Development of passion fruit juice beverage

Xiang-hao ZHU[1,2a], Zhen-hua DUAN[1,2b*], Yu-xia YANG[1,2c], Xin-hui HUANG[1d], Cheng-ling XU[1e] and Zhi-zhuo HUANG[1f]

[1]School of Food and Bioengineering, Hezhou University Hezhou, 542899, China

[2]School of Food Science and Technology, Dalian Polytechnic University, Dalian 116034, China

[a]237066520@qq.com, [b]dzh65@126.com (*corresponding author), [c]1297761238@qq.com, [d]804890382@qq.com, [e]634207307@qq.com, [f]760292021@qq.com

Abstract. In this experiment, the whole fruit of passion fruit was used as raw material. The effects of the ratio of material to liquid (RML), the amount of sucrose addition and the pH on the quality of passion fruit juice beverage were investigated by single factor test. And the optimum process conditions of passion fruit juice beverage were determined by orthogonal test. The results show that the optimum process paramenters were as follow: RML was 1: 3, pH was 4.0 and sucrose addition was 8%. Under such optimal conditions, the color of passion fruit juice beverage was red, the flavor of passion fruit was rich and it tasted pleasant.

1. Introduction

Passiflora edulis (*Passiflora caerulea* L.), Passifloraceae, Passion fruit, which known as passion fruit, Brazil fruit, egg fruit, is a perennial evergreen climbing vine[1]. Its fruit is berry, in which the whole fruit weight is about 35%, the pericarp is about 60%, and the fruit seed is about 5%[2]. The passion fruit has rich aroma and rich nutrients, which contains aromatic compounds up to more than 135; also contains citric acid, L-malic acid, L-lactic acid, L-ascorbic acid and other seven kinds of organic acids [3]; Fe, Cu, Mn, Zn, Se and other 21 kinds of trace elements; histidine, arginine, glutamic acid and other 17 kinds of amino acids, in the passionflower amino acid glutamic acid content of the highest, up to 64.90mg / 100g [4]. The passion fruit peel contains crude fiber, tea polyphenols, pectin, starch, protein, polysaccharides, flavonoids and other substances. Which contain that the content of crude fiber was 22.1%, the total phenol content was 2811.24 ± 22.74mg/100g, the content of pectin was 12.5%, the content of polysaccharide was 20.62g/100g and the total flavonoid content was 1180.67 ± 16.73mg/100g [5,6]. Passion fruits not only gets rich nutritious but also has a variety of health care functions, such as refreshing, solve thirst, help digestion, nourishing yin and make up kidney, eliminate fatigue and other effects; In addition the extract of passion fruit peel also has antiin flammatory, anticancer, antioxidant and sedation and other effects [7].

Passion fruit was often processed into fruit juice [8,9], fruit wine [10,11], jam [12], fruit vinegar [13,14] and so on, because it has a unique aroma. However, passion fruit peel was processed into animal feed or extracted pectin, dietary fiber and so on. The processing of Passion fruit juice beverage was mainly based on passion fruit pulp, so only the nutrients of the pulp was added to the beverage. But in this study, the whole fruit of passion fruit was processed into passion fruit juice beverage, which made the beverage with richer nutritious.

2. Materials and Methods

Materials Passion fruit was purple fruit, which was provided by Guangxi Hezhou Xindu town; food grade sugar was purchased from Liuzhou City Gu Li rock sugar Limited; food grade lactic acid was bought from Henan Jindan Lactic Acid Technology Co., Ltd.; food grade alkali was purchased from Nanjing Ganzhiyuan Sugar Co., Ltd.; pectinase (10000 U/mL) was bought from Novozymes (China) Biotechnology Co., Ltd.

Jd-322 beating machine was purchased from Jinda Electric Co., Ltd.; HH-6 digital constant temperature water bath was bought from Guohua Electric Co., Ltd.; KDC-40BSA- 124S electronic balance was got from Sartorius Scientific Instruments (Beijing) Co., Ltd.; YP1201N electronic balance was bought from Shanghai Shunyu Hengping Science Instrume- nt Co., Ltd.; LH-B55 digital refractometer was purchased from Luheng Biotechnology Co., Ltd..

