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Mitigation of greenhouse gases in ruminants through acetic acid as a food additive

Mitigación de los gases de efecto invernadero en los rumiantes a través del ácido acético como aditivo alimentario

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Abstract

The objective was to evaluate the result of the addition of acetic acid in sheep feed to mitigate the production of greenhouse gases. The research was carried out in the Faculty of Veterinary Medicine and Zootechnics in the Posta unit where the greenhouse gas production was evaluated with the experimental method carried out with two adult sheep being the donors of the rumen liquid In this method of assessment of pounds-force per square inch (PSI) in vitro using 125 ml glass bottle in an incubator at a temperature of 39 degrees Celsius with stubble and bran inoculated with acetic acid in different inclusion degrees 10, 15 and 20 for 96 hours in incubation taking measurements every 3 hours to observe the constant variation. It was compared with standard samples where only food was found without the addition of acetic acid. Each incubated sample was evaluated as a whole; each measure was evaluated in PSI taken with which a comparative analysis of these measurements and proportions was made, respectively. It was determined that the samples of stubble and bran with a degree of inclusion at 20% showed a marked difference in the reduction of greenhouse gases while the other inclusion degrees 15% and 10% reduced that production compared to the control group. It is concluded that acetic acid contributes to the mitigation of greenhouse gases with a level of 10% inclusion in the diet of sheep based on stubble and bran.

Gases Greenhouse Effect, Acetic Acid, Ruminants

Resumen

El objetivo fue evaluar el resultado de la adición ácido acético en la alimentación de ovinos para mitigar la producción de gases de efecto invernadero. La investigación se realizó en la Facultad de Medicina Veterinaria y Zootecnia en la unidad Posta donde se evaluó la producción de gases de efecto invernadero con el método experimental realizado con dos ovinos adultos siendo los donadores del líquido ruminal En este método de valoración de libras-fuerza por pulgada cuadrada (PSI) de manera in vitro utilizando frasco de 125 ml de vidrio en una incubadora a una temperatura de 39 grados centígrados con rastrojo y salvado inoculados con ácido acético en distintos grados de inclusión 10,15 y 20 durante 96 horas en incubación tomando medidas cada 3 horas para observar la variación constante. Se comparó con las muestras estándar donde se encontraba solo alimento sin adición de ácido acético. Se evaluó en conjunto cada muestra incubada, se valoró cada medida en PSI tomadas con lo que se realizó un análisis comparativo de estas medidas y proporciones respectivamente. Se determinó que las muestras de rastrojo y salvado con un grado de inclusión al 20 % mostró marcada diferencia en la reducción de gases de efecto invernadero mientras que los otros grados de inclusión 15% y 10% redujeron dicha producción comparada con el grupo testigo. Se concluye que el ácido acético contribuye a la mitigación de gases de efecto invernadero con un nivel de inclusión al 20% en la dieta de ovinos basada en rastrojo y salvado.

Gases Efecto Invernadero, Ácido Acético, Rumiantes

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Introduction

There are gases from the Earth's atmosphere that give rise to the so-called greenhouse effect, its importance lies in the increase in the temperature of the planet, keeping it at a range of values fit for life. The most important gases are: water vapor, carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), chlorofluorocarbons (CFC) and ozone (O3) (Morgan, 2003). Climate change is a phenomenon of great relevance, due to its implications for the economy of any country; particularly, in Mexican livestock, the negative impact is evident (Clark & Scholten, 2013).

Livestock will accelerate climate change, mainly through the emission of greenhouse gases (GHG), such as: methane (CH4) and carbon dioxide (CO2); produced in the anaerobic fermentation of carbohydrates (cellulose, starch, sucrose) of their diet, in addition to nitrous oxide (N2O) (Carmona, Bolivar, & Giraldo, 2005).

The microbiota constituted by bacteria, archaea, fungi and protozoa develops in an anoxic environment producing one of the largest quantities of methane (Espinoza Velasco, Ramírez-Mella, & Sánchez Villarreal, 2018). In the rumen, the structural carbohydrates (cellulose) of food are anaerobically fermented by the action of millions of bacteria and protozoa, resulting in: 65% CO2, CH427% and other gases, heat and short chain fatty acids.

A cow of 500 kg of weight can produce between 400-450 liters of methane per day (Berra, 2002). Research to mitigate ruminal methane gas focuses on feeding, selection of low emission animals, intensification of animal production, secondary compounds of plants, chemical inhibitors, nitrate, immunization, defaunación, reductive acetogenesis, bacteriophages, predictive models and inventories of emissions by region (Ungerfeld, Escobar Bahamondes, & Muñoz, 2018).

The reduction of GHG emissions is affected by the global demand for meat and milk, which will double by 2050, which is why the manipulation of diets through the addition of acetic acid is necessary (FAO, 2014).

