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Research Paper

Effect of Different Sugar Sources, Pectin Esterase and Acidulant Concentrations on Pumpkin Wine Production

Aman Deep Thakur, Anuj Saklani, Somesh Sharma* and V.K.Joshi[1]

**Department of Biotechnology, School of Bioengineering and Food Technology, Shoolini University, Solan, Himachal Pradesh 173214*

[1]Department of Food Science and Technology, Dr. Y.S.Parmar University of Horticulture and Forestry, Nauni Solan, Himachal Pradesh, India.

Corresponding author : V.K. Joshi; vkjoshipht@rediffmail.com

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Abstract

Pumpkin (*Cucurbita moschata*) is one of the important tropical vegetable grown all over the world and is used for cullinary purpose to make food products. Preparation of alcoholic beverages including pumpkin wine is another outlet for its economic utilization. The present study was conducted with the objective to prepare and evaluate the wine from pumpkin. The wines were prepared after diluting pumpkin pulp in 1:2 ratio with different concentrations of additives and sugar sources using DAHP @ 0.1 per cent and SO_2 @ 50 ppm. Among the different sugar sources, pectin and acidulant concentrations, the wine made with honey having 1 per cent pectin and 0.25 per cent acidulant and was ranked as the best. The results showed that the wine had many desirable characteristics like higher amount of alcohol, phenols, sensory scores and better other characteristics like acidity, sugars and volatile acidity than other treatments.

Keywords: pumpkin, DAHP, acidulant, higher alcohol, phenols, wine, pectin esterase.

Pumpkin (*Cucurbita moschata*) is one of the important tropical vegetable grown all over the world. The estimated production of pumpkins in the world during 2012 was 9673 thousand metric tons (Anon, 2012). China is the major producer of pumpkin with 8,359,623 metric tonnes (Anon, 2012). During 2012, 7,567,876 metric tonnes of pumpkins were produced in India (Anon, 2012). The major pumpkin producing states in India are Orissa (85%), Assam (7%), West Bengal (3%) and Karnataka (1.5%). Among the cucurbitaceous vegetables, pumpkin (*Cucurbita moschata*) has always been very popular for its high yield, good storage life, and longer consumption time, high nutritive value and fitness during transport. *Cucurbita moschata* has numerous traditional medicinal uses. In South and Central America, the coated pumpkin seeds are used to eating which prevent from worms and other intestinal parasites (Hopkins *et al.,* 1996). Pumpkins especially winter squashes are low in calories, high in fibre and vitamin A, B, C and E, and usually eaten as a vegetable, soup or pies. Seeds are high in protein, oil and minerals and are eaten raw or pressed to make oil (Maynard *et al.,* 1997). Wine preparation using pumpkin can also be one of the alternatives to utilize this vegetable. There is scanty of information on preparation I .... from pumpkin with repeat to dilution, addition of acid or pectin esterase. However, it is low in acid content and therefore, needs amelioration with acidulant. Further, the higher pulp content in the fruit also needs addition of enzyme like pectin esterase to extract. In the present study, the effect of acidulant, different sugar concentations and pectin addition was studied and the results have been reported in this communication.

Materials and Methods

The pumpkins were procured from different places of District Solan (Himachal Pradesh). The culture of *Saccharomyces cerevisiae* var. *ellipsoideus* strain UCD 595 used in the study was obtained from the Department

