Realization and Practical Application Analysis Of Lactic Acid Bacteria Fermentation Bioengineering

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ABSTRACT: Fermentation Engineering is the basis of biotechnology industrialization. Fermentation engineering plays an important role in biotechnology. Currently, among the known technologies, fermentation Engineering is the most effective means to put bacteria with special characteristics obtained by genetic engineering or cell engineering into industrial production, and finally realize the production benefits and economic value of biotechnology. Fermentation Technology is a traditional biotechnology with a long history. However, due to the transformation of modern biotechnology research results, new contents are continuously injected into it, and the traditional fermentation technology has shown new vitality, the variety of microbial fermentation products is increasing. This paper mainly expounds the research status of lactic acid bacteria and its fermentation biotechnology, aiming to provide reference for the deep processing of fermented products.

1. Introduction
Modern fermentation engineering refers to the modern fermentation technology that combines traditional fermentation technology with biotechnology. Modern fermentation engineering mainly includes strain breeding, culture, development and utilization of Microbial Resources, cell immobilization and bioreactor design, selection of fermentation conditions and automatic control, separation and purification of metabolites and other technologies.

Lactic acid bacteria are the main type of fermentation bacteria in modern fermentation engineering. Lactic acid bacteria are a kind of bacteria that can produce a large amount of Lactic Acid by using soluble carbohydrates, degrade lipids and proteins and produce a variety of essential amino acids and vitamins for human body, it is a probiotic with potential probiotic effect on the host[1]. Fermentation biotechnology with lactic acid bacteria can not only enrich nutritional value, but also produce special flavor substances, such as alcohol, aldehyde, acid, esters and sulfides. Lactic acid bacteria have the functions of improving oxidation resistance, regulating metabolism, delaying aging and enhancing anti-tumor ability. Lactic acid bacteria involved in fermentation can improve human digestion and promote the absorption and utilization of vitamins and minerals.

2. Classification And Variety Of Lactic Acid Bacteria
As probiotics, there are about 20 kinds of lactic acid bacteria which are often used in fermentation engineering, among which there are mainly Lactobacillus acidophilus, Lactobacillus plantarum, Leuconostoc, Lactobacillus brevis[2]. It is a kind of lactic acid bacteria used for special fermentation, which is the dominant flora in many traditional fermentation products. Lactobacillus acidophilus is
regarded as 3rd generation yogurt starter and is an important microorganism in human intestinal tract. The specific lactic acid bacteria fermentation is shown in Figure 1.

Figure 1. the fermentation of lactic acid bacteria

Lactobacillus is the most important strain in this family and is commonly used in food industry. It is widely found in dairy products, fermented foods, feed and human intestines. Ordinary lactic acid bacteria are extremely weak in vitality. They can only survive in relatively restricted environments. Once they are separated from these environments, they themselves will be destroyed. Only lactic acid bacteria treated by special technology can reach the intestinal tract. Lactic acid bacteria entering the intestine must have a large number and strong vitality in order to exert its biological efficacy.

3. Application Of Lactic Acid Bacteria In Biological Food Engineering

Adding lactic acid bacteria to milk can promote the secretion of gastric juice, promote digestion, have a maintenance function on the stomach, and can inhibit the growth of intestinal spoilage bacteria, and its biological health value is much higher than milk. Lactic acid bacteria have laid the foundation for changing from basic delicious food to natural, nutritional and health care needs[3].

Experiments have proved that 2.5 × 10^7 CFU/mL Lactobacillus acidophilus was inoculated into Lonicera edulis juice, fermented at 34℃ and pH 3.4, and detected by high performance liquid chromatography, the content of malic acid and citric acid in fruit juice decreased by 49.37% and 36.05% respectively, and the taste of fruit juice was improved[4].

Lactobacillus plantarum as a probiotic, it has the functions of regulating intestinal flora balance, participating in immune response and reducing cholesterol level, and is widely used. Bagher and others fermented sweet lemon juice with Lactobacillus plantarum LS5, and the number of bacteria increased from (7.0±0.1) CFU/mL to (8.63±0.38) CFU/mL after fermentation at 37℃ for 48 h, after fermentation, the pH value, lactic acid content and antioxidant capacity of lemon juice increase. Compared with unfermented lemon juice, ascorbic acid in fermented lemon juice is more stable.

Using lactic acid bacteria to ferment feed has the characteristics of rich nutrition, high digestion and utilization rate and a large number of probiotics compared with general feed. It is beneficial to improve the nutritional value and utilization rate of feed and degrade the anti-nutritional factors (soybean antigen, trypsin inhibitor, etc.) and toxic substances (such as ring acid, glucosinolates.) in the feed; lactic acid bacteria can also adsorb or degrade some mycotoxins in feed to reduce the impact of mycotoxins on animals. Produce many probiotic substances to promote animal health. The fermented feed contains a large number of active probiotics, which can effectively improve animal intestinal health, improve animal immunity and reduce animal diseases.

