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Effects of phytogenic feed additives on performance and enteric methane emissions in dairy cattle

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Introduction

Methane (CH_4) is a by-product of rumen fermentation and potent greenhouse gas. There has been an increased interest in the use of phytogenic feed additives (PFA) to modify rumen fermentation and decrease CH_4 emissions[1]. The objective of the current study was to use 3 different PFA to investigate their long-term efficacy on total dry matter intake (DMI, Kg/d), CH_4 production (g/d), milk yield and composition (Kg), in mid-lactating dairy cows.

Material and Methods

Animals: 56 mid-lactating multiparous Holstein cows (120±46 DIM; 648.15±64.79 Kg BW) were allocated to 4 groups.

Diet: 4 dietary treatments (n=14 animals/group/treatment); control (CON), without PFA in the diet; prototype 1 (PP1), prototype 2 (PP2), and prototype 3 (PP3) with the addition of PFA (25 g/h/d).

The PFA: Blend of Essential Oils (EO), tannins mixed in the compound feed.

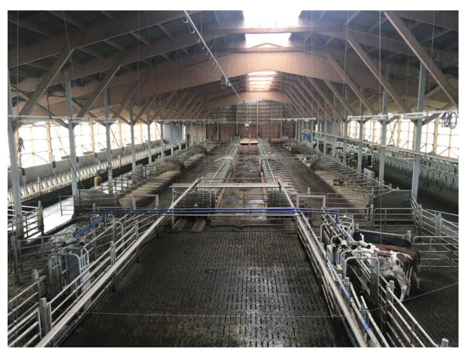
Trial design: After 4 weeks of the basal diet (75% forages based on hay:haylage 25:50, and 25% concentrate, DM basis, Table 1.) cows were gradually switched to an experimental diet for 2 weeks and continued the experimental diets for 3 months.

Location: Experimental Unit Herbipole Marcenat, France.

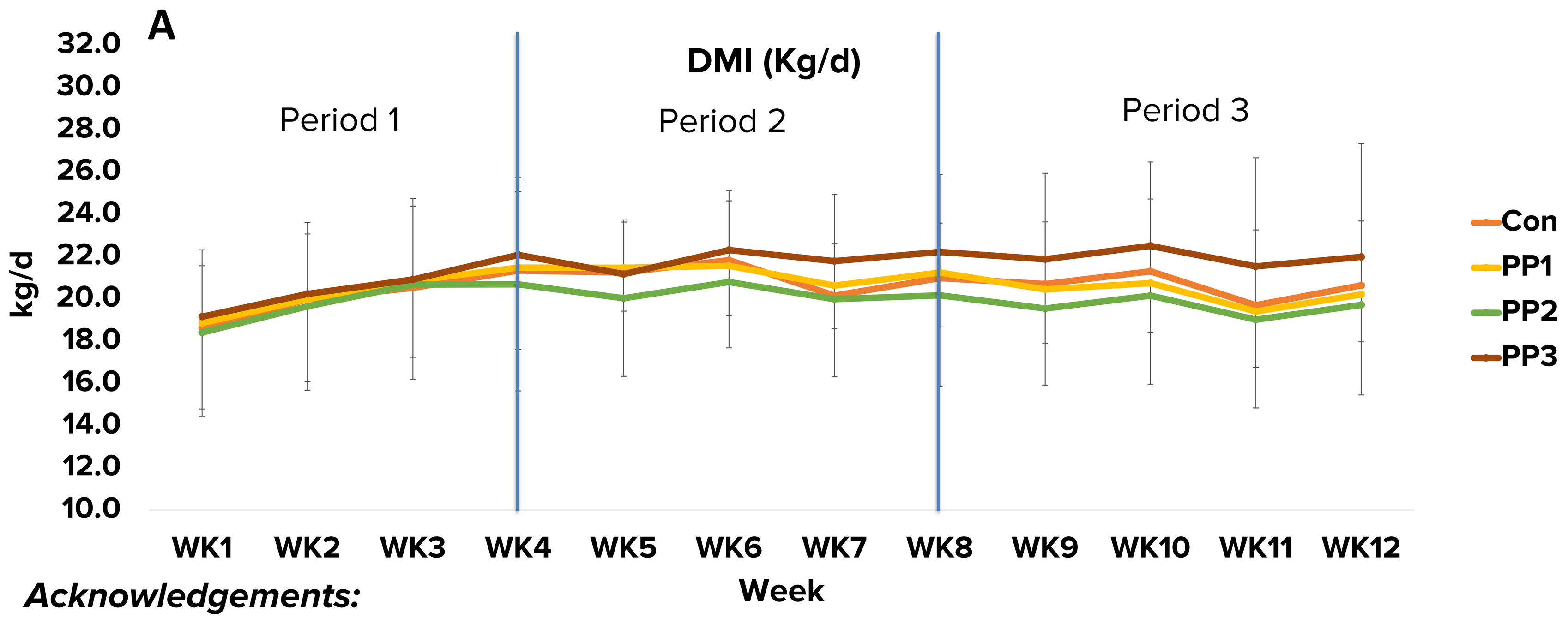
Table 1. Diet's composition in the PMR and basal compound feed

