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Grass for biorefinery-

Dairy cow responses to diets based on solid fraction of grass silage

Outi Savonen, Marcia Franco, Tomasz Stefański, Päivi Mäntysaari, Kaisa Kuoppala & Marketta Rinne

Natural Resources Institute Finland (Luke), Jokioinen, Finland

www.luke.fi

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Alternative, fibrous feed resources for ruminants

- Grazing ruminants have a great access to energy in the form of fibrous feeds because of their specialized digestion
- This system with pregastric retention and fermentation with symbiotic microorganisms has allowed ruminants to utilize fibrous feed resources
- Separation of fibrous silage solid fraction for ruminants feed could enhance the utilization of silage in farms

Separated solid fraction in ruminant diets

- There is limited information of the nutritive value of separated solid fraction of grass silage
- Increased fibre content, reduced crude protein (CP) content and decreased digestibility have been reported
- Similar changes have been detected due to delyed harvest of **grass silage**
- **in both cases fibre intake increases**

Changes in grass maturity vs. silage solid fraction in diet => fibre intake increases

- With increasing maturity of grass also the fibre **digestibility** decreases …

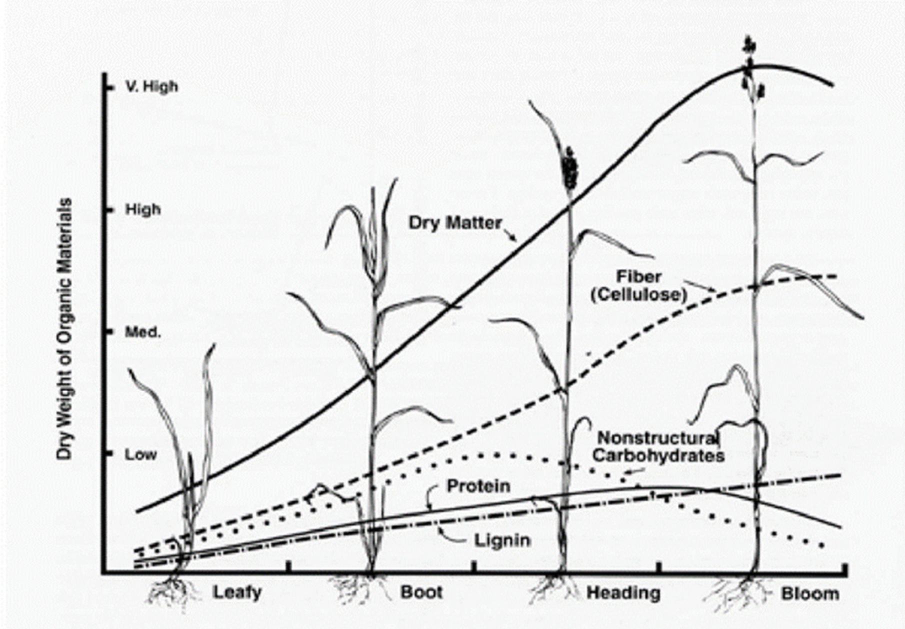

Figure 2: Forage dry matter and quality

Source: White, H. and D. Wolf. 'Controlled Grazing of Virginia Pastures': Virginia Cooperative Extension Publication Number 418-012, July 1996.

- …but in the present study fibre digestibility stayed the same, only the **amount** of fibre increased when silage solid fraction was included in the diet

The aim of this study

- To evaluate the effect of silage solid fraction fed to dairy cows on:

  - feed intake
  - ruminal fermentation
  - digestibility
  - milk yield and milk composition

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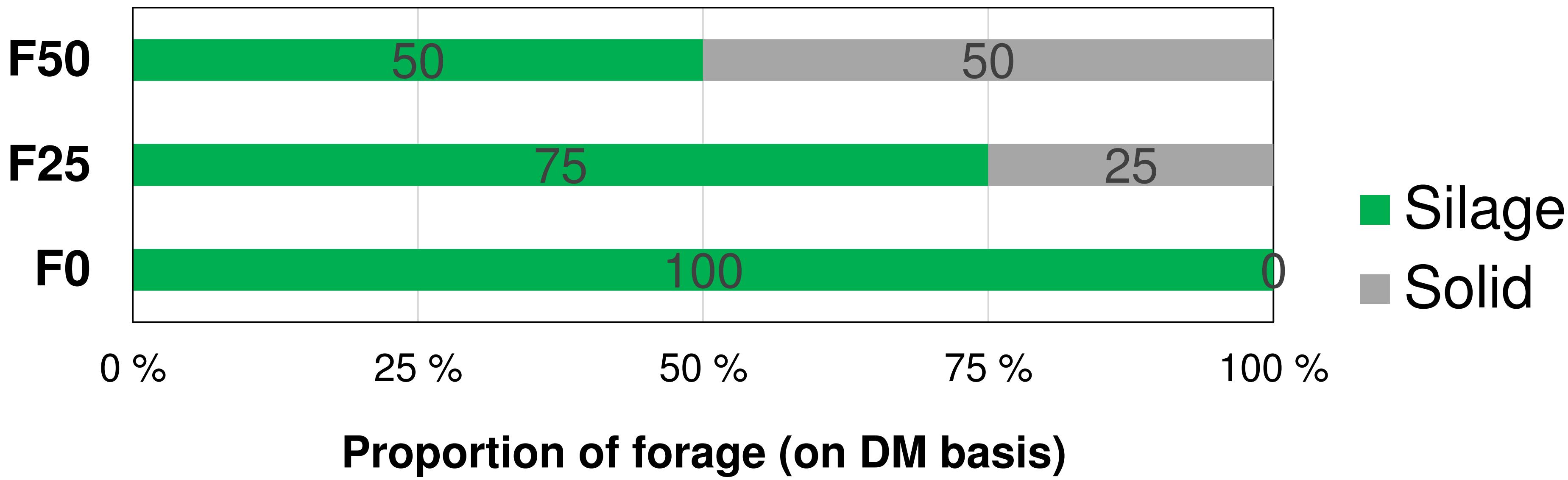
HYPOTHESIS:

There is no reduction in milk production in the diet containing silage solid fraction compared to original silage

Materials and Methods

- 24 multiparous Nordic Red cows, 4 rumen fistulated
- Experimental treatments: **F0**, **F25** and **F50**:



- Imbalanced change over design, 3 diets, 2 periods of 21 days

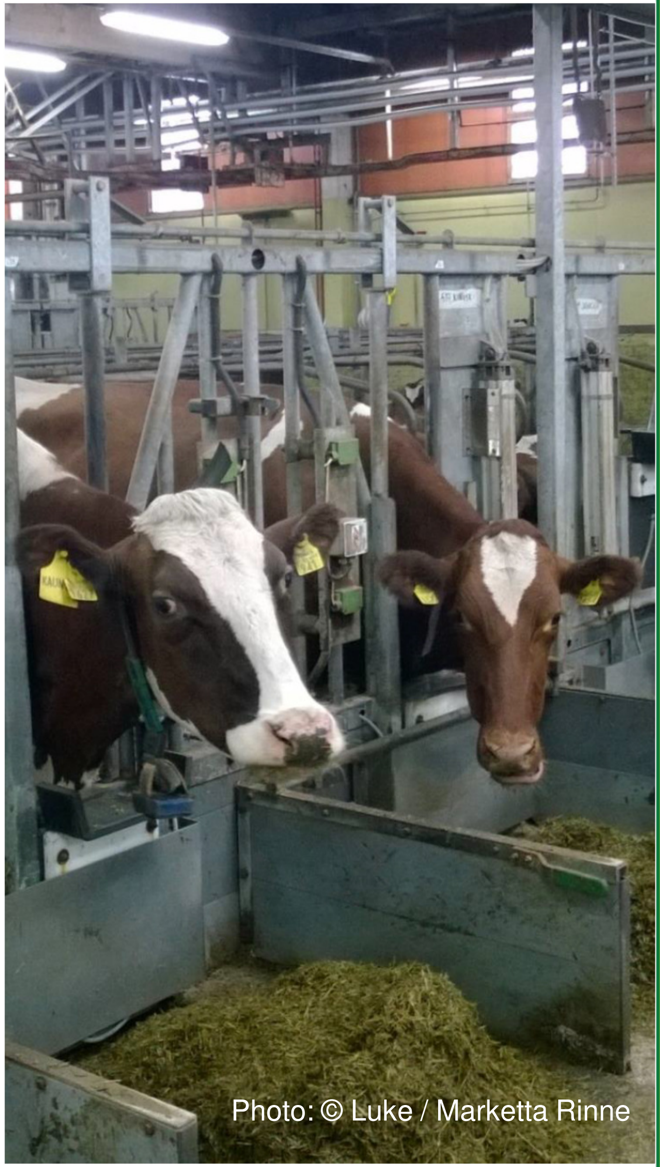
Feeds

Concentrate

- 13 kg /d standard concentrate

Forage *(ad libitum)*

- 1st cut grass silage, mixed timothy (Phleum pratense) and meadow fescue (Festuca pratensis)
- Harvested 21st and 22nd June 2017, preserved with formic acid-bесed additive (AIV 2 plus, 5 l/ton).
- Silage was fractionated into liquid and solid fractions



