Soybean as food material

Nutritional effect for human health and physicochemical properties in various foods.

*Tuesday 4th August 2009*

*Motohiko Hirotsuka*
Presentation Contents

1. Profile; FUJI OIL CO., LTD
2. Soy Food & Soy processing in Japan
3. Components in Soy bean
4. Physiological elements in Soybean & Trends of Soy Foods
5. Summary
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1. Profile; FUJI OIL CO., LTD
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5. Summary
1) Oils & Fats
   - Chocolate
   - Whipping cream products
   - Margarines • Shortening
   - Cheese material

2) Soy protein products
   2-1) Soy protein
       - Soy protein Isolate
       - Textured soy protein
       - Soy peptide
   2-2) Soy protein food
       - TOFU
       - Tofu burgers
       - GANMO

FUJI OIL CO., LTD
Hannan Business Operations Complex
(Izumisano city, Osaka, Japan)

Food Science Research Institute

Group 1;  Protein
Group 2;  Oil & Fat
Group 3;  Saccharide
Group 4;  Fermentation
Group 5;  Nutrition & Human health

Tsukuba Research and Development Center
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Typical processing process

- Soaking
- Heating
- Grinding
- Defating
- Flaking
- Extraction
- Sterilization
- Protein coagulation
- Soybean
- Soy Oil
- Defatted Soy Flour
- Tofu (fine tx)
- Tofu (rough tx)
- Soy Protein Isolate
- OKARA
Production of tofu derivative foods

1. Soaking
2. Heating and grinding
3. Separation
4. Soy milk preparation
5. Gelation
6. Protein coagulation
7. Sup.
8. OKARA
9. Seasoning
10. Deep fried
11. Film
Processing for Defatted soy flour

- flaking
- defatting → Soy Oil
- extrusion
- extraction → residue
- extract
- protein coagulation → Sup.
- Protein ppt.
- sterilization drying
- Soy Protein Isolate
  - Hydrolysis
  - Soy Peptide
Soy Protein Ingredients & their applications

- powder
- grain
- paste
- fiber
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Micro-Structure of Soybean by SEM
Constituents of soy bean

Major nutrients:
- Protein: 33.0%
- Carbohydrate: 28.8%
- Lipids: 21.7%
- Ash

Minor elements:
- Moisture
# Physiological elements in Soy

<table>
<thead>
<tr>
<th>Class</th>
<th>Element</th>
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<tr>
<td><strong>Protein</strong></td>
<td>Soy globulin</td>
</tr>
<tr>
<td></td>
<td>Enzyme</td>
</tr>
<tr>
<td><strong>Carbohydrate</strong></td>
<td>Fiber</td>
</tr>
<tr>
<td></td>
<td>Oligo saccharide</td>
</tr>
<tr>
<td><strong>Polyphenol</strong></td>
<td>Isoflavone</td>
</tr>
<tr>
<td></td>
<td>Phytate</td>
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<tr>
<td></td>
<td>Phytate</td>
</tr>
<tr>
<td></td>
<td>Saponin</td>
</tr>
<tr>
<td><strong>Lipid</strong></td>
<td>Phospho lipid</td>
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<td>Tochopherol</td>
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Recovery with the SDS-PAGE Analysis for SPI

Whole Protein
100%

SPI: Soy Protein Isolate
The protein composition of soy protein

- Glycinin (11S) 39%~43%
- β-conglycinin (7S) 19%~18%
- Others (LP) 36%~40%
Tofu-gels with each soy protein fraction
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Key Words (1)

$\beta$-conglycinin

TG

Visceral Fat

Obesity
Meta-analysis of the effects of soy protein intake on serum lipids.

