Improvements in Sorghum Milling Technologies

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Improvements in Sorghum Milling Technologies

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Introduction

- Sorghum is staple food for millions in African and Asian countries

- It ranks 5th in production worldwide, but is 2nd 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 degemering or decortication, then endosperm is reduced to grits or flour
  - Typically used for maize
  - Conventional Beall-type degeminator 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 - Adaption 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>
</tr>
</thead>
<tbody>
<tr>
<td>Meal extraction (%)</td>
<td>75.7a</td>
<td>83.7b</td>
</tr>
<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>
</tr>
<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
Canadian PRL dehuller was adapted for local conditions in West, Eastern and 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!