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Different factors influence to the fermented passion fruit beverage production

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Abstract
Fermented beverages have high expression in the market for beverages in general, is increasingly valued in situations where the characteristic aroma and flavor of the material that gave rise to them are kept after processing. The passion fruit (*Passiflora edulis*) is a well-known fruit in Vietnam. Our study focuses on investigation about some parameters including sugar content, pH, yeast *saccharomyces cerevisiae* supplementation and fermentation time to get the good fermented passion fruit beverage. Our results are as follows: pectinase supplementation 0.15 ml/100g (0.15%), water dilution 50% with juice, incubation at 40^{o}C in 1 hour with 1.5% yeast, pH of fermentation 4.0, fermentation temperature 26 ± 1oC; fermentation time 72 hours, syrup adding 65 ^{o}Brix. The final fermented passion fruit beverage has sensory score at 16.6. This investigation is suitable for a completely fermented passion fruit beverage production.

Keywords: Passion fruit, pectinase, saccharomyces cerevisiae, fermentation, fermented beverage

1. Introduction
Passion fruit (*Passiflora edulis*) is known for its natural attractive colouring, unique flavour properties and medicinal purposes. It not only has high amounts of vitamin A and C, potassium, dietary fibre, carotenoid and polyphenol, but also is the best tropical fruit having a floral, ester aroma with exotic tropical sulphur. However, its high acidity limits its use as an ingredient in the formulation of various preparations such as beverages, ice cream, marmalade, cocktails, etc (Renata De Marchi *et al*., 2009). It's one of these fruit and its main attractions include the intense yellow color of its pulp, acid and refreshing taste and an unmatched aroma, consisting mainly of esters, aldehydes, alcohols and ketones (Werkhoff *et al*., 1998).

Fig 1: Passion fruit (*Passiflora edulis*)

The fruit is of easy preparation. One needs only cut it in half lengthwise and scoop out the seedy pulp with a spoon. For home use, Australians do not trouble to remove the seeds but eat the pulp with cream and sugar or use it in fruit salads or in beverages, seeds and all. Elsewhere it is usually squeezed through two thicknesses of cheesecloth or pressed through a strainer to remove the seeds. Mechanical extractors are, of course, used industrially. The resulting rich juice, which has been called a natural concentrate, can be sweetened and diluted with water or other juices (especially orange or pineapple), to make cold drinks. In South Africa, passionfruit juice is blended with milk and an alginate; in Australia the pulp is added to yogurt. After primary juice extraction, some processors employ an enzymatic process to obtain supplementary "secondary" juice from the double juice sacs surrounding each seed. The high starch content of the juice gives it exceptional viscosity. To produce a free flowing concentrate, it is desirable to remove the starch by centrifugal separation in the processing operation. Passion fruit juice can be boiled down to a sirup which is used in making sauce, gelatin desserts, candy, ice cream, sherbet, cake icing, cake filling, meringue or chiffon pie,

cold fruit soup, or in cocktails.
The seeded pulp is made into jelly or is combined with pineapple or tomato in making jam. The flavor of passion fruit juice is impaired by heat preservation unless it is done by agitated or "spin" pasteurization in the can.
There are several researches mentioned to the fermented passion fruit beverage (Luciana C. Azevedo *et al*., 2009; Pattharaporn *et al*. 2010; Nzabuheraheza *et al*., 2014). The aim of our research is to find out major factors affecting to the fermented passion fruit beverage production.

2. Material & Method

2.1 Material

We selected ripe fruits of yellow passion fruit, produced in Tra Vinh province, Vietnam. The fruits were washed and cut to remove the pulp and evaluating the yield of pulp and peel. Then the pulp was subjected to analysis of soluble solids and pH in order to be made the necessary corrections in the must. A certain amount of fruit pulp was transferred to a fermentation vat of stainless steel, with a capacity of 10L, which were also added water and sugar. The mash was homogenized and vat closed to start fermentation, which occurred at room temperature (about 30 ^{o}C). The fermentation was monitored daily by reading the content of dissolved solids in the must, and the end of fermentation determined by the stabilization of ^{o}Brix.

