Ruminant Nutrition: The Role of Agricultural by Products in Beef Cattle Production

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ABSTRACT

Increasing demand on food of animal origin including red meat in developing country is predicted doubled or even three fold in 2050, while the production especially that from ruminant legs well behind the projected human requirements. Feeding and nutrition have been reported to be the main constraint to ruminant production. In Indonesia, such as in other tropical countries, availability of feedstuffs is fluctuating during the year. Discussion on the available feeds is urgent in the face of rapidly depleting natural resources, climate change, urbanization, population pressure, decreasing land for crop production, and the increasing competition of arable land for food, feed and biofuel production. The efficiency of use of the available feed resources is very important and determinant for animal performance and productivity. The utilization of low quality feed mainly from crop residues as well as agricultural by products and other non-conventional feed resources has a common practiced. However, the different technologies are needed to maintain feed availability, improve feed quality and to optimize the nutrient utilization by the animal. This paper discuss briefly role of agricultural by products in beef cattle production. One may explore more comprehensive information concerned in this issue by accessing the papers and previous review papers as indicated in the references listed.

Key Words: Agricultural by Products, Nutritive Quality, Beef Cattle

INTRODUCTION

The production cost of animal agriculture has been increased, due to among other the increased demands of grain for food and other feedstuffs for bio-fuel production. Competition of feedstuffs utilization for bio-fuel will limit the availability of feedstuffs for animal feeding and then direct or indirectly stimulates increase of feed price. Ruminants in the tropics are in a unique position to help satisfy this demand because of the sheer abundance of crop residues and other low quality roughages often referred to as 'lignocellulosics' and their potential to support ruminant production if specific nutritional strategies are employed. Agricultural-and industrial by-products are generally rich in fiber, less digestible and less efficient to the animal. The quality and quantity of feed provided to animals is the most important input for increasing the animal productivity. The increasing expansion of agro-industrial activity over the last few years has led the accumulation of a large quantity of lignocellulosics residues all over the world.Readers may refer to the several review papers as listed in the references (Leng, 1990; Westendorf, 2000; Agus, 2009; Davendra and Leng, 2011; Makkar, 2012; Makkar and Beever, 2012; Madhwa and Bakhsi, 2013).

AVAILABILITY OF FEED RESOURCES

In Indonesia and also generally in Asean countries the major agro-residues in term of volumes generated and used as ruminant feed can be classified as : 1) crop residues were found to be rice straw, rice husk, sugar cane tops, corn stover, corn stalk, soy bean hulls, 2) agro-industrial by products were found to be cereal bran, coconut cake, palm kernel cake, soya bean meal, molasses, biofuel co-products such as distillers dried grains and soluble (DDGS), pineapple waste, tapioca by product (onggok), coffee seed pulp,;3) non-conventional feed resources, and this category includes diverse feeds and by definition refer to those feeds that are not traditionally used in animal feeding; examples are oil palm leaves, palm press fiber, cassava foliage and other tuber foliage, sugar cane bagasse, cotton seed meal, rubber seed meal, cacao pod, fruit and vegetable wastes, aquatic plants such sea weed, and former foodstuffs(Davendra and Leng, 2011). Former foodstuffs and it should not be confused with food and catering waste that is not allowed to use as animal feed. Here we talk about former foodstuffs that are removed from the human food consumption market, by food manufacturers, because of unintentional and often unavoidable production errors. Examples of former foodstuffs used in animal feed are broken biscuits and chocolates, surplus bread, incorrectly flavored crisps, breakfast cereals, soy sauce, noodle (Westendorf, 2000). These former foodstuffs are now already commonly used as concentrate ingredient for beef cattle fattening in Indonesia.

The fibrous crop residues which have in common high biomass, low crude protein (3-4%), and high fiber content (35-48%). According to Egan (1989), crop residues can be subdivided into three categories: 1) those with low cell wall, crude fiber and lignin contents, and low digestibility (30-40%) and intake; these are not improved by chemical treatment; 2) those contains low cell wall, medium digestibility (40-50%), and capable some improvement with chemical treatment; 3) those with high cell wall contents, not highly lignified, high digestibility (50-60%) and intake. These fibrous crop residues form the base in feeding systems for ruminants and include all cereal straws, sugar cane tops, bagasse, cocoa pod husks, pineapple waste and coffee seed pulp. It is quite clear that feed availability is existing with plentiful and various type of feed. However, it seems to be quite difficult to find the quantitative data for each feed and the extent to which such feed is utilized. Quantitative estimates of the availability of feed resources and their used for ruminant feeding is needed to be updated (Davendra and Leng, 2001).

