



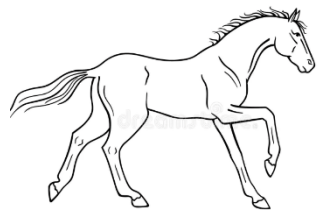
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Session 7 - #2212417

A possible mathematical approach to predict forage digestibility from faecal particle size distribution in horses



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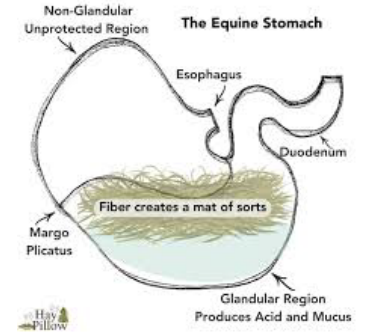
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Background

Forage and roughage quality and digestibility play a key role maintaining optimal nutrient absorption and gastrointestinal health.



Several studies have explored the relationship between **diet digestibility** and **faecal particle size** in ruminants, whereas information concerning horses are limited.



Horses seem to be more adapted to the consumption of **low-quality forages** and roughages, than ruminants.

Aim

The aim of this study was:

- I) To evaluate the effect of the administration of several roughages, characterised by different total tract apparent dry matter digestibility (**ttaDMD**), on faecal particle size (**FPS**) in horses.
- II) To develop a mathematical tool for **ranking and comparing** forages and roughages **ttaDMD** by means of faecal sieving

Materials and Methods/1 - Experimental design

Six healthy horses

BW 110 – 840 kg

BCS 5-6

Age: 6 to 16 years

Sex: four mares, two stallions

Six different breeds

Commercial stable
Individual box
Rubber mat
Paddock*

Six different forages

Ad libitum, in hay box

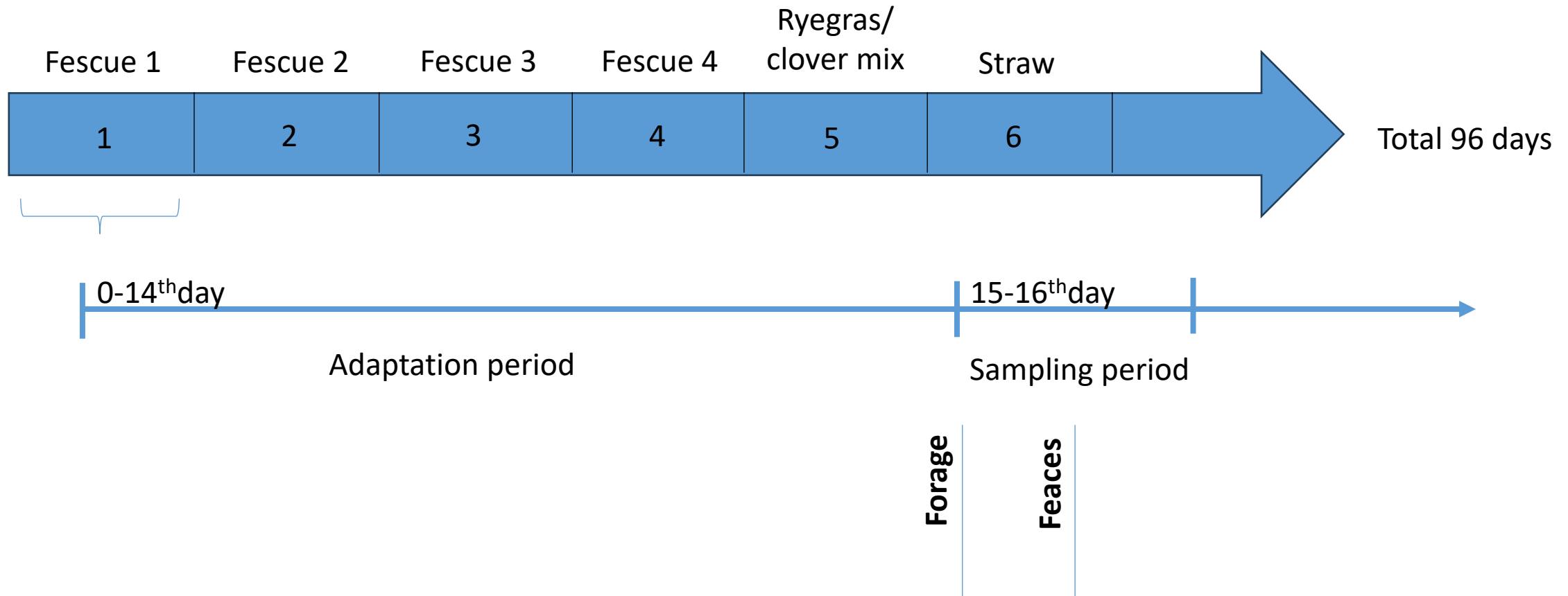
Four consecutive cuts of Fescue (*festuca arundinacea*)

