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Dry matter loss and nutritional composition of wet brewers grains ensiled with or without covering and with or without soybean hulls and propionic acid

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ABSTRACT

The present study evaluated the variation on nutritional composition of wet brewers grains mixed with soybean hulls or propionic acid and stored from 7 to 63 d. On d 0, treatments were randomly assigned to buckets (24 buckets per treatment) and consisted of wet brewers grains with no addition (NOADD) and added with soy hulls at 15 or 30% of DM (15SH and 30SH) and propionic acid at 0.40% of wet weight (PROP). Effects of mixture × time were detected ($P \leq 0.05$) for total DM loss and mean pH. Total DM loss of 15SH and 30SH was greater ($P \leq 0.01$) or did not differ ($P \geq 0.48$) compared with NOADD, whereas PROP tended ($P \leq 0.09$) to lessen total DM loss. Effects of mixture × time were detected ($P \leq 0.0004$) for concentrations of TDN, CP, ADF, NDF, and crude fat of nonspoiled DM material. Regardless of treatment, concentrations of TDN, ADF, NDF, CP and crude fat of nonspoiled DM mixture increased with storage days. Effects of mixture × time were detected ($P \leq 0.02$) for concentrations of macro and trace minerals. Regardless of treatment, concentrations of Ca, P, Mg, Na, and K decreased, whereas concentrations of S, Cu, Fe, and Zn increased as storage time increased. Overall, adding soy hulls at 15 or 30% of DM resulted in the greatest total DM loss and variation on nutrient composition, whereas adding propionic acid at 0.40% of wet brewers grains wet weight resulted in least DM loss and effect on nutritional composition.

Key words: ensiling, propionic acid, soy hulls, storage, wet brewers grain

INTRODUCTION

Brewers grains are by-products of barley brewing that can be marketed as wet (**WBG**) or dried brewers grains and were successfully included as alternative feed source for beef and dairy cattle (Preston et al., 1973; Davis et al., 1983; Ojowi et al., 1997). The availability of WBG is often beyond the producer use capacity during the summer, which forces producers to store the excess WBG during periods of hotter temperatures that exacerbate storage DM loss (Allen and Stevenson, 1975). In addition, because of the removal of the majority of sugars and starch after malting and mashing processes, and the relatively high moisture concentration of WBG (Westendorf and Wohlt, 2002), the process of ensiling WBG for long periods is difficult, leading to shortened storage life, offensive odors, and excessive DM loss (Allen and Stevenson, 1975). Earlier research focused on evaluating different methods of WBG storage by adding preservatives, by-products to decrease moisture, sodium chloride, and sodium hydroxide. Among those alternatives,

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authors identified that propionic acid is a viable option to improve fermentation quality and extend the storage life of WBG (Allen et al., 1975; Allen and Stevenson, 1975; Schneider et al., 1995).

The chemical composition of WBG is highly variable, partially because of differences in amount and type of grain used during the brewing process (Westendorf and Wohlt, 2002) and because of the unfavorable characteristics of WBG for good quality fermentation, the poststorage nutritional composition of WBG might also vary substantially. However, we are unaware of studies comparing the complete nutritional composition of different WBG mixtures after short- and long-term storage periods. Hence, our goal was to focus on variation of nutritional composition of WBG with or without covering and mixed with either soybean hulls to reduce moisture concentrations or propionic acid to reduce DM loss.

MATERIALS AND METHODS

Treatments

All procedures for the experiment were conducted from July to August 2014 at the Mountain Research Station (Waynesville, NC; 35.48°N, 82.99°W; elevation = 659 m).

On d −1, a 20,000-kg load of WBG was delivered at the Mountain Research Station and immediately stored in a single plastic silo bag. On d 0, approximately 600 kg of WBG were collected and mixed for 5 min using a vertical mixer wagon (Penta TMR Inc., Petrolia, Ontario, Canada) to obtain a uniform mixture. Treatments were randomly assigned to 19-L plastic buckets (24 buckets per treatment; 96 buckets total) and consisted of individually hand mixing WBG with (1) no addition (**NOADD**); (2) soybean hulls at 15 or 30% of DM (**15SH** and **30SH**); and (3) propionic acid at 0.40% of wet weight (**PROP**). The propionic acid concentration selected for this manuscript was identified as the optimal dosage for ensiling WBG (Allen et al., 1975) and achieved by adding a commercial liquid product (Myco-Lock; Trouw Nutrition USA LLC, Highland, IL; 59% propionic acid) at a rate of 0.68% of wet weight. Within each treatment, buckets were randomly assigned to receive or not individual sealing with a white-color, nonpermeable plastic sheet (HUSKY plastic sheeting, Poly-America, Grand Prairie, TX). After mixing the respective treatment, initial weight and 2 measurements of pH (pH electrode LE438, Mettler-Toledo, Columbus, OH) at 2 different sample locations chosen randomly were obtained from each bucket. All buckets (all treatments with and without covering) were then stored at ambient temperature with exposure to sunlight and precipitation for 7, 21, 42 and 63 d (6 buckets per treatment per storage period) to simulate on-farm storage practice.

Table 1. Average chemical composition (DM basis) at start of the study (d 0) of wet brewers grains added with no ingredient (NOADD), soybean hulls at 15 and 30% of DM (15SH and 30SH), and propionic acid at 0.40% of wet weight (PROP)[1]

Item	NOADD	15SH	30SH	PROP
DM, %	17.5	18.3	21.7	16.8
TDN,[2] %	72.2	70.4	69.4	72.3
CP, %	29.8	27.3	25.5	30.3
Crude fat, %	8.8	7.7	6.9	8.7
NDF, %	43.5	45.4	45.7	42.8
ADF, %	22.7	25.7	28.6	22.1
Ca, %	0.32	0.37	0.43	0.36
Cu, mg/kg	33	31	29	41
Fe, mg/kg	292	637	778	292
K, %	0.07	0.18	0.30	0.05
Mg, %	0.19	0.21	0.24	0.21
Mn, mg/kg	48	51	51	58
Na, %	<0.01	0.01	<0.01	0.05
P, %	0.63	0.55	0.50	0.56
S, mg/kg	0.36	0.34	0.31	0.37
Zn, mg/kg	84	89	78	99

[1]Treatments were randomly assigned to 19-L plastic buckets (24 buckets per treatment; 96 buckets total). Propionic acid was included at a rate of 0.40% of wet weight by adding a commercial liquid product (Myco-Lock; Trouw Nutrition USA LLC, Highland, IL; 59% propionic acid) at a rate of 0.68% of wet weight.

[2]Determined using equations described by Weiss et al. (1992).

Sample Collection and Laboratory Analysis

Six buckets per treatment were opened for sample collection at the end of each respective storage period. After sealing removal (if needed), each bucket was weighed, and the top layer of visible spoilage was carefully removed and weighed. Visible spoilage was characterized by the presence of a darker color and offensive odor compared with nonspoiled material. Thereafter, each bucket was emptied, and the remaining nonspoiled material was weighed and hand mixed before obtaining 2 measurements of pH and collecting 2 samples of approximately 200 g of wet weight each. Each sample was immediately stored at −80°C until laboratory analyses were conducted.

Samples were dried in a forced-air oven at 56°C for 96 h for calculation of DM concentration and total DM loss due to spoilage and fermentation (total DM loss, % of initial weight = nonspoiled material DM weight − initial total DM weight on d 0,