Trends in Horticulture (2021) Volume 4 Issue 1
doi:10.24294/th.v4i1.1796

ORIGINAL RESEARCH ARTICLE

The preparation of aloe-balsam pear compound beverage

Minsheng Zhou*, Chenyu Wang

School of Biotechnology and Food, Anyang Institute of Technology, Anyang 455000, China. E-mail: minshengchow@sohu.com

ABSTRACT

In this paper, a new compound health drink of aloe and balsam pear was developed by using high-quality aloe and balsam pear as main raw materials and white granulated sugar and citric acid as auxiliary materials. The effects of the addition of aloe juice, balsam pear juice, white granulated sugar and citric acid on the sensory quality of the beverage were investigated and analyzed. On this basis, the orthogonal test was conducted to determine the best formula for the beverage. The results showed that the order of the factors affecting the quality of the finished product was the addition of aloe juice > white granulated sugar > citric acid > balsam pear juice; the optimal formula is 24% aloe juice, 10% balsam pear juice, 7% white granulated sugar and 0.09% citric acid and the resulting beverage was bright in color, sweet and sour with good flavor, and its physical, chemical and health indicators meet the national standards.

Keywords: Aloe; Balsam Pear; Compound Beverage; Processing Technology

ARTICLE INFO

Received: 26 December 2020
Accepted: 4 February 2021
Available online: 25 February 2021

1. Introduction

With the improvement of living standards and the increasing incidence rate of obesity, hypertension, diabetes and other chronic diseases, consumers' health awareness is also gradually enhanced. The emergence of vegetable juice just meets people's demand for beverages. At the same time, China has many types of vegetables and high production, which has a unique resource advantage for the development of vegetable juice[1]. Combined with the huge demand potential for health drinks in the current market, the development prospect of vegetable juice compound health drinks is broad.

Aloe, belonging to Liliaceae, is a perennial succulent herb with the characteristics of juicy[1]. Studies have shown that aloe can clear away heat and relieve constipation, invigorate the spleen and stomach, regenerate muscle, and resist bacteria and inflammation[2]. Long term consumption of fresh aloe leaves or drinking aloe juice can improve the body's immunity, regulate body functions, detoxify and nourish the face, improve the symptoms of a variety of chronic diseases, and achieve the purpose of prolonging life[3–6]. Balsam pear contains protein, fat, carbohydrate, crude fiber and various vitamins, as well as balsam pear glycosides, protein-like active substances, a variety of amino acids, polysaccharides and various essential mineral elements for human body. It has the effects of lowering blood fat and blood pressure, inhibiting tumor, preventing and treating diabetes[7–9]; traditional Chinese medicine believes that it has the effects of clearing away heat and toxin, nourishing blood and Qi, tonifying the kidney, protecting the spleen,

nourishing the liver and brightening the eyes. It is a good food therapy product for diseases such as fever, dysentery, swelling and sore in summer[10].

Therefore, this paper selects aloe and balsam pear as the main raw materials, and uses the unique physiological effects of aloe and balsam pear to develop a health vegetable juice drink with good color, aroma and taste and special nutrients, which can enrich the types of vegetable juice and provide new ideas for vegetable processing. It is of great practical significance to make full use of vegetable resources and promote the development of vegetable cultivation and processing industry.

2. Materials and methods

2.1 Materials and reagents

Curacao aloe (Putian Hanjiang Jiangxia aloe Development Co., Ltd.); balsam pear (Production base of bitter melon in Shenxian County, Shandong Province); white granulated sugar (food grade) (Taikoo Sugar Limited (China)); citric acid (food grade) (Weifang Ensign Industry Co., Ltd.); ascorbic acid (food grade) (Northeast Pharmaceutical Group Co., Ltd.); sodium carboxymethyl cellulose (CMC-Na) (food grade) (Henan Qianzhi Trade Co., Ltd.); sodium alginate (food grade) (Henan Qianzhi Trade Co., Ltd.); ethyl maltol (food grade) (Zhengwei Food Ingredients Co., Ltd., Fuzhou).

