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Physico-chemical characteristics and sensory quality of pineapple vermouth

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ABSTRACT

Pineapple fruits are highly perishable and have a limited shelf-life. In an attempt to add value to the seasonal fruits, vermouth was developed using pineapple wine as a base material. The pineapple wine had 7.9% of total soluble solids, 1.23% of total sugars and 0.63% of acidity. The effect of alcohol (15 and 17%), sugar (8 and 10%) and spice extract levels (2.5 and 5%) on the physico-chemical characteristics and sensory quality on pineapple vermouth was evaluated. Vermouth with 17% alcohol level showed a pronounced increase in TSS, pH, alcohol and esters than corresponding vermouth with 15% alcohol level. Increasing the sugar level notably increased the TSS and sugar content. Addition of spice extract increased the level of esters, phenolic content, titratable acidity and colour units. Pineapple vermouth with 17% alcohol, 8% sugar and 2.5% spice extract had the highest sensory score (16.69) and considered the most acceptable product.

Key words: Pineapple, vermouth, spice extract, quality.

INTRODUCTION

Pineapple [*Ananas comosus* (L.) Merr] is one of the most popular and delicious tropical fruits. In terms of worldwide production, it is currently the third most important tropical fruit after bananas and mangoes (FAO, 7). This fruit owes its popularity among retailers and processors due to its exquisite sweet-sour taste, pleasant aroma and flavour thus qualifying it as one of the choicest fruits. It is commonly consumed as fresh and largely processed in forms of pineapple juice, canned rings, fruit powder, concentrate and as an ingredient in exotic foods (Rattanathanalerk, 19; Tokitomo, 21).

In India, pineapple is grown in an area of 1.05 lakh ha with a total production of 15.70 lakh tonnes (NHB, 14). It accounts for 1.9% of total fruit production in the country. However, a major constraint to pineapple marketing is the highly perishable nature of the fruit. Pineapple fruit has a short shelf-life due to high moisture content and the active metabolism increases the deterioration of the fruit soon after the harvest (Clemente and Scapim, 6). During the peak production period there is glut in the market, which leads to distress sale among the growers as ripe fruits cannot be easily transported over long distances and to niche markets. The post harvest losses are in the tune of 15-20% of the total production (Madan and Ullasa, 12) and up to 50-60% when ripe fruits are transported in bulk (Bhattacharya, 4).

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The production of pineapple vermouth can be a panacea for prevention of post-harvest losses and also a means of utilization of less appealing fruits (undersized/ irregular shaped fruits) for converting to a value-added product. Aperitif wines known as vermouth is traditionally prepared from grape wine which is fortified with 15-21% alcohol and containing spices and herbs extract imparting an aromatic flavour as well as a bitter taste to the product (Pilone, 17). There are few reports on vermouth from mango, apple, plum, sand pear, tamarind, pomegranate and wild apricot (Panesar *et al.*, 16). However, there are no reports on pineapple vermouth. The wine industry attempts to diversify the market by creating high quality new products with distinctive characteristics to meet demands of dynamic consumer preferences and market trends require wine producers to be constantly innovative in terms of sensory and quality parameters. Production of pineapple vermouth could be a good wise to obtain this aim. Therefore, this study was intended to explore the possibility of elaboration of a fermented beverage from pineapple which will serve as a way to prolong its shelf-life and add economic value.

MATERIALS AND METHODS

Fresh, healthy, ripe pineapple fruits (cv. Kew) were used for the study. After preliminary preparation, *viz.* washing, removal of crown and peeling, the fruits were cut into small pieces and juice was extracted by pressing in a domestic juice extractor. The juice was filtered through a clean sieve and TSS was raised to 24°B by adding sucrose. Di-ammonium hydrogen phosphate (0.1%) added as a nitrogen source for the yeast and juice was preserved with potassium metabisulfite (100 ppm) to prevent the growth of undesirable microorganisms and contamination. Fermentation was carried out at 30 ± 2°C by pitching pineapple juice with 10% v/v of 48 h culture of *Saccharomyces cerevisiae* var. *ellipsoideus* earlier propagated in small amount of must. As TSS became stable, wine was decanted and filled in sterilized glass bottles. This base wine was matured for three months before preparation of vermouth. A portion of this base wine was distilled to produce pineapple brandy in a laboratory glass distillation apparatus as per standard method. First one tenth of distillate called 'head' and last one tenth was discarded; only the middle portion of distillate was collected and further double-distilled to raise the strength of brandy (Amerine *et al*., 1).

