

TREATMENT OF CHINESE CABBAGE JUICE

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ABSTRACT

The coagulation of Chinese cabbage juice can be accomplished by applying the combine method of the formic acid with rate of 3% and in four hours the propionic acid with rate of 1% in the juice. The separation of coagulation into the protein paste and the brown juice completed in 6.5 hours by set up method in special storage. The protein paste can be stored safely for 30 days in anaerobic condition.

Key Words: Chinese Cabbage Waste, Wet Fractionation, Coagulation, Storage, Fibrous Residue, Protein Paste, Brown Juice.

INTRODUCTION

The traditional agriculture definitely limits what is presently possible to obtain from agricultural lands. And production of raw material has been strongly advocated during last decade. The more and better global demand for food and non-food materials prescribes optimal utilization of every potential source of plants and lands. The alternative is an ecologically better adapted agriculture based on production by photosynthesis in green plants (Carlson, 1985).

The food problem is the extremely significant one as it's called to satisfy the public's need in feeding. The animal origin protein on its amino acid composition has been required by the human being for the indispensable amino acids. This is one of the reasons for the stockbreeding development. But the productivity of the stockbreeding directly depends upon the stability of the fodder supply. One of the ways to solve the problems could be the modernization of the traditional system and development of the new concepts of technologies to produce fodder and protein supplements.

Green crops can be used for a simultaneously manufacturing of several food and non-food industrial products by a process called green crop fractionation or wet fractionation of green crops. Wet fractionation of green vegetation yields initially two fractions, a fibrous residue and a fiber free extract. Further treatment of the extract results again in two fractions, a wet coagulum and the deproteinised fluid or whey (Singh, 1996).

Now the plants for the green vegetative biomass fractionation are working in France, New Zealand, Russia and other countries (Singh, 1996). But the different technological versions of fractionation show various problems like high-energy consumption and high-price of the set of equipment (Proydak, 1993).

The fresh vegetable should be supplied to the human beings as a vital food everyday. The vegetable waste has been produced large amount at farm and intermediate market every day in Korea. The most popular method to remove the waste is to transport it to a garbage dump. But the volume of vegetable waste is such a large amount that the expenditure for the transportation is quit high. Also the valuable energy sources become just a trivial trash on a dumping ground. To save the transportation cost and accelerate the fermentation in a field, the vegetable waste should be treated mechanically and reduced the volume. In the process of the mechanical treatment, large amount of juice should be extracted from vegetable waste.

One of the main problems is how to treat the green juice without using municipal wastewater treatment system. The fractionation of green juice could be one of the way to treat the green juice for saving the bio resources by using the basic processes of protein coagulation and separating juice coagulation into protein paste and brown juice and storing the final products.

OBJECTIVES

The main objective of the research is to find out the method of fractionation of the green juice extracted from Chinese cabbage waste. The specific objectives are as follows:

1. to investigate the various technique of coagulation of Chinese cabbage juice for recycling the wasted protein,
2. to choose the effective method of separation of coagulation from the Chinese cabbage juice for the protein paste and the brown juice,

3. to investigate the method of protein paste storage,
4. to develop the effective resource saving technology for treatment of the green pure juice from Chinese cabbage waste by producing the protein paste, the fibrous residue, and the brown juice.

MATERIALS AND METHODS

The material for test was Chinese cabbage waste at 90.9 – 92.1% moisture content and extracted green juice from the Chinese cabbage waste at 95.9-96.5% moisture content.

1. Methods for Coagulation

In the industrial practice (“Pro-Xan”, ”Vepex”, “France-Lucerne”) for vegetative protein coagulation, the thermal methods of heating green juice (temperature 85-88 °C) were used. However it was reported that the temperature was too high to have a negative effect on quality and safety of the protein, vitamins, and biologically active substances. Beside those temperature effects, the large energy expenditure was another problem (Singh, 1996). The other effective method was chemical treatment for the vegetative protein coagulation by different acids (Dolgov et. al., 1978). Based On the chemical treatment, the biochemical methods were also used by using the fermented green juice (Stahman, 1976), the aerobic and anaerobic conditions (Beker, 1991), the previously fermented green juice (Ohshima et. al., 1997), and the previously fermented brown juice (Ge Danzhi et. al., 1996). Lately the combine method was developed with different combination of acids, which can work for the protein coagulation, and the storage of the protein paste and brown juice (Proydak, Dolgov, 1994). However these perspective methods excluding the combine method did not test in industrial conditions. Some researchers investigated the vegetative protein coagulation by using electrical current, different kind of radiation, and the new hydro mechanical method. However large energy expenditure restrained these new methods developed from industrialization (Proydak, Kireeva, 1993). Application of the molecular filtration for vegetative protein extraction did not success because of the expensive membranes (Proydak N., 1990).

