**////Title: Reducing the Carbon Footprint of Cattle Farming with Leftover Brewer’s Yeast**

**////Standfirst:**

Methane is one of the most potent greenhouse gases that contributes to the global climate crisis. As this gas is produced in the digestive systems of cattle, methane represents one of the greatest problems faced by the farming industry. Dr Robert Bryant, Dr Langdon Martin and their team at Warren Wilson College, North Carolina, propose an innovative feed supplement for cattle that helps to significantly reduce methane emissions: waste yeast from craft breweries. If used on a large scale, this new supplement could significantly decrease emissions associated with cattle farming, while also creating a new use for a waste product of the craft beer industry.

**////Main text:**

It is well established that cattle farming is a key contributor to the ongoing climate crisis. Aside from the energy and feed used by the cattle industry, there is another unavoidable contributor to global emissions: microbes in cows’ ‘stomach’, or rumen. Certain types of microbes found in cattle rumens produce greenhouse gases during digestion, most notably methane, which plays a huge role in climate change.

In fact, atmospheric methane has about 30 times the warming power of carbon dioxide over 100 years. Unfortunately, it has been estimated that an individual cow can produce up to 500 litres of this potent greenhouse gas every day, in addition to other pollutants, including ammonia. This daily quantity of methane is roughly equivalent to the carbon dioxide produced during a 50-kilometre car journey.

One common method to reduce the amount of methane and ammonia produced by cattle is to introduce antibiotics into their feed. This can help to shrink populations of certain unhelpful microbes in a cow’s rumen and therefore reduce the amounts of these deleterious waste molecules that are produced.

However, this method isn’t without its drawbacks. Antibiotics are costly, they can cause digestive problems, and they do not work against antibiotic-resistant microbes. In fact, antibiotics directly contribute to the rise of antibiotic-resistance, which is a serious public health issue. Therefore, researchers are searching for alternative ways to reduce the large carbon footprint of the cattle industry.

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Dr Robert Bryant, Dr Langdon Martin and their team at Warren Wilson College, North Carolina, in collaboration with Dr Michael Flythe of the USDA Agricultural Research Service, Kentucky, propose an innovative solution based on an unlikely ingredient: hops. Hops are most commonly used in the beer-making process as a bittering and flavouring agent. Many of these flavours are due to unique acids in hops, which are also known to have antimicrobial properties.

Craft breweries in particular use large quantities of hops, of assorted varieties, to enhance the flavour and aroma of their beers. Recipes for ‘India Pale Ale’, a popular craft beer style, require especially large quantities of hops. In fact, this beer style was invented when brewers realised that heavily hopped beers would last longer without spoiling – such as on voyages from Britain to India.

During the process of fermenting craft beer, a proportion of the hop acids, which are only slightly soluble in beer, become deposited into the yeast ‘cake’ within the fermentation vessel. This yeast cake, which is typically discarded at the end of the brewing process, contains an interesting mixture of these acids. Until now, this so-called ‘spent yeast’ has been considered a waste by-product, with minimal useful applications.

The team’s research shows that spent yeast from craft breweries, with its high concentrations of hop acids, could help to transform the cattle farming industry. By introducing spent yeast into cattle feed, the antimicrobial acids it contains can help to reduce populations of rumen microbes that produce methane and other pollutants.

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In a remarkable study, published in *Frontiers in Animal Science*, Dr Martin and his team acquired spent yeast samples from a local craft brewery. They collected samples that had been used in the fermentation process for various different beer styles – from those containing low quantities of hops, to highly-hopped India Pale Ales. This would allow the team to determine whether different concentrations of hop acids would have different effects on rumen microbes.

The researchers then mixed these yeast samples with fluid taken from cows’ rumens, and incubated the mixtures to simulate the rumen environment. The jars contained a mixture of ground corn and silage to represent a cow’s diet, and were tightly sealed in an oxygen-free atmosphere. The team left these mixtures to incubate at 39 degrees Celsius for 24 hours, before taking a sample of gas from the headspace above each mixture. They then ran tests on these gas samples to determine the quantities of methane produced by the microbes that grew.

The team then cooled the samples, before performing analysis to determine the ammonia concentrations produced during the growth. From these results, the researchers could directly compare how each sample of yeast impacted the production of methane and ammonia.

To ensure a complete comparison, the team also used normal baker’s yeast in several of their mixtures, which did not include any hop acids. Some of their mixtures also contained both baker’s yeast and monensin [moh-nen-sin], which is the antibiotic typically used to reduce methane-producing microbes in the cattle industry.

The results of these experiments were extremely encouraging. The team was able to show that the spent brewer’s yeast was significantly more effective at reducing methane production compared to both baker’s yeast and antibiotics. The researchers found that the spent brewer’s yeast also reduced the production of ammonia, though not as effectively as antibiotics.

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The team then evaluated how the original concentration of hops in the spent yeasts used in the fermentation process correlated to the effectiveness of the feed supplement. In the case of methane, the effect was astonishing: there was a dramatic reduction in methane production when using yeast samples from brews containing larger quantities of hops.

This result revealed that the most potent type of spent brewer’s yeast to use as a feed supplement comes from the fermentation of India Pale Ales and other highly-hopped beer styles.

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This study presents a promising solution to two different problems. By using spent yeast from craft breweries as a feed supplement, the team’s research shows how the cattle industry can significantly reduce emissions of greenhouse gases and other pollutants. The team’s solution would also help the craft beer industry to reduce the amount of waste they discard.

Introducing spent yeast into cattle feed has another advantage too, as it is full of vitamins, minerals and proteins that are important for nutrition. This benefit, combined with reduced populations of unhelpful microbes, means that cattle could require less feed. This, in turn, could save money for cattle farmers.

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This SciPod is a summary of the paper ‘Spent Craft Brewer’s Yeast Reduces Production of Methane and Ammonia by Bovine Rumen Microbes’ from *Frontiers in Animal Science.* [doi.org/10.3389/fanim.2021.720646](https://doi.org/10.3389/fanim.2021.720646)

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