Potato wine Brewing Process Optimization by Response Surface Analysis

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Abstract. The volatile aroma components in potato wine were detected by static headspace-gc-ms with potato wine as raw material. The effects of equilibrium temperature, equilibrium time, sampling amount and NACL addition on the number of effective peaks of aroma components in potato wine were studied by single factor experiment. Then the detection conditions were optimized by Orthogonal test. The results showed that under the conditions of 0.2 g NaCl addition, 6 mL sampling, 35 min equilibrium time and 40 °c equilibrium temperature, the number of effective peaks was 15, which was more than 5 aroma components before optimization. It laid a solid foundation for the establishment of a rapid and simple method for the determination of aroma components in wine.

1. Introduction
Potato wine has a long history of development, originated from Poland, and is biased towards faint scent wine. It smells fragrant and tastes delicious. Potato wine is rich in nutrition and contains a variety of vitamins and minerals. The production of potato wine is also very simple, first saccharifying potatoes, then adding distiller's yeast for fermentation, and finally distilling to obtain the finished product of potato wine. In view of its high nutritional value and simple fermentation method, many people began to study potato wine.

Aroma components in potato wine are the key to evaluate the quality of potato wine. Different contents of aroma components make wine show different qualities and styles. In order to make the industrialization of potato wine develop more smoothly, it is particularly important to study the aroma components of potato wine. Chromatographic technology is now widely used in the analysis of wine aroma components. There are many methods for extraction of wine aroma components, including headspace solid phase microextraction, steam distillation, purge and trap, static headspace technology, and liquid extraction technology [1]. Static headspace technology does not need liquid-liquid extraction of aroma components in potato wine [2], which can reduce the pretreatment time of samples and make aroma components easier to be detected. Therefore, static headspace technology was used in this experiment [3]. Because GC-MS can effectively separate complex aroma components from volatile wine, and mass spectrometer has high sensitivity, fast analysis speed and strong identification ability, GC-MS technology is adopted to detect aroma components in potato wine [4].

In this experiment, the chromatogram obtained by GC-MS was compared with NIST standard library by MS3000 quick retrieval program, and the characteristic peaks with similarity greater than
65% were screened out, and then the aroma components were further determined [5]. In general, by optimizing the detection conditions, five more target substances can be detected after optimization than before. It provides a theoretical basis for the establishment of a rapid and simple method for the determination of aroma components in potato wine in the future.

2. Materials and Methods

2.1. Test material
Potato wine

2.2. Test reagent
Sodium chloride, 51 kinds of liquor mixed standard, ethanol

2.3. Instrumentation and equipments
GC-MS3000 desktop chromatography-mass spectrometry
   AHS-6890A automatic headspace sampler.
   DB-WAX 57 CB (50m×0.25mm×0.20μm)
   FA2204B electronic balance
   Pipetting gun, top empty bottle, gland clamp

2.4. Method

2.4.1. Experiment on the effect of the amount of NaCl on the number of effective peaks. In order to explore the effect of NaCl addition on the number of effective peaks, under the conditions of 6mL of sample, 40°C of equilibrium temperature and 30min of equilibrium time, the effect of NaCl addition on the number of effective peaks was investigated and the optimal addition of NaCl was determined 0.2g

2.4.2. Effect of sampling amount of potato wine on effective peak number. In order to study the effect of sampling amount on the number of effective peaks, under the conditions of NaCl addition of 0.2g, equilibrium temperature of 40°C and equilibrium time of 30min, the effect on the number of effective peaks when the sampling amounts of potato wine were 4mL, 6 mL, 8mL and 10 mL respectively was investigated, and the optimal sampling amount of potato wine was determined.

2.4.3. Experiment on the effect of equilibrium temperature on the number of effective peaks. In order to study the effect of equilibrium temperature on the number of effective peaks, when the addition of NaCl is 0.2g, the equilibrium time is 30min and the sampling amount is 6mL, the effect on the number of effective peaks when the equilibrium temperatures are 20°C, 30°C, 40°C and 50°C respectively is investigated, and the best equilibrium temperature is determined.