2.2 Instruments and equipment

TD-2102B electronic balance (Yuyao Jinnuo Balance Instrument Co., Ltd.); TPM-3-1 beater (Shanghai Handing Machinery Technology Manufacturing Co., Ltd.); LDZH-100KBS data constant temperature water bath pot (Shanghai Shen'an medical instrument factory); AD300S-P high speed dispersion homogenizer (KN Equipment Shanghai Co., Ltd.); CBD-290W high pressure steam sterilizer (Qingdao Haier Co., Ltd.).

2.3 Process flow

2.3.1 Preparation of aloe juice

Aloe leaves → cleaning → peeling → cutting → debonding → color protection → beating → enzyme killing → filtering → aloe juice

2.3.2 Preparation of balsam pear juice

Balsam pear → cleaning → cutting → blanching → beating → filtering → bitter masking → balsam pear juice

2.3.3 Technological process of aloe and balsam pear compound health drink

White granulated sugar, citric acid
↓
Aloe juice and balsam pear juice → blending → filtration → homogenization → degassing
↑
Stabilizer, ethyl maltol
→ filling → sterilization → cooling → finished product

2.4 Key points of operation

2.4.1 Cleaning

Wash the dust on aloe leaves and balsam pear epidermis with tap water, soak it in 250 mg/kg sodium hypochlorite solution for 10–20 min for disinfection, and then rinse it with tap water.

2.4.2 Peeling and cutting

Peel off the outer skin of aloe leaves with a stainless steel knife, remove the transparent gel, avoid cutting the outer skin to make it mixed with gel, which will cause difficulties in subsequent filtration, and then cut the peeled aloe gel into 1 cm × 1 cm small pieces. Taking the central diameter of balsam pear as the axis, and cutting the balsam pear into uniform fruit blocks. Because the mesophyll of aloe is colorless, in order to ensure the color of the product, balsam pear does not peel, and it is necessary to select melons and fruits with normal color.

2.4.3 Debonding

Aloe leaf pulp was immersed in 1.0 mg/mL calcium lactate solution for 10 min.

2.4.4 Color protection

Transfer the aloe mesophyll after debonding to

the mixture of 0.01 mg/mL Na_2SO_3 and 0.5 mg/mL Vc, stir it, and complete the color protection treatment. Balsam pear juice was added with 0.02% Vc for color protection, which not only protected the color of compound juice, but also improved the nutritional value.

2.4.5 Slurry grinding

Small pieces of aloe are put into a high-speed tissue masher, beaten for 3–5 min, and then poured into a colloidal mill to improve the juice yield of aloe juice. Balsam pear is pulped with a juicer. The balsam pear juice is precooked in a 90 ℃ boiling pot to make it appear solidified sediment. After removing the large solidified sediment, it can be used.

2.4.6 Enzyme killing

After beating, the aloe juice is kept warm in a 70 ℃ water bath for 5 min, then quickly cooled to room temperature, and then 0.04% Vc is added and mixed evenly, which can inactivate enzymes, prevent oxidation loss of active substances in aloe, reduce the viscosity of aloe juice and facilitate filtration[11].

2.4.7 Filtering

The aloe juice and balsam pear juice obtained are filtered through a 150–180 mesh nylon filter screen to filter out pulp particles and dregs for future use.

2.4.8 Deployment

Add water according to a certain proportion of white granulated sugar, aloe juice, balsam pear juice and citric acid; add 0.15% sodium carboxymethyl cellulose and 0.02% sodium alginate as stabilizers[12], and add a small amount of ethyl maltol to enhance flavor.

2.4.9 Homogenization and degassing

Homogenize the compound juice at a pressure of about 25 MPa, and degasify it twice continuously under a vacuum of 0.09 MPa.

