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Associative effects of different feed combinations assessed using a Gas Production system

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Introduction

Associative effects of feed:

When two or more feeds of different digestibility coefficients are fed in a mixture, the digestibility of the whole mixture is usually different from the mean digestibility coefficient of the feeds in the mixture (Kitessa et al. 1999);

Associative effects may be negative or positive ;
(Weiss 1994; McDonald et al. 1995)

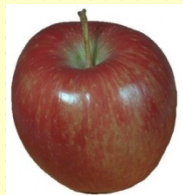
Associative effects depend on the kind of feeds and their incorporation ratio (grain/forage)
(Opatpatanakit et al., 1995)

Few information about the effects of by-products.

Gas production allows to follow the kinetics of fermentation in a rapid and cheap way

Objectives

- ▶ To evaluate the *in vitro* kinetics of rumen fermentation of by-products and roughages;
- ▶ To study the associative effects of different feed combinations and changes over the incubation time.



Material and methods

Equipment: Ankom^{RF} Gas Production System

- ▶ 36 bottles, capacity of 280 ml
- ▶ equipped with pressure detectors;
- ▶ Wireless transmission of data (1 min frequency)



Feeds

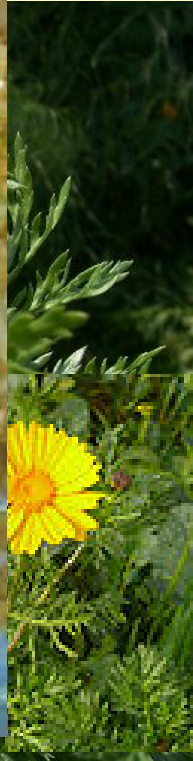
By-products

- ▶ Citrus pulp
- ▶ Apple pomace
- ▶ Tomato peels



Roughages

- ▶ *Silybum marianum*
- ▶ *Chrysanthemum coronarium*



Experimental design

5 feeds		3 by-products 2 roughages	x 3 repl.	} 15 bottles
6 combinations of: by-product + roughage 50% 50%			x 3 repl.	} 18 bottles
Blank (medium and rumen fluid)			x 3 repl.	} 3 bottles
				36 bottles

Inoculum preparation

Rumen fluid was:

- ▶ collected:
 - 2 h after morning feeding;
 - with oesophageal probe;
 - from 3 dry cow fed hay *ad libitum*;
- ▶ poured in preheated thermos (39°C)
- ▶ immediately transferred to the laboratory;
- ▶ filtered with 3 layers of cheesecloth;
- ▶ analysed for pH (discarded if higher than 6.8);
- ▶ used not later than 30 min from rumen collection.

