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Chemical and Bio-Transformation of Food Wastes and Plant Raw Materials to Valuable Products

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Food industry generates large amounts of by-products, which become wastes, if they are not properly utilized, e.g. tofu whey, soya molasses, brewer's spent grains, spent coffee grounds, fruits and vegetables pulps. All of them can be transformed into the food stuffs with enhanced functionalities, health benefits and/or sensory attributes using enzymes and microorganisms. On the other side, there are some raw plant and food materials, which can be applicable for isolation of food ingredients and biologically active substances through their (initial raw materials) chemical and bio-transformation.

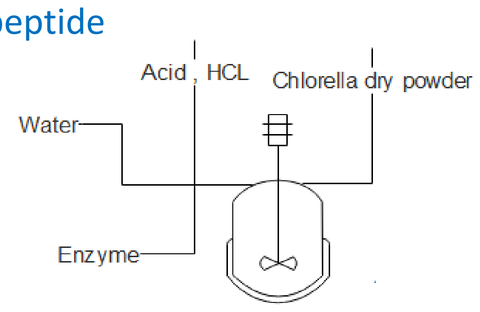
This research is aimed to isolate or produce some valuable biologically active substances (chlorella growth factor, glucosamine) and food ingredients (aminoacids, digestible sugars) from soya flour, chlorella algae, chitosan and brewer's spent grains using methods of chemical extraction and bio-modification.

Enzymatic extraction and encapsulation of *Chlorella algae* growth factor

Two factors effect the method of extraction directly :

- Chlorella growth factor (GF) is water soluble → Direct extraction with hot water
- GF is a subnucleus peptide → Difficult to reach due to cell wall and membranes

Enzymatic pre-treatment water extraction to increase the GF yield



- Extra treatment has increased the GF yield. **2 hours** treatment using Cellolux A (**3% of Chlorella mass**)was chosen as optimal for experiment;
- The enzymatic pre-treatment proved much better extract quality;
- At present time the use of enzyme treatment should be considered due to the high cost of cultivating Algae,
- Encapsulation using cellulose matrix was selected as an optimal method that could be used to increase bioavailability;
- **pH 6.5** was optimal for the reaction of gel formation.

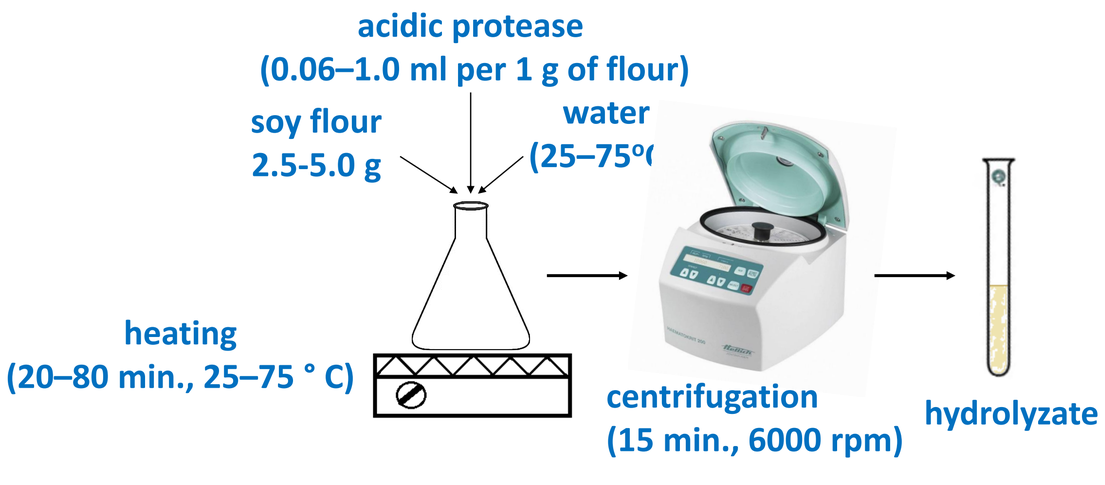
Catalytic activity of complex enzyme preparations in the reaction of hydrolytic decomposition of chitosan