Perennial ryegrass/clover mix (*lolium perenne/trifolium pratense*)

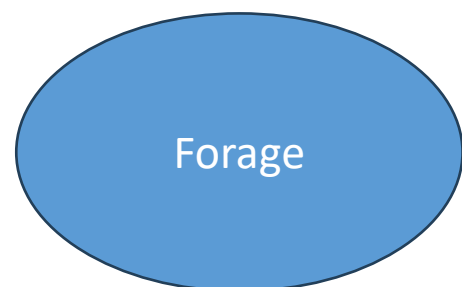
Straw (*triticum aestivum*)

Six consequential periods

Materials and Methods/2 - Sampling timeline



Materials and Methods/3 – NIRs, wet chem and fecal wet sieving



NIRFlex N-500, Buchi

Dry Matter

CP

EE

Ash

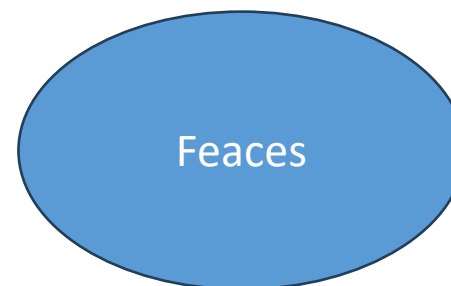
NDF

ADF

ADL

Wet chem

AIA



Wet sieving

S1 6.5 mm

S2 4.6 mm

S3 2.36 mm

S4 1.18 mm

S5 0.6 mm

S6 0.15 mm



Materials and Methods/4 – Stats and ttaDMD

1
GLM univariate
Rougaghe and sieve: fixed effect
Horse: random effect
Residue particles (RP): dependent variable

LSD post-hoc
SPSS v28

2
Regression and correlation between
ttaDMD and RP

3
Regression and correlation: RP X sieves

Slope X ttaDMD

$$\text{ttaDMD (\%)} = \left(1 - \frac{AIA_{\text{feed}}}{AIA_{\text{feaces}}}\right) * 100$$

Bergero et al., 2009

Results and Discussion/1 – Roughages chem and ttaDMD

Table 1. Roughages mean chemical composition analyzed by NIR spectroscopy, ttaDMD and AIA values (%DM).

Roughage	DM ¹ %	Ash % DM	Protein % DM	Fat % DM	NDF ² % DM	ADF ³ % DM	ADL ⁴ % DM	ttaDMD ⁵ %	AIA ⁶ % DM
Fescue 1	35.65	8.89	12.61	1.64	65.46	39.66	6.22	53.93	3.36
Fescue 2	29.03	9.67	10.25	2.17	56.19	29.55	2.58	68.94	3.15
Fescue 3	26.88	7.54	10.98	1.66	64.81	38.67	5.13	54.80	3.34
Fescue 4	20.15	9.30	12.75	2.02	58.96	34.30	4.02	51.27	3.13
Clover/rye grass mix	14.28	11.43	18.55	2.11	45.87	26.51	4.36	74.44	1.89
Straw	87.76	6.96	4.09	1.32	80.17	51.56	7.86	44.57	3.58

¹DM: dry matter

²NDF: neutral detergent fibre including residual ash, not treated with amylase

³ADF: acid detergent fibre including residual ash

⁴ADL: acid detergent lignin

⁵ttaDMD: total tract apparent dry matter digestibility

⁶AIA: acid insoluble ashes

Results and Discussion/2 – Forage on FPS

Table 2. Effect of different forage type, ordered by increasing total tract apparent dry matter digestibility (ttaDMD), on faecal particle size distribution (values are reported as least squared means, % of total weight).

