N4.2

Effect of rumen escape starch in maize silage based diets for dairy cattle [1]

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Abstract

The effect of rumen escape starch (RES) level in maize silage (MS) based diets on milk yield and composition was investigated in two trials (T1, T2) carried out in early lactation. MS was given as the sole roughage in T1 or with prewilted grass silage in T2. In T1 three RES-levels, 40, 52 and 59 g.kg DM-1, originating from two MS-cultivars and two concentrates (C), were compared in a latin square design with 18 Holstein cows: MSlCl, MShCl, MShCh (l, h: low, high RES-content). The two MS-cultivars had a similar S-content (315 and 318 g.kg DM-1), but a different S-fraction escaping the rumen (18.5 and 24.4 %). The two concentrates only differed in starch degradability. In T2 two RES-levels, 28 and 35 g.kg DM-1, originating from the previous two MS-cultivars, were compared in a cross-over design with 16 Holstein cows: MSlCl, MShCl.

Dry matter intake amounted to 19.1, 20.0 and 20.1 kg for MSlCl, MShCl and MShCh, in T1, and to 20.7 and 21.3 kg for MSlCl and MShCl, in T2. Milk yield tended (P>0.05) to increase with increasing RES-level and amounted to 26.1, 26.3 and 26.6 kg in T1 and to 28.8 and 29.7 kg in T2. Milk composition was almost unaffected. It is not clear whether the higher milk yield may be directly attributed to the RES-content and/or indirectly to the higher DM-intake.

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Introduction

- Is rumen escape starch important in dairy cattle nutrition ?
- Is rumen escape starch in maize silage important ?

Beneficial effect on cow performance, net energy value ?

"Starch content" was previously studied (De Brabander et al., 2004)

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Theoretical considerations of a lower starch degradability

PRO

- Rumen escape starch (RES) is digested in the small intestine
  → higher energetic efficiency
- Repartition carbohydrate digestion over rumen and small intestine
  → improved cow performance
- RES does not disturb rumen fermentation
  → improved feed efficiency

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Theoretical considerations of a lower starch degradability (continued)

CONTRA

- High RES-levels can depress starch digestibility
  → depressed energetic efficiency
- RES does not provide fermentable organic matter
  → lower microbial protein synthesis

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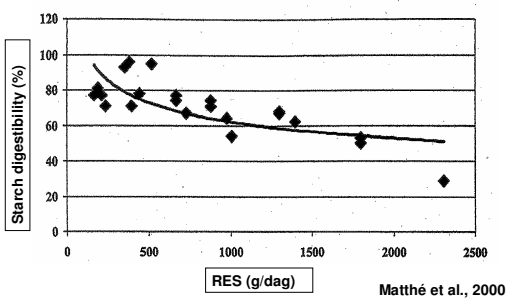
Effect of amount of rumen escape starch (RES) on starch digestibility in the small intestine



Matthé et al., 2000

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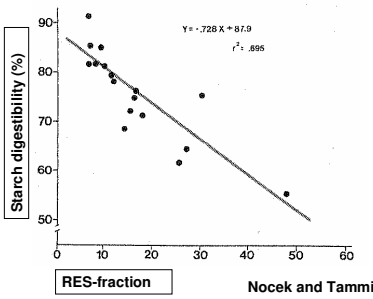
Effect of rumen escape fraction on starch digestibility in the small intestine



Nocek and Tamminga, 1991

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Feeding trials

Objective: effect of RES-level (equal S-content) on performance

in : early lactation
with : maize silage (MS) / MS + prew. grass sil. (PGS)

2 maize silage RES-levels (varieties)
2 concentrate RES-levels

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Two trials

1) MS$_l$ C$_l$ MS$_h$ C$_l$ MS$_h$ C$_h$

+ pressed beet pulp (2.8 kg DM) for sufficient FOM-supply
Latin square design, 18 cows, 15 weeks

2) MS$_l$ C$_l$ MS$_h$ C$_l$ + PGS

Cross-over design, 16 cows, 12 weeks

l,h = lower, higher RES-content, equal S-content

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Chemical composition of the maize silages

RES-content	*Low*	*High*
Dry matter (g/kg)	328	328
Chem. comp. (g/kg DM)		
Starch	315	318
Rumen esc. starch	58	78
Crude fibre	208	206
NDF	382	390
Starch escape fraction (%)	18.5	24.4

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Digestibility and nutritive value of the maize silages

RES-content	*Low*	*High*
Digestibility * (%)		
Org. matter	76.2 56.4	74.2
NDF	97.4	53.6
Starch		95.8
Nutritive value (kg^{-1} DM)	6.64 49	
NEL (MJ)	-39	6.56
DVE (g)	577	48
OEB (g)		-39
FOM (g)		542

* Digestibility determined with lactating cows

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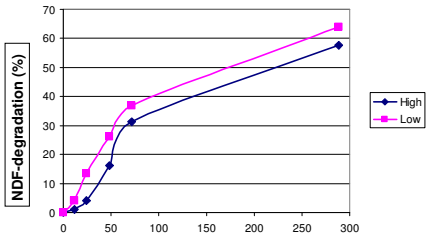
NDF-degradation (in situ) maize silage



