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Dairy Update

USE OF ALCOHOL FERMENTATION BY-PRODUCTS IN FEEDING DAIRY CATTLE

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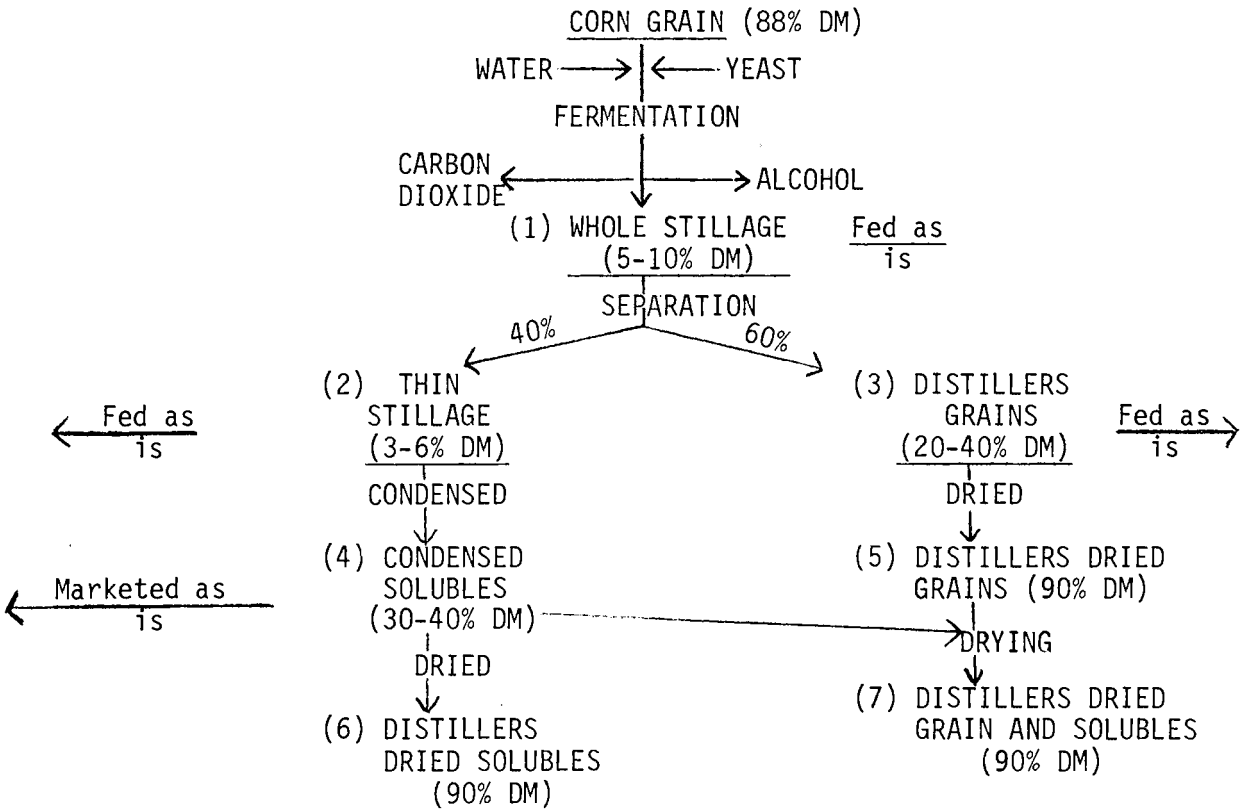
The fermentation of carbohydrate sources into ethyl alcohol is being proposed by many as a solution or partial solution to our energy problems. A major item in the feasibility and economic viability of alcohol production is the utilization of by-products as a livestock feed. The dried by-products have been used for many years and are well accepted as a livestock feed. However, the types of by-products produced from on-farm or small scale alcohol plants present a different problem for feeding than do dried products. Also, the nutritional value of these by-products are less well known, particularly for carbohydrate sources other than corn. Thus, the feeding value along with monetary value of by-products must be considered in the formulation of livestock rations.

TYPES OF BY-PRODUCT RESIDUES

Approximately one-third of the original material dry matter (DM) used for fermentation is recovered as by-product (i.e., 1 bushel of corn, 56 lb, yields 17.5 lb of by-product DM). Depending upon the processing method, this by-product can be broken into 7 different categories. The diagram below indicates the relationship among the 7 different by-product categories.



1. Whole stillage is the material remaining immediately after removal of alcohol. The dry matter content will be around 5 to 10% and the nutritional value will vary with type of material fermented and completeness of fermentation. This material may be fed directly and seems particularly suitable for feeding livestock at the still site. However, there may be some problems with feeding this low in dry matter material, discussed later. Transportation of this very liquid material certainly does not appear to be very economically feasible. Also, this material will have a pH of 4 to 4.5 from the acid addition before fermentation and the acids produced from fermentation. This will be no problem for feeding but could be corrosive to feeding equipment.

