広島大学大学院生物圏科学研究科 主催
広島大学日本型（発）畜産・酪農技術開発センター / 広島大学日本食の機能開発センター 共催

第 8 回 食料・環境問題国際シンポジウム
「安全な食料の持続的生産」

8th International Symposium on Food and Environment
"Sustainable Safe Food Production"

日　時：平成２７年１１月１３日（金）　13:00 – 16:30
場　所：広島大学生物生産学部 C206 講義室

Date: 13 November, 2015 (Fri.)　13:00 – 16:30
Venue: Room C206, Faculty of Applied Biological Science, Hiroshima University

研究科長からのご挨拶

急増する世界の人口に対し、十分かつ安全な食料をどのように確保するかは人類に課せられた直近の大きな課題です。人類の生存に欠かせない食料は、農作物、畜産物、天然資源および養殖の水産物として供給されています。しかしながら、近年の地球温暖化、異常気象、環境汚染によって各地域の伝統的な農作物が栽培に適さなくなり、世界的には農地の砂漠化が進行し、農地や沿岸域の汚染も続いています。私たちはこのような状況のなかで、安全で環境にやさしい手段で持続的な食料生産を行っていく必要があります。このシンポジウムでは、食料の健全で安定的な生産に関する具体的な方策についての情報を共有するとともに、将来に向けた提言やシンポジウム参加国間の技術および教育などの国際協力についても、活発に意見交換ができることを期待しています。

研究科長　　植松　一眞

Greetings from the Dean

Living in a sustainable world today presents an urgent and tremendous challenge for humans in their effort to provide safe and secure food supplies to feed the rapidly growing global population. Foods have supported the survival of humankind in the form of crops, farmed livestock as well as products of aquaculture and marine natural resources. However, traditional crops in each region are threatened with extreme weather changes, global warming and environmental pollution in recent years with desertification and pollution of farmlands and coastal areas becoming common around the world.
We are confronted with questions on how to achieve sustainable and eco-friendly food production targets to protect human health. This symposium will present current situations and issues as well as future prospects of sustainable and safe food production. Through this symposium, information can be shared on the current state of healthy food production, while cooperation in education and technology developed in different countries can be discussed. I hope that the active exchange of ideas and opinions can be pursued in this symposium.

Dr. Kazumasa Uematsu, Dean

Program プログラム

General Chairperson 総合司会: Lawrence M. Liao

13:00 広島大学大学院生物圏科学研究科とカナダ・アルバータ大学農学・生命・環境学部との部局間国際交流協定締結

Formal announcement of the MOU between the Graduate School of Biosphere Science, Hiroshima University and the Faculty of Agricultural, Life & Environmental Sciences, University of Alberta, Canada

Opening Message シンポジウム開会のご挨拶

Kazumasa Uematsu, Dean 研究科長 植松 一眞

Rationale of the Symposium 趣旨説明

Hiroshi Sakugawa, Vice Dean 副研究科長 佐久川 弘

13:10 "A novel approach to mitigate methane emission from ruminants"

（反芻動物からのメタン放出を抑制する新規な方法）

Dr. Masahito Oba (University of Alberta, Canada)

Chair 司会: Toshihisa Sugino 杉野 利久 --- Page 3

13:50 "Pre-Columbian horticultural practices of the Indigenous Peoples of the Americas"

（アメリカ先住民のコロンブス（アメリカ到着）以前の園芸法）

Dr. Noreen Willows (University of Alberta, Canada)

Chair 司会: Toshinori Nagaoka 長岡 俊徳 --- Page 4

14:30 Coffee break 休憩

Reports of studies supported by the 2014 Grant-in-Aid for Research from the Graduate School of Biosphere Science 2014 年度研究科長裁量経費による助成研究成果報告

14:50 "Roles of gluten in food system and development of gluten free products"

（グルテンの食品製造・加工における役割およびグルテンフリー食品の開発）

Dr. Masubon Thongngam (Kasetsart University, Thailand)

Chair 司会: Norihisa Kato 加藤 範久 --- Page 5

15:30 "Evaluation and utilization of rice as alternative feeds for cattle"

（ウシに対する代替飼料としてのイネの評価と利用）

Dr. Taketo Obitsu (Hiroshima University, Japan)