2.4.4. Experiment on the effect of equilibrium time on the number of effective peaks. In order to study the effect of equilibrium time on the number of effective peaks, when the addition of NaCl is 0.2g, the equilibrium temperature is 40°C, and the sampling amount is 6mL, the effect on the number of effective peaks when the equilibrium time is 10min, 20min, 30min and 40min respectively is investigated, and the best equilibrium time is determined.

2.4.5. Orthogonal test. The horizontal range of the four factors of NaCl addition amount, sampling amount, equilibrium time and equilibrium temperature was determined through single factor test results. The number of effective peaks with matching degree >65% was taken as the evaluation index, and the best combination was analyzed through L_{16}(4^4) orthogonal test. The orthogonal test results are shown in Table 1.
Table 1. Potato wine aroma ingredient test conditions optimization orthogonal test factors and level

| Level | (A)NaCl addition /g | (B)Sampling quantity | (C) Equilibrium time /min | (D) Equilibrium temperature/℃ |
|-------|---------------------|----------------------|--------------------------|-----------------------------|
| 1     | 0                   | 5                    | 20                       | 30                          |
| 2     | 0.1                 | 6                    | 25                       | 35                          |
| 3     | 0.2                 | 7                    | 30                       | 40                          |
| 4     | 0.3                 | 8                    | 35                       | 45                          |

2.4.6. Detection method

2.4.6.1 Sample pretreatment.
Take out 6mL of aged potato wine and 0.1gNaCl, add them into a 20mL top empty bottle, seal them, and put them into the sample chamber of the headspace sampler for testing.

2.4.6.2 Instrument parameters.
Headspace sampler parameters [6] [8]: sample volume 1mL, pressurization time 0.2min, sample injection time 1min, equilibrium temperature 40℃, equilibrium time 30min.

Gas chromatography conditions: sample inlet temperature 230℃, programmed temperature rise, initial temperature 45℃, retention time 6min, rise to 150℃ at 5℃/min, rise to 210℃ at 10℃/min, retention time 5min, column flow rate 1mL/min, split ratio 30: 1, purge flow rate 3mL/min, carrier gas pressure 60kpa, [9] carrier gas 99.99% helium.

Mass spectrum conditions [10],[12]: ion source temperature 250℃, interface temperature 230℃, column temperature 40℃, gasification chamber temperature 230℃, solvent peak time 2min, scanning mode: full scanning, multiplier high pressure 1000V v.

2.4.6.3 Qualitative method.
The chromatogram obtained in full scanning mode is compared with the standard chromatogram in NIST, and the target substance with similarity > 65% is screened out, and then quantitative analysis is carried out [13]

2.4.6.4 Quantitative method.
The relative content of aroma components was normalized by peak area method [14], and then the relative area of aroma components was brought into the standard curve of 51 detected internal standard substances [15], and the concentration of characteristic aroma components was calculated.

2.4.6.5 Data processing.
The experimental data were analyzed by variance analysis using IBM SPSS Statistics 19.0.
3. Results and Analysis

3.1. Effect of NaCl content on the number of effective peaks of aroma components in potato wine

![Fig. 1](image)

**Fig. 1** Effect of the addition of NaCl on the number of effective peaks of the aroma composition of potato wine

As can be seen from Fig. 1, the number of effective peaks increases with the increase of NaCl addition. At 0.2g, the maximum number of effective peaks reaches 11. Salt is added to reduce the solubility of aroma components, eliminate matrix effect and precipitate volatile aroma components. However, the increase of salt will affect the viscosity of the wine sample. The higher the viscosity, the lower the diffusion rate of the analyte [16], and the aroma components are not easy to be detected. Therefore, according to the test results, 0.2g NaCl is selected as the optimal addition amount.

3.2. The effect of sampling quantity of potato wine on the number of effective peaks of aroma components in potato wine

![Fig. 2](image)

**Fig. 2** Effect of sampling volume on the number of active peaks of potato wine aroma composition

It can be seen from Figure 2 that the number of effective peaks increases with the increase of potato wine sampling amount. The amount of potato wine sample will affect the vapor-liquid distribution balance in the headspace bottle. The volume of gas in the headspace bottle will be smaller and the pressure will be larger. In order to re-establish the balance, the aroma components will overflow. When the sampling amount is more than 6ml, the space in the headspace bottle becomes smaller, which is not conducive to the overflow of aroma components. Therefore, the best sampling amount of potato wine is 6ml.
3.3. Effect of equilibrium time on the number of effective peaks of aroma components in potato wine

![Graph showing the effect of balance time on the number of effective peaks of potato wine aroma composition.]