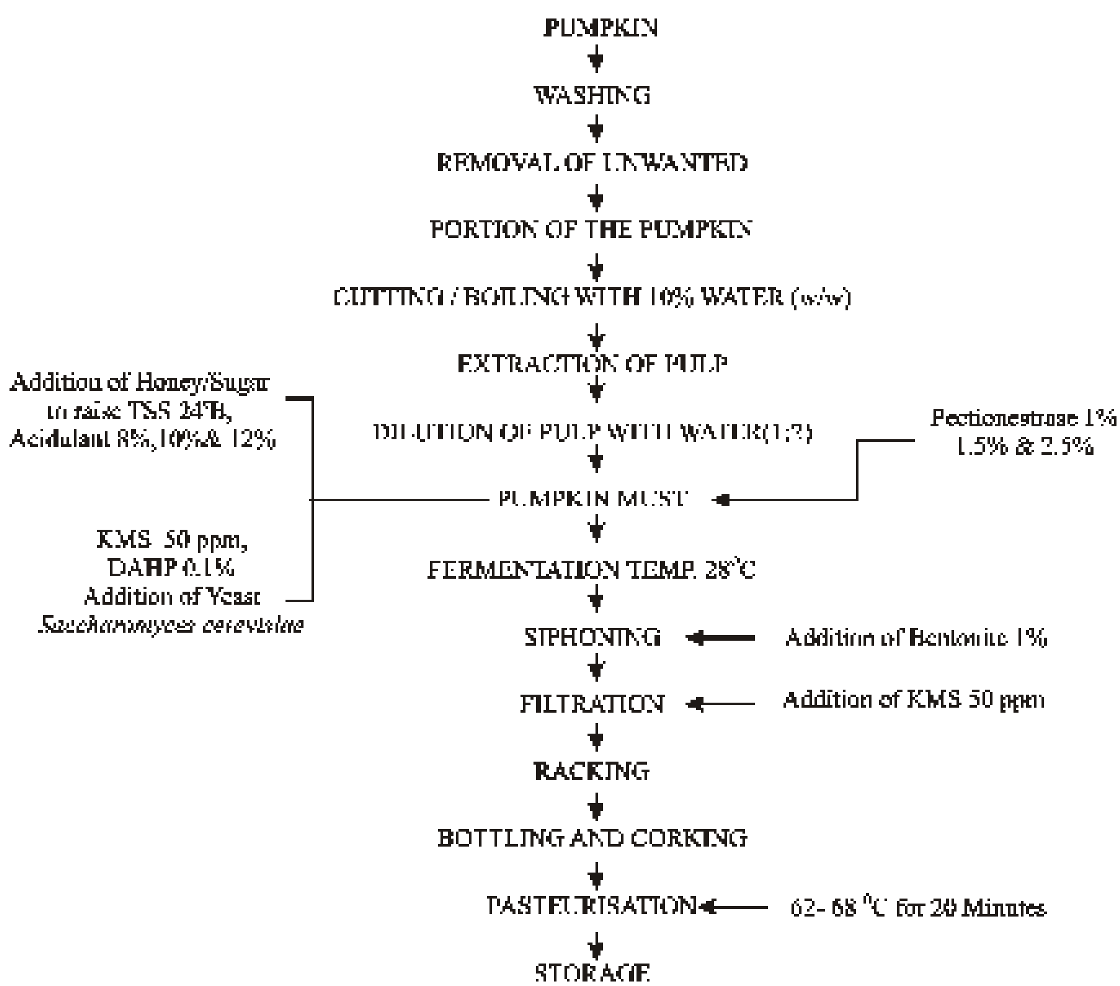

Fig. 1. Flow sheet of preparation of pumpkin wine

of Food Science and Technology, UHF Nauni, Solan (H.P.). Sucrose, honey and wild pomegranate used to ameliorate the must for wine preparation were procured from the local market, Solan. The pectinestrase enzyme used was manufactured by M/S Triton Chemical, Mysore, India, under the brand name of 'Pectinol'.

Preparation pumpkin wine making

Pulp was made by boiling the pumpkin with 10% water and passing through pulper and diluted with water in the ratio of 1:2 by weight. After the dilution sugar and honey were added individually to raise the TSS to 24^0B. After setting the TSS to 24^0B, acidity was set in three different treatments C_1 (0.25%), C_2 (0.50%) and C_3 (0.75%) by using pomegranate extract. Pectinestrase was also added in different concentrations P_1 (0.50%), P_2 (1.0%) and P_3 (2.5%) and di-ammonium hydrogen phosphate (0.1%) and 100 mg potassium metabisulphite (KMS) were also added and kept constant in all the treatments Two days prior to the preparation of must yeast starter culture was prepared and activated for fermentation. It was inoculated into must at the rate of 5 per cent and fermentation was allowed to continue, till bubbling ceases. During fermentation, the temperature was maintained at 25±C. At the end of fermentation, normally taking about a week, an air lock was put in the mouth of bottle to prevent the acidification process. The entire process is shown diagrammatically in Fig. 1. During the process of fermentation, fall in TSS and ethanol concentration were monitored at appropriate intervals of time. After the completion of fermentation process, siphoning was carried out to separate the wine from the sediment. The wine was filled in a suitable container and again racked. It was then, clarified by using 1 per cent bentonite in each treatment. The clarified wine filled in the bottles, keeping some space followed by capping. These were pasteurized in hot water at a temperature of 62^0-68^0 C for 15-20 minutes. The flow sheet of entire process is shown in Figure 1. Fresh pumpkin pulp was analysed for various characteristics.

Chemical characteristics

Total soluble solids (TSS) were measured with Erma hand refractometer (0-32^0B). Titratable acidity was estimated by treating a known aliquot of the sample against N/10 NaOH solution using phenolphthalein as an indicator. The decrease in TSS (^{0}B) during fermentation was recorded after every 24hrs.in all the wines. The pH was taken with Deluxe pH meter and prior to pH measurements, the instrument was calibrated with buffer solutions of pH 4 and 7. The total and reducing sugar were estimated by Lane and Eynon's volumetric method (A.O.A.C, 1980). Ethyl alcohol in the finished wines was determined by a colorimetric method (Caputi *el al*., 1986).The volatile acidity was determined by the standard method (Amerine *et al.,* 1980). The total phenols or tannin contents in different wine were determined by the Folin-Ciocalteu procedure given by Singleton and Rossi (1965). Total esters were determined in wine as per the method of Liberaty (1961). Higher alcohol in wine was estimated by the method given by Guyymon and Nakagiri (1952).

Sensory analysis

The sensory analysis of different wines conducted by semi-trained judges as per the method of Amerine *et al* (1980) on a composite scoring performa and coded sample were given to the judges. They were asked to rinse their mouth before or in between tasting the given sample. (Joshi, 2006) Each sample was evaluated for various quality attributes viz. colour and appearance, aroma, volatile acidity, total acidity, sweetness, body, flavour, bitterness, astringency and overall impression (Amerine *et al*., 1980) on a prescribed performa. For sensory evaluation, the wines were served chilled.