CHARACTERIZATION OF AGRICULTURAL BY PRODUCTS

According to Leng (1990), agricultural by products or crop residues that is considered also as low-quality forages are defined as those forages which are less than 55% digestible and are deficient in true protein (less than 80 g crude protein (nitrogen x 6.25; CP)/kg) and low insoluble sugars and starches (usually less than 100 g/kg). Low-quality forages are not used as the basis of diets in most temperate countries, but in tropical and subtropical countries often comprise practically the whole diet of ruminantseither grazing or fed under subsistence conditions. In these countries, which are mostly in the tropics, crop residues are a major component of a diet for large ruminants for a considerable part of or throughout the year.

The efficiency of utilization of 'low-quality' roughages by ruminants for productive purposes is altered by numerous factors which are associated with the feed or the animal. These include: 1) the availability of microbial nutrients in the feed to support an efficient microbial growth, and a high rate and extent of digestion in the rumen which in turn optimizes intake;2) the ratio of soluble cell components to refractory cell wall carbohydrates in the forage. This ratio markedly affects the population density-mix of the major micro-organisms in the rumen (e.g. bacteria, fungi and protozoa);3) the physiological state and previous dietary and health history of the animal which determines the quantitative demand for and balance of nutrients required; 4) the thermal environment which determines the requirements for substrate oxidation for maintenance of body temperature and alters the balance of nutrients available for anabolic functions;5) the chemical and physical characteristics of forage which determine the proportion of feed digested by microbial fermentation and the dietary nutrients that escape rumen fermentation and are available for digestion and absorption in the intestines.

ENSURING A BALANCED NUTRITION FOR RUMINANTS ON CROP RESIDUES-BASED DIETS

The priority for improving the utilization of a low-digestibility forage by ruminants is to optimize the availability of nutrients from fermentative digestion by: 1) ensuring that there are no deficiencies of microbial nutrients in the rumen and, therefore, the microbes in the rumen grow efficiently and, through fermentative activity, extract the maximum possible amounts of carbohydrate from the forage (i.e. the production rates and ratio of microbial cells to volatile fatty acids (VFA) produced is high); 2) ensuring that the microbial cells (which provide most of the protein to the animal) synthesized in the rumen are not lysed and fermented in the rumen but are available for digestion and absorption as amino acids from the intestines. It is also necessary to optimize the efficiency of utilization of the nutrients that arise from fermentative and intestinal digestion by supplementing with critical nutrients that escape orbypass rumen fermentation (Leng, 1990). This is to augment and balance the nutrients absorbed to provide sufficient for maintenance of homeostasis, maintenance of body temperature, exercise (or work), and any particular physiological or productive function. In any one location, therefore, supplementation strategies will need to vary according to climate, management and production targets.

OPTIMIZING MICROBIAL GROWTH IN THE RUMEN

The rumen microbes have specific requirements for both macro- and micro-minerals to meet the needs of structural components of cells and for components of enzymes and co- factors. Little is known about the requirements of the microbial milieu for trace elements and as a 'rule of thumb' it is accepted that if the animal is not deficient then it is unlikely that the rumen microbes will be deficient. However, there is more known about the requirements of microbes for sulphur, phosphorus, magnesium and ammonia (Durand and Komisarczuk, 1988). As with any deficiency of a nutrient, the likely scenario of a mineral deficiency for rumen organisms is first a reduced growth efficiency of microbes (lowered ratio of cells to VFA produced) with or without a decrease in digestibility. As the deficiencies become more extreme the digestibility of forage must decrease along with the decrease in microbial pool size and it is only then that feed intake will decrease. Correction of the deficiency will obviously have the reverse effects.

Requirements for Sulphur

Sulphur(S) is critical in the rumen for the synthesis of S-amino acids for microbial protein synthesis. A critical level in the rumen is 1ug/ml (Bray and Till, 1975). Lower levels than this are likely to deplete the size of the microbial pool, eventually decreasing digestibility in addition to lowering the protein:energy (P: E) ratio in the nutrients absorbed. The rumen fungi appear to be particularly dependent on S and grow only at low rates where plant materials are low in S. There is an absolute requirement for S and this is unrelated to CP content of a diet. Under S deficiency state, copper toxicity can result, particularly in fauna-free ruminants. S deficiencyof livestock, however, may be widespread in the tropics because of high rainfall and the highly soluble nature of most natural S salts in soil (Leng, 1990).