2.4.10 sterilization

The compound juice was treated by high temperature instant sterilization and sterilized at 135 ℃ for 5 s. The homogeneous liquid before sterilization should be preheated to 60 ℃ before entering the sterilizer, which is conducive to maintaining the active substances in Aloe Vera.

2.5 Experimental design

2.5.1 Single factor experiment

1) Determination of aloe juice addition

Balsam pear juice 8%, white granulated sugar 10%, citric acid 0.07%, set different aloe juice addition amount: 8%, 12%, 16%, 20%, 24%, to make finished beverage.

2) Determination of balsam pear juice addition

Aloe juice 20%, white granulated sugar 10%, citric acid 0.07%, set different amount of balsam pear juice: 6%, 8%, 10%, 12%, 14%, to make finished beverage.

3) Determination of white granulated sugar addition

Aloe juice 20%, balsam pear juice 10%, citric acid 0.07%, set different amount of white granulated sugar: 6%, 8%, 10%, 12%, 14%, to make finished beverage.

4) Determination of citric acid addition

Fix 20% aloe juice, 10% balsam pear juice and 10% white granulated sugar, and set different citric acid addition amounts of 0.03%, 0.05%, 0.07%, 0.09% and 0.11% to make finished beverage.

Organize 10 personnel to evaluate the sensory quality according to the scoring criteria (see **Table 1**), and take the average value as the result.

2.5.2 Orthogonal test

Combined with the results of the above single factor experiment, the orthogonal experiment of four factors and three levels was designed with aloe juice, balsam pear juice, white granulated sugar and citric acid as four factors (see **Table 2**).

2.5.3 Physical and chemical index inspection

Soluble solids were determined by hand-held refractometer. The total sugar content was determined by anthrone method, and the results were calculated by glucose. The total acid content is determined by acid-base neutralization titration, with 0.1 mol/L sodium hydroxide solution as the stand-

ard solution and phenolphthalein as the indicator. The results are calculated by citric acid.

Table 1. Sensory evaluation criteria

Index	Standard	Fraction
Color and luster	Light green, suitable in color	15–20
	Suitable color	5–15
	Yellowish color or dark green	0–5
Aroma	It has the unique aroma of balsam pear and aloe, and is harmonious without peculiar smell	15–20
	Balsam pear and aloe have light or exotic aroma	5–15
	Weak or incongruous aroma	0–5
Taste	Delicate taste, sweet and sour	20–30
	The taste is light, sour or sweet	10–20
	The taste is not pure and the mixed flavor is heavy	0–10
Structural state	The juice is translucent, without layering, impurities and with good fluidity	20–30
	There is a small amount of precipitation, no impurities and with good fluidity	10–20
	The juice is stratified or precipitated with poor fluidity	0–10

Table 2. Factors of orthogonal test

Level	Factor			
	A Aloe juice addition amount/%	B Balsam pear juice addition amount/%	C Addition amount of white granulated sugar/%	D Citric acid addition amount/%
1	16	8	7	0.05
2	20	10	9	0.07
3	24	12	11	0.09

2.5.4 Microbiological index test

Refer to GB4789.2-2016 for total bacterial count and GB4789.38-2012 for coliform group.

3. Results and analysis

3.1 Single factor experimental results

3.1.1 Effect of aloe juice on beverage quality

Although aloe juice contains high nutritional components, aloe juice contains certain anthraquinones, which have a bitter taste and can not be completely accepted by people. Therefore, the amount of aloe juice can not be added too much to ensure the taste. However, the low addition amount has little significance for supplementing a variety of trace substances and active substances, and the nutritional and physiological effects of the beverage are not significant enough.

It can be seen from **Figure 1** that with the increase of aloe juice, the sensory quality of the drink gradually improved, reached the peak at 20%, and the sensory score was 90, and then began to decline. Therefore, the addition amount should be controlled at about 20%.