2.2 Research method

2.2.1 Microbial method

- Yeast proliferation: passion fruit juice has soluble dry matter 100-120 g/l, pH 4.5-4.7.
- Fermentation medium: passion fruit juice has soluble dry matter 160-220 g/l, pH 3.5-5.0.
- Yeast proliferation and fermentation is conducted at temperature 25-27 ^{o}C.

2.2.2 Chemical method

- Total sugar and reduced sugar is determined by Bertrand.
- Total acidity is titrated by KOH 0.1N with Phenolphtalein as indicator.
- Ethanol content is analysed by chemical method.
- pH measurement is performed by pH meter.

2.2.3 Sensory evaluation

Products are evaluated by sensory method according to TCVN 3215 – 79 for three main parameters including turbidity, aroma and taste.

2.3 Research description

Passion fruits are purchased in Tra Vinh local market. They must be in technical ripen stage, without damage, special flavour, yellow color. Raw fruits are washed under tap-water to remove foreign matters and microorganisms on their skin. They are dripped for a while and then chopped into two parts to collect pulp. This handling must be quickly to avoid oxidation. This pulp is then treated with pectinase and incubated at 40 ^{o}C in 1 hour. Incubation is necessary to increase extraction recovery and decrease viscosity of fermentation medium so that extraction juice has better physio-chemical and sensory characteristics. This process creates more sugar owing to pectin hydrolyzation to produce simple sugar; brighter color compared to raw juice. After incubation, it should be pressed to collect juice; added sugar and water; adjusted acidity; sterilized at 60 ^{o}C in 15 minutes, and cooled. After cooling, it should be supplemented yeast and fermented immediately to avoid microbial contamination. After fermentation, it comes to stabilization and filtration. To get a pleasant taste, it's also supplemented with syrup. Fermented juice is then pasteurized at 60-62 ^{o}C in 30 minutes to eliminate microorganism. Final step is bottling and preservation.

2.4 Statistical analyses

Use Microsoft Excel 2003 at 95% confidence level

3. Result & Discussion

3.1 Effect of pectinase supplementation

3.1.1 Volume of juice extraction

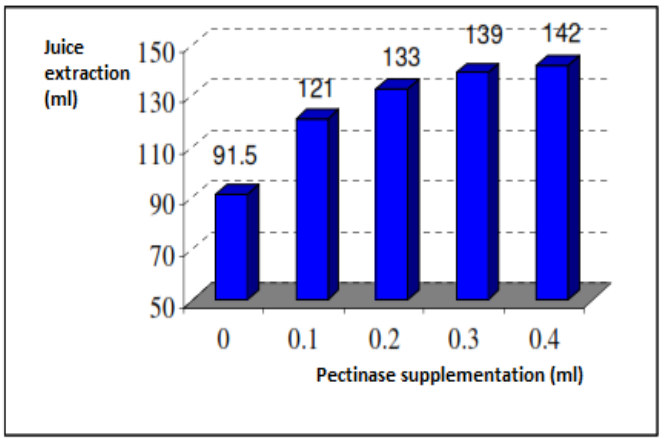

Fig 2: Effect of pectinase supplementation to juice extraction

Table 1: Sensory evaluation for passion fruit juice

Sample	Pectinase supplementation	Characteristics
1	Control	Brown yellow color, turbidity
2	0.1 ml	Yellow color, turbidity
3	0.2 ml	Yellow color, light turbidity
4	0.3 ml	Yellow color, not turbidity
5	0.4 ml	Strong yellow color, not turbidity

From table 1 above, we can either choose sample 3 (0.2 ml pectinase) or 4 (0.3 ml pectinase) for further researches.

