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Recycle technology for waste residue in potato starch processing: A review

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Abstract

Because of urgent demand for increase of food production and change for dietary pattern in developing countries, the development of potato industry has become the first among all food crops in developing and developed countries. Thus starch extraction industry plays a significant part in changing potato from a vegetable into a member of main food crops including rice, wheat and maize. While large amount of waste residue has been generated in potato starch processing, which contains various of organic materials such as protein, carbohydrate, starch et al., and brings waste of raw materials and a negative result to the environment if this waste residue is stacked outside without any disposal. This review focus on analysis and comparing of efficiency, technical requirements, economic and environmental effect of current recycle technologies for waste residue in potato processing, including bio-gas production, protein feed production and extraction of pectin and dietary fiber. Which shows that bio-gas production may have the most brilliant prospect in this field. Further research may be established in industrialization of this bio-gas producing technology, which may also contribute to future mixed culture fermentation technology, an effective way for growing energy crisis. While the other and most ideal solution lies in cleaner production: fully using of potato in food production and no waste residue will be generated.

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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 China[1]. Great efforts have been put in changing potato into the fourth of the main crops behind rice, wheat and maize, and in fact it has come true in many developed countries. Recently under the urgent demand for staple food strategy, potato starch processing industry has developed vastly in the north and south west of China[2], which shows great potential in solution of food

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crisis brought by population pressure in China, at the same time it brings a large number of waste residue containing useful organic materials such as protein, carbohydrate, pectin and cellulose[3]. Obviously if no efficient measure may be taken in further disposal of these waste residue, negative results in economy and environment may weaken the advantages of starch processing[4], but this recycling industry encounters big challenges. Firstly because of large amount of water existing in fresh waste residue, nearly 80 percent, it is not suitable for saving and long transport, thus generally it is stacked outside without any disposal, with the spoilage of organic materials for multiple kinds of bacteria within it, the environment may be destroyed by the terrible stench[5]. On the other side, if this potato waste residue is dried and produced into dry feed, the cost is out of control, even it is used for feed directly or buried locally, soil and underground water pollution may be brought, meanwhile remarkable waste is caused for its low use ratio[6].

Therefore it is necessary to make the waste residue processing industry keep up with the large scale potato starch extraction business. Current development in processing of waste residue from potato starch industry includes fermentation, physicochemical process and mixing disposal. Taking potato waste residue as a basic culture medium and introducing microorganism, many kinds of biological agent and organic materials are prepared based on fermentation. Physicochemical process means processing potato waste residue or extracting beneficial ingredient using physical, chemical or enzymatic method. Obviously mixing disposal is the combination of fermentation and physicochemical process[7]. Usually mixing disposal based on mixed fermentation is the most possible developing direction in this field[8]. In this review biogas production, protein feed production and extraction of beneficial materials such as pectin and dietary fiber will be analyzed and compared from the standpoint of efficiency, technical requirement, economics and environment effect.

2. Biogas production

Due to the environmental damage caused by a single system of energy supply based on fossil fuel, diversification of energy source and its location can provide good strategy of energy production and distribution to the consumer[9]. Security of energy supply is vital for attaining sustainable development in this world. Currently much of the world's energy comes from conventional sources, obviously the overuse of fossil fuels brought ecological-environmental irreversible threats such as global warming, climate change and acid rains. The weather and global warming may be stabilized by reducing 70% in carbon dioxide emission by 2050. 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 consumer. Biogas production based on anaerobic digestion process may be an ideal energy replacement. This technology is one of the major options in commercial generation of renewable energy from high moisture content organic wastes, which can be directly used in producing heat or electricity. Meanwhile the usage of biogas reduces greenhouse gases omission and the semi-solid sludge of the process can be used as a high-grade and environment-friendly fertilizer for the agricultural soils. In fact this technology improves the living standard and can directly contribute to the economic and social development of a country, especially a developing country.

Biogas fermentation is a relatively complicated process cooperated by multiple flora, which is composed of hydrolysis, acidification, enzyme digestion and methanogenesis stages in dynamic equilibriumThus biogas from potato pulp may be an ideal energy replacement. Researches show that single potato residue can produce little biogas for high content of organic acid. While when suitable inoculums such as rice straws, manioc waste and weeds with appropriate proportion are introduced in this system, the production improves remarkably10.

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/gVS. The principle may be explained that with the deepening of reloading, more and more potato residue replaces cattle manure, thus increasing volume of volatile fatty acid (VFA) comes into the fermentation system with potato residue, which is used by methane bacteria as premise material and produces much more biogas[11].

Fermentation system constructed in reloading acclimatization way may operate stably with higher gas production rate, average daily volume of 10.32L . Meanwhile the removal rate of COD in this system keeps 50%-53%, which shows a high-usage of the raw materials. 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