Fractionation of silage in Jokioinen January 2018

Constant input into the press was ensured by compressing silage to the screws manually


Photo: © Luke / Marketta Rinne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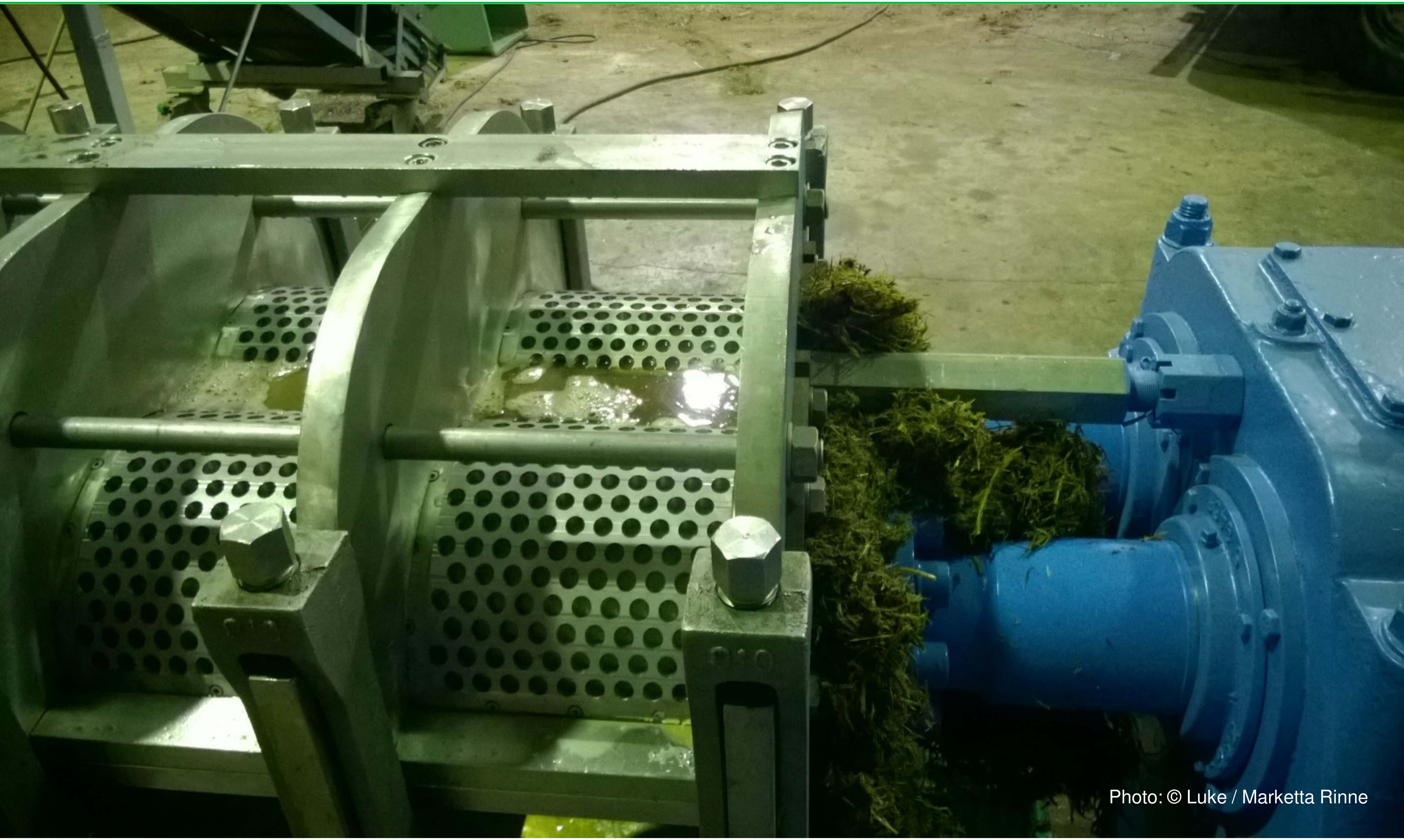
Haarslev twin screw press



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Separation of the liquid fraction

- Liquid was gathered from the bottom of Haarslev twin screw press and pumped into containers

- The liquid was used in an a feeding trial for fattening pigs

  - Results not presented here

Photos: © Luke / Marketta Rinne

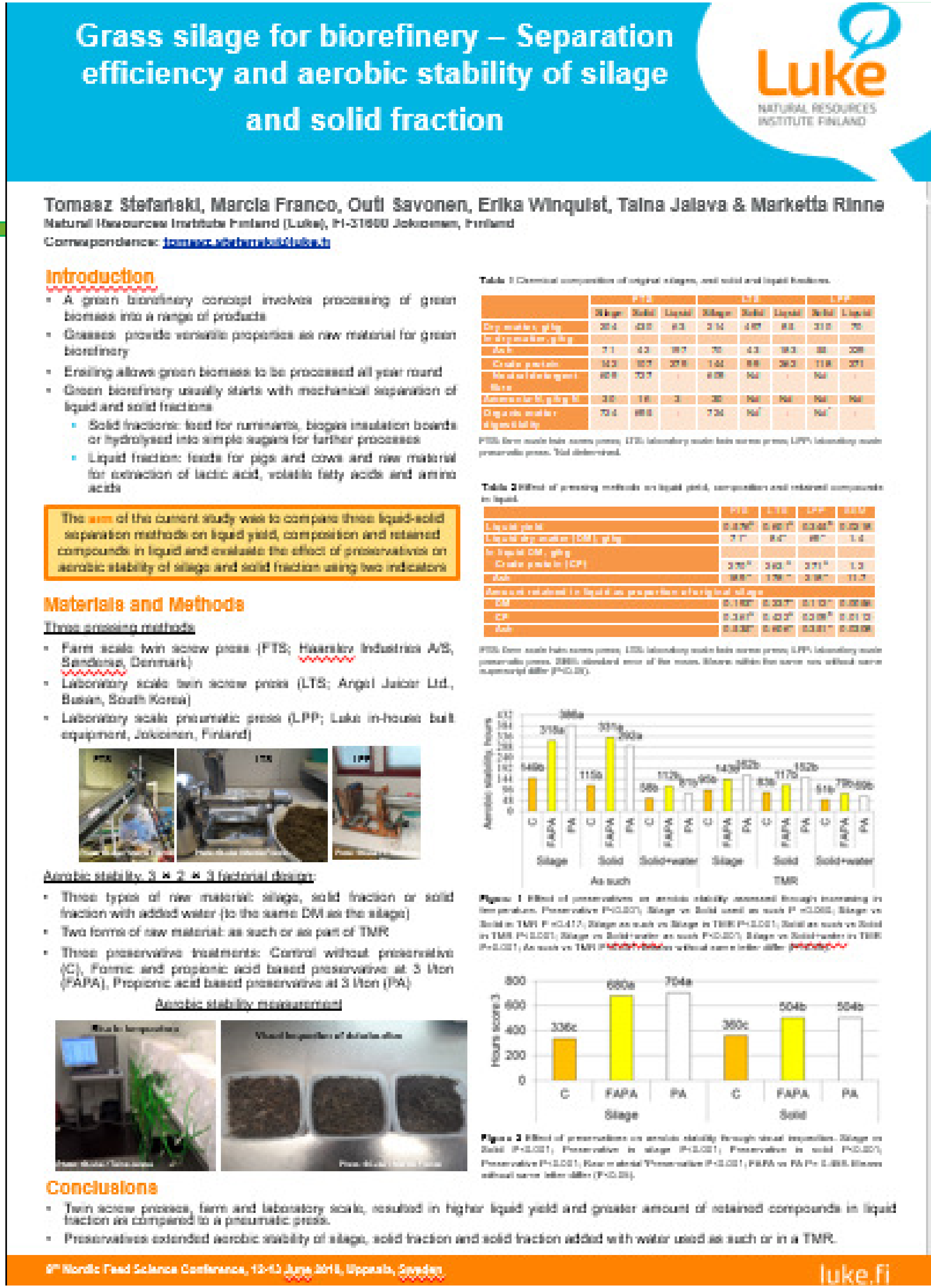
Silage solid fraction from twin screw press

Silage (left) and silage solid fraction (right)


Photo: ©Luke / Marcia Franco

In poster session:

- Description of production of the silage solid fraction used in this experment:
- Stefański, T., Franco, M., Savonen, O., Jalava, T., Winquist, E., Rinne, M. 2018. Grass silage for biorefinery – Separation efficiency and aerobic stability of silage, solid and liquid fractions. Nordic Feed Science Conference, Uppsala, Sweden, 12-13 June 2018.



