



Grass silage for biorefinery

Palatability of silage juice for growing pigs and lactating cows



M. Rinne, L. Keto, H. Siljander-Rasi, T. Stefański

Natural Resources Institute Finland – Luke, Finland

Surplus grass biomass could be used as raw material for green biorefineries

- Grass grows well in humid temperate areas with a capacity for high biomass production compared to annual crops and with environmental benefits
- Existing technology is available for its efficient cultivation, harvesting and preservation
- But there is limited demand of grass due to the size of ruminant and equine populations
- Green biorefineries offer or possibility to produce novel feeds suitable even for monogastric animals - and many other products



Simple example of a green biorefinery concept



Grassland
production

Harvesting and
preservation of grass

With this study, we wanted to find out the palatability of silage juice for pigs and cows

Mechanical
fractionation

Liquid fraction

Solid fraction

**Liquid feed
for pigs and
cows**

Production of silage juice at farm scale

Haarslev twin screw press

Constant input into the press assisted manually

Silage solid fraction from press

Silage from TMR wagon along a conveyor to press.

Silage juice production was succesful

- The twin screw press performed well with estimated throughput up to 1000 kg silage per hour
- The average yields were as follows:
 - Juice proportion (of original silage fresh weight) 488 g/kg
 - DM proportion retained in juice 0.182
 - Ash proportion retained in juice 0.774
 - CP proportion retained in juice 0.575



Chemical composition of original silage, solid fraction and liquid fraction

	Original silage	Liquid fraction
Dry matter, g/kg	264	100
In dry matter, g/kg		
Ash	102	255
Crude protein	126	166
NDF	547	Nd*
Sugars	37	120
Ethanol	6	21
Lactic acid	55	183
Acetic acid	21	65
In total N, g/kg N		
Soluble N	347	Nd*
Ammonium-N	47	102
In vitro OMD	0.726	Nd*

*Not determined. By definition, silage juice is totally soluble.

Silage juice palatability for pigs – trial set up

- The palatability trial was conducted at a commercial pig farm in spring 2017 using frozen and melted silage juice
- One pen with 8 pigs was used weighing 51.9 kg at the start and 60.6 kg at the end of the trial.
- Two days adjustment period:
 - First the liquid, then after 15 min pelleted feed to through
- Five days trial period:
 - Daily increasing portions of silage juice + standard portion of pelleted feed
- At start 2.6 L, at the end 4.1 L silage juice per pig per day



Photo: Marketta Rinne / Luke

Feedback from the pigs

- The pigs readily consumed silage juice when it was mixed with pelleted complete feed
- The daily growth rate was excellent but the measuring period was too short to make conclusions
- The proportion of silage juice in the diet was relatively low
 - 400 g DM/day
 - 12 % of energy intake
 - 23 % of crude protein intake
- After the palatability trial, we have also conducted a full scale feeding experiment with silage juice
 - Comparable performance to the control diet was achieved



Photo: ©Antti Hyppönen

Potential additional benefits in silage juice feeding

- The pH of silage juice is low, which may help in stabilizing the liquid feed and pig digesta thus improving the intestinal health
- If silage is preserved with chemical additives such as formic acid, it is extracted into the silage juice and can replace acids that would be added to liquid feed as stabilizers
 - In our case, the silage juice contained 7 g/kg formic acid
- The lactic acid bacteria inoculants could potentially be optimized for pig feeding to act as probiotics



Photo: ©Antti Hyppönen

Potential risks in silage juice feeding

- Grass silage may be very high in potassium (K) and subsequently high concentration in silage juice is to be expected
 - In this experiment the K concentration in silage juice was 7 g/kg resulting in a diet concentration approaching the maximum recommended level (7.8 vs. 10 g/kg, NRC 2005)
 - High K content in diet may cause loose faeces of the pigs
- Attention always needs to be paid to original silage hygienic quality and the preservation of the biorefined products



Photo: ©Antti Hyppönen

Multiple benefits foreseen for a pig farm

- Using silage juice as liquid feed can increase feed self sufficiency at farm, regional, national and EU level
 - Including grass based products in pig diets increases the proportion of non-human edible feeds in their diets
- New markets for grass
 - Increased grass cultivation with potential benefits in nutrient use efficiency, soil structure, soil carbon sequestration, biodiversity, improved rural livelihoods
- Possibility of including grass into crop rotation of pig farms
 - Plus possibility to use more manure per hectare than for cereals
- Grass fibre could be used for bioenergy e.g. in an on-farm biogas plant combined with pig slurry



What did cows think about grass juice?