Incubation procedure



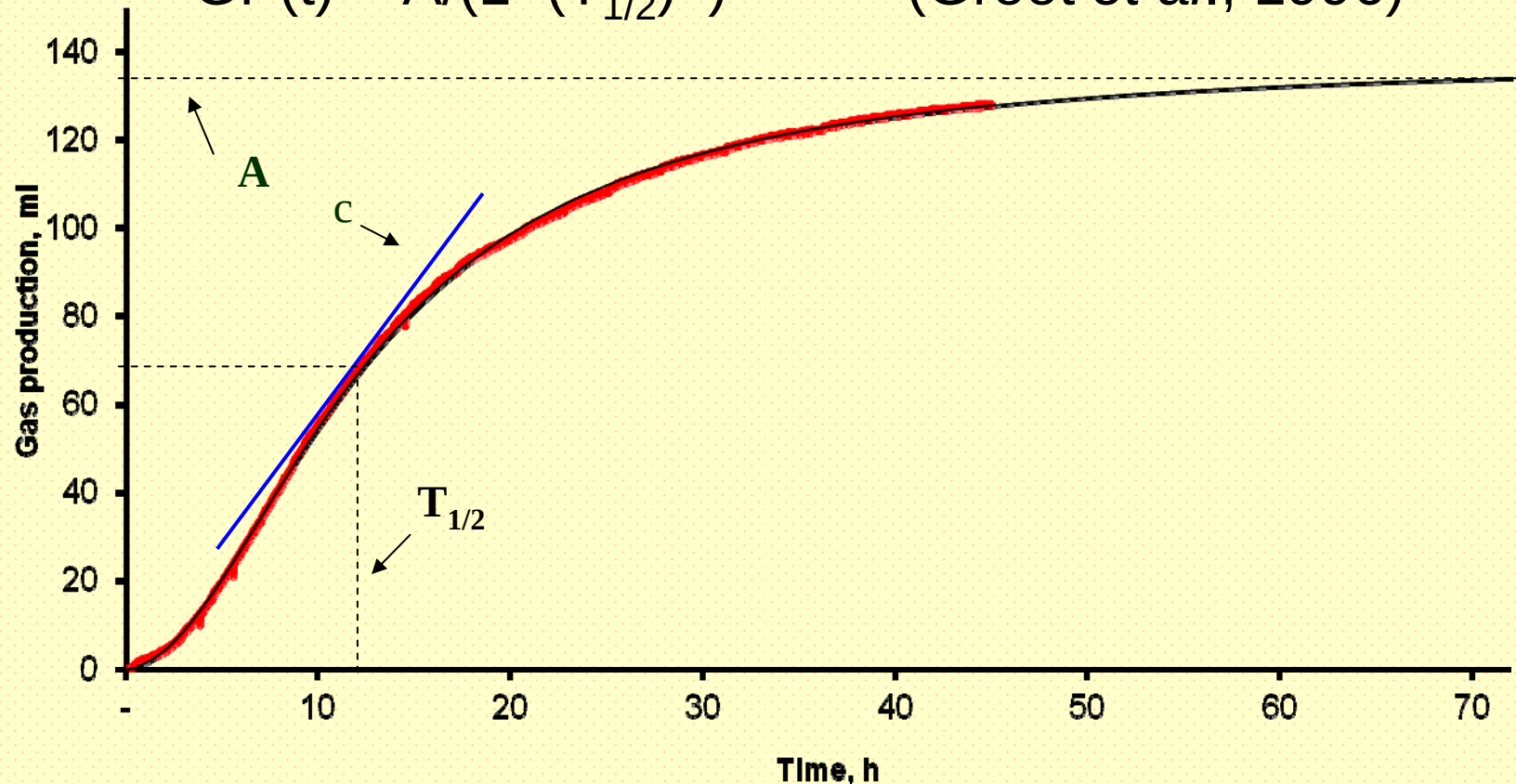
- ▶ Each bottle was filled with:
 - 0.500 ± 0.001 g of feed
 - 25 ml of filtered rumen fluid
 - 50 ml di medium (*Menke and Staingass, 1988*);
- ▶ Preparation was performed under a flow of CO_2 ;
- ▶ The bottles were placed in an incubator for 120 h at 39 ± 0.5 °C;
- ▶ The gas pressure was recorded continuously;
- ▶ Gas accumulated in bottle headspace was released when pressure reached 3.4 kPa.

Computation and fitting of GP kinetics

The cumulated values of pressure were converted in volume terms using the universal gas law as described by Lopez (1999).

GP data were fitted with:

$$GP(t) = A/(1+(T_{1/2})^c) \quad (\text{Groot et al., 1996})$$



Statistical analysis

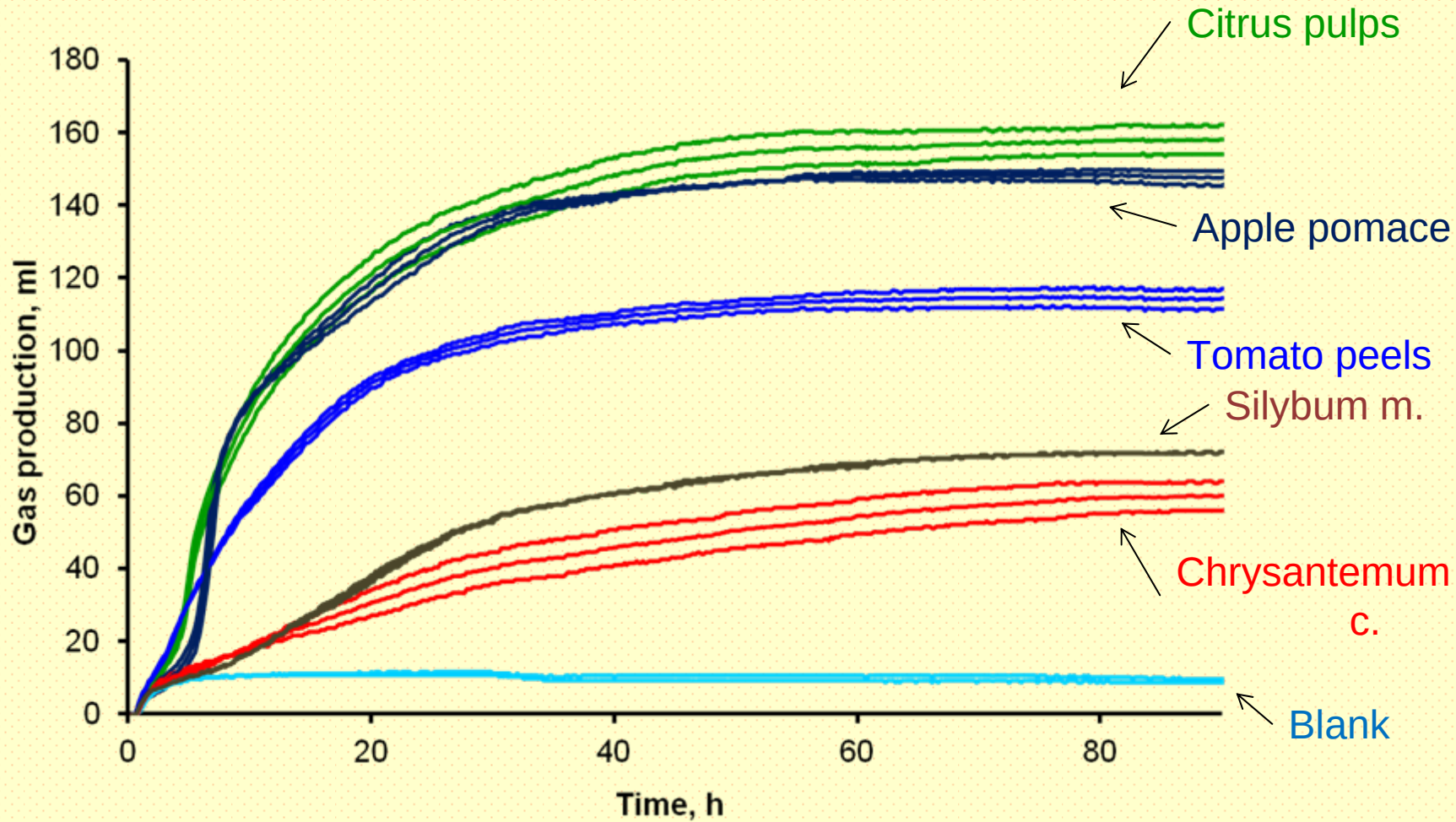
- ▶ The expected GP of each feed combination was computed as mean of GP obtained from single feeds (assuming absence of associative effects);
- ▶ Differences between measured and expected GP were computed for each feed combination;
- ▶ The differences of the 6 mixtures were submitted to ANOVA, within incubation times (6, 12, 24, 48 h), to test if they differ from zero