Feeding of the cows

- **F0** (silage) was given from automatic feeding wagon
- **F25** and **F50** => silage solid fraction and silage were mixed in a TMR wagon and delivered by hands at the same time as automatic wagon fed F0 (07:00, 13:00, 16:00 and 18:00)
- Concentrate was given from automatic feeders and in milking parlour

NNOFEED

Milk sampling

Milk samples

- were taken on last two days of both periods
- were analyzed for **fat**, **protein, lactose** and **urea**
- milk constituents were calculated as a weighted mean according to milk yield.

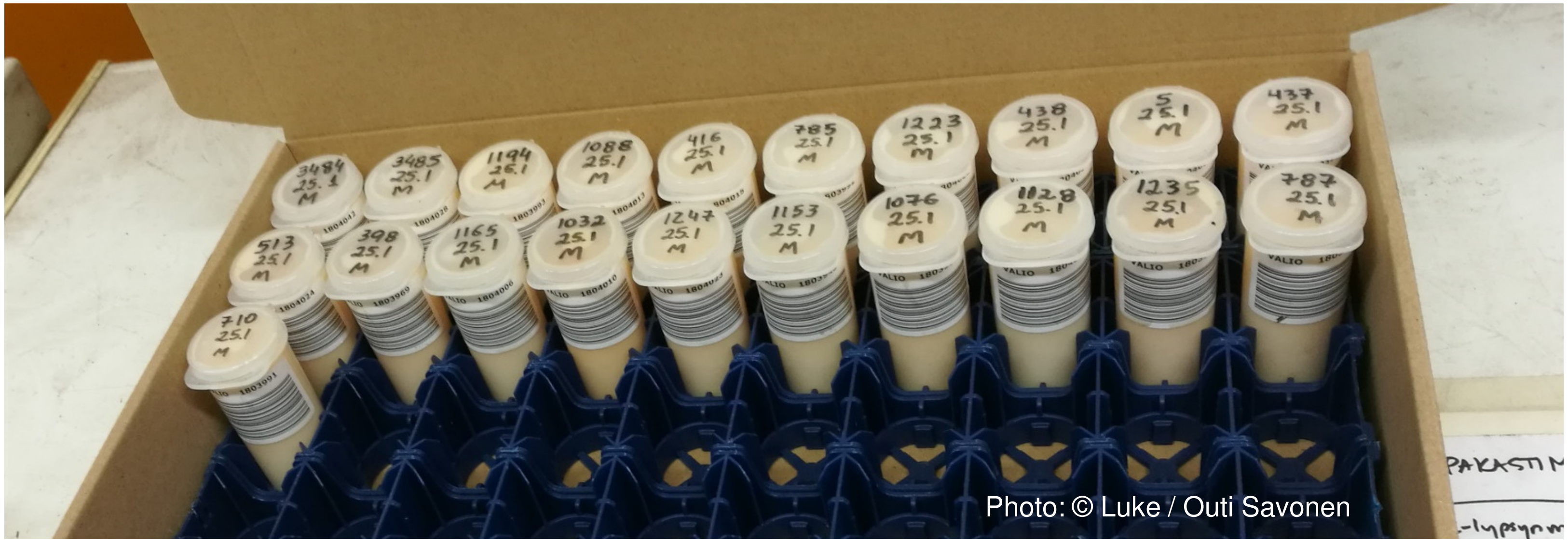


Photo: © Luke / Outi Savonen

Rumen fluid sampling

- Rumen fluid samples were taken during the third day in the last week of both periods
- For treatments F0 and F50 only
- Samples were taken 0, 3 and 6 hours after feeding and analyzed for

  pH, **NH_3** and volatile fatty acids **(VFA)**


Photo: © Luke / Marketta Rinne

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Faecal sampling for diet digestibility determination

- Faecal samples were taken on four days during the last week of both periods
- Crab samples were taken twice a day
- Samples were analyzed for

dry matter **(DM), ash**, crude protein **(CP),** neutral detergent fibre **(NDF)** and acid insoluble ash **(AIA).**

Data analysis

- Data was analyzed using a MIXED prosedure of SAS as 5% propability
- Dietary treatment as the **fixed effect** and cow as the random **effect**
- **Linear** (Lin) and **quadratic** (Quad) effects of addition of silage solid fraction were evaluated using orthogonal
  and polynomial contrasts

Fermentation quality of the original silage was good but it was rather wet

Variable	Result
Dry matter (DM, g/kg)	210
pH	4.0
Ammonia N, g/kg N	30
Lactic acid, g/kg DM	50
Acetic acid, g/kg DM	18
Propionic acid, g/kg DM	0.6
Butyric acid, g/kg DM	0.9

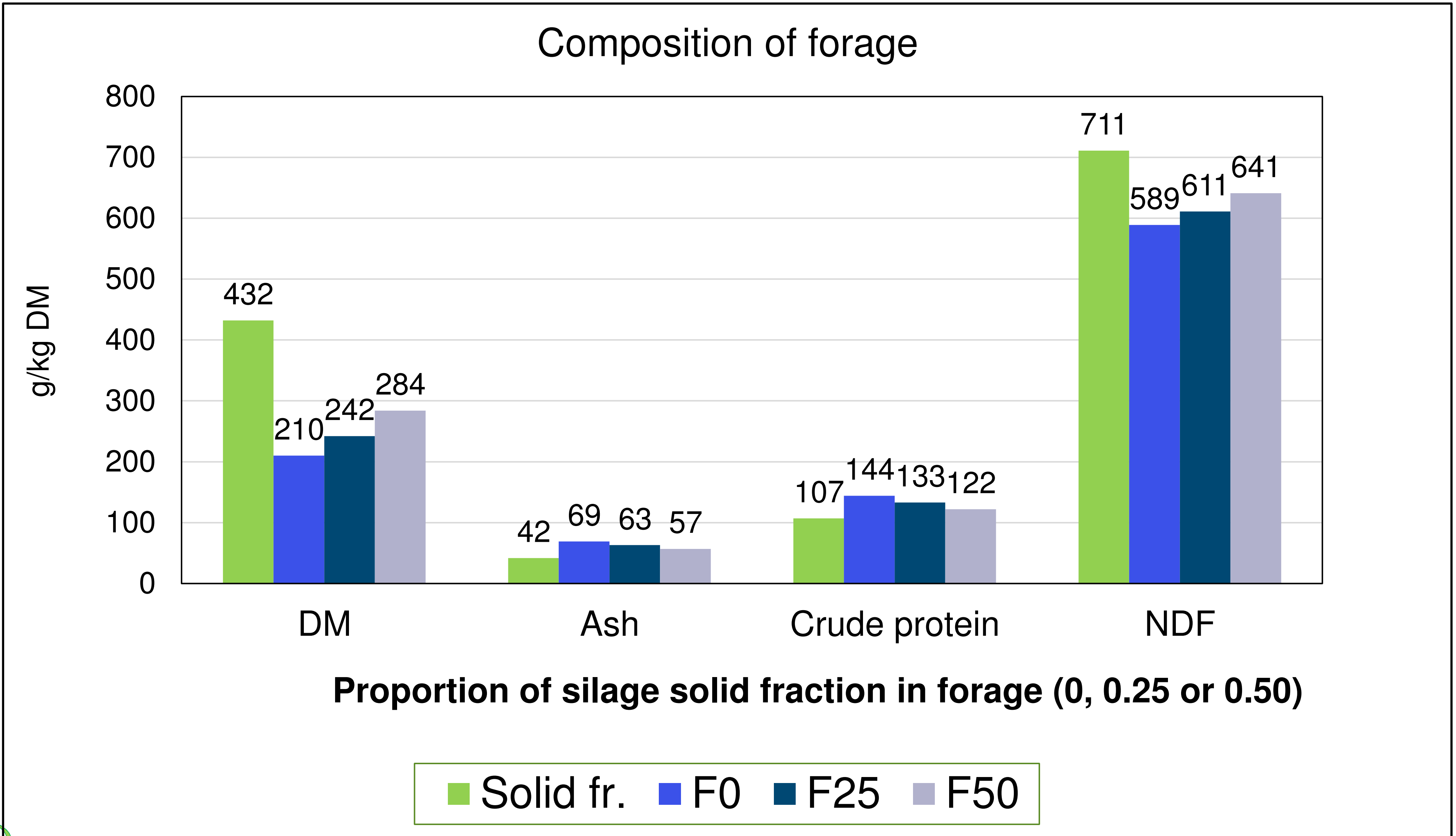
.