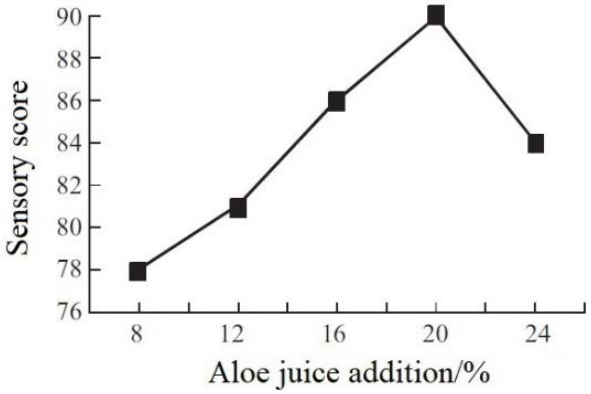

Figure 1. Sensory scores of beverages with different amounts of aloe juice.

3.1.2 Effect of balsam pear juice on beverage quality

Adding proper balsam pear juice, on the one hand, can enrich the nutritional efficacy of the drink, on the other hand, it can also improve the corresponding sensory score of the compound drink with the help of the natural color of balsam pear.

It can be seen from **Figure 2** that the best level of balsam pear juice consumption is 10%. Although excessive addition can better increase the color of the product, it also aggravates the bitter taste of the beverage, thus reducing the recognition of consumers. Therefore, the appropriate amount of balsam pear juice should be 8%–12%.

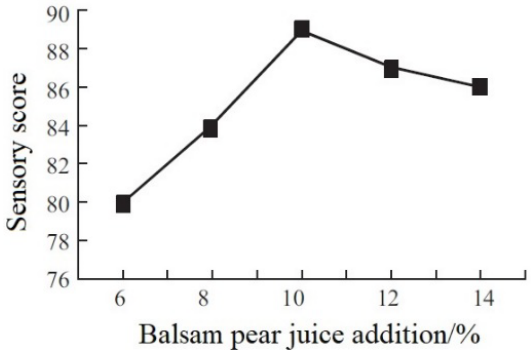

Figure 2. Sensory scores of beverages with different amounts of raw bitter melon gourd juice.

3.1.3 Effect of white granulated sugar addition on beverage quality

It can be seen from **Figure 3** that with the increase of the amount of white granulated sugar, the sensory score of the beverage gradually rises; when the addition amount was 10%, the sensory score reached the highest value of 88; after that, with the further increase of the addition amount, the sensory score decreased gradually; when the addition amount was 14%, the sensory score was only 77. A certain sugar content is a necessary condition to ensure the flavor of the beverage, so as to achieve the appropriate sugar acid ratio of the beverage. Therefore, with the increase of sugar content, the sensory score of the beverage gradually increased and further reached the maximum value. However, the high sugar content resulted in the high sweetness of the beverage, the imbalance of sugar acid ratio, which seriously affected the flavor of the beverage, and the sensory score decreased.

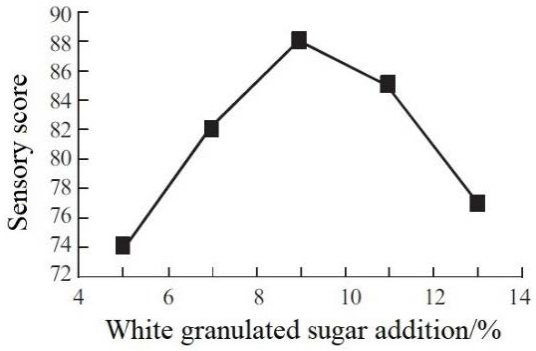

Figure 3. Sensory scores of beverages with different white sugar additions.