2. Thin stillage results from the mechanical separation (screening, pressing or centrifuging) of whole stillage into distillers grains and thin stillage. Thin stillage contains small grain particles, yeast cells and other soluble nutrients and represents approximately 40% of the nutrients recovered from whole stillage. Feeding and transportation problems will be similar to whole stillage. Thin stillage may be recycled back into the fermentation process as a source of water or liquid. However, thin stillage also is acid and recycling will concentrate these acids.

3. Distillers grains will account for about 60% of nutrients from whole stillage and contain approximately 20 to 30% dry matter. Dry matters may approach 40% under particular mechanical separations. This is the predominant material being fed or considered for feeding. It will contain the unfermented grain and be higher in all nutrients than the original grain except for carbohydrates which are converted to alcohol. Feeding and transporting this product because of its higher dry matter content will be of lesser concern than lower dry matter products but does require some considerations in ration formulation.

The following 4 products are commercially available and have been defined by the American Feed Control Officials. The grain used in the largest quantity for fermentation must be the first word in the naming of these products (i.e., Corn Distillers Dried Grains). These products are predominantly used in the feed industry as a protein supplement.

4. Condensed solubles are formed from drying or condensing thin silage to 30 to 40% dry matter. The primary commercial use for this product is in liquid supplements as a source of nitrogen (crude protein) and phosphorus.

5. Distillers dried grains are made from drying distillers grains (20 to 30% DM) to 90% dry matter.

6. Condensed distillers solubles are dried down to 90% dry matter to form distillers dried solubles.

7. Distillers dried grains and solubles are made from adding condensed distillers soluble to dried distillers grains and redrying to 90% dry matter. This product must contain at least 75% of the solids or nutrients from the original whole stillage.

NUTRITIVE VALUE OF BY-PRODUCTS

The nutrient content of various by-products from the distillers and brewers industry is listed in table 1. Very little nutrient information is available for feedstocks or grain, other than corn. The nutrient value of the by-product after fermentation will

vary with feedstock used, completeness of fermentation, process used to prepare feedstock, and process used for separation of solubles and grains. The variation in nutrient content is shown (table 2) by samples analyzed at the University. The completeness of fermentation will not only affect nutrient content of the by-product but also, the economic viability of alcohol production.

Table 1. Nutrient Content of Various Fermentation By-products.

	Nutrient composition (100% dry basis)						
By-product	Crude protein (%)	Net energy lactation (mcal/lb)	TDN (%)	Fat (%)	Crude Fiber (%)	Calcium (%)	Phosphorus (%)
Corn							
Grain	10.0	.92	88	3.5	2	.03	.31
Whole stillage	30.0	.92	88	8.8	7.5	.12	.88
Distillers grains	29.5	.88	84	8.0	12.8	.10	.95
Dried solubles	28.9	.92	88	10.0	4.2	.30	1.60
Distillers grains with solubles	29.8	.92	88		10.0	.16	.79
Potato							
Whole stillage	22.0			1.0	5.0		
Brewers grains (Barley, rice, corn and hops)	26.0	.68	66	6.2	16.0	.29	.54

Table 2. Nutrient Content of Alcohol By-products Analyzed at the University of Minnesota.

By-product	Dry matter (%)	Crude protein (% of DM)
Corn distillers grain - 6 samples		
Average	26.8	20.8
Range	17.5 - 32.6	15.6 - 31.6
Corn thin stillage	2.4	26.0
Barley distillers grain		
with 19.8% flax straw	50.1	19.6
with 13.2% flax straw	45.4	25.3

Distillers or brewers by-products should have less rumen degraded protein or more protein passing into the small intestine than soybean meal. This is especially true for dried by-products. The exact value of more protein passing intact to the small intestine is unknown for lactating dairy cows. Limited beef research indicates corn distillers dried grain with urea as a protein supplement result in gains and feed efficiencies equal to soybean meal.

The dry matter or moisture (100-dry matter) content of by-products will vary considerably from different operations. A dry matter guide is shown in table 3 but a dry matter or moisture analysis on the by-product is imperative. A dry matter value will be necessary for determining the economic value of the wet by-products. The conversion of nutrients from one basis (wet or dry matter) to another are illustrated below.

Wet to dry matter.

Corn distillers grains (wet basis)
moisture - 75%
crude protein - 7%

Conversion to dry matter basis
100-moisture content = Dry matter
100-75 = 25%

Protein content - dry matter basis

$$\frac{\text{7\% crude protein (wet basis)}}{\text{25\% dry matter}} \times 100 = \text{28\% crude protein (dry matter basis)}$$

Dry matter to wet basis.
Corn thin stillage (dry matter basis)
moisture - 96%
crude protein - 29%

Conversion to wet or as fed basis
100-96 = 4% dry matter

$$\frac{\text{29\% crude protein} \times \text{4\% dry matter}}{100} = \text{1.16\% crude protein (wet basis)}$$

Table 3. Average Range in Dry Matter of Distillers and Brewers By-Products.