Item	Diet
Forage (% of DM)	
Second-cut haylage	51.1
Mountain grass	23.7
Concentrate (% of DM)[1]	
Wheat	8.2
Corn	6.0
Barley grain	4.1
Sugar cane molasse	0.4
Soya bean meal (43.3% CP)	5.3
Dry magnesia	0.1
Dicalcium phosphate	0.4
NaCl	0.2
Sepiolite	0.1

Chemical composition (% of DM): 74.8% DM, 94.1 OM, 11.1 CP, 58.67 NDF, 33.72 ADF, 1.54 EE, 8.20 Ash, 0.81 NFC
Concentrate contained 88.0% DM, 95.8% OM, 17.2% CP, 1.9% EE, and 19.5% NDF (DM basis). Mineral-vitamin premix contained (g/DM): Ca, 2.46; P, 2.32; Mg, 2.85; Na, 2.65; Zn, 0.05; Mn, 0.08; I, 0.00003; Se, 0.00003; Co, 0.00008; Cu,0.006; vitamin A, 476,000 IU; vitamin D, 80,000 IU; vitamin E, 10.5.



Feed intake, BW, and milk yield were automatically recorded daily during the whole trial. Milk composition was determined twice a week for Milk fat, protein, and lactose. Due to Covid-19 epidemic there were no sampling between WK7 and 11. The CH_4 emissions (g/day) were measured using 2 GreenFeed® (C-Lock Inc., Rapid City, SD, USA) systems. The CH_4 emissions were also expressed by unit of intake (CH_4 yield, g/kg DMI), unit of milk produced (CH_4, g/kg FCM and g/kg FCM) and unit of NDF (CH_4 yield, g/kg NDF). All data were analyzed using the MIXED procedure of SAS (version 9.4; SAS Institute Inc.).



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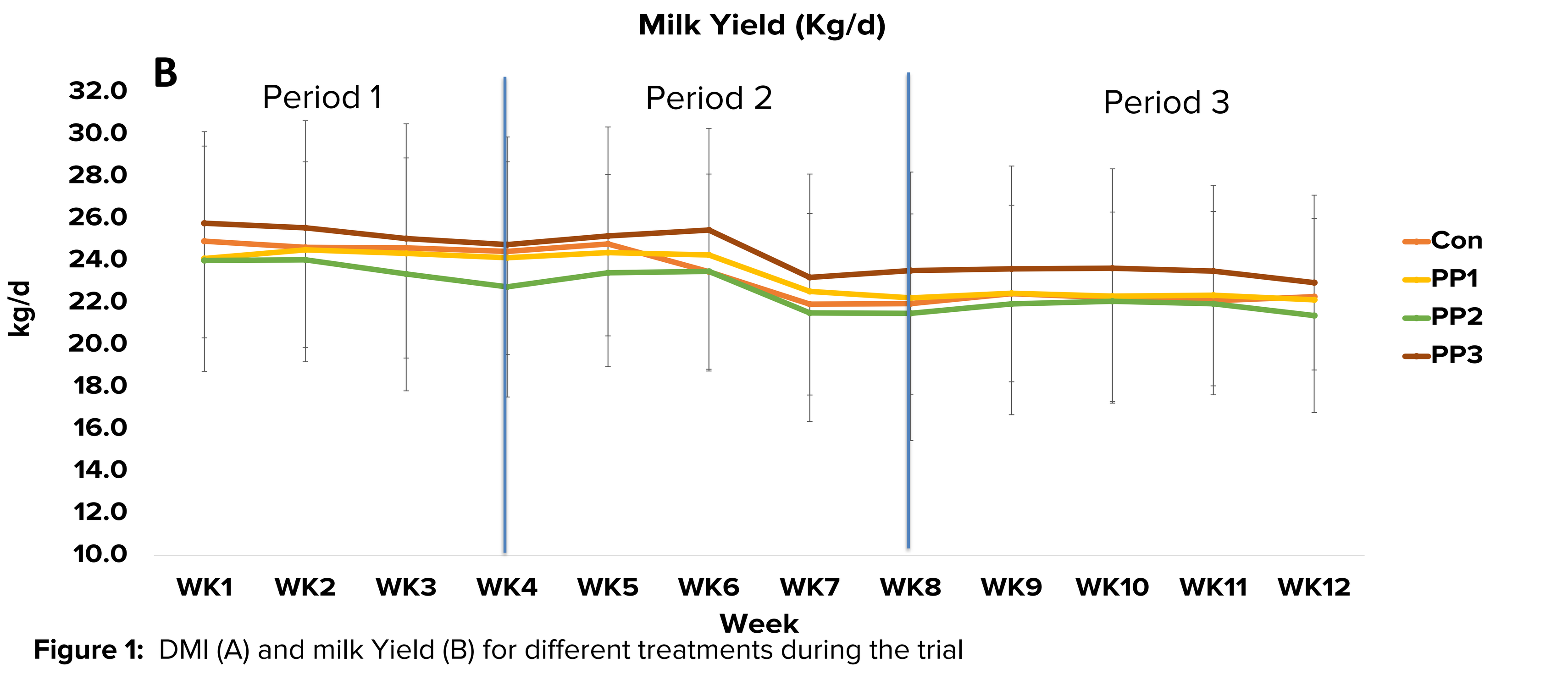