Base on the analysis of previous informations (Singh, 1996) and results from our own previous investigation (Proydak, Proydak, 1996), the next methods of protein coagulation of Chinese cabbage juice were developed for tests and listed as follows;

- A - the chemical method using the formic acid as a coagulant,
 B - the combine method using the formic acid as a coagulant and the propionic acid as a preservative,
 C - the combine method same as method B but application time of the propionic acid was delayed 4 hours,
 D - the biochemical method using lactic acid,
 E - the combine and biochemical method using lactic acid as a coagulant and the propionic acid as a preservative,
 F - the combine and biochemical method same as method E exception on using different application time for the propionic acid as delayed 4 hours.

Different kinds of acids and levels of their application as a coagulant and a preservative were selected base on the results of our own previous investigation on protein coagulation of Chinese cabbage juice.

As a function of response on the process of the protein coagulation of Chinese cabbage waste, the coefficient of protein coagulation K was introduced.

$$K = M_{np} / M_{nj} = M_p D_p P_p / M_l D_l P_l \quad (1)$$

where M_{np} , M_{nj} – mass of protein at the protein paste and the green juice, g ,

M_p , M_l – mass of the protein paste and the green juice, g,

D_p , D_l – dry material contents of the protein paste and the green juice, a part of one,

P_p , P_l – protein contents of dry material of the protein paste and the green juice, a part of one.

Methods of investigation were as follows;

Test A for chemical coagulation

- 1) to determine dry material and protein contents in the green juice,
- 2) to put 100g of the green juice in glass and add 2g (2% of the green juice, test A1) and 3g (3% of the green juice, test A2) of the formic acid as the coagulant,
- 3) to separate the coagulation by a centrifuge for 30 min at $g=7000$,
- 4) to determine the mass of the protein paste, dry material and protein contents of the separated coagulant.

Test B for combine coagulation by 2 acids applied at the same time,

to put 100 g of the green juice in glass and add 3 g (3% of the green juice) of the formic

acid and 1g (1% of the green juice, test B1), 2.5g(test B2), 4g(test B3) of the propionic acid as the preservative.

Test C for combine coagulation by 2 acids applied at 4 hours interval, to put 100g of the green juice in glass and add 3 g of the formic acid and in 4 hours 1g (test C1), 2.5g (test C2), and 4g (test C3) of the propionic acid.

Test D for biochemical coagulation, to put 100 g of the green juice in glass and add 3.5 g (3.5%) of the lactic acid as the coagulant.

Test E for combine-biochemical coagulation by 2 acids applied at the same time, to put 100 g of the green juice in glass and add 3.5 g (3.5%) of the lactic acid as the coagulant and 2.5g (2.5%) of the propionic acid as the preservative.

Test F for combine-biochemical coagulation by 2 acids applied at 4 hour interval, to put 100 g of the green juice in glass and add 3.5 g (3.5%) of the lactic acid as the coagulant and in 4 hours 2.5g (2.5%) of the propionic acid as the preservative.

All tests repeat 3 times. The coefficients of protein coagulation K were calculated by the equation (1).

2. Methods for separation of the coagulation

For the separation of green juice coagulation, the different kinds of centrifuges and filter presses were used even though unstable on the technical process and high price of facilities (Dolgov et. al., 1978). Recently the cheapest effective method of separation of the alfalfa green juice coagulation by set up was developed and successful tested at the industrial conditions (Dolgov, Proydak, 1990). By using the set up method, the separation of green juice coagulation from Chinese cabbage waste was tested.

During the separation of the coagulation by set up, the coagulation got a change of vertical coordinate border between protein paste in low part of glass and brown juice in its upper part.

For the test, 1000 g of the green juice was put in glass marked vertical scale. The coagulation of the green juice was prepared by using the chemical (A), the combine (B), the biochemical (D) and the combine-biochemical (E, F) methods, described by the methods of coagulation part. The vertical coordinate of border of the separated coagulant was checked from bottom of glass every 30 minutes for 40 hours. Every test repeats 3 times.

3. Methods for the storage of the protein paste

In different technical versions of wet fractionation for longtime storage, the drying of protein paste can be used and the protein paste can be concentrated with the moisture contents 8 to 12% as a result of drying. But for the process of drying, expensive equipments and high-energy expenditure are needed (Singh, 1996). The previous research suggested the effective storage of alfalfa protein paste in anaerobic conditions in a special storage system. The anaerobic conditions can be obtained by the layer of brown juice thickness 15 to 20 cm. above the protein paste (Proydak, 1996).

