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Evaluation of ensiled fruit wastes with crop by-products as feeds for ruminants

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Why Fruit Wastes?

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Fibers

Bioactive compounds (phytochemicals)

Pectins

Minerals

Sugars (& starch)

Vitamins

Lipids

Protein

Preserving fruit and crop watses

- Surge in amount but shortly available
- Low shelf-life
- Not homogenous
- Poor hygiene

- Weather dependent
- Costly (indoor drying)
- Space to dry and store
- Risk of contamination

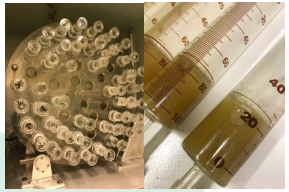
- **Ideal for wet and sugar-rich materials**
- Adaptable
- Need experience and know-how

THE PROJECT & EXPERIMENTS

Phase 1
Ensiling Exp

Screening

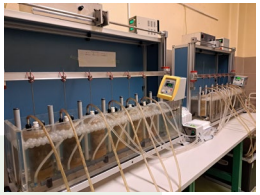
- Small scale ensiling
- Different resources
- Storage stability



Phase 2
Gas test Exp

Selection

- In vitro gas production
- Potential rumen degradability

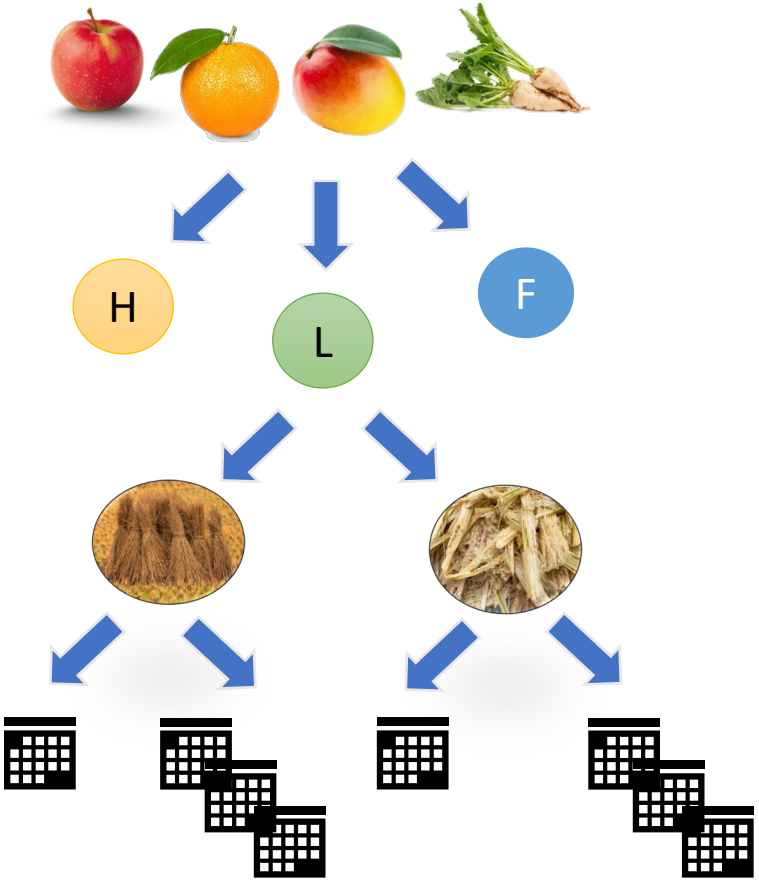


Phase 3
RUSITEC Exp

Test vs. Corn silage

- Rumen fermentation
- Nutrient degradation

ENSILING EXPERIMENTS



48 ensiling combinations
144 silage samples

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Ensiling and Gas Test Experiments