Twelve spices and herbs (Table 1) were added to the pineapple base wine and brandy of 1:1 ratio mixture to prepare spice extract. This mixture was heated at 60°C for 10 min. in a sealed container for 10 days. This extract was refrigerated for 2 days for sedimentation and then filtered (Joshi *et al.*, 10). In preparation of pineapple vermouth, base wine was fortified to alcohol levels, *viz*. 15 and 17% (v/v) with pineapple brandy (42% v/v). Each had 8 and 10% sugar levels (raised with sugar syrup 70°B) and added with 2.5 and 5% (v/v) spice extract to each levels of alcohol and sugar. Vermouths were filled in 200 ml capacity sterilized glass bottles and pasteurized at 65°C for 20 min.

Vermouths of different treatments were measured for TSS using Atago pocket refractometer (0-93) and expressed as degree Brix (°B) at 20°C. Titratable acidity (% citric acid) was determined by titrating a known volume of sample against 0.1 N NaOH using phenolphthalein solution as an indicator (Ranganna, 18). The pH was measured directly using pH meter (μ pH system 361, Systronics) which was standardized. Total sugars was measured by Lane and Eynon volumetric method by titrating the sample against boiling Fehling's solution and expressed as percentage (AOAC, 2). The centrifuged and near neutral samples were used for estimation of reducing sugars and expressed in percentage (w/v) (Miller, 13). Samples were distilled (3 ml distillate from 10 ml) and used for alcohol estimation by universal spectrophotometric method (Caputi *et al.*, 5). Total phenols were expressed as mg of gallic acid equivalents (GAE)/100 ml (Singleton and Rossi, 20), total esters in mg/l (Liberaty, 11) and volatile acidity in terms of acetic acid (g/100 ml) (Amerine *et al*., 1). The Hunter Lab System (model: Miniscan XE PLUS, USA) was used for colour determination on the basis of CIE L^*, a^* and b^* colour system.

The sensory evaluation of the different treatments of vermouth was performed on a prescribed performa. The vermouths were evaluated on the basis of 11 attributes, *viz*., colour, appearance, aroma, volatile acidity, total acidity, sweetness, body, flavour, bitterness, astringency and overall impression. Each score of the attributes were added to get an overall score of 20, scores between 17-20 is considered as superior, 13-16 is standard, 9-12 is below standard and 1-8 is unacceptable or spoiled (Amerine *et al.*, 1). A panel of 10 semi-trained judges were selected to give an appropriate evaluation of each attribute. Sensory scores were then obtained for each of the attributes on total scores of 10 to draw the spider web diagram (Joshi *et al*., 10).

Table 1. Spices and herbs used in pineapple vermouth preparation.

Common name	Botanical name	Part used	Qty/l (g)
Black pepper	*Piper nigrum* L.	Fruit	0.75
Cinnamon	*Cinnamomum zeylanicum* Beryn	Bark	0.25
Clove	*Syzygium aromaticum* L.	Fruit	0.25
Coriander	*Coriandersativum* L.	Seed	0.70
Cumin	*Cuminum cyminum* L.	Seed	0.50
Fenugreek	*Trigonella foenumgraecum* L.	Seed	0.50
Ginger	*Zingiber officinale* Rosc.	Dried root	1.00
Large cardamom	*Amomum subulatum* Roxb.	Seed	0.50
Nutmeg	*Myristica fragrans* Houth.	Seed	0.25
Poppy seed	*Papaver somnifera* L.	Seed	1.00
Rosemary	*Rosmarinus officinalis*	Flowering plant	0.10
Saffron	*Crocus sativus* L.	Flower	0.01

Statistical analysis of the quantitative data of parameters obtained from the experiment was carried out using factorial completely randomized design (CRD) with three replications. Standard deviation (SD) was also calculated. Mean comparison was performed using the Tukey's Honest Significant Difference (HSD) test. A difference was considered statistically significant when *p*-value was less than 0.05 ($p<0.05$). The data was analysed using SAS 9.3 (TS1MO) software package developed by SAS Institute (2000).

