



FELLOWSHIP SUMMARY REPORTS

- ❖ Please submit this Summary Report in Word, in Times New Roman, font size 11, using UK English spellings.

Cover page

- Name: Yutaka Uyeno
- The subject title and theme number of your research fellowship:
Associative effects of fruit byproducts and natural prebiotic supplementation on animal performance, rumen microbiota changes, and enteric methane emissions in meat goats (Theme number Managing Risks in a Connected World (Theme 2))
- Host institution: Tuskegee University, Tuskegee, AL, USA
- The name of your host collaborator: Dr. Byeng Ryel Min
- The dates of your fellowship: Oct. 31, 2022 – Dec. 20, 2022
- Statement of consent:
I agree with my report being posted on the Co-operative Research Programme's website.



FELLOWSHIP SUMMARY REPORTS

Main body

1. What were the objectives of the research project? Why is the research project important?

Although the primary sources related to greenhouse gas (GHG) emissions are dependent on human activity, methane emissions from ruminants also significantly contribute to the emissions and have become a focus of research activities. There is currently no robust, reproducible, non-chemical, and economically viable method for reducing CH₄ emissions from ruminants. Methane emissions from forage-based diets in ruminants are higher than in grain-based diets, which is directly associated with feed efficiency, digestibility, and nutrient contents (especially energy and fibre contents). It is well known that feeding ruminants diets containing a high starch concentration can improve productivity and reduce their enteric methane emissions. But this idea is not perfectly suitable for rumen function, since intensive acidification is hazardous to rumen microbes, particularly those contributing fibre digestion. In this context, grain-based byproducts are expected to produce less CH₄ than traditional diets containing the same level of starch. We sought to evaluate some varieties of grain-based material for feed use.

In accordance with the schematic background described above, the goal of this collaborative study was to develop a nutritional approach for ruminants capable of decreasing CH₄ eructation and improving feeding efficiency. The impact of CH₄ emissions from the animals was determined by in vitro cultivation technique which enables periodical monitoring of gas production level and its composition using an automated device (ex-vivo technology). The collaboration research also aimed to track changes in microbial community structure and composition in the rumen simulated culture fortified with different kinds of grain-based substrates, by applying DNA-based next generation sequencing (NGS).

2. What were the major achievements of the fellowship? (up to three)

In this occasion instead of conducting the feeding trial we succeeded to install ex-vivo evaluation the host institute;

2.1. Instillation of novel method for ex-vivo rumen cultivation

The ANKOM RF units, which is a proprietary system using radiofrequency pressure sensor modules, which communicate with a computer interface and dedicated software to record gas pressure values and transducible to gas volume, as well as cumulated ventilation at 5 psi to avoid fermentation retard by overpressure. Gas volumes were converted from determining increased pressure during fermentation by a pressure transducer device regularly vented at fixed pressure for such equipment has been adapted to determine the composition of gases, particularly methane produced from in vitro rumen fermentation. Rumen fluids sampled from two crossbred beef cattle via stomach tube was used for seed culture of this cultivation experiment, and for analysis of rumen fermentation rate (mainly volatile fatty acids) associated with microbial community structure (microbiome density). As such the visitor successfully introduced the whole system of the ex-vivo cultivation (Figure 1). Meanwhile, the proportion of methane in the gas failed to analyse by a gas chromatography (GC) system equipped on site (i.e., in the host institute) which was under maintenance. Instead, we found an instant way of gas preservation to collect the gas from the bottle by a syringe and injected it into vacuum-blood collection tube (Vacutainer) then sealed. Back to Japan and analysed GC to find comparable results of gas composition to those of other fermentation experiment the visitor has ever done.

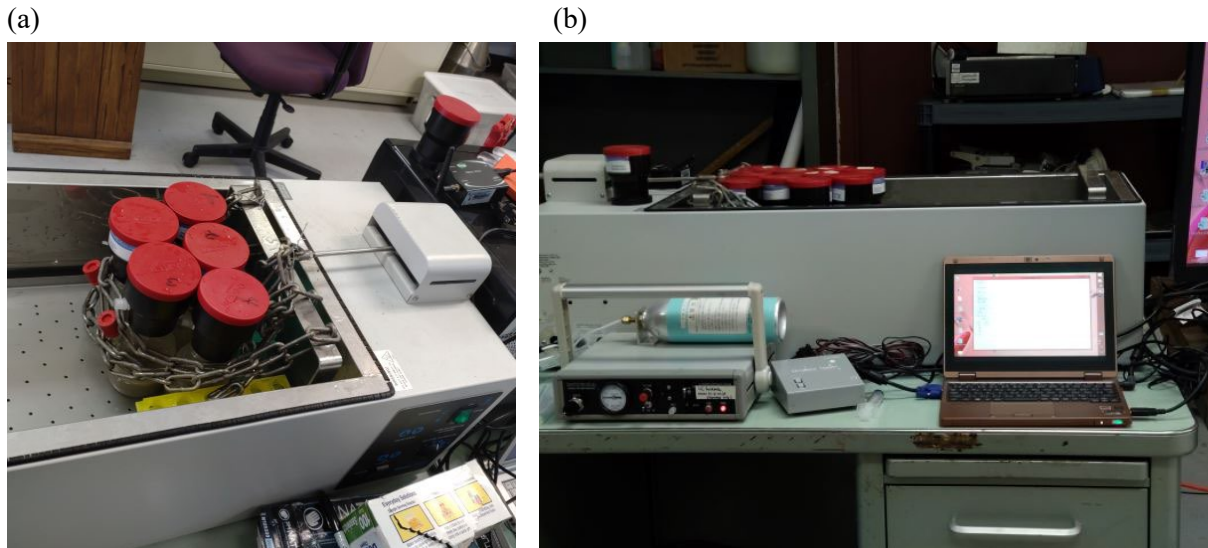


Figure 1. Ex-vivo cultivation system (a) and a portable gas chromatography (b)