Parameters	Co-substrate (Co)	Rice	Rice	Sugarcane	Sugarcane	SEM	P ≤ 0.05
	Duration (D), month	1	3	1	3		
pH	Apple	3.97	3.58	3.67	3.30	0.21	By, Co, By x Co, Du, By x Du
	Citrus	4.23	3.84	4.07	2.99		
	Mango	3.77	3.90	3.19	2.99		
	Sugarbeet	4.61	3.74	4.92	3.56		
DM loss (%)	Apple	3.37	9.26	5.65	15.40	1.84	By, Co, Du, By x Du
	Citrus	5.28	17.20	9.37	22.27		
	Mango	7.17	13.39	8.89	14.16		
	Sugarbeet	3.32	10.31	4.68	12.59		

No location effect (H, L and F)

By = byproducts
Co = Co-substrate
Du = Duration

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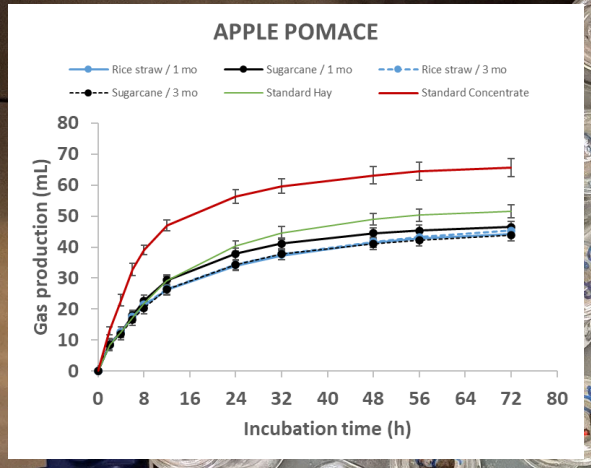
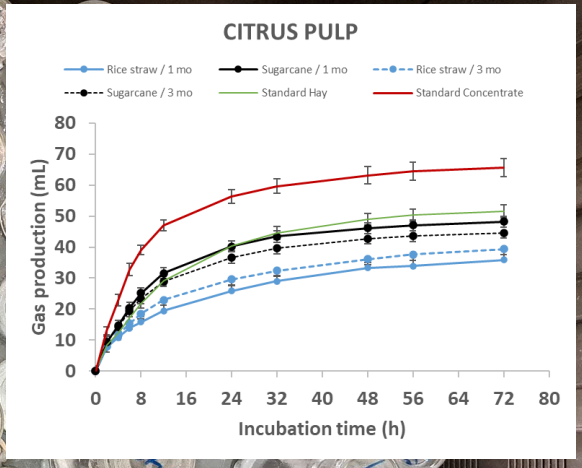
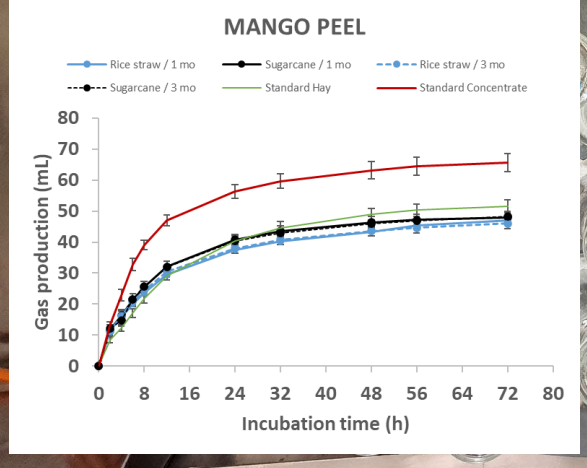
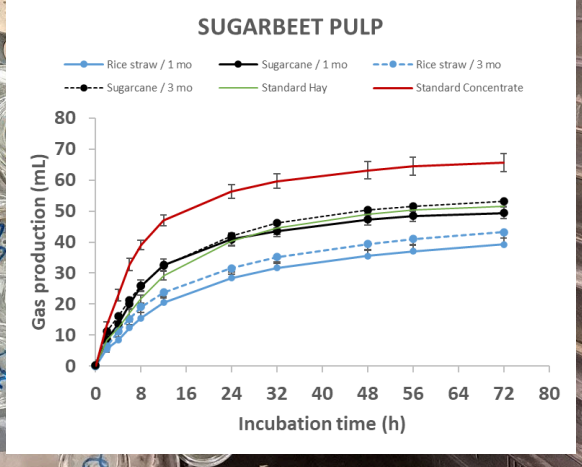

