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"Comparison of nutrient digestibility of sheep rations differing in main protein and/or non-forage fiber source"

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Comparison of nutrient digestibility of sheep rations differing in main protein and/or non-forage fiber source

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Abstract

An in vivo digestibility trial was conducted by the use of 4 castrated mature rams in a 4x4 Latin square experimental design. Significance level was determined at $P<0.05$. Four rations differing in main protein source, cotton seed cake (CSC) vs corn gluten meal (CGM), and/or non-forage fiber source, wheat bran (WB) vs corn gluten feed (CGF), were used, as follows: A) CSC and WB (control), B) CSC and CGF, C) CGM and WB and D) CGM and CGF. The four diets were designed to provide equal amounts of energy, protein and fiber, and were covering maintenance requirements for energy and protein. Ration D had higher digestibility of DM (76.1 vs 73.9; 74.7; and 74.5%, for rations D, A, B, and C respectively), OM (80.2 vs 78.9; 78.8; and 78.6%), NDF (59.9 vs 56.8; 56.6; and 56.2%), ADF (60.9 vs 52.1; 48.3; and 52.2%) and cellulose (73.1 vs 65.7; 66.4; and 64.9%). Above results suggest that CGF has superior fiber fraction digestibility compared to WB. Moreover, hemicellulose digestibility of B ration (67.1%) was higher compared to A (62.4%), which is in line with former conclusion. CP digestibility of A ration was the lowest (62.9 vs 74.1; 74.0; and 73.4%, for A, B, C and D rations, respectively), suggesting that the combination of CSC and WB affect negatively ration's CP digestibility. This could be explained, probably, by a reduced MCP synthesis, due to inadequate FME of this ration, or lower RUP digestibility or both.

Introduction

Cotton seed cake (CSC) is used extensively as main protein source in lactating ewes' diets. Nevertheless it seems that CSC reduces CP digestibility in comparison with protein sources high in RUP content (Sultan et al., 1995; Liamadis et al., 2003). Possibly CSC can't be the main protein source for high productive lactating ruminants, but, in opposite, this is not valid on fattening ruminants (Weixian et al., 1994), suggesting that the level of CSC inclusion in the diet is crucial. In the present trial CSC provided the 80 g/kg DM of the diet in purpose to strictly meet energy and protein requirements.

Moreover, research on non-forage fiber sources (NFFS) has been elevated latest relaying on their capacity to partly replace forages. Thus, different NFFS are nutritionally evaluated, mainly on cows' diets, whilst research on this field, on sheep diets, has been left behind. CGF is a NFFS high in effective NDF content (Armentano and Pereira, 1997; Allen and Grant, 2000). Bernard and McNeill (1991), reported greater digestibility of hemicellulose when CGF supplied 40% of dietary energy for steers, in comparison with supplements of SBM, shelled corn, soybean hulls, or wheat middlings.

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Materials and Methods

An in vivo digestibility trial was conducted by the use of 4 castrated mature rams in a 4x4 Latin square experimental design. Four rations differing in main protein source, cotton seed cake (CSC) vs corn gluten meal (CGM), and/or non-forage fiber source, wheat bran (WB) vs corn gluten feed (CGF), were used, as follows: A) CSC and WB (control), B) CSC and CGF, C) CGM and WB and D) CGM and CGF. The four diets were designed to provide equal amounts of energy, protein and fiber, and were strictly covering maintenance requirements for energy and protein (Table 1).

Table 1. Formulation, Chemical Analysis and Nutritive Value of experimental rations

