ABSTRACT: 119

ANALYSIS OF SOYMILK PROCESSING CHARACTERISTICS OF DIFFERENT SOYBEAN CULTIVARS AND ESTABLISHMENT OF EVALUATION METHODS OF SOYBEAN CULTIVARS SUITABLE FOR SOYMILK PROCESSING

JINGYAN L, XIAODI S & <u>SHUNTANG G</u>

China Agricultural University, Beijing, 100083, China
E-mail: shuntang@cau.edu.cn

Soymilk is a traditional food in East Asia, and different soybean cultivars lead to different processing characteristics of soymilk. Aimed at establishing the evaluation method to identify the adaptability of different soybean cultivars in soymilk processing, 67 soybean cultivars from different areas in China were chosen in this research to analys the chemical components and study the processing characteristics of soymilk. The main results show that soymilk made from soybeans with a higher content of protein has a higher yield and viscosity; while soymilk made from soybeans with a lower content of fat and oleinic acid has a higher viscosity. The components and content of fatty acids have a great effect on soymilk flavour, and a higher content of unsaturated fatty acids, including linoleic acid and linolenic acid, which leads to a higher beany flavour compound including hexanal and trans-2-hexenal. Therefore, the beany flavour including hay, lipid oxidation and cereal flavour is greater in sensory evaluation. On the other hand, the OAV value of soymilk is significantly related to the content of fatty acids of different soybean cultivars.

Based on clustering and discriminatory analyses in SPSS, soybean cultivars can be divided into three classes according to their rheological characteristics. Class I: the soymilk has a higher yield and lower viscosity; Class II: the soymilk has a lower yield and higher viscosity; and the remaining soybean cultivars compose the third class. Soybean cultivars can also be classified according to flavour. Class I: the soymilk has a heavy beany flavour and non-beany flavour; Class II: the soymilk has a heavy non-beany flavour and weak beany flavour; Class III: the soymilk has a weak beany flavour and non-beany flavour. Accordingly, an effective evaluation method has been established to identify the adaptability of different soybean cultivars in soymilk processing by means of analysing the chemical components of soybean in this research.

World Soybean Research Conference IX

CAU
Food Science

Analysis of Soymilk Processing Characteristics of Different Soybean Cultivars and Establishment of Evaluation Method of Soybean Cultivars Suitable for Soymilk Processing

Li Jingyan, Shi Xiaodi, Guo Shuntang

College of Food Science and Nutritional Engineering
China Agricultural University, PR China

