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RESEARCH PAPER

Preparation and Evaluation of Bael (*Aegle marmelos*) Vermouth

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Abstract

Vermouth was prepared from bael wine fortified with brandy to maintain 16 % alcohol content with 3 spice levels. Bael wine had TSS of 7.3 °B, 0.361% titratable acidity, 3.50 pH, 0.782 mg/100 ml total phenols, 0.45% reducing sugars and 11.50% ethanol content. The bael vermouth with 2% spice level was more acceptable organoleptically than 3.5 and 5% spice levels which had TSS of 7.2 °B, titratable acidity 0.339%, pH 3.32, ethanol content 16.71%, total phenols 0.779 mg/100 ml and carotene content of 38.95 µg/ 100ml after 6 month of ageing.

Keywords: Bael, vermouth, *Saccharomyces cerevisiae,* spices, total phenols

The bael fruit (*Aegle marmelos* Correa, family: Rutaceae), occupies an important place among the fruits. The fruit is known to possesses various nutritional and therapeutic properties for the cure of chronic diarrhea and certain other gastrointestinal disorders. Marmelosin (C_{18} H_{12} O_8), found in the bael fruit, is known as panacea of stomach ailments (Singh and Nath, 2004). The unripe fruits are astringent, digestive, stomachic and are prescribed to treat diarrhea and dysentery (Pande *et al.,* 1986). The ripe fruit is sweet, aromatic, nutritious, palatable and has excellent aroma which is not destroyed even during processing. Bael fruit because of its hard shell, mucilaginous texture and numerous seeds is not popular as a table fruit. It is usually processed into products like preserve, refreshing beverages, powder, leather, squash, nectar, toffee, jam and syrup (Singh *et al.,* 2012). Being excellent in flavour, nutritive and therapeutic values, the bael fruit has potential for processing into value added products like wines. These is a scanty information on preparation of wine (Panda *et al.,* 2014) from bael fruit.

A fortified wine containing spices and herb is called as vermouth. Vermouth is made commercially from grapes and is of two types; Italian (sweet) and French (dry type). Vermouth has also been reported from other fruits also, like mango, sand pear, plum apples (Joshi *et al.,* 1991; Joshi *et al.,* 1999 and 2011; Joshi and Sandhu, 2000 and Panesar *et al.,* 2009, Pralaya, 1986).

Vermouth is an aromatized wine having added sugar and extract of roots, herbs, spices and flowers (Amesine *et al.,* 1980; Fessler, 1971). It contains ethyl alcohol, sugars, acid, tannins, aldehyde, esters, amino acids, vitamins, anthocyanins, fatty acids and minor constituents like flavoring compounds (Joshi, 1997; Joshi *et al.,* 1999). The additives in fact, don't boost the alcohol content, but they do sculpt the flavor of the wine. Fessler (1971) has also recommended use of

herbs, roots and spices for development of flavoured wines with distinctive character. Vermouth can have alcohol content between 15% and 19% by volume (Joshi and Sandhu, 2000). Bael vermouth was prepared to increase its acceptability and to diversify the products from bael. It was matured and evaluated at different intervals and analysed for various physico-chemical and sensory quality characteristic and the results have been discussed in this paper.

Materials and Methods

Raw material

Bael fruits were obtained from the RHRSS, Raya Jammu. Fruits ware washed, broken into halves and pulp was scooped out with the help of stainless steel spoon. The scooped pulp was homogenized by blending it manually. The pulp was passed through the stainless steel sieve to remove seeds, and then, heated to boiling point with intermit ent stirring followed by cooling. Sugar used to ameliorate the bael must for the studies was procured locally. The pectin esterase enzyme used in the studies was manufactured by M/S Triton Chemicals, Mysore, India under the brand name "Pectinol".

Yeast culture

The yeast culture viz. *Saccharomyces cerevisiae* (MTCC 178) was obtained from Microbial Type Culture Collection, Institute of Microbial Technology (IMTECH), was maintained on yeast malt extract agar (YMEA) medium and re-cultured af er every two months or whenever needed.

Base wine preparation

Wine was prepared by diluting the bael pulp in 1:1 ratio with water, the must was ameliorated with sugar syrup to 24°B, and 200 ppm SO_2, DAHP 0.1% and pectinase enzyme 0.5% was added. A 24 hours old active culture was prepared and used for fermentation which was carried out in 2.5 liter capacity narrow mouth glass bot les. The detailed procedure is the same as standardized for the preparation of wine (Joshi 1997, Joshi *et al.,* 1999, Joshi *et al.,* 1991).