Statistical analysis of data

The data of quantitative estimation of various physico-chemical characteristics of different wines were analysed by Completed Randomized Design (CRD), while the data of sensory evaluation were analysed by the Randomized Block Design (RBD), as described by O'Mahony (1985).

Results and Discussion

Physico-Chemical Characteristics of Fresh Pumpkins

Table 1. Physico-chemical characteristics of fresh pumpkins

Characteristics	Range
Weight (kg)	4.6-8
Pulp (%)	68-79
TSS (oB)	3.3-4.1
T.A. (%CA)	0.11-0.13
pH	3.9-4.2
Total sugar(%)	0.55-0.62
Reducing sugar (%)	0.41-0.47
Colour	Light yellow-dark orange
T.A.	Titrableacidily

Physico-Chemical Characteristics of Pumpkin

It is clearly evident (Table 1) that the weight of pumpkin ranged from 4.6 to 8.0 kg, colour of fruit was light yellow to dark yellow and light orange to dark orange and the pulp yield ranged from 65 to 79 per cent. The colour is one of the important factors in maturity indices and the colour of pumpkins was dark yellow to dark orange showing that the pumpkins have been harvested at proper stage of maturity.

The results on chemical characteristics of pumpkin shows that the Total soluble solids (TSS) and titratable acidity range from 3.3 to 4.1^{0}B and 0.11 to 0.13 per cent (as citric acid) in the raw pumpkin. The titratable acidity is an important characteristic of fruit or vegetable due to its effect on taste (Wills *et al.,* 1981).Since, the pumpkin has very low acid content so needs addition of some acidulant for improving the taste of final product developed and fermentation by yeast (Amerine *et.al.*, 1980) Perusal of the data further revealed that the pH (3.9 to 4.3), total sugar (0.55 to 0.62 per cent) and reducing sugar content of the pumpkin ranged between (0.41 to 0.47 per cent). On the basis of weight, diameter, colour and pulp content it can be stated that the pumpkins have been procured at proper stage of maturity and have desirable characteristics for conversion into wine. Further, on the basis of chemical characteristics it can be concluded that pulp of pumpkin need amelioration with sugar and acid for preparation of table wine.

Fermentation behavior of must

The comparison of fermentation behavior (Figure 1) among the different treatments clearly revealed that at the initial stage (24 hour), the musts of all the treatments have witnessed fast reduction in TSS. But in case of S_1 sucrose source, C_1 acidulant 0.25 percent and pectin esterase P_3 2.5% ($S_1C_1P_3$) treatment there was fast reduction up to 48 hours. The pumpkin must ameliorated with S_1 sucrose source,

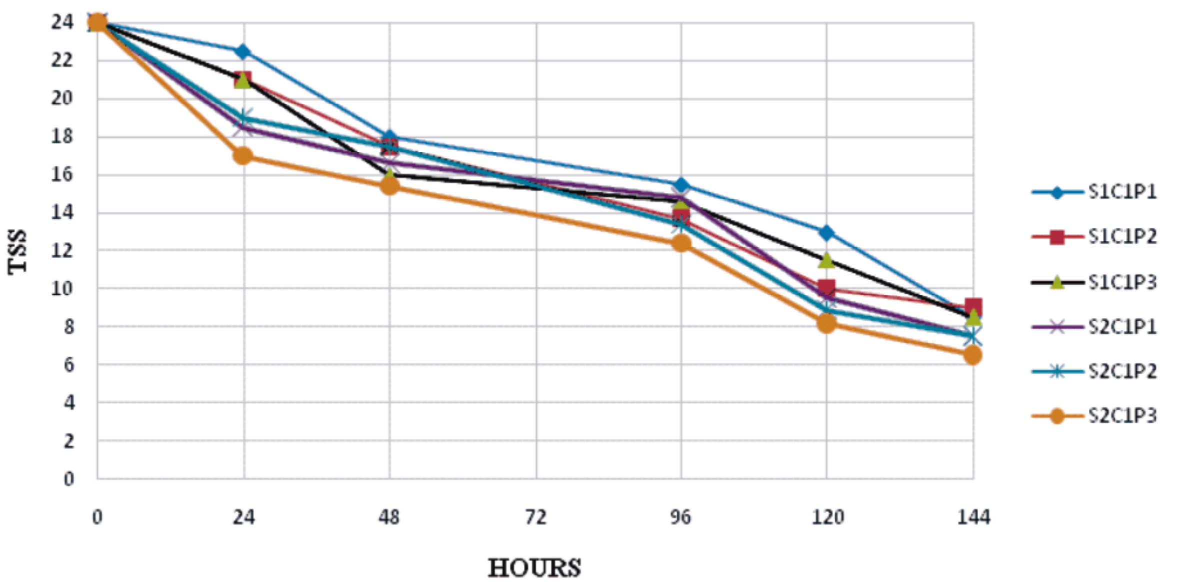

Fig. 2. Changes in pumpkin must during fermentation

C_1 acidulant 0.25 percent and pectin esterase P_3 2.5 % ($S_1C_1P_3$) recorded the highest reduction till 48 hours. However, the pumpkin must ameliorated with S_2 honey source, C_1 acidulant 0.25 percent and pectin esterase P_3 2.5 % ($S_2C_1P_3$) recorded the highest reduction till 24 hours. After that there was steady decrease in TSS and the pattern remained the same in all the treatments.