Item	Rations*			
	A (CW)	B (CF)	C (GW)	D (GF)
1. Composition (g/kg)				
Corn grain	490	500	500	500
Alfalfa hay	250	240	230	230
Wheat straw	60	80	100	120
Cotton seed cake	80	80	-	-
Corn gluten meal 60%	-	-	50	50
Wheat bran	80	-	80	-
Corn gluten feed	-	60	-	60
Salt	10	10	10	10
Dicalcium phosphate	15	15	15	15
**Meriden 001	15	15	15	15
Sum	**1000**	**1000**	**1000**	**1000**
2. Chemical analysis				
Dry matter (DM) (g/kg)	870	872	871	872
Organic matter (g/kg DM)	959	961	961	963
Crude protein (g/kg DM)	142	144	143	145
Ether extract (g/kg DM)	35	35	37	34
Crude fibre (g/kg DM)	160	163	159	164
NFE (g/kg DM)	621	620	625	619
NDF (g/kg DM)	356	343	332	327
ADF (g/kg DM)	193	190	179	182
ADL (g/kg DM)	52	33	29	29
Gross energy (MJ/kg DM)	18.1	18.1	18.2	18.2
3. Nutritive value [1]				
Metabolisable energy (MJ/kg DM)	10.9	11.0	11.0	11.0
Metabolisable protein (g/kg DM)	92	91	103	102
Digestible undegradable protein (g/kg DM) [2]	35	34	43	42

* CW= cotton seed cake + wheat bran, CF= cotton seed cake + corn gluten feed, GW= corn gluten meal + wheat bran, GF= corn gluten meal + corn gluten feed.

** Meriden 001= premix of vitamins and trace elements.

[1] MAFF (1990).

[2] DUP was calculated for a rumen outflow rate of $0.02/h^{-1}$

Results and Discussion

Ration D had higher DM and OM digestibility (P<0.1), mainly due to higher NDF and ADF digestibility of this ration (Table 2). Moreover, hemicellulose digestibility of B ration was higher compared to C, whilst cellulose digestibility of D ration was higher in comparison with rations A and C. Above results suggest that CGF has superior fiber fraction digestibility compared to WB.

C ration had superior CP digestibility compared to A, revealing that CGM increases ration's CP digestibility compared to CSC (Figure 1). Also, CP digestibility of A ration was the lowest suggesting that the combination of CSC and WB negatively affects ration's CP digestibility. This could be explained, probably, by a reduced MCP synthesis, due to inadequate FME of this ration, or lower RUP digestibility or both. Moreover, CGF inclusion in B ration increased CP digestibility, compared to A, even though DUP/MP ratio was low, due to high FME content of CGF.

NFE digestibility of D ration was higher compared to B, revealing that CGM increases ration's NFE digestibility compared to CSC.

Table 2. Nutrient digestibility of experimental diets

Item	Ration				SEM	P
	A (CW)	B (CF)	C (GW)	D (GF)		
Dry Matter (%)	73.9 ^{a}	74.7 ^{a}	74.5 ^{a}	76.1 ^{b}	1.38	†
Organic Matter (%)	78.9 ^{a}	78.8 ^{a}	78.6 ^{a}	80.2 ^{b}	1.41	†
Crude Protein (%)	62.9 ^{a}	74.1 ^{b}	73.6 ^{b}	73.3 ^{b}	3.38	†
Ether Exctract (%)	89.3 ^{a}	89.5 ^{a}	84.7 ^{b}	87.9 ^{ab}	1.63	*
Crude Fiber (%)	51.0 ^{a}	53.5 ^{ab}	51.9 ^{a}	55.7 ^{b}	2.57	†
NFE (N free extract) (%)	87.0 ^{ab}	86.0 ^{a}	86.4 ^{a}	88.0 ^{b}	1.04	†
NDF (%)	56.8 ^{a}	56.6 ^{a}	56.2 ^{a}	59.9 ^{b}	2.94	†
ADF (%)	52.1 ^{a}	48.3 ^{a}	52.2 ^{a}	60.9 ^{b}	3.18	*
Hemicellulose (%)	62.4 ^{ab}	67.1 ^{b}	59.2 ^{a}	58.8 ^{a}	3.00	*
Cellulose (%)	65.7 ^{a}	66.4 ^{a}	64.9 ^{a}	73.1 ^{b}	2.41	*

CW= cotton seed cake + wheat bran, CF= cotton seed cake + corn gluten feed, GW= corn gluten meal + wheat bran, GF= corn gluten meal + corn gluten feed.

Mean values with different superscripts in a row are significantly different († a,b - P< 0.1, *a,b - P< 0.05, NS= non significant).

Net protein utilization as though as biological value of C ration (Table 3) were lower compared to rations B and D (P<0,05), even though these three rations did not differ on CP digestibility. Above result suggest that the combination of CGM and WB negatively affects N balance, probably due to inadequate FME content of C ration.

