Mechanisms of Nitrogen Oxide Formation During Ensiling of Dairy Feeds, Michael Kosusko[i], Peter G. Green[ii], Mathew Cohen[ii], Sona Chilingaryan[iii], and Frank M. Mitloehner[ii]

Silage (ensiled feed), as a dairy's greatest operational cost, is its most critical feed commodity. The continued use of silage is essential to a highly productive and economically viable industry. (Ensiling is the process of converted harvested feed into fermented, stable anaerobic animal feed or silage.) Previous work has shown that silages are a major source of volatile organic compounds (VOCs) and a potential source of nitrogen oxides (NO_x) from dairies contributing to the emission inventories for the San Joaquin Valley and South Coast Air Basin in California. Both VOCs and NO_x are precursors to ozone formation and PM 2.5. Their emissions are long-standing air quality challenges in many areas of the country, but particularly in these California locations. As a result, California has been diligently identifying, understanding and reducing all sources of VOC and NO_x emissions.

The emission of NO_x has been observed during the ensiling process (Peterson et al. 1958, Maw et al. 2002). Substantial NO_x is not inherently present in corn. It is generated by an unknown mechanism during the early days of the ensiling process. The underlying question for this effort was whether the production of NO_x is due to biological activity from the growth of microbes or the production of NO_x is enzymatic, using precursor compounds already present in the harvested plant matter. Hence, our goal was to better understand mechanisms that could generate NO_x emissions from silage. To understand the mechanisms, NO_x emissions were compared before and after treatment by (a) sterilizing the microbes that are inherently present in chopped corn to discern whether NO_x formation during ensiling is microbial or is due to pre-existing plant enzymes, and (b) testing three chemical inhibitors to limit the activity of the peroxidase enzyme that is the most likely candidate to produce NO_2 from nitrate.

This paper will describe our test procedures, the results from testing, and conclusions and recommendations resulting from this effort.

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