Preparation of Bael brandy

A part of the base wine was distilled into brandy as per the standard procedure (Amerine *et al.,* 1980). First 1/10th of expected distillate called "head" was not taken. Similarly last 1/10th of distillate was discarded. Only the middle portion of the distillate was collected (Amesine *et al*., 1980).

Preparation of spices extract

Detailed list of spices used for the preparation of bael vermouth is given in table 1. Spices extract was prepared by taking wine and brandy in 1:1 ratio. Spices were immersed and gently heated at 60°C for 10 min for 10 days continuously. The extract was kept at low temperature for 2 days. The supernatant was separated by filtration and used in the vermouth preparation. (Joshi, 1997).

Table 1: Spices used in the preparation of bael vermouth

Common name	Botanical name	Parts used	Qty/L (g)
Coriander	*Coriander sativum L.*	Seeds	0.70
Cumin	*Cuminum cyaninum L.*	Seeds	0.50
Clove	*Syzygium aromaticum L.*	Fruit	0.25
Large cardamom	*Amomum subulatum Roxb.*	Seeds	0.50
Nutmeg	*Myristica fragrans*	Seed	0.25
Cinnamon	Cinnamomum zeylanicum Beryn	Bark	0.50

Mixing, bot ling and maturation

Bael vermouth was prepared with the addition in different ratios (2, 3.5, 5%) of clarified spice extract to the base wine fortified with brandy to raise the alcohol content to 16% (Joshi, 1997). It was filled in 200 ml capacity glass bot les which were sterilized at 65°C for 20 min and the entire producer is shown in Figure 1. These bot les were kept for maturation and analysis of different physico-chemical characteristics was carried out during maturation. Sensory evaluation was carried out af er six months of maturation.

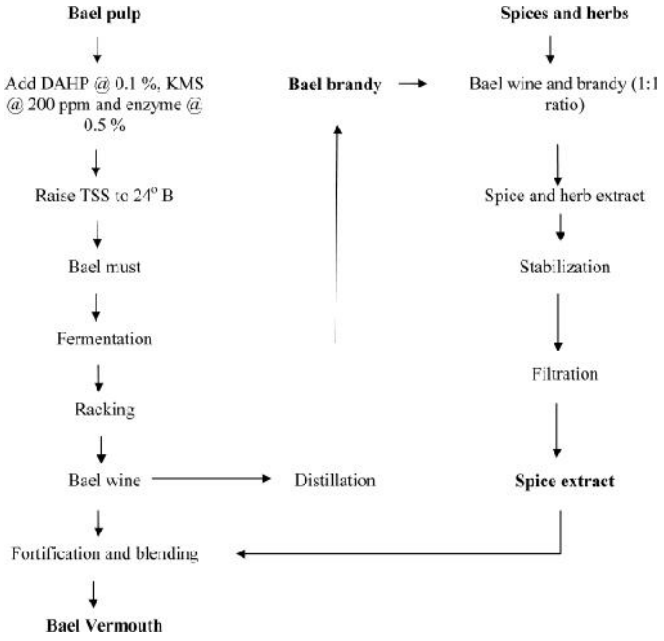

Fig. 1: Flow sheet for the preparation of bael wine and vermouth

Physico-chemical analysis of juice and wine

The pH of juice and wine was taken with digital pH meter. Prior to pH measurement, the instrument was standardized with the buffer solutions of pH 4 and 7. Hunter colour meter was used to measure the colour of the wine and vermouth. Colour was measured and expressed in CIE-Lab parameters as L (whiteness/darkness), a*(redness/greenness), and b*(yellowness/blueness) (Bakker *et al.* 1994). Total soluble solids (TSS) of bael juice, must, wine and vermouth were measured using Erma hand refractometer (0-32°B). Titratable acidity (% tartaric acid) was estimated by titrating a known aliquot of the sample against N/10 NaOH solution using phenolphthalein as an indicator (AOAC, 1980). Ethanol content was estimated by spectrophotometric method (Caputi *et al.*, 1968), whereas, total phenols in wine was determined by Folin-Ciocalteu procedure given by Singleton and Rossi (1965). Volatile acidity was determined by the standard method (Amerine *et al.*, 1980) was expressed by acetic acid (g/100 ml).

Results and Discussion

Physico chemical characteristics of bael base wine

Biochemical analysis of bael juice is shown in Table 2 which depicts that the juice is rich in sugar which may be utilized for the wine production and have phenols required for desirable astringency in wine.

