Effect of Storage Method on Nutrient Composition and Dry Matter Loss of Wet Distillers Grains

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Summary

Storage of distillers grains plus solubles was studied using 55-gallon barrels to mimic bunker storage. Six different cover treatments were evaluated when wet distillers grains plus solubles (WDGS) and straw were stored, or modified distillers grains plus solubles (MDGS) alone was stored for 60 days in 55-gallon barrels. Covering with plastic minimized spoilage (8%), and plastic or solubles as cover decreased DM loss (3-5%). Barrels filled with WDGS alone and uncovered were evaluated over 140 days of storage. With time, DM loss increased from 5 to 22%, while spoilage increased from 6 to 12%.

Introduction

Storing wet corn byproducts for long periods of time is difficult, especially when the most common storage method is a bunker. It is common for producers to mix WDGS with low-quality forage to help bulk up the byproduct so it packs into the bunker, minimizing the amount of air penetrating the mixture. As previous research shows, the spoilage process results in loss of DM at the surface of the bunker (*2010 Nebraska Beef Cattle Report,* p. 21). Another study illustrated that during the spoilage process, WDGS decreased in fat and increased in NDF, CP, pH, and ash (*2011 Nebraska Beef Cattle Repor*t, p. 18). Several cover treatments can be utilized to minimize the amount of surface exposed to oxygen. Therefore, Experiment 1 compares six different cover treatments and distillers: forage mixes, and Experiment 2 compares length of storage on nutrient loss when WDGS are left uncovered.

Procedure

Experiment 1

To replicate bunker storage, 55-gallon barrels were packed with one of two treatments: 70% WDGS and 30% straw mixture (DM) or straight MDGS (46% DM). Barrels were filled to approximately the same weight (300 lb) and packed to similar heights. All barrels were stored in a barn, subject to ambient temperature but not precipitation, for approximately 60 days. Table 1 describes the covers assigned randomly to each of the three replicates per treatment.

After 60 days of storage, each barrel was opened by carefully removing the solubles layer (if applied), the spoiled portion, and then the nonspoiled portion. When salt was used as a cover it was collected and analyzed as part of the spoiled layer. As in previous research, it was assumed that all of the spoilage occurred from the top down as it was exposed to the air. The spoilage was determined by appearance and texture. As each layer (solubles layer if applied, spoiled layer, and nonspoiled portion) was removed, representative samples were collected and analyzed for pH, fat, neutral detergent fiber (NDF), ash and OM, and CP. Nutrient analyses for both the spoiled and nonspoiled layers, along with nutrient analysis of the original WDGS sample, were used to determine the nutrient losses illustrated in Tables 2 and 3. In the calculations, the spoiled layer is included in the recovered DM etc., assuming that it would be fed. Therefore, if the spoiled layer were discarded, the loss would be the total of DM loss plus spoilage amount. Data were analyzed using the mixed procedures of SAS (SAS Inst., Inc., Cary, N.C.) using barrel as the experimental unit.

Experiment 2

Similar to Experiment 1, 55-gallon barrels were filled with WDGS to approximately the same weight (300 lb) and packed to similar heights. All barrels were stored in a barn, subject to ambient temperature but not precipitation, for 7, 14, 28, 56, 84,

Table 1. Cover treatments (Experiment 1).

WDGS : Straw	
Open	Barrels were left uncovered.
Plastic	6 mil plastic covering the surface of the mixture weighted down with sand and the edges were sealed with tape. This treatment would be comparable to plastic and tires in a bunker setting.
Salt	Salt was sprinkled over the surface of the mixture at a rate of 1 lb/ft^2 (2.76 lb total).
DS[1]	DS were poured over the surface of the mixture to make a 3-in layer (45 lb as-is).
DS[1] + Salt	DS and salt added at rates previously discussed and mixed together before application.
DS[1] + Straw	DS and straw (60:40 blend) added over the surface to make a 3-in layer (25 lb as-is).
MDGS	
Open	Barrels left uncovered and stored.
Plastic	6 mil plastic covering the surface of the mixture weighted down with sand and the edges sealed with tape. This treatment would be comparable to plastic and tires in a bunker setting.

[1]Distillers Solubles — thin stillage taken off during the milling process.

Table 2. Effects of different cover treatments on nutrient losses and pH of WDGS plus straw (Experiment 1).

