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Corn Gluten Feed

Composition, Storage, Handling, Feeding and Value

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Grain processing plants offer coproducts that are suitable for livestock use. A new corn wet milling plant in southeastern North Dakota (ProGold) produces an excellent coproduct feedstuff for dairy and beef cattle called corn gluten feed. Offered as both a wet and dry product, unique characteristics require that users become aware of the requirements for storage and handling of this milling byproduct.

Corn Quality

The industry's raw material is shelled corn, generally purchased as U.S. No. 2. Before the corn enters the plant, it is inspected for U.S. Grade factors and freedom from aflatoxin, insect, and rodent infestation; unfit shipments are rejected.

Dent corn is used primarily as animal feed, but also serves as a raw material for industry and as a staple food. Up to 93 percent of dent corn produced (including the corn equivalent of coproduct feeds from corn processing) is used as animal feeds. However, it is still an important human food and industrial material used in many specialized products by the milling industry in the United States. Components of the corn kernel can be visualized in Figures 1a and 1b.

What is Corn Gluten Feed?

Corn gluten feed (CGF) is a coproduct of the wet milling industry. A simplified overview of the milling process begins with separation of the corn grain. After removal of any foreign material, corn kernels are soaked in water and sulfur dioxide to swell the kernels. In the soaking (or steeping) process, nutrients migrate into the water (steep liquor). When the steeping is complete, this liquor is drawn off and concentrated.

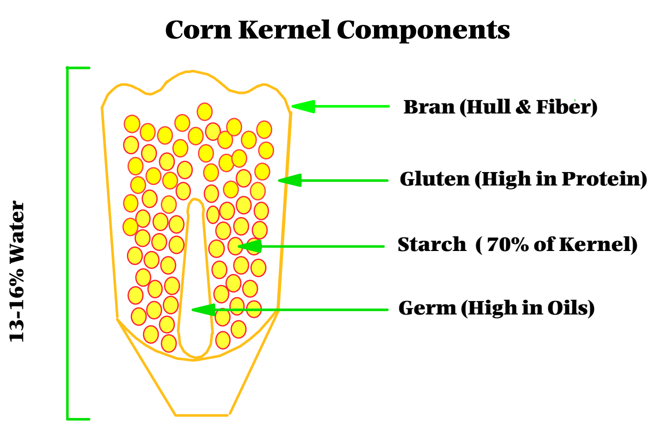

Figure 1a. Components derived from corn in the wet milling process.

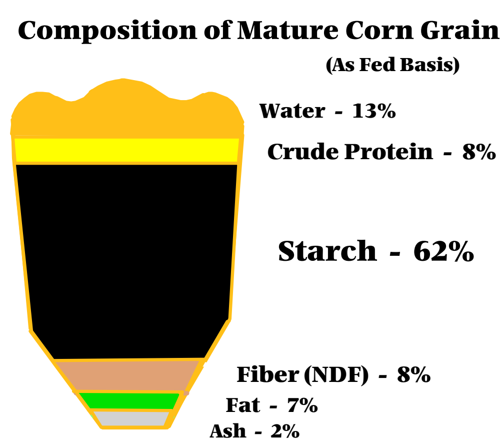

Figure 1b. Composition of corn grain.

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Corn Wet Milling

The wet milling process is outlined in Figure 2.

Accepted lots of corn grain are thoroughly cleaned by screening and aspiration. Cleanings are added to the coproduct feed. The clean corn is then steeped for 30 to 35 hours at 47 to 35^{o} C to soften it for the initial milling step. During subsequent wet-milling processes, the corn germ is separated from the kernel and processed to remove the oil. After the germ has been removed, the remaining portion of the kernel, which contains the bran (exterior portion or hull of the kernel), gluten and starch is screened and the bran removed. The bran (fiber portion) is then mixed with steep liquor and sold as wet corn gluten feed (WCGF) or with water removed, as dry corn gluten feed (DCGF). The ratio of bran to steep liquor is generally 2/3 to 1/3. When dried and further processed into a kernel or pellet, approximately 12-13 pounds of DCGF is produced per bushel of corn. The germ is marketed for its oil and the starch is further processed into fructose syrup.

Composition of Corn Gluten Feed

Corn gluten feed (whether wet or dry) is an excellent feed that is a moderately high source of protein (about 20-25%), low in starch (about 20%), high in digestible fiber and low in oil. Because of these characteristics, cattle can be fed relatively large amounts. Despite its high portion of fiber, it can still be regarded as an energy source. Corn gluten "feed" is often confused with corn gluten "meal." In contrast, the "meal" is high in bypass (ruminally undegradable) protein, while corn gluten feed has a high ruminally degradable protein fraction. The level of protein degradability appears to be slightly lower for DCGF (about 70%) than for wet (about 75%) and is an important factor when considering protein levels in the diet. Fiber in WCGF is somewhat more digestible than in the dry form, permitting greater intakes of wet versus dry corn gluten feed.