The initial stage (24 hour), The musts of all the treatments have witnessed fast reduction in TSS (Figure 3). But in case of S_1 sucrose source, C_2 acidulant 0.50 percent and pectin esterase P_3 2.5 % ($S_1C_2P_3$) and S_2 honey source, C_2 acidulant 0.50 percent and pectin esterase P_3 2.5 % ($S_2C_2P_3$) treatments there was fast reduction in total soluble solid content up to 48 hours as observed earlier also. The pumpkin must ameliorated with S_1 sucrose source, C_2 acidulant 0.50 percent and pectin esterase P_3 2.5 % ($S_1C_2P_3$) and S_2 honey source, C_2 acidulant 0.50 percent and pectin esterase P_3 2.5 % ($S_2C_2P_3$) recorded the highest reduction till 48 hours. After 96 hours, the trend changed clearly with the bending of curve followed by stabilization at 144 hours in wines prepared with sucrose and honey. Similar trend has been shown in Figure 4.

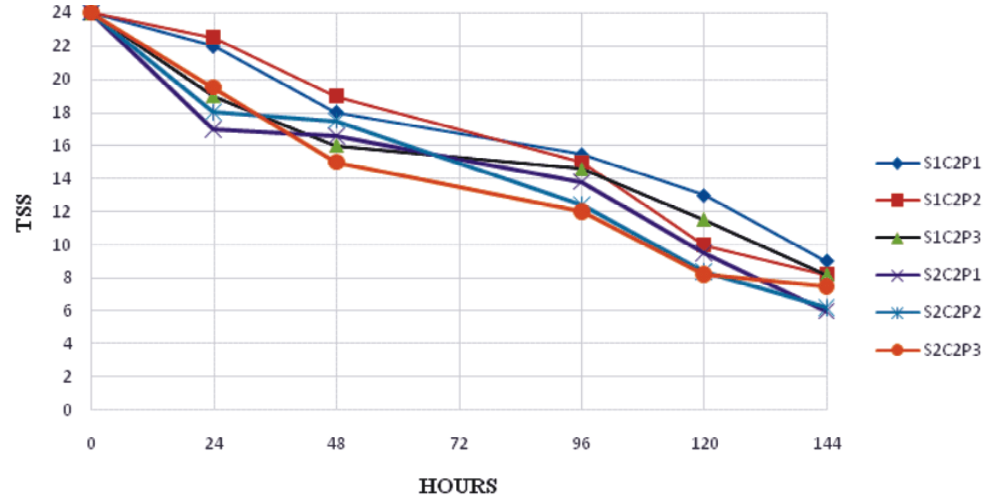

Fig. 3. Comparison of fermentation behaviour of pumpkin based wines prepared with different sugar sources, Pectin estrase and 0.50 percent acidulant

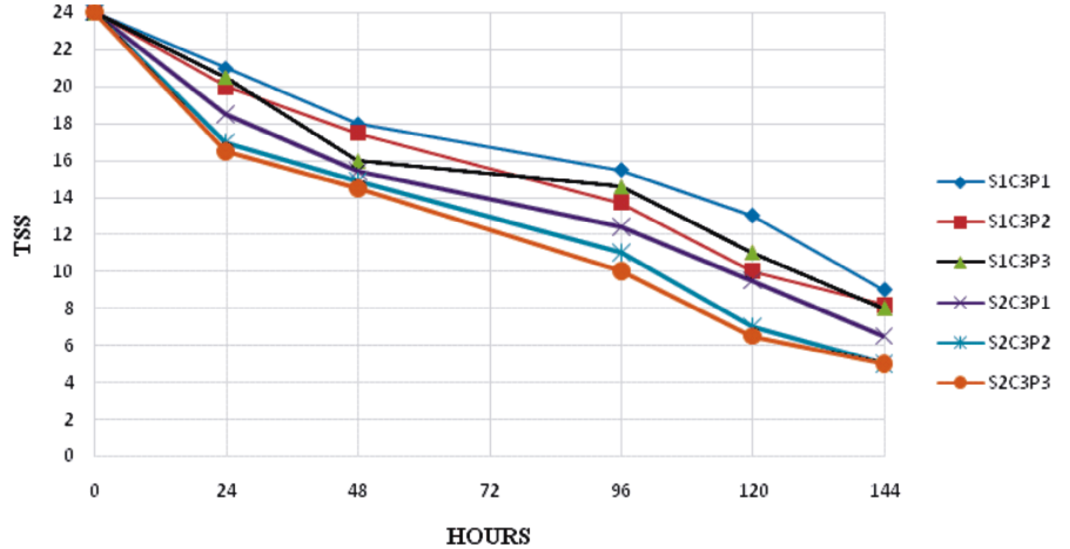

Fig. 4. Comparison of fermentation behaviour of pumpkin based wines prepared with different sugar sources, Pectin estrase and 0.75 percentacidulant

