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Research Article

Prunus domestica × *P. armeniaca* Cultivar Fengweimeigui: A New Natural Material for Fruit Wine

[1]Gao-Pu Zhu, [1]Han Zhao, [2]Xiao-Xing Zhou, [1]Meng-Pei Liu, [3]Yan-Li Huang,
[1]Ta-Na Wuyun and [1]Fang-Dong Li
[1]Non-timber Forestry Research and Development Center, Chinese Academy of Forestry and China Paulownia Research and Development Center, Zhengzhou 450003, China
[2]Administrative Office, Chinese Academy of Forestry, Beijing 100091, China
[3]Henan Province Institute of Landscape Planning and Design Company Limited, Zhengzhou 450045, China

Abstract: To add fruit wine type and increase *Prunus domestica* × *P. armeniaca* cultivar Fengweimeigui (Fengweimeigui) additional value, a new natural fruit wine was developed. Four treatments based on solid fermentation method were researched including the weight ratio of fruit and saccharose is 10:1 (T1), 5:1 (T2), 5:2 (T3) and 2:1 (T4), respectively. The results exhibited that the nutrition was affected with saccharose addition and two type's semi-dry and two sweet wines were designed. Semi-dry wine T1, has lowest sugar content of 5.86 mg/L with higher Mg (86.20 mg/L), Ca (136.00 mg/L) and the highest essential amino acid contents of 142.7 mg/L rich in Lys (55.2 mg/L), Phe (32.2 mg/L), Ile (6.10 mg/L), Leu (27.9 mg/L), Val (18.2 mg/L) and Tyr (8.2 mg/L). Semi-dry wine T2, has lower sugar content of 11.70 mg/L with higher P (108.00 mg/L) and the higher amino acid Met (3.50 mg/L), Gln (87.0 mg/L), Gly (57.0 mg/L), His (9.2 mg/L) and Arg (21.8 mg/L). Sweet wine T3, has higher sugar content of 68.80 mg/L with the highest total non-essential amino acid content of 2050.5 mg/L rich in Ala (255.2 mg/L) and Pro (1574.0 mg/L), meanwhile, the amino acid Met (36.8 mg/L) was detected. Sweet wine T4, has highest sugar content of 110.00 mg/L with the highest Fe (1.10 mg/L), Na (19.80 mg/L), alcohol concentration (15.20%) and amino acid Asp (74.8 mg/L). We therefore conclude that solid fermentation is a suitable method to preserve nutrients and value-added for Fengweimeigui fruits and four types wine are suitable for different age people.

Keywords: Fruit wine, fungal endophytes, *Prunus domestica* × *P. armeniaca* cultivar fengweimeigui, solid fermentation

INTRODUCTION

In general, fruits are important sources of carbohydrate, anthocyanins, minerals, trace elements, vitamins and have significant medicinal value and industrial applications. *Prunus domestica* × *P. armeniaca* cultivar Fengweimeigui is a new variety from inter-specific hybridization between *Prunus domestica* with *P. armeniaca* and created by the F1 backcrossed to the *Prunus domestica*. It contains abundant nourishments: total soluble solids, 17.3%; total sugar, 12.30%; total organic acid, 1.02%; vitamin C, 73.30 μg/g; and minerals 17.2 mg/kg P, 0.13 mg/kg Zn and 0.14 mg/kg Fe (Li *et al*., 2007; Lei, 2013). And the fruit firmness reaches to 8.62 kg/cm^2 result in the transportation ability and storage period are significant extend (Li *et al*., 2007; Lei, 2013). Although the highest content of anthocyanin in pericarp, but the organic acid over 2.50% so that it was inedible and discarded. Meanwhile, because the mature period in one tree was inconformity result in the fruits was uneven in sizes and lower economic value. Fungal endophytes in self-fruit have been an untapped natural source of biocatalysts (Reddy and Reddy, 2005; Suryanarayanan *et al*., 2012) to make the functional fruit wine, this is a suitable method to solve above problems (Panda *et al*., 2014; Cho *et al*., 2013; Araújo *et al*., 2011). In this study, based on solid fermentation method to produce fruit wine and improve residuum utilization ratio have been studied.

