Hydrolyzed soy protein contains bioactive peptides that release cholecystokinin from enteroendocrine cells
Presentation Outline

1. Introduction
   - Obesity and Health
   - Weight Management
   - Soy protein and nutrition
2. Increasing protein functionality
3. Satiety peptides
4. Summary
Growing Obesity Creating Need for Better Weight Management Solutions

- Approximately half the world’s population is overweight with a 17% global obesity rate, led by the U.S. (34%), Mexico (30%)

- Prevalence of obesity in the U.S. has doubled over the last 15 years

- Cost of obesity healthcare in the U.S. $350B by 2018 or 21% of total healthcare spending

Weight Management

• Many products exist in the marketplace to help people manage their weight.
• There are three main strategies used in weight management products:
  – Increase energy expenditure
  – Maintain lean body mass
  – Induce satiety
• Protein consumption leads to all three phenomena.
Satiety is a key component of weight management strategies

- Regulation of food intake is complex. Gut hormones play a major role.

- Protein consumption is associated with satiety. Soy protein is as good as milk or animal proteins at inducing satiety.
Soy Protein Consumption results in lower weight gain in ob/ob mice

- Body weight gain and food intake: Peptides from black soybeans (BSP) shown to reduce both total body weight gain and food intake in an acute study using leptin-deficient (ob/ob) mice.

Taken from Jang et al (2008) Intl J. Obesity, 32:1161
Soy Proteins

• The only nutritionally complete vegetable protein
• Used in a variety of food applications, but can be difficult to work with due to solubility and viscosity issues.
• Hydrolysis can oftentimes improve functionality, with the added benefit that it releases bioactive peptides.
Hydrolysis of soy proteins improves solubility at acid pH

%DH vs. Solubility at pH 4

%Degree of Hydrolysis

%Solubility +/- s.d.
Hydrolysis of soy protein can lead to improvements in viscosity.

DH vs. Viscosity and Solubility

Viscosity (cps, 10% P)

Solubility

Hydrolysis of soy protein can lead to improvements in viscosity.
Enteroendocrine Cell-based Screen for CCK Release

- Peptides / hydrolysates*
- BSA & media controls
- PMA‡ positive control

CCK measured in cell media by ELISA (4 hrs)

* Peptides/hydrolysates soluble in PBS
‡ PMA = phorbol 12-myristate 13-acetate (activator of Protein Kinase C)
Hydrolyzed soy stimulates CCK release from Enteroendocrine cells

Optimal conditions for CCK inducing peptide generation are enzyme dependent
Correlation between %Degree of Hydrolysis & CCK Release is Enzyme Dependent

Unique peptides are created with different enzymes & processing conditions
CCK release by hydrolysates is dose-dependent

EC$_{50}$ = 0.86
R$^2$ = 1.0

Select hydrolysates have been shown to stimulate release of CCK in a dose-dependent fashion, suggesting a true physiological response.
**In vitro** digestion of soy hydrolysate does not destroy CCK inducing bioactivity
CCK release induced by <10K fraction of control hydrolysate

The graph shows the CCK released (ng/mL) in relation to the mg/mL Protein (w/v) with different samples. The y-axis represents CCK Released (ng/mL) ranging from 0 to 0.25, and the x-axis represents mg/mL Protein (w/v) ranging from 0 to 10.

Key points:
- **PMA [+ve control]**
- **Whole control (>100K)**
- **Hydrolysate #2, sample 1**
- **Hydrolysate #2, sample #2**
- **Hydrolysate #3, sample #1**
- **Hydrolysate #3, sample #2**

Different hydrolysate samples are indicated by different colors and markers. The legend on the right categorizes the samples by different sizes and sample IDs:
- **Control hydrolysate**
- **>100K - 1%**
- **10-100K - 1%**
- **<10K - 1%**

Scanlon, Tulk
CCK-releasing hydrolysates contain substantial amts of <10 kDa peptides

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<thead>
<tr>
<th>MW range</th>
<th>Retent time</th>
<th>AUC</th>
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Summary

- Obesity is a significant global issue that needs to be addressed.
- Weight management strategies that include protein are most likely to be successful.
- Soy is an excellent source of nutritionally-complete protein.
- Enzymatic processing of soy protein:
  - can improve functionality, thus making it easier to incorporate soy into different food forms
  - Releases bioactive peptides that may be useful in, e.g., maintenance of lean body mass, or inducing satiety
- Bioactive peptides derived via hydrolysis of soy can release CCK from enteroendocrine cells in a dose-dependent fashion, and a significant portion of the bioactive portion survives digestion.
- The majority of this bioactivity is found in the <10 kDa fraction.
- Future work will focus on determining whether the bioactive peptides exert an enhanced satiating effect \textit{in vivo}
Path Forward

• Fractionate bioactive hydrolysate(s) to identify peptide(s) responsible for CCK release.

• Look at the effect of soy peptides on the release of other satiety hormones.
Thank you!

Questions?