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Rumen Degradability of *Imbrasia belina* (Mophane worm) and Carcass Meal

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Abstract: This study was carried out to evaluate the dry matter degradability of mophane worm and carcass meal. It is believed that farmers in the region are using mophane as a source of protein for their livestock. Nylon bags were used to incubate mophane and carcass meal samples in the rumen of two steers for different time periods. After each time period the bags were removed and washed under tap water. The residue in the bag was weighed and the percentage degradability was expressed as the amount of dry matter that disappeared after weighing the residue. Percentage dry matter disappearing was plotted against time and the graph used to derive degradation constants. It was found that mophane worm have higher readily soluble material '*a*', than carcass meal (33 versus 8%). This, together with the extent of degradation reaction, resulted in a higher degradation for mophnae worm than carcass meal. However, degradation of carcass meal was faster than that of mophane worm (0.171 verses 0.086^{-1}), but this did not improve the degradability of carcass as the degradation curve was lower than that of mophane worm. This may be due to an exhaustion of degradable material caused by the heat treatment of carcass meal. At an assumed passage rate of 0.05^{-1}, mophane worm had a higher effective degradability (ED) than carcass meal. This means that more mophane worm would be fermented in the rumen than carcass meal. In order to protect some of the mophane worm from rumen fermentation, it would be necessary to provide heat treatment either by roasting or baking.

Key words: Botswana, carcass meal, degradability, mophane, protein

INTRODUCTION

Imbrasia belina (Mophane worm) belongs to a group of moths or caterpillars of emperor moths[1]. Mophane worm inhabit and feed on mophane tree (*Colophospermum mopane*) leaves, hence the worm is confined to areas of mophane woodland[2]. Rural communities around mophane vegetation harvest the worm and either sell it locally or export it to South Africa. The most common use of mophane worm is to supplement human diet with protein. In South Africa mophane worm is packed and retailed or processed into livestock feed[3,4]. However, there is no literature in the Southern African region about its utilisation as livestock feed.

Available data on its nutritional composition indicate that mophane worm contain high level of crude protein[5,6], high content of calcium and phosphorous (Madibela 2002 unpublished data) and crude fat[5,6]. Its profile of essential amino acids which is comparable to that of soya bean and fishmeal was determined by[5,7,8] . Though mophane tree is known to provide nutrition to livestock, especially when the leaves are dry[7,8], the value of the worm as livestock feed has not been evaluated.

The value of protein diets is based on the proportions of the protein that would be degraded in the rumen (Rumen Degraded Protein; RDP) and that which would escape rumen fermentation (Un Degrade Protein; UDP). RDP is used by the rumen microorganisms to synthesize microbial protein while UDP is digested in the small intestine and utilised by the host animal for productive purposes. Therefore it would be interesting to know the percentage of mophane worm not degraded in the rumen. The objective of this study was to determine the dry matter degradability of mophane worm when incubated in the rumen of steers.

MATERIALS AND METHODS

Two fistulated steers which have been feeding on a diet consisting of grass hay and *Lablab purpureus* were used for the study in 2002. Mophane worm was sourced from Seleka village in the central district and carcass meal from Botswana Meat Commission. The samples were dried at 60°C for 48 h to determine dry matter percentage. They were then ground to pass through a 2 mm screen. The nylon bag procedure was carried out according to[9]. Briefly, a 3 g sample was weighted in triplicates into labelled nylon bags. The bags for each time period were fastened and secured together with nylon string for easy withdrawal. They were then incubated in the

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rumen for 0, 3, 6, 12, 24, 48 and 72 h. After removal from the rumen, the bags were rinsed with tap water to remove debris and attached bacteria before been place in a deep freezer. Zero hour bags were not incubated but were washed with the rest of the bags. After completion of incubation all the bags including the zero hour bags were washed under tap water until the water run clear. The bags were dried in an oven at 60°C for 48 h to determine the amount of dry matter remaining undegraded. Percentage dry matter degradability was expressed as the amount of dry matter that disappeared after weighing the residue.

The percentage of dry matter disappearing was plotted against time and the graphs used to derive the degradability constants[10]. Degradation constants (*a*, *b*, *a*+*b* and *c*) were estimated from the graphs which were described by the equation; $y = a + b(1-e^{ct})$, where *y* is the dry matter disappearance at time *t*, *a* is the zero-time intercept and represent readily soluble material; *b* is slowly degradable material while *c* is the rate of degradation expressed per hour (h^{-1})[11]. Effective degradability (ED) of dry matter was calculated using the equation; $ED = a + [bc/(c+k)]$[12], where *k* is the outflow rate from the rumen assumed to be 0.05 h^{-1}.

