CONSUMER MARKET RESEARCH FOR OPTIMIZATION OF
AN EXTRUDED SNACK PRODUCT AND PROCESS
FOR THE INDONESIAN MARKET

A THESIS
PRESENTED IN PARTIAL FULFILMENT
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ABSTRACT

A coextruded snack based on corn, defatted soya flour and Indonesian ingredients (rice and/or tapioca) was developed for Indonesian consumers, particularly to fit into the young adult niche market. Market and consumer research was carried out through collecting primary and secondary data and the results were utilized in the formulation of the extruded snack. Information about the snack market situation in Indonesia and consumer attitude towards extruded snack products indicated that there is an opportunity for success for a new-western style snack (extruded snack) in Indonesia and the key for success are product awareness and product attributes, notably crispiness and flavour.

The snack base was manufactured using a co-rotating and intermeshing twin screw extruder (Clextral BC-21) with a constant feed rate and optimized by changing ingredients and extrusion conditions set by a constrained mixture design scheme (Echip computer software). The effect of the extrusion conditions and ingredients on the functional, physical properties of the snack product was also studied in this project. The product cost was also optimized with a constraint of no more than Rp. 4000 per kg (NZ$ 2.70) finish snack product.

The study on the extrudate properties showed that an increase in rice flour increased moisture content (MC), Water Absorption Index (WAI), Nitrogen Solubility Index (NSI) and Breaking Strength (BS), while an increase in soya reduced the protein solubility and the extrudate became brownish. Consumer acceptability was mainly affected by the rice content, soya content and temperature in the last section (T4).

Specific Mechanical Energy (SME), an extrusion parameter, was calculated directly through torque measurements. Higher SME indicated higher energy used in the extrusion process, thus more starch degradation and protein denaturation occurred, producing extrudates with lower BS. Sensory evaluation showed that snacks with lower BS (a crispier product), higher $L^*$ and $b^*$ colour (light brownish yellow colour) had a higher acceptance.
The most preferred snack base was made from 28% defatted soya flour, 12% rice flour, 59.6% corn grits and 0.4% baking soda. These ingredients were processed in a twin screw extruder with a feed rate of 4.47 kg/hr. The four barrel temperature zones were set at 40°C, 80°C, 115°C and 140°C, respectively and 150 ml/hr of water was pumped to the barrel. The screw speed was set at 300 rpm. The snack acceptance was improved by coating the samples with flavours and the most preferred flavour determined by a sensory panel was a spicy flavour (Ethican - QZ 02346; Quest International).

The optimum product formulation was then tested in a larger scale consumer test in Indonesia. The results from the final product testing showed that the developed snack was accepted by the target consumers. However some improvements of the product in terms of oil content and product stickiness in the mouth are still necessary. The developed product had a better acceptance over the snacks already in the market in terms of nutritional image, crispiness, product appearance and main ingredients.

In addition a feasibility study on snack production in a single screw extruder was carried out and functional and physical properties of the resulting extrudates were compared with those produced using the twin screw extruder. The comparison of WAI, Glass transition temperature (Tg), NSI and BS of snacks manufactured using a single (Lallesse, Universal single screw extruder) and a twin screw extruder (Clextral BC21) showed that the extent of molecules degradation was lower in the single screw extruder than in the twin screw extruder. Sensory properties also indicated that the twin screw extrudate was crisper and suited to the consumers' preference than the single screw extrudate.

The developed product could be produced commercially either using a twin screw extruder or a single screw extruder, depending on the available equipment, although it was recognized that the snack manufactured using the twin screw extruder had a higher preference compared to those produced using the single screw extruder.
DEDICATION

to my parent, Mr. and Mrs. Harminto,
my sister and brothers, Daili, Ibnu and Ardian
for their understanding and encouragement throughout my course.

Make the best use of your possessions and capabilities to gain your goal;
and accept the limits of the situation.

It is THE WAY IT IS, therefore LET IT GO.
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<thead>
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<th>Description</th>
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<tbody>
<tr>
<td>TSE</td>
<td>Twin Screw Extruder</td>
</tr>
<tr>
<td>SSE</td>
<td>Single Screw Extruder</td>
</tr>
<tr>
<td>RSE</td>
<td>Reverse Screw Element</td>
</tr>
<tr>
<td>T₁</td>
<td>Temperature at the first zone in the twin screw extruder</td>
</tr>
<tr>
<td>T₂</td>
<td>Temperature at the second zone in the twin screw extruder</td>
</tr>
<tr>
<td>T₃</td>
<td>Temperature at the third zone in the twin screw extruder</td>
</tr>
<tr>
<td>T₄</td>
<td>Temperature at the forth/last zone in the twin screw extruder</td>
</tr>
<tr>
<td>MC</td>
<td>Moisture Content</td>
</tr>
<tr>
<td>w/w</td>
<td>Weight per weight basis</td>
</tr>
<tr>
<td>wwb</td>
<td>Weight by wet basis</td>
</tr>
<tr>
<td>WAI</td>
<td>Water Absorption Index</td>
</tr>
<tr>
<td>WSI</td>
<td>Water Solubility Index</td>
</tr>
<tr>
<td>NSI</td>
<td>Nitrogen Solubility Index</td>
</tr>
<tr>
<td>Tg</td>
<td>Glass transition temperature</td>
</tr>
<tr>
<td>BS</td>
<td>Breaking Strength</td>
</tr>
<tr>
<td>SME</td>
<td>Specific Mechanical Energy</td>
</tr>
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</table>

All other abbreviations are standard chemical, mathematical or country symbols.
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