3.1.2 Result of sugar content

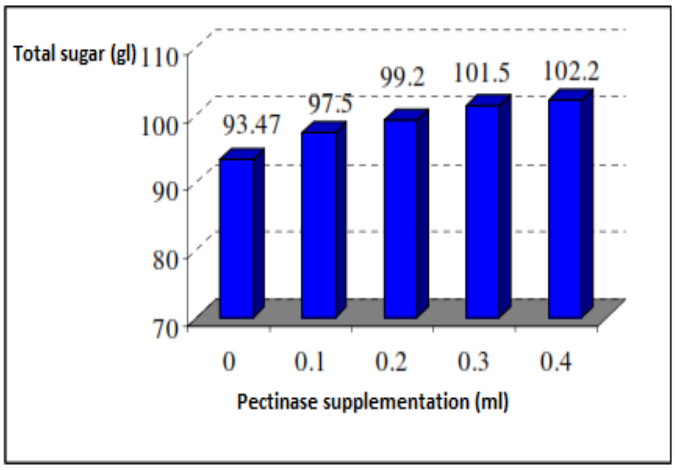

Fig 3: Effect of pectinase supplementation to sugar content
From figure 3 we see that total sugar increases dramatically when supplementing 0.3 ml pectinase/ 200 ml juice to get the highest sugar content (101.5 g/l).

3.2 Effect of water supplementation

3.2.1 Result of dry matter in juice after dilution

Table 2: Dry matter in passion fruit juice after dilution

% H_2O supplementation	Dry matter content (g/l)			Average dry matter content (g/l)
	Measure #1	Measure #2	Measure #3	
30	92	95	90	92
40	86	88	84	86
50	80	82	78	82

3.2.2 pH of juice after dilution

Table 3: pH in passion fruit juice after dilution

% H_2O supplementation	pH			Average pH
	Measure #1	Measure #2	Measure #3	
30	3.10	3.15	3.20	3.15
40	3.40	3.50	3.40	3.41
50	3.80	3.70	3.90	3.80

3.2.3 Result of juice sensory after dilution

Table 4: Sensory score of passion fruit juice with important factor after dilution

%H_2O / Parameter	30	40	50
Taste	8.6	8.4	8.2
Aroma	5.2	5.0	4.8
Color and turbidity	3.6	3.4	3.4
Average score	17.4	16.8	16.4

We don't see any difference in sensory value in case of 30, 40, 50% dilution. So 50% dilution is selected for next experiments.

3.3 Sugar content for fermentation.

After adding sugar into fermentation batch, we conduct the fermentation process and analyse some key points: ethanol, residual sugar, product sensory quality.

Table 5: Average score of fermented product by different sugar contents

Initial sugar content (g/l) / Parameter	Sample #1 160	Sample #2 180	Sample #3 200	Sample #4 220
Taste	5.8	6.6	7.4	7.0
Aroma	3.8	4.2	4.8	5.0
Color and turbidity	3.0	3.2	3.6	3.6
Average score	12.6	14.0	15.8	15.6

Sugar content has positive effect to ethanol formation. However if it's too high, it will create high osmosis pressure on yeast leading to low ethanol accumulation. This phenomenon can be clearly seen in figure below.

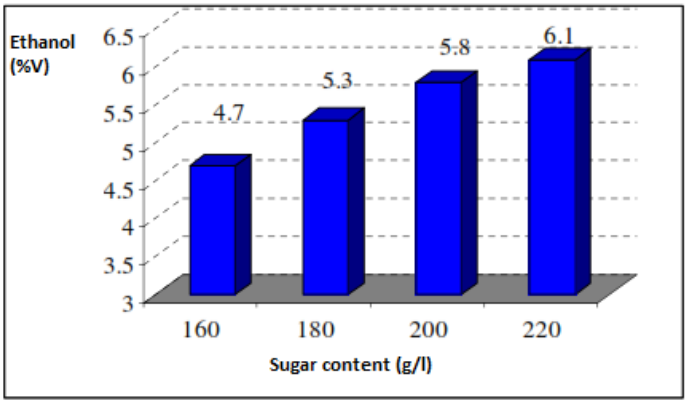

Fig 4: Effect of sugar content to ethanol formation

The more initial sugar content in fermentation batch, the more residual sugar can be remained (see figure 5 below).

