Influence of age and formalin treatment on the chemical composition and *in vitro* dry matter digestibility of manure collected from steers fed on a high-concentrate diet

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The chemical composition and *in vitro* dry-matter digestibility (IVDMD) of manure collected from steers fed on a high-concentrate diet were investigated. The influence of the time interval between excretion and freeze drying of manure on its chemical composition and IVDMD and the influence of formalin treatment (8 g/kg) thereupon, were also studied. A relatively high mean IVDMD with large variation (67,8 ± 8,8%) was measured for freshly excreted manure. The mean content of acid detergent fibre (ADF) was found to be relatively low (20,3 ± 4,2%). A mean crude-protein (CP) content of 14,5 ± 1,3% consisting mainly of true protein (TP) (93,1 ± 6,3%) but containing an above-normal proportion of nitrogen in the ADF fraction (21,4 ± 3,6%), was measured. Under room conditions, a 24-h time interval between excretion and freeze drying had little influence on the chemical composition and IVDMD of the manure. Formalin treatment under these conditions negatively influenced the chemical composition and IVDMD of these parameters with respect to nutritive value.

Die chemiese samestelling en droëmateriaal-*in vitro*-verteerbaarheid (DMIVV) van mis, afkomstig van osse wat op 'n hoë-kragvoerrantsoen gevoer was, is ondersoek. Die invloed van tydsverloop vanaf versameling van die mis tot vriesdroging, asook die invloed van formalienbehandeling (8 g/kg) van die mis op die chemiese samestelling en DMIVV daarvan, is nagegaan. 'n Relatief hoë gemiddelde DMIVV met 'n groot variasie (67,8 ± 8,8%) en 'n lae suuronoplosbare veselinhoud (20,3 ± 4,2%) is gemeet. Daarby was 'n hoë gemiddelde ruproteïeninhoud (14,5 ± 1,3%) wat hoofsaaklik uit ware-proteïen (93,1 ± 6,3%) bestaan het, maar 'n hoë proporsie stikstof in die suuronoplosbare-veselfraksie bevat het (21,4 ± 3,6%), ook gevind. 'n Tydsverloop van 24-h onder kamertoestande voordat die mis gevriesdroog is, het die chemiese samestelling en DMIVV daarvan min beïnvloed. Formalienbehandeling onder hierdie toestande het die chemiese samestelling en DMIVV ten opsigte van voedingswaarde negatief beïnvloed.

Keywords: Chemical composition, *in vitro* dry-matter digestibility, manure, steers

Manure excreted by cattle still contains many nutrients (Anthony & Nix, 1962) which can be reutilized by ruminants (Anthony, 1967). Nutrient composition of excreta is primarily influenced by level of intake and roughage to concentrate ratio in ruminant diets (Fisher, 1974 as reported by Smith & Wheeler, 1979). According to Smith (1981), however, more definitive information is needed on nutrient composition in relation to a number of factors including age and storage of waste, as this information is needed to provide the basis for designing systems for nutrient conservation. Little data on these aspects are available.

Ten Simmentaler steers (15 months old) were fed on a high-concentrate diet consisting of 60% grain sorghum meal and 40% maize silage. A high-protein concentrate (HPC–60) was included in the grain sorghum meal so that the ultimate protein content of the diet was 13%. Manure was collected individually from each steer and subjected to the following treatments within 1 h after excretion:

(1) Part of the manure was frozen, followed by freeze drying (t = 1);
(2) part was treated with formalin (38%) (8 g/kg wet manure) followed by freezing and freeze drying (t = 1, F);
(3) part was left for 24 h under room conditions, frozen and freeze dried (t = 24); while
(4) part was treated with formalin (38%) (8 g/kg wet manure), left for 24 h under room conditions, frozen and freeze dried (t = 24, F).

The manure of treatments 3 and 4 was mixed three times during the 24-h period and flattened each time to increase the surface being exposed to air. This was done in an attempt to mimic kraal conditions. Treatments 2, 3 and 4 were only performed on the manure of five steers.

The following analyses were performed on the dried manure after milling through a 1-mm sieve: IVDMD (Tilley & Terry, 1963 as adapted by Engels & van der Merwe, 1967); ADF (van Soest, 1963); crude protein (Clare & Stevenson, 1964); true protein (Agrawala, Duncan & Huffman, 1953); and ADF–N (Goering, Gordon, Hemken, Waldo, van Soest & Smith, 1972).

The mean (± SD) IVDMD and chemical composition of the manure excreted by the steers are shown in Table 1. A mean of 67,8 ± 8,8% was measured for IVDMD. This value is equal to the IVDMD of maize silage and compares well with digestibility values of manure obtained in other limited studies. Braman (1975) reported an *in vitro* organic-matter digestibility of between 41% and 46% for manure obtained from steers fed on a high-concentrate diet. Manure in the above-mentioned experiment was collected only eight times during a period of 30 days. Johnson, Overcash & Wilk (1974) reported an IVDMD of 42% for manure collected from cows fed 31% or 43% concentrate and 69% or 57% corn or small grain silage. Lucas, Fontenot & Webb (1975) found an IVDMD of only 15,8% for fecal waste from cattle fed a 50% roughage ration. The faeces in this experiment,

Table 1 Mean (± SD) chemical composition and *in vitro* dry-matter digestibility of manure collected from steers fed on a high-concentrate diet

Number of steers	Measurement				
	IVDMD[a] (% DM)	ADF[b] (% DM)	CP[c] (% DM)	TP[d] (% CP)	ADF–N[e] (% total N)
10	67,8 ± 8,8	20,3 ± 4,2	14,5 ± 1,3	93,1 ± 6,3	21,4 ± 3,6

[a] *In vitro* dry-matter digestibility.

