A nutrition-secure childhood for 6-24 months old infants and young children in South Africa: Does the viscosity of sorghum and other complementary porridge samples limit nutrient intake?

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INTRODUCTION
Meeting nutritional needs of 6 - to 24 month-old children is challenging (Dewey 2013).

- Worldwide, 6 M children below 5 years die per year (Black et al., 2013).
- 50% of deaths= malnutrition (UNICEF, 2015).
- A further 156 M (24%) globally are stunted (UNICEF/WHO/World Bank, 2016).
- In RSA, 27% of the children under 5 years are stunted (National Department of Health, Statistics SA, South African Medical Research Council, and IFC. (2017).
PROTEIN-ENERGY MALNUTRITION (PEM)

• The most lethal form of malnutrition (Bazaz et al, 2016).
• “Inadequate” protein and energy in diet.

Causes are multivariate and multifaceted.

➢ Inappropriate viscosity of complementary foods (Abiose et al., 2015).

Does sorghum hold potential to promote adequate energy and protein intake in young children to guarantee a nutrition-secure childhood?
**BUT...HOW MUCH IS ADEQUATE?**

*Unpacking the terms of reference*

*Assumptions (informed by empirical evidence)*

<table>
<thead>
<tr>
<th>Age-group of young children</th>
<th>6-8 Months</th>
<th>9-11 Months</th>
<th>12-24 Months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assumed functional gastric capacity <em>(Based on 30g/kg reference body weight)</em></td>
<td>249g/meal <em>(8,3kg)</em></td>
<td>285g/meal <em>(9,5kg)</em></td>
<td>345g/meal <em>(11,5kg)</em></td>
</tr>
<tr>
<td>Energy density of complementary food (kJ/g)</td>
<td>Number of meals/day</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.5</td>
<td>3.7</td>
<td>4.1</td>
<td>5.0</td>
</tr>
<tr>
<td>3.4</td>
<td>2.8</td>
<td>3.1</td>
<td>3.7</td>
</tr>
<tr>
<td>4.2</td>
<td>2.2</td>
<td>2.5</td>
<td>3.0</td>
</tr>
</tbody>
</table>

*WHO/UNICEF (1998); Dewey and Brown (2003)*
DIETARY ENERGY REQUIREMENTS FOR CHILDREN HAVING LOW BREAST MILK ENERGY INTAKE

DIETARY PROTEIN REQUIREMENTS FOR CHILDREN HAVING LOW BREAST MILK ENERGY INTAKE

<table>
<thead>
<tr>
<th>Age range</th>
<th>Protein from Breast Milk</th>
<th>Protein Required from Complementary Foods</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-8 months</td>
<td>3.9</td>
<td>5.2</td>
</tr>
<tr>
<td>9-11 months</td>
<td>2.9</td>
<td>6.7</td>
</tr>
<tr>
<td>12-24 months</td>
<td>1.8</td>
<td>9.1</td>
</tr>
</tbody>
</table>

SO.. IS THE VISCOSITY OF SORGHUM (AND OTHER INDIGENOUS) COMPLEMENTARY PORRIDGE SAMPLES REALLY A CONCERN?

• Porridge viscosity characterisation is elusive
• Sorghum porridge thickness relates to flow properties (Engmann & Burbidge 2013).
• Too thick or too thin? Spoon-thick: 1–3 Pa.s (But at what shear rate?) (Thaoge et al., 2003; Oyarekua, 2011).

1. Temperature & Time
2. Chemical composition
3. Force, shear rate
4. oral conditions

• A single shear rate or a range? (Nicosia, 2013; He et al., 2016; Chambers et al., 2017).
RESEARCH QUESTION

Does the viscosity of sorghum and other complementary porridge samples commonly consumed by 6-24 months old infants and young children in South Africa limit nutrient intake?

Objective

To determine the flow properties (dynamic viscosity), protein and energy content of commercial and locally available complementary porridge samples for 6 to 24 months children in South Africa, -

with the aim of optimising protein and energy intake in young children to improve their nutritional status.
EXPERIMENTAL DESIGN

Independent

Complementary porridges

15 commercial formulas

6 to 8 months

9 to 12 months

8 indigenous/local flour types

13 to 24 months

Solids (2; 4; 6; 8; 10; 16%)

Dependent

Viscosity (40°C)

- Protein content
- Energy content
- Protein intake/day
- Energy intake/day
DECREASE IN THE VISCOSITY OF A COMPLEMENTARY PORRIDGE WITH INCREASING SHEAR RATE (MEASURED AT 40°C).
VISCOSITY PROFILE OF A SORGHUM AND OTHER PORRIDGE TYPES CONSUMED BY YOUNG CHILDREN OF AGE 6-24 MONTHS IN SOUTH AFRICA.