Effect of pressing on liquid yield, composition and retained compounds in liquid
(Haarslev twin screw press)

Variable	Result
Liquid yield, g liquid/kg original silage	0.576
DM in liquid, g/kg	71
In liquid, g/kg DM	
Crude protein (CP)	270
Ash	189
Amount retained in liquid as proportion of original silage	
DM	0.193
CP	0.361
Ash	0.535

Stefański, T, Franco, M, Savonen, O, Jalava, T, Winquist, E & Rinne, M. 2018. Grass silage for biorefinery – separation efficiency and aerobic stability of silage and solid fraction. Proc of the 9th Nordic Feed Science Conference, Uppsala, Sweden, June. 2018.

The composition of forage changed systematically when the amount of silage solid fraction was increased.



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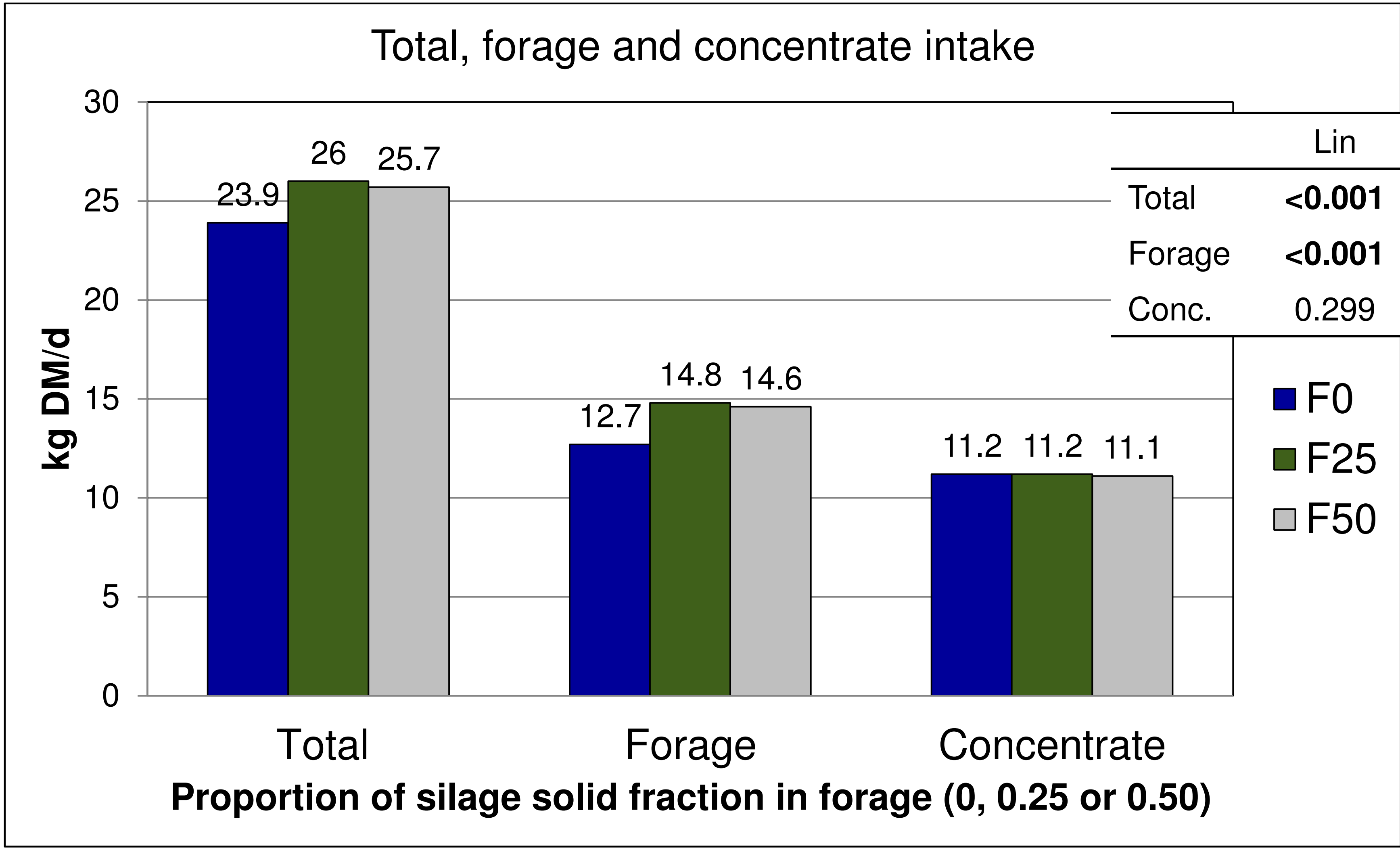
Cows fed F25 managed to increase forage intake but cows fed F50 were unable to further compensate.
There were no differences in concentrate intake.



	Lin	Quad
Total	**<0.001**	**<0.001**
Forage	**<0.001**	**<0.001**
Conc.	0.299	0.160