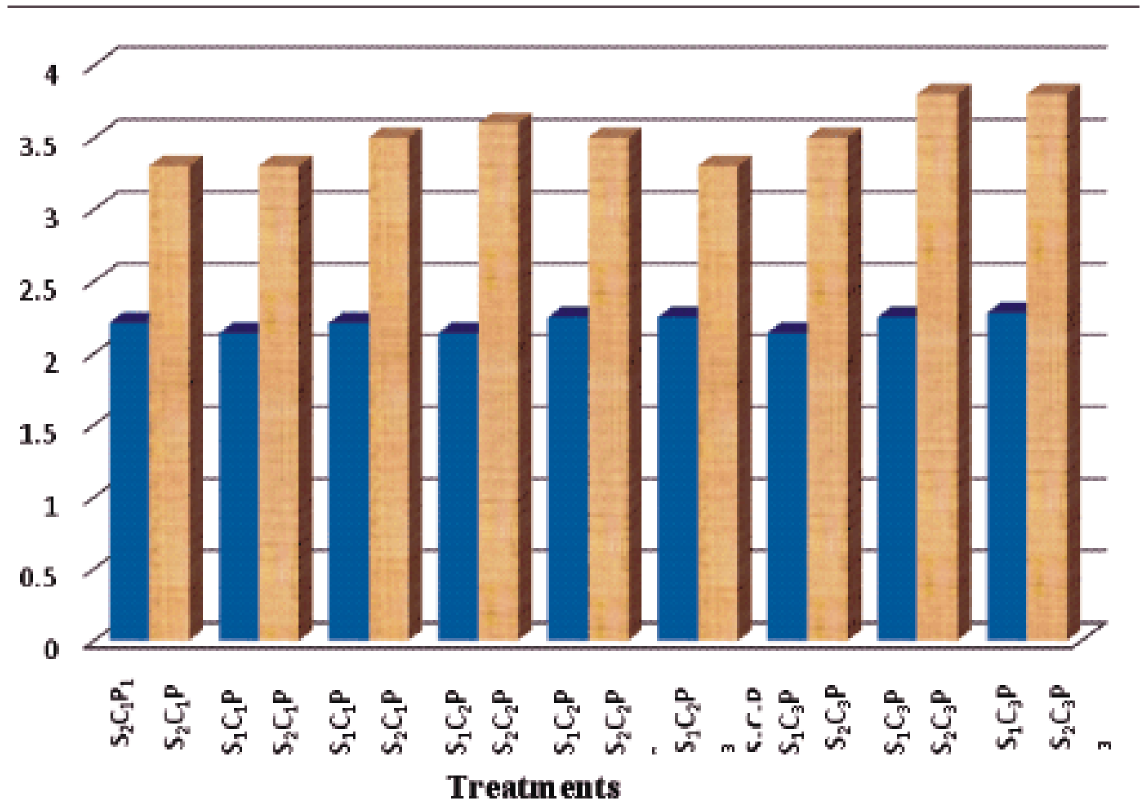

Fig. 5. Comparison of rate of fermentation of various treatments.

Fermentability of must of different treatments

The highest rate of fermentation 2.28 OB/24 hr was obtained in wines prepared with S_1 sucrose source, C_3 acidulant 0.75 percent and pectin esterase P_3 2.5% ($S_1C_3P_3$), and lowest 2.14 was recorded in treatment $S_1C_2P_2$ prepared S_1 sucrose source, C_2 acidulant 0.50 percent and pectin esterase P_3 1.5%. (Figure 5) However, in case of wines ameliorated with honey as sugar source the highest rate of fermentation was recorded 3.8 in treatments S_2 honey source, C_3 acidulant 0.75 percent and pectin esterase P_3 1.5 % ($S_2C_3P_2$) and S_2 honey source, C_3 acidulant 0.75 percent and pectin esterase P_3 2.5 % ($S_2C_3P_3$). and lowest rate of fermentation (3.3) in treatments $S_2C_1P_1$, $S_2C_1P_2$ and $S_1C_2P_3$ prepared with 0.25, 0.50, 0.75 per cent acidulant and 1,1.5, 2.5 per cent pectin esterase respectively.

Table: 2 Effect of sugar source, acidulant and pectin esterase concentration on the total sugars (%) content of pumpkin wines

Acidulant (%)	Sugar Sources								Grand Mean (Acidulant)
	Sucrose (S_1)			Mean	Honey(S_2)			Mean	
	Pectin esterase				Pectin esterase				
	P_1	P_2	P_3		P_1	P_2	P_3		
C_1 0.25	0.37	0.32	0.31	0.33	1.81	1.89	1.22	1.64	0.98
C_2 0.5	0.27	0.31	0.26	0.28	1.56	2.05	1.12	1.57	0.92
C_3 0.75	0.24	0.25	0.25	0.25	0.96	0.86	1.14	0.98	0.61
Mean	0.29	0.29	0.27		1.44	1.60	1.16		
Grand Mean (P) (Pectin esterase)	0.86	0.94	0.71						

Contd.

Grand Mean (S) (Sugar Sources)	0.28	1.16							

CD (P≥0.05)

Sugar Sources (S)	0.037	S×P	0.022
Acidulant (C)	0.046	C×P	0.027
Pectin esterase (P)	0.046	S×C×P	0.039
S×C	0.022		

The perusal of data clearly revealed (Table 2) that there were significant differences among the wines prepared using different sugar sources. Among the various treatments the TSS content range from 5.1 to 9.0^{0}B. The lowest (5.1^{0}B) was recorded in wine prepared with honey ($S_2C_3P_2$), having 0.75 per cent acidulant and 1.5 per cent pectin esterase.

