Characteristics of Extrusion Processed Foods from Whole Pigeon pea

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Wednesday 2nd March 2016
Introduction

• Pigeon pea is among grain legume highly cultivated in Africa.
• Nutritious due to major composition, mainly starch 45%, protein 23%, Fat 2% & dietary fibre 27%.
• Underutilised due to prolonged cooking time and presence of anti-nutritional factors.

Objective

• To develop good quality ready to eat snack foods from 100% whole pigeon pea through extrusion cooking in order to improve utilisation and availability for food security.
Structural matrix and nutritional composition of native pigeon pea

- Starch granule: 45% seed weight
- Protein Matrix incorporating protein bodies: 23% seed weight
- Cell wall material
- Seed coat

(Dietary fibre 27%)
**Material and method**

**Pre-treatment prior to extrusion**

Nigerian-Agatu Pigeon pea (5 months post harvest)

Alkaline blanching (0.5% Sodium bicarbonate) in Jacketed vessel @ 90°C, 5mins

Draining

Wet grain

Wet milling

BBHME (22% moisture content)

BBE (11% moisture content)

Hydrothermal blanching in Jacketed vessel @ 90°C, 5mins

Draining

Wet grain

Wet milling

HTTHME (22% moisture content)

HTTE (11% moisture content)

Mixing with H₂O at ambient condition

Milling

NPPE (11% moisture content)

NPPHME (22% moisture content)
Production of extruded snack foods from 100% whole pigeon pea

Pigeon pea seed (Pre-treated/native)
Milled - whole pigeon pea as feed material

Twin screw extruder for extrusion cooking
Extrusion condition:
Screw speed: 400rpm, Barrel temperature (9 segmented heating zones) 30-120°C,
Die temperature: 150°C, Feed rate 14kg/hr

Extruded snack food from pigeon pea
Method of evaluation of extruded pigeon pea snacks

Nutritional composition
- Starch content: AOAC-Megazyme
- Protein content: Nitrogen Analyser
- Dietary fibre: Enzymatic-gravimetric method

Physicochemical characteristics
- Expansion ratio: extrudate diameter/die diameter
- Bulk density
- Hardness: TA-XT2 Plus Texture Analyser
- Cold water solubility index

Thermal and Structural characteristics
- Degree of starch gelatinisation: Differential Scanning Calorimeter (DSC)
- X-ray pattern: X-ray diffractometer
- Pasting properties: Rapid Visco Analyser (RVA)
- Microstructure: Scanning Electron Microscope
Result: Physico-chemical characteristics of pigeon pea extrudates

NPPE: extrudate from native pigeon pea
HTTHME: extrudate from wet milled hydrothermally treated pigeon pea
HTTE: extrudate from dry milled hydrothermally treated pigeon pea
BBHME: extrudate from wet milled alkaline treated pigeon pea
BBE: extrudate from dry milled alkaline treated pigeon pea

WSI (cold water solubility index)
SEI (Sectional expansion index)

Good Product Quality Index
Low bulk density, high SEI and low hardness
### Result: Nutritional and Anti-nutritional composition of pigeon pea extrudates

<table>
<thead>
<tr>
<th></th>
<th>NPP</th>
<th>NPPHME</th>
<th>NPPE</th>
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<th>BBHME</th>
<th>BBE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein content (%)</td>
<td>22.58</td>
<td>22.42</td>
<td>20.37</td>
<td>21.32</td>
<td>22.06</td>
<td>23.09</td>
<td>22.11</td>
</tr>
<tr>
<td>Starch content (%)</td>
<td>39.27</td>
<td>37.74</td>
<td>33.99</td>
<td>37.33</td>
<td>30.33</td>
<td>36.30</td>
<td>35.62</td>
</tr>
<tr>
<td>Dietary Fibre (%)</td>
<td>28.06</td>
<td>25.33</td>
<td>23.60</td>
<td>22.09</td>
<td>23.63</td>
<td>21.99</td>
<td>19.89</td>
</tr>
<tr>
<td>Phytic acid (g/100g)</td>
<td>0.72</td>
<td>ND</td>
<td>0.71</td>
<td>ND</td>
<td>0.63</td>
<td>ND</td>
<td>0.64</td>
</tr>
<tr>
<td>Oxalic acid (g/100g)</td>
<td>0.01</td>
<td>ND</td>
<td>0.01</td>
<td>ND</td>
<td>0.01</td>
<td>ND</td>
<td>0.01</td>
</tr>
<tr>
<td>Trypsin inhibitor (TIU/g)</td>
<td>16841</td>
<td>ND</td>
<td>688</td>
<td>ND</td>
<td>224</td>
<td>ND</td>
<td>593</td>
</tr>
</tbody>
</table>

**NPP**: Native pigeon pea  
**NPPHME**: extrudate from high moisture native pigeon pea  
**NPPE**: extrudate from native pigeon pea  
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**BBE**: extrudate from dry milled alkaline treated pigeon pea

Extrusion cooking resulted in decrease in trypsin inhibitor (95%) and phytic acid (10%).

**ANF**: Anti-nutritional factor
Result: X-Ray pattern on the impact of extrusion on starch crystallinity

Starch Crystalline peak

Absence of starch crystalline peak

Effect of extrusion cooking on the starch gelatinisation

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</thead>
<tbody>
<tr>
<td>Cold water peak viscosity @5 min, 20°C</td>
<td>30</td>
<td>207</td>
<td>1256</td>
<td><strong>2762</strong></td>
<td>989</td>
<td>899</td>
<td>849</td>
</tr>
<tr>
<td>Degree of gelatinisation of starch (DSC enthalpy)</td>
<td>0</td>
<td>30</td>
<td>69</td>
<td>83</td>
<td>60</td>
<td>50</td>
<td><strong>90</strong></td>
</tr>
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Absence of crystalline peak, increase in cold water viscosity and DSC degree of gelatinisation are attributes of good quality extrudates
RESULT: EXTRUDATES MICROSTRUCTURE
Conclusions

• Extrusion with low moisture alkaline treated pigeon pea resulted in an increase in the expansion of the snacks, decrease in force necessary to chew the snacks and reduction of some anti-nutritional factors thereby making it an ideal nutritious crunchy snack.

• Wet milled product from hydrothermally treated pigeon pea could serve as an alternative breakfast cereal for children due to the high degree of starch gelatinisation and cold water viscosity.

• However high moisture extruded native sample are more suitable for animal feed.

• This study has confirmed that it is possible to extrude 100% pigeon pea into different products without the addition of processing ingredients.
Recommendations

• We are advocating for intensive research in extrusion cooking of other grain legumes as an efficient technique to increase food security in Africa due to its nutritional composition, longer shelf life (one year) and low production cost

• Hence, extruded grain legumes will be able to compete favourable with commercially available extruded cereals (wheat, corn, barley and oat) products
Acknowledgement

- **Conference sponsor**: Legume Innovation lab
- **Home Institute**: Federal Polytechnic Oko, Nigeria
- **PhD sponsor**: Federal Government of Nigeria
- **PhD Supervisors**: Dr Bettina and Dr Bill
- **Technical Team for Extrusion**: Mrs Val and Mr Johno
Thank you for listening

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