Requirements for Phosphorus

Phosphorus (P) deficiency is often widespread in tropical countries and P supplementation for the animal and the microbes is essential. Most protein meals or grain by-products are high in P (5-10 g/kg) and supplements of proteins often correct such a deficiency. Undoubtedly during long periods of P deficiency this mineral may become deficient in the rumen, and will reduce microbial growth efficiency and at times digestibility and intake of forage (Durand et al. 1986). Where a protein meal is used to supplement a low-quality straw-based diet there is little likelihood of a P deficiency in the rumen.

Requirements for Magnesium

Magnesium (Mg) is often deficient in young grass, tropical forage, straw and other low-quality forages and a deficiency of Mg can reduce the digestibility and intake of forage as Mg is essential for all rumen micro-organisms and particularly for cellulolytic microbes. Mg sufficiency is a precondition for the optimal utilization of low-quality forages. Mg is not likely ever to be deficient in isolation and ‘shot gun’ mixtures are often the best approach to correct such a deficiency.

Requirements for Ammonia

Ensuring adequate ammonia in the rumen to supply the majority of N for microbial growth is the first priority in optimizing fermentative digestion of forage. Satter and Slyter (1974) suggested that 50-80 mg ammonia per liter rumen fluid was the optimum for maximizing microbial growth yield and this has been widely accepted. However, studies from two laboratories in Australia have indicated that the minimum level of rumen fluid ammonia for optimum voluntary intake of low-N, low-digestibility forage by cattle is about 200 mg/liter even though the digestibility of the forage (in nylon bags) was optimized below 100 mg/l (Leng, 1990).

IMPROVING NUTRITIVE VALUE OF CROP RESIDUES

Several different technologies i.e. physics, chemical, biological or microbiological technology are required to maintain feed availability, to improve feed quality and to optimize the nutritive value of the diet. The technology by utilizing microorganism in feed has long been well known such as the utilization of microbes in the ensilage process. The main objective of microbes utilization in animal feed are: 1) preserving and maintaining the nutritive value by fermentation technology such as ensilage, 2) improving the nutritive value of low quality feedstuffs and 3) improving the stomach (rumen) condition thus optimizing the digestion and absorption of the nutrients by the host. The microbes effective (or effective microorganisms) to be used in animal feed might be bacteria, fungi, yeast or mixture of them (bacteria, yeast, fungi) or its fermentation products or extracted products of fermentation process such as enzymes. At this time being, some commercial farms in Indonesia have already adopted this method of fermented rice straw as the fiber sources of the livestock (Agus, 2009).

Basically, biological treatment is a limited composting. During the composting, decomposition of organic matters occurs through biochemical process that involved microbes. In the initial process of composting, the temperature will increase and microbes will multiply. Later, the degradation will slowed down until the balancing point is reached. During the fermentation, the protein percentage will increase, and most of component’s residue that had been digested from the metabolized one will decrease the dry matters digestibility. Utilization of EM in the fermentation process of rice straw has shown the positive impact on the nutritive value to the animal. This method has been adopted by many farmers and feedlot industries in many parts of Indonesia (Agus, 2009).

Effective microbes has been using in the animal production to optimize the nutritive value of low quality feed and improve the performance of livestock. Many types of EM, single or mixture of different microorganisms, have been commercialized and now available in the market. In Indonesia, the utilization of EM in laboratory scale or field conditions has been practiced widely and showed the positive effects to the animal performances. However, the mode of action of the EM in the digestion, metabolism and its safety aspect, as the increased demand of natural and healthy animal product, thus it need further evaluation.

CONCLUSION

The availability and efficient use of the feed resources are the primary driven of performances to optimize productivity from livestock. Role of agricultural by product will play more and more important in the future for ruminant feeding especially in the topics. Underutilized feed resources available such as fibrous crop residues, agro-industrial by products or other non-conventional feeds need to be optimized either through biotechnology treatment such as fermentation method to improve their nutritive quality or supplementation strategies especially minerals or protein sources to optimize the rumen microbes in fermenting the fibrous feed thus maximizing their nutrients used for optimum ruminants production. Further research on quantitative estimates of respective agro-industrial feed resources and its utilization for optimum ruminant production is required particularly in the tropical regions.

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