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Recycle technology for potato peel waste processing: A review

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Abstract

Acting as the fourth main crop behind rice, wheat and maize, potato plays an important role in human diet all over the world. Food processing industries particularly potato chips manufacturing industries generate a huge volume of potato peel as by product which is usually discarded causing environmental concern due to its microbial spoilage. Traditionally potato peel waste is used for producing low value animal feed, fertilizer, which causes waste of abundant nutritive materials having the properties of antioxidant, antibacterial, apoptotic, chemopreventive and anti-inflammatory. This review introduces principals and technologies of several advanced development of potato peel waste in food processing, phyto-pharmaceutical and biosynthesis industries, analyzes their advantages and disadvantages from the standpoint of popularization and economy, thus evaluates possibilities of future mass production of these products. Based on comparison of their possibilities, this review points out that biogas production, lactic acids, phenolic acids extraction from potato peel waste has better prospect for their contribution to food strategy in China, meanwhile ultrasonic extraction of steroidal alkaloids may have great potential in pharmaceutical field. Problem of higher cost still exists in these industries, thus future efforts should be put in lowering cost of all these extracting methods, and driving the further development of potato peel waste into practice.

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1. Introduction

In 2014, Chinese potato production reached one fifth of the total output in this world, thus undoubtedly potato is the most powerful food supplement for solution of increasingly severe food crisis in China¹. Acting as the fourth main crop behind rice, wheat and maize, potato plays an important role in human diet all over the world. With the deepening of potato processing industries, complete utilizing of the raw material shows more and more importance

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for the urgent demand for reducing feedstock waste and releasing the environmental pressure from potato residue. Therefore whole potato powder production is replacing traditional starch extraction, which accelerates the staple food strategy of potato. While no potato food processing may be started without the step of peel removal, and the generation of potato peel is unavoidable². Industrial processing generates between 70 and 140 thousand tons of peels worldwide annually³. Traditionally potato peel waste is used for producing low value animal feed⁴, fertilizer or being raw material of biogas, which causes waste of abundant nutritive materials within it having the properties of antioxidant, antibacterial, apoptotic, chemopreventive and anti-inflammatory⁵. Current researches focus on several advanced developments of potato peel waste in food processing, phyto-pharmaceutical and biosynthesis industries, which increase the value of potato peel recycling. This paper introduces several advanced potato peel processing technologies such as lactic acids, phenolic acids extraction, ultrasonic extraction of steroidal alkaloids et al., analyzes their advantages and disadvantages from the standpoint of popularization and economy. Further potential and developing direction may be found based on comparison of these recycling technologies.

2. Biogas production

The weather and global warming may be stabilized by reducing 70% in carbon dioxide emission by 2050⁶. Therefore due to the environmental damage caused by a single system of energy supply based on fossil fuel, diversification of energy sources and its location can provide good strategy for energy production and distribution to the consumer⁷. Biogas production based on anaerobic digestion process may be an ideal energy replacement.

Biogas fermentation is a relatively complicated process cooperated by multiple flora, which is composed of hydrolysis, acidification, enzyme digestion and methanogenesis stages in dynamic equilibrium. Biogas production based on waste residue in potato starch processing has been researched more: FU et al. start potato residue biogas fermentation system based on reloading acclimatization method, a typical technology of mixture fermentation, the average biogas production ratio may reach 0.55L/gVS, much higher than multiple inoculum fermentation of 0.32L/gVS⁸. Akbar et al. Made research on biogas production by co-digestion of potato pulp with cow manure in a continuously stirred tank reactor system, they pointed that an average energy production of 2.8 kWh (kgVS)-1 was achieved and the COD removal treatments was about 61%. The energy efficiency of 92% of the process also showed the optimum control of the process by the pilot⁹. While with the deepening of replacement of the whole potato powder to traditional starch extraction, potato peel is replacing potato pulp, thus it's necessary to make research on recycling of potato peel waste.

Except for a little more complicated processing technic, no more cost will generate. Therefore this technology shows more possibility in future popularizing, because it develops energy from waste residue in potato starch processing, a potential pollutant towards the environment with high efficiency, ordinary technical requirement and the most important, low cost.

3. Lactic acid extraction

Lactic acid (LA) is a useful organic acid that is widely used in food, pharmaceutical, cosmetic and industrial applications¹⁰. The global market for LA is experiencing steady growth, and rapid development and commercialization of polylactic acid is driven by rising oil prices, strict government regulations and consumer demand for green products. Generally LA is produced through carbohydrates fermentation with bacteria and fungi.

Recently with the popularizing of mixed fermentation technology, great achievement has been made in lactic acid extraction from potato peel waste. LIANG et al. Made research on lactic acid production from potato peel waste by anaerobic sequencing batch fermentation using undefined mixed cultures. They illustrated that lactic acid could be produced successfully by anaerobic fermentation with undefined mixed cultures in a sequencing batch bioreactor. Fermentation with gelatinized potato peel waste generated a significantly higher yield of lactic acid than that of feeding with un-gelatinized one. Decreasing solid retention time and solid content increased lactic acid production with a good overall production yield and productivity, 138mgg⁻¹d⁻¹. This approach of converting food waste using mixed microbial cultures can lower operational costs for lactic acid production compared to traditional pure culture fermentation¹¹ and demonstrates a potential for producing value-added bioproducts from potato peel waste.

Other researches showed the similar results: Dreschke et al. Obtained a high yield of 0.037gg⁻¹ feedstock with mixed fermentation¹² and LIANG et al. Reached 0.22gg⁻¹ with undefined mixed culture fermentation. While this

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