

THE BIOLOGY AND MANAGEMENT OF WILD RUMINANTS

CHAPTER EIGHT

PROTEIN METABOLISM OF WILD RUMINANTS

by

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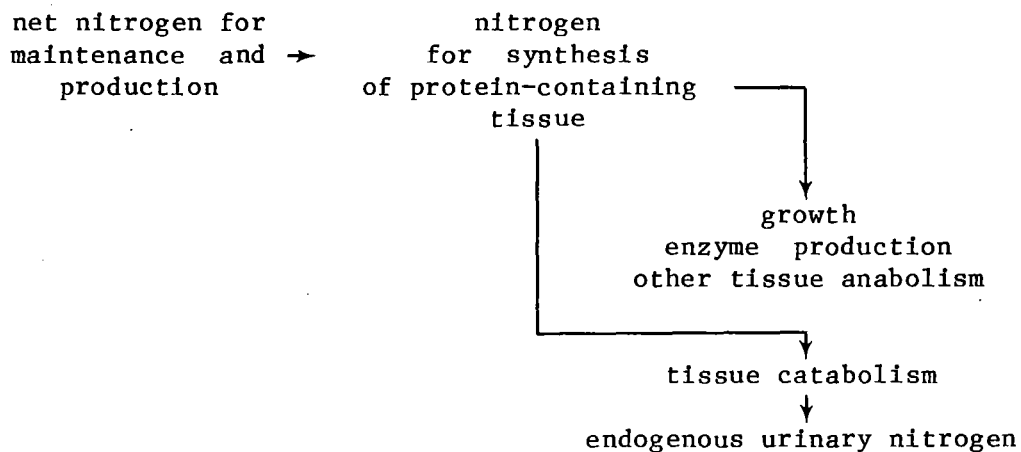
CHAPTER 8. PROTEIN METABOLISM

Protein metabolism involves the breakdown of the protein in food ingested into amino acids to be synthesized into new proteins that become part of different animal tissues. Muscle tissue is the main protein depot in the body as it is primarily protein and water.

The pathways and terms used to describe protein metabolism from ingestion to net use are listed below. The word nitrogen is used rather than protein because nitrogenous compounds are used by ruminants to synthesize protein-containing tissue.

$$\begin{array}{rcl} \text{Total} & & \text{fecal} \\ \text{nitrogen} & - & \text{nitrogen} \\ \text{intake} & & = \end{array} \quad \begin{array}{c} \text{apparent} \\ \text{digestible} \\ \text{nitrogen} \end{array}$$

$$\begin{array}{rcl} \text{apparent} & & \text{metabolic} \\ \text{digestible} & - & \text{fecal} \\ \text{nitrogen} & & \text{nitrogen} \end{array} = \begin{array}{c} \text{true} \\ \text{digestible} \\ \text{nitrogen} \end{array}$$

$$\begin{array}{rcl} \text{true} & & \text{urinary} \\ \text{digestible} & - & \text{nitrogen} \\ \text{nitrogen} & & = \end{array} \quad \begin{array}{c} \text{net nitrogen for} \\ \text{maintenance and} \\ \text{production} \end{array}$$


The fundamental unit or building block of a protein molecule is the amino acid. Amino acids contain amino groups ($-\text{NH}_2$) and carboxyl groups ($-\text{COOH}$) which link together to form peptides. Many amino acids linked together form a polypeptide, and very long polypeptides are proteins.

The breakdown of or hydrolysis of natural proteins has yielded 26 different amino acids (McCauley 1971:190). Many of these are present in animal tissue, and can be produced by the process of transamination, or the inter-conversion from one to another. Some cannot be produced from other amino acids, so they must be present in the diet. These are called essential amino acids.

Amino acids not synthesized into protein are deaminated in the kidneys and liver and ammonia is produced (Pantelouris 1967). Ruminants convert ammonia to urea, which may then be used by rumen microflora in their own protein metabolism.

The ruminant animal has an advantage over the monogastric animal when meeting its protein needs because the intestinal microflora synthesize proteins which are, in turn, available to the ruminant host. Thus the ruminant does not need to have all of the essential amino acids supplied directly in the diet because the microflora synthesize these for the host. The total protein in the diet must be adequate in order to provide the necessary nourishment for the microflora (Crampton and Harris 1969:171). Ruminants also have a metabolic adaptation for the conservation of protein resources. The recycling of urea is a nitrogen conservation adaptation when protein intake goes down. This is characteristic of winter range conditions when many species of wild ruminants are on browse or highly lignified diets.

This chapter deals with the applied aspects rather than the biochemical aspects of protein metabolism. The TOPICS that follow include material on the factors affecting protein metabolism (TOPIC 1), measurements of protein metabolism (TOPIC 2), and estimates of protein costs for production (TOPIC 3). The equations presented will be used when evaluating range and diet characteristics in PART IV.

LITERATURE CITED

- Crampton, E. W. and L. E. Harris. 1969. Applied animal nutrition. W. H. Freeman and Co., San Francisco. 753 pp.
- McCauley, W. J. 1971. Vertebrate physiology. W. B. Saunders Company, Philadelphia. 422 pp.
- Pantelouris, E. M. 1967. Introduction to animal physiology and physiological genetics. Pengamon Press, Oxford. 497 pp.

REFERENCES, CHAPTER 8

PROTEIN METABOLISM

BOOKS

TYPE	PUBL	CITY	PGES	ANIM	KEY WORDS-----	AUTHORS/EDITORS--	YEAR
edbo	butt	loen	297	rumi	dig phys & nutr, proc symp	lewis,d ed	1961
aubo	cfmo	code	154	rumi	gastro-intestini prot loss	nielsen,k	1966
aubo	dcch	coor	400	rumi	dig physiol & nutri, vol 1	church,dc	1969
aubo	dcch	coor	400	rumi	dig physiol & nutri, vol 2	church,dc; smith/	1971

TYPE	PUBL	CITY	PGES	ANIM	KEY WORDS-----	AUTHORS/EDITORS--	YEAR
aubo	clpr	oxen	272		metab of prot, mammal body	bach,sj	1952
edbo	rupr	nbnj	80		prot met, hormones & grwth	bur biol research	1953
aubo	meth	loen	198		protein metabolism	fisher,rb	1954
aubo	ccth	spil	68		dynan equili body proteins	whipple,gh	1956
edbo	rupr	nbnj	119		serology, biochem, protein	cole,wh,ed	1958
edbo	blsp	oxen	402		role of g-i tract, prot met	munro,hn,ed	1964
edbo	acpr	nyny	566		mammal protein meta, vol 1	munro,hn,ed; alli	1964
edbo	acpr	nyny	642		mammal protein meta, vol 2	munro,hn,ed; alli	1964
edbo	acpr	nyny	...		mammal protein meta, vol 3	munro,hn,ed	1964
edbo	acpr	nyny	763		mammal protein meta, vol 4	munro,hn,ed; alli	1970
aubo	hein	loen	82		protein: basis of all life	mcdonagh,jer	1966
edbo	rupr	nbnj	303		protn met & biol functions	bianchi,cp,ed; hi	1970
edbo	acpr	nyny	560		plasma protn metab; regula	rothschild,ma,ed/	1970
edbo	butt	loen	515		prot met & nutr, proc symp	cole,dja,ed	1974
edbo	else	nyny	398		biochem evol & orig of lif	schoffenfiels,e,e	1977
aubo	nhpc	nyyn	804		prot trnovr in mamm body &	waterlow,jc; gar/	1978
edbo	base	nyny	260		N, elctroly, wat, ener met	rechcigl,m,jr,ed	1979