February 2013, Durban

Content

Research background

flavor

fat
lipoxygenase
fatty acids

yield

soybean protein

viscosity

soybean protein
polysaccharide

Soy milk

complex
uncertain
nonlinear

Vegetable-protein drink

More than 2000 years in China

Research background

Rich varieties in China

At present, soybean cultivars conserved has been as many as 28000

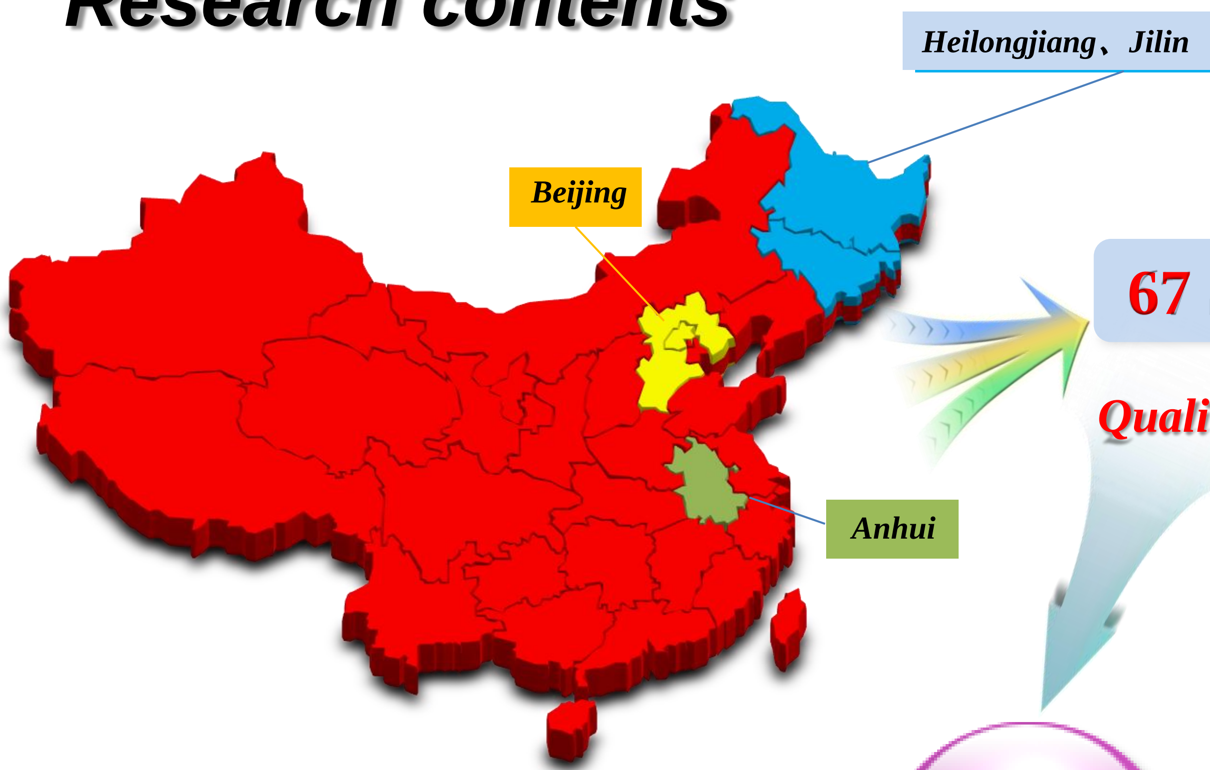
Among 16082 cultivars analyzed, the content of protein is in the range of 29.3~52.9%, and the fat content is 10.7~24.2%

Research background

✓What is breeding characteristics of soybean cultivars suitable for soymilk processing?

✓How to evaluate the processing suitability of soybean cultivars during the production of soymilk?

Research contents



67 Soybean Cultivars

Quality Characteristic Analysis

- **Protein/ Fat/Ca/P**
- **Fatty Acid**
- **LOX Activity**

Research contents

Processing Quality

Yield
Viscosity

Flavor Quality

Sensory Evaluation
Flavor Compounds

Soybean Cultivars

Protein/Fat/Ca/P
Fatty Acid
LOX Activity

Clustering Analysis

Discriminant Analysis

Quality Classification

Evaluation Method

Research results

Yield

Table 1 Correlations between soybean components and soymilk yield

	volume yield	weight yield
Protein	0.160*	0.267 *
P	-0.103	-0.026
Fat	[illegible]	[illegible]
Oleic Acid	-0.196	0.136
Linoleic Acid	-0.215	-0.047
Linolenic Acid	-0.071	-0.110

* P<0.05， ** P<0.01

Both weight yield and volume yield have positive correlations with the content of protein, and there are no correlations between soymilk yield and the other components.