It can be seen from fig. 3 that the increase of equilibrium time increases the number of effective peaks to a certain extent, but it will remain unchanged after reaching 30min. Because after the sample is heated, volatile and semi-volatile substances in the sample are released and adsorbed [17], and heat balance is achieved in the gas and liquid phases, so that more volatilization of aroma components of potato wine can be detected more easily. However, the equilibrium time depends on the diffusion speed of the aroma components in the wine. The larger the molecular diffusion coefficient, the faster the diffusion speed of the aroma components, and the shorter the equilibrium time required for the sample. If the equilibrium time is too long, the volatile components will not change much, and the number of effective peaks will even decrease. Therefore, 30min is the best balance time.

3.4. Effect of equilibrium temperature on the number of effective peaks of aroma components in potato wine

![Graph showing the effect of equilibrium temperature on the number of active peaks of the aroma composition of potato wine.]

As can be seen from fig. 4, as the equilibrium temperature increases, the aroma components are decomposed, the faster the movement speed is, the easier it is to be detected, and the number of effective peaks is also increasing. When the equilibrium temperature is 40℃, the maximum number of effective peaks is 11, and then it will remain unchanged. Because of different temperatures, the
distribution coefficient of aroma substances in the top-empty bottle is different [18]. With the increase of temperature, the higher the vapor pressure, the shorter the time to reach equilibrium, and the higher the sensitivity of analysis, while the decrease of distribution coefficient is not conducive to the detection of aroma components. Choose a lower equilibrium temperature, because too high a temperature will affect the decomposition of aroma components in potato wine, making the top empty bottle pressure too high. Therefore, 40˚C is chosen as the best equilibrium temperature.

3.5. Orthogonal test results
The horizontal range of NaCl addition amount, sample amount, equilibrium temperature and equilibrium time was determined through the results of single factor test. The optimal combination of conditions for detecting aroma components was determined through orthogonal test with the number of effective peaks as evaluation index.

Table 2. Results and analysis of positive test results for the detection conditions of the aroma ingredients of potato wine

| Test number | A | B | C | D | Number of effective peaks (number) |
|-------------|---|---|---|---|-----------------------------------|
| Test number | NaCl addition | Sampling quantity | Equilibrium time | Equilibrium temperature | |
| 1           | 1 | 1 | 1 | 1 | 6                                 |
| 2           | 1 | 2 | 2 | 2 | 8                                 |
| 3           | 1 | 3 | 3 | 3 | 13                                |
| 4           | 1 | 4 | 4 | 4 | 9                                 |
| 5           | 2 | 1 | 2 | 3 | 10                                |
| 6           | 2 | 2 | 1 | 4 | 8                                 |
| 7           | 2 | 3 | 4 | 1 | 13                                |
| 8           | 2 | 4 | 3 | 2 | 10                                |
| 9           | 3 | 1 | 3 | 4 | 5                                 |
| 10          | 3 | 2 | 4 | 3 | 15                                |
| 11          | 3 | 3 | 1 | 2 | 9                                 |
| 12          | 3 | 4 | 2 | 1 | 10                                |
| 13          | 4 | 1 | 4 | 2 | 6                                 |
| 14          | 4 | 2 | 3 | 1 | 11                                |
| 15          | 4 | 3 | 2 | 4 | 6                                 |
| 16          | 4 | 4 | 1 | 3 | 9                                 |
| K1          | 36 | 27 | 32 | 40 |
| K2          | 41 | 42 | 34 | 33 |
| K3          | 39 | 41 | 39 | 47 |
| K4          | 32 | 38 | 43 | 28 |
| K1j         | 9 | 6.75 | 8 | 10 |
| K2j         | 10.25 | 10.5 | 8.5 | 8.25 |
| K3j         | 9.75 | 10.25 | 9.75 | 11.75 |
| K4j         | 8 | 9.5 | 10.75 | 7 |
| R           | 2.25 | 3.75 | 2.75 | 4.75 |