APPLE POMACE
Rice straw / 1 mo
Sugarcane / 1 mo
Rice straw / 3 mo
Sugarcane / 3 mo
Standard Hay
Standard Concentrate
Gas production (mL)
Incubation time (h)


CITRUS PULP
Rice straw / 1 mo
Sugarcane / 1 mo
Rice straw / 3 mo
Sugarcane / 3 mo
Standard Hay
Standard Concentrate
Gas production (mL)
Incubation time (h)


MANGO PEEL
Rice straw / 1 mo
Sugarcane / 1 mo
Rice straw / 3 mo
Sugarcane / 3 mo
Standard Hay
Standard Concentrate
Gas production (mL)
Incubation time (h)


SUGARBEET PULP
Rice straw / 1 mo
Sugarcane / 1 mo
Rice straw / 3 mo
Sugarcane / 3 mo
Standard Hay
Standard Concentrate
Gas production (mL)
Incubation time (h)

RUSITEC Experiments

	Ensiled Product (**fruit silages were ensiled with sugarcane bagasse for 3 mo*)			
Item (% dry matter unless mentioned)	Corn silage	Apple pomace silage	Citrus pulp silage	Mango peel silage
Dry matter (%)	29.6	23.3	22.4	22.5
Organic matter	95.6	96.9	95.3	94.6
Crude protein	9.0	5.8	8.8	6.8
Ether Extract	2.69	1.7	2.5	2.7
Neutral detergent fiber	40.7	63.4	55.0	37.3
Non-fiber carbohydrates	45.3	26.0	29.0	47.8
Lactic acid	5.7	3.9	2.57	4.66
Acetic acid	0.77	1.18	0.77	0.62
Ethanol	0.15	9.8	12.7	19.1
Ammonia-N (ppm)	1914	294	569	0
pH	3.8	3.4	3.8	3.9
DM loss (%)	1.6	1.3	3.2	4.8

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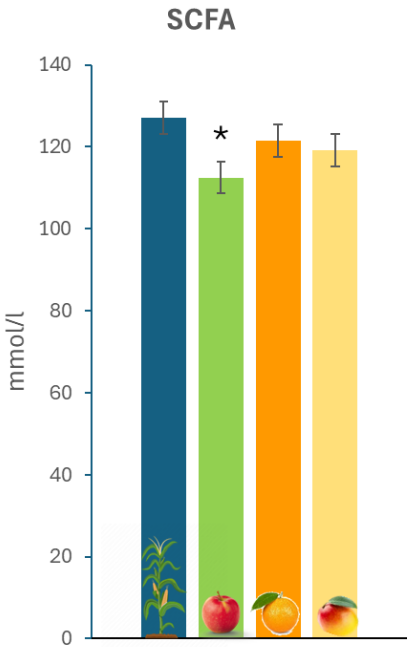
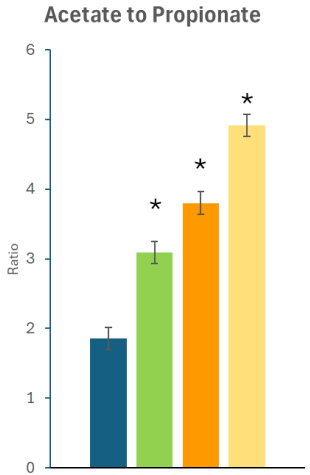
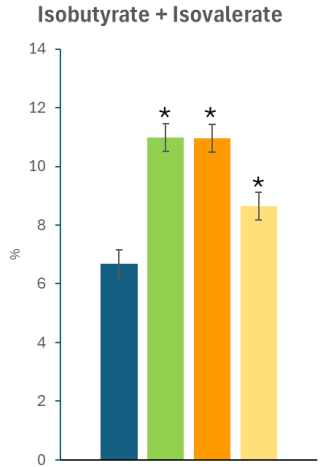
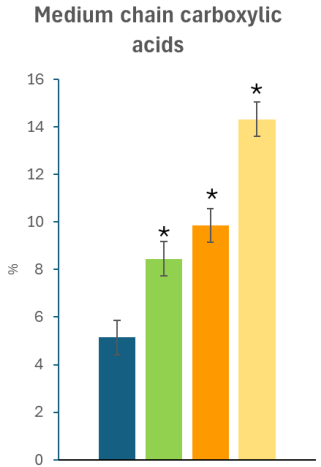
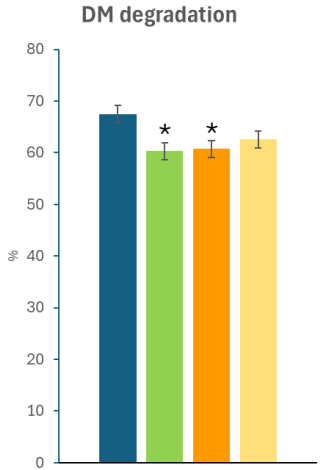
Results