RESULTS AND DISCUSSION

The area under the curve for mophane shows that more material was degraded than for carcass meal. The extent of the degradation curve for carcass was also limited as indicated by Fig. 1. Mophane had high soluble material and slowly degraded material hence it had high effective degradability. However the degradation rate was high for carcass meal.

According to Butler[13] dietary protein fractions (RDP and UDP) fed at optimum ratios relative to requirements must be considered rather than simply using crude protein (CP) percentage. This is because highly degraded fraction of dietary protein is attributed to lowering fertility in dairy cows fed high level of protein with low supply of fermentable metabolisable energy[14]. It was proposed that rumen degradable nitrogen leading to high ammonia impair fertilization, ova or early embryo survival[15]. Previous studies[5,6] observed that mophane worm has a crude protein level of 55.8%. In the present study it was found that mophane worm have high effective degradability, 23.4 percentage units more than carcass meal. This means that in the rumen, more mophane worm will be fermented than carcass meal. Even the extent of the degradation reaction for mophane was higher than that of

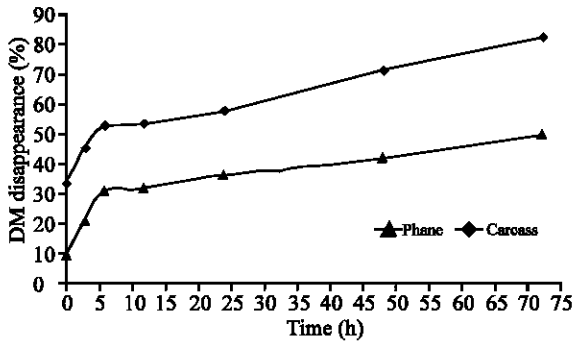

Fig. 1: Disappearance of phane and carcass meal dry matter with time

Table 1. Mophane worm and carcass meal dry matter degradability constants and effective degradability at passage rate of 0.05^{-1}

Parametres	Mophane worm	Carcass meal
a	33	8
b	48	40
c	0.086	0.171
a+b	81	48
ED	63.4	40.0

carcass meal. The difference may be due to the nature of how carcass meal was processed. During cooking and drying, carcass meal is exposed to high pressure which creates high thermal state. Heat denatures protein making it less degraded in the rumen. Heat treatment creates cross-linkages between peptide chains and carbohydrates thus lowering their susceptibility to ruminal degradation, thereby increasing protein that escapes the rumen. However, excessive heat may overprotect the protein to a degree where it is neither fermented in the rumen nor digested in the intestine[16]. Contrary to its low ED, carcass meal had higher value of c (rate of degradation) than mophane worm which was unexpected. However, this did not result in improvement in the degradability of carcass meal due to the limited degradable material caused by heat treatment of carcass meal. Therefore, the total degradation of carcass meal was limited by the low amount of slowly degradable material (b) and the reduced soluble material (a).

The results of this study have implication to the protein metabolism of mophane by ruminants. Through normal ruminal fermentation, RDP provides a source of ammonia for microbial protein synthesis[13]. Intake of excess RDP leads to rumen microflora not able to maximize microbial protein synthesis. Under normal circumstances some of the ammonia that escapes incorporation by the microorganisms diffuses out of the rumen into the portal blood and is detoxified in the

liver by conversion to urea[13]. Whenever the liver's capacity for detoxification is exceeded, ammonia in the blood will be elevated[17]. The inability of rumen microorganisms to capture and incorporate ammonia is believed to be due to absence of readily fermentable carbohydrates[18]. The need to detoxify ammonia by the animal tissues can be energetically costly[19]. Limited energy may results in deamination of dietary protein which is then used as microbial energy source, thereby realising even more amounts of ammonia into the circulation[18]. Since high ammonia will diffuse into the reproductive tract fluids and exerts toxicity on early embryo[20] increased ammonia will heighten the risk of toxicity even before it is converted to urea by the liver[18].

It is recommended that further studies should be conducted to find the protein degradability of mophane worm. It is likely that protein degradability may be similar to dry matter degradability observed in the present study. In that case, it would then be worthwhile exploring the benefits of heat treatment to reduce the degradability of mophane worm. Reducing protein degradability would result in increase in milk production and may alleviate deleterious effects of protein on fertility in dairy cows.

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