Excellent combination: A_3B_2C_4D_3
Table 3. Analysis of variance of orthogonal experimental results

| Source of variation | Sum of squares | Variance | Mean square | Variance ratio | Significant |
|---------------------|----------------|----------|-------------|----------------|-------------|
| A                   | 11.5           | 3        | 3.833       | 5.75           | 0.092       |
| B                   | 35.5           | 3        | 11.833      | 17.75          | 0.021*      |
| C                   | 18.5           | 3        | 6.167       | 9.25           | 0.050       |
| D                   | 51.5           | 3        | 17.167      | 25.75          | 0.012*      |
| Error               | 2              | 3        | 0.667       |                |             |
| Total variation     | 1488           | 16       |             |                |             |

Note: "***" means that the effect on the results is extremely significant when P < 0.01, "*" means that the effect on the results is significant when P < 0.05

According to Table 2, it can be seen that the range R of four factors A, B, C and D and the equilibrium temperature are the most important factors, followed by the sampling amount, equilibrium time and NaCl addition amount. The optimal level group of optimized detection conditions is A₃B₂C₄D₃, while the optimal result of single factor test is A₃B₂C₃D₃, in which the number of effective peaks is 15 and 10 respectively, with no significant difference in equilibrium time. Therefore, it can be determined that the optimal combination for detection of aroma components in potato wine is A₃B₂C₄D₃.

Table 3 shows that the difference in equilibrium temperature is the most significant, followed by sampling amount. The difference in equilibrium time and NaCl addition amount is not significant, which is consistent with the result of range analysis.

To sum up, the best conditions for static headspace-air mass spectrometer to detect aroma components in potato wine are NaCl addition of 0.2g, sampling amount of 6mL, equilibrium time of 35min, and equilibrium temperature of 40°C.

3.6. Comparison before and after optimization of detection conditions for aroma components in potato wine

According to the orthogonal test, the optimal conditions for detecting aroma components in potato wine were optimized, and the obtained spectra were compared with NIST standard spectra library.

There are 10 kinds of aroma components before optimization, which are ethyl acetate, 2-ethylhexanol, propanol, acetic acid, isopropyl acetate, acetal, isobutanol, pentanol, butyl lactate, ethyl hexanoate.

After optimization, 15 aroma components were detected, including ethyl acetate, propanol, β-phenylethanol, acetic acid, isopropyl acetate, ethyl decanoate, isobutanol, acetal, 2-ethylhexanol, butyl lactate, propylene glycol, methyl 3-methylhexanoate, butyl 5-methylpropionate, pentanol and ethyl hexanoate.
Quantitative analysis of aroma components in potato wine

Table 4. Comparison of aroma composition before and after potato wine test method optimization

| Retention time | Compound                  | Molecular formula | Before optimization | Postoptimality |
|---------------|--------------------------|-------------------|---------------------|---------------|
|               | Relative content/%       |                   |                     |               |
| 3.32          | Ethyl acetate            | C4H8O2            | 28.64%              | 31.19%        |
| 4.11          | Propyl alcohol           | C3H8O             | 2.17                | 3.15%         |
| 4.15          | Acetic acid              | C2H4O2            | 0.07%               | 0.33%         |
| 4.33          | Isopropyl acetate        | C5H10O2           | 1.51%               | 1.78%         |
| 5.38          | Isobutanol               | C4H10O            | 0.46%               | 2.58%         |
| 5.53          | Acetal                   | C6H14O2           | 0.66%               | 2.99%         |
| 5.99          | Butyl lactate            | C7H14O3           | 0.45%               | 1.41%         |
| 7.29          | Propylene glycol         | C3H8O2            | -                   | 1.16%         |
| 10.94         | Methyl 3-methylhexanoate | C8H16O2           | -                   | 1.4%          |
| 11.17         | Butyl 5-methylpropionate | C8H16O2          | -                   | 0.13%         |
| 17.06         | Amyl alcohol             | C5H12O            | 0.49%               | 0.87%         |
| 20.95         | Ethyl hexanoate          | C8H16O2           | 11.02%              | 18.3%         |
| 26.26         | 2-ethylhexanol           | C8H18O            | 0.51%               | 2.64%         |
| 28.93         | β-phenylethanol          | C8H10O            | -                   | 0.29%         |
| 33.06         | Ethyl decanoate          | C12H24O2          | -                   | 0.72%         |

"-" means that the above components are not detected and the sum is not 100, and column loss is inevitable.

