Grass silage for biorefinery – Separation efficiency and aerobic stability of silage and solid fraction

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Introduction

- A green biorefinery concept involves processing of green biomass into a range of products
- Grasses provide versatile properties as raw material for green biorefinery
- Ensiling allows green biomass to be processed all year round
- Green biorefinery usually starts with mechanical separation of liquid and solid fractions
  - Solid fractions: feed for ruminants, biogas insulation boards or hydrolysed into simple sugars for further processes
  - Liquid fraction: feeds for pigs and cows and raw material for extraction of lactic acid, volatile fatty acids and amino acids

The **aim** of the current study was to compare three liquid-solid separation methods on liquid yield, composition and retained compounds in liquid and evaluate the effect of preservatives on aerobic stability of silage and solid fraction using two indicators

Materials and Methods

Three pressing methods

- Farm scale twin screw press (FTS; Haarslev Industries A/S, Søndersø, Denmark)
- Laboratory scale twin screw press (LTS; Angel Juicer Ltd., Busan, South Korea)
- Laboratory scale pneumatic press (LPP; Luke in-house built equipment, Jokioinen, Finland)

Aerobic stability, 3 × 2 × 3 factorial design:

- Three types of raw material: silage, solid fraction or solid fraction with added water (to the same DM as the silage)
- Two forms of raw material: as such or as part of TMR
- Three preservative treatments: Control without preservative (C), Formic and propionic acid based preservative at 3 l/ton (FAPA), Propionic acid based preservative at 3 l/ton (PA)

Aerobic stability measurement

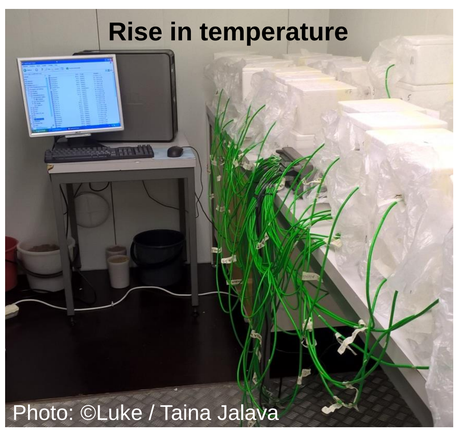

Table 1 Chemical composition of original silages, and solid and liquid fractions.

	FTS			LTS			LPP	
	Silage	Solid	Liquid	Silage	Solid	Liquid	Solid	Liquid
Dry matter, g/kg	204	430	63	214	497	85	310	70
In dry matter, g/kg								
Ash	71	42	197	70	43	183	55	229
Crude protein	142	107	279	144	99	262	118	271
Neutral detergent fibre	609	727	-	609	Nd*	-	Nd*	-
Ammonia-N, g/kg N	30	16	3	30	Nd*	Nd*	Nd*	Nd*
Organic matter digestibility	724	695	-	724	Nd*	-	Nd*	-

FTS: farm scale twin screw press; LTS: laboratory scale twin screw press; LPP: laboratory scale pneumatic press. *Not determined.

Table 2 Effect of pressing methods on liquid yield, composition and retained compounds in liquid.

	FTS	LTS	LPP	SEM
Liquid yield	0.576[a]	0.601[a]	0.345[b]	0.0218
Liquid dry matter (DM), g/kg	71[b]	84[a]	69[b]	1.4
In liquid DM, g/kg				
Crude protein (CP)	270[a]	263[a]	271[a]	1.2
Ash	189[a]	178[a]	218[a]	11.7
Amount retained in liquid as proportion of original silage				
DM	0.193[b]	0.237[a]	0.112[c]	0.0056
CP	0.361[a]	0.422[a]	0.209[b]	0.0112
Ash	0.535[a]	0.606[a]	0.351[b]	0.0308

FTS: farm scale twin screw press; LTS: laboratory scale twin screw press; LPP: laboratory scale pneumatic press. SEM: standard error of the mean. Means within the same row without same superscript differ (P<0.05).