3.1.4 Effect of citric acid addition on beverage quality

As can be seen from **Figure 4**, from 0.03%, with the increase of concentration, the sensory score quickly reached the maximum value of 91 points; when the amount of citric acid was more than 0.07%, the sensory score decreased gradually. Citric acid is acidic. Proper addition can make the beverage moderate in acidity and sweetness, and improve the taste of the beverage; when the addition amount is less than 0.05%, the sour taste of the beverage is not obvious. When the addition amount is more than 0.09%, the beverage is too sour and astringent, so the sensory quality gradually decreases. Therefore, when citric acid was 0.07%, aloe and balsam pear compound beverage had the best taste.

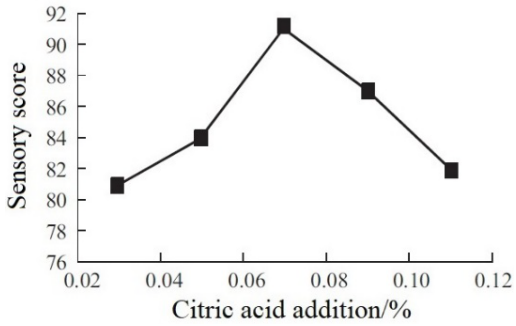

Figure 4. Effect of citric acid addition on beverage quality.

3.2 Orthogonal test

In order to optimize the formula of the finished product, based on the single factor experiment, four factors that have a great impact on the quality of the finished product, namely, the addition of aloe juice, balsam pear juice, white granulated sugar and citric acid, were selected for L_9 (3^4) orthogonal test. The sensory evaluation method was used to determine the best formula of compound vegetable juice. See **Table 2** for the factor level table of aloe balsam pear compound health drink.

It can be seen from the *R* value in **Table 3** that the primary and secondary factors affecting the quality of aloe and balsam pear composite health drink are a > c > d > b, that is, the largest factor affecting the quality of the finished product is the addition of white granulated sugar, followed by the addition of citric acid, followed by the addition of aloe juice, and the addition of balsam pear juice has the least impact on the quality of the finished product. It can be concluded from the comparison of *k* value that the formula with the best flavor and taste is $A_3B_2C_3D_3$.

Table 3. Orthogonal test results of aloe bitter melon compound drink

Test No.	*A* Aloe juice volume/%	*B* Balsam pear juice volume/%	*C* White granulated sugar content/%	*D* Citric acid content/%	Average sensory score
1	1	1	1	1	74
2	1	2	2	2	79
3	1	3	3	3	89
4	2	1	2	3	81
5	2	2	3	1	86
6	2	3	1	2	78
7	3	1	3	2	88
8	3	2	1	3	91
9	3	3	2	1	87
K_1	242	243	243	247	
K_2	245	256	247	245	
K_3	266	254	263	261	
k_1	80.7	81	81	82.3	
k_2	81.7	85.3	82.3	81.7	
k_3	88.7	84.7	87.7	87	
R	8	4.3	6.7	5.3	
Primary and secondary order	$A>C>D>B$				
Superior level	A_2	B_2	C_2	D_3	
Superior combination	$A_3B_2C_3D_3$				

However, the optimal combination obtained from the analysis is not in the nine orthogonal tests. Therefore, parallel confirmatory tests shall be conducted with treatment group 8 in the orthogonal table, that is, $A_3B_2C_1D_3$. The operation results are shown in **Table 4**.

Table 4. Sensory score verification test

Combination	Factor				
	Color (20 Points)	Aroma (20 Points)	Taste (30 Points)	Organizational status (30 Points)	Score
$A_2B_2C_1D_2$	18	18	26	29	91
$A_2B_2C_2D_2$	19	18	28	27	92

According to the confirmatory test, the scores of the two groups have little difference. The main reason is that the addition of white granulated sugar has increased, which has enhanced the sweetness and better covered up the bitterness of aloe and balsam pear. However, the low saccharification of diet is gradually recognized by the majority of consumers, so the best formula is determined as $A_3B_2C_1D_3$ combination, that is, the addition of aloe juice is 24%, balsam pear juice is 10%, white granulated sugar is 7%, and citric acid is 0.09%. The beverage prepared under this condition: light green, uniform color, fine texture, no bubbles, trace pulp, no impurities, with the comprehensive flavor of aloe and balsam pear, moderate acidity and sweetness, and no peculiar smell.