	WDGS+ Straw (Open)	WDGS + Straw (Plastic)	WDGS + Straw (Salt)	WDGS + Straw (Solubles)	WDGS + Straw (Solubles + Salt)	WDGS + Straw (Solubles + Straw)	*P*-Value
DM Loss, %	8.1[a,d]	3.5[b]	7.3[a,b,d]	5.2[a,b]	-1.6[c]	11.05[d]	<0.01
Spoil, %	19.0[a]	7.8[b]	23.4[c]	17.8[a,d]	15.0[d]	17.2[a,d]	<0.01
Non-Spoil, %	81.0[a]	92.2[b]	76.6[c]	82.2[a,d]	85.0[d]	82.8[a,d]	<0.01
OM Loss, %	9.08[a]	3.89[b]	9.47[a]	13.59[c]	7.82[a]	19.54[d]	<0.01
Fat Loss, %	17.33[a]	4.80[b]	21.75[c]	24.70[d]	4.88[b]	28.93[e]	<0.01
NDF Loss, %	4.85[a]	2.47[a]	5.20[a]	7.63[a]	6.05[a]	15.55[b]	<0.01
Non-spoiled pH after[1]	4.33[a]	4.03[b]	4.33[a]	4.03[b,d]	4.03[b]	4.31[a]	<0.01
Spoiled pH after2	6.72[a]	6.77[a]	7.11[a]	6.88[a]	6.11[b]	6.82[a]	<0.01
Nutrient recovery for covers							
OM recovered, %	—	—	—	43.15	59.51	32.41	0.44
Fat recovered, %	—	—	—	12.10[a]	96.13[b]	7.11[a]	<0.01

[a,b,c] means with different superscripts are different ($P < 0.05$).
[1]Nonspoiled layer of WDGS after storage, original pH was 4.42.
[2]Spoiled layer of WDGS after storage, original pH was 4.42.

Table 3. Nutrient losses of modified distillers grains plus solubles alone stored with no cover (Open) or with plastic covering (Plastic) in Experiment 1.

	MDGS (Open)	MDGS (Plastic)	*P*-Value
DM Loss, %	12.2	2.8	<0.01
Spoil, %	38.7	4.6	<0.01
Non-Spoil, %	61.3	95.4	<0.01
OM Loss, %	12.49	2.92	<0.01
Fat Loss, %	24.03	3.89	<0.01
NDF Loss, %	5.77	2.25	0.17
Non-spoiled pH[1]	4.27	4.31	0.60
Spoiled pH after[2]	6.70	6.82	0.77

[1]Nonspoiled layer of MDGS after storage, original pH was 4.63.
[2]Spoiled layer of MDGS, original pH of 4.63.

112, and 140 days, with two barrels weighed and sampled on each of these days. The two layers, spoiled and non-spoiled, were measured, separated, weighed, and sampled. The spoiled and non-spoiled samples were then analyzed for DM, ash and OM, fat, NDF, CP, and pH. Losses illustrated in Table 4 were calculated the same as described in Experiment 1. Data were analyzed using the Mixed procedure of SAS using barrel as the experimental unit.

Results

Experiment 1

There was an interaction ($P < 0.01$) between the cover treatment and amount of spoilage, DM loss, organic matter loss, fat loss, and pH for the WDGS: straw mixture and straight MDGS (Tables 2 and 3). The height of material in the barrels was just over 2 ft. If the material was stored in a bunker at a height of 10 ft, the losses would be proportionally less, about 20% as much of 1.6% DM loss and 3.8% spoilage for the open (noncovered) bunker. Spoilage caused a loss in DM, fat, and OM. Also, pH increased in the spoiled portion. The greatest loss in fat resulted when solubles and solubles + straw were used as covers. Microbes causing the spoilage are utilizing fat in the distillers for an energy source. Therefore, there is less fat available for the animals' use when they are fed the distillers: forage combination. Using plastic as a cover resulted in the least amount of fat loss for both the WDGS:straw mixture and the MDGS. The other treatments fell intermediate in terms of fat loss during the spoilage process.

Barrels using plastic and distillers solubles + salt as covers had the least amount of DM, OM, and fat lost because both covers (plastic and solubles + salt) resulted in the least amount of spoilage out of the six cover treatments. There were no interactions between NDF content and the type of cover used. The spoilage process also caused the pH of the original mixtures to increase from an initial pH of 4.42 to 6.77 with a plastic cover, and 6.11 with a solubles + salt cover. The greatest increase in pH numerically was when salt was used as a cover (4.42 to 7.11).