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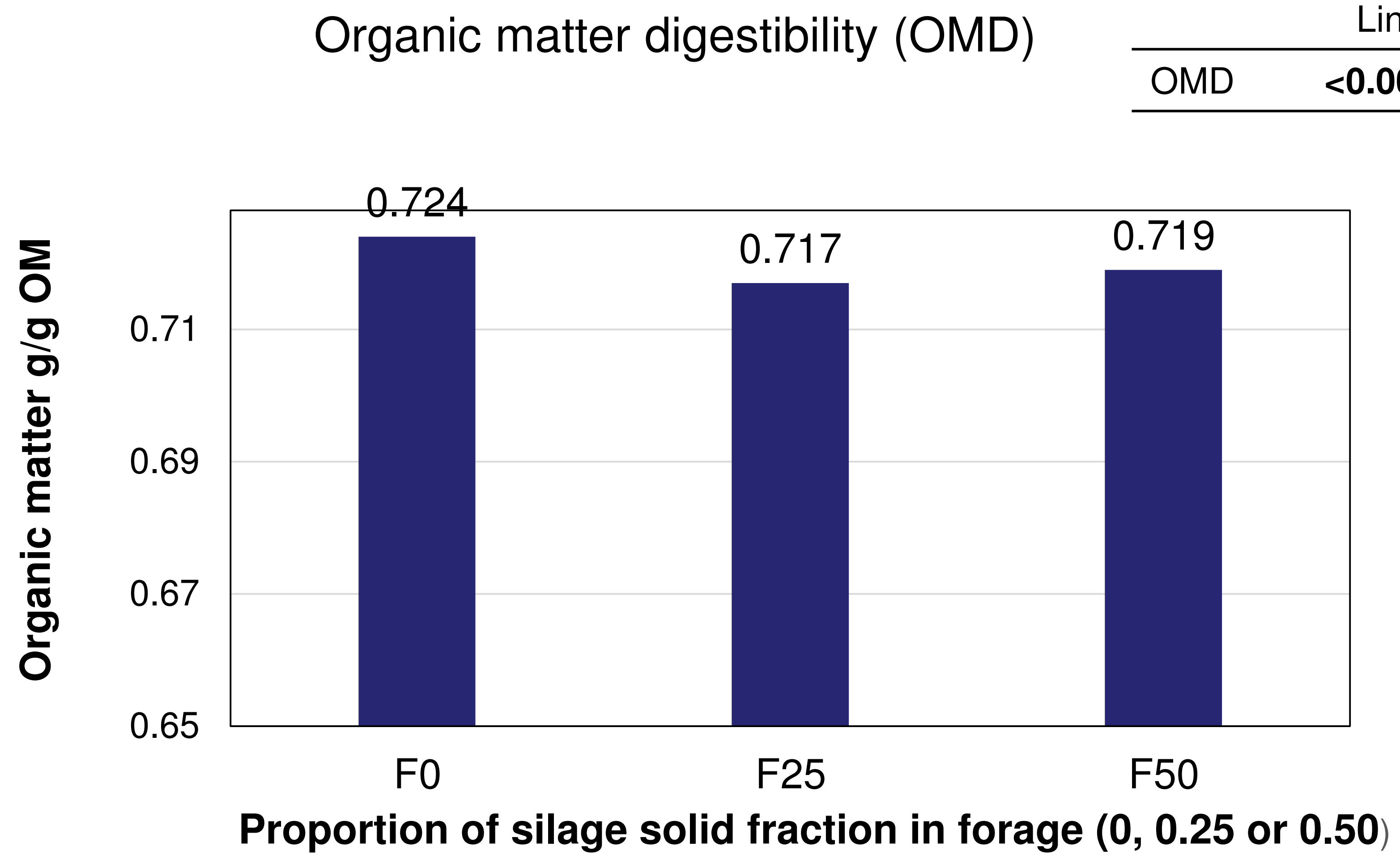
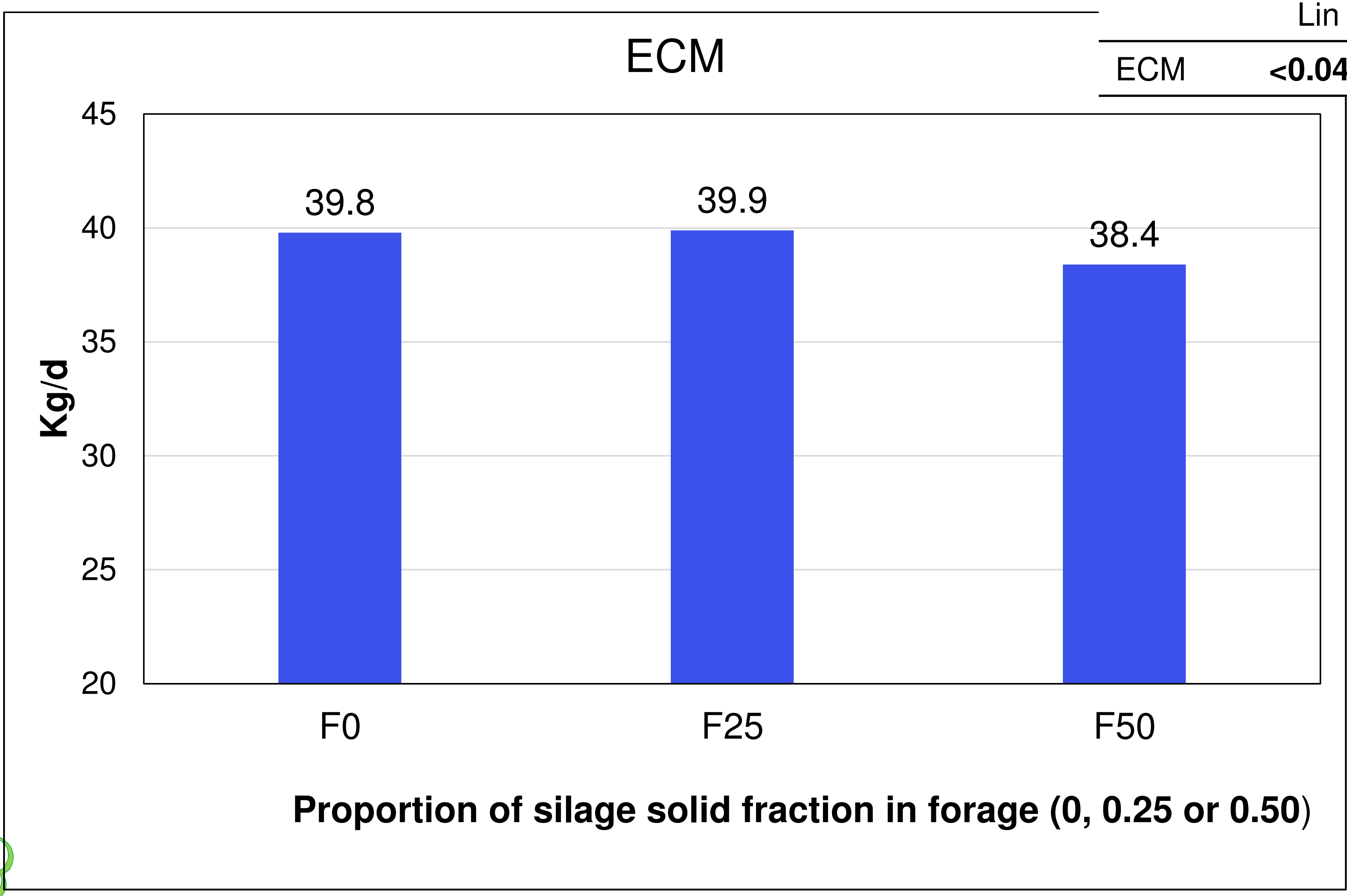
Diet organic matter digestibility (OMD) decreased sightly with increasing silage solid fraction proportion.

	Lin	Quad
OMD	**<0.001**	**<0.001**



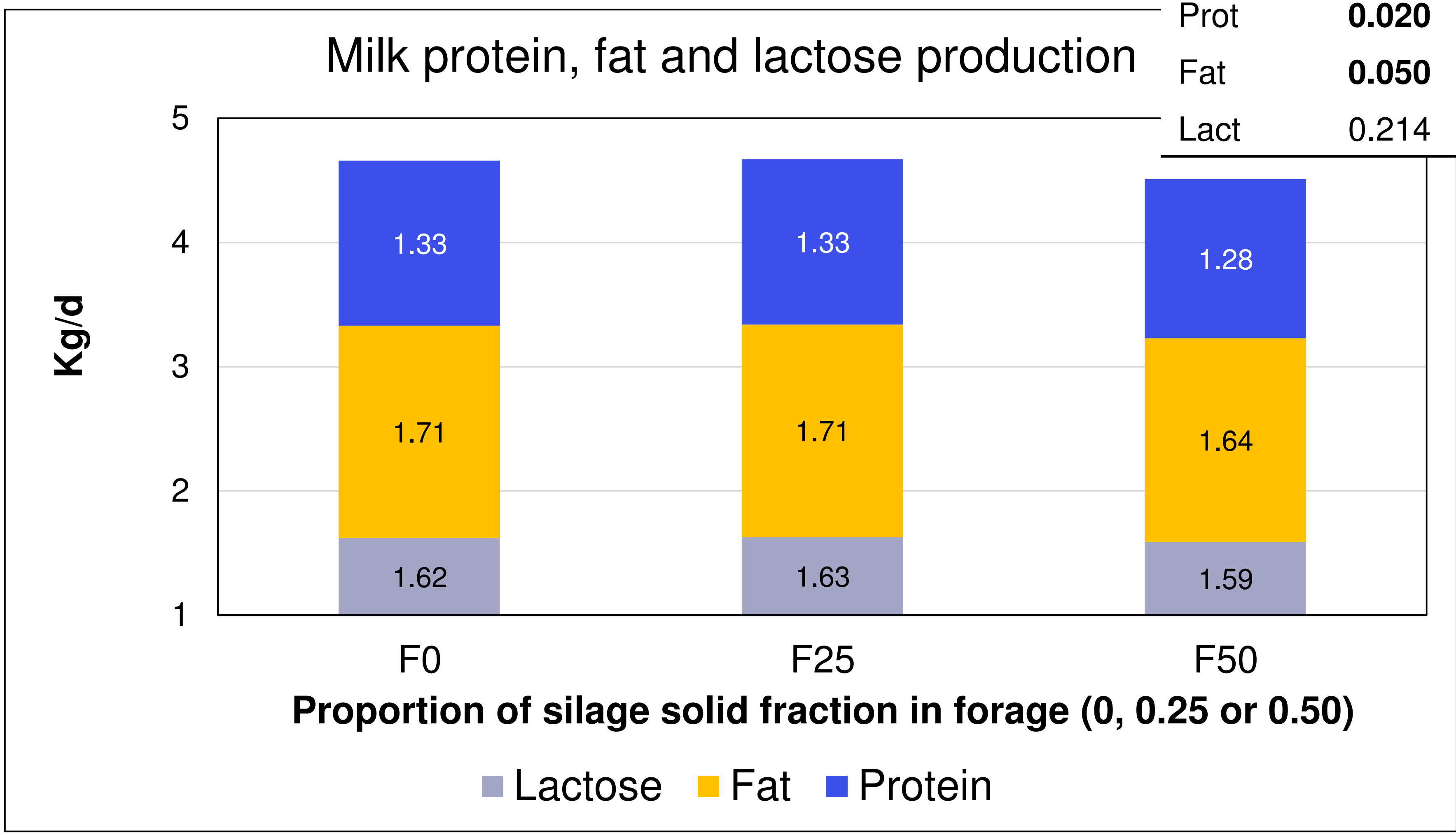
ECM production decreased linearly when silage solid fraction increased in diet.