3.3 Product health quality indicators

3.3.1 Sensory indicators

The product is light green with uniform color and no stratification. Fine texture without bubbles. There is a small amount of pulp, particle precipitation and no impurities. It has the comprehensive flavor of aloe and cucumber, with delicate taste, moderate acidity and sweetness, and no peculiar smell.

3.3.2 Physical and chemical indexes

Soluble solid content 10%; total sugar 9%; total acid 0.09%.

3.3.3 Microbial indicators

Total number of bacterial is 32 (CFU/mL) and coliform group is 16 (MPN/100mL), all of which conforms to GB 7101-2015 National Standard on Food Safety: Beverage.

4. Conclusion

Through the above analysis, it can be concluded that the primary and secondary order of the influence of each factor on the beverage is aloe

juice addition > white granulated sugar addition > citric acid addition > balsam pear juice addition. When aloe juice, balsam pear juice, white granulated sugar and citric acid were added at 24%, 10%, 7% and 0.09%, the beverage is bright in color, sweet and sour with good flavor, and its physical, chemical and hygienic indexes met the national standards.

Conflict of interest

The authors declare that they have no conflict of interest.

References

1. Gu W, Zhu S. Luhui zaipei yu jiagong liyong (Chinese) [Cultivation, processing and utilization of aloe]. Shanghai: Shanghai Science Popularization Press; 1999. p. 25–32
2. He We, Nan J. Luhui huanggua fuhe yinliao de gongyi yanjiu (Chinese) [Study on the technology of aloe and cucumber concordant beverage]. Nongjia Keji 2014; (1): 227–229.
3. Yang J, Yuan Z. Luhui huaxue chengfen de baojian gongxiao yu chanping kaifa (Chinese) [Health care efficacy and product development of aloe chemical components]. China Dairy 2001; (4): 6–8.
4. Shakib Z, Shahraki N, Razavi B M, *et al*. Aloe vera as an herbal medicine in the treatment of metabolic syndrome: A review. Phytotherapy Research 2019; 33(10): 2649–2660.
5. Hęś M, Dziedzic K, Górecka D, *et al*. *Aloe vera* (L.) Webb.: Natural sources of antioxidants—A review. Plant Foods for Human Nutrition 2019; 74(3): 255–265.
6. Yang P. Luhui pingguo fuhe baojian yinliao de gongyi yanjiu (Chinese) [Study on the technology of aloe-apple compound health drink]. Beverage Industry 2004; 7(5): 41–43.
7. Chen F, Huang G, Yang Z, *et al*. Antioxidant activity of *Momordica charantia* polysaccharide and its derivatives. International Journal of Biological Macromolecules 2019; 138: 673–680.
8. Fan M, Kim EK, Choi YJ, *et al*. The role of *Momordica charantia* in resisting obesity. International Journal of Environmental Research and Public Health 2019; 16(18): 3251.
9. Elangovan A, Subramanian A, Durairaj S, *et al*. Antidiabetic and hypolipidemic efficacy of skin and seed extracts of *Momordica cymbalaria* on alloxan induced diabetic model in rats. Journal of Ethnopharmacology 2019; 241: 111989.
10. Tian H, Han Y. Microwave drying characteristics and dynamic model of balsam pear. Food Research and Development 2017; 38(23): 125–129.
11. Zhang T, Tian H, Liu C. Study on noenzymatic browning of aloe products and their inhibition methods. Wuxi: Journal of Wuxi University of Light Industry 2002; 21(5): 496–498, 502.
12. Zhang L, Han Y, Gu Z, *et al*. Effects of homogenization and addition of stabilizing agents on stability of mixed vegetable and fruit juice. Food Science 2006; 27(1): 112–114.