Chair 司会: Akihiro Ueda 上田 晃弘 --- Page 7

16:10 General Discussion 総合討論

Chair 司会: Hiroshi Sakugawa, Vice Dean 副研究科長 佐久川 弘

16:25 Closing Remarks 閉会の辞 Yukinori Yoshimura, Vice Dean 副研究科長 吉村 幸則

■**Reports of studies supported by the 2014 Grant-in-Aid for Research from the Graduate School of Biosphere Science, Hiroshima University** 2014 年度研究科長裁量経費による助成研究報告

A novel approach to mitigate methane emissions from ruminants

Masahito Oba
Department of Agricultural, Food and Nutritional Science,
Faculty of Agricultural, Life & Environmental Sciences, University of Alberta, Canada

Methane is a greenhouse gas emitted by livestock industry, and it has a global warming potential 21 times that of carbon dioxide. It has been estimated that cattle alone are responsible for 11 to 17% of the methane generated globally. In addition to environmental concerns, methane emissions account for approximately up to 12% of the ingested gross energy of cattle, affecting the efficiency of energy utilization. Enteric methane emissions from cattle can be reduced through dietary manipulations, natural compounds such as tannins and saponins, and synthetic compounds. Recently, 3-nitrooxypropanol (NOP) was identified as a potential inhibitor of enteric methanogenesis from an in vitro rumen simulation screening assay. Two studies were conducted at the University of Alberta to confirm efficacy of NOP in reducing methane emissions while evaluating its effects on rumen fermentation, nutrient digestibility, and animal productivity. In Study 1, twelve ruminally cannulated Holstein cows were used in a crossover design with 28-d periods. Cows were fed a diet containing 38% forage on a dry matter basis with either 2,500 mg/d of NOP or silicon dioxide (control). Enteric methane emissions were measured using the sulfur hexafluoride tracer gas technique. Feeding NOP did not affect dry matter intake (DMI); however, methane production was reduced from 17.8 to 7.2 g/kg of DMI. No change in milk or milk component yields was observed, but cows fed NOP gained more body weight than control cows (1.06 vs. 0.39 kg/d). Concentrations of total volatile fatty acids in ruminal fluid were not affected by treatment, but a reduction in acetate proportion and a tendency for an increase in propionate proportion was noted, and as such, a reduction in the acetate-to-propionate ratio was observed (2.02 vs. 2.36). Protozoa counts were not affected by treatment; however, a reduction in methanogen copy count number was observed when NOP was fed (0.95 vs. 2.69 × 108/g of rumen digesta). In Study 2, fifteen ruminally cannulated Holstein cows were used in a 3 × 3 Latin square design with 28-d periods. Cows were fed a 60%-forage diet (dry matter basis) with either 2,500 (HIGH), 1,250 (LOW) or 0 (CON) mg/d of NOP. Feeding NOP reduced methane yield from 19.9 to 15.3 g/kg DMI for CON vs. LOW and from 19.9 to 12.6 for CON vs. HIGH. In addition, there was a decrease in molar proportion of acetate and increase in molar proportion of propionate with feeding NOP in a dose dependent manner, and apparent total tract digestibility of dry matter (62.7 vs. 58.4%) and neutral detergent fiber (38.0 vs. 30.7%) were increased with the HIGH dose compared to CON. However, feeding NOP at either dose did not affect DMI, milk production, body weight gain, microbial profile and ruminal pH. These data indicate that feeding NOP to lactating dairy cows can reduce methane emissions without compromising DMI, apparent total tract nutrient digestibility, or milk production.

Pre-Columbian horticultural practices of the Indigenous Peoples of the Americas

Noreen Willows
Department of Agricultural, Food and Nutritional Science,
Faculty of Agricultural, Life & Environmental Sciences, University of Alberta, Canada

