Research status and development of application fields in enzyme technology

Y B Ji\textsuperscript{1,2}, S W Wang\textsuperscript{1}, M Yu\textsuperscript{1,2,3}, X Ru\textsuperscript{1}, C Wei\textsuperscript{1}, H J Zhu\textsuperscript{4}, Z Y Li\textsuperscript{1}, H Zhao\textsuperscript{1}, A N Qiao\textsuperscript{1}, S Z Guo\textsuperscript{1} and L Lu\textsuperscript{1}

\textsuperscript{1}Research Center on Life Science and Environmental Science, Harbin University of Commerce, Harbin 150076, China
\textsuperscript{2}Engineering Research Center of Natural Anticancer Drugs, Ministry of Education, Harbin 150076, China
\textsuperscript{3}E-mail: yumiao913@163.com

Abstract. Biological enzymes are catalyzed by living cells, most of which are proteins, and very few are RNA. Biological engineering as a new high-tech has been rapid development, enzyme manufacturing and application areas are gradually expanding. In this paper, the status and progress of the application of enzyme technology are reviewed by reviewing the literature. and aims to provide reference for the application of enzyme technology and provide scientific basis for its future research and development in new field.

1. Introduction
Enzyme technology refers to the use of enzymes in a certain bioreactor catalytic conversion of material technology. The research of enzyme technology plays an important role in the application of enzymes in industrial production. Enzyme technology contains a lot of content, such as directional enzyme catalysis, increased enzyme selectivity and in large-scale synthesis reaction conditions to make the enzyme more stable, enzyme technology to improve the enzyme engineering. It is mainly about the nature of the molecular level, So far, the enzyme technology research is more abundant, in recent years, enzyme technology has also been rapid development, this paper summarizes the field of application of enzyme technology, its application has been throughout the industrial, pharmaceutical, agricultural, chemical analysis, environmental protection, Energy development and life science theory research and other aspects. At the same time, the types of enzymes, technical applications, key development and sources were classified, and the problems and application prospects of enzyme technology were discussed.

2. Introduction to enzymes
Enzymes are macromolecules with biocatalytic functions. The enzymes are highly specific and have a wide range. There are currently more than 4000 enzymes found, and enzymes in organisms are far greater than this number. There are many ways to classify enzymes. This paper lists several types of enzymes commonly used in various fields. See table 1 for details.
Table 1. Enzyme overview table.

| Enzymes        | source                                           | Application areas               | Key development                                                                 |
|----------------|--------------------------------------------------|---------------------------------|---------------------------------------------------------------------------------|
| Soil enzyme    | Microbiological, animal and plant secretion and Remains of the remains | agriculture                     | Improve the soil, improve crop yields and so on                                 |
| Amylase        | Animals, plants, microbes                        | Food production                 | Juice processing, Vegetable processing, syrup manufacturing, and glucose processing and so on. |
| Curing enzyme  | Immobilization method                            | Environmental protection        | Water purification, environmental testing, treatment of white pollution and so on. Production of drugs, treatment of diseases and so on. |
| Protease       | Animals, plants, microbes                        | Medicine field                  | Fermentation, material synthesis and so on. Textile industry energy development, the development of new substances, deinking treatment, cotton fabric degumming and so on. |
| Microbial enzymes | Animals, plants, microbes                  | Biochemical production          |                                                                                  |
| Biological enzymes | Living cells                                   | Textile industry, energy development |                                                                                  |

From the table 1 can be analyzed for a wide range of applications, including industrial, pharmaceutical, agricultural, chemical analysis, environmental protection, energy development, life sciences research and other aspects, so far, the industrial use of enzyme preparations are basically divided into Two categories: The first category is hydrolytic enzymes, including amylase, cellulase, protease, lipase, pectinase, lactase, etc., accounting for more than 75% of market sales. At present, about 60% of the enzyme preparation has been produced with genetically modified strains. The second category is non-hydrolytic enzymes, accounting for about 10% of market sales, and there is a tendency to increase year by year, mainly for the analysis of reagents and pharmaceutical industry. The food industry and the feed industry account for the largest share of the application, accounting for 45% of the total sales, 32% of the detergent, 11% for the textile industry, 7% for the paper industry and 4% for the chemical industry.

3. Application of enzyme technology

3.1. Application of enzyme technology in agriculture

Soil enzyme is a kind of biologically active substance with catalytic ability. The results showed that the degree of resource abundance and complexity of the community in the moderate degradation succession stage increased the stability of the grassland community, which was beneficial to the increase of the community productivity, resulting in the increase of plant litterfall to the soil and the increase of soil fertility [1]. The results showed that long-term organic and inorganic fertilizers could significantly increase soil bacterial diversity and change the community structure of soil bacteria and fungi, improve soil enzyme activity, improve farmland ecosystem productivity and improve ecosystem productivity. Health has a better effect [2]. The results show that acetylcholinesterase can be used for
rapid qualitative screening of organophosphorus and carbamate pesticide residues in agricultural products [3].

