Soy-based High Protein Foods

Soo-Yeun Lee
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Health Benefits of Soy

- Reduces the risk of cardiovascular diseases
- Alleviates menopausal symptoms
- Helps to prevent osteoporosis and certain types of cancers
- High quality protein source

Health Benefits of High Protein Diet

- Effective in reducing body weight and body fat
- Enhances weight loss by
  - Stabilizing blood glucose
  - Sparing muscle protein
  - Increasing satiety

Overall Objectives

- Develop an extruded soy-based high protein foods
  - aid in weight loss/control
  - enhance protein consumption
- Increase soy consumption in human diet so consumers gain nutritional benefits of soy
Soy-based high protein breakfast cereal

Katherine Yeu, Youngsoo Lee, Soo-Yeun Lee

Formulations

Four formulations with soy protein content of 6.5 to 9.5 g per 30 g serving were developed:

- 6.25 g soy protein/serving: FDA guideline for claiming role of soy protein in reducing risk of CVD
- 10 g protein/serving: high protein foods
- 5 g fiber/serving: high fiber foods
### Theoretical Nutritional Content

<table>
<thead>
<tr>
<th>Amount of soy protein per serving (30g)</th>
<th>6.5g (A)</th>
<th>7.5g (B)</th>
<th>8.5g (C)</th>
<th>9.5g (D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein (g)</td>
<td>8.59</td>
<td>9.44</td>
<td>10.31</td>
<td>11.17</td>
</tr>
<tr>
<td>CHO w/o TDF (g)</td>
<td>12.54</td>
<td>11.31</td>
<td>10.06</td>
<td>8.82</td>
</tr>
<tr>
<td>Fat (g)</td>
<td>0.73</td>
<td>0.77</td>
<td>0.81</td>
<td>0.85</td>
</tr>
<tr>
<td>Fiber (g)</td>
<td>4.61</td>
<td>4.90</td>
<td>5.20</td>
<td>5.50</td>
</tr>
</tbody>
</table>

CHO-Carbohydrate, TDF-Total Dietary Fiber
## Compositional Analyses

<table>
<thead>
<tr>
<th></th>
<th>Formula A</th>
<th>Formula B</th>
<th>Formula C</th>
<th>Formula D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fat (g)</td>
<td>0.73</td>
<td>0.75</td>
<td>0.77</td>
<td>0.91</td>
</tr>
<tr>
<td>Protein (g)</td>
<td>8.59</td>
<td>9.07</td>
<td>9.44</td>
<td>10.03</td>
</tr>
<tr>
<td>Fiber (g)</td>
<td>4.61</td>
<td>4.33</td>
<td>4.9</td>
<td>4.57</td>
</tr>
<tr>
<td>Carbohydrate (g)</td>
<td>12.54</td>
<td>13.76</td>
<td>11.31</td>
<td>12.39</td>
</tr>
<tr>
<td>CHO/Protein</td>
<td>1.46</td>
<td>1.52</td>
<td>1.2</td>
<td>1.24</td>
</tr>
</tbody>
</table>

For 30 g serving.
Theoretical values in Black.
Empirical values in Red in highlighted column.
Manufacturing Process

Blend Dry Ingredients
- Mix Dry Powders
- Add Soybean Oil

Cook and Mix
- Add water to ~18% moisture
- Mix in high-pressure heated barrel

Forming
- Form shape with die outlet
- Cut into small pieces with pelletizer

Collect and Dry
- Samples collected on trays
- Dried for 1 hour in forced air oven
Texture in milk

Means with the same letter are not significantly different
Consumer Test 1: Samples Description

Four sets of treatments

1. Unflavored evaluated dry
2. Cinnamon flavored evaluated dry
3. Unflavored evaluated with milk
4. Flavored evaluated with milk
Consumer Test 2: Samples Description

Sample A, cinnamon flavored
Sample A, unflavored
Sample D, unflavored

Kellogg’s Smart Start w/ Soy protein
Nature’s Path Optimum Power
Kashi Go Lean
General Mill’s Fiber One
Zoe’s O’s
<table>
<thead>
<tr>
<th></th>
<th>Calories</th>
<th>Fat</th>
<th>Total CHO</th>
<th>Fiber</th>
<th>Protein</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smart Start</td>
<td>109</td>
<td>1</td>
<td>22</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Optimum Power</td>
<td>104</td>
<td>1</td>
<td>22</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Go Lean</td>
<td>81</td>
<td>1</td>
<td>17</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>Fiber One</td>
<td>60</td>
<td>1</td>
<td>25</td>
<td>14</td>
<td>2</td>
</tr>
<tr>
<td>Zoe's O's</td>
<td>97</td>
<td>2</td>
<td>19</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Sample A</td>
<td>89</td>
<td>1</td>
<td>18</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Sample A w/ cinn</td>
<td>89</td>
<td>1</td>
<td>18</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Sample D</td>
<td>85</td>
<td>1</td>
<td>15</td>
<td>5</td>
<td>11</td>
</tr>
</tbody>
</table>

