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## Study on Extraction of Dietary Fiber from Potato Peel by Acid-base Chemical Method

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# Study on Extraction of Dietary Fiber from Potato Peel by Acid-base Chemical Method

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**Abstract.** In this paper, potato peel were used as raw material. Taking water-insoluble dietary fiber as index, the effects of acid-alkali extraction time, concentration of acid extraction and alkali extraction on water-insoluble dietary fiber in potato peel were investigated by acid-base chemical method. The optimum process conditions for extracting dietary fiber were determined by neutral detergent method. The results showed that the yield of water insoluble dietary fiber could reach 12.6% when the acid-alkali extraction time was 35 minutes, the acid extraction concentration was 1.5%, the alkali extraction concentration was 1.6%.

## 1. Introduction

Potato production in China ranks first in the world. Nearly 70% to 80% of potato production is used for fresh food or deep processing [1]. On average, millions of tons of potato peel residue are produced every year. Usually, it is used as animal feed or burial directly in food processing factories, which makes the residue of potato peel not fully utilized. Potato peel residue is rich in nutrients, such as flavonoids, polyphenols and proanthocyanidins. The content of dietary fiber is higher, about 50% of the dry base. Therefore, pectin, starch, protein and other polysaccharides [2] and dietary fiber can be extracted from potato peel residue. There are five methods to extract dietary fiber, namely chemical method, enzymatic method, enzyme-chemical combination method, membrane separation method and microbial fermentation method [3-6]. In this work, the acid-base chemical method was used to extract crude fibers from potato peel to obtain water-insoluble dietary fibers, which could provide theoretical basis for the comprehensive utilization of potato peel.

## 2. Materials and methods

### 2.1 Materials

Potato peel: Harbin McCann Food Co. Ltd. Sulfuric acid, sodium hydroxide, anhydrous ethanol, anhydrous ether, methyl red, phenolphthalein, Ethylenediaminetetraacetic acid disodium salt, sodium tetraborate, sodium lauryl sulfate, ethylene glycol ether, disodium hydrogen phosphate, phosphoric acid, acetone: marketed, analytically pure. Alpha thermostable amylase: ACROS Chemical Reagent Company.

### 2.2 Equipment and instruments

Analytical Balance: BSA223, Beijing Saidolis Balance Co., Ltd; Pulverizer: FW135, Tianjin Tester Instrument Co., Ltd; Constant Temperature Water Bath; HWS24, Shanghai Yiheng Technological Instrument Co., Ltd; Cellulose Analytical Instrument: NAI-CQW-6, Shanghai Naai Precision Instrument Co., Ltd; Ashing Furnace: SX-12-9, Ningbo Shengguang Furnace Co., Ltd.



## 2.3 Method

*2.3.1 Pretreatment of raw materials.* The fresh potato peel was dried to constant weight in a drying box at 105°C. After crushing and sieving, the dried potato peel was put into a large jar and cooled in a dryer for reserve.

*2.3.2 Determination of water-insoluble dietary fiber in potato peel.* Residues → neutral detergent (100ml), decalin (2ml), sodium sulfite (0.5g) → start counting after boiling, keep slightly boiling for 1h → adding heat-resistant alpha-amylase (25ml), keep in thermostat for 1h at 37°C → wash the enzyme solution with hot water and wash with pure acetone → weighed the sample.

(1) Thermal extraction method: the extracted residue was placed on a quartz crucible and in a fibre analyzer for thermal extraction. Neutral detergent (100 ml), high temperature resistant alpha amylase (2.5 mg) and decalin (2 ml) as the defoamer were added. The power of the electric heating plate was adjusted to keep the microboiling state for 1 h. After heating, the sample was immediately filtered and washed with hot water until no foam in the filtrate.

(2) Cold extraction method: the sample was put in the fiber analyzer for cold extraction, and the residue was washed with acetone four times to make sure the two were fully contacted and mixed until the filtrate was colorless. Then residual solids were placed into the oven (105°C) for 4h after drying, the weigh was measured after cooling in the dryer. The residue after constant weight was put in the ashing furnace and was ashed at 550°C for 3 h. Finally, it was cooled and weighed in the dryer.

### *2.3.3 Optimization of extraction parameters of water-insoluble dietary fiber from potato peel. Effect of extraction time on the extraction of water-insoluble dietary fiber*

Each sample (2 g±0.0001g) was weighed accurately, and added 100ml of 1.25% dilute sulfuric acid. The samples were refluxed for 10min, 20min, 30min, 40min, 50min under micro-boiling condition respectively. Shaking once every 5min to ensure full contact between samples and reagents. After hot water filtration, the samples were also alkali extracted with 100ml of 1.25% sodium hydroxide solution. The yield of water insoluble dietary fiber was used as the evaluation index to determine the optimal reflux time.