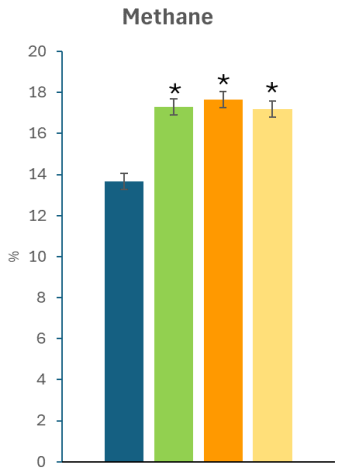


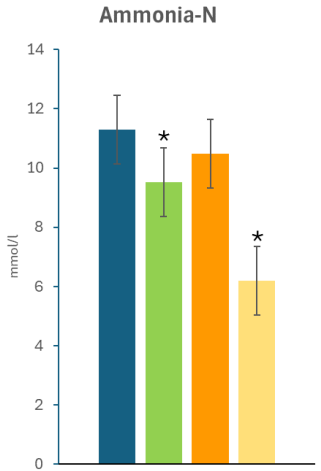






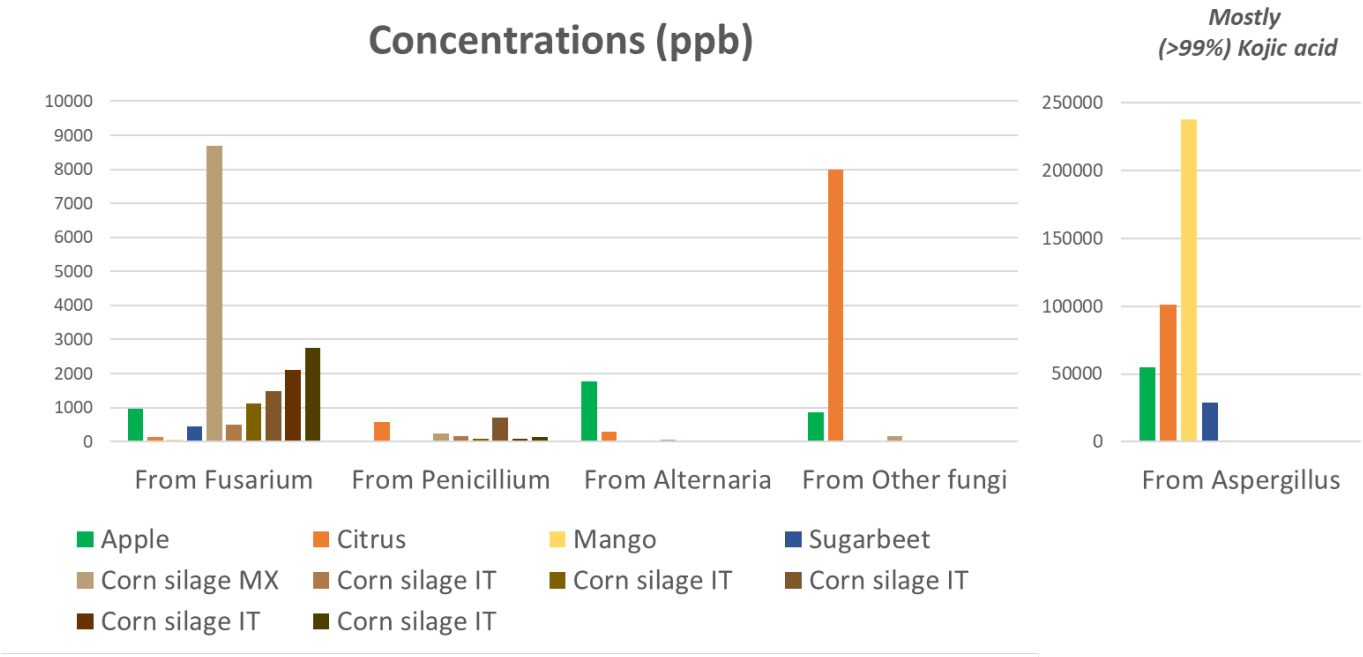




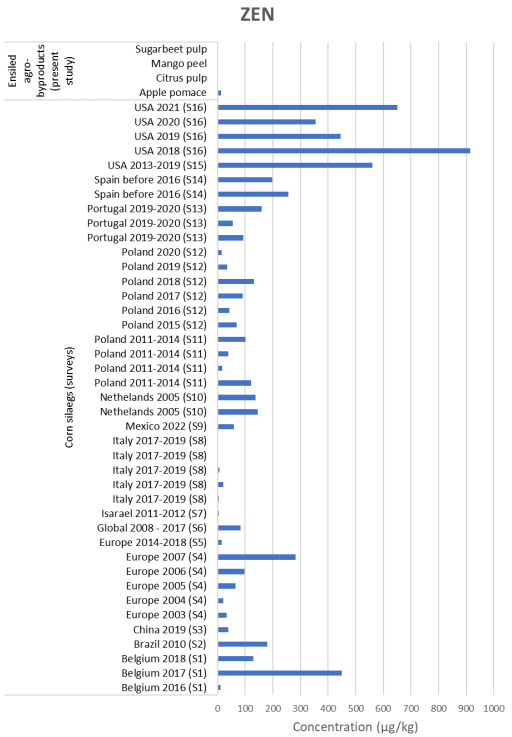


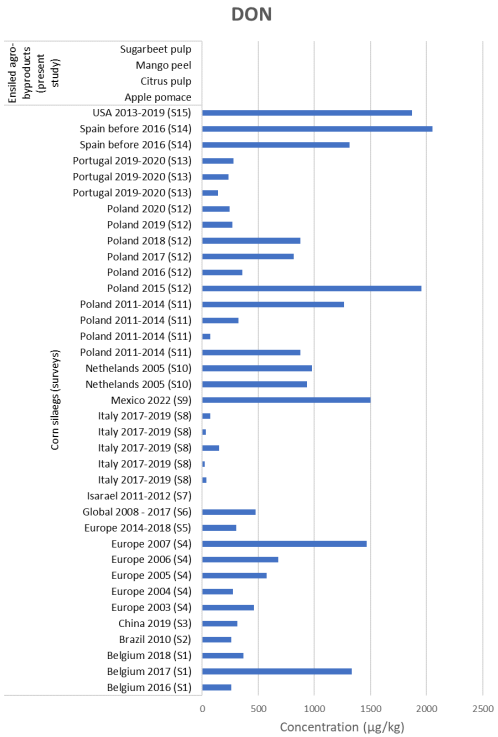
* P < 0.05 vs. Control

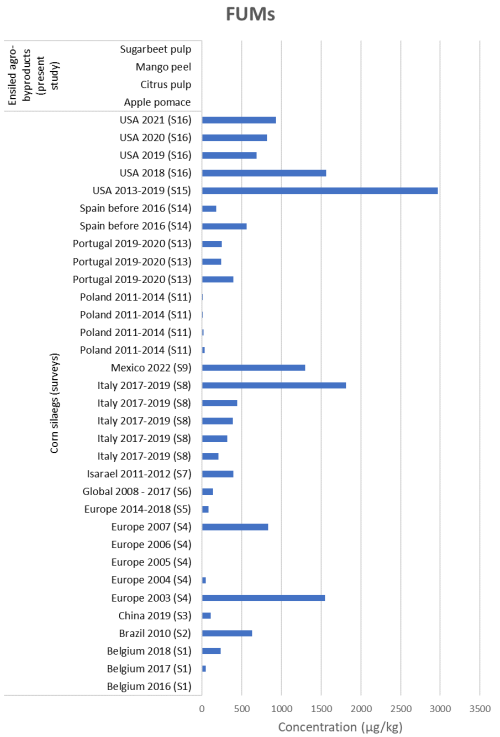
Fungal metabolites (including mycotoxins)



Regulated *Fusarium* mycotoxins







Pesticide residues

Pesticide residues in samples (µg/kg)	Buprofezin	Chlorantraniliprole	**Chlorpyrifos**	DEET (Diethyltoluamide)	Didecyldimethylammonium chloride (DDAC)	Difenoconazole	Dodine	**Fipronil**	Imazalil
Apple pomace silage	0.0	10.7	82.6	8.01	10.5	0.0	0.0	0.0	0.0
Citrus pulp silage	0.0	0.0	17.1	8.76	17.0	66.1	0.0	0.0	28.9
Mango peel silage	2.2	0.0	18.3	4.85	15.4	0.0	**2.5**	34.2	0.0
