged from 14 to 22% (Amerine et al., 1980), whereas the addition of spices extract led to a slight decrease of the alcohol content of wild apricot vermouth. This could be attributed to the dilution by the addition of the spices extract. Volatile acidity increased with the increase of ethanol concentration. The volatile acidity of the prepared vermouths was lower than the value recommended by Amerine and Ough (1979), stating that in sound and aged wines, the volatile acidity should not exceed 0.07%. Onkarayya (1985) reported volatile acidity in a range between 0.071% and 0.091% for mango vermouth, which is quite higher than what was found in our products.

The significant increase in higher total esters content in vermouth compared to base wine may be attributed partially to the addition of spices/ herbal extract and to the process of maturation during which ethyl alcohol and acetic acid combine to form ethyl acetate, a highly desirable attribute of good wine. Amerine (1980) summarised total esters in various wines ranging between 200 and 400 mg/L. The characteristics of wild apricot vermouth were comparable to those found in the literature (Joshi et al., 2012; Pilone, 1954; Panesar et al., 2011; Yadav al., 2012; Onkarayya, 1985; Feher and Lugasi, 2004; Chauhan et al., 2016).

The decrease in total phenols observed during maturation has been reported, which can be attributed to the precipitation. In his earlier work, a similar reduction in total phenolic content was also reported (Joshi et al., 2012; Amerine et al., 1980; Joshi and

Sandhu, 2000). Spices mainly contribute to total phenols content; therefore, the increase in phenol concentration was found in vermouth with 5% spice levels. The decrease in total phenols was observed, with an increase in alcohol content. Phenols are important in endowing the wine with desirable astringency (mouth puckering property). Polyphenols are considered important as these play a significant role in the protection against oxidative stress (Feher and Lugasi, 2004), though excessive phenols could also result in excessive astringency of winemaking unpalatable (Joshi, 1977).

Conclusions

Wild apricot vermouth (WAV) of different sugar, alcohol and spice levels was prepared from base wine, and the effect of maturation on WAV physico-chemical properties was investigated. Wild apricot base wine contained residual sugars, desirable acidity, the proper amount of TSS, low volatile acidity and an adequate amount of tannins and total esters. It was found sound and medium alcoholic, thus suitable for conversion into vermouth. The results of WAVs analysis after 0, 3 and 6 months of maturation showed a decrease in TSS, total sugar and ethanol content, whereas reducing sugar and titratable acidity increased. Total esters, the important constituent in vermouth, increased, while total phenols decreased in all analysed WAVs. The overall results indicate that maturation of WAV favoured the desirable physico-chemical and sensory properties.

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