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Utilizing the Growing Supply of Distillers Grains

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INTRODUCTION

Across the Midwest, ethanol plants (primarily dry mill vs. wet mill process) are being planned and built, and existing plants are being expanded. Today more than 98 percent of commercially-produced ethanol is used to extend gasoline. The attributes of ethanol allow it to be used as an octane booster and as the preferred oxygenate for gasoline. Ethanol maintains widespread support for its ability to improve the environment and public health by reducing harmful vehicle emissions. Ethanol contains 35 percent oxygen, and adding ethanol to fossil fuels (gasoline and diesel) results in more complete fuel combustion, which reduces tailpipe emissions. Ethanol is non-toxic and is rapidly biodegraded in surface water, ground water and soil. Energy legislation signed into law by President Bush on August 8, 2005 includes a nationwide renewable fuels standard (RFS) that will double the use of ethanol and biodiesel by 2012. Provisions of the RFS established a starting volume of 4 billion gallons of renewable fuels in 2006, which increases to 7.5 billion gallons by 2012.

Two methods used to produce ethanol from corn are wet milling and dry milling, and each process generates unique co-products. Primary products of wet milling corn include corn starch, corn syrup, sweeteners and corn oil, in addition to feed co-products—corn steep liquor, corn germ meal, corn gluten feed and corn gluten meal. Dry mills are significantly less expensive to build and typically produce only three products—ethanol, distillers grains and carbon dioxide (CO2). A well-managed plant utilizing modern dry mill technology generates about 2.85 gallons of ethanol, 18 pounds of distillers dried grains with solubles (DDGS) and 18 pounds of CO2 from each bushel of corn processed. A typical area plant processes 20 million bushels of corn annually. From 1980 to 2000, the tonnage of distillers grains increased ten fold from 320,000 to 3.5 million metric tons (1 metric ton = 1000 kilograms = 2204.6 pounds). From 2000–2004, distillers grains production again doubled to more than 7.3 million metric tons. Distillers grains remain the fastest growing commodity feed for livestock.

An illustration may help to put the present volume of distillers grains into perspective. The national dairy herd of approximately 9 million cows would need to consume 7.2 pounds of distillers grains per day over a 305-day lactation period to balance the supply. Distillers grains are also used in the rations of dairy replacements, in the diets of other classes of livestock such as beef, swine and poultry, and are an important export commodity. While our national livestock base is sufficient to make use of all available distillers grains, other feed ingredients now included in diets must be displaced. Currently there are 101 ethanol plants in operation and 33 new plants under construction. Ethanol production is expected to top 4.5 billion gallons this year. Most ethanol plants built in the last ten years employ dry mill technology and dry mills generate about 75 percent of the total ethanol volume. With increasing supplies and relatively stable exports (about 1 million metric tons), it is evident that U.S. dairy and

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livestock producers are supplementing animal diets with distillers grains.

Various cereal grains (corn, sorghum, wheat, rye, etc.) are used to produce grain alcohol or ethanol. In the Midwest, where most plants generate fuel and not beverage ethanol, the predominant grain used is corn. During processing, cleaned whole kernel grain is ground to increase the surface area. Water is then added to make a mash, which is cooked under pressure. Cooking serves to gelatinize the starch and greatly reduces the undesirable microbial populations within the mixture. Next, the mash is cooled and enzymes are added to liquefy the mass and to convert the starch into sugar. Yeast is then added to ferment the sugar, turning it into alcohol and CO2.

After removal of ethanol through the distillation processes, the mash is run through centrifuges where grain particles are separated from dissolved solids. The dissolved solids are then concentrated into syrup through multiple evaporators. The syrup may be marketed as condensed distillers solubles (CDS) or dried to become dried distillers solubles (DDS). However, very little CDS or DDS is presently produced. At most plants, the solubles are added to the spent grain or cake to become distillers wet grain with solubles (DWGS) or DDGS.