Total Sugar

The perusal of data (Table 3) clearly revealed that there were significant differences among the wines prepared using different sugar sources. Among the various treatments the total sugar content range from 0.24 to 2.05 percent. The highest total sugar content were observed in wines madeusing honey having 0.50 per cent acidulant and 1.5 percent pectin esterase ($S_2C_2P_2$). However, the lowest total sugar content was obtained in ($S_1C_3P_1$) having 0.50 acidulant and 1.0 per cent pectin esterase.

Reducing Sugar

The perusal of (Table. 3) clearly revealed that there were significant differences among the wines made using different sugar sources. Among the various treatments the reducing sugar content range from 0.10 to 4.91 per cent. The highest reducing sugar contents were observed in wines ($S_1C_3P_2$) prepared using sucrose having 0.75 per cent acidulant and 1.5 per cent pectin esterase. However the lowest reducing sugar content was recorded in wines with honey ($S_2C_3P_1$) having 0.75 acidulant and 1 % pectin esterase.

Table: 3 Effect of sugar source, acidulant andpectin esterase on the Reducing Sugar (%) content of pumpkin wines.

Acidulant (%)	Sugar Sources								Grand Mean (Acidulant)
	Sucrose (S_1)			Mean	Honey (S_2)			Mean	
	Pectin esterase				Pectin esterase				
	P_1	P_2	P_3		P_1	P_2	P_3		
C_1 0.25	0.75	1.06	1.45	1.09	0.18	0.26	0.13	0.18	0.64
C_2 0.5	3.50	2.20	1.30	2.34	0.20	0.16	0.14	0.17	1.26
C_3 0.75	3.35	4.91	4.25	4.25	0.10	0.22	0.16	0.16	2.21
Mean	2.54	2.70	2.34		0.16	0.16	0.14	0.17	
Grand Mean (P) (Pectin esterase)	1.35	1.43	1.24						
Grand Mean (S) (Sugar Sources)	2.50	0.17							

CD (P≥0.05)

Sugar Sources (S)	0.026	S×P	0.013
Acidulant (C)	0.027	C×P	0.016
Pectin esterase (P)	0.027	S×C×P	0.023
S×C	0.013		

Table 5. Effect of sugar source, acidulant and pectin esterase concentration on the titratable acidity (%) content of pumpkin wines.

Acidulant (%)	Sugar Sources								Grand Mean (Acidulant)
	Sucrose (S1)			Mean	Honey(S2)			Mean	
	Pectin esterase				Pectin esterase				
	P_1	P_2	P_3		P_1	P_2	P_3		
C_1 0.25	0.30	0.29	0.31	0.30	0.36	0.39	0.44	0.39	0.34
C_2 0.5	0.57	0.61	0.61	0.60	0.48	0.48	0.48	0.48	0.54
C_3 0.75	0.79	0.81	0.81	0.80	0.76	0.76	0.77	0.76	0.78
Mean	0.55	0.57	0.58		0.53	0.54	0.56	0.54	
Grand Mean (P) (Pectin esterase)	0.54	0.55	0.57						
Grand Mean (S) (Sugar Sources)	0.56	0.54							

CD (P≥0.05)

Sugar Sources (S)	0.012	S×P	0.007
Acidulant (C)	0.015	C×P	0.009
Pectin esterase (P)	0.052	S×C×P	0.013
S×C	0.007		

Table 6. Effect of sugar source, acidulantandpectin esterase concentration on the pH content of pumpkin wines.

Acidulant (%)	Sugar Sources								Grand Mean (Acidulant)
	Sucrose (S_1)			Mean	Honey(S_2)			Mean	
	Pectin esterase				Pectin esterase				
	P_1	P_2	P_3		P_1	P_2	P_3		
C_1 0.25	3.38	3.40	3.48	3.42	3.24	2.53	2.36	2.44	2.93
C_2 0.5	3.38	3.43	3.45	3.42	2.32	2.35	2.47	2.47	2.94
C_3 0.75	3.48	3.45	3.55	3.49	1.84	1.86	1.83	1.84	2.66
Mean	3.42	3.42	3.42		2.20	2.24	2.24	2.25	
Grand Mean (P) (Pectin esterase)	2.84	2.83	2.83						
Grand Mean (S) (Sugar Sources)	3.42	2.55							

CD (P≥0.05)

Sugar Sources (S)	0.036	S×P	0.022
Acidulant (C)	0.045	C×P	0.027
Pectin esterase (P)	0.045	S×C×P	0.038
S×C	0.022		

Table 7. Effect of sugar source, acidulant and pectin esterase concentration on the alcohol (%) content of pumpkin wines.