Passion Fruit Juice Beverage Processing. Passion fruit→ selection→ cleaning→ beating→ enzy- molysis→ filtration→ allocating→ colloid mill treatment→ filling→ exhaust→ sealing→ sterilization → cooling

Operation Points: ①selection, cleaning: passion fruits were the same mature, no pests, uniform size, and passion fruits were washed and placed dry until used; ②beating: passion fruit and water have been beating by a certain percentage; ③enzymolysis: 0.004% pectinase was added to passion fruit juice and placed in 40℃water bath for 20 min; ④filtration: After the enzymolysis, the passion fruit juice was filtered with 8 layers of gauze; ⑤allocating: A certain amount of sucrose was added to percolation the good passion fruit juice and the juice was adjusted to the appropriate pH; ⑥colloid mill treatment: the allocated of a good passion fruit juice beverage was treated for 5 min in colloid mill; ⑦filling: passion fruit juice beverage were filled into PET / PE composite vacuum food packaging bags; ⑧sterilization [15]: the packaging of passion fruit juice beverage was placed in 85±2℃ water bath sterilization 15 min.

Experimental Design On the basis of preliminary experiment, the basis conditions were as follow: the RML of passion fruit and water was 1: 3, the amount of sucrose was 8% and the pH was 4.0. The effects of various factors on the quality of passion fruit juice beverage were studied. The single factors test of passion fruit were as follow: RML were 1: 2, 1: 3, 1: 4, 1: 5 and 1: 6; sucrose additions were 4%, 6%, 8%, 10% and 12% and the pH were 3.0, 3.5, 4.0, 4.5 and 5.0.

Determination of the Optimum Technological Conditions of Passion Fruit Juice Beverage. On the basis of single factor test, in order to further study the optimum processing conditions of passion fruit juice beverage processing, that the orthogonal experiment was designed with three factors: sucrose addition, RML and pH value. Orthogonal test factors and levels were shown in Table 1.

Table 1 Passion fruit juice beverage orthogonal test factor level.

Level	Factor		
	A Sucrose addition /%	B RML(passion fruit: water)	C pH
1	6	1:2	3.8
2	8	1:3	4.0
3	10	1:4	4.2

Determination of Indicators. Method for determination of total acid reference national standard GB/T 12456-2008; Soluble solids were measured by a refractometer [16]. The sensory evaluation of passion fruit juice beverage was carried out from four aspects: color, smell, taste and organization of beverage. The method was to select 10 people to evaluate and grade the passion fruit juice beverage. The specific scoring criteria were shown in Table 2; Excel2007 and Origin 8.5 were used for data processing and graphics drawing .

Table 2 Test criteria for sensory evaluation of passion fruit juice beverage.

Project	Grading	Sensory score / point
Color (20 points)	red, color and shade appropriate	16～20

Odor (30 points)	light red, color and shade more appropriate	9～15
	orange-red, blue-green, red or brown	0～8
	a strong passionflower flavor, odor coordination	21～30
	passiflora flavor slightly lighter	11～20
	passiflora fragrance was light or uncoordinated	0～10
Taste (30 points)	sweet and sour taste, taste pleasant	21～30
	sweet and sour more palatable, taste lighter	11～20
	partial acid, partial sweet	0～10
Organizational status (20 points)	juice turbidity was more uniform, there was little sediment, no impurities	16～20
	juice turbidity had more sediment, no impurities	9～15
	the juice was layered and has impurities	0～8

3. Results and Analysis

Effect of RML on Quality of Passion Fruit Juice Beverage. Different RML has different effects for passion fruit juice of color, smell, taste, tissue state. As can be seen from Table 3, the color of passion fruit juice beverage gradually changed from red to orange-red. The aroma gradually of passion fruit fades, but it tasted with sweet and sour basic palatability, and the sediment was gradually reduced with the increase of water in the proportion. It was mainly due to that the proportion of water increased and the proportion of passion fruit pulp decreased in the beverage. When the RML was 1: 3, The appearance of the passion fruit juice beverage was red, with a small amount of sediment and no impurities; it tasted sweet and sour palatable and flavor pleasant; The sensory evaluation score of passion fruit beverage was higher than other RML tests. When the RML were 1: 5 and 1: 6, which sensory score of passion fruit juice beverage were lower than other RML test, which aroma of beverage were lighter, and which color were orange red.