Research results

Viscosity

Table 2 Correlations between soybean components and soymilk viscosity

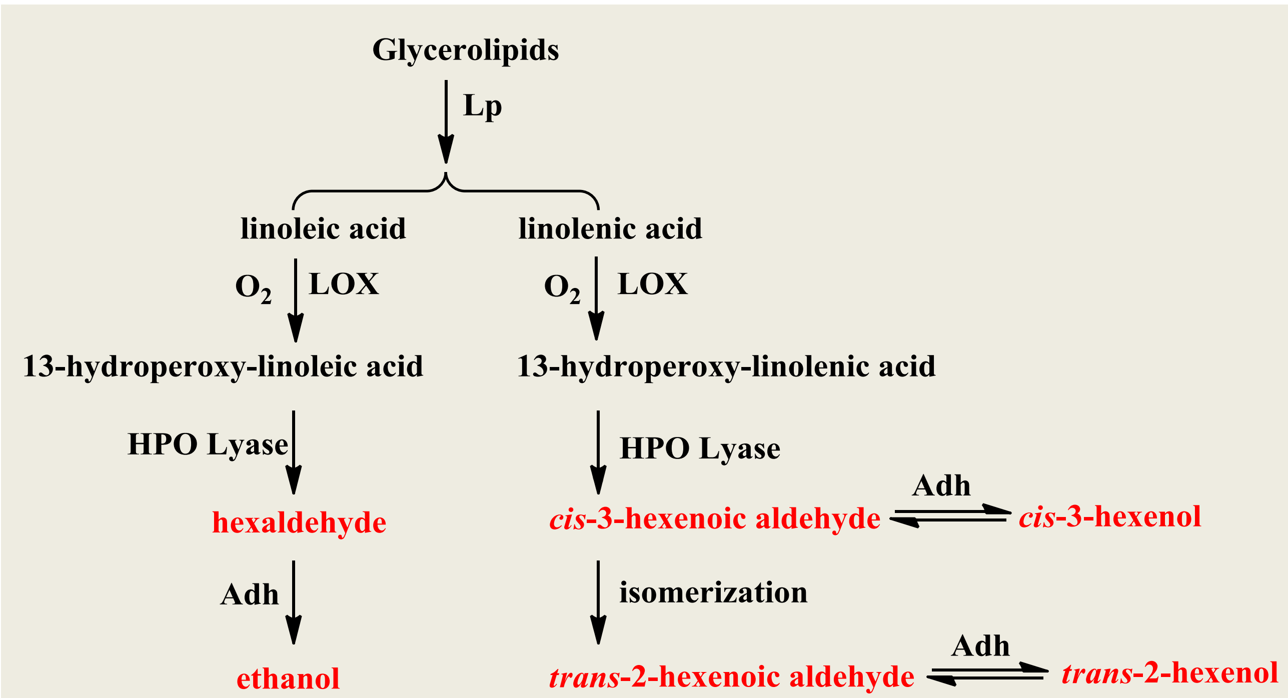
	kinematic viscosity	dynamic viscosity
Protein	0.307*	0.148
P	-0.148	-0.103
Fat	-0.272*	-0.113
Oleic Acid	-0.049	-0.264*
Linoleic Acid	0.005	0.239
Linolenic Acid	0.064	0 .150

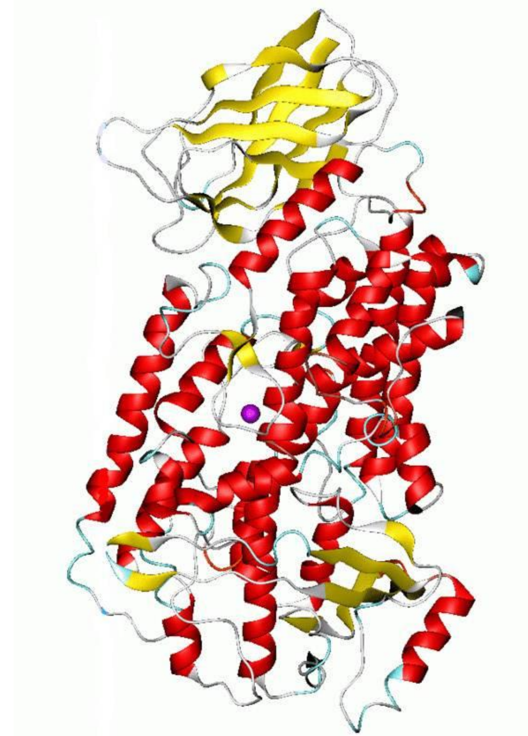
* P<0.05 , ** P<0.01

The higher the content of soluble protein is and the lower the contents of fat and oleic acid are, the relatively higher the viscosity of soymilk will be.

Research results

Flavor





The flavor compounds of soymilk are attributed to soybean lipoxygenases (LOX).

LOX can catalyze the conversion of polyunsaturated fatty acids like linoleic acid and linolenic acid to hydroperoxides and form micromolecular compounds, such as aldehydes, ketones and alcohols.

Research results

Flavor

Critical flavor compounds

beany flavor

- hexanal
- *trans*-2-hexenal
- 1-octene-3-ol
- pentanol
- acetic acid
- benzaldehyde
- *trans*, *trans*-2,4-decadienal

non-beany flavor

- 3 - methyl - butyraldehyde
- trans-2- octenal
- nonanal
- *trans*-2-nonenal

Non-beany flavor compounds are formed during the heating of soymilk (Lv, J. Food Sci, 2010).

