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A REVIEW OF PROTEIN-ENERGY RELATIONSHIPS IN RUMINANT ANIMAL NUTRITION.

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ABSTRACT

The principal aim of animal production is the production of high quality protein products in the form of meat, milk and eggs for human consumption and by-products such as hides and skin, wool, fur, hoofs, horns and manure. The production of these products require large quantities of protein and energy , thus a good understanding of the relationships between the energy requirement and protein production, metabolism in ruminant nutrition and the influence of animal related environmental factors is an important prerequisite for improving efficiency of production. Consequently various relationships or interactions between protein and energy as elucidated by various researchers were collated and reviewed. Further research in the tropics especially those that are very practicable and could be easily applied by farmers was recommended

Keywords: Energy, Nutrition, Protein, Relationships, Ruminant Animals

INTRODUCTION

The principal aim of animal production is the production of high quality protein in the form of meat, milk and eggs for human nutrition. Other products (non food) are hides and skin, fur, horns, fibre, Hooves, Fibre (wool) etc, these are raw materials for industries that help 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), thus a good understanding of the relationship between the energy requirements for protein production, and certain animal related environmental factors in nutrition is an important prerequisite for improving efficiency. Besides the more empirical assessment of such Interaction, the study of interactions at a cellular and at organ level is growing in importance. Consequently a concise and systematic study of the interactions/relationships between protein and energy (carbohydrates lipid and other energy yielding metabolites) is expedient. Given the endemic animal protein shortage in developing countries (Gboshe and Ukorebi 2020), the application of this knowledge will lead to a more productive, and more efficient ruminant animal production.This paper gives a review of the present state of knowledge and future prospects in this field of research.

FEED INTAKE AND ENERGY INTAKE

The most important purpose to which feed nutrients are put is the production of energy;therefore feed intake is almost synonymous with energy intake. The concept of total digestible nutrient which is the sum of all digestible organic nutrients, carbohydrates ,fibre, protein and fats (2.25) represents the approximate energy value of feeds these nutrients may be immediately used for energy or stored as glycogen , fat or gets incorporated into the body tissue. (Mac Donald *et al*,,2002) When ever there is shortage, energy

stored in form of glycogen or fat will be mobilized and when these sources are exhausted, proteins will be hydrolyzed and deaminated and used for energy production.Thus every organic nutrient, is a source of energy (Hagemeister *et al* 1980). MacDonald *et al* (2002) reported that fatty acids absorbed from the blood by the liver

may be catabolized for energy production or used for synthesis of triacylglycerols. These then re-enter the blood supply in the form of lipo protein where they may be used for lipid synthesis for energy production and fatty acid synthesis

EFFECTS OF CARBOHYDRATES AND FATS ON PROTEIN DIGESTION IN RUMINANTS

Fibre may protect the protein molecules from enzymatic action in protein feed stuffs contaianing carbohydrates e.g Bambara nut offal. Reactions may occur between Amino acids of the protein and the reducing sugars to form complexes, the linkages that are produced resist the action of enzyme, the presence of high percentage of fat in the feeding stuff. under heat treatment could impair protein digestibility because of the complex formed by the oxidative products and the protein. Presumably the carbonyl products of fats oxidation may react with epsilon amino group of the lysine chain to produce linkages resistant to reactions of digestive enzymes.(Mac Donald *et al* ;2002) Available evidence suggests that simultaneous presentation of carbohydrates and Amino acids is important for optimum retention of dietary nitrogen, similarly, experimental data with rats and dogs indicate that carbohydrates is most effective in sparing nitrogen when fed with protein. Also other evidence shows that nitrogen retention is improved by feeding carbohydrates and protein simultaneously.

Energy Supply and Milk Protein Content

Hagemeister (1980) reported that at a given level of energy, milk yield increases with protein intake. Bacterial protein synthesis also depends on energy supply. Thus the interaction between dietary protein and dietary energy and the degradability of dietary protein will influence the small response in milk yield (and protein intake).Gordon (1977), demonstrated these relationships and showed the importance of energy supply on protein yield and protein content of milk. An increase in the plain of nutrition is normally associated with an increase in milk protein content (Thomas 1980). The effects are partly related to increase in energy intake..

ENERGY REQUIREMENTS FOR 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 ofthe animal ($W^{0.75}$ kg). The true net nitrogen utilization corresponds to true net energy (Kaufman *et al* 1980). Protein synthesis requires the necessary amino acids as well as Some 5 moles of ATP/mole peptide bond synthesized provided that it does not increase the rate of turn over of already existing tissues . one mole of ATP in the ruminant on average requires 95KJ ME. it means that the energetic efficiency of protein synthesis from ME approximates2400/ (1.1 x 2460 +5x95)77%. In the young rapidly growing ruminant, protein deposition appears to be accompanied by an increased rate of turn over so that a considerable addition of ATP is needed for this purpose, decreasing the energetic efficiency.

ENERGY SUPPLY FOR MICROBIAL PROTEIN SYNTHESIS

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 (DOMR) (ARC, 1984). There is a wide variation in the DOMR/DOM values published for goats but they do not differ consistently from those in the large survey for sheep and cattle (ARC 1980). 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)..