Metabolisability of energy of D ration was higher compared to C, indicating that CGF increases diet's metabolisable energy compared to WB. Additionally, ME/DE ratio of C ration was lower in comparison with rations B and D, probably due to lower N retention of rams fed with C ration.

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Table 3. Energy value and N balance of the four diets

Item	Ration A (CW)	B (CF)	C (GW)	D (GF)	SEM	P
N balance						
Retained N (% intake)	19.5 ^{ab}	29.9 ^{a}	8.9 ^{b}	25.4 ^{a}	8.03	*
Retained N (% digested)	27.9 ^{ab}	40.3 ^{a}	12.5 ^{b}	34.4 ^{a}	10.7	*
Energy value						
(DE/GE) (%)	76.6	76.9	76.6	78.2	1.14	NS
(ME/GE) (%)	62.3 ^{ab}	63.3 ^{ab}	61.2 ^{a}	64.3 ^{b}	1.25	*
(ME/DE) (%)	81.4 ^{ab}	82.3 ^{b}	80.1 ^{a}	82.2 ^{b}	0.69	*

CW= cotton seed cake + wheat bran, CF= cotton seed cake + corn gluten feed, GW= corn gluten meal + wheat bran, GF= corn gluten meal + corn gluten feed.

Mean values with different superscripts in a row are significantly different (*a,b - P< 0.05, NS= non significant).

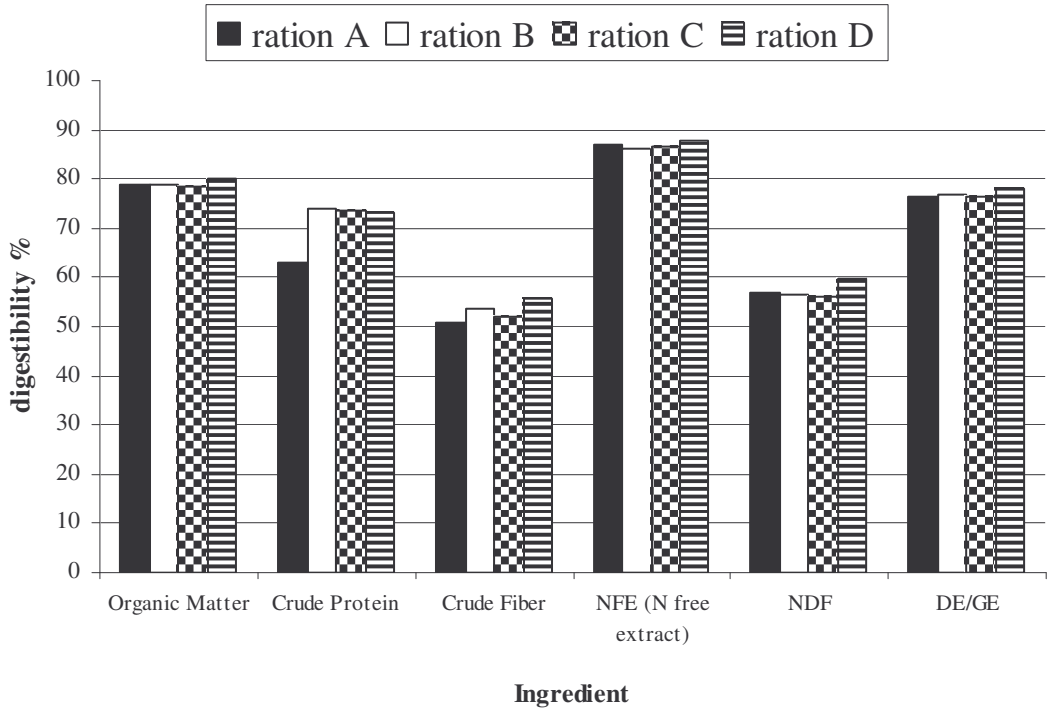

Figure 1. Nutrient digestibility of experimental diets.

Conclusions

- CGF has superior fiber fraction digestibility compared to WB.
- CGM increases ration's CP and NFE digestibility in comparison with CSC
- The combination of CSC and WB negatively affects ration's CP digestibility
- The combination of CGM and WB negatively affects N balance and ME/DE ratio, probably due to inadequate FME

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