MATERIALS AND METHODS

Sample collection: Fully ripened and healthy *Prunus domestica* × *P. armeniaca cultivar* Fengweimeigui fruits, whether big or small, without diseases and insect pests were selected from garden of the Experimental Site of Non-timber Forestry Research and Development

Corresponding Author: Ta-na Wuyun, Non-timber Forestry Research and Development Center, Chinese Academy of Forestry and China Paulownia Research and Development Center, Zhengzhou 450003, China

Fig. 1: Fruits

Fig. 2: Pulp

Fig. 3: Wine

Center, Chinese Academy of Forestry, Yuanyang County, China, during June 2013 (day temperature 28±2°C, night temperature 25±2°C) (Fig. 1).

Self-Fermentation process: The strategy was self-fermentation based on fruits endophytic fungi. The total process included ten steps. First, Fengweimeigui fruits were cleaned and dried. Second, the fruits was put a closed room and use ultraviolet disinfection with 8~12 h. Third, the fruits were crushed with hands and became pulp (Fig. 2). The seeds were manually removed from the pulp. About 600 mL of pulp was extracted from 1 kg of fruits. Fourth, the different weight of saccharose were added, the four level were designed including the weight ratio of fruits and saccharose 10:1 (T1), 5:1 (T2), 5:2 (T3) and 2:1 (T4) respectively. Next, the pulp was stirred every 6 h interval until the saccharose were melted (about 3 times). Then the fermentation divided into two stages including higher temperature and constant lower temperature. At the higher temperature stage the fermentation was carried out at surrounding temperature 33±2°C last 5 days, but the lower constant temperature stage the temperature keeps 25±2°C last 60 days. After fermentation, racking was carried out at room temperature. First racking carried out at 3°-5° Brix and 3 time repeats in 20 days interval was processed to discard the deposited residues at the

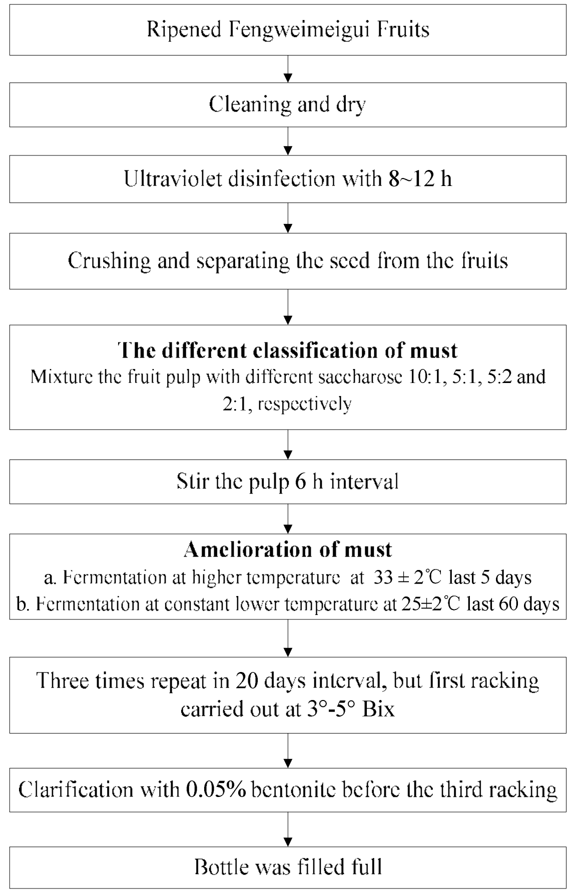

Fig. 4: Procedure for making fengweimeigui wine

bottom. 0.05% bentonite was added before the final racking to remove the last remaining residues for clarification (Fig. 3). Finally, the bottles were filled with wine. The procedure for making wine from Fengweimeigui fruits is shown in Fig. 4.

Composition and content analysis: The composition and content of amino acid was analysis based on GB/T 5009.124-2003 (China) and the minerals and trace elements were analysis based on GB/T 14924.12-2001 (China). The juice pH value, this was done by the method of Ofori and Hahn (1994). The pH meter was standardized using buffer solutions of acidic and basic values of 4.0 and 9.08 at 25°C (pH Meter FE20-FiveEasy Plus^{TM}, Mettler Toledo, Switzerland). The biochemical constituents (total sugar, total fat, total protein and ethanol) were determined by the methods suggested in Amerine and Ough (1980).