Table 3 Effect of different RML on sensory quality of passion fruit juice beverage.

RML	Sensory evaluation	Sensory score / point
1:2	Red, color and shade appropriate; a strong passionflower flavor, odor coordination; sweet and sour more palatable; juice turbidity was more uniform, more sediment, no impurities	83.70
1:3	Red, color and shade appropriate, a strong passionflower flavor, odor coordination; sweet and sour taste, taste pleasant; juice turbidity with a little sediment, no impurities	89.00
1:4	Light red, color and shade more appropriate, a strong passionflower flavor, odor coordination; sweet and sour more palatable, taste lighter; juice turbidity with a little sediment, no impurities	83.00
1:5	Orange- red; passion fruit aroma slightly lighter; sweet and sour more palatable; juice turbidity with a little sediment, no impurities	71.20
1:6	Orange- red; passion fruit fragrant; sweet and sour more palatable; juice turbidity with a little sediment, no impurities	65.90

Soluble solids and total acid were important indicators of fruit juice beverage. It reflected in Fig. 1, when the RML was changed from 1: 2 to 1: 6, the passion fruit juice beverage soluble solids decreased slightly, The total acidity decreased from 4.59 g/kg to 1.86 g/kg. This was because that in a certain amount of passion fruit juice beverage, passion fruit juice content decreased, resulting in passion fruit juice beverage soluble solids and acid content decreased with the change of RML. When the RML was

1: 2, 1: 3 and 1: 4, the soluble solids and total acid of passion fruit juice beverage were in accordance with NY/T 292-1995 standard.

Comprehensive each indicators of the situation, the RML of the passion fruit juice were 1: 2, 1: 3 and 1: 4, which were determined as the level of orthogonal test.

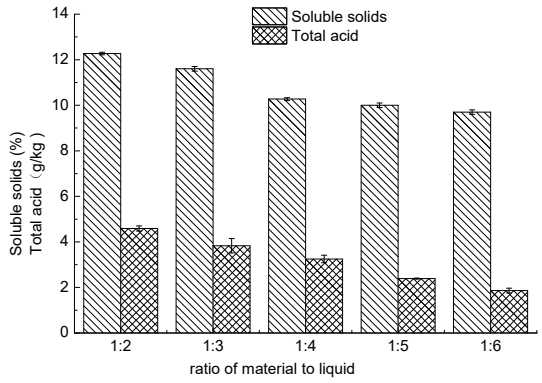

Fig. 1 The effect of different RML on the quality of passion fruit juice beverage.

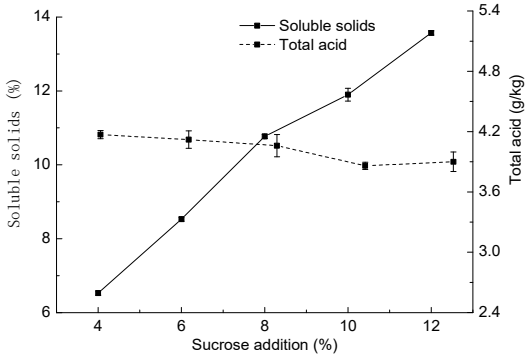

Fig. 2 Effect of different sucrose additions on the quality of passion fruit juice beverage.

Effect of Different Sucrose Content on Quality of Passion Fruit Juice Beverage. Sugar was a beverage commonly used to improve the taste of the material. The amount of different sucrose showed a different sweetness in the beverage. So only the sugar was added in the right circumstances, the beverage would has a pleasant taste. It can be seen from Table 4 that passion fruit juice beverage was tasted better with the increase in the amount of sucrose. When the amount of sucrose was 8%, the passion fruit juice beverage was sweet and sour taste and taste pleasant, the sensory score of passion fruit juice was higher than other sucrose addition test. However, when the amount of sucrose was less than 6%, the aroma and sweet of passion fruit juice beverage were not enough. When the amount of sucrose was 12%, the entrance of the passion fruit juice beverage was strong sweet.