After the optimization of the static headspace-gas chromatography-mass spectrometry detection conditions, there are 5 kinds more than before, namely propylene glycol, methyl 3- methyl acetate, butyl 5- methyl propionate, β-phenylethanol and ethyl decanoate. The peak area normalization method was used for quantitative analysis of each aroma component [20].

4. Conclusion and Discussion

This experiment is to study the detection conditions of aroma components in potato wine and make optimization. The test results are as follows:

1. The instruments used in this test are mainly static headspace sampler and gas chromatography-mass spectrometry [22]. Firstly, headspace sampling is carried out through single factor test, and then the optimal levels of four factors, namely, equilibrium time, equilibrium temperature, NaCl addition amount and potato wine sampling amount, are respectively determined according to the number of effective peaks. The orthogonal test of L16(44) was further used to determine the best combination. The optimal combination of orthogonal test was the optimized detection conditions. The effective peaks before and after optimization were compared. It was found that the optimized detection conditions of static headspace-gas chromatography-mass spectrometry instrument could have 5 more aroma components than before optimization, namely propylene glycol, methyl 3- methyl acetate, butyl 5- methyl propionate, β-phenylethanol and ethyl decanoate.

2. In the process of detecting potato aroma components by static headspace-gas chromatography-mass spectrometry [23], the equilibrium temperature has the greatest influence on the detection results, followed by the sampling amount of wine, the equilibrium time should not be too long, and the addition amount of NaCl has no significant influence on the detection of potato aroma components.

3. The best conditions for static headspace-gas chromatography-mass spectrometry to detect the aroma components of potato wine in wine-making laboratory are: sample volume 6 mL, NaCl addition 0.2 g, equilibrium temperature 40℃, equilibrium time 35 min.
This experiment studied the detection of aroma components in potato wine under the use of static headspace-gas chromatography-mass spectrometry. The effective peak number was used as the evaluation basis. Compared with liquid-liquid extraction, headspace solid-phase microextraction and purge-and-trap technologies [24], sample pretreatment still needs to be improved. However, static headspace sampler can be used for simple and rapid test and pre-test [25]. Therefore, static headspace-GC-MS technology can lay a solid foundation for the subsequent establishment of a fast and simple detection method for wine aroma components.

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References
[1] Li Dengkun, Liu Xiangping, Zha Hexia, etc. Determination of volatile compounds in wine by static headspace-gas chromatography [J]. Chinese Journal of Hygiene Inspection, Vol. 25 (2015) No. 11, p. 1730-1732.
[2] Ji Houwei, Yang Jingguo, Wang Fang et al. Application progress of static headspace-gas chromatography in the tobacco industry [J]. Physical and Chemical Inspection (Chemical Volume), Vol. 50 (2014) No. 09, p. 1188-1192.
[3] Mo Yanxia, Yin Juyi, Gu Xiaojun, etc. Research status and application prospects of wine organic acids [J]. Science and Technology of Food Industry, Vol. 36 (2015) No. 06, p. 380-384.
[4] Gong Hongsheng, Liao Liewen, Hu Wenbin et al. Research progress of the application of GC-MS in the detection of food pesticide residues [J]. Food and Machinery, Vol. 29 (2013) No. 05, p. 245-248.
[5] You Hongmei. Analysis of plasticizers and aroma components in wine by gas chromatography-mass spectrometry [D]. Harbin University of Science and Technology, 2014.
[6] Zhang Qian, Liu Weilun, Lu Yanan et al. Application progress of headspace gas chromatography-mass spectrometry [J]. Chinese Journal of Chromatography, Vol. 36 (2018) No. 10, p. 962-971.
[7] DARTIGENAVEC, JEANDETP, MAUJEAN A. Study of the contribution of the major organic acids of wine to the buffering capacity of wine in model solutions[J]. Am J Enol Viticul, Vol. 51(2000) No. 4, p. 352-356.
[8] MORATAA,GOMEZ-CORDOVCSMC.SUBERVIOLAJet,al.Ad-sorptionofanthocyanins by yeast cell walls during the fermentation of red wines[J]. J Agr Food Chem, Vol. 51(2003) No. 14, p. 4084-4089.
[9] Dun Zhuciren, Zhan Xiaxiu, Labazaxi et al. Study on volatile components in gardenia based on headspace-mass spectrometry usage [J]. Tibet Science and Technology, (2018) No. 12, p. 70-73 + 77.
[10] Zhou Wenjie, Zhang Fang, Wang Peng et al. Study on the characteristic aroma components of Korla fragrant pear wine based on GC-MS / GC-O combined with chemometrics [J]. Food Science, Vol. 39 (2018) No. 10, p. 222-227.
[11] REBIERE L, CLARKAC, SCHMIDTKELM, et al. A robust method for quantification of volatile compounds within and between vintages using headspace-solidphase microextraction coupled with GC-MS application on Semillion wines[J]. Analytica chimica acta,
[12] CABREDO-PINILLOSS, CEDRON-FERNANDEZ, SAENZ-BARRIO. Comparison of different extraction methods applied to volatile compounds in wine samples previous to the determination by gas chromatography [J]. Analytical letters, Vol. 37 (2004) No. 14, p. 3063-308.