Both WCGF and DCGF can vary in color from yellow-light brown to dark brown, depending on the amount of steep liquor, drying temperature and drying time. DCGF generally darkens with increased drying temperature or time. While darker color variations do not identify inferior product, extremely dark DCGF may be heat damaged. Furthermore, care must be taken with diets containing high amounts of corn and corn byproducts which may be limiting in amino acids, particularly lysine.

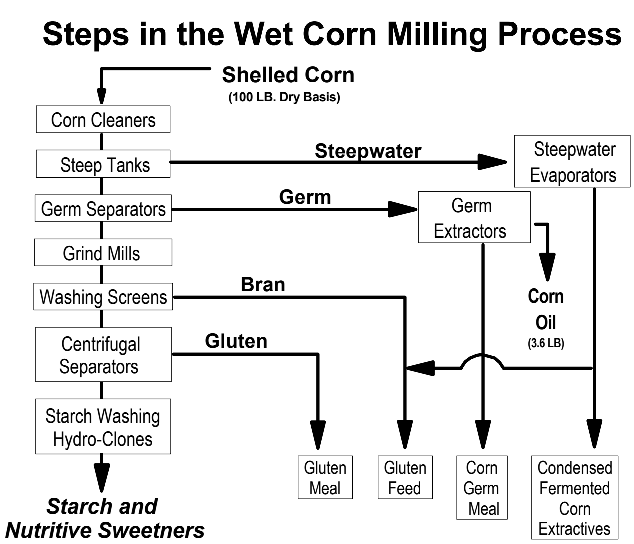

Figure 2. Overview of wet corn milling process.

Table 1 lists the commonly accepted nutrient values for both the wet and dry form of corn gluten feed.

Table 1. Nutrient composition of corn gluten feed.[1]

	Wet Corn Gluten Feed		Dry Corn Gluten Feed	
Type of Nutrient	DM Basis	As Fed	DM Basis	As Fed
	percent			
Dry Matter	43.0	—	90.0	—
Crude Protein	21.5	9.0	21.5	18.0
ADF	14.0	6.0	8.4	7.6
NDF	37.9	16.3	8.4	7.6
TDN (average)	88	—	78	—
Crude Fat	1.2	.5	1.2	.5
Ash	8.2	3.5	8.2	3.5
Calcium	.1	.04	.1	.04
Phosphorus	1.2	.52	1.2	.52
Magnesium	.28	.12	.28	.12
Potassium	1.8	.78	1.8	.78
Sulfur	.4	.17	.3	.17
Lysine	.24	.1	.6	.1
Tryptophan	.09	.04	.2	.04
Methionine	.14	.6	.5	.06
Cystine	.4	.2	.4	.2
	parts per million			
Iron	165.0	—	165.0	—
Zinc	114.4	—	114.4	—
Copper	6.0	—	6.0	—
Manganese	26.4	—	26.4	—
Net Energy — Maintenance, Mcal/lb	.99	—	.87	—
Net Energy — Gain, Mcal/lb	.65	—	.57	—
Net Energy — Lactation, Mcal/lb	.86	—	.82	—

[1]Approximate nutrient composition, values will vary.

Handling and Storage of Corn Gluten Feed

Dry Corn Gluten Feed

Both the dry and wet forms of CGF have their advantages and require special attention when receiving and storing. DCGF is available as flakes or pellets. While nutritionally identical, the density of pellets (as compared to flakes) gives the advantage of reduced transportation cost. Pellet hardness will vary substantially, depending on the binding agent used in processing. DCGF can be stored in any structure that will accommodate pellets. Flow characteristics may cause a problem with bridging during unloading and in some gravity flow operations. DCGF can also cause corrosion to metal storage when it contacts moisture because of its acidic nature from steeping in water with sulfur dioxide.

Wet Corn Gluten Feed

WCGF has distinct storage requirements but can be handled in a variety of ways. For best results, WCGF should be placed in a sealed structure to reduce spoilage. When stored in an open pile for a few days in warm weather, mold growth develops and spoilage is rapid. Texture of the wet product is similar to oatmeal, which restricts flow and makes handling difficult. Good results have been obtained by mixing the WCGF with other feedstuffs and blowing the mixture into an upright silo. Attempting to blow WCGF alone will plug the blower pipe. Adding corn, haylage, or other alternative feeds will generally keep the blower pipe clear. Mixing corn silage (one part on a wet basis) with WCGF (two parts) results in a mix that is high in energy and contains about 15% crude protein on a dry matter basis. A mixture of two parts haylage (40% dry matter) and one part WCGF yields about 68% TDN and 18% crude protein on a dry matter basis. Since these mixtures will pack tightly, check with the manufacturer to be sure that your storage unit and unloading system can handle the extra pressure.