Table 4 Effects of different sucrose additions on sensory quality of passion fruit juice beverage.

Sucrose addition /%	Sensory evaluation	Sensory score /point
4	Red, color and shade appropriate; a strong passionflower flavor, odor coordination; partial acid; juice turbidity was more uniform, a little sediment, no impurities	70.10
6	Red, color and shade appropriate; a strong passionflower flavor, odor coordination; sweet and sour more palatable, lighter taste; juice turbidity was more uniform, a little sediment, no impurities	85.20
8	Red, color and shade appropriate; a strong flavor of passionflower, odor coordination; sweet and sour taste, taste pleasant; juice turbidity with a little sediment, no impurities	91.80
10	Red, color and shade appropriate, a strong passionflower flavor, odor coordination; sweet and sour more palatable, taste lighter; juice a little sediment, no impurities	83.80
12	Red, color and shade appropriate; a strong flavor of passionflower, smell coordination; partial sweet; juice turbidity with a little sediment, no impurities	78.10

It can be seen from Fig. 2 that with the increase of the sucrose content, the soluble solids increase in the passion fruit juice beverage, but the change of the total acid was not significant. It was because that the concentration of sucrose increased, which led to increase refractive index of passion fruit juice

beverage, while the total acid did not change[17]. When the amount of sucrose was 4%, the soluble solids of passion fruit juice were 6.53% and the total acid was 4.17 g/kg, but the soluble solids did not meet the requirements of NY/T 292-1995. When the amount of sucrose was 12%, the soluble solids of passion fruit juice beverage were 13.57% and the total acid was 3.90 g/kg. When the amount of sucrose was 4% and 12% in passion fruit juice beverage, the soluble solids difference were 51.88% and the total acid difference was 6.47%. It was found that the addition of sucrose had a great influence about the soluble solids of passion fruit juice beverage, but the total acid basically did not affect. However, when the amount of sucrose was 6%, 8%, 10% and 12%, the soluble solids and total acid of passion fruit juice were in accordance with NY/T 292-1995 standard.

Comprehensive sensory evaluation, soluble solids and total acid three indicators, the content of sucrose in the passion fruit juice beverage were 6%, 8% and10%, which were determined to be the range of orthogonal test.

Effect of Different pH on Quality of Passion Fruit Juice Beverage. As can be seen from Table 5, the different pH of the passion fruit juice beverage presents a different color. When the passion fruit of the passion fruit juice beverage was 3.0, the sensory score was low, the color was too bright, and the partial acid, affecting the appearance and taste of the passion fruit juice beverage. When the pH was 5.0, the passion fruit juice beverage was blue and green, the flavor of passion fruit was rich and it tasted sweet and sour palatably, but the flavor was light. This was because that the passion fruit juice beverage contains passion fruit skin pigment I, the pigment solution were red in acid or near acidic conditions, and its color was deeper in the lower pH of the pigment solution. When pH> 5, the pigment solution changes from red to blue and green, and the color increases with increasing pH [18]. When the pH was 4.0, the color of passion fruit juice beverage was red, the flavor of passion fruit was rich, it smelled coordination, and it tasted pleasant. The appearance of the passion fruit juice beverage has a small amount of sediment but no impurities.

Table 5 Effects of different pH on sensory quality of passion fruit juice beverage.

pH	Sensory evaluation	Sensory score / point
3.0	Red; with a strong passion of passion fruit, odor coordination; over the acid; juice turbidity was more uniform, a little sediment no impurities	56.10
3.5	Light red, color and shade more appropriate; with a strong passionflower flavor, odor coordination; partial acid; juice turbidity was more uniform, a little sediment, no impurities	65.00
4.0	Red, color and shade appropriate; with a strong flavor of passionflower, odor coordination; sweet and sour taste, taste pleasant; juice turbidity with a little sediment, no impurities	89.20
4.5	Light red, color and shade more appropriate; with a strong passion of passion fruit, odor coordination; sweet and sour more palatable, taste lighter; a little sediment, no impurities	79.20
5.0	Blue and green; with a strong flavor of passion fruit; odor coordination; sweet and sour more palatable, taste lighter; juice turbidity with a little sediment, no impurities	78.30