	Lin	Quad
ECM	**<0.043**	**<0.161**

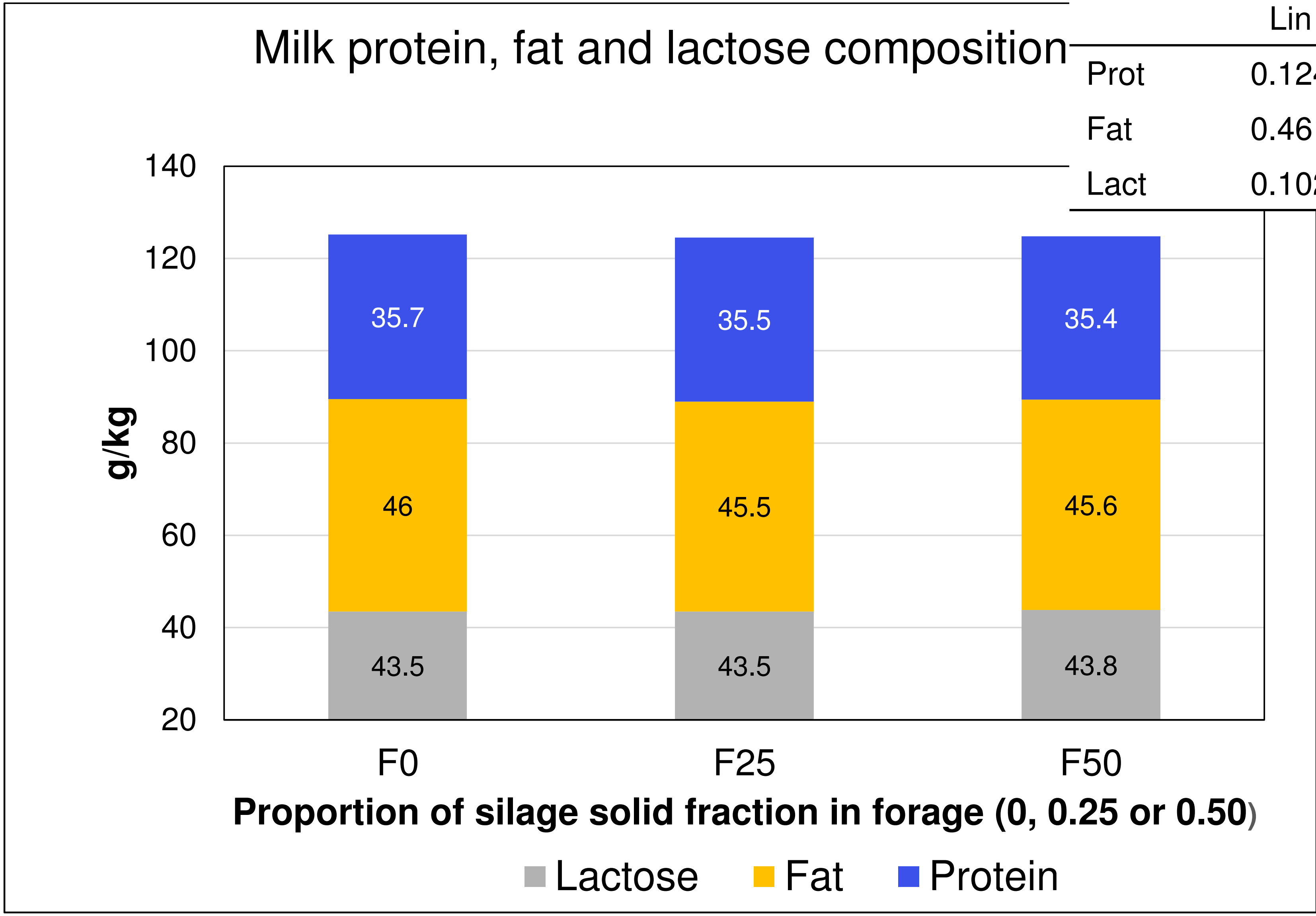


Milk fat and milk protein production decreased linearly when the proportion of silage solid fraction increased in diet.

	Lin	Quad
Prot	**0.020**	0.090
Fat	**0.050**	0.244
Lact	0.214	0.210



There were no differences in milk composition between the diets.

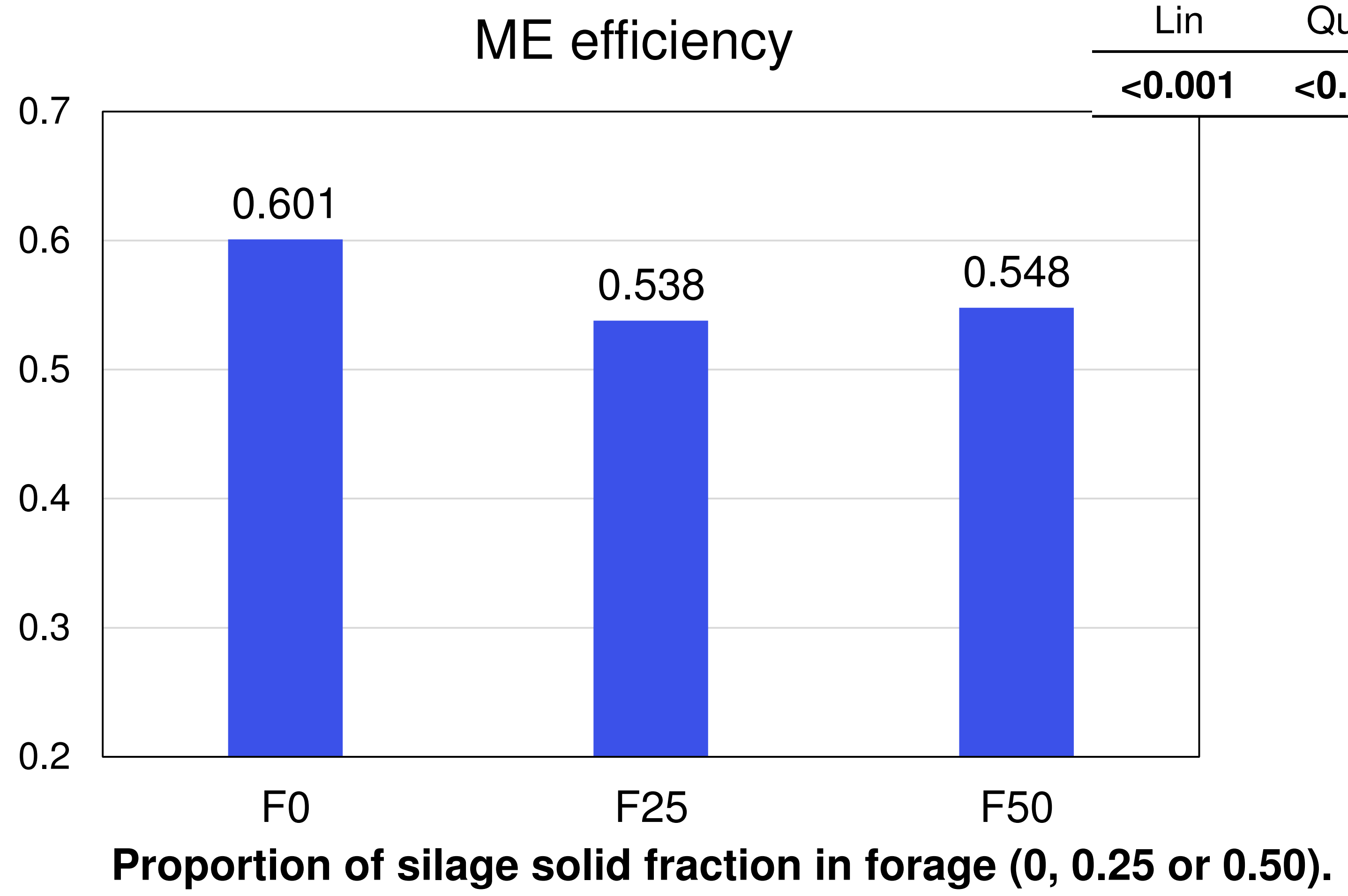


	Lin	Quad
Prot	0.124	0.997
Fat	0.461	0.956
Lact	0.102	0.341

In terms of milk production efficiency using the original silage resulted in higest values.

