Improvements in Sorghum Milling Technologies

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Introduction

- Sorghum is staple food for millions in African and Asian countries
- It ranks 5\textsuperscript{th} in production worldwide, but is 2\textsuperscript{nd} most important after maize in Africa
- The crop is adapted to drought conditions and therefore could be a strategic grain for food security in Sub-Saharan Africa
Limitations

- Sorghum has been neglected until recently; Little R&D efforts compared to other common cereals
- Sorghum food industry is non-vibrant (largely traditional products)
- Generally there is lack of suitable sorghum food processing technologies
  - Low production capacity
  - High milling loses
  - Variable product quality
Sorghum milling

Purpose of milling is to:

- Separate the starch-rich endosperm (84 %) from the pericarp (6 %) and the germ (10 %)
- Reduce the “clean” endosperm to small particles (meal)
- Critical considerations – efficiency (economics) of milling technology and meal quality

Cross section of the sorghum kernel

P = Pericarp
FE = Floury endosperm
CE = Corneous endosperm
G = Germ
Two basic approaches to cereal grain milling

- Break open kernel, then scrape endosperm from bran
  - Mainly used for wheat milling (roller milling)
  - Multiple grinding and separation steps (sifting, aspiration and gravity separation)

- Pericarp (bran) and germ are first removed by degerming or decortication, then endosperm is reduced to grits or flour
  - Typically used for maize
  - Conventional Beall-type degerminator cause breakage of sorghum endosperm; bran contamination (integral germ and spherical shape)

- Both approaches have been tried for sorghum
Trends in development of milling technologies

- **Perten 1983 - Adaptation of wheat roller milling technology for sorghum**
  - Uneconomical low yields
  - Products of inferior quality (bran contamination)

- Lately small roller mills (2-3 roller pairs) are gaining popularity
  - Optimisation of milling process with respect to roller gap, tempering, and sieving
  - Improved yields but bran contamination still high
Roller milling cont.

Comparison of milling performance of abrasive decortication and roller milling using 10 sorghum varieties with different physico-chemical properties

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Abrasive Decortication</th>
<th>Roller Milling</th>
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<tbody>
<tr>
<td>Meal extraction (%)</td>
<td>75.7a</td>
<td>83.7b</td>
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<tr>
<td>Ash (%)</td>
<td>1.18a</td>
<td>1.29b</td>
</tr>
<tr>
<td>Oil (%)</td>
<td>2.46a</td>
<td>2.64b</td>
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<tr>
<td>L</td>
<td>84.6b</td>
<td>82.4a</td>
</tr>
<tr>
<td>Cab</td>
<td>10.8a</td>
<td>11.6b</td>
</tr>
<tr>
<td>hab</td>
<td>70.5b</td>
<td>68.6a</td>
</tr>
</tbody>
</table>

Other considerations;

- Roller mill – narrow particle size distribution; wide for hammer mill
- Roller mill has significantly higher meal output (about 195% higher than abrasive and hammer milling system)
- Roller mill has high energy efficiency (32 kg meal/1kwh), while abrasive hammer mill produced 12.9 kg meal /1kwh
Difficulties with separation of bran

- Starch granules in mesocarp makes pericarp very friable
- Forms small bran flakes which are difficult to separate from meal
- Bran layer should be toughened to separate as large flakes

Focus on tempering
- Best tempering moisture content
- Treatment temperature
- Time

Other technologies considered

- German Schule
- Swiss Decomatic
- Danish United Milling System
- Prairie Research Laboratory (PRL) Dehuller
- PeriTec system
PRL Dehuller and hammer mill

- Canadian PRL dehuller was adapted for local conditions in West, Eastern ad Southern Africa, and India
- Dry grain is decorticated by abrasive carborundum disks revolving at high speed in a barrel (fine bran removed by aspiration)
- Milling package (dehuller & hammer mill) was technically and economically viable
- Gave rise to sorghum industry in the region (service milling for villagers)
- Adequate technical support by RIIC contributed to industry success in Botswana
Improvements in production capacities

- Increasing demand for sorghum meal require higher production capacities.
- Attempts to build larger dehullers compromised milling efficiency and meal quality.
- Commercial mills now install normal PRL dehullers in series and/or in parallel.
- 4-5 dehullers feed one hammer mill.
- Typical capacities are 2 to 2.5 tons per hr.
Production capacities

- Some mills now using PeriTec decorticator – Vertical Debranner VCW (Satake Corporation)
- Debrans by abrasion using revolving carborundum wheels and hexagonal slotted screen (stage 1) and friction (stage 2)
- Bran is removed by blowing air through the system from bottom to top outlet
- Requires conditioning of grain with 1-3% moisture (by weight) for 3-5 min before debranning – permits gradual stripping of pericarp layers
- Offers controlled rate of bran removal, uniformly debranned grains and improved power efficiency
- High input capacities – 2 to 10 tons

PeriTec system; Used with Satake Corporation’s permission
Grain cleaning

- Millers now installing grain cleaning equipment (sieving, aspiration and metal removal)
- Necessary for high production capacities
Selection of varieties

- Meal quality varies with sorghum varieties used
- Millers aim to meet consumer demands
- Blending of different varieties commonly practiced
- Typically hard to intermediate endosperm texture preferred
- Light coloured meals with medium course texture preferred in Botswana
- Taste is also important
Conclusions

- Abrasive decortication is still the only appropriate technology for decorticating sorghum to meet consumer preferences.

- Roller milling has potential as an alternative sorghum milling process but still requires optimisation of the tempering process.
THANK YOU!