It can be seen from Fig. 3 that the soluble solids and total acid of passion fruit juice beverage decreased with the pH increase in the pH test range. When the pH was 3.0, the soluble solids of the passion fruit juice beverage were 12.93% and the total acid was 21.86 g / kg. When the pH was 5.0, the soluble solids of the passion fruit juice beverage were 9.93% and the total acid was 3.42 g/kg. The total acid and soluble solids at pH 3.0 were higher than those at pH 5.0. This may be because in the adjustment of the pH process, when the pH was adjusted to 3, lactic acid was added to increase the total acid content of passion fruit juice; when the pH was adjusted to 5, the total acid in the passion fruit juice beverage decreased, this was because that the addition of the edible base consumes the

acidic substance in the beverage. Therefore, except for different pH values other conditions were the same, the soluble solids of lower pH were higher than the higher pH in the passion fruit juice beverage[19]. When the pH was 4.0, the soluble solids and total acid of passion fruit juice beverage were 10.47% and 4.54g/kg, all of which meet the requirements of NY/T 292-1995 standard. The standard require of its soluble solids ≥ 8%, its total acid was between 0.2% and 0.5% [20].

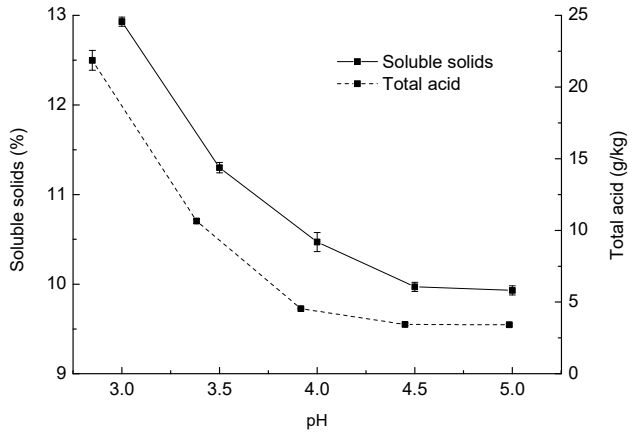

Fig. 3 Effects of different pH on the quality of passion fruit juice beverage.

Orthogonal Test Results According to the results of single factor test, the influencing factors of passion fruit juice beverage were determined. Orthogonal experiment was carried out to optimize the processing conditions of passion fruit juice beverage. The results were shown in Table 6.

Table 6 Orthogonal test results of passion fruit juice beverage.

Test number	Test factor						
	Sucrose addition /%（A）	RML（B）	Blank column	pH（C）	Soluble solids/%	Total acid g/kg	Sensory score / point
1	1（6）	1（1:2）	1	1（3.8）	10.37	6.65	70
2	1	2（1:3）	2	2（4.0）	8.9	4.42	78.9
3	1	3（1:4）	3	3（4.2）	8.67	3.04	74.5
4	2（8）	1	2	3	11.13	4.59	83.1
5	2	2	3	1	11.13	4.63	90.1
6	2	3	1	2	10.03	3.58	77.8
7	3（10）	1	3	2	12.77	5.01	79.9
8	3	2	1	3	12.27	3.52	74
9	3	3	2	1	11.9	4.44	75
K_1	27.93	34.27	32.67	33.4			
K_2	32.3	32.3	31.93	31.7			
K_3	36.93	30.6	32.57	32.07			
k_1	9.31	11.42	10.89	11.13			
k_2	10.77	10.77	10.64	10.57			
k_3	12.31	10.2	10.86	10.69			
R_1	3	1.22		0.56			
Factor primary and secondary			A＞B＞C				
Optimal combination			$A_3B_1C_1$				