Research results

Fatty Acid

- **Range of the content:**
  - **stearic acid：1.25%~9.19%**
  - **palmitic acid： 7.91%~22.10%**
  - **oleic acid： 15.27%~42.29%**
  - **linoleic acid： 29.95%~70.20%**
  - **linolenic acid： 2.36%~14.86%**

LOX Activity

- **Range of the content:**
  - **27.33 ~172.69 U/mg**

Research results

Flavor

beany flavor

Table 3 Correlations between soybean components and beany flavor compounds

	hexanal	ans-2,4- lienal	OAV (beany flavor)
Protein	-0.112		-0.290*
P	-0.011		-0.055
Fat	0.172		0.243*
Ca	0.103	5*	-0.032
LOX Activity	0.057	9	-0.207
Palmitic Acid	-0.228	9	-0.469**
Stearic Acid	-0.079	9	-0.338**
Oleic Acid	-0.260*	8	-0.365**
Linoleic Acid	0.254*	0	0.463**
Linolenic Acid	0.228	3	0.344**

OAV(Odor Activity Values):
OAV=the concentration of flavor compound/ sensory threshold
The higher OAV is, the bigger contribution the flavor compound makes in the whole flavor profile.
OAV of beany flavor is the sum of the OAV of each beany flavor compound, and OAV of non-beany flavor is the sum of the OAV of each non-beany flavor compound.

Research results

Flavor

non-beany flavor

Table4 Correlations between soybean components and non-beany flavor compounds

	3-methyl-butyraldehyde	nonanal	trans-2-octenal	trans-2-nonenal	OAV (non-beany flavor)
Protein	-0.009	0.217	0.161	-0.072	-0.116
P	-0.110	-0.035	-0.135	-0.111	-0.186
Fat	0.061	0.007	0.000	0.036	0.110
Ca	0.146	0.026	0.197	0.104	-0.050
LOX Activity	0.030	0.063	0.039	0.136	-0.131
Palmitic Acid	-0.245*	-0.060	-0.042	-0.064	-0.369**
Stearic Acid	-0.206	-0.027	-0.073	-0.132	-0.402**
Oleic Acid	-0.240	-0.180	-0.057	-0.002	-0.230
Linoleic Acid	0.258*	0.126	0.082	0.024	0.322**
Linolenic Acid	0.271*	0.128	0.004	0.098	0.342**

Research results

Flavor

- ***Saturated fatty acids can hardly react with LOX, so if the content of saturated fatty acids is high, the concentration of soymilk flavor will be relatively low. Accordingly, if the content of unsaturated fatty acids is high, the concentration of soymilk flavor will be relatively high.***

- ***In sensory evaluation, the soybean cultivars, which have high content of fat, unsaturated fatty acids and low content of saturated fatty acids , have the relatively heavy beany flavor, hay flavor, oil-oxidation flavor and grain flavor.***

Research results

Clustering analysis and Discriminant analysis

Clustering analysis

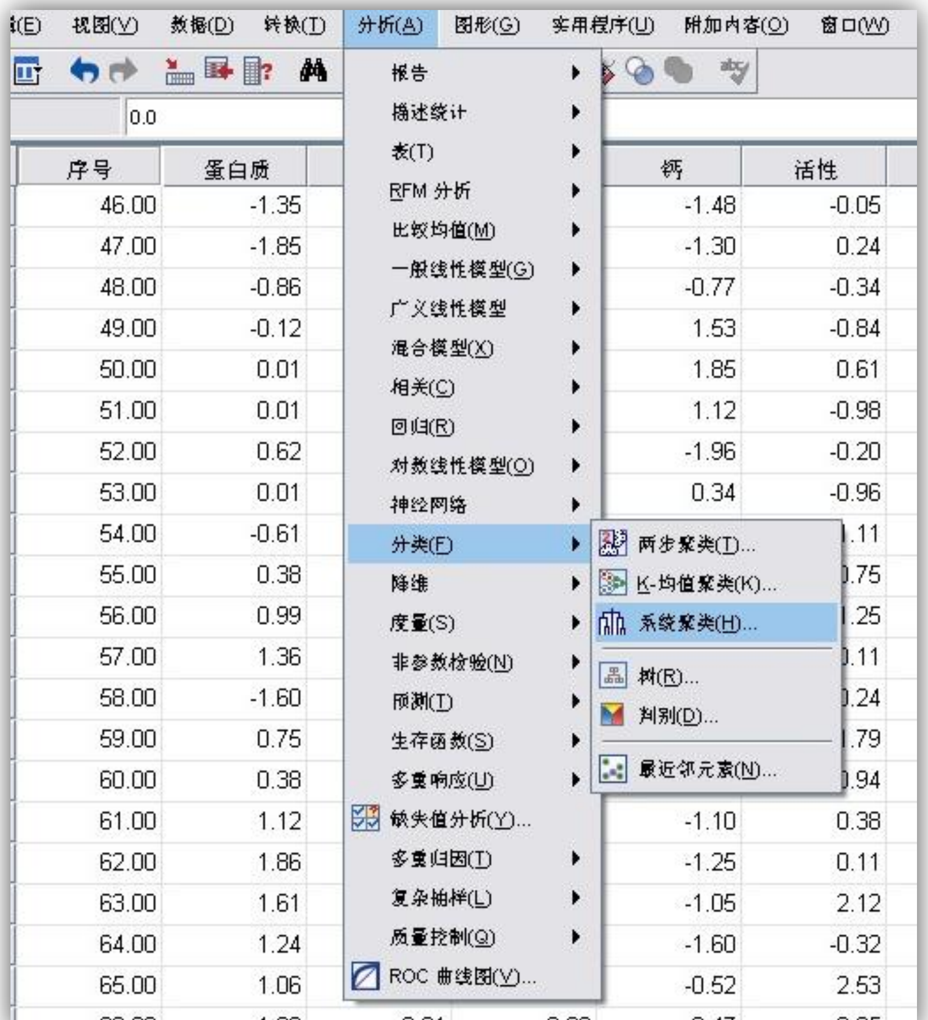
- The objects that have the similar properties can be divided and classified.
- Data can be sorted into several classes.
- In the same class, the data have a high similarity, while the data in the different classes have a relatively greater difference.