RESULTS AND DISCUSSION

The pineapple base wine had a medium content of alcohol (10.45%) and TSS of 7.9°Brix (Table 2). Titratable acidity was 0.63%, pH of 3.19 and residual amount of sugars which is indicative of adequate fermentation. The wine contained low amount of volatile acidity (0.018%) an indication of sound wine and was within the limits (0.040%) of legal standards (Amerine *et al*., 1). This reflects that microbial spoilage was absent in the base wine and thus suitable for development of vermouth. Colour values of *L**, *a** and *b** were 61.68, 2.51 and 35.53 respectively.

With an increase in the alcohol levels, there was a slight decrease on the TSS of vermouth (15.90 and 16.03°Brix) (Table 3). However, there was an increase in the pH from 3.25 to 3.31 as the pH of brandy is neutral; consequently the titratable acidity in vermouth with (15% alcohol level) was higher (0.74%) as compared to 17% alcohol level vermouth (0.69%).

Table 2. Physico-chemical characteristics of pineapple wine.

Characteristics	Mean ± SD*
TSS (°Brix)	7.9 ± 0.08
pH	3.19 ± 0.01
Titrable acidity (%)	0.63 ± 0.02
Reducing sugars (%)	0.44 ± 0.08
Total sugars (%)	1.23 ± 0.07
Alcohol (% v/v)	10.45 ± 0.08
Volatile acidity (%)	0.018 ± 0.004
Total esters (mg/l)	73.63 ± 0.20
Total phenols (mg/l)	133.33 ± 0.46
Colour	
*L**	61.68 ± 0.03
*a**	2.51 ± 0.01
*b**	35.53 ± 0.04

*SD = Standard deviation; n = 3.

Table 3. Effect of alcohol level on the physico-chemical characteristics of pineapple vermouth.

Characteristics	Alcohol level (%)*	
	15	17
TSS (°Brix)	15.90^b	16.03^a
pH	3.25^b	3.31^a
Titrable acidity (%)	0.74^a	0.69^b
Reducing sugars (%)	3.78^a	3.70^b
Total sugars (%)	9.38^a	9.16^b
Alcohol (% v/v)	15.02^b	17.05^a
Volatile acidity (%)	0.022^b	0.023^a
Total esters (mg/l)	134.74^b	136.98^a
Total phenols (mg/l)	237.89^a	236.27^b
Colour		
*L**	61.61^b	61.97^a
*a**	2.50^a	2.50^a
*b**	35.74^a	35.68^b

*Means are irrespective of sugar and spice level; Means followed by the different letter(s) within a row are significantly different at $p<0.05$ according to Tukey's HSD test.

Higher alcohol level decreased the sugar content. There was a decrease in reducing sugars with 17% alcohol level vermouth (3.78 to 3.70%), which might be due to dilution effect, likewise total sugars also decreased from 9.38 to 9.16%. Volatile acidity was lower in 15% alcohol level vermouth (0.022%) then in 17% alcohol level vermouth (0.023%), which is contributed by addition of brandy. An increase in total esters occurred with an increase in alcohol levels (134.74 to 136.98 mg/l) which is expected as brandy contains esters which may have contributed to the wine. There was a small decrease (237.89 to 236.27 mg/l) in total phenolics with higher alcohol level. Amerine *et al.* (1) summarized total esters range from 200 to 400 mg/l in varied wines. These results were supportive to the findings of Attri *et al*. (3) in sand pear vermouth and Joshi and Sandhu (9) in apple vermouth. Whereas for colour, with higher alcohol level there was a small increase in *L** (61.61 to 61.97) indicating that the product becames brighter, there was no significant difference in *a** and a slight reduction in *b** (35.74 to 35.69) is an indicative of a change in colour towards blueness.

Increasing the sugar levels significantly increased the TSS (14.68 to 17.26°Brix) (Table 4). Similarly, there was an increase in the reducing sugars (3.53 to 3.95%) and total sugars (8.46 to 10.06%). There was an increase in the pH (3.26 to 3.31) with higher sugar level and there was significant difference in

Table 4. Effect of sugar level on the physico-chemical characteristics of pineapple vermouth.

Characteristics	Sugar level (%)*	
	8	10
TSS (°Brix)	14.68[b]	17.26[a]
pH	3.26[a]	3.31[a]
Titrable acidity (%)	0.73[a]	0.70[b]
Reducing sugars (%)	3.53[b]	3.95[a]
Total sugars (%)	8.46[b]	10.06[a]
Alcohol (% v/v)	16.03[a]	16.00[a]
Volatile acidity (%)	0.024[a]	0.021[b]
Total esters (mg/l)	130.13[b]	141.59[a]
Total phenols (mg/l)	238.08[a]	236.32[b]
Colour		
*L**	61.75[b]	61.83[a]
*a**	2.51[a]	2.51[a]
*b**	35.72[a]	35.70[b]

*Means are irrespective of alcohol and spice level; Means followed by the different letter(s) within a row are significantly different at p<0.05 according to Tukey's HSD test

Table 5. Effect of spice level on the physico-chemical characteristics of pineapple vermouth.