The evaluation of the protein paste storage in anaerobic condition was obtained by measurements of the change of the protein contents and the value of pH of protein paste.

The methods of investigation were as follows;

- 1) to put the protein paste in 1000 ml glasses which was made by methods of coagulation A, B, D, E, F, describing in Methods of coagulation,
- 2) to measure the protein contents and pH of protein paste at beginning and every 5 days for 30 days, each test repeats 3 times.

RESULTS AND DISCUSSION

1. Coagulation of Chinese cabbage juice

The protein coagulation coefficients K of the different methods for coagulation were calculated by the equation (1) and shown in Table 1. The chemical coagulation method, A, shows the biggest values of coefficients K and the combine-biochemical method, E, and combine method, C, also show high value of K. In the chemical method, the coefficients of protein coagulation K increased from 34.175 (A1) to 36.391(A2) with increase of the rate of the coagulant, the formic acid, from 2% to 3%. These results matched with the previous results of alfalfa protein coagulation investigation (Dolgov, Proydak, 1990). The combine method C increases the coefficients of protein coagulation K more than 10% as compared with method B.

Table 1. Coefficients of protein coagulation of Chinese cabbage juice by different methods

Test	Method of coagulation	Condition of coagulation	Average coefficients of Protein coagulation K, %
1	A	A1	34,175
		A2	36,391
2	B	B1	29,771
		B2	29,141
		B3	29,113
3	C	C1	33,863
		C2	33,93
		C3	32,08
4	D	D	31,515
5	E	E	34,252
6	F	F	32,956

The combine (C) and combine-biochemical (F) methods which were distinguished from method B and E by the delayed application time of two acids show better coagulating and preserving properties compared to those of the method B and E. The recommendation of the best method for the coagulation of Chinese cabbage protein should be suggested after obtaining the results of protein paste storage.

2. Separation of the coagulation

The results of separation of coagulation by set up method are shown in Fig 1 according to the chemical (A), the combine (B), the biochemical (D) and the combine-biochemical (E, F) coagulation methods. The stable separation of coagulation of Chinese cabbage juice can be obtained by the chemical and the combine methods in 5.5 and 6.5 hours, respectively. For coagulations getting by biochemical (D) and the combine-biochemical (E, F) methods, the time of separation is about 16 hours. The big differences between of the separating time came from the different chemical properties of the formic and the lactic acids.

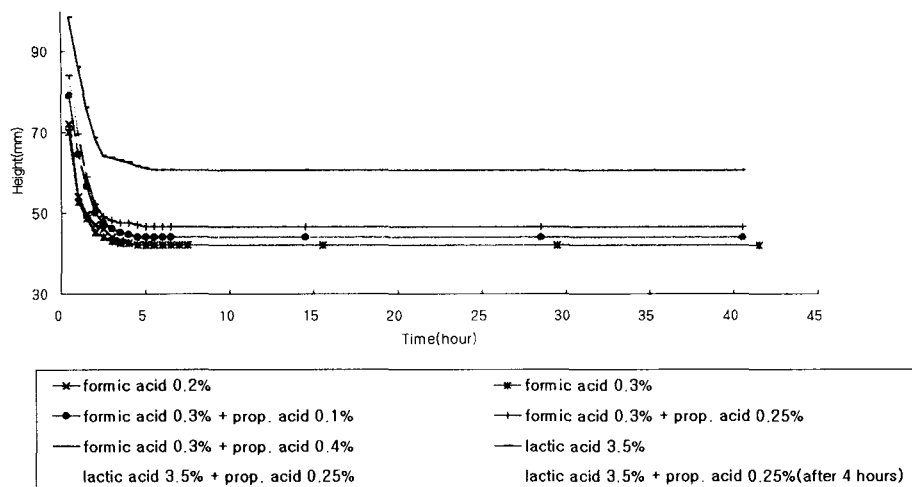


Fig. 1. Separation of coagulation by set up method.

3. Storage of protein paste

During the storage of the protein paste in an anaerobic condition for 30 days, the protein contents decreased from 1.6 to 2.8 % without significant difference among the methods of A, B, D, E, F.

In 30 days, pH of protein paste from chemical coagulation (Fig.2) was reduced from 3,77 to 3,68 (A1) and from 3,52 to 3,45 (A2). After combine coagulation, pH of protein paste is reduced from 3,5 to 3,43 (B1), from 3,46 to 3,4 (B2) and from 3,5 to 3,45 (B3). The values of pH of protein paste, getting by biochemical and combine-biochemical method, is reduced from 5,37 to 3,27 (D), from 5,33 to 4,41 and then to 3,47 (E) in 30 days. The pH of protein paste, getting by combine-biochemical method F, is reduced from 5,38 to 3,54 and then is increased to 3,85. This result indicates the beginning of spoiling of protein paste. So, the combine method showed the least change of pH and the best condition for anaerobic storage protein paste from Chinese cabbage juice.