2.2 Application of developed methodology to novel feed resource investigation

Our collaboration research also focused on developing practical nutrition-based low-emission, high-deposit animal production systems that can be expanded to the farm scale. To discover the feasibility of unused resource for ruminant feed which involves enteric methane reduction we analysed several varieties of treated grains ordinary ration was partly substituted by the four treated grains (A to D) as a substrate of the ex-vivo cultivation. As shown in Figure 2, there were some remarkable variations of fermentation characteristics and the amount of methane production during fermentation. These outcomes will further contribute to determining the diversity and functionality of the rumen microbial communities, and then describe practical means to amend ruminant health and productivity by optimizing the activity of inherent rumen microbes under specific conditions.

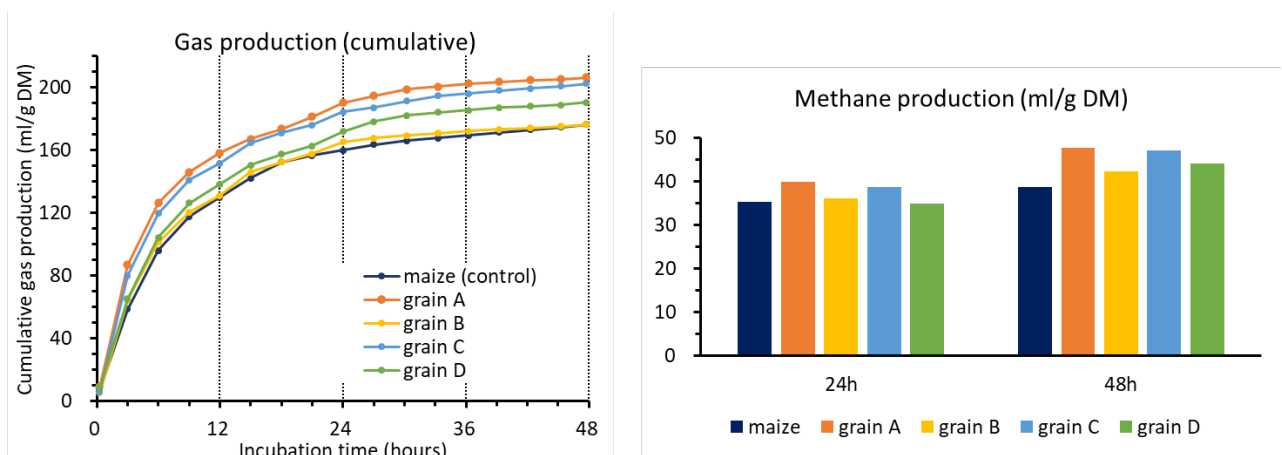


Figure 2. Ex-vivo fermentation results of cumulative gas production (a) and methane production (b).

The project is on the way to being achieved: The data or research is still ongoing or being analysed. It is expected that the research goals, i.e., to discover the potential benefits of feeding novel feed resource will be reached completion of this collaborative project.



3. Will there be any follow-up work?

- Our team has been preparing one original research article for submission.
- My fellowship gave technical support for successful approval of a new research budget awarded for the host researcher, which still involves me as a contribution member.

4. How might the results of your research project be important for helping develop regional, national or international agro-food, fisheries or forestry policies and, or practices, or be beneficial for society?

While this collaborative research well contributes to the development of an abatement strategy for GHG emissions, it will also provide insight into how best to apply dietary introduction of novel resources, to improve the efficiency of animal production and animal health. The experiment provided data that will be relevant to present a strong background for animal producers to pay more attention to improving profitability in their business. These will be useful to improve the producers' practices and enable the consumer to make sustainable choices.

The research budget recently awarded for the host ultimately aims to this innovative objective described above. Furthermore, this program will promote international scientific cooperation, together with encourage advanced animal production countries to expand the relationships with developing countries where they have rich feed sources plants containing a wide variety of feed resources that have been yet used to address the challenge of establishing a better animal production system and sustainable environment.

5. How was this research relevant to the CRP research theme?

This project fits within the frame of Theme "MANAGING RISKS IN A CONNECTED WORLD" of the CRP by 1) implementing solutions to address conflicts lying between animal husbandry as a human activity and a sustainable environment and 2) suggesting an approach for the efficient use of natural resources to enhancing sustainability. Project members are experts in various scientific fields, such as intestinal microbiology, plant chemistry, animal nutrition, and feed science. This multidisciplinary project will be essential to accomplishing the stated research objectives.

6. Satisfaction

- Did your fellowship conform to your expectations? - - Yes, it definitely does.
- Will the OECD Co-operative Research Programme fellowship increase directly or indirectly your career opportunities? - - It will probably do.
- Please suggest any improvements in the Fellowship Programme.
 - The currency rate has changed compared to the time of decision, so it would be better to adjust the amount to meet with the rate at the time of provision

7. Advertising the Co-operative Research Programme

- How did you learn about the Co-operative Research Programme?
 - Via E-mail notification from University office
- What would you suggest to make it more "visible"?
 - Sorry, I have no idea with it.