Characteristics	Spices level (%)*	
	2.5	5.0
TSS (°Brix)	15.79[b]	16.15[a]
pH	3.30[a]	3.26[a]
Titrable acidity (%)	0.70[a]	0.73[a]
Reducing sugars (%)	3.76[a]	3.72[a]
Total sugars (%)	9.15[b]	9.40[a]
Alcohol (% v/v)	16.05[a]	15.97[b]
Volatile acidity (%)	0.022[b]	0.023[a]
Total esters (mg/l)	134.38[b]	137.34[a]
Total phenols (mg/l)	233.46[b]	240.95[a]
Colour		
*L**	61.82[a]	61.76[b]
*a**	2.51[a]	2.49[b]
*b**	35.70[a]	35.73[b]

*Means are irrespective of alcohol and sugar level; Means followed by the different letter(s) within a row are significantly different at p<0.05 according to Tukey's HSD test

titratable acidity (0.73 and 0.70%). Different sugar levels in vermouth showed small differences in the alcohol concentrations (16.03 and 16.00%) and colour which could be due to the dilution of vermouth by addition of sugar syrup to raise the sugar levels. Total esters content was higher (141.59 mg/l) in 10% sugar level vermouth then at 8% sugar level vermouth (130.13 mg/l). Volatile acidity at 8% sugar level vermouth was higher (0.024%) as compared with 10% sugar level vermouth (0.021%). However, with an increase in sugar level total phenols content was decreased (238.09 to 236.32 mg/l). These decreases in volatile acidity and total phenols were expected with increase in sugar levels as sugars are not expected to contain the same. These results were in accordance with of the findings in wild apricot vermouth (Joshi *et al.*, 10).

Pineapple vermouth with 5% spice extract had higher TSS (16.15°B) compared to 2.5% spice extract (15.79°B) and this is due to the contribution of soluble solids from spice extract (Table 5). Titratable acidity was higher in 5% spice level vermouth (0.73%) than with 2.5% spice level vermouth (0.70%). The addition of increased amount of spice extract lowered the pH of vermouth (3.30 to 3.26). Out of the two spice levels, product with 5% spice level had lower reducing sugars (3.72%) than in 2.5% spice level vermouth (3.76%) which may be due to dilution effect of higher concentration of spices extract, similar results were observed in apple vermouth (Joshi and Sandhu, 9). Total sugars were higher (9.40%) in 5% spice level vermouth than in the lower spice level (9.15%). The TSS in the spice extract may contain acids, sugars and salts which may have enhanced the titratable acidity and total sugars and reduced the pH. Increased spice level decreased the alcohol concentration (16.05 to 15.97%), which may be due to dilution by higher quantity of spice extract. With an increase in spice level *L** lowered (61.82 to 61.76) which meant that there was an increase in the blackness, there was a decrease in *a** (2.51 to 2.49) which is an indicative towards greenness however, an increase in *b** (35.70 to 35.73) indicate there was an increase in yellowness which is expected as the colour of spice extract may have added pigment to the vermouth. Vermouth with 5% spice level also contained higher volatile acidity (0.023%) than lower spice level (0.022%). Higher total esters were found in higher spice level (137.34 mg/l) than in the lower spice level (134.38 mg/l). Total phenols in 5% spice level vermouth were higher (240.95 mg/l) than with 2.5% spice level vermouth (233.46 mg/l). Addition of spice extract increased the values of volatile acidity, esters and phenols in the vermouth. These findings were similar to the observations in mango vermouth (Onkaryya, 15) and plum vermouth (Joshi *et al.*, 8).

The results of sensory evaluation of different vermouths prepared with varied alcohol, sugar

Table 6. A comparison of mean sensory attributes of different treatments of pineapple vermouth.