Acidulant	Sugar Sources								Grand Mean (Acidulant)
	Sucrose (S_1)			Mean	Honey(S_2)			Mean	
	Pectin esterase				Pectin esterase				
	P_1	P_2	P_3		P_1	P_2	P_3		
C_1 0.25	12.20	10.63	11.25	11.36	11.37	12.16	10.14	11.19	11.27
C_2 0.5	11.45	11.24	11.45	11.38	10.44	10.66	11.19	10.76	11.07
C_3 0.75	12.17	11.14	10.68	11.33	08.68	09.12	08.76	08.85	10.09
Mean	11.94	11.00	11.12		10.16	10.65	10.03	10.26	
Grand Mean (P) (Pectin esterase)	11.05	10.82	10.57						
Grand Mean (S) (Sugar Sources)	11.35	10.26							

CD (P≥0.05)

Sugar Sources (S)	0.168	S×P	0.101
Acidulant (C)	0.260	C×P	0.124
Pectin esterase (P)	0.200	S×C×P	0.176
S×C	0.101		

Table 8. Effect of sugar source, acidulant andpectin esteraseconcentration on the volatile acidity (%) content of pumpkin wines

Acidulant (%)	Sugar Sources								Grand Mean (Acidulant)
	Sucrose (S_1)			Mean	Honey(S_2)			Mean	
	Pectin esterase				Pectin esterase				
	P_1	P_2	P_3		P_1	P_2	P_3		
C_1 0.25	0.05	0.03	0.04	0.04	0.03	0.03	0.04	0.03	0.03
C_2 0.5	0.05	0.02	0.04	0.04	0.02	0.04	0.01	0.02	0.03
C_3 0.75	0.08	0.03	0.06	0.05	0.04	0.04	0.03	0.04	0.04
Mean	0.06	0.03	0.05		0.03	0.04	0.02		
Grand Mean (P) (Pectin esterase)	0.05	0.03	0.03						
Grand Mean (S) (Sugar Sources)	0.05	0.03							

CD (P≥0.05)

Sugar Sources (S)	0.007	S×P	0.004
Acidulant (C)	0.009	C×P	0.005
Pectin esterase (P)	0.009	S×C×P	0.007
S×C	0.004		

Pectin esterax (P_1) 0.50% (P_2) = 1.01% (P_3) 2.0

Table 9. Effect of sugar source, acidulant and pectin esterase concentration on the total phenols (mg/l) content of pumpkin wines

Acidulant (%)	Sugar Sources								Grand Mean
	Sucrose (S1)			Mean	Honey(S2)			Mean	
	Pectin esterase				Pectin esterase				
	P_1	P_2	P_3		P_1	P_2	P_3		
C_1 0.25	619.4	370.7	457.0	482.3	899.1	651.3	752.8	767.7	625
C_2 0.5	623.6	618.7	552.7	598.2	628.1	604.5	612.4	615	606.6
C_3 0.75	533.8	519.1	609.1	554.5	754.7	590.3	691.1	678.7	616.6
Mean	592.8	526.2	526.7		760.6	651.6	685.4		
Grand Mean (P) (Pectin esterase)	676.7	588.8	606						
Grand Mean (S) (Sugar Sources)	534.6	685.8							

CD ($P \geq 0.05$)

Sugar Sources (S)	14.86	S×P	08.97
Acidulant (C)	18.20	C×P	10.99
Pectin esterase (P)	18.20	S×C×P	15.55
S×C	08.97		

pH

Perusal of (Table 6) the revealed that the pH of different wines was significantly different from each other. Among the various treatments, the pH ranged from 1.83 to 3.55 per cent. The highest pH was observed in wines $S_1C_3P_3$ prepared using sucrose as sugar source having 0.75 per cent acidulant and 2.5 per cent pectin esterase concentration. However, the lowest pH was obtained in wines fermented with honey ($S_2C_3P_3$) having 0.75 per cent acidulant and 2.5% pectin esterase.

Alcohol

It is clearly evident from the results (Table 7) that alcohol content in different wines was significantly different from each other. Among the various treatments the alcohol content ranges from 8.68 to 12.20 per cent. The highest alcohol content was observed in wines$S_1C_1P_1$ prepared using sucrose as sugar source having 0.25 per cent acidulant and 1 per cent pectin esterase. However, the lowest alcohol content was obtained in wines prepared with honey as sugar source ($S_2C_3P_1$), having 0.75 per cent acidulant and 1 per cent pectin esterase.

Volatile acidity

A perusal of the data (Table 9) further revealed that volatile acidity of different wines was significantly different from each other. Among the various treatments the volatile acidity ranges from 0.015 to 0.08 per cent. The highest volatile acidity was observed in wines $S_1C_3P_1$ prepared using sucrose having 0.75 per cent acidulant and 1 per cent pectin esterase. However, the lowest volatile acidity content was observed in wines ($S_2C_2P_3$) prepared with honey as sugar source, having 0.50% acidulant and 2.5% pectin esterase.

Total Phenols

Perusal of the results (Table 9) clearly revealed that total phenol content in different wines were significantly different from each other. Among the various treatments, the phenol content ranges from 370.7 to 899.1 mg/l. The highest phenol content (899.1mg/l) were observed in wines ($S_2C_1P_1$) prepared using honey as a sugar source, having 1 per cent pectin esterase and 0.25 per cent acidulant. However, the lowest phenol content (370.7 mg/l) was recorded in wines prepared with sucrose as sugar source ($S_1C_1P_2$) having 1.5% pectin esterase and 0.25 per cent acidulant concentration.