.COMBINING PROTEIN AND ENERGY NEEDS

Protein requirements depend on body weight and rate of gain, as a general rule, the protein requirement for maintenance is relatively lower than the requirement for production.. The metabolizable energy requirements

for calves for maintenance have been estimated as 115 kcal/kg $W^{0.75}$ (ARC 1980). Energy required for gain of real calves was described by Toullec (1989) by the following equation ME=0.1worts + 0.84(LWO0.335) (LW 12) where ME is the metabolizable energy requirements in Kcal, LW is the live weight in Kg and LWG is she live weight gain in Kg Table 1 below shows the approximate amounts of net energy required for different forms of production..

TABLE 1: Approximate Amounts of Net Energy Required for Different Forms of Animal Production

Type of production	Net energy (MJ)
Milk production	3
One litre cow's milk	
Meat production	10
One Kg carcass from young, lean steer one kg carcass form fat old animal	
Wool production	24
One kg of fleece including wanes etc	
Cultivation	3
620kg ox ploughing medium soil (per km)	
Draught	1.9
620 kg drawing cart on tarmac road (per km)	

SoureChesworth (1992)

The fattier the meat the more expensive it is to produce in terms of the energy which must be fed to the animal.

THE ENERGY COST OF PRODUCTION

When the quantity of energy supplied by the diet exceeds the requirements for maintenance then some of the extra energy is available for the processes of animal production. The most obvious use for this extra energy is in the growth and fattening of the animasl own body but in other cases it could be excreted as milk, used for production of a fetus or be transformed into physical work. The metabolizable energy supplied to the animal can now be divided into two parts depending upon whether its use is of benefit or loss. Taking away the lost energy and the heat increment of feeding leaves the animal with a fraction of its energy input which is of direct benefit this energy is termed net energy(maintenance) this is the quantity of energy which is used in maintaining the animals vital processes, eventually this energy appears as heat which is dissipated in the environment the other part of the energy available for production will depend on the types of animal being considered. (Chesworth, 1992)

According to Chesworth (1992), it costs up to 8 times more energy to produce one kilogram of meat than to produce one kilogram of milk. Since there is much more water in milk than in meat there is also a difference between young and old animals in the amount of energy needed for the production of one kilogram of meat. Due to the fact that there is a higher proportion of bone in the growth of young animals

but the major factor is that older animals deposit more fat and less water in their meat than younger ones do. The fact that fat has a higher energy content than muscle means that the fatter the meat the more expensive it is to produce in terms of the energy which must be fed to animals.(Chesworth, 1992)

CONCLUSION AND RECOMMENDATIONS

From the literature reviewed so far it can be concluded that a knowledge of the relationship/interactions between protein and energy and hence their application could lead to a more productive and more efficient ruminant animal production.

Further research is required especially in the tropics, such research should be ones that are very practicable and could easily be applied by farmers.

REFERENCES

Abalaka,E,O, Yahaya, B, Effienokwu, J.N, Adegbe, J.Y, Odiba, J, and Ali, P.A (2021) Weights of By-products of Carcass of West African Dwarf Goats fed *Panicum maximum* and Bambara Nut Offal and Cereal Spent Grains Based Supplement diet .*International. Journal of Agriculture. and Rural Deveiopment.* 24 (1): 5617 - 5621

Agricultural Research Council (1980). The Nutrient Requirements of Ruminant Livestock : Common wealth Agricultural Bureaus.Pp.12 - 15

Agricultural Research Council (1984) Energy and Protein Requirements of Ruminants. Willingford U.K CAB International Pp 67-69

Agricultural Research Council (1993) Energy and protein Requirements of Ruminants. Willingford U.K CABP Pp 89-91

Chesworth, J. (1992) Ruminant Nutrition: The tropical Agriculturalist Series CTA/ Macmillan .Series. Pp 46

Gboshe, P.N and Ukorebi, B.A (2020). Performance and Carcass Characteristics of West African Dwarf Goats fed cassava peel meal partially replaced withsSugar cane peel meal. *Animal and Veterinary Science (Special Issue*: *Promoting Animal and Veterinary Science Research)* 8(1):31- 34

Gordon, R J (1977). The effect of Protein Content on the Response of Lactating Cows to Different Levels of Feeding *British. Journal of Animal. Production*. 25: 181-191

Hagemeister, H.,Luping, W. and Kaufman, W (1980). Bacterial Protein Synthesis in the High Yielding Dairy Cow. .W..Haresign (Editor) Recent Advances in Animal lNutrition, Butter Worth Publishers, London, Pp.67-.

Mc Donald, P., Edward, P.A,, Greenhalgh, J.F.D and Morgan C.A (2002). Animal Nutrition 2nd ed. Pearson Education Ltd, Singapore: Pp 308.

Thomas, P.C (1980) Influence of Nutrition on the Yield and Milk Protein Content, Dietary Protein and Energy Supply in: Factors Affecting the Yield and Content of Milk Constituents of Commercial Importance. *International .Dairy Feed.Bull Doc*.125:142-151

Toullec R. (1989). Veal Calves, In:RJarrige (Ed) Ruminant Nutrition: Recommended Allowances and Feed Tables. Institute National, de la Recherche Afronomique, John Libbey and co. Ltd, London .Pp 10 – 13