3.2. Application of enzyme technology in food industry
Enzyme technology can be used in the food industry to increase production processes, increase production and reduce waste of resources. Sources of enzymes for the food industry include animals, plants and microbes [4]. Zhou Changchun [5] and others believe that enzyme technology can be applied to the fruit and vegetable juice processing industry, the literature shows that immobilized enzyme method can remove the bitterness of raw materials, and elaborated immobilized enzyme method, the enzyme can also be applied to carrots Juice production and clarification of litchi juice. Liu Yi [6]. Through the analysis of the application of enzyme technology in grain processing, fruit and vegetable processing and meat processing, the main application scope of enzyme technology in food processing is expounded, which shows that enzyme technology can also be applied to food safety testing, The main method for the enzyme-linked immunonassay and enzyme biosensor method. Wu Jie [7] and others believe that the enzyme can change the baking food structure, improve food flavor and color, and can produce food grade oligosaccharides, increase the use of by-products, such as: in the small lobster processing 70 % of the material, and the protein mass fraction of about 35%.

3.3. Application of enzyme technology in environmental protection
With the rapid development of modern biotechnology and the gradual improvement of human environmental protection awareness, biotechnology has been widely used in environmental protection work. Modern biotechnology with high efficiency, low consumption, good safety and other advantages for environmental protection work provides a lot of convenience [8]. Song Jia [9] and others reported that enzyme technology can be applied to environmental monitoring, waste gas treatment, sewage purification, municipal solid waste treatment, etc., Yao Bu-xuan [10] suggested that the combination of biosynthesis can effectively play the synergistic effect of the biological enzyme and coenzyme function in the AAO wastewater treatment process, so that the COD can be reduced from 1500mg / L to 100mg / L, and the secondary Pollution, with significant economic and social benefits. Wang Wei-ping [11] believe that the application of biological enzyme technology is simple, rapid and sensitive advantages in pesticide residue detection. It has a broad application prospect, and has far-reaching significance for human health and environmental protection. Environmental protection work is inseparable from the application of biotechnology, biotechnology has played an irreplaceable important role in environmental protection work.

3.4. Application of enzyme technology in pharmaceutical industry
Biotechnology has been introduced into the pharmaceutical industry, making the bio-pharmaceutical industry become one of the most active and fastest-growing industries. At present, the enzyme technology has been widely used in the pharmaceutical industry, biosensors, monoclonal antibody diagnosis and so on [12]. In addition, the enzyme technology can also be used for the extraction of active ingredients of traditional Chinese medicine and pharmaceutical production and so on. The results showed [13] that under the optimum conditions: pectinase 0.3%, hydrolysis temperature 50, hydrolysis time 3h, enzyme PH3, jujube juice extraction rate can reach 51.89%, 35.93% of total sugar, soluble solids of 10.57%, the jujube juice, jujube rich natural color and good stability. Wang Hongyun [14] and others have shown that enzyme technology has a unique advantage in the extraction of traditional Chinese medicine, the enzyme can be more moderate to the decomposition of medicinal materials, promote the release of active ingredients, improve the extraction rate of effective ingredients. Ji Xue-hui [15] and others believe that enzyme technology can improve the extraction of polysaccharides, flavonoids, oils, alkaloids and saponins.
3.5. Application of enzyme technology in biochemical production
Enzyme technology can also be used in the production of biochemistry. Perfumes can be produced by biochemical methods in the spice industry. Biochemical means can produce spices compound in the spice industry, Ju Jing-qiang [16] believe that aspergillus fruitizae KM-1 strain can be used to quantitatively produce 2-heptanone, 2-nonanone and 2-undecanone using octanoic acid, decanoic acid and dodecanoic acid contained in coconut oil, and γ-decalactone of 10 carbon atoms was obtained from castor oil, The production method of γ-decalactone of 12 carbon atoms was obtained. D-arabinose attracting great attention from the community because of its many drug activity, microbial enzyme can produce D-aluo sugar [17], Zhang Xiaoling [18] believe that the fermentation process of enzymatic preparation of vinegar has the characteristics of slow, medium, fast, stable, short fermentation time, fast synthesis of acetic acid and good flavor in the process of alcohol fermentation.

3.6. Other applications of enzyme technology
Zheng Jie [19] believe that compared with the chemical deinking method, waste paper enzyme deinking time is short, less energy consumption, deodorization easy to bleach, pulp whiteness is high, especially in the increasingly prominent environmental problems in today's world, More environmentally friendly enzymatic deinking has a very good application prospects. The technology developed by Buckman [20] can handle different types of waste paper raw materials, bringing more potential benefits for different paper mills: improving slurry filtration performance; reducing steam consumption by 4% to 8%; Improve paper machine speed 5% to 10%; improve the ratio of waste paper; to improve paper uniformity and strength; white water system is more clean. Enzyme technology can also be used for the development of new energy sources, such as the development of new functional sugars. In addition, bio-enzyme technology has been in some edible fungus deep processing has been rapid development because of its high efficiency, mild conditions, low energy consumption, low pollution, simplify the process and other advantages [21].