For 30 g serving size
Effect of Soy flour Content

Means with the same letter are not significantly different
Effect of Flavor

Means with the same letter are not significantly different

Cinnamon
No Cinnamon
Means with the same letter are not significantly different
Consumer Test 2 Results: With Information

Means with the same letter are not significantly different.
Results & Discussion

- Overall acceptance was more greatly influenced by formulation (soy flour content)

- Comparable acceptance scores resulted for samples with 41, 47, 54% soy and slightly decreased with 60% soy

- Potential for commercialization
Conclusions: Next Step

Optimization of Formulation C (54% soy)

- Similar physical properties and acceptance scores as formulations with less soy content
- Meets high protein and good source of fiber requirements
Development and Consumer Acceptance of an Extruded Soy-based Indian-style Snack Food

Erika Neely, Youngsoo Lee, Soo-Yeun Lee

Objectives

- Enhance soy foods consumption in international market segments such as India
  1. Develop Indian-style soy-based extruded snack food
  2. Determine cross-cultural differences in consumer acceptance
     - Conduct testing in the U.S. with “surrogate” consumers
     - Conduct testing in India with actual target consumers
Rationale and Significance

- India could benefit from soy foods
  - 25% of India is vegetarian, some regions nearly 70% (Achaya, 1994)
  - 28.6% of population is considered below poverty line (FAO, 2004)

- Soy not a traditional element of Indian diets
  - Consume only 0.22kg/year per capita (FAO Food Balance Sheets, 2003)
  - Unfamiliarity may lead to poor acceptance

- No cross-cultural sensory studies with India
  - Untapped market for product development opportunities
  - Studies with other countries show distinct preference differences
Materials

- Soy meal
- Corn meal
- Chickpea flour
- Salt
- Soybean oil
- Slightly ground cumin seeds
- Slightly ground coriander seeds
- Ground turmeric
- Ground red chili
Experimental Design

- $3 \times 3 = 9$ test samples

<table>
<thead>
<tr>
<th></th>
<th>100% soy flour (F)</th>
<th>50% soy flour 50% soy grits (H)</th>
<th>100% soy grits (G)</th>
</tr>
</thead>
<tbody>
<tr>
<td>52% soy</td>
<td>![Image]</td>
<td>![Image]</td>
<td>![Image]</td>
</tr>
<tr>
<td>62% soy</td>
<td>![Image]</td>
<td>![Image]</td>
<td>![Image]</td>
</tr>
<tr>
<td>72% soy</td>
<td>![Image]</td>
<td>![Image]</td>
<td>![Image]</td>
</tr>
</tbody>
</table>
U.S. Consumer Test

- 72 consumers
  - Recruited on UIUC campus
  - Consume Indian-style snacks at least once a month

- 9 samples served to each consumer in balanced order
  - 10 g sample served in plastic 2 oz. cups
  - Rinsed with plain yogurt, warm and cool water between each sample
  - 2 minute break after every 3rd sample

- Panelists evaluated in individual booths using Compusense Commuter software

- Asked first about overall liking, then specific attributes
India Consumer Test

Recruited at ISKCON Temple in Bangalore, India

- Recruited at ISKCON Temple in Bangalore, India
- 9 samples served to each consumer in balanced order
- 10 g sample served in plastic zip top bags
- Rinsed with buttermilk, warm and cool water between each sample
- 2 minute break after every 3rd sample
- Panelists evaluated in small groups on individual paper ballots
- Asked first about overall liking, then specific attributes
Panelist Vegetarian Status

- India:
  - Vegetarian
  - Not vegetarian
  - Other

- U.S.:
  - Vegetarian
  - Not vegetarian
Soy Product Consumption Frequency

- At least a few times a week
- At least a few times a month
- At least a few times a year
- Once a year or less

<table>
<thead>
<tr>
<th>Test Location</th>
<th>U.S.</th>
<th>India</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Panelists</td>
<td></td>
<td></td>
</tr>
<tr>
<td>at least a few times a week</td>
<td>35</td>
<td>15</td>
</tr>
<tr>
<td>at least a few times a month</td>
<td>30</td>
<td>10</td>
</tr>
<tr>
<td>at least a few times a year</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>once a year or less</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
What types of soy-containing foods have you consumed?

- Soy milk
- Soy yogurt
- Soy cheese
- Soy frozen desserts
- Tofu
- Miso
- Natto
- Soy sauce
- Soy meat substitutes
- Whole soy beans
- Soy protein powders
- Soy breakfast cereal
- Soy energy bars
- Soy salty snacks
- Soy-containing bread
- Other
Means with the same letter are not significantly different at a level of 5% as determined by Fisher’s LSD test.
U.S.: Factorial Arrangement of Means for Overall Liking
Means with the same letter are not significantly different at a level of 5% as determined by Fisher’s LSD test.
Summary

- A highly acceptable soy-based snack was successfully produced using extrusion processing.
- Consumer tests showed differences in acceptance for U.S. and Indian consumers of Indian-style snacks.
- Manipulations of soy level and grits content affected acceptability.
Future....

- Modeling study with addition of whey protein
- Intellectual property – Trade mark
- Other funding sources
Acknowledgements

- ISA
- NSRL
- ISKCON Bangalore and Akshaya Patra Foundation
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