NDF-degradability
RES-low : 51.1 %
RES-high : 46.2 %

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Starch in concentrate

RES-content	*Low*	*High*
Starch (g/kg DM)	202	190
Rumen esc. fraction (%)	11.5	31.0
RES (g/kg DM)	23	59

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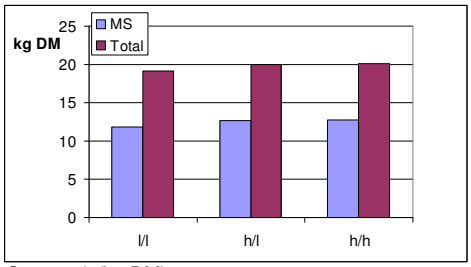
Feed intake – Trial 1



Content (g/kg DM)			
Starch	232[a]	233[a]	232[a]
RES	**40[a]**	**52[b]**	**59[c]**
FOM	614[a]	590[b]	581[c]

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Nutrient supply and production results

TRIAL 1

RES-content MS/C	*l/l*	*h/l*	*h/h*
Nutrient intake			
NEL (MJ)	129[a]	135[a]	135[a]
DVE (g)	1517[a]	1588[a]	1609[a]
NEL (% requir.)	107[a]	111[a]	112[a]
DVE (% requir.)	103[a]	107[a]	110[a]
Production			
Milk (kg)	26.1[a]	26.3[a]	26.6[a]
Fat (%)	4.14[a]	4.16[a]	4.09[a]
Protein (%)	3.31[a]	3.26[a]	3.24[a]
LW-gain (kg)	0.29[a]	0.69[b]	0.65[ab]

[a,b] : signif. different at P = 0.05

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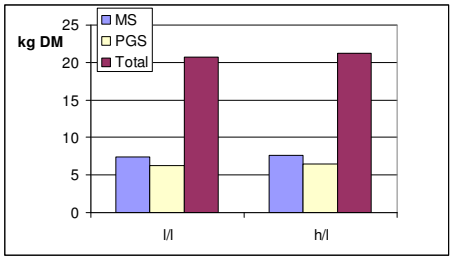
Feed intake – *Trial 2*



Content (g/kg DM)		
Starch	177[a]	179[a]
RES	**28[a]**	**35[b]**
FOM	606[a]	593[b]

PGS: 532 g NDF, 100 g ash, 78.4 % OMD (in vitro), 6.3 MJ NEL

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Nutrient supply and production results

TRIAL 2

RES-content MS/C	*l/l*	*h/l*
Nutrient intake		
NEL (MJ)	133[a]	135[a]
DVE (g)	1690[a]	1722[a]
NEL (% requir.)	105[a]	106[a]
DVE (% requir.)	102[a]	103[a]
Production		
Milk (kg)	28.8[a]	29.7[a]
Fat (%)	4.42[a]	4.29[a]
Protein (%)	3.37[a]	3.30[a]
LW-gain (kg)	0.39[a]	0.79[b]

[a,b] : signif. different at P = 0.05

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Indications of energy efficiency

Trial	*kg milk*	*NEL-intake (MJ)*	*NEL-eq. * output (MJ)*
Starch content (previous exp.) Difference vs. diet lowest S-content			
1	- 0.9	- 5.2	- 5.9
	- 0.4	- 1.7	- 3.4
2	- 0.9	- 3.4	- 4.9
	- 0.7	0	- 0.5
3	- 1.0	- 5.5	- 6.2
Rumen escape starch content (pres. exp.) Difference vs. diet lowest RES-content			
1	+ 0.2	+ 5.2	+ 8.6
	+ 0.5	+ 6.1	+ 8.1
2	+ 0.9	+ 1.6	+ 9.8

* based on: FPCM and LW-change

→ "indication": somewhat higher energetic efficiency of RES

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RES in concentrates – 15 trials

Starch sources	*Wheat Barley*	*Maize Sorgho*
kg milk	27.4	28.0
% fat	3.69	3.71
% protein	3.26	3.24

Matthé et al., 2000

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Conclusions

- A higher rumen escape starch content tended to increase DM-intake and milk yield. As milk fat and protein content tended to decrease, milk fat and protein production was unaffected.
- If LW-change is taken into account, the results indicate a somewhat higher energetic efficiency of RES.

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References

- De Brabander D.L., Geerts N., De Campeneere S. and J.M. Vanacker, 2004. Effect of starch content of maize silage based diets for dairy cattle. Book of abstract 55th Ann. Meeting EAAP, Bled, 3-10 Sept., p. 97.
- Matthé A., Lebzien P. und G. Flachowski, 2000. Zur Bedeutung von Bypass-Stärke für die Glucoseverzorgung von hochleistenden Milchkühen. Ubers. Tierernährg. 28, 1-64.
- Nocek J.E. and S. Tamminga, 1991. Site of digestion of starch in the gastrointestinal tract of dairy cows and its effect on milk yield and composition. J. Dairy Sci., 74, 3598-3629.

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