Discriminant analysis

- According to the properties of objects in the known classes, the unknown objects can be estimated and classified into the known classes.

67 kinds of soybean cultivars were classified by the clustering analysis and discriminant analysis.

Clustering analysis and discriminant analysis



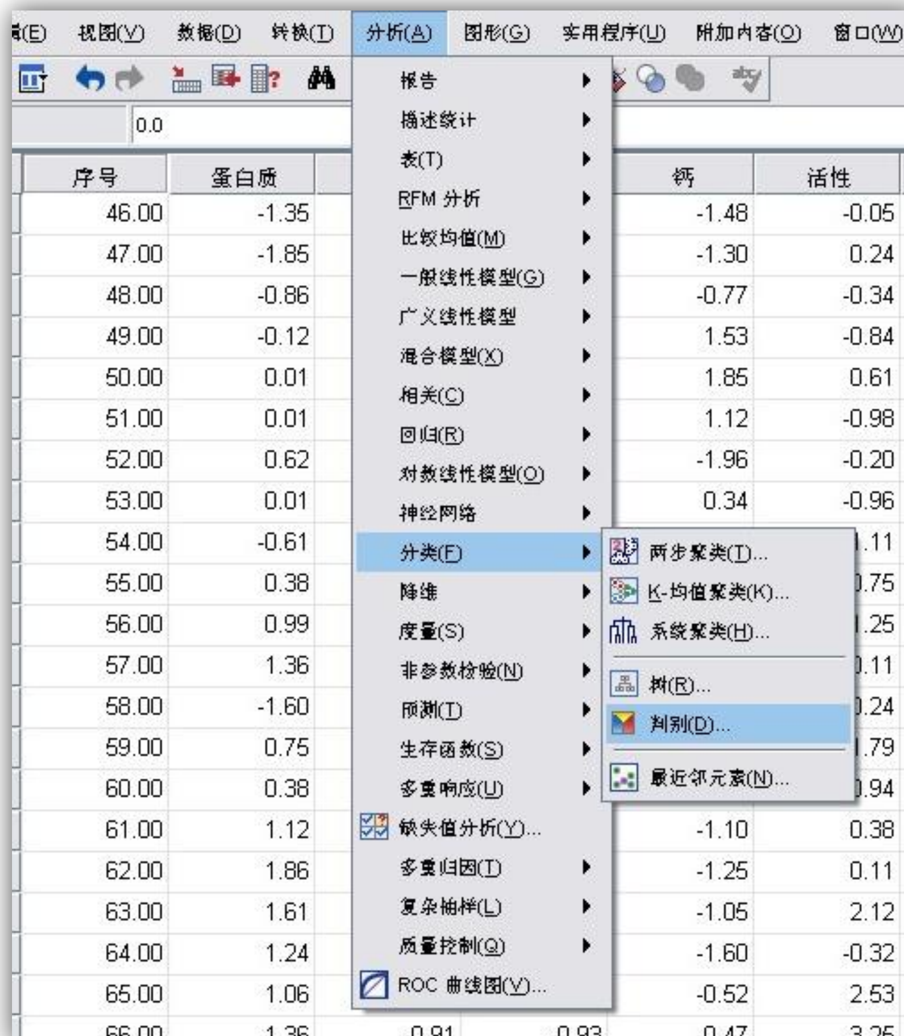


Figure 1 clustering analysis and discriminant analysis by Statistical Product and Service Solutions (SPSS)

Evaluation of processing quality

- Class I: the soymilk has a higher yield and lower viscosity;
- Class II: the soymilk has a lower yield and higher viscosity;
- The remaining soybean cultivars compose the third class.

