Executive Summary:

Electrolyte leakage is proposed as a method to assess activity access for subsequent biological or chemical processing of forage or biomass. Smaller particle sizes and subsequent bioprocessing may enhance activity access, but could result in greater loss of non-damaged material due to smaller particle size.

In the current study, electrolyte leakage was used to evaluate activity access of different harvest treatments for corn silage. The study involved three harvest methods: chopped (C) silage, processed (P) silage, and shredded (S) silage. Each treatment was divided into post-storage lab treatments which included three pan sizes (19, 8.1, and 1.8 mm) and one sieve of 2.64 mm to assess activity access among different particle size fractions of corn silage.

Conductivity Index Results:

Effect of harvest method and subsequent Hobart processing on conductivity index of different particle size fractions of corn silage (μS/cm²).

Leaking within the 3 rows...

1. Smaller particles have higher conductivity index compared to larger particles.
2. The variation for different particle fractions is less for chopped shredded silage.

Comparing columns (within the 3 rows)...

1. Small particles exhibited comparable conductivity index for chopped, processed, and shredded silage.
2. Conductivity indices of long particle size fractions are higher for processed or shredded silage.

Related uses of Electrolyte Leakage:

- Processed carrot cell damage (Joy and Lada, 2006)
- Grain mold invasion (Marks and Stroshine, 1998)
- Forage cell rupture (Kraus et al., 1999)

Procedure for Measuring Electrolyte Leakage:

1. A 5 dm³ GM 200 ml of distilled water (at 25°C)
2. Systems are seeded to 100 per 30 minutes
3. Filter at least 150 min of solution (grades 157.5, 12.5, and 2.64 μm pore size membranes
4. Measure ion conductivity in microSiemens (μS/cm²)
5. Normalize for sample size and initial (water only) reading

Harvest Treatments:

- Whole plant corn silage was harvested at 55 to 65% moisture (m.o.) with three different methods:
  - Chopped (C) silage — harvested with a precision cut forage harvester with the theoretical length of cut (TLC) set to 0.05 mm.
  - Chopped and processed (P) silage — harvested with the same harvester with a TLC of 19 mm with the warped corn processing rolls were chopped.
  - Shredded (S) silage was harvested with a prototype shredding harvester (Zhang et al., 2003).

Post-Storage Lab Treatments:

Large particle fractions were processed (post-storage) in a Hobart using industrial food processors with a SPEED-UP of 250 rpm for 1 minute in-situ to simulate further particle size reduction which might occur in a bio-refinery.

Particle Size Distribution resulting from 3 Harvest Methods:

- For chopped and processed silage, the particle size distribution shows a wider range of particle sizes compared to chopped and shredded silage.

Some analysis among columns...

1. Shredding alone yielded comparable conductivity indices relative to chopped and processed silage.
2. Hobart processing further increased conductivity index of long particle size fractions from processed or shredded silage to shredding alone.
3. Longer particle size does not “capture” surface area.

Industrial Implications:

Longitudinal sheave takes less energy than cross-fiber chopping; it may be the harvest and particle size reduction method of choice with regard to energy and power as well as subsequent bioprocessing. A dry mass weighted average conductivity index was computed based on percentage of mass in each particle size fraction, moisture content of each particle size fraction, and conductivity index of each particle size fraction. Without considering Hobart processing, which would be very expensive on an industrial scale, these weighted average estimates were 72%, 76%, and 77% for P, C, and S, respectively. Despite the much higher mass percentage of long material in shredded silage the weighted average activity access indices in terms of conductivity index was higher because of the much higher conductivity of the longer particles.