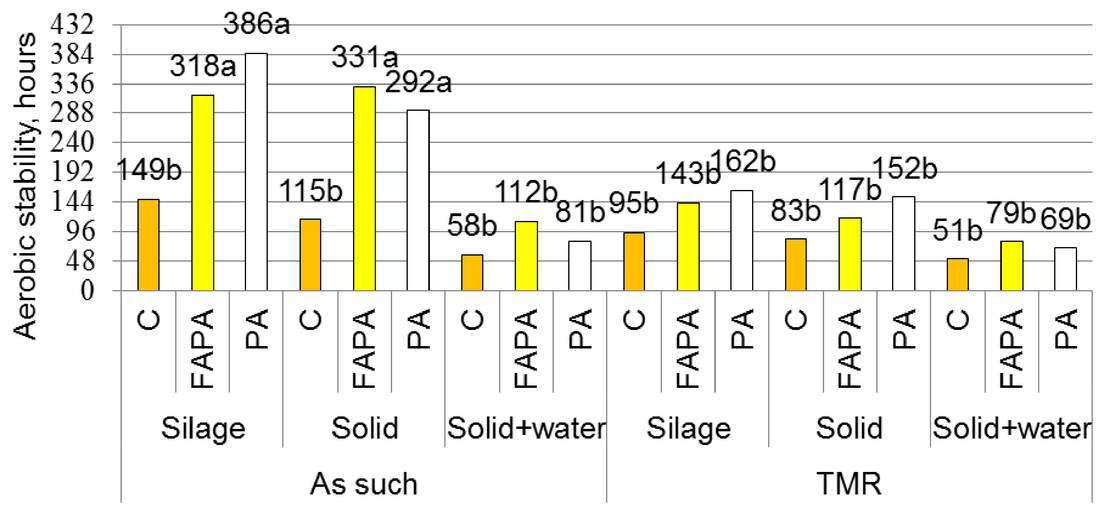

Figure 1 Effect of preservatives on aerobic stability assessed through increasing in temperature. Preservative P<0.001; Silage vs Solid used as such P =0.060; Silage vs Solid in TMR P =0.417; Silage as such vs Silage in TMR P<0.001; Solid as such vs Solid in TMR P<0.001; Silage vs Solid+water as such P<0.001; Silage vs Solid+water in TMR P=0.001; As such vs TMR P<0.001. Means without same letter differ (P<0.05).

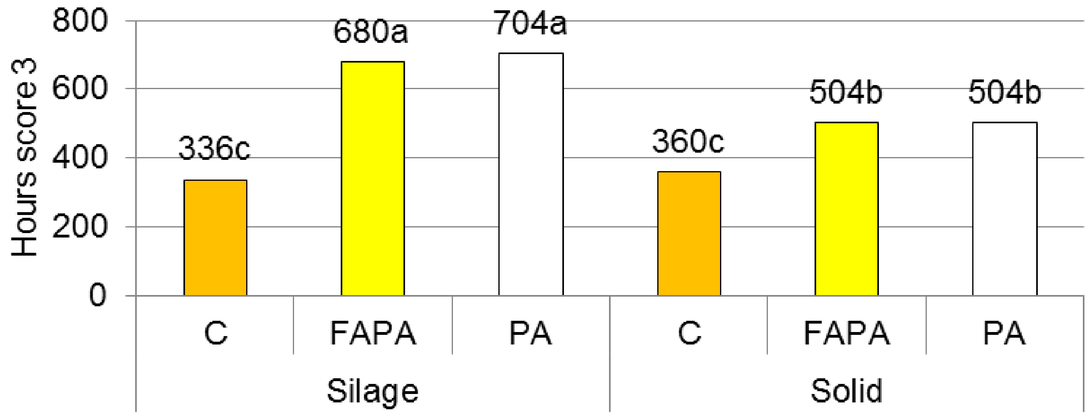

Figure 2 Effect of preservatives on aerobic stability through visual inspection. Silage vs Solid P<0.001; Preservative in silage P<0.001; Preservative in solid P<0.001; Preservative P<0.001; Raw material*Preservative P<0.001; FAPA vs PA P= 0.458. Means without same letter differ (P<0.05).

Conclusions

- Twin screw presses, farm and laboratory scale, resulted in higher liquid yield and greater amount of retained compounds in liquid fraction as compared to a pneumatic press.
- Preservatives extended aerobic stability of silage, solid fraction and solid fraction added with water used as such or in a TMR.