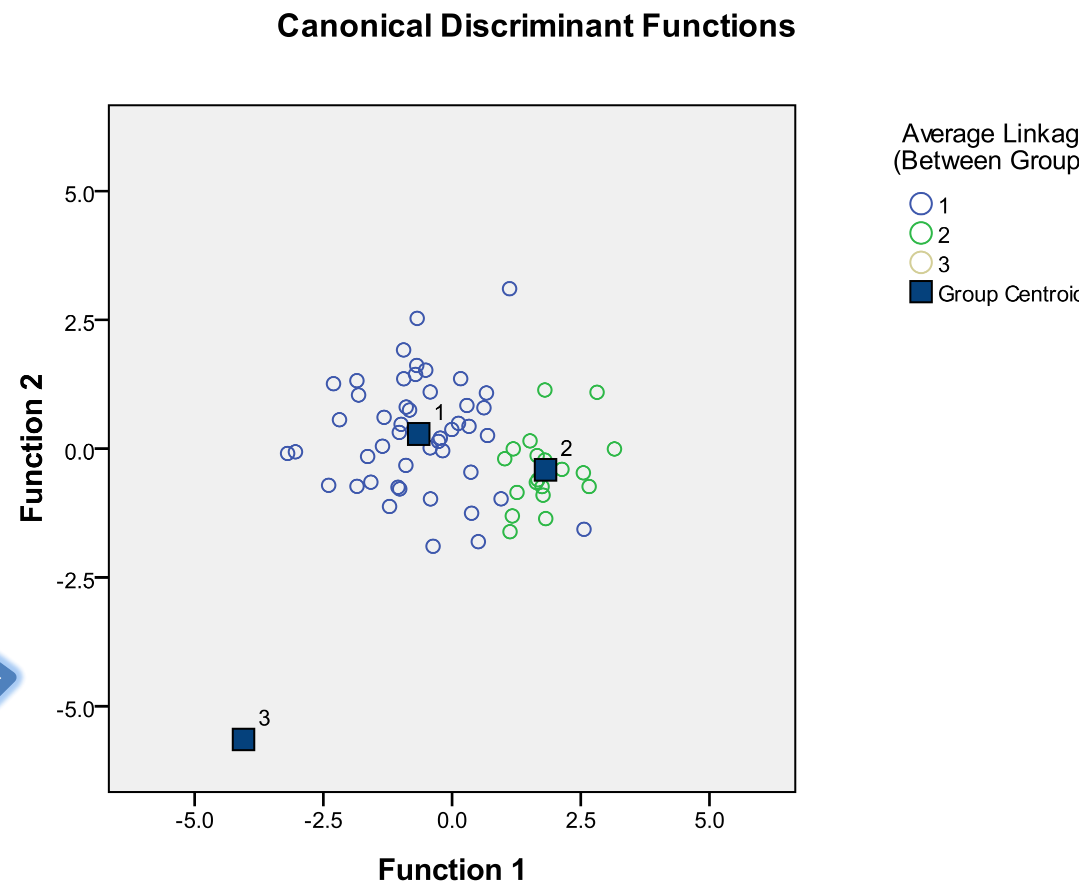
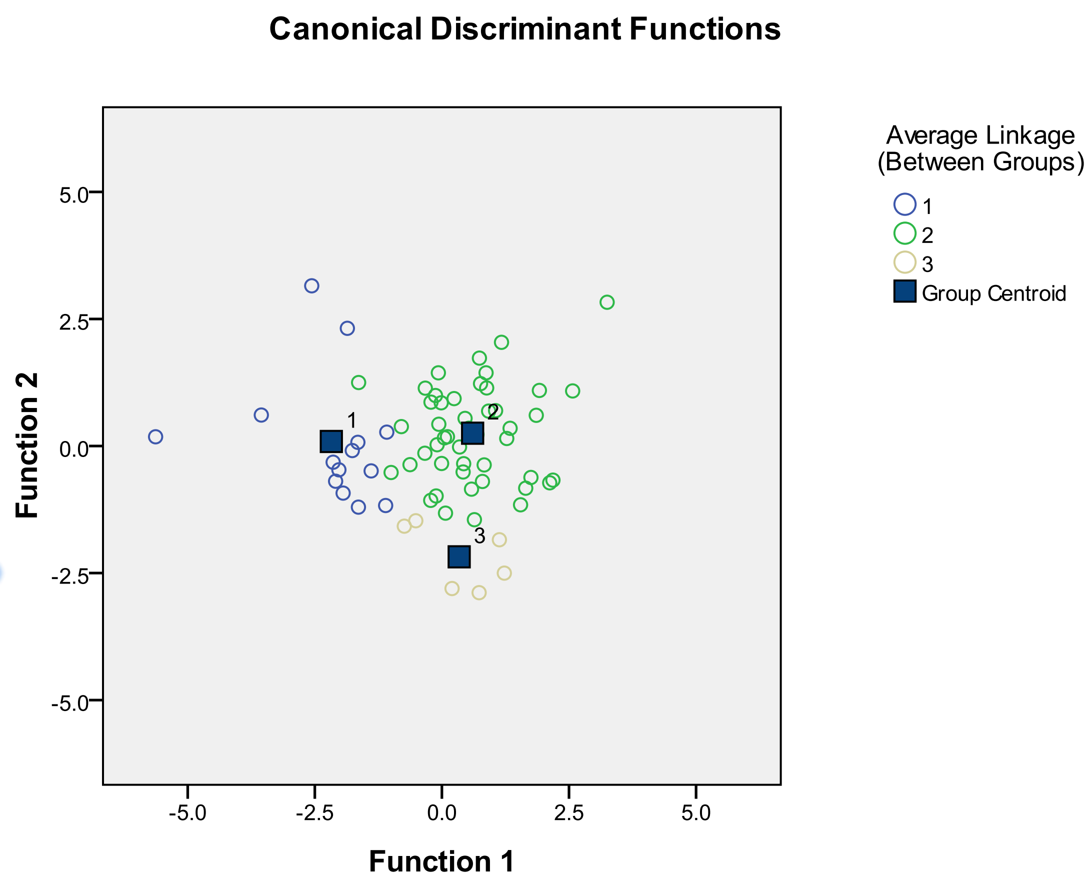


