A New Model of Vegetable Waste Resource Treatment Combining Rapid Volume Reduction and Biochemical Technology

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Abstract. In the process of planting, selling and processing vegetables, a large number of wastes will be produced. If these wastes are used as resources for secondary use, they will produce great value. At present, the utilization rate of vegetable waste is very low, and the related technology research is also lagging behind. At present, China actively advocates the development of green economy, energy conservation and emission reduction, and improve the utilization rate of resources. As an important available resource, vegetable waste has received great attention. Therefore, the research on vegetable waste recycling technology is deepening. Based on the analysis of the current situation of vegetable waste recycling treatment, this paper proposes a new model of vegetable waste treatment, which combines rapid volume reduction treatment with biochemical technology to produce organic fertilizer, in order to provide a reference for the reuse of vegetable waste.

1. Introduction
China is the largest country of vegetable production and consumption in the world. At present, vegetable production has become the second largest crop in China's planting industry after grain production. In recent years, with the improvement of people's living standards, the market demand for pollution-free and organic vegetables is increasing, and the planting area and output of vegetables are on the rise. According to the statistics in 2016, the vegetable planting area is more than 25 million Hm², and the annual output is more than 800 million tons, which is increasing year by year [1].

With the centralized development of vegetable industry, the problem of waste emerges. In general, the waste of vegetables can account for about 30% of the total amount of vegetables on average [2], so it is calculated that the total amount of vegetable waste in the whole year can reach 300 million tons, which is amazing.

At present, the utilization rate and harmless treatment rate of vegetable waste in China are very low. The existing treatment methods are mainly direct returning to the field, feed, composting, biogas utilization and so on. There is no economic and applicable treatment technology, therefore, most of the waste vegetables have not been effectively used and are often dumped and piled up at will. The water content of vegetable waste is high and it is easy to rot, so it can not be treated by incineration and landfill. In the process of waste accumulation, a large number of greenhouse gases will be released and leachate will be produced. The surface water and groundwater will be polluted by surface runoff
scouring or direct leakage of sewage, which will cause serious pollution to air, water, soil and environment [3, 4]. Therefore, the harmless treatment and resource utilization of vegetable waste is of great significance to the healthy development of vegetable industry and environmental protection in China.

2. Current Situation of Vegetable Waste Treatment and Resource Utilization

Based on the investigation of major vegetable producing areas, such as Shandong, Gansu, Yunnan, Hunan and other places, it is found that at present, the main modes of utilization of vegetable waste resources are direct field return, simple anaerobic retting, mixed aerobic composting, biogas utilization and feed utilization.

2.1. Direct Field Return

The "carbon nitrogen ratio" of vegetable waste is low [5], and it is easy to ferment, which is more suitable for direct returning to the field than other crop straws. After returning to the field, vegetable waste can improve the physical and chemical properties of the soil after a certain period of fermentation, so as to improve the yield and quality of crops. According to relevant statistics, the average annual return rate of vegetable waste is about 16%, and the trend is relatively increasing [6]. However, most of the vegetables in our country are planted in the way of continuous cropping all the year round. The diseases and insect pests of vegetables are serious [7]. The vegetable waste itself contains the organization of diseases and insect pests. Especially in the high temperature period of summer and autumn, the vegetable waste is very easy to rot, promoting the spread of harmful pathogens, and directly returning to the field is easy to increase the diseases and insect pests of the next crop, with a high risk.

2.2. Simple Anaerobic Retting

Vegetable tailing has high water content and is easy to degrade [8]. Therefore, vegetable waste can be made into liquid organic fertilizer by simple anaerobic retting, which is a new way of fertilizer utilization of vegetable waste. Retting can solve the possible diseases and insect pests when returning to the field directly, and can produce the nutrients needed by many crops. The results showed that after retting for a certain period of time, all kinds of medium and trace elements in vegetable waste could be transferred to liquid fertilizer to a certain extent, and existed in the effective form that plants could use. Applying appropriate amount of vegetable waste retting can significantly increase the yield and quality of rape, but excessive amount will inhibit the growth of plants.