#### *Effect of the concentration of acid-base extraction on the extraction of water-insoluble dietary fiber*

Each sample (2 g±0.0001g) was weighed accurately, and added 100ml of 0.75%, 1.00%, 1.25%, 1.50%, 1.75% dilute sulfuric acid respectively. The samples were refluxed for 30min under micro-boiling condition. Shaking once every 5min to ensure full contact between samples and reagents. After hot water filtration, the samples were also alkali extracted with 100ml of 1.25% sodium hydroxide solution. The yield of water insoluble dietary fiber was used as the evaluation index to determine the optimal the concentration for acid-base extraction.

#### *Effect of the concentration of alkaline-base extraction on the extraction of water-insoluble dietary fiber*

Each sample (2 g±0.0001g) was weighed accurately, and added 100ml of 1.25% dilute sulfuric acid. The samples were refluxed for 30min under micro-boiling condition. Shaking once every 5min to ensure full contact between samples and reagents. After hot water filtration, the samples were also alkali extracted with 100ml of 0.75%, 1.00%, 1.25%, 1.50%, 1.75% sodium hydroxide solution respectively. The yield of water insoluble dietary fiber was used as the evaluation index to determine the optimal the concentration for acid-base extraction.

#### *Determination of optimum conditions of water-insoluble dietary fiber in potato peel*

On the basis of single factor experiment, reflux time of A (min), the concentration of acid-base extraction of B (%) and the concentration of alkaline-base extraction of C (%) were selected to design L9 (34) orthogonal experiment. The levels and factors were shown in Table 1.

Table 1. The factors and levels table.

Levels	A Reflux (min)	B Concentration of acid- base extraction (%)	C Concentration of alkaline- base extraction (%)	D Blank
1	25	1.4	1.4	
2	30	1.5	1.5	
3	35	1.6	1.6	

### 3. Results and discussion

#### 3.1 Effect of extraction time on the extraction of water-insoluble dietary fiber

The results of extraction rate and yield of dietary fiber measured at different time of reflux purification under certain acid-base concentration were shown in figure 1 and figure 2.

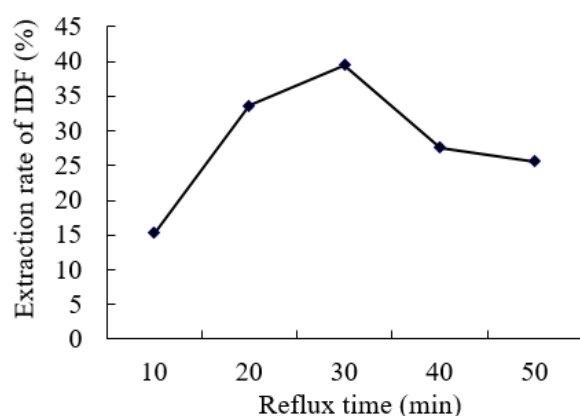


Figure 1. Effect of reflux time on extraction rate of dietary fiber.

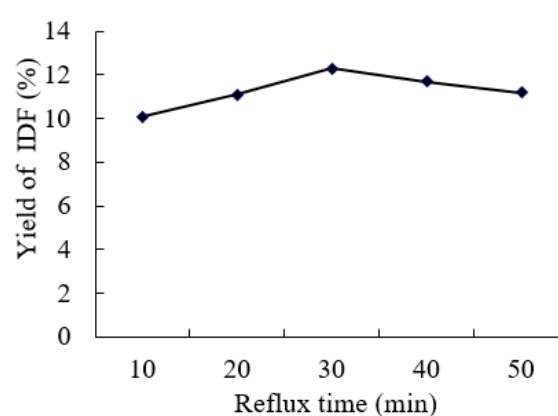


Figure 2. Effect of reflux time on the yield of dietary fiber.

As shown in figure 1, the extraction rate of water-insoluble dietary fiber increases with the increase of extraction time first, then decreases, and finally tends to be flat. When the reflux time is 30 minutes, the extraction rate of dietary fiber is the highest (up to 39.5%). Figure 2 shows that the yield of water-insoluble dietary fiber increases first, then decreases, and finally tends to be flat with the increase of reflux time, which is similar to the trend of extraction rate of dietary fiber. When reflux time is 30 minutes, the yield of dietary fiber reaches 12.3%.

#### 3.2 Effect of the concentration of acid-base extraction on the extraction of water-insoluble dietary fiber

Under the reflux time of 30 min at a concentration of 1.25% alkaline liquor, the extraction rate and yield of dietary fiber with different acid extraction concentration were shown in figure 3 and figure 4.