[b] Acid detergent fibre.

[c] Crude protein.

[d] True protein.

[e] Acid detergent insoluble nitrogen (nitrogen associated with the ADF fraction).

however, were dried at 120°C. According to unpublished results by these authors, drying of manure at 120°C rather than freeze drying might have lowered digestibility.

A large variation in individual values resulted in a large standard deviation (8,8%). The lowest value recorded was 47,6% whereas the highest was 80,4%. Seventy per cent of the values, however, were distributed between the values of 63% and 71%. This variation may have been due to differences in selective intake, quantity of intake and digestion capability.

Low ADF values (20,3 ± 4,2%) measured, correlated negatively (r = 0,93) with IVDMD. ADF content therefore seems to be a good indication of the IVDMD of manure obtained from steers fed on the same diet.

The high CP content (14,5 ± 1,3%) found, lies within the range of 13—19% reported for cattle manure (Johnson, 1979). Of this crude protein, 93,1 ± 6,3% was found to be true protein. Nitrogen in cattle waste (including nitrogen from urine), normally contains only 29% true protein (Smith, 1973 as reported by Arndt, Day & Hatfield, 1979). The ADF–N value of 21,4 ± 3,6% measured, indicates that the availability of protein may be low. This may partially explain the lower digestibility of protein in diets containing cattle excreta (Smith & Wheeler, 1979).

The influence of time elapsed between excretion and freeze drying (age) and the influence of formalin treatment on the IVDMD and chemical composition of manure are shown in Table 2. The data clearly indicate that a time-lag of 24 h under the circumstances described had little influence on the chemical composition and IVDMD of manure. Although not strictly applicable to the practical situation which may differ from place to place and time to time, the results suggest that deterioration of the nutritional value of manure, collected from roofed kraals with concrete floors, may not be too serious, provided that it is collected at least once a day.

Treatment with formalin (Table 2) resulted in a significant ($P < 0,01$) difference between the IVDMD, ADF and ADF–N content of treated and untreated manure. Formalin exerted a negative influence on the

Table 2 Influence of different treatments on the chemical composition and *in vitro* dry-matter digestibility of manure collected from steers[a] fed on a high-concentrate diet

Measurement	Treatment				Least significant difference[j]
	t=1[b]	t=1+F[c]	t=24[d]	t=24+F[e]	
IVDMD[f]	65,6[1]	55,1[2]	64,5[1]	53,8[2]	3,8; $P < 0,01$
ADF[g]	20,9[1]	24,7[2]	22,0[1]	25,1[2]	1,3; $P < 0,01$
CP[h]	15,0[1]	14,8[1]	14,6[1]	14,4[1]	1,1; $P < 0,05$
ADF–N[i]	18,9[1]	33,8[2]	20,2[1]	38,3[2]	10,2; $P < 0,01$

[a] Steers — Manure of five steers was collected.

[b] t=1 — Manure was collected and freezed within 1 h.

[c] t=1+F — Manure was collected, treated with formalin and freezed within 1 h.

[d] t=24 — Manure was treated as described under t=1, but freezed after a time-lag of 24 h.

[e] t=24+F — Manure was treated as described under t=1+F, but freezed after a time-lag of 24 h.

[f] IVDMD — *In vitro* dry-matter digestibility.

[g] ADF — Acid detergent fibre.

[h] CP — Crude protein.

[i] ADF–N — Acid detergent insoluble nitrogen (nitrogen associated with the ADF fraction).

[j] Least significant difference – Values with common superscripts do not differ significantly.

feeding value of all three parameters. Formalin depressed IVDMD by approximately 10 percentage units irrespective of whether the time interval was 1 or 24 h. This effect of formalin has also been reported on silage (Wilkins, Wilson & Cook, 1974), although the extent of depression at comparable rates (g/100 g DM) of formalin application appeared to be less. This decrease in IVDMD seems to be associated with a simultaneous increase in ADF content. Formalin treatment increased the ADF content of manure (Table 2) significantly ($P < 0,01$) after a time interval of 1 and 24 h. The above-mentioned results therefore indicate that formalin treatment of manure has no beneficial effect on the preservation of utilizable energy but rather promotes a deleterious effect.

Formaldehyde did not effect the CP content (Table 2) of manure. However, the proportion of nitrogen bound to the ADF fraction (ADF–N) increased significantly ($P < 0,01$) to a value of 38,3% after 24 h (Table 2). This suggests that the availability of CP was decreased to a value comparable to that of heat-damaged haylage (Thomas, Hillman, Huber & Lichtenwalner, 1972).

In conclusion it can be said that manure collected from steers fed on a high-concentrate (80%) diet seems to have a digestible energy value that compares well with that of maize silage, and a protein value sufficient to supply the growth needs of young steers. The results furthermore suggest that the nutritive value of manure will not be influenced significantly when collected once

daily from the concrete floors of roofed kraals. Treatment of manure on the floor with formalin, however, will decrease, rather than preserve its nutritive value.

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