DWGS are usually offered for sale within a 150-mile radius of the plant because of the transportation costs associated with the movement of liquid. For a plant, not having to dry the distillers grain represents a significant energy cost savings. Assuming these savings are passed on to the customer, the ethanol plant achieves more efficient energy production from each bushel of corn and dairy producers have the potential to realize greater income over feed costs.

NUTRIENT COMPOSITION OF DISTILLERS GRAINS WITH SOLUBLES

Important factors to consider when evaluating any feedstuff for inclusion in dairy rations are nutrient composition and variability. The nutrient composition of distillers grains, as with many byproduct feeds, can be influenced by several things, including type of grain used, grain quality, grinding procedures, extent of fermentation, drying conditions, quantity of solubles blended back with the cake and particle separation. Depending on the plant and whether DWGS or DDGS is being produced, the relative proportions of cake to solubles of the final product varies. The composition of DWGS can range from 65 percent cake and 35 percent solubles to 45 percent cake and 55 percent solubles on a dry matter basis.

An approximate three-fold increase in the concentration of protein, fat and fiber is found in distillers grains as compared to corn. Unlike corn, however, which is high in starch, distillers grains is practically devoid of starch. The ethanol production process enhances the digestibility of the fiber. Highly digestible fiber and moderate fat content classify corn distillers grains as a high-energy feed. The fermentation residues contain yeast cells, B-complex vitamins and other nutrients formed during the fermentation-distillation process. The protein quality of corn distillers grains is similar to other corn products, which are inherently low in lysine. DDGS and DWGS are excellent sources of ruminally undegraded protein (RUP). Heat-damaged protein may occur during the drying of distillers grains or solubles reducing the efficiency of protein utilization by animals. The potential for heat damaged protein is usually of greater concern with DDGS than DWGS. Compared to corn grain, phosphorus is three times higher in distillers grains. This higher phosphorus level must be considered when formulating dairy diets to minimize phosphorus excretion into the environment.

NUTRITIONAL ASPECTS—DAIRY DIETS

DDS, CDS, distillers dried grains (DDG), DDGS and DWGS have been successfully utilized in dairy rations for more than a century. A great deal of research comparing these products to other protein and energy feeds has been conducted during the past 50 years in which the value of distillers byproducts was proven [6, 7, 8]. DDGS has become a common component of commercial dairy protein supplements, often comprising 25-35 percent of the blend on a dry matter basis (DM basis) depending upon the price of other competing ingredients. In a comparison commonly used by dairy nutritionists, 1 kg of DDGS is roughly equivalent to 0.6 kg of shelled corn and 0.4 kg of soybean meal.

Nebraska researchers directly compared wet and dried distillers grains from corn or sorghum [1]. Diets of lactating dairy cows in this study included 25 percent corn silage, 25 percent alfalfa haylage and 15 percent distillers grains with solubles (DM basis). Treatments were corn DDGS, corn DWGS, sorghum DDGS and sorghum DWGS. Milk production was similar (71 vs. 72 pounds) comparing wet to dried with a slight advantage of corn over sorghum. Milk protein and milk fat values were also similar across treatments, with a slight advantage of DDGS compared to DWGS. Dry matter intake was also similar, suggesting that the higher moisture content of the DWGS diets did not limit intake. Water per se does not limit dry matter intake, and because low pH and elevated organic acids are not characteristics of DWGS, it does not seem likely that feeding wet distillers grains will adversely affect intake. However, intake may be depressed if the inventory of DWGS is not turned over fast enough to prevent spoilage.

FEEDING GUIDELINES

As rations are formulated, each ingredient is examined for its nutritional contribution and interactions with other feeds, such as physical form, rumen dynamics and effect on amino acid profile. DWGS and DDGS are very palatable feeds and frequently comprise 5–15 percent of the dietary dry matter of lactating dairy cows. Studies report successful dietary inclusion rates of more than 30 percent distillers grains (DM basis) in dairy diets. The basic limit to the quantity of distillers grains in dairy diets is related to protein content, protein quality and total dietary fat. Distillers grains are an excellent source of RUP and, depending upon protein characteristics of other ration ingredients, feeding high levels of distillers grains may increase RUP above dietary recommendations, which may depress rumen ammonia levels. When this occurs, rumen microorganisms are starved for nitrogen, which reduces microbial protein production and depresses fiber digestion and dry matter intake. Maximizing the quantity and quality of protein available to the intestine is vital to achieving high levels of milk production. A costly error of any dairy diet is to limit microbial protein synthesis.