K_1	14.1	16.25	13.75	15.71
K_2	12.8	12.56	13.44	13
K_3	12.96	11.05	12.67	11.15
k_1	4.7	5.42	4.58	5.24
k_2	4.27	4.19	4.48	4.33
k_3	4.32	3.68	4.22	3.72
R_2	0.43	1.74		1.52
Factor primary and secondary			B＞C＞A	
Optimal combination			$A_1B_1C_1$	
K_1	223.4	233	221.8	235.1
K_2	251	243	237	236.6
K_3	228.9	227.3	154.4	231.6
k_1	74.47	77.67	73.93	78.37
k_2	83.67	81	79	78.87
k_3	76.3	75.77	51.47	77.2
R_2	9.2	5.23		1.67
Factor primary and secondary			A＞B＞C	
Optimal combination			$A_2B_2C_2$	

From Table 6, the difference between R1, R2 and R3 shows that the RML, sucrose addition and pH affect the quality of passion fruit juice. The effect of sucrose addition on sensory evaluation and soluble solid were significant, and the effect on total acid was small. The optimum process for soluble solids was $A_3B_1C_1$, which was consistent with the addition of sucrose was 10%, the RML was 1: 2 and the pH was 3.8. The optimum process for sensory evaluation was $A_2B_2C_2$, which was consistent with the addition of sucrose was 8%, the RML was 1: 3 and the pH was 4.0. The optimum conditions for the total acid were $A_1B_1C_1$, which was consistent with the addition of sucrose was 6%, the RML was 1: 2 and the pH was 3.8.

It can be seen from Table 6, 1 to 9 test groups of soluble solids were in accordance with NY/T 292-1995 standard. Only No. 1 test group and No. 7 test group of the total acid did not meet the standard's requirements. So the sensory score was the main criterion for screening the best technological conditions. In the nine test groups, the sensory score of the test group No. 5 was the highest, it's total acid and soluble solid were also in accordance with the standard. But the condition of No. 5 test group was different to the sensory evaluation of the best process conditions. Therefore, further verification test was needed.

Verify The Test Results It can be seen from Table 7 that the sensory evaluation score of the $A_2B_2C_2$ was higher than $A_2B_2C_1$ test group. So the sensory quality of the $A_2B_2C_2$ test group was better than the $A_2B_2C_1$ test group. And the soluble solids and total acid of $A_2B_2C_2$ test group of passion fruit juice beverage were in accordance with standard. From the comprehensive analysis of the test indicators, we can see that the optimum conditions of passion fruit juice beverage were $A_2B_2C_2$, which was consistent with the amount of sucrose was 8%, the RML was 1: 3 and the pH was 4.0.

Table 7 The main quality indicators of the test of passion fruit juice beverage.

Test plan	Soluble solids (%)	Total acid (g / kg)	Sensory score (point)
$A_2B_2C_1$	11.01	4.32	88.50
$A_2B_2C_2$	10.51	4.58	94.10

4. Conclusion

It can be seen that the optimum conditions of the passion fruit juice beverage processing were as follow: the addition of sucrose was 8%, the RML was 1: 3 and the pH was 4.0. Under the process

conditions, the color of passion fruit juice beverage was red, the flavor of passion fruit was rich, it smelled coordination, and it tasted pleasant. The appearance of the passion fruit juice beverage has a small amount of sediment but no impurities. The soluble solids were 10.51% and the total acid was 4.58 g/kg of passion fruit juice beverage, which were in accordance with NY/T 292-1995 standard. The study on the technological conditions of passion fruit juice beverage provides the theoretical basis for the development of passion fruit juice beverage.

Acknowledgments
This work was financially supported by the authors wish to thank the financial support provided by the Guangxi Special Fruits & Vegetables Deep Processing and Fresh Technology Research (Project No. YS201601) for the research work. And the author would like to thank Professor Zhen-hua Duan for his guidance.

