# Ensiling of Whole Wheat Plant at Different Maturities and Dry Matter

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## Story in Brief

Wheat forage was harvested with a forage chopper and ensiled in 1-gallon experimental silos. Maturity of the wheat was late boot, milk and soft dough; within each maturity, dry matter levels were 25, 35 or 45 percent. All combinations of maturity and dry matter resulted in adequate reduction of the pH to preserve the forage. Later maturities had more available non-structural carbohydrates for fermentation than earlier maturities had, as evidenced by the lower final pH, and resulted in less dry matter loss during fermentation. Addition of 1 percent of forage dry matter as formic acid (FA) before ensiling resulted in lower final pH values and less dry matter loss than in forage not treated with FA, especially at natural field dry matter. Fermentation was improved if wheat forage was ensiled at the milk or soft dough stage of maturity rather than at the boot stage. Within each maturity, dry matter content had no effect on any fermentation characteristic except final pH.

## Introduction

Levels of beef production have been acceptable when silages are used as a major part of the ration. The advantages of harvesting wheat forage as a silage rather than as a hay include reduced field losses and increased mechanization. The quality of the silage after fermentation is dependent upon the maturity at which it was ensiled. Information on the effect of dry matter content on the fermentation of wheat forage is limited because maturity and dry matter levels are usually not considered independently. The objective of this research was to determine the effects of maturity and dry matter, independently and collectively, on fermentation characteristics of ensiled wheat forage.

## Experimental Procedure

Wheat forage from one field was harvested with a forage chopper at three stages of maturity (late boot, milk and soft dough) and ensiled in 1-gallon, cardboard containers at 25, 35 or 45 percent dry matter. The field dry matters at the time of harvesting were 27, 33 and 44 percent for late boot, milk and soft dough stages of maturity, respectively. As maturity increased, so did dry matter, so water had to be added to forage prior to ensiling to achieve the desired experimental dry matters. Before the wheat forage was ensiled, one half of each maturity and dry matter combination was treated with formic acid (FA) at a level of 1 percent of the dry matter. The other half was the untreated control. All silos were packed with a hand operated press to expel as much air as possible. Each silo was lined with two individually sealed plastic bags. Three silos were filled for each treatment combination. Forage was allowed to ferment for 60 days; then each silo was opened, mixed and sampled. Data were analyzed as a 3 by 3 factorial arrangement of treatments within FA control and treated groups.

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## Results and Discussion

The pH of each maturity and dry matter combination plus dry matter loss during fermentation are presented in Table 1. Within each of the control groups, lower dry matter content resulted in a lower final pH value. In the fermentation process, the reduction in pH from the initial value is the result of microbial fermentation of highly digestible, non-structural carbohydrates (sugars). As maturity increases, the plant becomes more reproductive and begins to develop seed heads that are higher in non-structural carbohydrates and provide more fermentable substrates than when less mature. This characteristic was evident in this trial. No differences in final pH values due to either maturity or dry matter were noted when FA was added before ensiling. Adding organic acids to forage materials at ensiling is one way of rapidly lowering the pH to preserve the material without using fermentable products of the plant.

The conversion of energy stored in the plant material to end products of fermentation is dependent upon the type of bacteria present and is 95 to 99 percent efficient. The end products are organic acids, alcohol and carbon dioxide. Energy is lost when the end products of the fermentation process escape as gases to the atmosphere or as water soluble products within run-off or seepage. This loss is dramatized by a loss in the amount of dry matter remaining after fermentation. The dry matter loss in this study decreased by 50 percent as maturity increased. With increased maturity, more readily available substrates were available for fermentation; thus, less dry matter was required to produce the acids necessary to lower the pH and preserve the remaining material. Because the dry matter content before and after fermentation was determined by heating the samples, the losses could also in part reflect volatile compounds that were driven off by the heat. Apparently, the stage of maturity determined the end products of fermentation. The addition of FA before ensiling reduced dry matter loss at milk and soft dough stages of maturity, as reflected by the overall means across all dry matter levels. Reduction of such losses was marked at dry matters of 25 and 35 percent for milk stage silage and 45 percent for soft dough silage. The optimum dry matter levels for FA addition correspond with the natural field dry matter of that maturity, but it was apparent that FA would be beneficial if added to wilted silage also.

**Table 1. Fermentation characteristics of wheat forage ensiled at three maturities and dry matter (DM) levels with and without formic acid (FA)**

| | Late boot stage | | Milk stage | | Soft dough stage | |
|---|---|---|---|---|---|---|
| DM Levels, % | C[a] | FA | C | FA | C | FA |
| | | | Final pH | | | |
| 25 | 5.24 | 4.39 | 4.76 | 4.76 | 4.47 | 4.52 |
| 35 | 5.16 | 6.06 | 4.95 | 4.39 | 4.51 | 4.72 |
| 45 | 5.89 | 4.89 | 5.24 | 4.84 | 4.98 | 4.41 |
| Mean | 5.43 | 5.11 | 4.98 | 4.66 | 4.65 | 4.55 |
| | | | DM loss (%) | | | |
| 25 | 22.10 | 32.98 | 10.84 | 2.94 | .48 | 2.59 |
| 35 | 19.85 | 24.98 | 9.08 | 4.06 | 1.03 | 5.77 |
| 45 | 18.83 | 19.88 | 14.62 | 9.16 | 14.66 | 1.73 |
| Mean | 20.26 | 25.95 | 11.51 | 5.39 | 5.39 | 3.36 |

[a]C = Control.