Sieve ¹	Forages (% of total weight)												SEM	P-value
	Straw		Fescue 4		Fescue 1		Fescue 3		Fescue 2		Perennial ryegrass /clover mix			
ttaDMD %	44.57	a ²	51.27	b	53.93	b	54.80	b	68.94	c	74.44	d	0.085	≤0.001
S1	0.13	aA ³	0.39	aA	0.53	aA	0.44	aA	0.60	aA	4.03	bA	0.292	≤0.001
S2	0.42	aA	1.14	aA	2.08	aA	1.27	aA	1.98	aA	6.05	bA	0.364	≤0.001
S3	6.62	aA	10.52	abB	28.32	cCD	14.04	abB	19.61	bcB	20.23	bcBC	1.627	≤0.001
S4	26.62	B	28.84	C	22.03	BC	27.18	CD	20.09	B	25.62	C	1.005	0.059
S5	38.27	cC	24.72	bC	15.80	aB	24.44	bC	19.62	abB	25.31	bC	1.362	≤0.001
S6	27.93	bBC	34.39	cD	31.24	bcD	32.63	bcD	35.77	cC	18.75	aB	1.155	≤0.001

¹ S1: 6.50, S2: 4.60, S3: 2.36, S4: 1.18, S5: 0.6, S6: 0.15 mm

²(a-d) Different lowercase letter within a row are statistically different (p<0.001).

³(A-D) Different uppercase letter within a column are statistically different (p<0.001).

Results and Discussion/3 – Correlation and Regression ttaDMD and RP

Table 3. Mean values, regressions and correlations coefficients between ttaDMD and RP on each sieve.

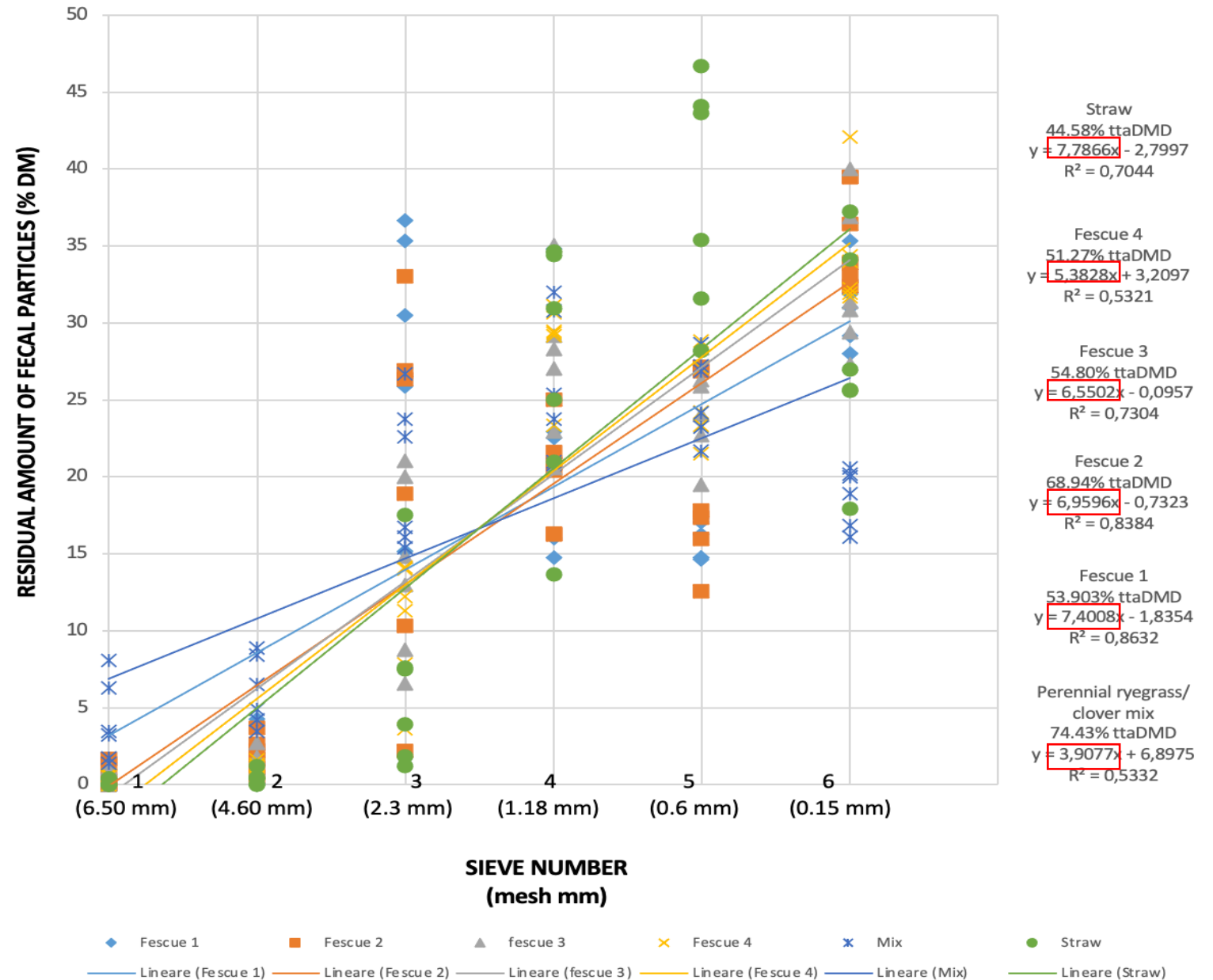
Sieve ¹	Correlation		Regression	
	r	significance	equation	R ²
S1	0.639	≤0.001	$y = 4.406x + 52.521$	0.408
S2	0.668	≤0.001	$y = 3.690x + 49.078$	0.447
S3	0.421	0.013	$y = 0.520x + 48.577$	0.177
S4	– 0.320	0.065	$y = - 0.649x + 73.426$	0.102
S5	– 0.312	0.072	$y = - 0.464x + 68.774$	0.097
S6	– 0.303	0.082	$y = - 0.540x + 73.310$	0.092