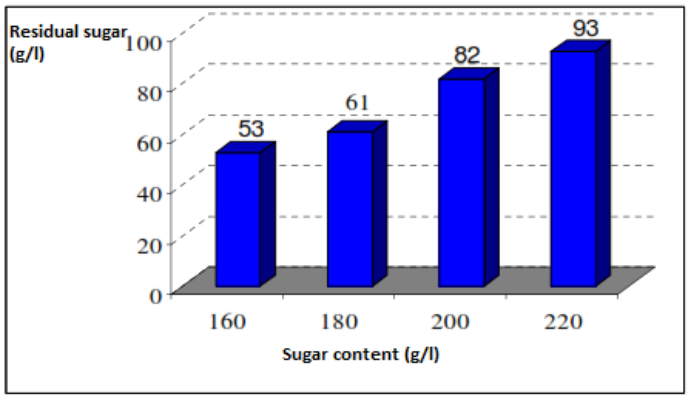

Fig 5: Sugar content change during fermentation

Initial sugar content in passion fruit juice is quite low 82 g/l so it's necessary to add more sugar to get the appropriated concentration for fermentation, for instances: sample #1: 7.8 g/l; sample #2: 9.8 g/l; sample #3: 11.8 g/l; sample #4: 13.8 g/l, equivalent to sample #1: 160 g/l; sample #2: 180 g/l; sample #3: 200 g/l; sample #4: 220 g/l.

3.4 Effect of pH for fermentation

Table 6: Average score of samples fermented at different pH values

pH / Parameters	Sample #1 3.5	Sample #2 4.0	Sample #3 4.5	Sample #4 5.0
Taste	5.4	8.6	6.8	5.0
Aroma	4.4	5.2	4.6	4.0
Color and turbidity	2.8	3.4	3.0	2.4
Average score	13.6	17.2	13.4	11.4

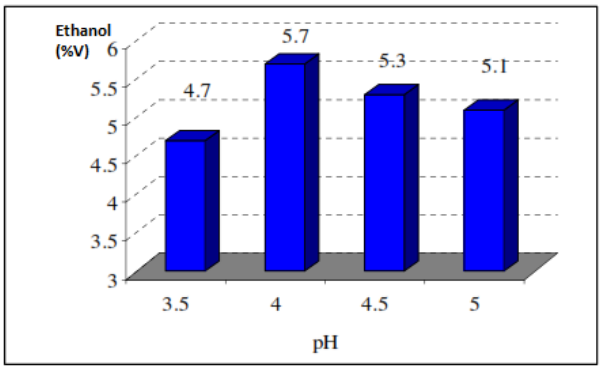

Fig 6: Effect of pH to ethanol formation

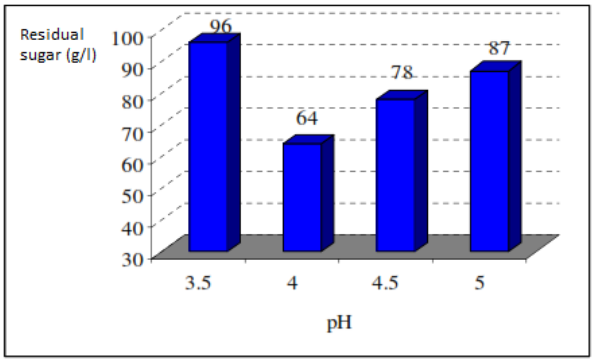

Fig 7: Effect of pH to sugar content change during fermentation

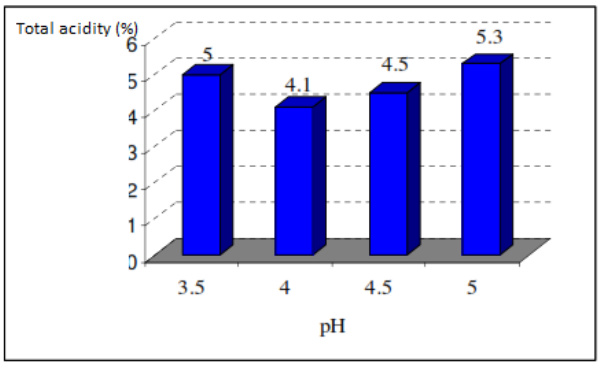

Fig 8: Effect of pH to the total acidity during fermentation

From figures above, pH=4 is optimal for passion fruit fermentation.

