ENERGY SUPPLY FOR MICROBIAL PROTEIN SYNTHESIS IN RUMINANT ANIMAL NUTRITION: A REVIEW

[1]Ocheja, J.O,[2]Damba, D.B,[3]Adejo, C.O[3], [1]Maisakala, A.A, [1]Lamido, A.I[1],[1]Musa, K, [5]Oricha, M.I [5]Amedu,G and [4]Ayuba, E.M

[1]Department of Animal Science, Federal University, Kashere, Nigeria

[2]Department of Animal Health and Production Technology, Federal College of Horticulture, Dadin Kowa, Nigeria

[3]Department of Animal Production, Kogi State University, Anyigba, Nigeria

[4] Department of Agronomy, Federal University ,Kashere, Nigeria

[5]Department of Animal Health and Production Technology, Kogi State Polytechnic, Itakpe Campus, Nigeria

(Ocheja, J.O josiahocheja@yahoo.co.uk)

AiBSTRACT

The production of high quality protein such as meat, milk and eggs for human consumption and by-products such as hides and skin, wool, fur, hoofs, horns and manure requires large quantities of protein and energy thus a good understanding of the protein and energy requirements as well as the mechanisms of energy supply for microbial protein synthesis is important for improving efficiency of production.Consequently various relationships or interactions between protein and energy as well as mechanisms for energy supply for microbial protein synthesis as elucidated by various researchers were collated and reviewed.Further research at cellular levels on the energy requirements and supply for microbial protein synthesis especially those that are very practicable and could be easily applied by farmers was recommended.

Keywords: Energy, Nutrition, Microbial Protein, Ruminant Animals

INTRODUCTION

The production of high quality protein in the form of meat, milk and eggs for human nutrition and other by-products such as hides and skin, fur, horns, fibre, Hooves etc, requires the production and supply of energy (MacDonalds *et al*.,2002),these non food by-products are raw materials for industries that helps to develop the economy.(Abalaka *et al*, 2021)

The net protein synthesis (protein deposition, protein in milk, eggs, meat, protein for production of fibre etc.) is a process which requires much energy (Mac Donald *et al*, 2002)The way an animal is fed also reflects in the quality of its products and by-products (Ocheja *et al.*,2020)

Consequently a concise and systematic study of the mechanisms of energy production and distribution for the production of microbial protein and hence production of high quality protein products such as meat and milk as well as other by-products is very important and the application of this knowledge will lead to a more productive, and more efficient ruminant animal production.

This paper gives a review of how energy is produced and made available for microbial protein synthesis.

MATERIALS AND METHODS

Literatures on energy production and supply for microbial protein synthesis were assembled from journals, conference proceedings, books and from the internet, there after discussed and reviewed.

RESULTS AND DISCUSSION

Energy Requirements for Microbial Protein Synthesis

The Portion of the true energy (or of the protein) which is available for production is the amount remaining after the maintenance needs are satisfied. These maintenance energy and protein (or nitrogen) are proportional to (or dependent on) the metabolic size of the animal ($W^{0}.^{75}$ kg).

The amount of energy available for microbial protein synthesis was defined in terms of the proportion of apparently digestible organic matter (DOM). That is apparently digested in the rumen (ARC, 1984).

The value adopted in ARC (1984) was 0.65 for all diets for both sheep and cattle. Microbial protein synthesis should be related to the amount of fermentable metabolizable energy (FME) in the feed (ARC 1993) Sophisticated models attempt to relate microbial yield with the rate of carbohydrate fermentation and rate of passage, theoretical growth rate, the energy cost of bacteria maintenance and the form of nitrogen available to the micro-organisms. Many of the relationships involved in such calculations are based on laboratory determination and the value of the models (Mc Donalds*et al*., 2002)

Energy Supply and Mechanisms of Microbial Protein Synthesis

The microbes must have a readily available source of energy for protein synthesis, consequently feeds should be low in rumen degradable protein and high in readily fermentable carbohydrates