Packing the material into silo bags is an excellent means of storing WCGF while maintaining the quality of the feed. The material undergoes little apparent fermentation because of the relatively low pH (4.3) of the feed when delivered. Researchers at NDSU evaluated WCGF stored in a silage bag for one year and noted no significant changes in product composition during the storage period.

The wet material arriving directly from the plant will have a temperature of 90-100° F. Whether stored on the ground or a silage bag, freezing temperatures during the coldest winter months are not a problem and actually extend the storage life of WCGF. Figure 3 shows the temperature change of WCGF bagged in September 1995 and stored for one year. Even simply dumping WCGF on the ground between several large round bales set at a width to accommodate live bottom delivery trucks worked very well. Unprotected WCGF stored on the ground at Fargo during the time period of December through March resulted in very little spoilage for up to three to four weeks. However, as daytime temperatures exceeded 45-50° F, spoilage and crusting of WCGF on the surface became more apparent. As air temperatures rise, protecting the pile with plastic will reduce direct sunlight, helping prolong the quality of the coproduct for up to seven to 10 days in our climate. However, elevated summertime temperatures reduce WCGF freshness to only three to four days. As freshness declines, feed refusal becomes more of a problem. If WCGF cannot be consumed quickly during warm periods when spoilage is most rapid, additional protection is necessary to offset waste.

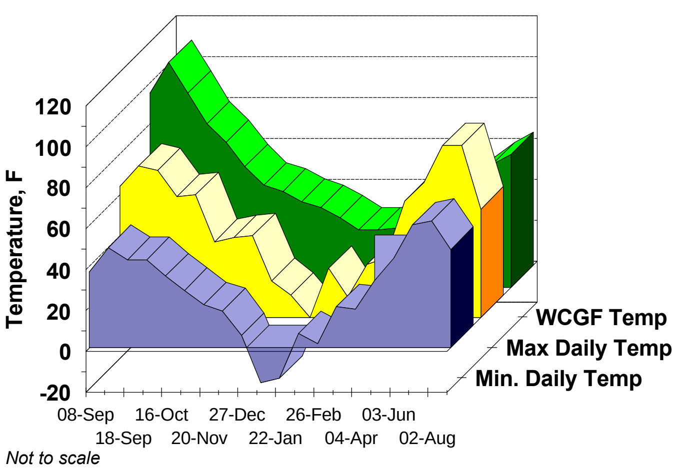

Figure 3. Longterm WCGF storage temperatures in silo bag and daily minimum and maximum air temps.

Can WCGF Be Ensiled?

To evaluate ensiling and storage characteristics of WCGF mixed with other common feedstuffs, NDSU researchers combined WCGF with chopped alfalfa, barley screenings, corn and raffinate (a sugarbeet processing byproduct) in a mini-silo experiment. Table 2 gives a breakdown of the various combinations used and subjective observations made after 60 days (June through August) of storage. Samples were collected at 0, 15, 30, and 60 days to analyze for compositional changes in storage. While incomplete, it demonstrates that WCGF will adequately ensile only with an adequate supply of other feeds.

Table 2. Combinations of WCGF with common feedstuffs to evaluate fermentation, storage, and feed value.

Ingredients	Ratio	Observation
WCGF	100:0	no noticeable change; some white mold due to repeated exposure to sampling
WCGF: Alfalfa	90:10	limited fermentation odor
	80:20	limited fermentation odor
	70:30	appears to be fermented
WCGF: Screenings	90:10	no noticeable change in odor or color
	80:20	only a hint of fermentation
	70:30	very limited fermentation, some off-odor
WCGF: Raffinate	95:5	no apparent fermentation
	90:10	no change in odor or color
	Layered	crusted, surface mold; beneath crusty seal, normal color and odor; attracted flies
WCGF: Corn	80:20	little change in odor or color; minimal fermentation
WCGF: Alfalfa:Corn	33:33:33	prominent ensiling odor, color, and texture from fermentation; looks good, no mold indicating a more appropriate temperature and pH change

There may be changes not evident from these general observations, but it is apparent that good silage-making techniques and perhaps preservatives are required for storing and mixing of WCGF and other common feeds in the bunker, silo, or bag.