Table 2: Biochemical composition of bael juice

Parameter	Bael juice
TSS (°B)	16.0
Titratable acidity (%)	0.123
pH	4.30
Total phenol (mg/100 ml)	0.812
Carotenoid (μg/100 ml)	54.0

The base wine had total soluble solids as 7.3 ºBrix, whereas titratable acidity and pH were recorded as 0.361 per cent and 3.50, respectively. The results revealed that proper fermentation of wine had taken place (Table 3).

Table 3: Physico chemical composition of bael wine

Parameters	Bael wine
TSS (°B)	7.3
Titratable acidity (% TA)	0.361
pH	3.50
Alcohol (%v/v)	11.50
Reducing sugars (%)	0.45
Total sugars (%)	2.43
Volatile acidity (%AA)	0.019
Total phenols (mg/100ml)	0.782

The low volatile acidity of 0.019 per cent shows the soundness of fermentation, which was within the limits of the legal standards (0.040%) as recommended by Amerine *et al.* (1980). Total phenols and sugar contents were found within the limits, which showed that the base wine was sound and of medium alcoholic, thus suitable for conversion into vermouth. These values of various parameters/ characteristics were similar and quite comparable with those of sand pear vermouth base wine, plum vermouth base wine and apple vermouth base wine as reported earlier (Atri *et al.*, 1994; Joshi *et al.*, 1991; Joshi and Sandhu, 2000).

Effect of maturation

As is evident from the table 4, the TSS of vermouth decreased during maturation which might be due to the interaction of TSS with alcohol resulting in their precipitation during maturation. Similarly, the higher total soluble solids of vermouths with 5% spices extract might be the contribution of total soluble solids by spices extract. Similar results have been reported in sand pear vermouth, plum vermouth, *mahua* vermouth and apple vermouth by Atri *et al.* (1994); Joshi *et al.* (1991); Yadav *et al.* (2012) and Joshi and Sandhu, (2000) respectively.

Increase in reducing sugars was observed in all the treatments, from 0.35 to 0.64 per cent, 0.32 to 0.61 and 0.30 to 0.59 percent in vermouth with 2, 3.5 and 5% spice extract, respectively because of hydrolysis of non-reducing sugars into reducing sugars. Vermouths with 5% spice level had lower reducing sugar content apparently due to dilution effect of higher concentration of spices extract. Similar

Table 4: Physico chemical changes in bael vermouth during maturation

Parameters	Spice levels (%)	0 month	6 month	Mean	C.D	
TSS (° B)	2	7.5	6.9	**7.2**	SE*	0.01
	3.5	7.6	7.4	**7.5**	D*	0.03
	5	7.7	7.2	**7.4**	SE x D	NS
Reducing sugar (%)	2	0.35	0.64	**0.49**	SE	0.02
	3.5	0.32	0.61	**0.46**	D	0.03
	5	0.30	0.59	**0.44**	SE x D	NS
Total sugar (%)	2	2.41	2.15	**2.28**	SE	0.01
	3.5	2.43	2.17	**2.30**	D	0.03
	5	2.53	2.27	**2.40**	SE x D	NS
Titratable acidity (%)	2	0.314	0.364	**0.339**	SE	0.001
	3.5	0.324	0.374	**0.349**	D	0.001
	5	0.339	0.389	**0.364**	SE x D	0.002
pH	2	3.26	3.20	**3.23**	SE	0.02
	3.5	3.23	3.17	**3.20**	D	0.04
	5	3.19	3.11	**3.15**	SE x D	0.11
Ethanol content (%)	2	16.89	16.54	**16.71**	SE	0.03
	3.5	16.62	16.34	**16.48**	D	0.02
	5	16.35	16.11	**16.23**	SE x D	NS
Volatile acidity (% AA)	2	0.022	0.025	**0.023**	SE	0.002
	3.5	0.026	0.031	**0.028**	D	0.001
	5	0.030	0.035	**0.032**	SE x D	NS
Total phenols (mg/ 100 ml)	2	0.796	0.763	**0.779**	SE	0.001
	3.5	0.819	0.779	**0.799**	D	0.001
	5	0.842	0.803	**0.822**	SE x D	NS
Carotenoid (µg/100 ml)	2	39.28	38.63	**38.95**	SE	0.03
	3.5	40.93	40.28	**40.60**	D	0.02
	5	41.46	40.81	**41.13**	SE x D	0.03

* SE : spice extract, D: Duration

results were observed in apple vermouth by Joshi and Sandhu (2000). The total sugars decreased with increase in duration of maturation from initial levels of 2.41 to 2.15, 2.43 to 2.15 and 2.53 to 2.27 per cent in bael vermouth with 2, 3.5 and 5% spice extract respectively. Decrease in total sugar might be due to the Maillard's reaction resulting in non-enzymatic browning involving reaction of sugar with amino acid (Zoecklein *et al.*, 1995) and the same is reflected in the enhancement of colour due to browning. Similar findings have been reported by Yadav *et al.* (2012) while working on preparation and evaluation of mahua vermouth.