- A palatability trial was conducted at Luke with fresh silage juice
 - The experiment lasted 5 days
- Five cows in individual pens were used
- Feed consumption and milk production was measured daily
- The cows were fed as follows:
 - Water freely
 - Ad libitum access to grass silage
 - 8.2 kg DM concentrate per day
 - 20 kg of silage juice per day in two portions

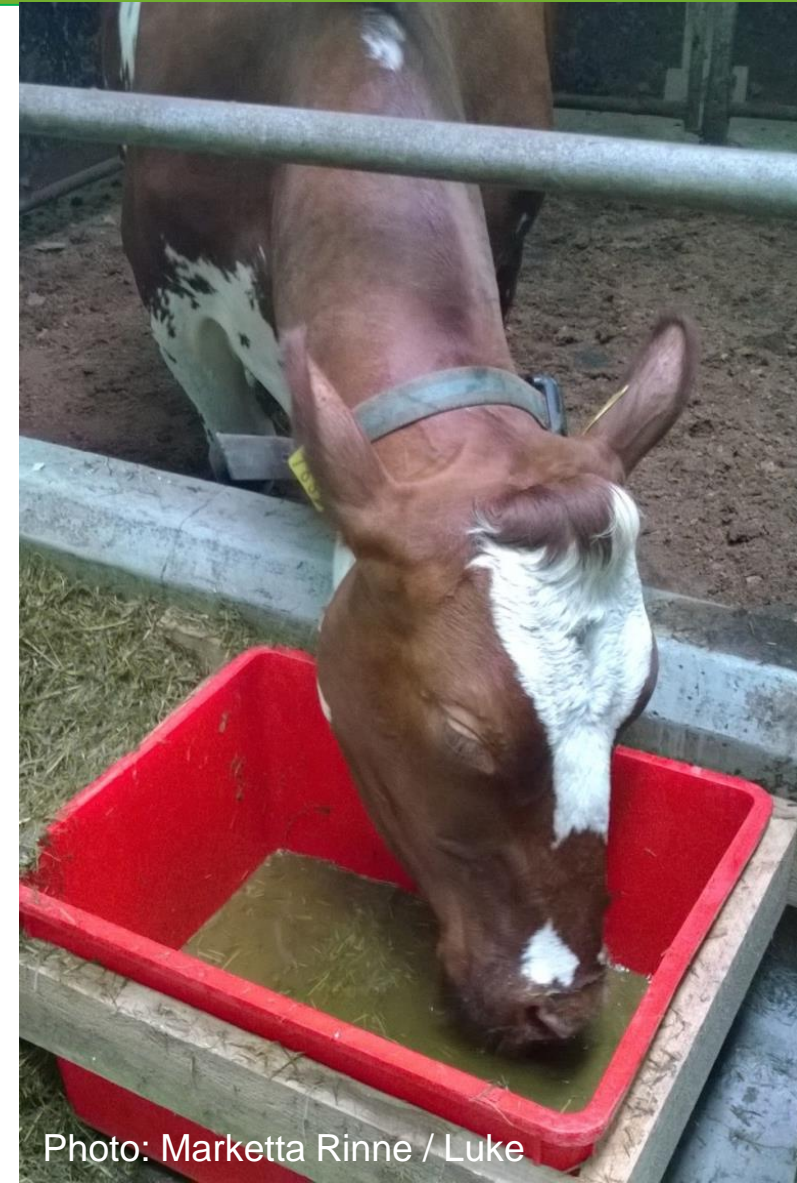