Taking Delivery of WCGF

The cost of spoilage losses of any feed are significant, especially with wet and/or ensiled feeds. Coproducts such as wet corn gluten feed present challenges in handling, and mixtures that facilitate movement of the material may exceed the structural integrity of the storage unit.

One convenient method of storage is the silo bag. Using bags eliminates the costs of a permanent structure, plus the flexibility of relocating the bags where they are needed. There are annual costs associated with the rental of the bagger, purchase of the bags and disposal of the plastic after use. Furthermore, feeds like WCGF do require extra skill when filling the bags with wet feeds. However, for operations that do not consume WCGF fast enough to avoid spoilage, the silo bag is a reasonable alternative. It also permits the user the flexibility to receive multiple loads and long-term storage to take advantage of favorable prices.

Many producers will invest very little in facilities to manage this feed. As noted, simply unloading WCGF on the ground is feasible, especially in cold months. NDSU researchers found limited storage losses attributable to the freezing temperatures when stored unprotected. However, over time, seepage from the WCGF mass and the weight of delivery trucks and feeding equipment will cause drainage problems. A concrete pad 12 to 14 feet wide and long enough to accommodate delivery vehicles is a suitable improvement and can be enhanced with retaining walls as the operator sees fit. Be mindful of seepage and place the pad so effluent drains away from the traffic pattern. The runoff could be directed into the waste lagoon. Also, plan deliveries so all of the previous load of WCGF is fed before receiving new material, or otherwise arrange receiving to accommodate feeding the oldest material first to avoid extra spoilage losses.

Percent spoilage is a function of the size of the pile and the exposed surface. Simply stated, the larger the pile, the less the loss due to spoilage and weather when properly packed. Large bunker silos take advantage of this relationship. Managers of bunker silos might ask, "At what point does the added number of loads put into storage at one time offset the costs associated with bagging?"

One approach would be to calculate the exposed area that is lost due to spoilage. Geometric shape can influence the total surface area, but regardless of configuration, the greater the storage area, the lower the proportion of loss to surface spoilage. In Figure 4, using three different configurations and a constant 18 inches of surface spoilage, the relationship is clear. As the storage mass increases, the percent loss declines.

Every farm situation is different and must be analyzed on its own merits. This comparison simply dramatizes that relationship. It suggests that producers receiving three to four or more loads at one time can offset storage losses to some degree. On the other hand, users of WCGF receiving one or two loads at a time need to consider ways to reduce spoilage. The silo bag can be very cost effective in this situation.

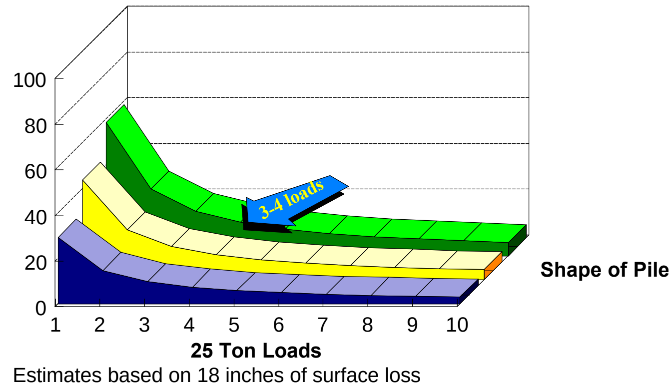

Figure 4. Relationship of simulated storage losses to the quantity of feed received and surface area.

Covering a bunker silo becomes immensely important when storing wet feeds such as WCGF, wet brewers grain. Sealing (covering) a horizontal silo is troublesome, but rewarding as well. Wet feeds are subject to elevated levels of loss due to spoilage. As a result, special attention must be given to storage and handling to avoid greatly increasing the overall cost to the user.

Planning Your Needs

Wasting of feed is a high cost concern in the feed yard. The inherent characteristics of WCGF prohibit long-term storage during warm weather periods without some means of reducing oxidation and spoilage. When planning for delivery and utilization of wet coproducts, storage, management/handling practices and quantity stored are important economical factors.

The density of WCGF is approximately 25 pounds per cubic foot. One truck load yields about 50,000 pounds (as is) or 25 tons when leaving the plant. This quantity will require about 1,800 cubic feet of storage per truck load. These factors and the time of the year need to be considered when planning for delivery.

If your herd utilizes only one truck load every few weeks, a silage bag is probably the most economical approach. Extended storage in an oxygen-limited environment and minimization of waste is justified when utilization time is greater than conventional shelf life. If there is an opportunity to receive several loads at once, it appears putting any amount over three 25-ton semi-loads into a bunker becomes cost effective based on given controlled losses due to spoilage. The wet nature of WCGF (55-57% water) means handling can be a challenge. Be prepared to deal with seepage.

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