3.5 Effect of yeast supplementation to fermentation

Table 7: Average score of samples supplemented by different yeast ratio

Yeast ratio (%)	**Sample #1**	**Sample #2**	**Sample #3**	**Sample #4**
Parameters	**1.0**	**1.5**	**2.0**	**2.5**
Taste	7.2	8.4	7.6	6.8
Aroma	3.8	4.8	4.2	3.8
Color and turbidity	3.0	3.2	2.8	2.8
Average score	14	16.4	14.6	13.4

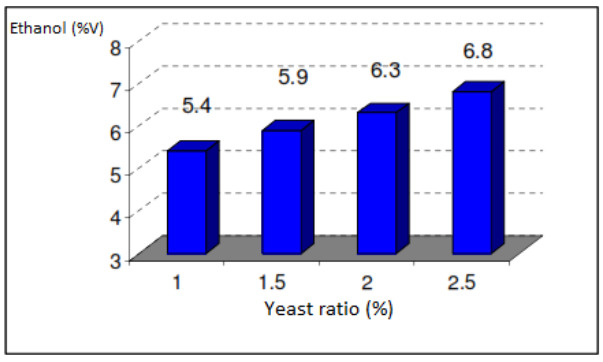

Fig 9: Effect of yeast supplementation to ethanol formation

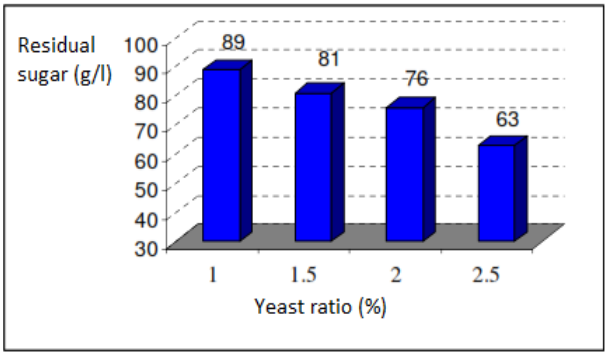

Fig 10. Effect of yeast supplementation to residual sugar

From above figures, we select yeast ratio supplementation 1.5% for further experiments.

3.6 Effect of fermentation time

Fermentation time is also very important to low-alcohol product quality. In case of short fermentation time, samples can't get specific characteristics (ethanol, color, aroma and taste). Long fermentation time also create high ethanol and bad flavour. So it's necessary to find out the appropriated fermentation time.

Table 8: Average score for samples fermented at different times

Fermentation time (hour)	**Sample #1**	**Sample #2**	**Sample #3**	**Sample #4**
Parameters	**48**	**60**	**72**	**84**
Taste	6.2	7.0	8.0	6.8
Aroma	2.8	3.2	3.8	3.2
Color and turbidity	2.2	2.6	3.4	3.6
Average score	11.2	12.8	15.2	13.6

Fermentation time directly affects to ethanol formation. The more substrate and longer fermentation time are, the ethanol formation is also high and vice versa.