Data analysis: The experimental layout was a complete randomized plot with three replicates of five sampled per treatment. The data collect with Microsoft Office Excel 2013 software and the statistic analysis with data processing system DPS v6.05 software. The variance

Table 1: The proximate composition of main nutrition fengweimeigui wine (mg/L)

Treatment	Protein	Fat	Sugar	Fe	Mg	Na
T1	0.58±0.01aA	0.03±0.00aA	5.86±0.05dC	ND	86.20±1.82aA	8.10±0.15bB
T2	0.60±0.01aA	0.01±0.00cC	11.70±0.90cC	ND	80.80±1.81bB	10.00±1.20bB
T3	0.52±0.02bB	0.02±0.00bB	68.80±3.05bB	0.40±0.05bB	64.40±1.96cC	7.90±0.12bB
T4	0.52±0.02bB	0.03±0.00aA	110.00±4.71aA	1.10±0.20aA	60.50±1.86dC	19.80±1.90aA
Treatment	Zn	Ca	P	pH	Alcohol (%)	
T1	1.40±0.11aA	136.00±2.70aA	98.70±2.41bB	3.90±0.10a	9.70±0.20cB	
T2	1.20±0.12bAB	117.00±5.36bB	108.00±4.23aA	3.97±0.06a	10.80±0.59bcB	
T3	1.10±0.12bcB	97.40±1.84cC	98.30±2.40bB	3.96±0.06a	11.90±1.25bB	
T4	0.96±0.07cB	104.00±3.51cC	97.40±1.65bB	4.03±0.08a	15.20±1.10aA	

Values are means±S.D. (n = 5); Means in columns without letters in common differ significantly (p<0.05); ND: Not detected

Table 2: The proximate content of essential amino acid in fengweimeigui wine (mg/L)

Treatment	Lys	Trp	Phe	Met	Thr
T1	55.2±2.0aA	ND	32.2±1.2aA	3.1±0.1bB	ND
T2	46.2±2.2bB	ND	24.0±1.4bB	3.5±0.2aA	ND
T3	35.6±1.4cC	ND	23.2±1.0bBC	2.2±0.1dD	ND
T4	30.6±1.6dC	ND	19.8±1.5cC	2.7±0.1cC	ND
Treatment	Ile	Leu	Val	Total	
T1	6.1±0.5aA	27.9±1.5aA	18.2±1.2aA	142.7±1.9aA	
T2	2.8±0.2bB	15.2±1.4bB	14.4±1.2bB	106.1±1.6bB	
T3	1.3±0.1bB	8.2±0.2cC	13.4±0.7bB	83.9±1.5cC	
T4	1.0±0.0bB	7.2±0.1cC	11.8±0.6cB	73.1±1.0dD	

Values are means±S.D. (n = 5); Means in columns without letters in common differ significantly (p<0.05); ND: Not detected

Table 3: The proximate content of non-essential amino acid in fengweimeigui wine (mg/L)

Treatment	Asp	Ser	Gln	Gly	Ala	Cys
T1	58.4±1.6cC	ND	51.6±1.5cC	54.2±1.1bA	248.7±8.3aA	13.4±1.2a
T2	64.9±1.4bB	ND	87.0±1.6aA	57.0±1.3aA	200.0±8.1bB	13.2±0.8ab
T3	47.6±1.3dD	36.8±1.8	57.2±0.9bB	39.8±1.9cB	255.2±10.5aA	11.6±1.0bc
T4	74.8±1.3aA	ND	46.4±1.5dD	28.4±1.6dC	137.4±8.2cC	11.0±0.9c
Treatment	Tyr	His	Arg	Pro	Total	
T1	8.2±0.1aA	8.6±0.1bA	20.8±1.4aA	1211.0±20.8bB	1683.1±21.7bB	
T2	5.3±0.1bB	9.2±0.2aA	21.8±1.3aA	1228.0±16.8bB	1691.7±25.9bB	
T3	4.6±0.1cC	5.2±0.1dC	13.9±1.4bB	1574.0±29.7aA	2050.5±21.4aA	
T4	5.2±0.2bB	5.9±0.5cB	13.0±1.4bB	1108.0±13.9cC	1435.3±16.9cC	

Values are means±S.D. (n = 5); Means in columns without letters in common differ significantly (p<0.05); ND: Not detected

analysis use Duncan's multiple range test. Significance was accepted at p≤0.05.