4. Conclusion
Enzyme technology has the advantages of low investment, low energy consumption, good effect and so on, and the enzyme has a high degree of specificity, the company's production efficiency and product quality has been greatly improved, increasing the economic income of enterprises, the extensive application of enzyme technology significantly improve the quality of life of the people. However, the environment required for the enzyme is harsh, and it is difficult to ensure the enzyme activity in industrial production, and there is a problem that the use efficiency is low, resulting in a problem that the use cost is increased. Therefore, it is of great potential to improve the efficiency of enzyme usage and improve the activity of enzymes in harsh environment. It is also the direction for future researchers to work hard.

Acknowledgments
This work is supported by Postdoctoral foundation of China (2015M581467); Natural Science Foundation of Heilongjiang Province (D201138); Key Science and Technology Research Project of Ministry of Education (211045); Doctoral Foundation of Ministry of Education (20112332110003); Heilongjiang Postdoctoral special Foundation (LBH-TZ1613); Heilongjiang Postdoctoral Grant (LBH-Z15107); The Scientific Research Team Program of Harbin University of Commerce (2016TD002); Harbin Special Foundation for Young Technological Innovative Talented Person (2013RFQXJ150).

References
[1] Hu L, Wang C L, Wang C T, et al 2014 Changes of soil enzyme activities and microbial community structure in alpine meadow under different degradation succession stages in Sanjiangyuan area. Journal of Grassland Science 23(03) 8-19
[2] Lu H F, Zheng J W, Yu X C, et al 2015 Effects of Long - term Inorganic Organic Fertilizer on Microbial Community Diversity and Enzyme Activity in Paddy Soil Derived Journal of Plant
Nutrition and Fertilizer 21(03) 632-643
[3] Zhu S M, Zhou C N, He J S, et al 2014 Rapid detection of pesticide residues based on enzyme inhibition method Journal of Agricultural Engineering 30(06) 242-248
[4] Zhang H Y, Zheng X D, Xu P, et al 2002 Enzyme technology and its application in food industry Grain and oil processing and food machinery (06) 31-33
[5] Zhou C C 2004 Application of Enzyme Technology in Fruit and Vegetable Juice Processing Industry China Food Additives (05) 59-62
[6] Liu Y 2015 Application of Enzyme Technology in Food Processing and Detection Food engineering (03) 12-14
[7] Wu J, Gao Z C 2016 Application of Enzyme Technology in Food Processing Shandong Industrial Technology (22) 232-233
[8] Tang Q, Li Z S 2002 Application and Prospect of Biotechnology in Environmental Protection Environmental Pollution Control Technology and Equipment (10) 28-35
[9] Song J 2014 Application and Prospect of Biotechnology in Environmental Protection Chemical Management (15) 214
[10] Yao B X 2009 Application of Biological Enzyme Technology in Coking Wastewater Treatment Journal of Fuel and Chemical Engineering 40(06) 40-41 + 44
[11] Wang W P, Wu Y, He L J, et al 2008 Application of Biological Enzyme Technology in Rapid Detection of Pesticide Residues Analysis and Testing Technology and Instruments (02) 72-78
[12] Yang J, Zhang Y B, Wu W T 2013 Immobilized Enzyme Technology and Its Application in Medicine Journal of Pharmaceutical Biotechnology 20(06) 553-556
[13] Peng Y T, Sun Y E, Wang W D 2012 Application of Enzyme Technology in Extraction of Jujube Juice Food Industry 33(01) 31-33
[14] Wang H Y, Li M 2014 Application of Enzyme Technology in Polysaccharide Extraction of Dendrobium Journal of Yunnan Traditional Chinese Medicine 35(06) 81-83
[15] Ji X H, Zhang H 2011 Application of Enzyme Technology in Extraction and Separation of Traditional Chinese Medicine 29(10) 2365-2367
[16] Ju J Q, Chen F L 2010 Production of Spice Compounds by Biochemical Methods Chinese Journal of Food Additives (05) 139-143
[17] Wang M L 2015 Production of D-Alanosine by Microbial Enzyme Shandong Food Fermentation (01) 34-36
[18] Zhang X L 1999 Discussion on Improving the Utilization Rate of Starch by Reforming Acetic Acid Fermentation Process Journal of Food & Beverage (01) 20-21
[19] Zheng J, Sun G W, Zhang S J, et al 2013 Application of Biological Enzyme Technology in Deinking of Waste Paper Heilongjiang Papermaking 41(04) 10-15
[20] 2014 Application of Barkman Filterase Technology in Packaging Paper International Paper 33(06) 70-72
[21] Li P W, Wang S, Liang R R, et al 2014 Application of Microorganism and Enzyme Technology in the Development of New Functional Sugar Amino Acids and Biological Resources 36(04) 1-7