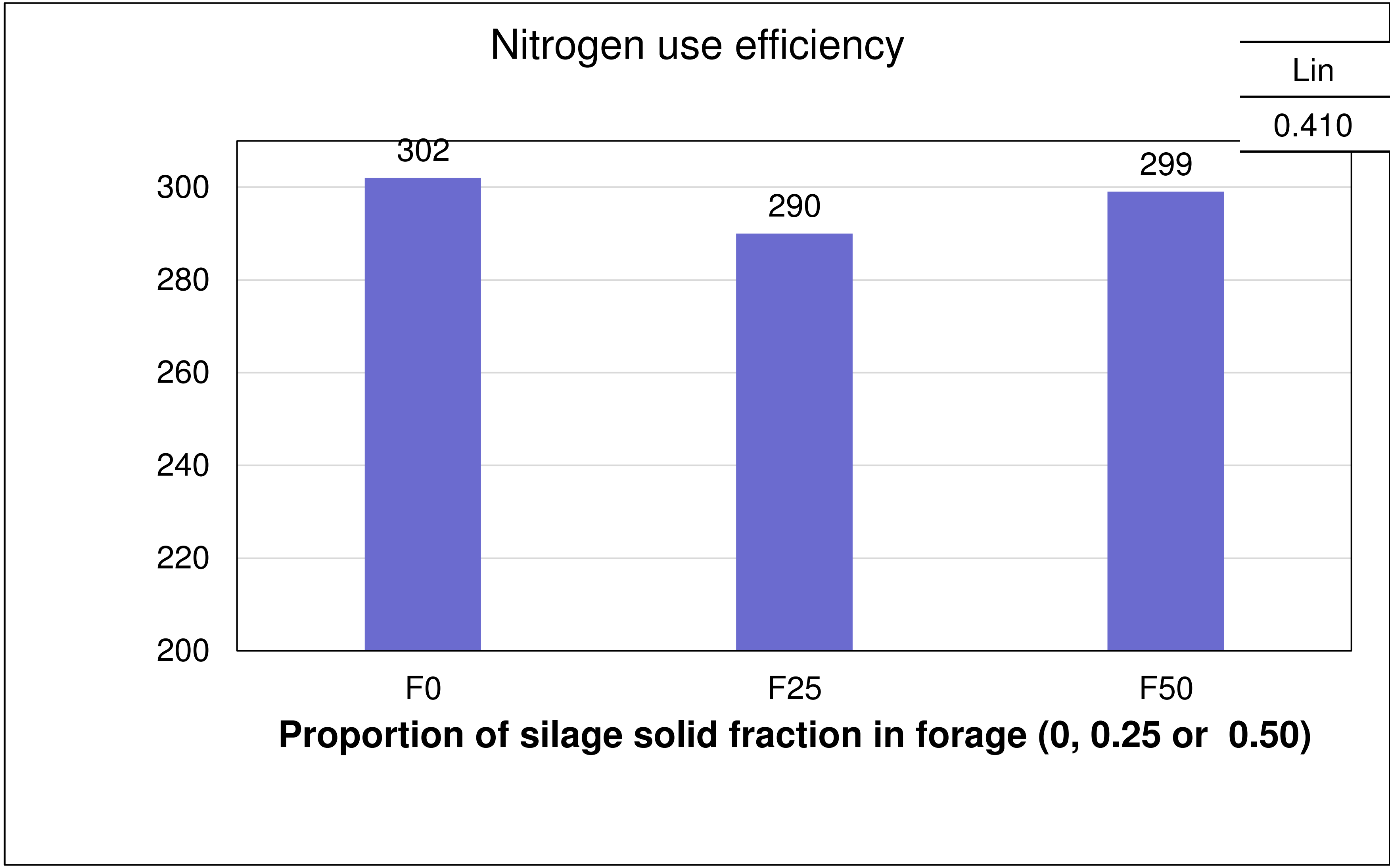
(Metabolizable energy (ME) excreted in milk) / (ME intake - ME for maintenance)

Lin	Quad
<0.001	**<0.001**



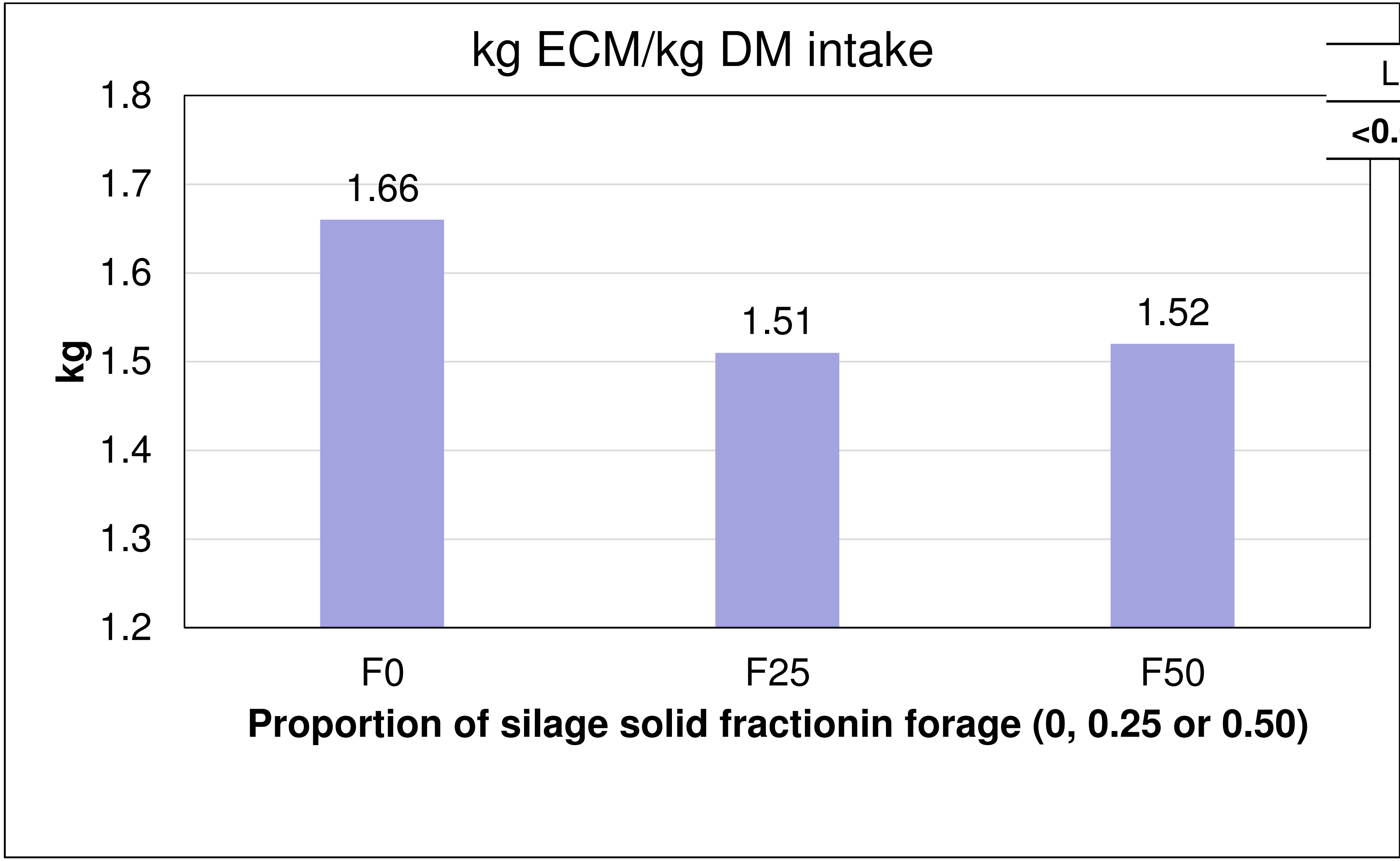
Nitrogen use efficiency was the highest in original silage.

