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Effect of supplementation with whole wheat or whole oat grains on the dimensions of faeces particles from lambs

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ABSTRACT

A new method for measuring the dimensions of particle in faeces from lamb is described. The method included a washing procedure by use of nylon bags, freeze drying, dry sieving, scanning and identification of the individual faeces particles use of image analysis. The method is demonstrated on faeces from lamb fed a basal diet of concentrate and hay including the effect of supplementation with whole oat or whole-wheat grain. The distribution of particle length in the individual dry sieving fractions can be described by gamma distribution functions. The distribution of particle length and width was significantly affected by grain supplementation.

KEY WORDS: particle length, width, washing technique, image analysis, gamma distribution

INTRODUCTION

Small ruminants like sheep and lamb can digest whole unprocessed grain. *Ad libitum* feeding with unprocessed grain has been demonstrated to lead to a higher forage intake, a higher rumen pH value, a higher fibre digestion and a higher daily gain in lamb compared with *ad libitum* feeding with processed grain (Tait and Beames, 1988). The critical point is where the grains are masticated and digested. Nørgaard and Bendixen (2002) found a higher mean geometric particle length of 1.5 mm in faeces from cows fed mature grass silage compared with 0.84 mm of faeces particles from cows fed silage of young grass (Nørgaard and Sehic, 2003). The aim of the present investigation was to study the effect of supplementation with whole grain on particle size distribution in faeces from lamb.

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MATERIAL AND METHODS

Six growing Shropshire lambs with a body weight of 45 kg were fed 75 g commercial concentrates plus 150 g green hay twice daily. Half of the lambs were supplemented with 400 g whole wheat and half with 500 g whole oat twice daily for a period of 2 weeks followed by a period of 2 weeks without grain supplementation. 50 g faeces were collected from each lamb daily during the last 3 days in each period. Three mixed faeces samples of 10 g was placed into a 150×90 mm nylon bag with a pore size of 10 µm together with 20 ml liquid soup. The closed bags were pre-treated in a tempered water bath one h before washing in a washing machine positioned for normal wash at 40ºC. The washed faeces particles were freeze dried before dry sieving through sieves with pore sizes of 2.56 mm (K), 1.0 mm (M) and 0.5 mm (S) including collection of the smallest particles in the bottom bowl (B). The relative mass proportions on M, S and B fractions were named m_M, m_S and m_B, respectively. Two sub samples from K, M, S and B were distributed on a CanonScan9900F and colour scanned against a blue background at 450, 600, 1200 and 2400 dpi, respectively. Overlapping particles were separated before scanning. The individual particles were identified and their area (A), length (PL) and width (PW) were measured by image analysis by use of Image ProPlus (Nørgaard and Bendixen, 2002). The arithmetic mean length (APL) and width (APW) was estimated weighing the A values within sieve fractions and by the sieve mass proportions. A gamma distribution function γ_i (x, α_i,β_i) for PL and PW values from each sieving fraction was estimated by weighing the A values. An overall composite distribution function (C) was estimated as: m_M x γ_S + m_S× γ_{S1}+m_B×γ_B. The estimated mode length (Mode_PL) and width values (Mode_PW) were estimated by a stepwise (0.001 mm) identification of the maximal C(PL) and C(PW) value. The median length (MPL) and width (MPW) as well as the 95% length (CPL) and with (CPW) values were estimated from the cumulative C(PL) and C(PW) distribution functions by use of the CDF function in SAS. Effect of supplementation was statistically analysed by use of proc GLM in SAS version 8.01.

RESULTS

The length distribution of washed and dried faeces particles from a lamb supplemented with whole-wheat grain in the 4 sieving fractions including the proportions in each are shown in Figure 1. Supplementation with whole grain significantly increased the proportion of particles retained in the bottom bowl, the particle length and width distribution in term of the arithmetic mean, mode and median (Table 1).

