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Optimization of the Technology of Chlorogenic Acid Extraction from Yacon (Smallanthus Sonchifolius) using Box-Behnken Design

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Yacon is a species of perennial daisy originally grown in South America, which has strong adaptation capacity and resistance to strong light and low temperature. Chlorogenic acid CGA has strong capacity to scavenge free radicals and antioxidant activity, hence it is extensively applied to the medicine, food and daily cosmetics industries. Currently, there are many extraction methods used for, such as water extraction, organic solvent extraction and enzymolysis extraction. In the Meanwhile, ultrasonic and microwave are often coupled with conventional extraction method, which is evident to upgrade extraction efficiency. Additionally, ultrahigh pressure extraction, supercritical fluid extraction, reverse micellar solution extraction and other novel advanced extraction technologies are also available in the extraction of CGA. Novel extraction technologies of CGA having the feature of high efficiency; however, they are deficient with complicated operation, high energy consuming and high demand for equipment. While soxhlet extraction is one of the good choice, low energy consuming, simple operation and high extraction rate. Currently, soxhlet extraction is extensively applied to many natural products.Moreover, the technology parameters of soxhlet extraction of CGA are less reported, so that a soxhlet extractor was used to extract CGA from yacon using Box-Behnken design.

All determinations were carried out in triplicate and significant differences ($p<0.05$) were calculated using Duncan's multiple range test.

Single factor experiment was carried out to explore the effect of syphon time, ethanol concentration and liquid-solid rate on extraction rate of CGA. In single factor experiment, the levels of syphon time were 1, 2, 3, 4, 5 and 6, the levels of ethanol concentration were 10%, 30%, 50%, 70% and 90%, and the levels of liquid-solid rate were 5, 10, 15, 20 and 25 mL/g, respectively.

Each group was repeated 3 times and average value was available. In single factor experiment, the effect of soxhlet extraction technology was drawn out; technology optimization by response surface design was in the overall assistance of Design-Expert soft including experimental design, data analysis, building model and technology optimization.

Effect of syphon times on the extraction rate of CGA: In the condition of 50% ethanol concentration and 15 mL/g liquid-solid rate, the effect of different syhon times on the extraction rate was shown in **Figure 1**. The extraction rate of CGA increased with the increasing of syphon time, the change of extraction rate was evident when syphon time was in 2~4, and the extraction rate reached the top of 5.03% in 5~6 syphons. Hence, the optimal syphon times were 5 times.

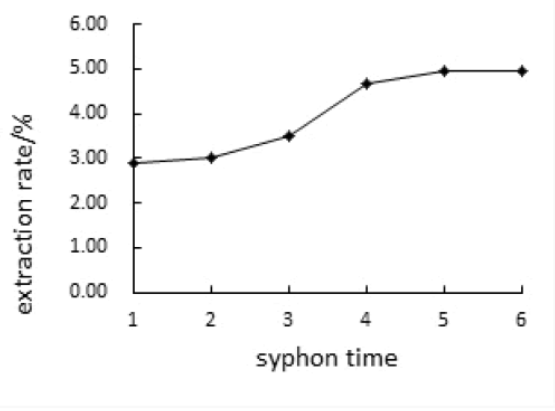

Figure 1: Effect of syphon times on the extraction rate of CGA..

As a a physiological active compound of phenylpropanoids in many plants formulating

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through shikimic acid pathway in the process of aerobic respiration, chlorogenic acid (CGA) is increasingly marching into daily chemical and food industries. Current study has used many extraction technologies to get CGA, but soxhlet extraction is less applied to extract CGA. Traditional technology spends much time and vitality, and its extraction rate is low, while novel advanced technology is faced with complicated operation, high demand for instrument and high cost. Compared with technologies above, soxhlet extraction in the study is universally applied that takes advantage of solvent reflux and siphon principle to make solid extracted constantly by pure solution, soxhlet extraction has good choice, low energy consumption and high extraction rate.

Chlorogenic acid (CGA) is a physiological active compound of phenylpropanoids in many plants formulating through shikimic acid pathway in the process of aerobic respiration, which was proved evident medicine value and medical care function. In the study, Chlorogenic acid (CGA) in yacon was extracted by soxhlet extraction, single factor experiment and response surface design was in assistance to construct secondary multiple regression equation where extraction rate responded to extraction parameters. $Y=-36.55875+5.14708X_1+0.73858X_2+1.27525X_3-0.00500X_1X_2+0.01\ \ 050X_1X_3-0.006900X_2X_3-0.47208X_1\ 2-0.00610X_2\ 2-0.032883X_3\ 2$.

Soxnlet extraction was determined that its optimal extraction technology included syphon time of 5, ethanol concentration of 50.41% and liquid-solid rate of 15.33 mL/g, and the extraction rate was 5.21% which had little error of 0.01% with actual value of verification experiment. Hence, response surface methodology could apply to the optimization of soxhlet extraction of Chlorogenic acid (CGA) in yacon, obtained model was reliable and extraction rate in the optimal technology was high. Meanwhile, ethanol concentration and liquidsolid rate were extremely significant to affect extraction rate, the interaction of syphon time and ethanol concentration was significant and that of syphon liquid-solid rate was also significant.

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