[13] Lu Ning, Wan Xiaochun, Pan Dong. Preliminary study on the relationship between aroma components and quality of jasmine tea [J]. Food Science, 2004 (06): 93-97. [11] GB / T 10345-2007, Baijiu Analysis method [S].

[14] Shen Haiyue. Research on aroma substances of sauce-flavor liquor [D]. Jiangnan University, 2010.

[15] Zhang Ting, Chen Xiaowei, Zhang Shasha et al. GC-MS analysis of aroma components of cassava wine produced by fermentation of different koji [J]. Food Research and Development, Vol. 40 (2019) No. 02, p. 125-131.

[16] Wu Zengsheng. Research on Analysis Methods of Volatile Flavor Substances in Beer [D]. Northeastern University, 2008.

[17] Chai Chuan, Yu Sheng, Cui Xiaobing, et al. Static headspace-mass spectrometry analysis of volatile components in light tempeh [J]. Food Research and Development, Vol. 34 (2013) No. 14, p. 81-85.

[18] Huang Huizhen, Liang Hui, Liu Xiucai, etc. Analysis of volatile aroma components in Fujian special tea by trapped headspace-mass spectrometry [J]. China Test, Vol. 43 (2017) No. 11, p. 59-63.

[19] Wang Duliu, Ye Wenbin, Zhang Shaofei et al. Analysis of aroma components of "Mingliuzi Wine" by gas chromatography-mass spectrometry [J]. Brewing Science and Technology, (2017) No. 08, p. 132-135.

[20] Li Weiqing, Wang Hao, Jiang Liting et al. Determination of volatile components in litchi fruit vinegar by headspace solid phase microextraction coupled with gas chromatography-mass spectrometry [J]. China Brewing, (2011) No. 12, p. 160-162.

[21] Kong Chengshi. GC-MS study on volatile flavor compounds of dry wine [D]. Qingdao University of Science and Technology, 2013.

[22] Qi Xinchun, Zhang Huining, Wei Leipeng et al. Optimization of conditions for detecting aroma components in wine by static headspace-mass spectrometry [J]. China Brewing, Vol. 36 (2017) No. 09, p. 168-172. Kong Chengshi.

[23] Wang Yang, Wang Jie, Liu Yaqiong et al. Determination of aroma components in apple pomace fermentation distilled wine by headspace solid phase microextraction-gas chromatography-mass spectrometry [J]. Food Science, Vol. 33 (2012) No. 12, p. 205-209.

[24] You Hongmei, Li Fengqin, Yu Zhigang. Analysis of aroma components of Bei Okura liquor by gas chromatography-mass spectrometry [J]. Chemical Research and Application, Vol. 26 (2014) No. 11, p. 1820-1824.

[25] Müller A, Düchting P, Weiler E W. A multiplex GC-MS/MS technique for the sensitive and quantitative single-run analysis of acidic phytohormones and related compounds, and its application to Arabidopsis thaliana [J]. Planta, Vol. 216 (2002) No. 1, p. 44-56.