Photo: Marketta Rinne / Luke

The cows were kept in individual pens to allow measurement of juice intake



Boxes with
silage juice

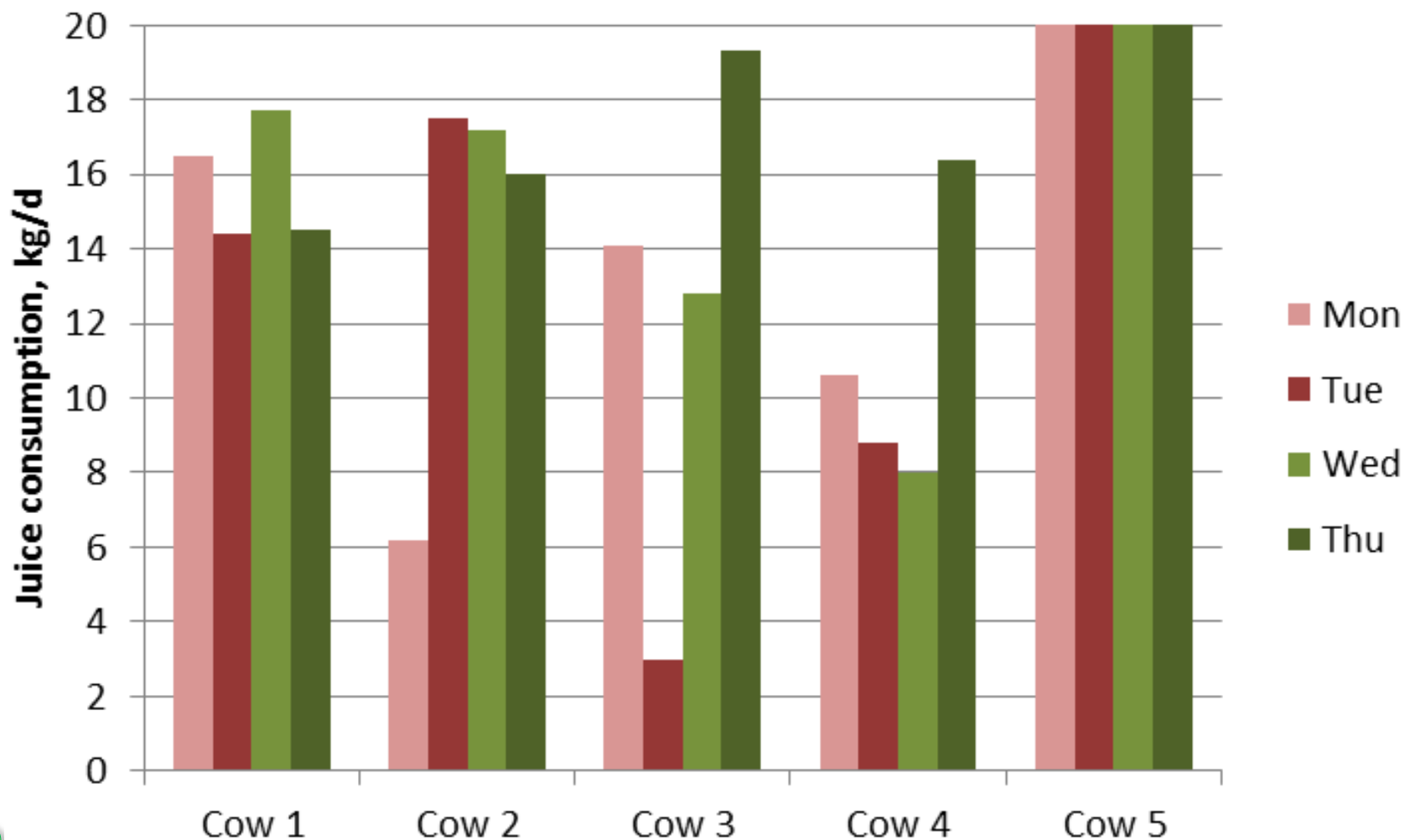
Description of the dairy cow palatability trial

Silage intake, kg DM/d	10.9
Concentrate intake, kg DM/d	8.2
Silage juice intake, kg DM/d	1.5
Total DM intake, kg/d	20.6
Energy corrected milk, kg/d	28.1