References
[1] D. Q. Huo, L. Jiang, L. L. Ma, "Berry fruit research and its development progress, " Food industry science and technology , Vol. 33, pp. 391-395, April, 2012(In Chinese) .
[2] K. Zhou, “Research on key technologies of integrated processing of passiflora ,” Guangxi University, May,2015(In Chinese).
[3] Q. F. Wang, L. P. Li, L. Gao, “Determination of organic acids in passiflora by reversed - phase high performance liquid chromatography, ” Journal of Tropical Crops, Vol. 36, pp. 1511-1517,February, 2015(In Chinese).
[4] B. Y. Deng, X. R. Shen, Y. C. Deng, “Comparative analysis of nutritional components of hainan’s passion fruit, lotus fog and jujube, ” Food Science and Technology, Vol. 34, pp. 335-338,February, 2013(In Chinese).
[5] M. M. Cheng, “Study on extraction, modification and functional properties of water - insoluble dietary fiber from passion fruit peel, ” South China Agricultural University, 2016(In Chinese).
[6] L. J. Wen, H. J. Mao, Y. C. Zhang, “Study on composition and antioxidant activity of passion fruit peel, ” Food Science, Vol. 29, pp. 54-58, July, 2008(In Chinese).
[7] X. J. Liu, J. Z. Pu, L. M. Yu, “Research progress on deep processing status and bioactivity of passion fruit, ” Guangzhou Chemical Industry, Vol. 45, pp. 23-24, May, 2017(In Chinese).
[8] R. G. Lin, “Development of shatian pomelo and passion fruit compound juice beverage, ” Food and Machinery, Vol. 30, pp. 204-206, July, 2014(In Chinese).
[9] W. Du, Q. H. Li, Y. Chen, “Study on the Production Technology and Stability of Berry Fruit - Mango Compound Beverage, ” Food Research and Development, Vol. 37, pp. 106-109, August, 2016(In Chinese).
[10] Y. L. Pan, H. Y. Qin, Y. Q. Huang, “Study on the technology of immobilized yeerian - passiflora compound fruit wine by immobilized yeast, ” China Brewing, Vol. 30, pp. 178-182, September, 2011(In Chinese).
[11] F. D. Nzabuheraheza , A. N. Nyiramugwera, “Golden wine produced from mixed juices of passion fruit (Passiflora edulis), mango (Mangifera indica) and pineapple (Ananas comosus), ” African Journal of Food Agriculture Nutrition & Development, Vol. 14, pp. 9105-9116, July, 2014.
[12] H. Kan, R. X. He, “Development of compound lotus of yacon and passion fruit., ” Northern Gardening, Vol. 30, pp. 178-182, May, 2008(In Chinese).
[13] Z. J. Wang, Y. H. Zhou, W. L. Chen, “Development of compound fruit vinegar of passiflora , ” Chinese condiments, Vol. 40, pp. 96-99, February, 2015(In Chinese).
[14] Y. L. Pan, Y. Q. Huang, X. Huang, “Study on fermentation technology of celery fruit - passiflora compound fruit vinegar, ” China Brewing, Vol. 31, pp. 208-211, May, 2012(In Chinese).
[15] X. X. Li, Y. Luo, F. Liang, “Study on the formula and stability of turbid - type lacquer juice beverage, ” Food and Fermentation Industries, Vol. 39, pp. 216-222, July, 2013(In Chinese).
[16] J. Y. Nie, J. Li, G. F. Xu, “Screening of suitable methods for determination of soluble solids

content of fruit , ” Storageand Process, pp. 62-64, October, 2014(In Chinese).
[17] H. Y. Sun, X. Y. Wang, W. X. Liu, “Study on the preparation technology of green tea - kiwi compound beverage, ” Food Science and Technology, Vol. 35, pp. 227-231, January, 2014(In Chinese).
[18] X. D. Chen, J. X. Wang, L. Zhang, “Study on the stability of pigment I of passion fruit , ” Food Science, Vol. 29, pp. 94-97, April, 2008(In Chinese).
[19] N. Round , N. M. Rigby, A. J. Macdougall, “A new view of pectin structure revealed by acid hydrolysis and atomic force microscopy, ”, Carbohydrate Research, Vol. 29, pp. 94-97, April, 2010.
[20] Ministry of Agriculture of the People 's Republic of China, “Green food with passion fruit juice beverage,” NY/T 292, 1995(In Chinese).