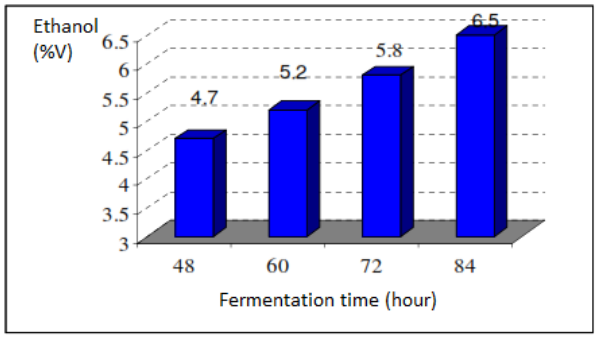

Fig 11: Effect of fermentation time to ethanol formation

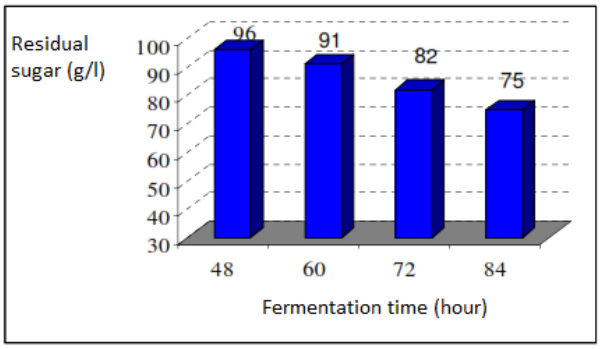

Fig 12: Effect of fermentation time to residual sugar content

Sample #3 has the fermentation time 72 hours which is different to sample #1 and sample #2. Ethanol formation is quite high (5.8) but residual sugar content is rather low (8.2). Sensory characteristics as ethanol, residual sugar, taste, color, turbidity are inacceptable. So we choose 72 hours for passion fruit fermentation time.

3.7 Effect of taste adjustion

Taste adjustion creates pleasant feeling for samples. So fermented passion fruit juice must be adjusted by syrup 65%.

Table 9: Sensory score of samples adjusted taste

Syrup supplementation (%)	Average score without important factor	Important factor	Average score with important factor
5	3.6	2.0	7.2
6	4.2	2.0	8.4
7	3.4	2.0	6.8
8	3.2	20	6.4

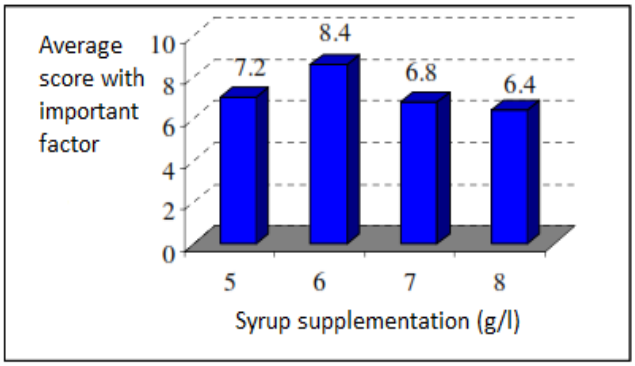

Fig 13: Sensory score with important factor of samples after being adjusted taste

From figure above, adjustion at 6% gives the highest sensory score (8.6). So this value is chosen.

3.8 Treatment after fermentation

After fermentation, beverage must be stabilized, filtrated, added syrup 6% and then pasteurized at 60-62 ^{o}C to inactivate yeast and lactic bacteria. This beverage will be filled in bottles, preserved and consumed.

Table 10: Production cost of fermented passion fruit beverage

Description	Quantity	Unit price	Amount (VND)
Passion fruit	1 kg	8,000 VND/kg	8,000
Pectinase	7.5 ml	880,000 VND/litre	6,600
Sugar	150 g	12,000 VND/ kg	1,800
Na_2CO_3	1.5 g	90,000 VND/kg	135
Yeast	20 ml	20 VND/ml	400
Glass bottle 240 ml	1 bottle	1,000 VND/bottle	1,000
Others (electricity, water, labor, deduction)	-	-	3,000
Total			20,935

In order to get 1 litre of fermented passion fruit beverage, production cost will be 20,935 VND/litre. In case of 240 ml bottle filling, production cost for one bottle is 5,030 VND. In mass production, this cost can be reduced dramatically.

Fig 14: Fermented passion fruit beverage

4. Conclusion

Our study finds out some major factors affecting to the fermented passion fruit beverage. This approach helps diverse products from passion fruit in small and medium scale production in every household in Tra Vinh province, Vietnam. Product has pleasant taste, yellow-brown color, low turbidity and safety. This can satify almost consumers including woman and the old.

5. Reference

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