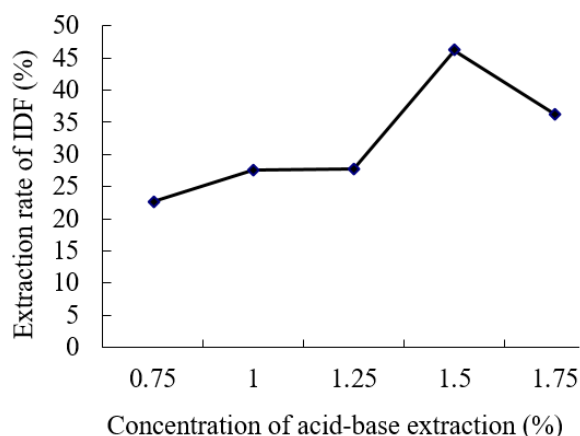


Figure 3. Effect of the concentration of acid-base extraction on the extraction rate of water-insoluble dietary.

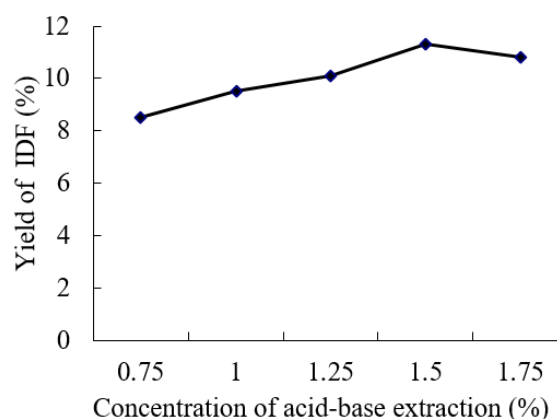


Figure 4. Effect of the concentration of acid-base extraction on the yield rate of water-insoluble dietary.

As shown in figure 3, the extraction rate of water-insoluble dietary fiber increases slowly first, then rises sharply, and finally decreases sharply with the increase of acid extraction concentration. When the concentration of acid extraction is 1.5%, the yield of water insoluble dietary fiber is the highest (up to 46.2%). The extraction rate of water-insoluble dietary fiber increases with the increase of acid extraction concentration. Especially, the extraction rate increases sharply from the acid-base concentration of 1.25%, Under this condition then decreases sharply at the concentration more than 1.5%. The reason may be that the ability of acid solution to destroy the cell wall structure of potato peel decreases, or that some water-soluble dietary fibers are transformed into water-soluble dietary fibers, resulting in a sudden increase of the yield of water-insoluble dietary fibers [7]. As shown in figure 4, the extraction rate of water insoluble dietary fiber increases gradually, then decreases with the increase of acid extraction concentration. When the concentration of acid extraction reaches 1.5%, the yield of water insoluble dietary fiber is the highest (up to 11.3%).

### 3.3 Effect of the concentration of alkaline-base extraction on the extraction of water-insoluble dietary fiber

Under the reflux time of 30 min at a concentration of 1.25% acid-base liquor, the extraction rate and yield of dietary fiber determined by different alkali extraction concentration are shown in figure 5 and figure 6.

As shown in figure 5, the extraction rate of water-insoluble dietary fiber decreases first, then increases slowly, and finally decreases with the increase of alkali extraction concentration. According to the correlative references [8], it is found that the alkali extraction concentration is 1.5%, and the extraction rate is higher. The curve obtained by the experiment accords with this conclusion. Therefore, the extraction rate of water-insoluble dietary fiber is 36.1% at the alkali extraction concentration of 1.5%. As shown in figure 6, the yield of water-insoluble dietary fiber increases slowly at first, and then decreases sharply with the increase of alkali extraction concentration. The highest yield of IDF is 12.3% when the alkali concentration is 1.5%.

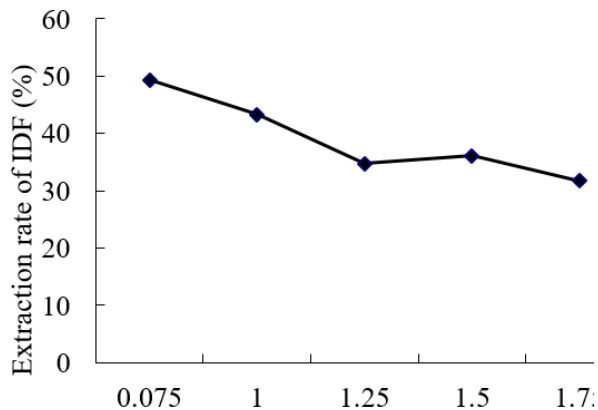


Figure 5. Effect of the concentration of alkaline-base extraction on the extraction rate of water-insoluble dietary.