Figure 2 Classification chat of soybean milk character

1 The elementary indexes are the content of protein, P, fat and Ca
2 The data which contain elementary indexes, yield and viscosity are standardized and classified by clustering analysis, and discriminant analysis is used to examine the result.

Evaluation of flavor quality

- Class I': the soymilk has a heavy beany flavor and non-beany flavor;
- Class II': the soymilk has a heavy non-beany flavor and weak beany flavor;
- Class III': the soymilk has a weak beany flavor and non-beany flavor.



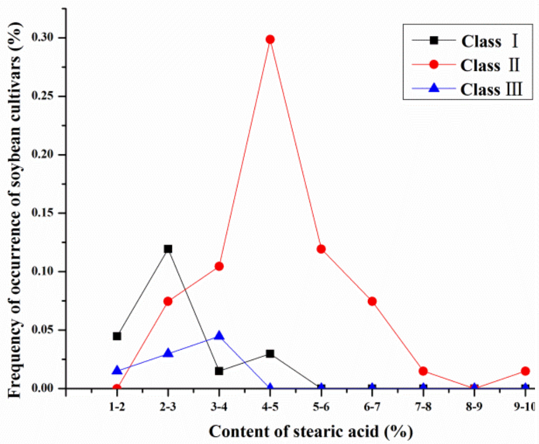
Figur 3 Classification chat of soybean milk aroma

1 The elementary indexes are the content of protein, fat, LOX activity, palmitic acid, stearic acid, oleic acid, linoleic acid and linolenic acid.

2 The data which contain elementary indexes, the indexes of sensory evaluation and the flavor compounds are standardized and classified by clustering analysis, and discriminant analysis is used to examine the result.