4. System for Chinese cabbage juice treatment

Based on the test results, the new technical system for treatment of Chinese cabbage waste was worked out (Fig. 3). The Chinese cabbage waste disintegrates in special unit 2 and then squeezed out the green juice by screw press 2. Then the fibrous residue can be

used for the silage or the pellets of grass flour. The green juice separated from the fibrous mixture by filter 4.

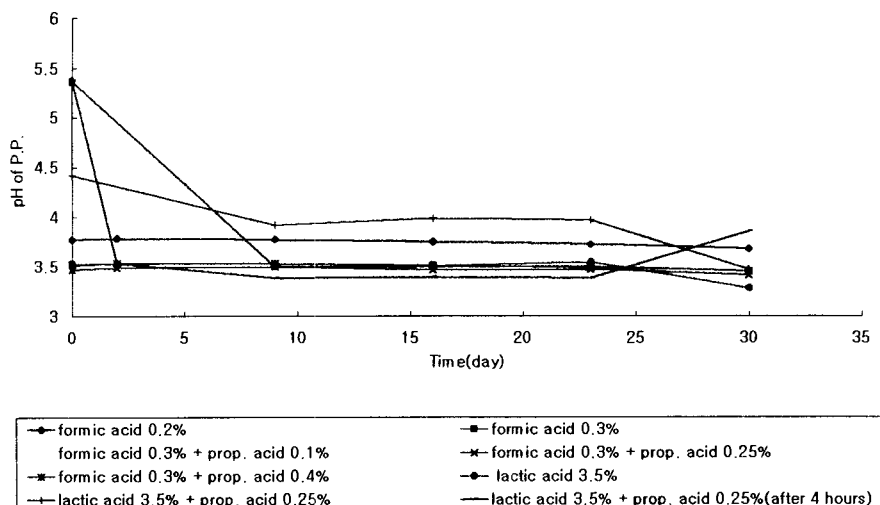


Fig.2 pH of protein paste during the storage.

Then the combine coagulation method using the mixture of coagulant (the formic acid) and the preservative (the propionic acid) can be used to obtain the coagulation from the clean juice of the Chinese cabbage waste. The coagulation will be collected into the special storage 6, where the protein paste can be separated from the brown juice on top. Finally the brown juice pumped to the storage 7.

CONCLUSIONS

1. The coagulation of juice from Chinese cabbage waste can be obtained by applying the formic acid of 3% as a coagulant and then in 4 hours the propionic acid of 1% as a preservative with maximum recovery of protein coagulation among the various methods of coagulation in this test.
2. The separation of coagulation into the protein paste and the brown juice completed in 6.5 hours by set up method in special storage.
3. The protein paste in anaerobic condition can be stored at least 30 days.
4. The resource saving technology allow to treat the Chinese cabbage waste on the pro-

tein paste with protein contents 35 to 40% in dry materials, the fibrous residue with high level of cellulose and deproteinised brown juice with vitamins and biological-active substances. The protein paste can use as the full-bodied substitutes of animal origin protein (fish and meat-bone flours, milk and others) in the ration of farm animals and poultry. The brown juice recommend using for ensiling rough fodder, preparation wet fodder and others. From the fibrous residue can prepare high quality briquette silage.

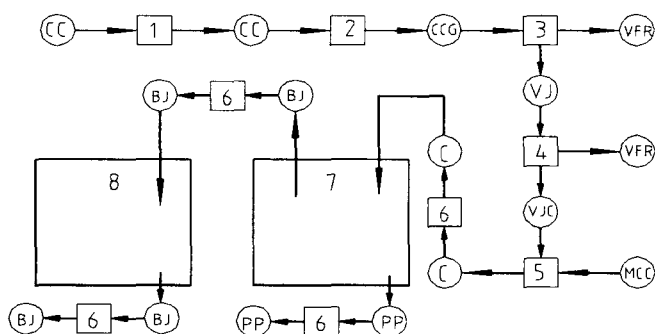


Fig.3. Technical system for treatment of Chinese cabbage waste.

CC-Chinese cabbage; CCG-cutting CC; VFR- vegetative fibrous residue; VJ-green juice; VJC-clear VJ; MCC-mixture of coagulant and preservative; C-coagulant of VJC; BJ-brown juice.

1- feeder; 2-gringer; 3-screw press; 4-filter; 5-pump; 6-unit for C separation and PP storage; 7-unit for BJ storage.

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