How many yellow jelly beans are in the jar?

(Apparent starch digestibility vs fecal starch analysis)

Many dairy producers and nutritionists use fecal starch analysis from a pen of cows as a proxy for apparent (estimated) digestibility of starch from a mixed ration. This generally works well because the relationship between estimated starch digestibility and fecal starch is strong in cows where starch digestibility rates are high. However, in animals or pens that have poorer digestibility, this relationship is not as strong. It is in this circumstance where the diagnostic value of fecal starch is most needed. There is a better approach. We can use an analogy, representing the starch in a ration that helps us under the nutrition composition of the feed.

We've all seen games where you guess the number of small objects such as jelly beans in a jar. The person guessing closest usually walks away with some sort of prize. Aside from pouring out the jar and physically counting them, you can take a simple but more analytical approach by measuring the size or volume of a representative jelly bean then estimating the approximate volume of the jar. Now, instead of a pure "guess", once can estimate analytically the number of jelly beans as a brief mathematical exercise.

Let's consider a variation on that guessing activity. A jar has a mixture of colored jelly beans and you are asked how many yellow beans are present. Again, we could pour out the whole jar and count the number of yellow jelly beans. How would you approach the problem of being "analytical" in your guess? A possibility would be to take the percentage of yellow beans that you see on the surface and multiply this by the number of beans you estimated from your earlier mathematical approach. Fecal starch is a bit like taking a sample "from the surface", but it only gives us so much information.

Let's look at a further example. What if you don't know the volume of the jar and just pull a handful of beans that you count and then venture an estimate? What if you were asked how many yellow jelly beans are in the jar, again without knowing the volume of the jar? Or how about if you were asked how many yellow beans were eaten from the jar observing that at least a few handfuls of jelly beans had been consumed? In contemplation, we recognize we are critically short on the information needed to provide an analytical estimate. This is similar to the problem of relating fecal starch back to an estimate of digestibility. You are missing what was the original content of starch (yellow beans), as well as the understanding of how much was pulled from the jar and eaten.

So how would you estimate how many yellow jelly beans have been eaten from the jar? You could pull a few handfuls and count the number of yellow jelly beans and estimate back to what might have been a starting position before some of the beans were eaten… but this is a "rough" approach. You don't know the starting volume or the original percentage of yellows that were in the jar. We can draw an analogy to the use of fecal starch analysis as a diagnostic estimating how much starch was digested by considering what remains. Fecal starch analysis alone provides some

estimate, but without knowing the level of starch in the ration and the degree to which the digestion process changed the overall ratio, we are left with a "guess" of how much starch was digested. As in our yellow jelly bean example.

How do we get around the problem of lack of information needed to estimate what percentage of starch was digested? Let's consider that the black jelly beans are indigestible and use that information to our advantage. I don't like the black or licorice jelly beans so they might as well be indigestible! If you knew that the black jelly beans were never going to be eaten, you would have a piece of valuable information to deduce how many yellows may have been eaten.

Using indigestible NDF (iNDF) as an internal marker allows us to relate the starting starch level to the residual fecal starch level without needing to know the original volume. What we do is relate the amount of iNDF to starch in our original ration to the amount of iNDF to starch in our fecal material. Knowing how this ratio changes from the start to the finish of the process of digestion in a cow allows us to calculate digestibility. This basic approach is used in animal research all the time to calculate apparent nutrient digestibility.

Back to our jelly bean example, we could start with a sample of beans from the jar before any were eaten, counting 10 black beans and 10 yellow beans. Now we take a sample after folks have pawed through and taken their favorite colored beans. We count 20 black beans and 2 yellow beans. We can now calculate that with the doubling of black beans (that are undigestible…) we need to double the original yellow bean count to 20 as well. What the black beans tell us is the degree to which the bean count was reduced by people eating from the jar. If nobody ate any yellow beans, we would have had 20 remaining. However, we had 2 yellow beans remaining. Mathematically, 2/10 = 10% unselected and 90% consumed. This is a better approach than estimating yellow consumption by eyeballing the small sample we've taken and counting the yellows remaining. This same approach is how we estimate how much starch appears to be digested in the cow.

How can you increase the quality of diagnostic information when estimating digestibility? While fecal starch is a good indicator, it leaves out some vital pieces of information. As stated earlier, it's more problematic in pens exhibiting poorer digestibility. If the ratio of starch to iNDF in the ration is determined as well as the ratio of starch to iNDF in the remaining fecal material, a reasonable estimate of digestibility can be calculated.

This process is accomplished at CVAS by running an Apparent Nutrient Digestibility. A sample of TMR is taken from what is fed to a group of cows as well as a composite of manure from 10 cows in that group. NIR is used to determine protein, NDF, iNDF and starch for the TMR and fecal samples. The sample report provides estimates of digestibility of protein, NDF, and starch as well an estimate of rumen and post rumen starch digestibility based on equations from Ferraretto et al. JDS vol 96 No. 1, 2013 page 542 (see below).

This gives you one more tool in the toolbox to evaluate herd nutritional performance. This report of digestibility is offered at CVAS by NIR with next day turnaround. In times when every jelly bean (nutrient) is important, this tool gives an inside look at how the ration may be impacting cow performance.

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Apparent Nutrient Digestibilities through TMR and Fecal Evaluation

Farm Name: **WEAVER FALLS DAIRY** **Date Reported:** **06/13/2016**

Paired Samples used in determination

TMR INFORMATION	
Lab ID:	14736 114
Description:	1 - TMR - BAG
Date Sampled:	06/10/2016
Date Received:	06/13/2016

FECAL INFORMATION	
Lab ID:	14736 115
Description:	2 - MANURE - BOWL
Date Sampled:	06/10/2016
Date Received:	06/13/2016

TMR ANALYSIS	% DM Basis
Dry Matter	46.6
Starch	26.2
NDF	29.5
Crude Protein	16.1
Lignin	2.99
uNDF	10.1

FECAL ANALYSIS	% DM Basis
Dry Matter	15.30
Starch	5.70
NDF	49.10
Crude Protein	16.2
Lignin	6.75
uNDF	27.00

APPARENT NDF DIGESTIBLITY	% NDF
Apparent pdNDF Digestibility as % of pdNDF	57.4
Apparent NDF Digestibility as % of Total NDF	37.7
Expected Range (% of pdNDF)	48.5 - 77.1
Expected Range Average	62.8

APPARENT STARCH DIGESTIBLITY	% Starch
Apparent Starch Digestiblity	91.9
Ideal Range	94 - 98
Expected Range	88.5 - 99.6
Expected Range Average	94.5
Estimated Rumen Digestibility	52
Estimated Post Rumen Digestibility	39.6

APPARENT PROTEIN DIGESTIBLITY	% Protein
Apparent Protein Digestiblity	62.4
Expected Range (% of Total Protein)	51.5 - 74.1
Expected Range Average	62.8

Starch digestibility will vary based on many factors including amount of starch in the diet, starch particle size, dry matter of corn and corn silage, length of time starch products have fermented in storage, diet composition, milk production level, and general rumen health. Estimated rumen and post rumen digestibility values are based on a summarization of studies reported by Ferraretto et al., JDS Vol. 96, No.1, 2013 page 542.