RESULT ANALYSIS

The content different of major components: In this study, the sugar (saccharose) was the only additional materials and the main nutrition was affected with sugar addition. All of the treatments, the contents of protein and fat were lower, but the alcohol concentration was increased with sugar additional (Table 1). Level T1 and T2, the sugar were 5.86 and 11.70 mg/L, respectively, the standard are suitable for semi-dry wine with lower alcohol concentration 9.70 and 10.80%, respectively. Treatment T3 and T4, the sugar over 68.80 mg/L, belongs to the sweet wine with higher alcohol concentration 11.90 and 15.20%, respectively.

In minerals and trace elements part, T1 has the highest contents Mg (86.20 mg/L), Zn (1.4 mg/L) and Ca (136.00 mg/L) shown that the wine included abundant mineral materials, so, the T1 was the best wine suitable for semi-dry for old peoples in this study. Treatment T2 has the higher protein (0.60 mg/L) and 108.00 mg/L P. However, Treatment T3 has the lower content of main nutrition. Treatment T4 has the highest sugar (110.00 mg/L), Fe (1.10 mg/L), Na (19.80 mg/L) and 4.03 pH shown the wine was suitable for young people or virgin pulp wine.

The content different of essential amino acid: The total content of essential amino acid was declined with saccharose addition and the difference was significant (p<0.01) (Table 2). Except amino acid Met was the highest content at treatment T2, others are same tendency: T1>T2>T3>T4, but the difference level was changed. Among these difference, the treatment T1 has the highest contents of amino acid Lys (55.2 mg/L), Phe (32.2 mg/L), Ile (6.1 mg/L), Leu (27.9 mg/L), Val (18.2 mg/L) and total essential amino acid (142.7 mg/L) and the difference reached to significant difference (p<0.01). The result showed that the total essential amino acid was the typical composition in T1 wine. The contents of amino acids Trp and Thr were not detected in this experiment.

The content different of non-essential amino acid: The total content of non-essential amino acid from highest to lowest at different treatments was T3, T2, T1 and T4, but the every part has difference (Table 3). The T1 has the highest amino acid Cys (13.4 mg/L) and Tyr

(8.2 mg/L), but others were lower. Treatment T2 has the highest amino acid Gln (87.0 mg/L), Gly (57.0 mg/L), His (9.2 mg/L) and TArg (21.8 mg/L), but others were lower. Especial is T3 level, the total non-essential amino acid reached to the highest 2050.5 mg/L and the content of Pro reached to the highest 1574.0 mg/L, next the amino acid Ala reached to 255.2 mg/L, these difference were significant difference ($p<0.01$) than others, meanwhile, amino acid Ser was found and the content reached to 36.8 mg/L. Treatment T4 only has the highest amino acid Asp (74.8 mg/L). The results shown treatment T3 has abundant non-essential amino acid and the amino acid of Pro and Ser were the typical composition.

DISCUSSION

This is a primary study. We have designed a new wine type. Wine prepared from *Prunus domestica* × *P. armeniaca* cultivar Fengweimeigui fruit pule is a novel beverage rich essential amino acid, non-essential amino acid, minerals and trace elements etc. In Fengweimeigui fruits wine, the more amino acid contents were higher than apple wine, apple-pine wine and apple-herb wine (Lee *et al*., 2013). And the pH is approximate Mango wine and fermented cashew apple products, but alcohol concentration is higher than Mango wine (Araújo *et al*., 2011; Musyimi *et al*., 2012). At T1 and T2, the sugar contents are lower than *Achras sapota* functional wine, but T3 and T4 are higher (Reddy and Reddy, 2005). However, the mineral contents of Na, Fe, Ca and Mg are higher very much than kiwifruit wine (Towantakavanit *et al*., 2011), but the content of Fe (ND~1.10 mg/L, Table 1) was far lower than wines at national wines standard (8.0 mg/L). The shelf-life period of the fruit is short (10-15 days). This study suggests a method to ferment from self fungal endophytes these fruits into value-added products such as wine to preserve their nutrients, minerals and taste etc. and make them available to consumers all year round.

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