¹ S1: 6.50, S2: 4.60, S3: 2.36, S4: 1.18, S5: 0.6, S6: 0.15 mm.

Results and Discussion/4

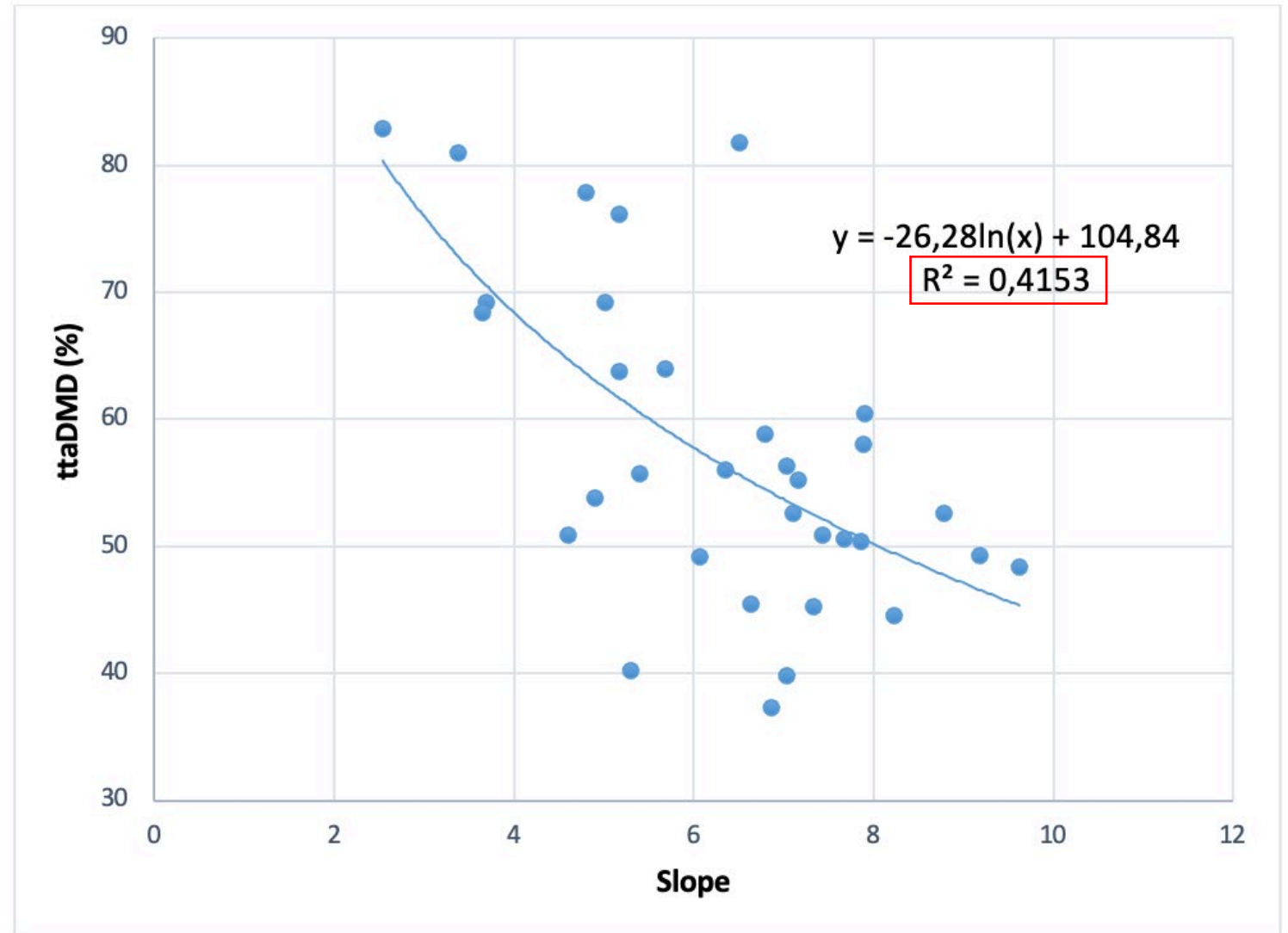
Figure 1. Relationship between **Residual particle** and **Fecal particle size** distribution, without distinction among horses.

