A sustainable biorefinery resource based on rapeseed meal

Current challenges and developments of bio-diesel research in China

DONG Xu, WEI Fang, GUO Lu, HU Xiao, JIANG Mu, YANG Mei, NIU Yan, CHEN Hong

1, Oil Crops Research Institute, Chinese Academy of Agricultural Sciences, Wuhan, 430062, chenhongref@yahoo.com
2, The Key Lab for Genetics and Improvement of Oil Crops, Ministry of Agriculture, Wuhan, 430062

Introduction

In the modern world, sustainable development has become one of the most important issues.
- The rapid development of world economy
- Traditional mineral reserves, such as petroleum oil, natural gas and coal, are becoming exhausted,
- Energy sources and environmental problems became more and more urgent.
- Exploring of alternative sustainable resources is rapidly gained recognition.
  - According to Chinese governmental renewal energy policy, consumption of bio-diesel in China would be around 0.2 million tons in 2010 and 2 million tons in 2020.
- Bio-refineries would play a dominant role for maintaining modern civilization in the future.
  - Renewable bio-fuel and bio-material, such as bio-diesel and biobased resins and plastics.

Motivation for Biorefinery

- Alternative bio-resources of mineral reserves
  - petroluem, coal
- Improving environmental quality
  - Smog, acid rain, waste disposal
  - Global climate change
- Economic development of countryside
  - Modulating and optimizing Chinese agriculture framework
  - Increasing feedstock prices
  - Improving farmer incomes
Techniques and products of biorefinery

Crop science
- genomics
- metabolites
- enzyme engineering
- conversion processes
- Enzyme/chemical hydrolysis
- Fermentation
- Gasification
- Pyrolysis co-firing
- Products
- Plastics, resins, foams, phenolic resins, solvents, cleaning fluids, chemical intermediates, adhesives, tallow, waxes, carbon black, paints, coatings
- Renewable fuels: ethanol, Bio-diesel
- Power: electricity, heat

Oil-crop biorefinery
- Oil-crops are very important raw material of bio-refineries
- High content of oil (20-60%) and protein (~40%)
- Products of bio-refinery from oil-crops
  - Bio-diesel
  - Bio-based resins and plastics

Main oil crops in China
- Chinese oil crops include soybean, rapeseed, peanut, sunflower, sesame, flax, etc.
- The planting area of oil crops is about 24.7 million ha.
- The yield of oilseeds is about 44.27 million tons/year, about 15% of total yield in the world
- High energy efficiency crops (oil content 20-60%)

Price of difference oilcrops meal

In 2007
Oilseed Rape in the World

Rape oilseed accounts for approximately 10 percent of global oil-seed production, taking second place behind soybeans. China, Canada, Australia and Europe are the main rape-growing regions in the world. They produce two-thirds of the global harvest.

Rapeseed cultivation is widely developed for oil production.
- In China, the output of rapeseed meal is more over 7 million tons in 2006 to 2007.
- Defatted rapeseed meals with 30–45% of protein content.
- Rapeseed meals are low cost, and are usually used for the supplementation of animal feed.
- Rapeseed meals contain toxic metabolites which are not favorable for the growing of animals.

Toxic components in rapeseed meal

- Glucosinolates are biologically inactive, but their hydrolysis produces a number of goitrogenic and toxic compounds.
- Other antinutritional factors: sinapine and tannins.
- High in fiber and phytic acid.

Why choice Bacillus natto

Why choice Rapeseed meals
**Our approach and technology**

- Rapeseed meals
- Rapeseed protein
- Extracted rapeseed meals
- Chemical/physical/enzyme hydrolysis
- Fermentation
- Active components: Peptides, Polyglutamic acid, Streptokinase

**Rapeseed residues**

- Peptides
- Bio-plastics
- Extracted rapeseed meals
- Rapeseed protein
- Additives: -1.940.193.040.193.04oxazolidone (mg/g)
- -3.080.244.893.044.89isothiocyanates (mg/g)
- 1.1659.801.1265.8665.86glucosinolates (μmol/g)

**Research progress**

- Fermented rapeseed meals and dregs
- Detection limit: 0.01mg/g

**High efficient conversion technology based on nano-immobilized enzyme**

**Standard curve of urokinase activity**

- X-axis: area of clear zone
- Y-axis: natural logarithm of urokinase activity
- Different natto Bacillus strains
Ultrafiltration was used based on different molecular weight for separation and purification.

Polyglutamic acid
MW > 100 k D

Nattokinase
MW 27.7 k D

Peptide MW < 10 k D

Protein

Polyamide (Nylon)

molecular formula
Protein-plastic modified from rapeseed meals

Summary

- Rapeseed is blooming as one of the most important alternative bio-resources material of bio-refinery and bio-diesel.
- It is very important to research processing technique for increasing the value of the byproducts, such as meals.
- High efficient conversion, integration and low cost green techniques were developed in our institute.
- The sustainable development of oilseed production is important for the food security and even energy security in the future. Meanwhile, it is highly related to the livelihoods of nearly 400 millions famers in china

Call for Scientific Exchanges and Cooperation

- High efficiency, high-throughput and low cost green processing techniques for bio-fuel.
- Processing technique for increasing the value of the byproducts, such as protein and glycerol.
- Breeding, genetic and metabolic engineering research for high yield of seed production and high oil contents.
- Study on plant physiology and plant pathology in order to improve cultivation techniques for the lower input costs and labor-saving.

Acknowledgements

1. High throughput quantification and in-situ determination of ultra-trace phytoestrogenic compounds in Arabidopsis and its relative crops and their applications in the study on the mechanism of pathogenic resistance, National Natural Science Foundation of China (9071701), 2008-2009.
5. Production of phytosterol ester using immobilized whole cell enzyme by using solvent-free system. Innovative Foundation of Hubei province, 2007-2010.
7. Study on functional and active components of fermented rapeseed meal and highly efficient and contened techniques for isolation, purification and characterization. Research Foundation of the Director General of Oil Crops Research Institute, Chinese Academy of Agricultural Sciences, 2006-2008.
Thank you for your attention