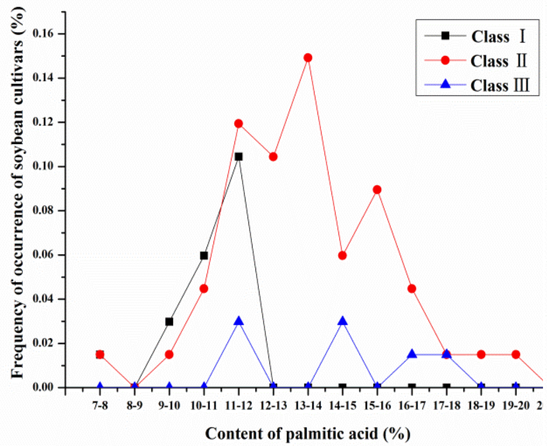
Research results

Stearic acid



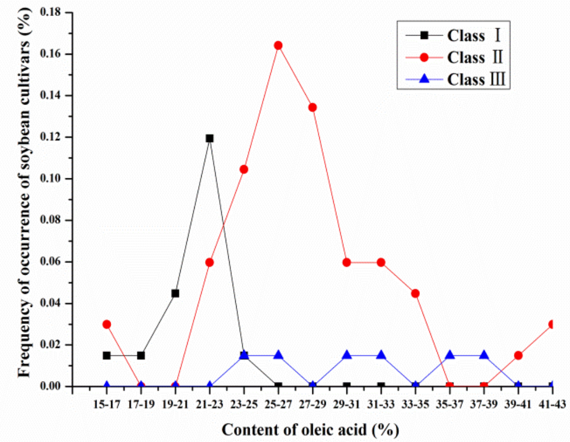
3-6%

Palmitic acid



12-15%

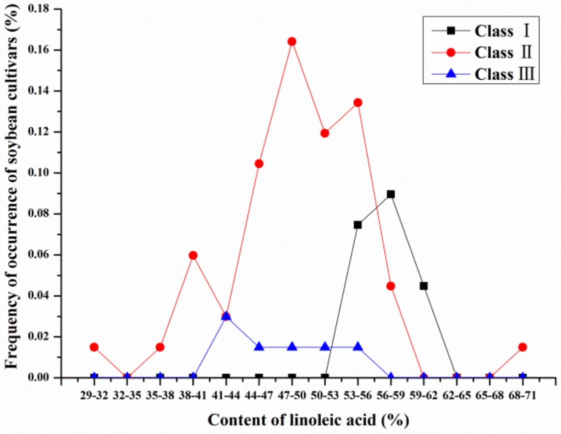
Oleic acid



23-29%

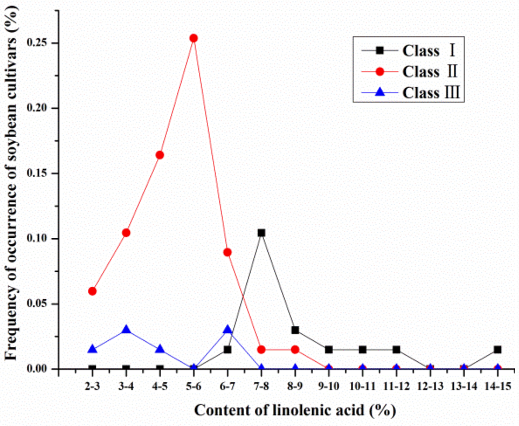
Research results

Linoleic acid



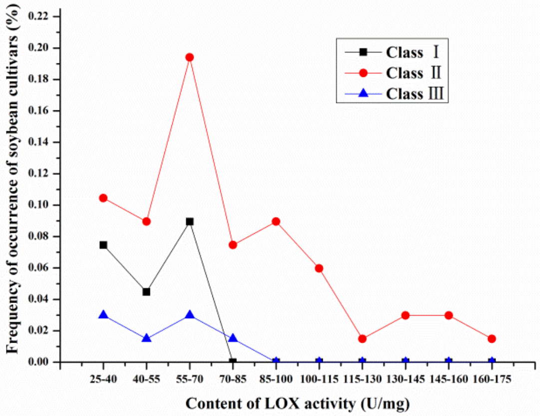
42-53%

Linolenic acid



4-6%

LOX activity



No significant difference

Conclusion

- ***In this study, the yield, viscosity and flavor of soymilk prepared by different soybean cultivars were measured, and the correlations of soybean components and the three aspects were analyzed respectively.***
- ***According to the clustering analysis and discriminant analysis, the soymilk was classified into three classes.***
- ***The fatty acids of soybean cultivars which can produce relatively good soymilk flavor (Class Ⅱ') were analyzed, and the content range of each fatty acid was determined. However, we still have to verify and confirm these results.***
- ***It is still a part of the whole research for the establishment of evaluation method of soybean cultivars suitable for the soymilk processing .***

Thank you!

FSNE College