The Indigenous peoples of the Americas excelled at plant domestication. In 1492 when Christopher Columbus arrived in the Caribbean nearly 300 food crops were being cultivated in South, Central and North America, including corn (maize), potatoes, beans, manioc, peanuts, tomatoes and squash. Many of these crops were introduced to Europe, Africa and Asia in the 15th and 16th centuries. It has been estimated that foods domesticated in the Americas constitute 60% of the world's crops now in cultivation. This transfer of crop plants between the American and Afro-Eurasian hemispheres was part of the 'Columbian Exchange'. In this presentation, I will talk about important crop species developed by Indigenous peoples of the Americas. I will discuss horticultural methods that were used by Indigenous peoples and whether these ancient horticultural practices can help sustainably and efficiently produce safe food today. One such method is the interplanting of corn, beans and squash. This sophisticated method of companion planting was used by First Nations peoples of Canada and the United States. It provided long-term soil fertility and a healthy diet. This intercropping system was more advanced than agricultural methods employed by Europeans at the time they arrived in the Americas. In Canada today, companion planting is being investigated as a sustainable way to increase crop yields, reduce fertilizer use, and maintain soil health. The Aztecs had irrigation systems, formed terraced hillsides, and fertilized their soil. They developed chinampas, also known as "floating gardens", which had very high crop yields. These artificial islands were created by building up extensions of soil into shallow lake beds. Chinampas may be a viable model for modern sustainable agriculture. The Indigenous peoples of Peru improved agricultural yield with guano (i.e., seabird droppings), which is an excellent plant fertilizer due to its high content of nitrogen, phosphate and potassium. Incan law stated that killing or disrupting the nesting birds that produced guano was punishable by death. Europeans began harvesting vast quantities of guano and by 1900, many guano deposits were depleted. Today, farmers are again investigating organic fertilizers for their crops.

Roles of gluten in food system and development of gluten free products

Masubon Thongngam
Department of Food Science and Technology, Faculty of Agro-Industry
Kasetsart University, Bangkok, Thailand

At the present, gluten-free products become popular and get a lot of attention from health concern consumers globally. Consequently, the number of gluten-free products has increased dramatically and their quality has also been improved drastically in recent years. Initially, gluten-free diets were created for the specific group of consumers who have been diagnosed with “Celiac disease”

Celiac disease (CD) is an autoimmune disorder involving both an innate and adaptive immune response, occurring in genetically predisposed children and adults. This disease could be stimulated by the prolamin proteins of wheat (gliadin), rye (secalin), barley (hordein) and other grains closed to wheat family. After exposure to the prolamin protein, it could cause damages to the small bowel mucosal area leading to malabsorption of micronutrients such as iron, folate, vitamin B as well as calcium. Nowadays, the patients who are diagnosed with Celiac disease have increased. In US, 1% of general population or around 1 to 133 were diagnosed with CD and also 1:232, 1:50 and 1:100 in Netherlands, Finland and UK respectively. There are no medical treatments for Celiac disease and the only treatment presently is lifelong adherence to a strict gluten-free diet. U.S Food and Drug Administration (USFDA) has defined the term “Gluten-free” product as the product contained less than 20 ppm (mg/kg) of gluten. This definition has been used by other countries as well. In addition, the U.S has also established new regulation for food labelled gluten-free as: no gluten containing grain present in the product and the food could only contain the ingredients derived from a source containing gluten but it has to limit to a level of less than 20 ppm.

Gluten defines as a cohesive, viscoelastic proteinaceous material. It consists of 2 types of proteins, gliadin and glutenin, usually presenting in wheat. Gliadin contributes to the viscosity and extensibility of dough system; while glutenin gives cohesiveness and elasticity. Usually gluten is frequently used as a major ingredient in bakery or cereal based products; however, there are other ingredients derived from wheat and barley such as soy sauce, malt and malt syrup also adding into food product.

Due to the increase of diagnosed Celiac disease and wheat related food illness patients as well as the health concern consumers, there are many gluten-free products available in the market presently. However, the quality of these products is still inferior when compared with wheat products. According to gluten functionality, it plays a critical role for developing three-dimensional network, contributing to textural and sensorial properties of products. Therefore, there are many researches conducting to find alternative resources to replace wheat to overcome these disadvantages. Presently, the uses of non-gluten protein source and alternative flours have been developed. In addition, sometimes the mixtures of different sources have been studied as well in order to achieve the desired viscoelastic properties.

Nowadays, the alternative flours frequently used to replace wheat are rice, sorghum, corn, millet, teff, ragi, Job's tear, potato and tapioca; however, these flours have limited structure building potential. Therefore, the mixtures of different flours are developed in order to get the desired texture. Furthermore, there are other protein sources used to replace wheat gluten and improve product quality like milk protein and legume protein. In addition, other ingredients such as hydrocolloids are also added to improve the quality of gluten-free products. Even though the incorporating blends of ingredients or developing new formulation could improve the quality of the products, the processing parameter could also reinforce the improvement. There is a research study on the effect of particle size on the characteristics of final bread and its result showed that the smaller flour particle size caused the weaker structure and retained less CO_2 leading to smaller loaf size.