Treatment Max. score	Attributes											
	Appearance 2	Colour 2	Aroma 4	Volatile acidity 2	Total acidity 2	Sweetness 1	Body 1	Flavour 2	Bitterness 1	Astringency 1	Overall impression 1	Total score 20
1. Pineapple vermouth (15% alcohol)												
a) 8% S & 2.5% SE	1.69	1.73	3.52	1.47	1.52	0.69	0.86	1.69	0.81	0.72	1.74	16.44
b) 8% S & 5% SE	1.60	1.65	3.54	1.52	1.55	0.67	0.80	1.71	0.84	0.69	1.70	16.27
c) 10% S & 2.5% SE	1.73	1.69	3.53	1.47	1.49	0.75	0.84	1.59	0.71	0.71	1.73	16.24
d) 10% S & 5% SE	1.67	1.67	3.55	1.49	1.54	0.70	0.78	1.61	0.72	0.66	1.70	16.09
2. Pineapple vermouth (17% alcohol)												
a) 8% S & 2.5% SE	1.68	1.62	3.68	1.49	1.51	0.74	0.83	1.82	0.71	0.75	1.86	16.69
b) 8% S & 5% SE	1.53	1.57	3.55	1.53	1.53	0.68	0.80	1.83	0.75	0.73	1.77	16.27
c) 10% S & 2.5% SE	1.57	1.64	3.56	1.48	1.46	0.75	0.81	1.67	0.69	0.74	1.76	16.13
d) 10% S & 5% SE	1.53	1.53	3.58	1.51	1.51	0.69	0.80	1.69	0.73	0.69	1.73	15.99

S = sugar; SE = spice extract

and spices level showed significant difference for various sensory quality attributes (Table 6). The colour and appearance with 15% alcohol and 2.5% spice extract scored higher but for aroma virtually all treatments were comparable. In bitterness and astringency vermouth of all treatments were comparable. However, with respect to total acidity vermouth with 17% alcohol scored lower than 15% alcohol. The sum of scores of different treatment clearly reveal that the highest score was awarded to vermouth with 17% alcohol as it had a good blend of body, flavour and aroma. In an earlier finding, sweet product with 17% alcohol was considered the best for wild apricot vermouth (Joshi *et al.*, 10). The alcohol content of grape vermouth was raised from 14 to 22% (Amerine *et al.*, 1) while for sand pear (Attri *et al.*, 3) and plum vermouth (Joshi *et al.*, 8) products with 15% alcohol content scored the best. With respect to concentration of sugar used, the scores varied among the treatments, wherein, 8% sugar scored better for flavour and astringency as compared to 10% sugar which scored more for body. Volatile acidity, total acidity, flavour and bitterness of pineapple vermouth of 5% spice level scored highest whereas, body, sweetness, appearance and astringency with 2.5% spice level was preferred by the panel of judges. Since there was not much difference for the scores of vermouth with spices level of 2.5 and 5%, the lower quantity was preferred. Based on sensory evaluation scores of the different treatments pineapple vermouth with 17% alcohol, 8% sugar and 2.5% spice extract was adjudged the best (Fig. 1). This combination was most liked and scored highest as the most acceptable product.

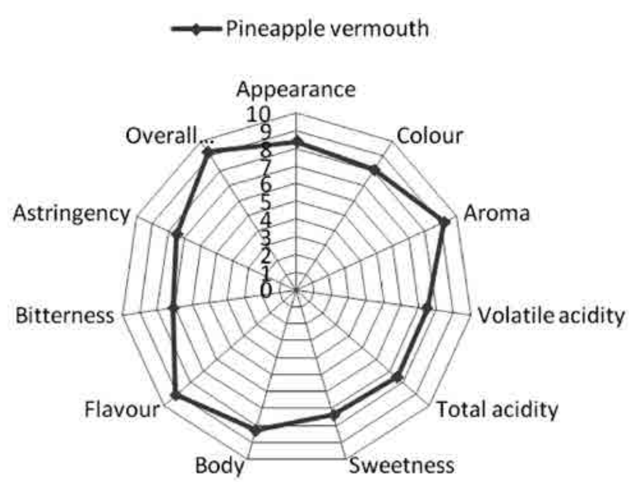

Fig. 1. Spider web diagram of sensory qualities of pineapple vermouth with 17% alcohol, 8% sugar and 2.5% spice extract.

The present study suggests that there is a possibility of pineapple fruit to be utilized for development of good quality vermouth from a sound pineapple base wine. It was apparent from the result that the variations in alcohol, sugar level and spice extract concentrations effected the physico-chemical and sensory qualities of pineapple vermouth. The product holds good promise for commercialization in view of its high consumer acceptability.

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