By-product	Dry Matter Range (%)
Alcohol	
Whole Stillage	5 - 10
Distillers grains	20 - 35
Thin stillage (solubles)	1 - 6
Condensed solubles	30 - 40
Dried distillers grains	90 - 94
Dried distillers solubles	94 - 96
Dried distillers grains with solubles	89 - 93
Brewers industry	
Brewers grains	20 - 30
Dried brewers grains	90 - 94

PRICING OF ALCOHOL BY-PRODUCTS

The dollar value of corn distillers products should be based on corn and soybean meal prices since these two ingredients are the most likely ones to be replaced in the ration. The price of distillers products can be estimated as follows:

1. multiply the price of corn per hundred weight by .57
2. multiply the price of soybean meal per hundred weight by .54
3. add the two products
4. the answer is price of distillers by-products on a 100% dry matter basis.

Example:

Corn - $5.50 per cwt
Soybean meal - $13.00 per cwt
5.50 x .57 + 13.00 x .54 = $10.16 per cwt of dry matter

5. To compute price as fed or wet basis, multiply price per cwt of dry matter by decimal equivalent of dry matter.

Example:

Corn distillers grain with solubles - 94% dry matter.
$10.16 x .94 = 9.55 per cwt
whole stillage - 8% dry matter.
$10.16 x .08 = $ .81 per cwt or $ .0081 per lb.

These prices do not consider the cost of transportation. For dried products, the transportation costs should be similar to corn and soybean meal. The cost of transporting whole or thin stillage should be deducted from their nutrient value.

FEEDING BY-PRODUCTS TO DAIRY CATTLE

Dried distillers grains are good sources of protein, palatable and have been successfully utilized in dairy rations. An Illinois trial comparing dried by-products and conventional protein sources shows no difference in milk production (table 4). Therefore, conclusions from this study indicate dried by-products should be purchased on their nutrient content only and no price advantage should be given to their lower rumen degradable protein content. However, some other trials have shown a slight production advantage for distillers grains. Conclusions were the slightly higher production was due to more protein escaping rumen digestion. Describing conditions under which protein from distillers by-products will give a production advantage are very uncertain and affected by many conditions such such as types of feedstuffs fed, method of feeding and frequency of feeding. Therefore, distillers by-products should be priced on their nutritive value.

Table 4. Comparison Between Conventional Protein Supplements, Dried Brewers Grains and Dried Distillers Grains With Solubles for Lactating Dairy Cows (Illinois).

	Protein Supplement		
	Soybean Meal and Wheat Bran	Dried Brewers Grains	Dried Distillers Grains and Solubles
No. of cows	21	21	21
Ave. daily milk (lbs)	54.1	54.3	53.2
Ave. production 305 day	17,501	17,561	17,225
Highest ave. yield (lb/da)	85.8	84.7	79.2

Limited information is available on feeding of whole stillage or wet distillers grains to dairy cattle. The high moisture (low dry matter) content of these products makes it difficult for animals to consume enough material to get significant amounts of nutrients from them. Incorporating a higher amount of these wet products into rations can reduce dry matter intake and decrease animal performance. The following guidelines should be considered when incorporating wet distillers products into rations. The amounts or levels given are for individual products only, and if 2 or more of the wet products are used, amounts should be substantially below individual recommendations.

Lactating Cows

1. Limit whole stillage to 100-150 lb per cow per day. Cows in early and peak lactation to 50-100 lb per day.

2. Wet grains should be fed at the level of 5-8 lb of dry matter per cow per day or no more than 20% of the total ration dry matter.

Dry Cows

1. Limit to about 50 lb per cow daily of whole stillage.

2. Wet grain recommendations are similar to lactating cows, but avoid excessive protein and energy content in the ration.

Heifers

1. Similar to dry cows for whole stillage and about one-half the recommended wet grain levels.

2. Avoid overconditioning of heifers.

3. Heifers less than 4 months old should probably not be fed wet distillers products.

Know moisture or dry matter content of materials used, (a more detailed analysis is desirable) so intake can be obtained. Properly balance the total ration, especially for protein, energy, and minerals.

SUMMARY

The fermentation by-products from alcohol production will be acceptable feedstuffs for dairy cattle. Their nutrient content will vary with feedstock used, process of feedstock, completeness of fermentation, and processing of fermentation residue. This nutrient content of the by-product being considered, should be known. Prices should be determined on nutrient basis and adjusted for dry matter content. Dried by-products can be incorporated into dairy rations up to 25-30% of the total dry matter whereas, wet by-products should not exceed 20% of the total ration dry matter.