*Commercial formulas prepared as per manufacturer instructions at 25% solids. Indigenous porridge samples at 10% solids.
**PROTEIN AND ENERGY INTAKES FROM SORGHUM AND OTHER COMMON PORRIDGE SAMPLES FOR 6-8 MONTHS-OLD CHILDREN IN SOUTH AFRICA.**

*Analysis done at temperature of 40 °C, shear rate of 50 s⁻¹ and a critical viscosity limit of 3Pa.s.*

<table>
<thead>
<tr>
<th>Total nutrient requirements/day</th>
<th><em>BM intake level</em></th>
<th>Required from #CP level</th>
<th><strong>Porridge type and solids content [%]</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Energy (3229,8 kJ/day)</strong></td>
<td>Low</td>
<td>2318</td>
<td>A1 [25], A2 [25], A3 [25], S [8,4], M [8,1], PM [11,1], B [10,7]</td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td>1495</td>
<td></td>
</tr>
<tr>
<td><strong>Protein (9,1 g/day)</strong></td>
<td>Low</td>
<td>5</td>
<td>2658, 2658, 2658, 1046, 1121, 1494, 1345</td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td><strong>Viscosity (Pa.s)</strong></td>
<td>3</td>
<td>0,3, 0,5, 1,4, 3, 3, 3, 3</td>
<td></td>
</tr>
</tbody>
</table>

*Breast milk; #Complementary porridge; **A1, A2 and A3 are commercial; - S (sorghum), M (maize), PM (pearl millet) and B (bambara) are indigenous.*
Analysis done at temperature of 40 °C, shear rate of 50 s⁻¹ and a critical viscosity limit of 3Pa.s.

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<thead>
<tr>
<th>Total nutrient requirement/day</th>
<th>*BM intake level</th>
<th>Required from #CF</th>
<th>**Porridge type and solids content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>*BM intake level</td>
<td>Required from #CF</td>
<td>**Porridge type and solids content (%)</td>
</tr>
<tr>
<td>Energy (3603,6 kJ/day)</td>
<td>Low</td>
<td>2944</td>
<td>2658</td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td>2012</td>
<td></td>
</tr>
<tr>
<td>Protein (9,6 g/day)</td>
<td>Low</td>
<td>7</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Viscosity (Pa.s)</td>
<td>3</td>
<td>0,3</td>
<td>0,5</td>
</tr>
</tbody>
</table>

*Breast milk; #Complementary porridge; **A1, A2 and A3 are commercial; - S (sorghum), M (maize), PM (pearl millet) and B (bambara) are indigenous.
PROTEIN AND ENERGY INTAKES FROM SORGHUM AND OTHER COMMON PORRIDGE SAMPLES FOR 12-24 MONTHS-OLD CHILDREN IN SOUTH AFRICA.

*Breast milk; #Complementary porridge; **A1, A2 and A3 are commercial; - S (sorghum), M (maize), PM (pearl millet) and B (bambara) are indigenous.

Analysis done at temperature of 40° C, shear rate of 50 s⁻¹ and a critical viscosity limit of 3Pa.s.

<table>
<thead>
<tr>
<th>Total nutrient requirement/day</th>
<th>*BM intake level</th>
<th>Required from #CF</th>
<th>**Porridge type and solids content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy (4695,6kJ/day)</td>
<td>Low 4318 Average 3242</td>
<td></td>
<td>2658 2658 2658 1449 1253 2070 1863</td>
</tr>
<tr>
<td>Protein (10,9 g/day)</td>
<td>Low 9 Average 5</td>
<td></td>
<td>23 23 23 6 6 16 24</td>
</tr>
<tr>
<td>Viscosity (Pa.s)</td>
<td>3</td>
<td>0,3 0,5 1,4</td>
<td>3 3 3 3</td>
</tr>
</tbody>
</table>
WE NEED TO FIND THE CRITICAL BALANCE!

- Porridge Viscosity for age
- Protein & energy content; Easiness to swallow
INCREASING SOLIDS CONTENT OF THE PORRIDGE SHOULD INCREASE NUTRITIVE VALUE. BUT THEN, VISCOSITY RAPIDLY INCREASES BEFORE THIS HAPPENS.

- Compositing
- Fermentation
- Enzymatic hydrolysis
- Electro-magnetic energies....
CONCLUSIONS

• The flow properties (dynamic viscosity) of Sorghum and some of the common South African complementary porridge samples is a limiting factor for protein and energy intake in infants and young children of ages 6-24 months.

SIGNIFICANCE OF FINDINGS

• Need to explore technologies to improve the oral flow properties of sorghum and other common complementary porridges, in order to optimize protein and energy intake.
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THANK YOU