4. Prospect Of Bioengineering Application Of Lactic Acid Bacteria

Although lactic acid bacteria are only a part of the fermentation group in the fermentation process, they play an important role in the formation and improvement of fermentation flavor substances and
nutrients, moreover, lactic acid bacteria can use the diversity of chemical components of plants themselves to produce a variety of metabolites through the fermentation process, thus changing the functional characteristics of fermented foods.

Fermentation with lactic acid bacteria can improve antioxidant activity. In the process of fermentation, due to the participation of lactic acid bacteria in catabolism, the content of phenols, vitamins and other components in the fermentation process increases, and the antioxidant capacity is enhanced. Jin Yuhong [5] and others inoculated lactic acid bacteria into red dates, and compared the antioxidant activity differences among red date fermented beverage, red date juice and red date wine. The results showed that the content of polyphenols and flavonoids in red date fermented beverage was higher, the antioxidant activity is higher than that of jujube juice and jujube wine, which is mainly due to the changes in the structure, composition and content of polyphenols and flavonoids in Jujube caused by lactic acid bacteria participating in fermentation. Park et al. used Lactobacillus plantarum LP-115 to ferment mixed berry juice, and fermented at 37°C for 36 hours with 1g/ L inoculation amount. The antioxidant activity of mixed berry juice after fermentation was (209.57±2.93) μmol/g increased significantly to (268.30±1.75) μmol/g, and the antioxidant activity increased by about 28%.

Lactic acid bacteria fermentation has good hypoglycemic effect. Lactic acid bacteria can secrete acidic substances, reduce pH value, inhibit the growth of pathogenic bacteria, and help the intestinal tract to establish a normal flora environment, thus directly or indirectly affecting the body's blood sugar metabolism and achieving the effect of reducing blood sugar [6]. Wan Yujun found that the proportion of neutral sugar and uronic acid in carrot pulp polysaccharide fermented by lactic acid bacteria was significantly higher than that of unfermented carrot pulp, these polysaccharides can better protect cells from high blood sugar damage and strong hydrogen and oxygen free radicals, thus effectively intervening in type II diabetes, it is proved that the polysaccharide in lactic acid bacteria fermented carrot pulp has better hypoglycemic effect than that in unfermented carrot pulp.

Lactic acid bacteria fermentation has the effect of enhancing immunity. Studies have confirmed that organic acids, polysaccharides and antioxidant substances fermented from fruit and vegetable juices can regulate the flora structure in gastrointestinal tract, enhance the immune function of the body and improve the immunity of the body. Wang Zhiding and others inoculated Bifidobacterium longum, Lactobacillus acidophilus, Lactobacillus bulgaricus and Streptococcus thermophilus into fruit and vegetable juice with 4% inoculation amount at 37 ℃ for 24 hours, and then fed mice with fruit and vegetable juice, its macrophage phagocytic function, humoral immune response function and T lymphocyte immune function are obviously enhanced, proving that fermented fruit and vegetable juice can be used for humoral immunity, cellular immunity and mononuclear macrophage system improve immunity and enhance immune system function. Yin Man and others made compound fermented fruit and vegetable juice with lactic acid bacteria fermenting more than 10 kinds of fruits and vegetables such as apple, banana, pear, white radish and tremella, using water, ethanol, n-butanol, ethyl acetate and chloroform as extractnts, animal experiments were carried out with the obtained extracts respectively. The results showed that the n-butanol phase extract had a significant effect on promoting proliferation of spleen lymphocytes in BALB/c mice, and the compound fruit and vegetable fermented juice extracts have a good effect of protecting spleen lymphocytes from oxidative stress injury, which proves that the compound fermented fruit and vegetable juice has immune regulation effect[7].

5. Progress Of Lactic Acid Bacteria Fermentation Research At Home and Abroad

Lactic acid bacteria fermentation has always been a hot research topic in China. Luo Xia and others inoculated Lactococcus La3 in the sterilized water decoction of Astragalus membranaceus with an inoculation amount of 10% by volume, and fermented the water extract at 37 ℃ for 48 hours for animal experiments. Among them, astragalus polysaccharide and Astragaloside IV can effectively enhance the immune ability of macrophages in low immunity model mice, and the bacteriocin, organic acid and other substances produced by fermentation can reduce serum cholesterol and enhance the immunity of the body, anti-tumor and other effects[8]. Ma Xiaojuan and others fermented carrot pulp with Lactobacillus plantarum NCU166, and found that the fermented carrot pulp had good inhibitory
effect on Escherichia coli and salmonella after sterilization. Liu Xiaoying and others fermented Pueraria lobata with Streptococcus thermophilus and Bacillus bulgaricus. The results showed that the content of total flavonoids and total reducing power of Pueraria lobata after fermentation were ta, and the antioxidant capacity was enhanced. Yang Chong and others fermented Nanfeng tangerine juice with lactic acid bacteria. The VC content in the fermented tangerine juice remained above 80%, effectively retaining vitamins, and the contents of total flavonoids and polyphenols increased significantly, it is proved that lactic acid bacteria fermentation can improve the nutritional value and biological activity of the product. [9]

