BSC Animal Nutrition Inc.
Professional Nutrition & Management Services

DAIRY-UPDATE

VOLUME 8
Issue 2
September 2015

A REVIEW ON STARCH UTILIZATION OF CORN FOR DAIRY COWS

By Sylvia Borucki, PhD

FACTS

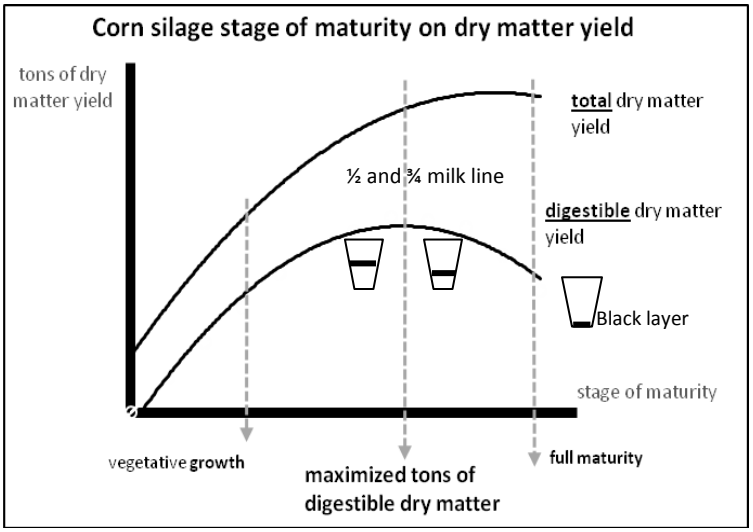
- A major source of energy for the cow is coming from starch, 70% of the diet is carbohydrates and 20 to 30% of these are coming from starch.
- Starch is digested mainly in the rumen (50 to 80%) and affects not only the amount of energy that the cow gets but it also feeds the microbes in the rumen, which are a source of protein for the cow (microbial protein).
- The total tract digestion of starch is on average higher than 90%; the more starch that we can get digested in the rumen the more we get closer to 100% digestion of it.
- High digestibility of starch in the rumen is desirable unless we get a very rapid digestion peak that alters the rumen pH (and balance) and affects rumen microorganisms, decreases fiber digestion and produces rumen acidosis.
- Significant response in milk production to increased total tract starch digestion (68 to 98%) was found by a meta-analysis performed by Ferraretto et al. (2013).

STARCH DIGESTION FROM CORN SILAGE

Based on analysis for SW Ontario, the averages are 29.5 % starch (± 7.05) and 42% NDF (± 4.9) (SGS Labs Oct-Dec 2014) for the whole plant corn silage.

Corn silage and grain starch digestibility will depend on:

- **Kernel maturity** (harvest time): At ½ milk line and ¾ milk line in the kernel we maximize the total digestible yield of dry matter and starch.



- **Kernel particle size**:
  - Processing: benefits of processing the kernel begin to be more significant after 32 % dry matter of the whole plant.
  - If the (theoretical) cut length is lower than 1 cm, the benefits of the processing are less significant compared to cut lengths between 1cm and 2.5 cm;
  - Testing: on the field we can do the bucket test or send a fresh green chop sample to the Lab to evaluate the kernel processing score (KPS)

  https://www.asi.k-state.edu/species/beef/research-and-extension/kernelprocessor.pdf
- Duration of the **silage fermentation** process: After one month of being ensiled, the whole plant starch digestibility increases approx. 10%; the starch digestibility then increases to 15% and 20% more after 4 and 8 months of being ensiled respectively.

- **Type of grain** (flint, dent, floury): The corn kernel is designed to protect the seed until conditions are suitable for germination. Therefore, a fibrous pericarp protects both the embryo and its developmental energy source — **the starch-rich endosperm**. Starch granules are surrounded by hydrophobic proteins (**prolamins** and others) that repel water, and prevent premature starch hydration before germination is suitable. For feeding purposes, this protein matrix interferes with starch digestion.

  - The endosperm of **floury** corn is soft textured, and when mature and dry, weakness of the discontinuous protein matrix allows starch granules to be more digestible. The endosperm of **flint** corn consists of hard-textured, densely packed, crystalline starch that is translucent or vitreous, and therefore less digestible. Concentrations of **prolamins** increase with kernel maturation and they peak at the time of black layer formation (about 30% kernel moisture).

  - Yellow **dent** corn, common in North America, is the result of historic crossbreeding between flint and floury types. Shorter-season hybrids tend to have more flint in their pedigree that increases cold tolerance and early vigor of the seedling. **Common hybrids** have moderately high prolamins. More floury genetics often have a lower absolute density and lower test weight.

  - **Zein** (corn prolamins) differs from other kernel proteins in that it is soluble only in aqueous alcohol or fermentation acids (lactic, acetic) but not in water (or rumen fluid). Microbial activity during fermentation and the chemical action of various fermentation end products (acids, yeast-generated alcohol) as well as gelatinization (starch damage associated with heat processing) serve to alter kernel storage proteins, removing most of the negative effects of zeins on starch digestibility in the rumen.

STARCH DIGESTION FROM CORN GRAIN

- **Harvest/processing**: High-moisture corn ruminal digestibility is higher (64.5%) than dry corn (53.5%), and also higher compared to steam flaked corn (58.5%) Ferraretto et al. (2013). But differences between them are reduced if we compare total tract digestibility: 94.2, 92.0 and 93.9% respectively.

- **Type of corn grain endosperm** *(discussed before)*

- In **dry corn grain** the major aspect that we can control is the ***particle size***. It was found that between 500 to 1,500 microns (µm) the total tract digestibility is >94% compared to 88-90% total tract digestion with particle sizes between 1500 and 3500, or lower than 80% with particle sizes >3500. The grinding effect increasing the rumen and total tract digestibility is more effective when the endosperm is "flint" type.

- For high-moisture corn (HMC), the moisture (%) and pH obtained during harvest and storage very much influence the starch digestibility; moistures higher than 30% and pH lower than 4 have a greater impact, increasing digestion. The extent of HMC fermentation is therefore, very important.

FECAL SAMPLES

Can be used as a way to evaluate total tract starch digestibility. Samples must be refrigerated all the way to the lab, because if not there can be a 20% difference with the real value.

DAIRY UPDATE is published in the interest of helping dairy producers become more profitable. We welcome your comments.

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BSC Animal Nutrition Inc.
R.R. # 4, St. Marys, Ont. N4X 1C7
Toll Free: 1-800-268-7769
Telephone: 519-349-2190
Fax: 519-349-2191
E-mail: info@bscanimalnutrition.com

BSC Representatives

Peter Vingerhoeds **519-229-8810**
Ben Dekker **519-899-4769**
Sylvia Borucki **519-275-4199**
Candace Schiestel **519-697-6374**