Table 10. Effect of different sugar sources on the sensory scores of pumpkin wines

Treatment	Appearance	Colour and depth	Aroma and bouquet	Volatile acidity	Total acidity	Sweetness	Body	Flavour	Bitterness	Astringency	Overall impression
Max. score	2	2	4	2	2	1	1	2	1	1	2
$S_1C_1P_1$	2	2	2.5	1.5	2	0.5	1	1	1	1	1.5
$S_1C_1P_2$	1.5	2	2.5	2	1.5	0.5	1	2	1	1	1.5
$S_1C_1P_3$	1.5	1.5	2	2	1.5	1	1	2	0.5	0.5	1.5
$S_1C_2P_1$	2	2	1.5	2	1	0.5	1	1.5	0.5	0.5	1.5
$S_1C_2P_2$	2	2	2.5	1.5	2	0.5	1	1	1	1	1.5
$S_1C_3P_3$	1.5	2	2.5	2	1.5	0.5	1	2	1	1	1.5
$S_1C_3P_1$	1.5	1.5	2	2	1.5	1	1	2	0.5	0.5	1.5
$S_1C_3P_2$	2	2	1.5	2	1	0.5	1	1.5	0.5	0.5	1.5
$S_1C_3P_3$	2	2	2.5	2	1.5	1	1	2	1	1	2
$S_2C_1P_1$	1.5	2	2.5	2	2	1	1	1.5	1	1	1.5
$S_2C_1P_2$	1.5	1.5	2.5	2	2	1	1	2	1	1	1.5
$S_2C_1P_3$	2	2	2.5	1.5	2	0.5	0.5	1.5	0.5	0.5	0.5
$S_2C_2P_1$	2	1	4	2	2	1	1	2	1	1	2
$S_2C_2P_2$	2	2	2.5	2	2	1	1	2	1	1	1.5
$S_1C_2P_3$	2	2	2.5	1.5	2	0.5	1	1	1	1	1.5
$S_1C_3P_1$	1.5	2	2.5	2	1.5	0.5	1	2	1	1	1.5
S1C3P2	1.5	1.5	2	2	1.5	1	1	2	0.5	0.5	1.5
S1C3P3	2	2	1.5	2	1	0.5	1	1.5	0.5	0.5	1.5
CD ($P \leq 0.05$)	0.22	0.18	0.38	0.29	0.37	0.12	0.13	0.24	0.36	0.15	0.23

Scale – According to Amerine *et al.* (1980)

Rating – Superior: 17-20, Standard: 13-16, Below standard: 9-12, Unacceptable: 1

Amongst the sugar sources, pectin esterase and acidulant concentrations the wines prepared with honey having 1 per cent pectin estrase and 0.25 per cent acidulant concentration had many desirable characteristics like higher amount of alcohol, phenols, sensory scores (Table 10) and other quality characteristics like acidity, pH, sugars and volatile acidity than other treatments. Therefore, for the preparation of pumpkin based herbal wines ameliorationwith honey as a sugar source, 1 per cent pectin esterase as clarifying enzyme and 0.25 per cent acidulant for proper sugar acid blend were selected.

Conclusion

Investigations were carried out to determine the suitability of pumpkin for wine preparation, Wines prepared with honey having 1 per cent pectin esterase and 0.25 per cent acidulant had most of the desirable characteristics like higher amount of alcohol, total phenols, sensory scores and other comparable characteristics like acidity, sugars and volatile acidity than other treatments.

References

A.O.A.C. (1980). Association of Official Analytical Chemists. *Official Methods of Analysis.* Hortwitz, W., 13th edn. Washington, D.C. p. 1015.

Amerine, M.A, Kunkee, Ough, C.S., Singleton, V.L. and Webb, A.D. (1980). Technology of wine making. AVI Publ. Co. Inc. Westport, Ct, p. 794.

Caputi, A.Jr. Ueda, M. and Brown, J. (1986). Spectrophotometric determination of ethanol in wine. *Am. J. Enol. Vitic.,* **19**: 160-165.

Hopkins, D.L. and Thomas, C.E. eds.(1996). Uses of *Cucurbita moschata American Journal S*, APS Press, 3340 Pilot Knob Road, St. Paul, MN. 328-332.

Joshi, V.K. (2006). Sensory Science: Application in Food Evaluation. Agro-tech Publ. Academy, Jaipur p. 536

Liberaty, V. (1961). *Ester determination and their applications to wine.* M.Sc. Thesis, Univ. of California, Davis.

Maynard, D.N., and Hochmuth, G.J. (1997). *Knotts Handbook for Vegetable Growers, 4th edn*. John Wiley and Sons, Inc. 605 Third Avenue, New York, N.Y.

Mahony, O.M. (1985). *Sensory Evaluation of Food Statistical Methods and Procedures,*Marcel Dekker, Inc. New York, p 168-169.

Maynard, D.N., and Hochmuth, G.J. (1997). *Knotts Handbook for Vegetable Growers, Fourth Edition*. John Wiley and Sons, Inc. 605 Third Avenue, New York, N.Y. ISBN # 0-471-13151-2.

Singleton, V.L. and Rossi, J.A.Jr. (1965). Colorimetry of total phenolics with phosphomolybadic phosphotungstic acid reagents. *Am. J. Enol. Vitic.,* **16**:144-158.

Wills, R.B.H., Lee, T.H., Graham, W. B., Mc Glasson and Hall, E.G. (1981). Postharvest: An introduction to the physiology and handling of fruit and vegetables. AVI, Westport, CT PP 543-581.