Update of protein and amino acid requirements for non-productive function: the systali project

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A precise system of protein unit is a challenge for improving, through diet formulation, animal efficiency in protein resources transformation and hence for reducing N losses in environment. In this perspective, as part of the revision of ruminant feed unit systems (INRA "Systali" project), it was decided to update the protein requirements in ruminants as well as responses to changes in protein supply. In a first step, the method of evaluation of maintenance requirements has been changed by the determination of different mandatory nitrogen losses observed in practical situations. The three main ways of N losses, which result in N losses in environment and in non-productive protein requirements are, in decreasing order of importance, metabolic fecal protein (MFP), urinary endogenous nitrogen losses (UEN) and loss of protein from phanere (scurf). These updates have been made by a factorial approach and were largely based on meta-analysis of large databases built from literature.

A non-negligible part of protein transiting through the gut lumen is of endogenous origin. At the duodenum level this fraction account for 14.2 gCP/kg DMI (1g CP = 6.25 g N).This fraction is already important at the level of the duodenum. Feed protein systems consider the endogenous protein flowing to the duodenum either as a supply to or a requirement (or both or none of them) for the ruminant. In our approach this fraction has been calculated from experimental data only in order to have a precise quantification of RUP (feed protein non- degraded in the rumen) and to calculate the profile of amino-acids truly digestible at the intestinal level (AADI). MFP is generally considered to be proportional to the level of dry matter intake (DMI). In the literature the proposed values of MFP ranged approximately from 15 to 30 g CP/kg DMI. Therefore, animals having a higher level of performance also present a higher MFP loss. Based on numerous experimental data, in the Systali proposal, MFP was predicted not only from DMI but also from the non-digestible fraction of organic matter. The metabolisable protein (MP= protein truly digestible in intestine, or PDI) requirements associated with MFP is calculated by dividing MFP values by PDI efficiency. The efficiency of converting MP to net protein is generally considered as equal to 0.67.The new INRA feeding system proposes a variable efficiency according to MP supplies and protein requirements for productive and non-productive functions.

Classically, EUN was measured on reference animals receiving a protein-free diet with a normal supply of energy. This type of diet is not compatible with a productive life and with a normal situation of health and well-being. Therefore it was decided to change the situation of reference to measure EUN losses on animals receiving a low N diets allowing at least survival; in this case N intake = N fecal loss, so apparent digestible N intake =0. Three independent approaches were applied to estimate EUN, providing very close values. It was also necessary to correct urinary N loss measured in these animals fed low N diets by the urinary excretion of purine N issued from rumen microbes. Proposition: As EUN mostly represents the inefficiency of whole body protein renewal, the MP needed for this requirement is proposed to be used with a efficiency of conversion of 100%.

For protein requirement linked with phanere loss, as no recent data were available the same equation applied in most of the current feed unit systems was kept.

The new values of "non-productive" PDI expenditure and their variable efficiency were applied to experiments performed on cows or goats; this allowed studying and precisely quantifying the variations of milk responses to protein supply and to essential amino acid profile.

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