A 1996 research study recommended limiting the amount of crude protein coming from corn sources in dairy rations to 60 percent of the total crude protein. Corn silage, corn grain, corn distillers grains, corn gluten meal and corn gluten feed were identified as the corn sources of total crude protein [9]. As corn protein is deficient in lysine, this appeared to be a good recommendation. Since then, however, the 2001 Nutrient Requirements of Dairy Cattle has become a valuable tool for evaluating dairy diets [10]. When diet ingredients and cow data are entered, the ration evaluation program predicts the nutrient requirements of the animal, nutrients supplied by ration ingredients, and positive or negative balances. The model predicts dietary ruminally degraded protein (RDP) and RUP and also identifies when amino acids such as lysine or methionine may limit milk production. Use of the model suggests that the crude protein limitation of 60 percent from corn sources may be increased if feeds high in lysine content, such as blood meal or ruminally protected lysine sources, are included in multiple corn source diets.

Usually the non-fiber carbohydrate (NFC) and starch content of dairy rations should not exceed 35-40 percent and 25–30 percent (DM basis), respectively. Diets exceeding these levels of NFC and starch have the potential for causing ruminal acidosis. A characteristic of distillers grains is that its net energy of lactation equals that of corn without contributing appreciably to the starch load in the rumen. However, the low NFC and the moderately high-fat content of distillers grains may present additional nutritional challenges. Rumen microorganisms need readily available sources of energy and nitrogen to grow rapidly. Other ration ingredients need to complement distillers grains to provide a balanced ration. If whole oilseeds like soybean or cottonseed are fed, the maximum potential inclusion of distillers grains will probably need to be reduced to avoid dietary fat levels greater than 6 percent. Although the feeding guidelines outlined above may seem complex, nutritionists apply these principles to distillers grains as well as to a variety of other feedstuffs every day in countless dairy diets. If suggested guidelines are followed, distillers grains can be used effectively in dairy cattle diets.

HANDLING AND STORAGE CONSIDERATIONS

DDGS is relatively easy to handle and store on farm, whereas DWGS offers some challenges. Fresh DWGS typically has a dry matter content ranging from 30-40 percent. Some ethanol plant managers, seeking to gain competitive advantage, are further drying their DWGS. Higher dry matter DWGS (40–50 percent DM) improves the handling characteristics of the product, making it more attractive to dairy operators and expanding the distance from the plant where it is economically feasible to market DWGS. As described above, cooking the mash greatly reduces microbial populations. The process creates a product that is initially low in microorganisms, including those responsible for spoilage. When exposed to air, the product typically has a shelf life of two to seven days depending on the weather. On large dairies, DWGS is often delivered via end dump or live floor trailers, stored on bunker silo floors or in-ground pits and used before spoilage occurs. The DWGS used in the Nebraska trial was stored in nine-foot diameter silo bags and researchers reported excellent keeping quality over the year-long study. A logical conclusion for this extended shelf life was the exclusion of air provided by the plastic bag. It is unlikely there is sufficient residual fermentable substrate and lactic acid-producing bacteria to facilitate fermentation processes similar to other ensiled crops. Silo bag storage may make feeding DWGS possible for more dairies in close proximity to ethanol plants.

SUMMARY

Distillers grains with solubles are excellent feed resources for dairy cattle but must be competitively priced to displace feedstuffs currently included in dairy rations. As ethanol production increases to meet demand and the renewable fuels standard, the supply of distillers grains will significantly increase. DWGS is subject to biodegradation and must be handled properly at the plant as well as on farm. Diet inclusion rates and on farm storage strategies must be developed in order to capture the maximum feeding value of distillers grains. Savvy ethanol plant managers recognize the importance of product consistency and are beginning to provide additional services to dairy customers.

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