There are also many studies on lactic acid bacteria fermentation abroad. Dimitrovski et al. used Lactobacillus plantarum PCS26 to ferment Jerusalem artichoke juice and blueberry juice mixed juice, and separately fermented Jerusalem artichoke juice as a control. The results showed that, the volume ratio of the two kinds of fruit juice is 1:1, which is the most popular among consumers. When stored at 4 ~ 7 ℃, the shelf life of the mixed fruit juice is (19.7±0.5) from Jerusalem artichoke juice fermented separately, extended to (35.7±6.4) d. After lactic acid fermentation for 48 hours, Ricci et al. used Headspace Solid Phase Microextraction-gas chromatography-mass spectrometry to detect volatile odor. The results showed that, fermented fruit juice contains 82 different classes of volatile compounds, including alcohols, terpenes and alkenes, organic acids, ketones and esters[10]. Fermented cashew apple juice with Lactobacillus plantarum, Lactobacillus casei and Lactobacillus acidophilus, and detected the bioactive substances and volatile substances in it. The results showed that, the strain was injected into the fruit juice with a strain of 9.18 (lg(CFU/mL)), fermented at 30℃ for 48 h, then concentrated tannin in cashew apple juice, the contents of VC and phenolic metabolites increased, while the content of hydrolyzed tannin decreased. The number of viable bacteria had a certain effect on the antioxidant activity of cashew apple juice. After fermentation, Lactobacillus plantarum, the number of viable Lactobacillus casei and Lactobacillus acidophilus decreased to 6.56, 6.15 and 7.58 (lg(CFU/mL)), respectively, 1,1-diphenyl-2-trinitrophenylhydrazine (1,1-diphenyl-2-picrylhydrazand2,2′-biazin-bis(3-ethyl-benzothiazole-6-sulfonate)(2,2-azino-bis-(3-ethylbenzthiazoline-6-sulphonate), ABTS) cationic free radical scavenging ability will decrease from 75% ~ 95% to 50% with the decrease of viable bacteria number The fermented cashew apple juice increases the whisky flavor and sour taste, which proves that the compound fermentation of strains can increase the bioactive substances and flavor substances in the juice. Li Wein et al. combined 4 strains of Lactobacillus paracasei 20241, animal Bifidobacterium 6165, Streptococcus thermophilus 6063 and Lactobacillus acidophilus 6005 according to the combination of single strain and multiple strains, inoculation amount with a volume ratio of 2% was inoculated in apple juice for fermentation. A total of 48 aroma components were identified in the fermentation process by gas chromatography. Among them, alcohols in the aroma components of apple juice fermented by multiple strains, the content of esters and other aroma substances is significantly higher than that of apple juice fermented by single strain, which endows apple juice with stronger fruit aroma, faint scent and flower fragrance. It is proved again that the content of flavor substances obtained by multi-strain fermentation is higher than that fermented by single strain. Verón et al. used Lactobacillus plantarum S-811 to ferment cactus pear juice. The results showed that Lactobacillus plantarum S-811 fermentation could rapidly reduce the pH value from 5.5 to 3.7 and accelerate the fermentation rate, and significantly improve the hypoglycemic effect of cactus pear juice, obese mice intake of fermented cactus pear juice after body mass decreased significantly, high blood sugar and hyperlipidemia improved.

Lactic acid bacteria fermented fruits and vegetables improve the functional characteristics of fruits and vegetables, giving new flavor and taste to fruits and vegetables, but there have been studies mainly on the functional characteristics of fermented fruits and vegetables, such as lactic acid fermentation can affect the oxidation resistance of fruits and vegetables. Previous studies have proved that the phenolic compounds contained in fruits and vegetables themselves have certain influence on the oxidation resistance, but the specific composition of phenolic compounds, the change rule of content after fermentation and how to affect the oxidation resistance are still lack of in-depth research. And the cell experiment method is single, only the intracellular antioxidant capacity evaluation method is used,
and the clinical experiment results are less. The study of antioxidant process in organisms should be strengthened in the future.

6. CONCLUSION

The rich nutritional value created by fermentation engineering is closely related to lactic acid bacteria, but the current fermented fruits and vegetables only stay at the research level, and there are still some differences between actual production links and scientific research, for example, the environment in the fermentation process with large output is not easy to control, the cost is high, and scientific research is not in line with actual production, so few applications to actual production, direct starter or compound direct starter should be studied to develop fermented fruit and vegetable products with higher stability and richer taste. In the future research, the functional characteristics of fermented fruits and vegetables still need to be further explored to develop more functional lactic acid bacteria fermented fruit and vegetable foods with various forms.

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