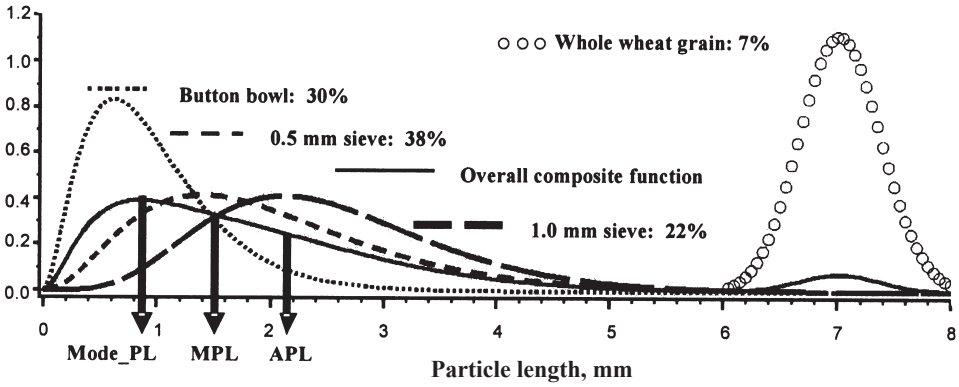

Figure 1. Length distribution of washed and dried faeces particles from the 4 sieving fractions, the mass proportion in each sieve fraction, the composite distribution function for the overall distribution of particle length, mode (Mode_PL), median (MPL) and the arithmetic mean length (APL) of faeces particles from a lamb fed a basal diet supplemented with whole-wheat grain

Table 1. The length and width dimensions as well as the distribution of washed faeces particles in the 3 sieve fractions excluded whole grain in the 2.56 mm sieve

	Basal diet		Basal diet supplemented with			
			whole wheat grain		whole oat grain	
	mean	SEM	mean	SEM	mean	SEM
Observations	6		2		3	
1.0 mm sieve	5	4	5	8	22	6
0.5 mm sieve	44	3	48	5	47	4
Bottom bowl	51[a]	3	47[a]	5	31[b]	4
Mode_PL, mm	0.59	0.07	0.75	0.12	0.87	0.10
MPL, mm	1.14[a]	0.11	1.38[b]	0.18	1.67[b]	0.15
APL, mm	1.33[a]	0.10	1.49[b]	0.17	1.79[b]	0.14
CPL, mm	3.44	0.43	3.47	0.75	4.34	0.62
Mode_PW, mm	0.22[a]	0.02	0.30[b]	0.04	0.34[b]	0.03
MPW, mm	0.48[a]	0.05	0.67[b]	0.09	0.77[b]	0.08
APW, mm	0.58[a]	0.05	0.75[b]	0.08	0.83[b]	0.06
CPW, mm	1.69	0.20	1.99	0.34	1.98	0.28

[a,b,c] values with different superscript within a row are significantly different (P<5%)

Only whole grains were retained in the 2.56 mm sieve. The grains accounted for zero to 7% of the washed and dried faeces particles from lambs supplemented with whole grains.

DISCUSSION

The particle length distribution in faeces from lamb had generally the overall the same shape as reported from image analysis of faeces from cow (Nørgaard

and Sehic, 2003). The arithmetic means, the modes and the 95% percentiles of particle length in faeces from lamb supplemented with whole grain were within the level observed by Nørgaard and Sehic (2003) in washed and dried faeces particles from cows fed grass silage of 85% of *ad libitum* intake. Van Soest (1982) reported a linearly increasing particle size at increasing intake measured by wet sieving technique of faeces from cattle fed forage. The longer and wider particles found in faeces from grain supplemented lambs might be due to a higher intake or to hard and lignified fibres in especially the oat husk. The critical particle length and width of 3.4-4.3 mm and 1.7-2 mm, respectively, shown in Table1, is higher compared with the critical particle size of 1.18 mm found by sieving technique (Lechner-Doll et al., 1990). The dimensions of whole grains found in faeces were much larger than the estimated critical particle length and width of non-whole grain particles.

CONCLUSIONS

A method for analysing dimensions of faeces particles by use of image analysis is described. The distribution of particle length and particle width of washed faeces particles from lamb was affected by supplementation with whole grains.

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