Presently, the market share of the gluten-free product has increased drastically each year due to the increase number of diagnosed celiac disease and other wheat related food illness patients. Moreover, there are more customers believing that the "gluten-free" products are healthier. With the market growth, the development of gluten-free product quality is continuing in order to improve both textural and nutritional properties. It is now a challenge to find proper alternative resources to replace wheat perfectly as well as process that could industrialize and low cost.

Evaluation and utilization of rice as alternative feeds for cattle

Taketo Obitsu
Animal Science Division, Department of Bioresource Science
Graduate School of Biosphere Science, Hiroshima University

Introduction

The number of dairy farmers and the amount of milk production in Japan are gradually declining because of higher production costs. Global fluctuation in cereal and forage prices raises feeding cost for livestock farmers dependent upon imported feeds. In fact, Japan's feed self-sufficiency ratio is calculated at 27% on total digestible nutrient basis. To improve the low self-sufficiency of feed and to reduce production cost, Japanese government promotes increasing the production and utilization of domestic feeds. One of the strategies to improve feed self-sufficiency and to reduce feed cost is the utilization of rice as livestock feeds. Although rice is the main staple food in Japan, domestic rice consumption is decreasing due to the growing westernized life style. Cultivating feed rice would then contribute to preserve rice fields and rural communities. In addition, the production of feed rice contributes towards maintaining the material cycle between livestock and crop farming sectors by exchanging feeds and manure.

Recently, various types of feed rice have been developed to be used for whole-crop silage and grain sources. In this talk, I present recent findings on nutritional properties of various types of rice feeds for dairy cattle.

Rice grain

Both unhulled rice grain and brown rice grain are used for dairy and beef production, although the crushing treatment is necessary for unhulled rice to improve digestibility. For brown rice, processing such as crushing, steam flaking and pelleting are also applied. The starch content of brown rice is similar to that of corn grain. Unhulled rice has low starch and high fiber contents compared with brown rice. Ruminal starch degradability of rice grain is higher than in corn but lower than in barley and wheat. For dairy cows, steam flaked brown rice can be used in mixed diets at the level of 30% of dry matter without adverse effects on milk production.

Whole-crop rice silage

Whole mature rice plants can be used as whole-crop silage. Harvested whole plants are chopped, baled and wrapped, then preserved as round bale silages. Nutritional values of rice silages prepared from the conventional cultivar are lower than those of grass or corn silages, because they have high lignin content and cause fecal loss of ingested paddy. To address these problems, new types of cultivars which have low-panicle and high leaf and stem proportion have been developed. These types have high sugar content in the stem and leaf. Paddy excretion is low due to the low proportion of panicles. The short panicle type shows higher fiber digestibility and less fecal paddy excretion, which contributes to higher energy content of the short panicle type silage. However, the higher starch degradation of rice grain in whole-crop silage may affect ruminal fiber digestion.

Amino acid supply for rice diets

Both grains and silages of corn and rice have relatively low protein content. Thus, optimum supply of protein and amino acids for rice diets needs to be considered. No difference in amino acid flux released by visceral tissues was observed between the corn and rice grain diets with or without methionine. Even in a more practical study, supplementation of methionine did not affect milk production and mammary arterial-venous differences of amino acids in lactating cows fed the rice grain or rice silage based diets.

Alcohol in whole-crop rice silage

Whole-crop rice silage contains relatively higher amount of ethanol (about 5% of dry matter) compared with grass silage and whole-crop corn silage. Dietary alcohol is absorbed in the gastrointestinal tract and probably affects energy and amino acid metabolism in ruminants. Ruminal ethanol infusion for sheep with restricted feed intake reduced glucose concentration but increased triglyceride and lactate concentration in the plasma. The reduction of plasma methionine concentration was also observed with ruminal ethanol infusion.

The information of the nutritive values of the rice diets for ruminant production has been accumulated in the past few years, which proved that these diets can replace imported feeds to some extent. Further studies need to explore utilization of these feed resources for sustainable and value-added livestock production.