Sugarbeet pulp silage	0.0	0.0	15.6	9.15	0.0	7.18	0.0	0.0	0.0
Applications	insecticide	insecticide	insecticide	insect repellents	antiseptic/disinfectant	seed applied fungicide	fungicide	insecticide	fungicide for citrus

Pesticide residues in samples (µg/kg)	Imidacloprid	Lufenuron	Metalaxyl	Methoxyfenozide	Phorate-sulfoxide	**Phoxim**	**Profenofos**	**Propargite**	Pyridaben
Apple pomace silage	0.0	29.8	0.0	0.7	3.0	8.1	10.3	4937.3	27.0
Citrus pulp silage	0.0	0.0	2.5	0.0	0.0	0.0	91.7	62.7	0.0
Mango peel silage	2.6	0.0	0.0	0.0	0.0	14.5	0.0	108.3	0.0
Sugarbeet pulp silage	0.0	2.5	0.0	0.7	0.0	0.0	0.0	19.2	0.0
Applications	insecticide	veterinary flea control	fungicide	insecticide	insecticide metabolite	Insecticide	insecticide/miticide	insecticide	insecticide

Photo: http

Conclusions

- Suitable and versatile for ensiling
- The rumen fermentation resembles the forage characteristics
- The strong ruminal effect of mango peel silages might be partly attributed to its bioactive compounds
- Fruit and crop byproduct silages might be safer than corn silage in terms of mycotoxins, but pesticide residues can be a concern

Things need to be considered before making byproducts as common feed sources

- Acceptance and palatability
- Animal production performance & product quality
- Price control and volatility
- Farm hygiene and environmental impact
- Safety (contaminants) – **ONE HEALTH**

ACKNOWLEDGEMENT

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Providers of by-products in Pakistan

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