If the diet is deficient in protein or if protein resists degradation the concentration of rumen ammonia will be low (50mg/liters) and the growth of rumen microbes will be low ,consequently the breakdown of carbohydrates will be retarded (Mc Donalds*et al.,* 2002) The efficiency with which the nitrogen is captured by the rumen micro-organisms depends not only on the speed and extent of break down but also upon the synchronous provision of a readily available source of energy to fuel the synthesis of microbial protein. Failure to achieve this balance can result to rapid and extensive breakdown and the synthetic powers of the microbes may be overwhelmed. Wastage may then occur since excess ammonia is absorbed and largely excreted as urea , some ammonia is recycled via the rumen, the extent of recycling has been put at 70% of nitrogen intake for diets of low protein (about 5g/kg) and as little as 11%for feeds of about 20g protein/kg

The part of the feed crude protein which is immediately degradable is unlikely to be as effective a source of nitrogen for the microbes as that which is the more slowly degraded nitrogen fraction is incorporated into microbial protein with an efficiency of 1.0, whereas the immediately degraded is less efficiently used. Estimates of the efficiency with which immediately degraded protein is incorporated vary but 0.8 is a commonly used figure , the yield of microbial protein which which becomes available post ruminally by the host has been related to the energy of the diets stated in terms of digestible organic organic matter (DOM) , digestible organic matter digested in the rumen (DOMDR), total digestible nutrients (TDN) net energy for lactation (NEL) metabolizable energy (ME) fermentable organic matter (FOM) fermentable metabolizable energy (FME) and Rumen degradable carbohydrates, the last 3 eliminates fat and products of fermentation , neither of which are considered to provide energy which can be utilized by rumen micro-organisms . The energy of fermentation products is significant in the case of silages and some distillery and brewery products. Hays are not considered to have undergone fermentation, though they often contain measurable amounts of fermentation products such as acetic and propionic acids . The routine measurements of the contributions of fermentation products of metabolizable energy in individual foods has not been a feasible proposition and assumed values are commonly used , the validity of such values is questionable in view of the variation in the magnitude and diversity of the fermentation products in individual foods. (Chestworth,1992)

Nature of Feeds Suitable for Energy Production and Supply for Microbial Protein Synthesis

Chesworth, (1992) reported that microbes use simple compounds when there is no protein available , many cannot use true protein and when presented with an expensive protein will devote much energy to the task of breaking it down into simple (and cheap)compounds.

According to Chestworth(1992)adding a small amount of materials that is readily broken down may stimulate the microbes so that not only do they actively break down this new material , they attack the original food with renewed vigour . Materials which are good sources of instant energy are usually ones with large proportions of Alpa linked polysaccharides in them. In tropical countries this usually mean a grain diet such as maize or sorghum or a sugar by-product such as molasses. The addition of a relatively small supplement of one of these foods to a poor quality diet can lead to a worthwhile increase in intake.

The gross energy values of fibrous residues are as high as almost any other food (around 18 – 19 MJ/kg) but their digestible energies are very low this means that the microbes of the rumen are short of immediately available energy. Most fibrous residues have low levels of crude protein and thus will fail to meet their nitrogen needs, faced with this double failure to meet their nutritional needs , it is not surprising that the microbes are less enthusiastic in breaking down these poor quality roughages . The deficiencies are thus in the provision of a readily available source of energy and in the amount of ammonia which the microbes can use in making up their own supplies of amino acids

The micro-organisms splitting non-structural carbohydrates (NSC) are unable to use amino nitrogen and have to rely on ammonia as their source of nitrogen. It has been claimed that the yield of a non- starch carbohydrates splitting bacteria is increased by almost 20% when the proportion of peptides in the total NSC peptides increase from 0 – 14% , above 14% there is no further increase in yield , the relationship used usedin predicting microbial protein from fermentable energy have high standard error of estimate andshould be used with caution in addition such relationships may be used to calculate to calculate yields of microbial protein only when the energy supply is limiting .

CONCLUSION AND RECOMMENDATIONS

Knowledge of the mechanisms of energy production and supply for microbial protein synthesis and hence their applications could lead to a more productive and more efficient ruminant animal production.

Further research especially at cellular levels on energy production for microbial protein synthesis is required and such research should be ones that are very practicable and the results can easily be applied by farmers.

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