CONCENTRATION OF BONE EXTRACTS USING GRADIENT SERIES MEMBRANE

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Abstract – A concentration system of microfiltration and reverse osmosis membrane was designed for the concentration of bone extracts to substitute traditional process, which always consumed lot of energy and decreased the quality of products. After being broken into blocks, the fresh bone material was added to extraction tank with water (33%~40%, w/w) to prepare bone extracts, the hot pressure extraction time was 30~120 min at pressure of 0~0.3 MPa. After standing in slag and degreasing, bone extracts were concentrated to brix of 5º~50º using microfiltration and reverse osmosis membrane, which follows by blending and sterilization operation. This gradient series membrane could remove water from bone extracts at the lower temperature, and thus decreasing the loss of nutrition and flavor. In addition, this technology could reduce the consumption of energy and cost of production.

Key Words – Livestock and poultry bone; membrane concentration; reverse osmosis; microfiltration

I. INTRODUCTION

China is a large animal-origin food production and consumption country. Livestock and poultry bones have abundant nutritional ingredient, such as proteins, lipids, minerals and other nutrients. It is worthy to make good use of those bones. After deep processing, livestock and poultry bones can develop new, natural, green, nutritious bone soup, ossein and other bone-source food, which can improve the comprehensive benefits of meat processing enterprises [1]. However, the traditional process techniques, such as extraction and vacuum concentration, are all high energy-consumption process. Moreover, it can lead to the changes of bone extracts' flavor substance and decrease of quality [2]. Membrane separation technology is an approach for separating solvent and the solute or different components in the solutions by using the selectivity of polymer membrane. It has great advantages in continuous operation and low energy consumption. Integrated membrane technology realizes the organic combination of various membrane separation process and overcome the shortcomings of single membrane concentration [3]. The purpose of this study was to design an integrated membrane concentration system of microfiltration tandem reverse osmosis membrane and provide the basis for industrialized production of bone extraction by membrane concentration.

II. MATERIALS AND METHODS

Gradient membrane concentration is composed of two parts: microfiltration filtering system (Figure.1-A) and reverse osmosis concentration system (Figure.1-B). Ceramic membrane and first level reverse osmosis membrane were used for microfiltration filtering and reverse osmosis concentration, respectively. The basic composition of ceramic membrane was α-Al_2O_3 (99%), which was coated with ZrO_2. The ceramic membrane has 37 channels with the diameter of 2.6~2.8 mm. The membrane pore size was 5~50 nm and membrane inlet pressure was 0.3~0.6 MPa. The reverse osmosis membrane was polyamide composite membrane and the model number was 8040 (high temperature film).

When filtering, the extracting solution was moved into the ceramic membrane circulation tank, and then transferred into the first level ceramic membrane through security filter by the high-pressure pump. Filtration liquid produced by the second level ceramic membrane and first level ceramic membrane in series were transferred into the first level reverse osmosis circulation tank by the pump. Thick liquid was looped back to the ceramic membrane tank. When the material liquids in the first level reverse osmosis circulation tank reached a certain level, the pump will be started and transferred the liquid into the reverse osmosis concentration system for concentration. Filtration liquids produced by the ceramic membrane were introduced into first level reverse osmosis membrane by the reverse osmosis high pressure pump. The reverse osmosis pure water was recycled to reuse under the action of reverse osmosis high pressure pump in the same way, and thick liquid was looped back to the first level reverse osmosis circulation tank.

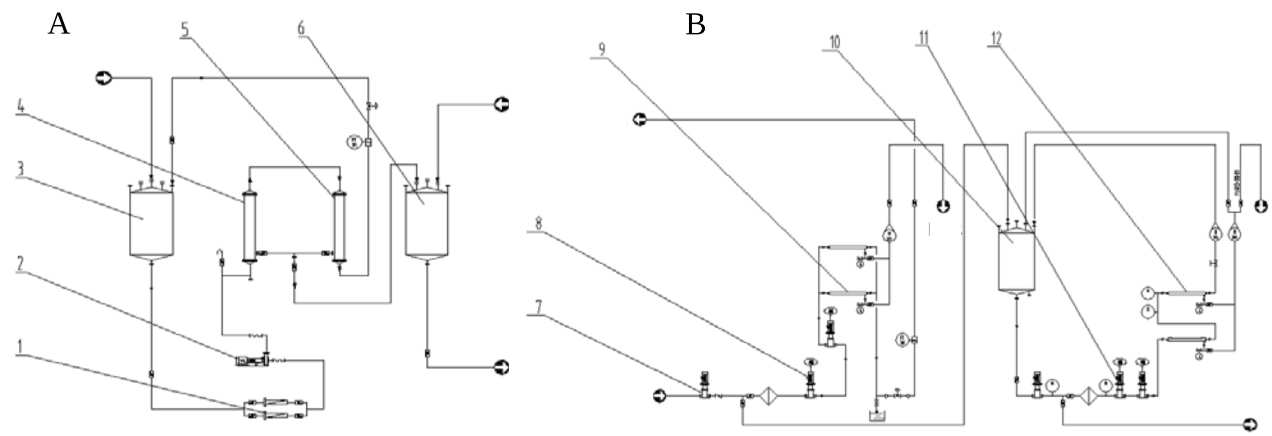

Figure 1. Concentrated flow chart of bone extracts by membrane. A. Microfiltration filtering system; B. Reverse osmosis concentration system
1 Security filter; 2 High pressure pump; 3 Ceramic membrane tank; 4 First level ceramic membrane; 5 Second level ceramic membrane; 6 First level reverse osmosis circulation tank; 7 Material liquids pump; 8 Reverse osmosis high pressure pump; 9 First level reverse osmosis membrane; 10 Second level reverse osmosis material liquids tank; 11 Second level reverse osmosis high-pressure pump; 12 Second level reverse osmosis membrane

When the first level reverse osmosis material liquids were concentrated to 60% of total volume (40% moisture was removed), the switched valve would pump the liquids into the second level reverse osmosis material liquids tank. The reverse osmosis pure water was recycled to reuse by opening the second level reverse osmosis high pressure pump, and thick liquids looped back to the second level reverse osmosis material liquids tank. The process was circulated until the Brix of the material liquids reached 26° (80% moisture was removed).

III. RESULTS AND DISCUSSION

Take the 2000 L bone extracting liquids that concentrated from 3° to 20° (Brix value) as an example. Compared with the traditional double effect vacuum evaporator, the gradient series membrane was concentrated without steam and the consumption of cooling water. The energy consumption was reduced by 80.50% and the cost was reduced by 83.43%. Meanwhile, membrane separation technology is a low temperature concentration technique, which could reduce the nutrients and flavor loss and improve product quality in the concentration process. Although the integrated membrane technology is now widely used in food and other fields, membrane fouling and membrane loss and other issues cannot be underestimated. In order to reduce the membrane pollution and minimize membrane loss, we need to continue to develop new membrane materials and optimize the production process.

IV. CONCLUSION

A concentration system of microfiltration and reverse osmosis membrane was designed for the concentration of bone extracts to substitute traditional process. It could reduce operating costs, energy consumption and provide the basis for the standardization and industrial application of integrated membrane technology.

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