(N excreted in milk / N intake)



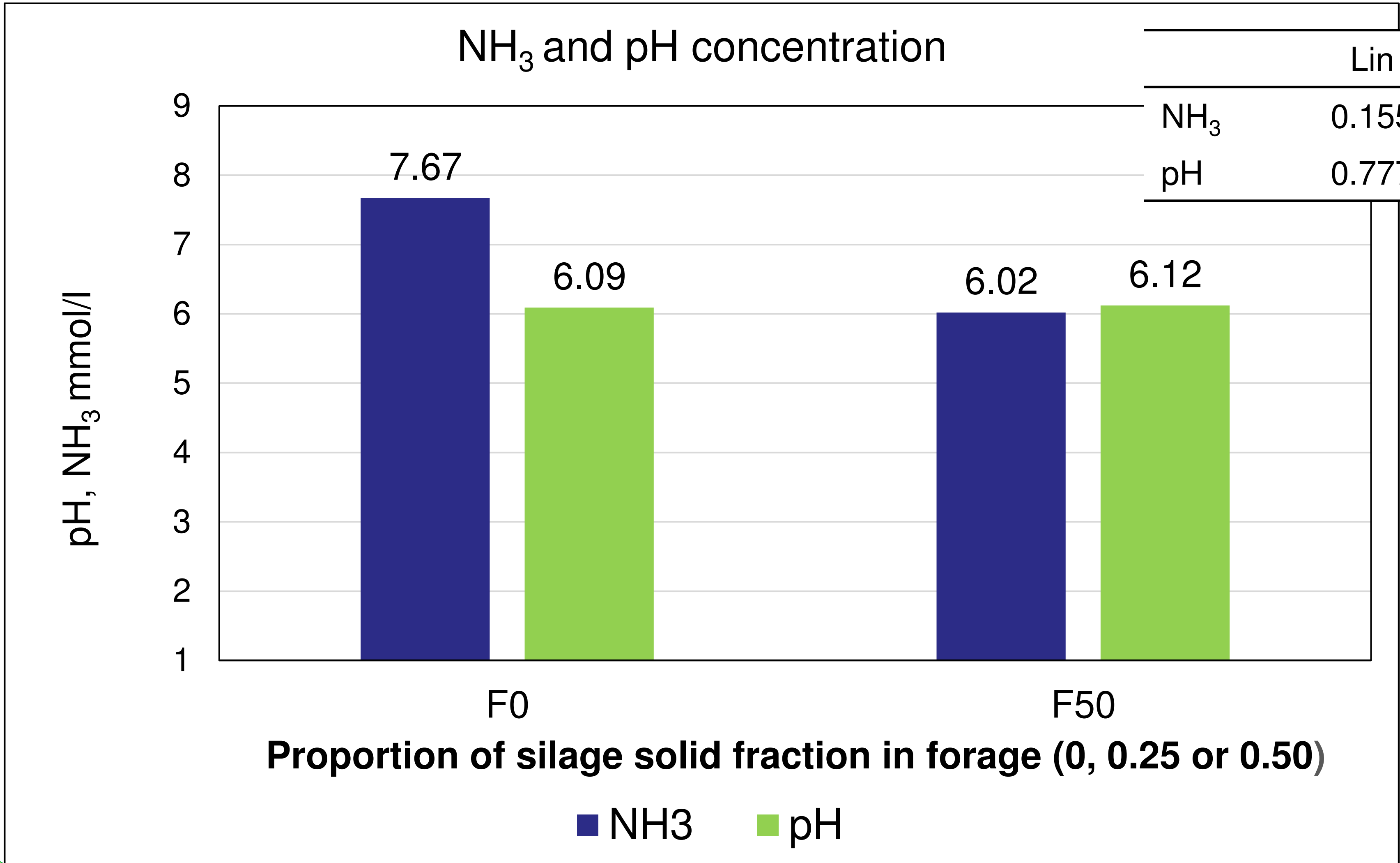
Lin	Quad
0.410	**0.002**

Milk production efficiency resulted in highest values using the original silage.



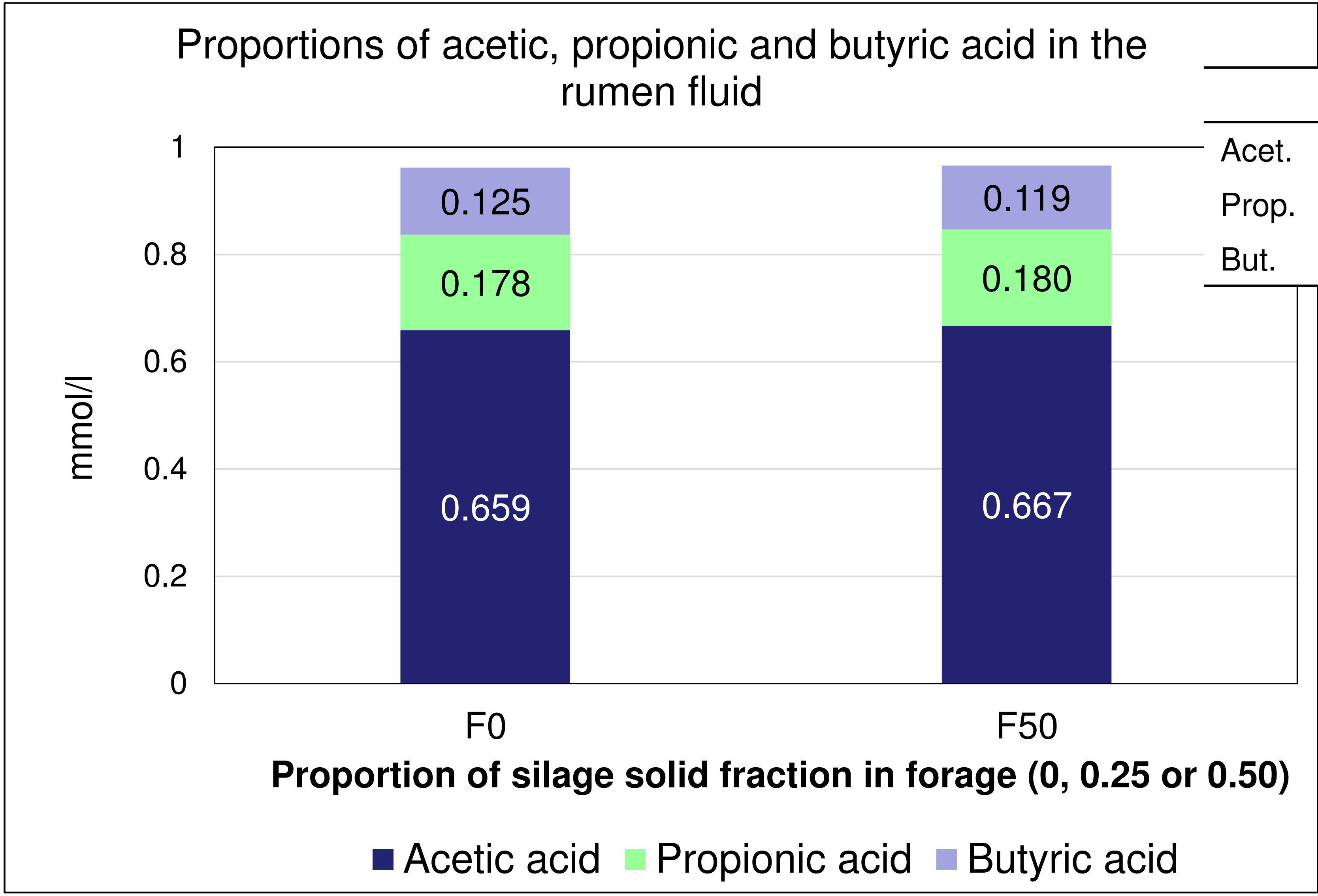
Lin	Quad
<0.001	**<0.001**

Ammonia N (NH_3) concentration and pH in rumen fluid were not significanty different but changed numerically in a logical way.



	Lin
NH_3	0.155
pH	0.777

Effects of silage solid fraction to the proportions of volatile fatty acids (VFA) were minor.



	Lin
Acet.	**0.020**
Prop.	0.561
But.	0.056

Conclusions

- Dairy cows increased DM intake and reduced ECM production in response to increased silage solid fraction proportion in the forage

  =>Silage solid fraction was not as good as the original silage for high producing dairy cows.

- Farm scale biorefinery could be used to improve the utilization of silage

  => **Solid fraction** to heifers and dry cows

  => **Silage juice** to fortify total mix rations

- If there are higher added-value uses for silage liquid

  => production potential of silage solid fraction for ruminant production is only marginally reduced

Thank You

Outi Savonen
outi.savonen@gmail.com

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