Regressions equations and roughage ttaDMD are reported on the right.



Results and Discussion/5

Figure 2. Relationship between the **slope** coefficients of the linear functions of Figure 1 and **ttaDMD** of the tested roughage by each horse.



Conclusions

Faecal particle size is affected by roughage digestibility, with **high-fibre forages** having lower digestibility, resulting in **smaller faecal particles** compared to forages with higher digestibility.

The **slope** coefficients of the linear functions describing RP on the sieves would allow for **ttaDMD estimation** with a reliability of about **40%**.

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RESEARCH ARTICLE

Faecal particle size distribution in relation to forage type and digestibility in horses: preliminary results

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Limitations of the trial:

Limited number of animals included
Range of ttaDMD 40-75 %



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Thankyou for your attention!

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Table 1. Comparison among sieve mesh sizes (mm) used in studies for faecal particle evaluation in horses (similar mesh sizes are grouped together in the same column).

Authors	Sieve mesh sizes (mm)													
Carmalt and Allen 2008	6.7	4.75	4.0	3.36	2.36	1.41	0.85	0.589	0.355	0.15	0.075	0.053		
Cichorska et al 2014		4.76			2.4	1.60								
Clauss et al 2014;														
Fritz et al 2012;														
Hummel et al 2008;	16.0	8.0		4.0		2.0	1.0	0.500		0.25	0.125	0.063		
Zwirglmaier et al 2013														
Gunnarsdottir et al 2014			4.75		3.35	2.36	1.18	0.60	0.300					
Grenet et al 1984	8.0	6.3		4.0		2.5	1.25	0.80	0.40		0.16			
Miyaji et al 2011		5.6			2.36	1.18		0.60						
Müller 2009				4.0		2.0		0.500		0.25	0.125			
Müller 2012;						2.0	1.0	0.63	0.315	0.20	0.100			
Wickstrom 2010														
Rouquette et al 2005							1.0		0.40		0.16	0.100	0.071	0.032
Whitehouse et al 2023				4.0		2.0	1.0	0.500		0.25	0.125	0.063		
PRESENT STUDY	6.5	4.60			2.36	1.18		0.60			0.15			
Sieve	S1	S2			S3	S4		S5			S6			