The production of methane increases with the digestion of the fiber, due to the increase in the amount of acetic acid in relation to propionic acid, so the most digestible forages and quality fibers such as soybean husk generate more methane. While the fermentation of starch generates changes in ruminal pH, not suitable for the development of methanogenic and higher production of propionic acid, due to the stimulation of amylolitic bacteria, which leads to a decrease in the generation of methane (Alvarez Nivia, 2018).

The emission of CH4 and N2O have an impact on animal production, work is being carried out in the search and implementation of practices aimed at mitigating their emissions, with the aim of impacting the profitability of the production units (Alayón Gamboa, and others, 2018).

Hypothesis

The addition of acetic acid in the feed of sheep, reduces the emission of greenhouse gases.

Objective

The objective of the present investigation was the addition of acetic acid in sheep feed to mitigate the production of greenhouse gases.

Materials and methods

The present investigation was carried out at the facilities of the FMVZ-UMSNH, posta unit, which is located on the Morelia-Zinapécuaro highway, Km 9.5, in the municipality of Tarímbaro, Michoacán, México.

The in vitro phase was carried out with ruminal liquid of two ovines on a corn silo diet, fresh and ground oats, bran and molasses, food and water ad libitum. 1lt of ruminal fluid was extracted with gold-ruminal probe and vacuum pump, placing in amber glass bottles of 125 ml with 10% ruminal fluid and 90% buffer solution (Posada, Noguera, & Bolibar, 2006).

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– For the solution of macro minerals (1L): 5.7gr of sodium phosphate, 6.2gr of potassium phosphate and 0.6gr of magnesium sulfate are weighed. 500ml of distilled water was placed in the flask and placed on a magnetic stirrer; to which the reagents were added one by one, the solution is passed to a volumetric flask and it is poured up to 1L.

– For the solution of micro minerals (25ml): 3.3gr of calcium chloride, 2.5gr of manganous chloride and 0.25gr of cobalt chloride are weighed. A 25ml beaker is placed in the magnetic stirrer, 15ml of distilled water is added, adding the minerals, the 25ml sample is poured and the solution is placed in the flask. 0.999g of total food was weighed, incubated in a water bath at 39.5ºC, a sample of acetic acid was added, incubating at 39ºC x 96 hrs and measuring at 3, 6, 9, 12, 24, 36, 48,60, 72 and 96 hrs, with pressure transducer.

After incubation and measurement, statistical and mathematical calculations were performed to observe variations in gas production.

Results

The production of gases within the flasks with ruminal liquid of stubble and bran during the incubation time at 96 hrs of observation registered a significant decrease at different degrees of inclusion of acetic acid as an additive for GHG mitigation, the best results were with the 20% additive achieving a reduction of 23.1% with respect to the control. The control diet based on stubble and on the basis of bran produced in total PSI 41.27 ± 1.9 of greenhouse gases. The diet with the same base of the control but including 20% acetic acid was the best performance in the mitigation of gases with a PSI of 31.74 ± 1.8 representing the best option. The inclusion additive at 10% generated a reduction of 8.6% also compared to the control with a production of 37.7 ± 1.6 PSI of gases.

Including 15%, a 6.6% decrease in gas production was observed compared to the control in stubble and bran with a total of 38.52 ± 1.9 PSI.

Discussion

Previous studies conducted in pigs by Berra and Finster (2002) showed that incubation with a specific diet with an inclusion degree of acetic acid reduced gas production after 72 hrs of incubation with respect to the control group. A similar effect has been achieved with the incubation of acetic acid in bran and stubble the sheep. (Bruni & Chilibroste, 2001). In his research on greenhouse reduction techniques, he determined that the use of acetic acid in the diets of animals whether they are ruminants or monogastric helps with the reduction of up to 10 or 15% of the emissions, whether in excrement, burps or gases in set with better solubility of the residues shown thus better digestibility.

In both cases the studies of Bruni (2001) and Berra and Finster (2002) were about the use of acetic acid addition to the diet of the animals, however none of them has carried out studies in sheep or ruminants with acetic acid, so that the results are satisfactory because the objective of this research was met, another factor that can change but nevertheless support is the incubation time because it varies from 72 to 96 hours. However (Marrero, and others, 2014), in his research mentions that in combination with sodium bicarbonate could have more relevant results. The production of gas was higher in the control and inclusion bottles of 10 and 15% than what was observed with the bottles with an inclusion degree of 20%.

However, the aforementioned works contemplate the reduction of gas production in other species but nevertheless given this practice contemplates and complements the investigations carried out with acetic acid but this time in sheep with positive results so the research can be validated.

Conclusions

It is concluded that acetic acid contributes to the mitigation of greenhouse gases, the inclusion of 20% of the additive to the diet of sheep based on stubble and bran represents the best option; while at an inclusion level of acetic acid of 10 and 15%, although they show reduction, they are lower.

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With this additive an alternative to climate change is presented with the reduction of 23.1% of greenhouse gases produced in the rumen and to be applied in bovine meat and milk with increasing global demand is a real alternative, it is recommended to conduct more research to improve the results and find new additives.

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