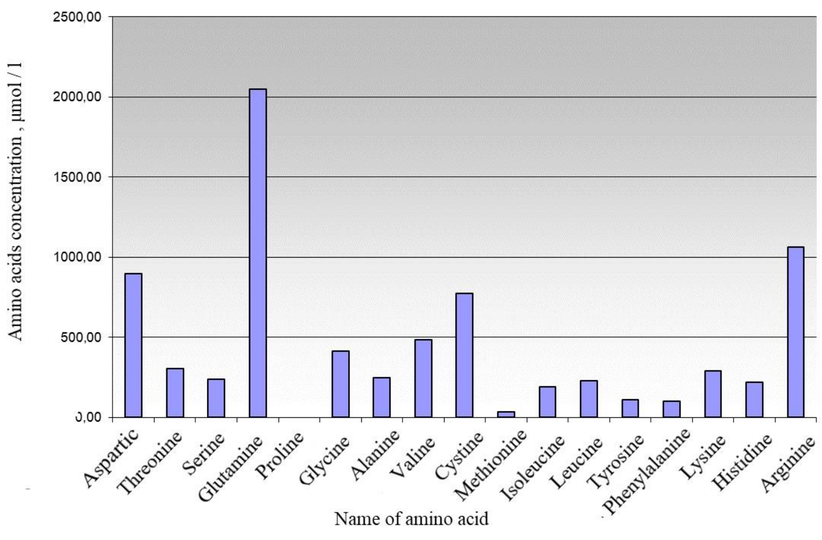
Carrier	Enzyme preparation
γ-Al_2O_3	GlucoLux-F
γ-Al_2O_3modified with MTM	CelloLux-A
γ-Al_2O_3 modified with APTES	GlucoLux-F
γ-Al_2O_3 modified with EPPMS	Protosubtilin
γ-Al_2O_3 modified with MPTMS	Amylosubtilin

MTM – trimethoxymethylsilane; APTES –aminopropylethoxysilane;
EPPMS- 3- (2, 3-epoxypropoxy) propyltrimethoxysilane;
MPTMS - mercaptopropyltrimethoxysilane

- Amilosubtilin showed the highest catalytic activity (**37,209×10^{-4} μmol/min)**;
- Amilosubtilin immobilized onto γ-Al_2O_3 by covalent binding using glutaraldehyde as a crosslinking agent showed the highest stability, retaining **26.07%** of its activity by the 4th cycle.

Treatment of soy flour with Distizym FM for its enrichment with specific amino acids





The optimal conditions for hydrolysis: 5 g of the introduced substrate (hydromodule 1:6), hydrolysis time is 40 minutes, hydrolysis temperature is 20–25 ° C and a dosage of the enzyme induced is 0.06 ml per 1 g of soy flour.

Bio-conversion of brewer's spent grains

The purpose of the enzymatic treatment is to break down 1-4→β-glycosidic bonds which can not be broken down by human gastric enzymes with the release of glucose.

Enzyme preparations:

- Distizym FM ;
- CelloLux-A dry;
- CelloLux-A liquid;
- Hemicellulose from *Aspergillus niger;*
- CelloLux-F
  from *Trichoderma viride* (*reesei*).

- CelloLux-F is the most suitable complex enzyme preparation for processing brewer's spent grains among all the studied ones;
- The optimal conditions for the fermentation of brewer's spent grains to obtain the highest glucose yield equal to 0.0525 mg / g are 25% solution of the complex enzyme preparation CelloLux-F, 12% suspension of grains, exposure time 2 h, temperature 40 ° C, stirring speed 130 rotations per minute;
- Fermented brewer's spent grains contain the highest amount of glutamate and glutamic acid (66%) regarding the total number of amino acids. The fraction of essential acids such as leucine, lysine and methionine was 13.8%.

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