

## Studies on stable method for making of low-moisture round bale silage and evaluation of its quality

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### Summary

Round bale forage packing systems are common all of Japan due to their high labor efficiency. However, it is difficult to dry hay enough to keep round bales without quality deterioration caused by molding, leaf loss and/or leaching of minerals in rain under Japanese climatic conditions. To resolve this problem, round bale silage (RBS) system that each round bale is wrapped with stretch plastic film has been adopted lately.

RBS is convenient for transporting and now commercialized. Previous studies indicate that the optimal moisture content for the production of RBS is 50-60%. Therefore, it has been recommended not to make RBS with low moisture content (20-50%) because the quality is spoiled by the possible proliferation of aerobic bacteria. However, minimization of bale weight by reducing moisture content is important for transportation of silage. Then the development of stable method for the production of low-moisture RBS is required. Furthermore, standardization of the criteria for evaluating the quality of low-moisture RBS is necessary for marketing of forage.

This study was conducted to develop a method for making and marketing good quality low-moisture RBS. The objectives were (1) to determine the optimal number of wrapping film layers and optimal moisture content for keeping

high quality of low-moisture RBS, (2) to examine the effect of the color of wrapping film on fermentative quality and bound protein (BP) content, (3) to determine the effect of maceration on in sacco degradability and digestibility and (4) to standardize the criteria of forage quality. For these purpose, the experiments were carried out in Hokkaido district from 1994 until 2000.

1. In order to determine the optimal number of wrapping film layers and optimal moisture content for keeping high quality of low-moisture RBS, timothy (*Phleum pratense* L.) was used in the experiments. The numbers of film layers used for wrapping were 2, 4, 6 or 2+2 (2 layers wrapped in the usual direction followed by 2 layers wrapped in the reverse direction). The moisture contents of the silage were 20, 40 or 50%. No mold was observed after 2 months in silage bales wrapped with 4 or 6 film layers. The mean temperatures at the center of those bales ranged from 25 to 30°C. Silage fermentation was poor, but V-score, which was proposed by MASAKI (1994), increased as the dry matter (DM) content increased. The dry matter intake (DMI) per metabolic body size of silages with 20, 40, 50% moisture contents and of hay made from the same herbage were 49, 53, 43 and 51g/kgBW<sup>0.75</sup>/d, respectively. After 11 months of storage, mold was not observed in silage bales wrapped in 4, 6 or 2+2 film layers, and there were no differences in chemical composition or

fermentation characteristics among those silage bales. However, the surface was covered with a considerable amount of mold in silage bales wrapped in 2 film layers. The temperature of the silage wrapped in film layers that had intentionally ripped rose to 48 °C, and mold had grown around the rip after only one week.

2. To examine the effect of the color of stretched plastic film on fermentative quality and BP content of RBS, timothy and alfalfa (*Medicago sativa* L.) were used. Round bales were wrapped individually with black or white colored stretch film. The temperature in the surface of RBS with black colored film was about 10°C higher than the RBS with white colored film. Regardless of film color, BP contents of RBS were similar to that of raw materials. However, for RBS with black colored film, moisture content was uneven, the pH of RBS was rather high and fermentation was repressed. RBS wrapped with white colored film showed rather low pH and stable fermentative quality.

3. Making a high quality alfalfa RBS is heavily dependent upon weather conditions. Recently, a mechanical maceration treatment for freshly cut forage material was developed, which enhances drying rate and reduces selective leaf loss of alfalfa. This treatment resulted in shredded stems into numerous fibrous pieces and in a severely damaged cuticle increasing surface area. However, it was not determined how these changes affected digestibility of macerated low-moisture silage. In this experiment, the effect of maceration on in sacco degradability and digestibility of low-moisture silage were investigated. First and second cutting alfalfa or second cutting timothy were prepared. Two treatments were; 1) maceration, processed with a large-scale forage mat maker prior to wilting to approximately 50% DM content (FM treatment), and 2) conventional conditioning, tedded and wilted to the same DM content as that in the FM treatment

(CC treatment). These silages were chopped into 20-mm length for each experiment. *In sacco* DM degradability was similar for both FM- and CC-treated silage, but CP degradability of FM-treated alfalfa silage was higher than that of CC-treated one. There were no differences between FM- and CC-treated silage in DM, organic matter (OM), acid detergent fiber (ADF) and neutral detergent fiber (NDF) digestibility, and total digestible nutrients (TDN) contents of alfalfa and timothy. In first cutting alfalfa silage, there were no significant differences between FM- and CC-treated silage in energy digestibility and metabolizability.

4. To standardize the criteria of forage quality of marketed low-moisture wrapped RBS, fermentation characteristics, BP content and chemical composition were investigated on RBS of timothy and alfalfa. Variations in forage values among sampling sites of baled silages were also to qualify the representative collection. Forage plants examined were harvested at three different growth stages; early, optimum and late cutting of the first harvest. Those were wilted to 30-50% of moisture content in crop fields. Effect of sampling site on the contents of moisture, CP, ADF and NDF was investigated for twelve wrapped RBS varying in forage crops, growth stages and wrapping film color. Among twenty-one points plotted equally in the wrapped RBS, the plots of 30cm from the top or bottom and 20cm from the north, east, south and west side edges were the best place representing the quality of whole bale. The mean concentrations of lactic, acetic and butyric acids in the RBS were very low at 0.65%, 0.30% and 0.04%, respectively. The mean pH values of 5.5 also showed poor fermentation of the silages, suggesting that these fermentation profiles were not appropriate for standardizing the quality evaluation of the wrapped RBS with low-moisture content. The BP content of silage was similar to that of raw materials. The contents of moisture, CP, ADF

and NDF, as already extensively used for evaluating nutritive value, appeared to be useful and simple indices to standardize the forage evaluation of those silages.

5. In order to evaluate variations in the quality of low-moisture RBS prepared from each crop field, the suitable sampling numbers of bales were investigated with the simple random sampling on RBS. Variations in the quality of wilted grasses among the samplings were also examined. Two crop fields were tested. The mean concentrations of moisture, CP and ADF in silages cultivated from the field A and B were 56, 15 and 41% and 34, 8 and 38%, respectively. The contents of moisture, CP and ADF of wilted grasses were variable within each windrow and among the windrows. This result suggested that the chemical analysis of original or wilted grasses do not accurately evaluate the quality of

ensiled material. The suitable sampling numbers of bales were found. The number of bale was the same for both fields when moisture and ADF contents were used for indices of the quality. In contrast, the variance of the CP content in the silages was significantly different between the crop fields.

The results of this study showed that (1) wrapping the bales in at least four layers of film could preserve the quality of low-moisture RBS, (2) RBS with white colored film showed lower pH and more stable fermentative quality than RBS with black colored film, (3) maceration increased the degradable fraction of CP in the alfalfa stem, but had no effects on digestibility and metabolizability of energy in chopped silage, and (4) the contents of moisture, CP, ADF and NDF appeared to be useful and simple indices to standardize the forage evaluation of those silages.