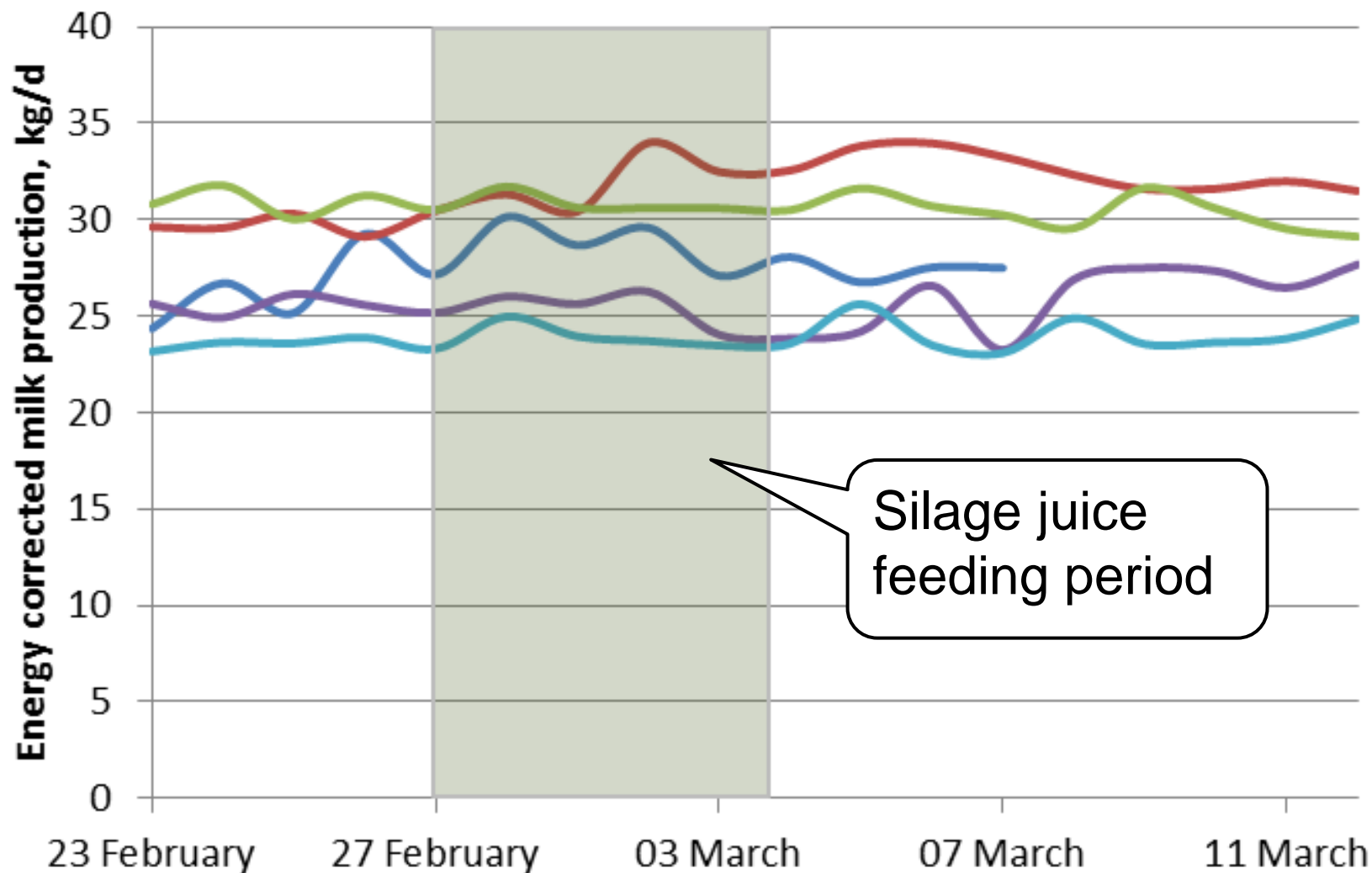


Photo: Marketta Rinne / Luke

Average silage juice consumption was 14.7 kg per day or 1.47 kg dry matter per day



Milk production of cows was not changed compared to time before or after the silage juice feeding



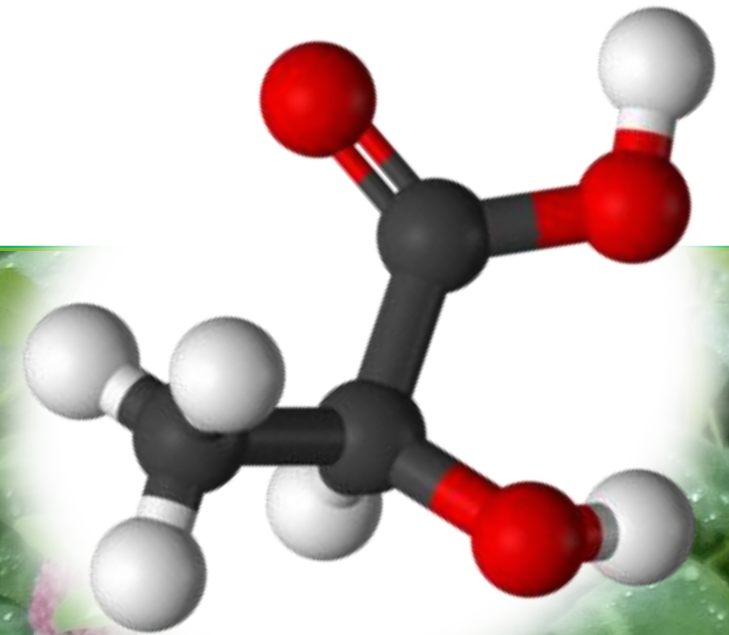
Silage juice
feeding period

Silage juice could bring benefits in dairy production

- Silage juice was readily consumed by cows (up to 20 l day was offered)
- The TMR of high producing dairy cows could be fortified by silage juice to increase the amount of on-farm produced grass in the diet
- The soluble components (amino acids, sugars) may partly escape rumen degradation due to fast passage rate in the liquid phase
- The more fibrous press residue could be diverted to dry cows / heifers with lower nutrient requirements



What next!?



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- Biorefineries provide multiple benefits for the society
- Technical solutions for on-farm and industrial applications exist
- The economic competitiveness at least on short term remains the bottle neck