Table 5: Sensory characteristic of bael vermouth *

Characteristic/ score	2% spice extract	3.5% spice extract	5% spice extract
Colour (2)	1.64	1.56	1.49
Appearance (2)	1.66	1.63	1.35
Aroma (4)	3.45	3.30	3.28
Volatile acidity (2)	1.58	1.45	1.45
Total acidity (2)	1.59	1.41	1.40
Sweetness (1)	0.70	0.67	0.63
Body (1)	0.84	0.80	0.72
Flavor (2)	1.75	1.47	1.39
Astringency (1)	0.68	0.69	0.62
Bit erness (1)	0.82	0.80	0.79
Overall acidity (2)	1.60	1.37	1.35
Total (20)	**16.31**	**15.15**	**14.47**

Rating : superior = 17- 20, standard = 13- 16, below average = 9-12, unacceptable = 1-6

The titratable acidity increased and pH decreased significantly over a period of six months of maturation in bael vermouths, which could be due to the production of organic acid and is correlated with increase in volatile acidity. A reference to the titratable acidity of plum vermouth (Joshi *et al.*, 1991) showed that there were significant differences among the vermouth of various treatments. The higher acidity in 5% spiced level vermouths in the respective treatments might be due to the higher concentration of spices level. Corresponding to the titratable acidity, pH values of the vermouth prepared from different fruits were found to be different (Amerine *et al.*, 1980). Nevertheless, the pH remained sufficiently acidic to prevent the occurrence of spoilage.

Significant decrease in alcohol concentration during maturation was observed in bael vermouth, which was at ributed to the changes occurring during maturation process. Similar results have been reported in sand pear vermouth (At ri *et al.*, 1994), apple vermouth (Joshi and Sandhu, 2000) and plum vermouth (Joshi *et al.*, 1991). The difference in alcohol content with different spice level could be due to the dilution of ethanol by addition of spice extract.

Volatile acidity increased with increase in the spice level in bael vermouth. The vermouth of various treatments was found to have volatile acidities of less than the legal limits for the wine (Amerine *et al.* 1980). Amerine and Ough, (1979) recommended that in sound and aged wines the volatile acidity should not exceed 0.07%, however Onkarayya, (1985) have found volatile acidity in a range between 0.071% and 0.091% which is quite higher than found in our study.

A significant increase in total phenol vermouth of all the treatments than base wine, which might possibly be at ributed to the addition of spices/ herbal extract. At ri *et al.* (1994) reported that addition of herbs/ spices improves the phenolic content of vermouth. Decrease in total phenols during maturation however was observed, which was at ributed to the precipitation of phenolic compounds. In earlier work, a similar decrease in total phenolic content was also observed (Amerine *et al.*, 1980; Joshi and Sandhu, 2000). Total phenols content are mainly contributed by spices, therefore increase in phenols and tannins concentration was documented in vermouth with 5% spices level. Phenols are important in endowing the wine with desirable astringency (mouth puckering property). Polyphenols in vermouth have a role to play in the protection against oxidative stress (Feher and Lagasi, 2004).

Carotenoid content in vermouth were found to be very less as compared to the pulp it-self which might

be because of dilution during must preparation and or oxidation or precipitation of carotene content during fermentation.

Sensory evaluation of bael vermouth

The data in table 5 reveal that on the basis of the mean score of overall acceptability of bael vermouth with 2% spices extract was ranked the best. Out of the three spices levels used in vermouth preparation, 2% spiced level vermouth was preferred on the basis of overall blend for most of sensory characteristics. These results are similar to the findings of Joshi and Sandhu, (2000) in apple vermouth.

Conclusion

In the present study, beal vermouth was prepared and its bio-chemical and sensory at ributes were evaluated which was acceptable among the consumers. Bael fruits are seasonally available in India in sufficient quantities during the summer months. Variety of phenolic compounds found in the bael wine has added its value as an antioxidant rich beverage.

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