The problems of simple anaerobic retting are slow fermentation and low temperature, so it is difficult to kill pests and diseases [9]. The thermophilic bacteria contained in the fertilizer after anaerobic decomposition will also pollute the environment, which is not conducive to the sustainable production of the land. Without reasonable proportion, the fertilizer efficiency is low. Artificial composting, labor intensity is high, and the efficiency is not ideal. The treatment time is long, resulting in large occupation of the site and outdoor treatment. In addition, it is easy to produce harmful gases, compounds and some harmful mixtures in the fermentation process.

2.3. Mixed Aerobic Compost

Through the experiment, vegetable waste and crop straw, soybean meal, livestock manure and other compost combined aerobic fermentation, the reaction process will not produce harmful substances, and after the correct treatment, the odor produced by fermentation is smaller, compared with the anaerobic fermentation process, greatly reducing the fermentation time. Aerobic composting has the characteristics of controllable process, easy operation, fast degradation, good resource effect and low operating cost. Moreover, the organic fertilizer added with vegetable waste has comprehensive nutrition, which plays an important role in improving the physical and chemical properties of soil, increasing the soil activity, eliminating the residues of harmful substances and inhibiting the growth of soil pathogens, as well as promoting the growth of crops and improving the quality of products [10].
But centralized composting investment is big, difficult to manage, technology has bottleneck, production base is difficult to promote.

2.4. Biogas Utilization
The ratio of chemical oxygen demand to nitrogen is about 100:4, which can meet the requirement of methanogenic microorganism [11]. Anaerobic fermentation can be realized without adding nitrogen source and nutrients. The biogas residue and biogas slurry produced by anaerobic fermentation can be used as fertilizer for plants, which can obviously improve the resistance of crops, inhibit the continuation of diseases and insect pests, and improve the soil quality [12].

However, the time of anaerobic fermentation is long, the amount of periodic treatment is small, the fermentation conditions are demanding, and the treatment of anaerobic fermentation technology has higher requirements on fermentation facilities and scale. The secondary treatment of waste water and residue will increase additional costs, and improper treatment will cause secondary pollution. The project is suitable for large-scale vegetable bases due to its high investment, large floor area and high management and operation cost, while it is not suitable for vegetable producing areas and distribution centers scattered in all parts of the country with large and small quantity but small scale.

2.5. Feed Utilization
As fresh vegetables, vegetable wastes are rich in many nutrients. The research shows that vegetable wastes do not contain any other toxic substances except some tissues that suffer from diseases and insect pests, which can be used as livestock feed after proper treatment. At present, the main methods of fodder are silage, ammoniation and conversion of tailing to microbial protein products by microbial treatment. It has been reported that high-quality protein feed was developed by using Alpine baby cabbage waste as raw material, adding bran and solid mixed bacteria for fermentation; vegetable waste and fishery by-products for fermentation, after heat treatment, can be used as an alternative component of pig feed [13]; or by adding bran, corn, salt and other auxiliary materials to vegetable wastes for fermentation, as a breeding Tenebrio (bread Bug) Feed [14].

Using vegetable waste as raw material to produce feed can improve feed quality and reduce feed production cost. However, although the fermentation time of producing feed protein is short, it requires aseptic operation, which requires high sustainability, stability and reliability of vegetable waste, and the daily treatment capacity is limited, so it is not suitable for large-scale production.

The above-mentioned methods have their own advantages and disadvantages, which can achieve the purpose of recycling vegetable waste in different situations, but there is an important problem, that is, low efficiency, long time, slow effect, and cannot achieve the purpose of rapid volume reduction. Vegetable waste, especially Chinese cabbage waste is different from other farmland waste, which is very perishable. Especially in the peak season of Chinese cabbage production, if a large number of accumulated waste is not treated in time, it is easy to rot and produce pollution. Therefore, before the resource-based treatment of cabbage, the reduction of waste capacity is a very important link.