Dr. Anderson (1995)
Effect of Protein Species on serum lipid level
(6 week Rat)
Powdered Soy β—Conglycinin

(Sterilized • Dried)
Obesity Type;

Apple type / Pear Type
Obesity with visceral Fat

Obesity with subcutaneous fat

CT-scan image of abdominal cross-section
Obesity with visceral Fat

Disturbance of adipocytokine secretion
(adiponectin ↓, PAI−I • TNF−α ↑)

diabetes  hyperlipidemia  hypertension

Metabolic Syndrome
Test Food

Powdered Soy $\beta$-Conglycinin (Casein) → Tablet

Dextrin 50%

Test Design

Continuous intake of 6g tablets with 6g sample per Day.

The test carried for 6 month.
Change in Serum TG

TG Change (md/dl)

Placebo

*,p<0.05; **,p<0.01
Change of Visceral fat area

Net change of visceral fat area (cm²)

Placebo

Test

0 12 20 Post

Placebo
Effect of $\beta$-Conglycinin on Lipid Metabolism
Soy protein

I. Simomura, Osaka Univ.
Key Words (2)

Soy Peptide
Stress
Conformation of Glycinin

Utumi et.al :: Proceedings of the National Academy of Sciences
USA 100, 7395-7400 (2003)
Soy protein and peptide solution (8%)
Peptide Transporter
Gut absorption of Amino acid and Peptide

Free amino acids

Peptides

Small intestine cell

One by one

Together
Experimental design for absorption rate of amino acid, peptide and protein with same amino acid composition.

**Protein**

**Peptide**

**Amino acid mixture**

**Analysis of Free Amino Acid**

blood drawing

(0, 5, 10, 15, 20, 25, 30, 40, 60, 80, 100, 120, 180 min)

Intake as a drink
Increment of essential amino acid

KFLIMVTW
Increment of branched-chain amino acid
Experimental design for suppression of CPK increment in serum with soy peptide

1. Blood drawing for measurement of initial CPK value.
2. Squat 25 times
   - Rest for 1 min
3. Intake the peptide drink
4. Blood drawing for measurement of CPK value after 30 min. and 18 hr.

4 cycle
Indicator of **Muscular Inflammation**

Muscular exercise

After 1～2 days

**Muscular Inflammation**

**muscle pain**

---

**Inflammation**

**Muscle**

Leakage of **CPK** from muscle cell

**vein**

**CPK** is considered as a indicator of **Muscular Inflammation**

**CPK**: Creatine PhosphoKinase
Change of CPK value in serum after muscle exercise

** : p < 0.01

- 8000mg soy peptide
- placebo

<table>
<thead>
<tr>
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<th>Before</th>
<th>30 min</th>
<th>18 hour</th>
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<tbody>
<tr>
<td>Placebo</td>
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<td></td>
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<tr>
<td>8000mg</td>
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Key Words (3)

Isoflavon
Female hormone
Female hormone; Estrogen

Soy Isoflavone & Female hormone

- daidzin: H, H
- genistin: OH, H
- glycitin: H, OCH$_3$
Rationale for Choice of Soybean Estrogen

CHD Mortality

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<thead>
<tr>
<th></th>
<th>U.S.</th>
<th>Japan</th>
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<tbody>
<tr>
<td>Females</td>
<td>100</td>
<td>50</td>
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Breast Cancer Incidence - 1985

<table>
<thead>
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<th>Japan</th>
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<tbody>
<tr>
<td>Incidence/100,000</td>
<td>200</td>
<td>50</td>
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</table>

Endometrial Cancer

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<th>U.S.</th>
<th>Japan</th>
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<tbody>
<tr>
<td>Rate/100,000</td>
<td>100</td>
<td>50</td>
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</table>

Urinary Excretion of Soybean Phytoestrogens (Genistein/Daidzein in nmol/24 hours)

- Japanese Women: 3,000
- U.S. Women: 35
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Production of soy bean

(2006-2007 USDA)

USA 86.8
Brazil 59.0
China 16.2
Argentine 47.2
others 26.6

(Total 235.77 million tons)

unit: million ton
Food Shortage & Environmental Problems

Beef; 1kg

Soy flour; 30kg
water; 20,000kg
Soy bean will save all of the world

Thank you very much!
$\beta$-conglycinin (tablet)

Soy Peptide (powder)