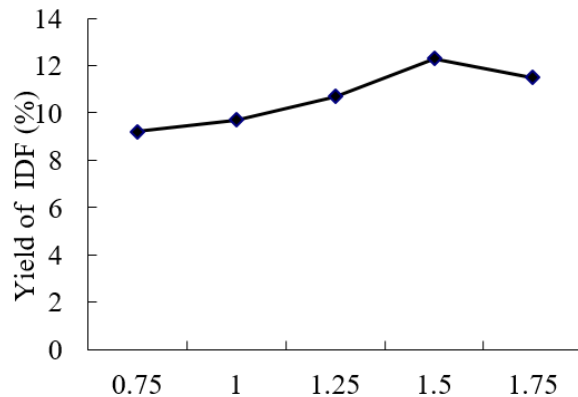


Figure 6. Effect of the concentration of alkaline-base extraction on the yield rate of water-insoluble dietary.

### 3.4 Determination of optimum conditions of water-insoluble dietary fiber in potato peel

According to the optimum range determined by single factor experiment, orthogonal experiment table L<sub>9</sub> (3<sup>4</sup>) was designed. The results were shown in table 2.

As shown in Table 2., it can be obtained by comparing the range that the reflux time, the concentration of acid-base extraction and alkaline-base extraction have significant effects on the extraction rate of water-insoluble dietary fiber, and reflux time has the most apparent influence on. According to the influence of each factor on extraction rate, the effect sequence of every factor is: A > B > C. According to the table of the orthogonal test and range analysis, the maximum K value of A is A<sub>3</sub>, the maximum K value of B is B<sub>2</sub>, and the maximum K value of C is C<sub>3</sub>. In conclusion, the optimum extraction process of water-insoluble dietary fiber from potato peel is A<sub>3</sub>B<sub>2</sub>C<sub>3</sub>, that is, reflux time is 35 minutes, the concentration of acid-base extraction is 1.5% and the concentration of alkaline-base extraction is 1.6%. The yield of water-insoluble dietary fiber is 12.6%. The optimum parameters for extracting water-insoluble dietary fiber from potato peel are determined.

Table 2. L<sub>9</sub>(3<sup>4</sup>)Orthogonal test results of the yield of dietary fiber

Numbers	A Reflux time (min)	B Concentration of acid- base extraction (%)	C Concentration of alkaline-base extraction (%)	D Blank	Yield (%)
1	1	1	1	1	11.2
2	1	2	2	2	11.9
3	1	3	3	3	11.7
4	2	1	2	3	12.2
5	2	2	3	1	12.3
6	2	3	1	2	12.0
7	3	1	3	2	12.3
8	3	2	1	3	12.4
9	3	3	2	1	12.1
k <sub>1</sub>	11.60	11.90	11.867	11.867	
k <sub>2</sub>	12.167	12.20	12.067	12.067	
k <sub>3</sub>	12.267	11.933	12.10	12.10	
Range	0.667	0.30	0.233	0.233	
Optimization levels	A <sub>3</sub>	B <sub>2</sub>	C <sub>3</sub>		

As shown in Table 2, it can be obtained by comparing the range that the reflux time, the concentration of acid-base extraction and alkaline-base extraction have significant effects on the extraction rate of water-insoluble dietary fiber, and reflux time has the most apparent influence on. According to the influence of each factor on extraction rate, the effect sequence of every factor is:  $A > B > C$ . According to the table of the orthogonal test and range analysis, the maximum K value of A is A3, the maximum K value of B is B2, and the maximum K value of C is C3. In conclusion, the optimum extraction process of water-insoluble dietary fiber from potato peel is A3B2C3, that is, reflux time is 35 minutes, the concentration of acid-base extraction is 1.5% and the concentration of alkaline-base extraction is 1.6%. The yield of water-insoluble dietary fiber is 12.6%. The optimum parameters for extracting water-insoluble dietary fiber from potato peel are determined.

#### 4. Conclusion

In this paper, the extraction process of water-insoluble dietary fiber from potato peel was optimized by analyzing the factors affecting the yield of water-insoluble dietary fiber. The optimum extraction process of water-insoluble dietary fiber by acid-alkali chemical method was determined as follows: the optimum concentration of acid-base extraction was 1.5%, the optimum concentration of alkaline-base extraction was 1.6%, and the optimum reflux time was 35 min. Under this condition, the yield of water-insoluble dietary fiber was 12.6%. Potato peel was also rich in pectin and water-soluble dietary fiber. Its high nutritional value could be further developed and utilized.

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