3. Fertilizer Making Technology of Vegetable Waste Combined with Rapid Capacity Reduction and Biochemical Treatment
On the basis of full investigation and production practice, according to the characteristics of vegetable production and distribution in China and the existing actual situation, this paper puts forward a multi-channel recycling technology of vegetable waste, which combines rapid capacity reduction and biochemical treatment, and constructs a modular capacity reduction biochemical treatment system model. Capacity reduction module is the basis of all resource-based processing. Through the fast crushing and solid-liquid separation of vegetable waste, the purpose of rapid volume reduction can be achieved, and the problem of waste accumulation in the short term can be solved to the greatest extent. After the solid-liquid separation, the vegetable liquid and vegetable dregs are respectively used as resources. For example, the vegetable liquid is made into nutrient solution or foliar fertilizer, the remaining sewage can be reused or irrigated in farmland or afforestation after being treated to meet the
standards, and the vegetable dregs are made into feed or organic fertilizer according to different situations.

Among all the modes of resource utilization, the production of organic fertilizer is the most cost-effective one. According to the research on the fermentation process of traditional compost, it is found that the traditional compost has four processes: (1) low temperature stage: the fermentation microorganism starts to breed, and this stage has a long time and low fermentation efficiency; (2) medium temperature stage: the fermentation microorganism has a certain number of breeding, and the development enters into the fermentation process; this stage also needs a certain time; (3) high temperature stage: a large number of fermentation microorganisms Reproduction, the main position, into the rapid fermentation process; (4) post mature stage: high temperature fermentation completed, the temperature dropped, into the post mature stage. The whole process takes a long time, and it takes ten days or tens of days to complete fermentation. According to the above situation, a rapid fermentation method was designed in this paper. The main process flow is as follows:

(1) After the vegetable waste is broken, the solid-liquid separation makes the solid waste meet the requirement of certain moisture content;
(2) Heating, high temperature sterilization, killing harmful bacteria;
(3) Pretreatment and proportion of materials were carried out to meet the best nutrition and pH value of microbial fermentation;
(4) Cool down, add fermentation bacteria and auxiliary materials, and then mix the materials to accelerate the implantation and propagation of microorganisms;
(5) Add appropriate amount of oxygen to fully meet the fermentation conditions.
(6) Cooling to normal temperature, adding functional soil beneficial bacteria culture, forming functional organic fertilizer.

Through the above-mentioned treatment process, 2-4 hours can completely kill the pathogenic microorganism, 4 hours can expand and propagate the soil functional bacteria to form the functional bio organic fertilizer, each functional bacteria group is in a high activity state, which can not only supplement a large number of organic nutrient elements and organic matter, improve the soil structure, but also effectively prevent and control soil borne diseases; at the same time, bio carbon based, silicon-based curing technology and The technology of ferromanganese polymer magnetic absorption can passivate, solidify and extract heavy metals, and reduce the harm. Finally, after 6-24 hours, the materials can be completely fermented, decomposed, deodorized and concentrated to make high-quality organic fertilizer, greatly shortening the fertilizer making cycle of organic fertilizer. The technology can be applied to all kinds of farm waste, livestock waste, kitchen waste, etc. it has been applied to many projects and achieved good results. The comparison of temperature change between the technology proposed in this paper and ordinary composting treatment is shown in figure 1.
Figure 1. The comparison of temperature change between the technology proposed in this paper and ordinary composting treatment.

4. Conclusion
It is an urgent problem to realize the harmless treatment and resource utilization of vegetable waste in China. In the international and domestic ecological development demand of low-carbon emission reduction, seeking low input, low energy consumption, harmless, high-yield, high-efficiency utilization technology of vegetable waste is the development direction of low-carbon economy and waste recycling.

At present, the market model of vegetable waste treatment is still in a mixed stage, and there is no uniform industry standard and treatment model. In this paper, the model of rapid capacity reduction plus biochemical treatment to produce high-quality organic fertilizer is better than the existing resource-based treatment model in terms of economic input, actual operation or cost maintenance, and has a good prospect for development. In line with the state's development direction of environmental pollution control, beautiful villages, green mountains and rivers, and agricultural ecological recycling.

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