Covers like plastic and solubles + salt resulted in less spoilage, thus decreasing nutritional losses for the treatments. The barrels left uncovered resulted in the greatest amount of spoilage, which caused greater nutritional losses for the distillers products. The plastic and solubles + salt covers reduced the amount of air that reached the surface of the mix, allowing the distillers to retain original feeding value. However, up to 80% of the solubles can be lost when used as a cover, which is decreased when mixed with salt. Mixing solubles with straw, then using that mixture as a cover did not dramatically increase recovery of the cover for feeding. It was difficult to separate the cover from the mixtures below the cover, which is important to note.

Experiment 2

An interaction between the number of days the WDGS was stored and the amount of DM, OM, and NDF recovered (Table 4) was observed. The spoilage caused a loss of DM,

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Table 4. Nutrient losses (expressed as a % of the original amount of nutrient) of wet distillers grains plus solubles stored uncovered over time (140 days) in Experiment 2.

	Day 7	Day 14	Day 28	Day 56	Day 84	Day 112	Day 140	SEM	*P*-Value
DM Loss, %	8.6^{a,b}	5.0^{a}	6.6^{a}	17.3^{b,c}	17.6^{b,c}	22.4^{c}	21.1^{c}	2.05	<0.01
Spoil, %	6.4	6.0	5.8	5.8	9.6	12.5	11.7	1.76	0.10
Non-Spoil, %	93.7	94.1	94.2	94.2	90.4	87.6	88.3	1.76	0.10
OM Loss, %	8.80^{a,b}	4.85^{a}	6.35^{a}	18.15^{b,c}	18.75^{b,c}	23.90^{c}	22.60^{c}	2.25	<0.01
Fat Loss[3], %	3.15	-0.75	-2.70	5.75	3.35	5.10	2.70	3.67	0.67
NDF Loss[3], %	1.20^{a,b}	-12.60^{b}	0.50^{a,b}	17.60^{b,c}	16.75^{b,c}	21.45^{b,c}	27.10^{c}	4.82	<0.01
CP Loss[3], %	3.95	-2.60	-5.80	0.80	1.15	8.20	-7.05	3.06	0.08
Nonspoiled pH after[1]	3.67^{a}	3.87^{a,b}	3.93^{a,b,c}	4.26^{c}	4.22^{c,b}	4.09^{c,b}	4.12^{c,b}	0.07	<0.01
Spoiled pH after$_{1}$	4.78^{a}	6.18^{b}	6.50^{c}	6.60^{c,d}	6.43^{c}	6.55^{c,d}	6.72^{d}	0.05	<0.01

^{a,b,c} means with different superscripts are different ($P < 0.05$).
[1]Nonspoiled layer of WDGS pH after storage, original pH was 3.7.
[2]Spoiled layer of WDGS pH after storage, original pH was 3.7.
[3]Negative numbers indicate an increase in that nutrient.

organic matter, and NDF. Spoilage also increased the pH of the WDGS from 3.95 on the day it was placed in the barrel to 6.72 on day 140 ($P < 0.01$). The nonspoiled layer increased from 3.95 to 4.12 on day 140 ($P < 0.01$). There was no statistical effect on CP; however, CP increased numerically from day 7 to 140. Days 7, 14, and 28 showed the least amount of DM loss, averaging a loss of 6.73% DM ($P < 0.01$). Numerically, days 112 and 140 showed the greatest loss of DM (22.4% and 21.1%), while days 56 and 84 fell intermediate ($P < 0.01$). Conversely, when looking at spoilage with time, there appeared to be no statistical difference ($P = 0.10$), but numerically the amount of spoilage over time increased from day 7 to 140 (6.35-11.70%). Since WDGS cannot be "stacked" in a bunker, the 2 ft height in the barrels may represent the height if stored in a bunker, and losses would be similar between the bunker and barrels.

Over time the amount of OM lost do to spoilage increased from 4.85% on day 14 to 22.60% on day 140 ($P < 0.01$). However, there was no statistical effect of time on the amount of fat lost ($P = 0.67$), indicating that the amount of fat lost due to spoilage didn't depend on the length of time the WDGS was stored.

In conclusion, the storage time for WDGS had no effect on the amount of fat lost. However, the longer WDGS was stored the greater affected the loss of DM, organic matter, and NDF.

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