Figure 1: DMI (A) and milk Yield (B) for different treatments during the trial

Results

Data of total DMI (DM, kg/d), milk yield (Kg) (Figure 1; A, B respectively) and milk composition (data not shown), were separately analyzed in 3 periods. No treatment differences in all variables were observed within the different periods.

Table 2: The BW and CH_4 emissions for cows given diets without (CON) or with the inclusion of PFA

Item	Period				SEM	*P*-Value		
	Period1*	Period2	Period3	Overall		TRT	Period	Interaction
BW (Kg)					15.40	0.16	<0.001	<0.001
Con	709.57	717.17	712.88	713.21				
PP 1	713.51	716.39	710.40	713.43				
PP 2	683.66	685.03	676.61	681.77				
PP 3	713.15	718.89	720.71	717.58				
CH_4 (g/d)					59.03	0.79	0.49	0.910
Con	487.54	491.54	490.78	501.05				
PP 1	480.30	491.82	513.00	500.83				
PP 2	540.55	511.15	522.41	531.12				
PP 3	528.16	534.79	568.44	552.33				
gCH_4/kgDMI					1.03	0.32	0.08	0.005
Control	25.16	25.75	26.10	25.39				
PP 1	25.34	24.26	24.02	24.42				
PP 2	24.21	24.35	24.01	23.99				
PP 3	24.33	23.84	22.73	23.57				
gCH_4/kgECM					1.11	<0.001	<0.001	0.327
Con	20.04^{b}	21.01^{b}	22.79^{b}	21.30^{b}				
PP 1	20.53^{b}	21.29^{b}	$23.33a^{b}$	21.78^{b}				
PP 2	24.97^{a}	24.62^{a}	25.39^{a}	25.00^{a}				
PP 3	22.57^{a}	21.24^{b}	24.37^{ab}	22.73^{b}				
gCH_4/kgFCM								
Con	20.70^{b}	21.78^{b}	23.12^{b}	21.87^{b}	1.22	<0.001	0.005	0.274
PP 1	20.87^{b}	21.46^{b}	23.41^{b}	21.91^{b}				
PP 2	26.49^{a}	25.41^{a}	26.13^{a}	26.01^{a}				
PP 3	23.24^{b}	21.74^{b}	24.48^{b}	23.15^{b}				
gCH_4/kgNDF					2.32	<0.001	<0.001	0.301
Con	51.82^{a}	51.66^{a}	55.83^{a}	53.10^{a}				
PP 1	43.02^{b}	43.75^{b}	47.44^{b}	44.78^{b}				
PP 2	51.23^{a}	49.78^{ab}	53.62^{a}	51.54^{a}				
PP 3	48.39^{ab}	47.42^{b}	49.71^{ab}	48.50^{ab}				

*Period 1= Week 1 to Week 4, Period 2= Week 5 to Week 8, Period 3= Week 9 to week

The BW, total CH_4 and gCH_4/kgDMI remained similar for all treatments between periods (Table 2). The g CH_4 per kg of, ECM, FCM and NDF were affected by treatment ($P \leq 0.05$). Between the groups and during the trial cows in control group produced less CH_4. The cows in the PP3 and PP2 group showed a decrease in CH_4 emissions g/kgNDF during Period 2 compared to the period 1 and period 3 ($P < 0.05$).

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Conclusion

Results from the present study showed that current PFA mixtures with current dosage did not have strong affect on intake, milk performances and methane emisions in dairy cows over a 3-month period did not have strong affect on CH_4 concentration. Future studies are required to evaluate the effective dosage of PFA on methane production in the rumen.

Reference:
1 Knapp, J.R., Laur, G.L., Vadas, P.A., Weiss, W.P. and Tricarico, J.M. (2014) Invited Review: Enteric Methane in Dairy Cattle Production: Quantifying the Opportunities A d Impact of Reducing Emissions. Journal of Dairy Science , 97, 3231-3261. https://doi.org/10.3168/jds.2013-7234