Mitigating Methane Emissions from Enteric Fermentation in Beef Cattle Using Three Herbs

María Fernanda Vázquez-Carrillo[1], Hugo Daniel Montelongo-Pérez[2], Manuel González-Ronquillo, Epigmenio Castillo Gallegos[1], Octavio Alonso Castelán Ortega[2*]

[1]Faculty of Veterinary Medicine and Animal Science, Universidad Nacional Autónoma de México, Mexico City, Mexico

[2]Faculty of Veterinary Medicine and Animal Science, Universidad Autónoma del Estado de México, Toluca, Estado de México, Mexico

*** Correspondence:**
Octavio A. Castelán-Ortega
oacastelano@uaemex.mx

SUMMARY

The cattle represent a significant source of greenhouse gases (GHG) through both enteric fermentation and indirectly through activities such as feedstuff production. Cattle emitted 4.6 gigatonnes CO_2 equivalents, of which 2.5 gigatonnes originated from beef and 2.1 gigatonnes from dairy cattle. Therefore, mitigating GHG like methane (CH_4) originating from the cattle industry, offers an opportunity to reduce GHG emissions and climate change over the short term. The objectives of the present work were to evaluate the *in vivo* antimethanogenic effects of *Cymbopogon citratus* (CC), *Matricaria chamomilla* (MC) and *Cosmos bipinnatus* (CB) on beef cattle fed a finishing diet (FD) high in concentrate (forage-to-concentrate ratio [F:C] was 19.4:80.6), and the effects of increasing levels of CC on enteric CH_4 emissions by beef cattle fed a total mixed ratio (TMR) low in concentrates (F:C ratio of 49.3:50.7) Two experiments were conducted to address the objectives. For the first experiment, eight Charolaise x Brown Swiss steers, distributed in a replicated 4 x 4 Latin square experimental design were used. In this experiment, three herbs (treatments) supplemented at low doses were evaluated in addition to a control diet (CO). The CO diet, FD offered *ad libitum*, was formulated to meet the metabolizable energy and protein requirements of the animals. The three other treatments consisted of the CO, plus 365 g dry matter (DM)/day of CB, 365 g DM/day of MC, or 100 g DM/day of CC. Experiment 2 aimed to test the effects of increasing levels of CC supplementation (0%, 2%, 3%, and 4% DM of the daily DM intake) on CH_4 emission. Four Charolaise x Brown Swiss steers fed the TMR as basal diet, distributed in a single 4 x 4 Latin square experimental design were used. During each experimental period

(all experiments), the dry matter intake (DMI), apparent digestibility of the DM (DigDM)and fiber fractions were measured, the CH_4 emissions were quantified in two open-circuit respiration chambers, and the live weight gain was measured weekly to calculate average daily live weight gain (ADWG). The results of Experiments 1 show that CC significantly reduced methane yield (g of CH_4/kg DMI) by 33 %, CB reduced methane yield by 28% ($P<0.01$) without any effect on ADWG, and MC had no significant effect on CH_4 yield but significantly reduced ADWD ($P<0.05$). The total daily emission (g CH_4/d) was numerically reduced by 16 % by the CC treatment. The results from Experiment 2 show that CC supplemented at 2% of the DMI significantly ($P<0.05$) reduced the total daily CH_4 emissions by 26 % without affecting the DM digestibility or the ADWG in comparison with the CO. Supplementation levels 2% and 3% of CC numerically reduced the CH_4 yield by 12% and 15.5%, respectively. However, 3% and 4% levels significantly reduced the DigDM and the digestibility of the fiber fractions ($P<0.05$). It was concluded that 100 g DM per day of CC, and 365 g DM per day of CB (Experiment 1) reduced enteric CH_4 yield by beef cattle, without significant effects on animal performance. Supplementation levels of CC of more than 2% of the DMI can reduce total daily CH_4 emissions but at the expenses of a decrement on the DigDM and the digestibility of the fiber fractions. However, more research is necessary to elucidate the effects of these herbs on other variables such as rumen fermentation, volatile fatty acid production, and rumen microbe populations and to evaluate whether the antimethanogenic effect is maintained over the long term.