Results

Chemical composition of feeds

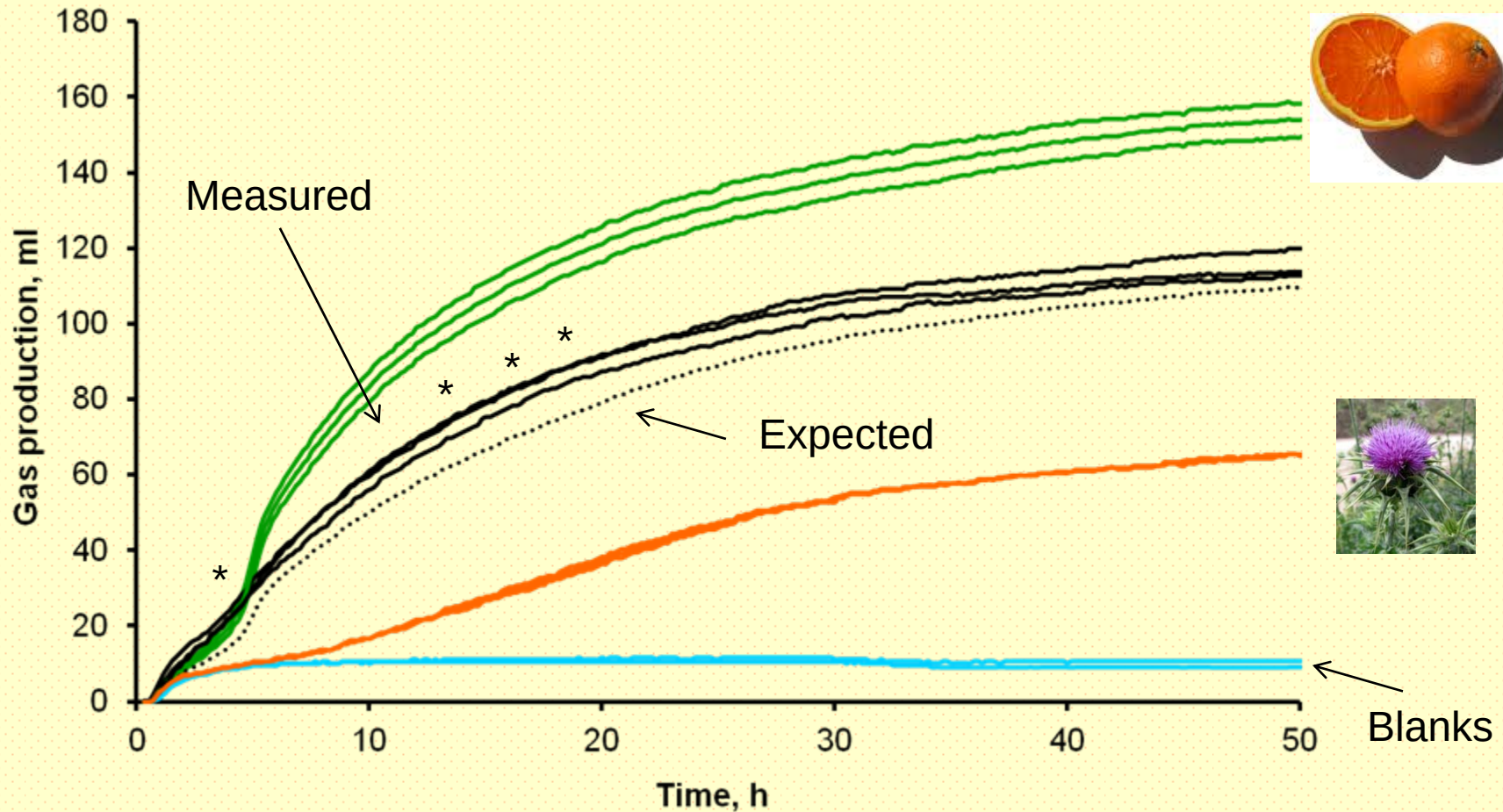
Feed	DM %	Ash	CP	EE	NDF	ADF	ADL
		% DM					
By-products							
Citrus pulp	21.1	2.6	5.7	0.6	25.7	11.7	0.0
Apple pomace	15.9	2.1	2.3	1.0	23.7	9.5	1.6
Tomato peels	7.3	11.8	12.1	1.7	33.1	30.0	9.8
Roughages							
<i>Silybum marianum</i>	88.1	13.0	4.3	0.6	68.8	52.4	8.6
<i>Chrysanthemum coronarium</i>	90.6	5.6	2.3	0.6	79.0	58.1	10.2

Kinetics of GP of single feeds



Kinetics of combination

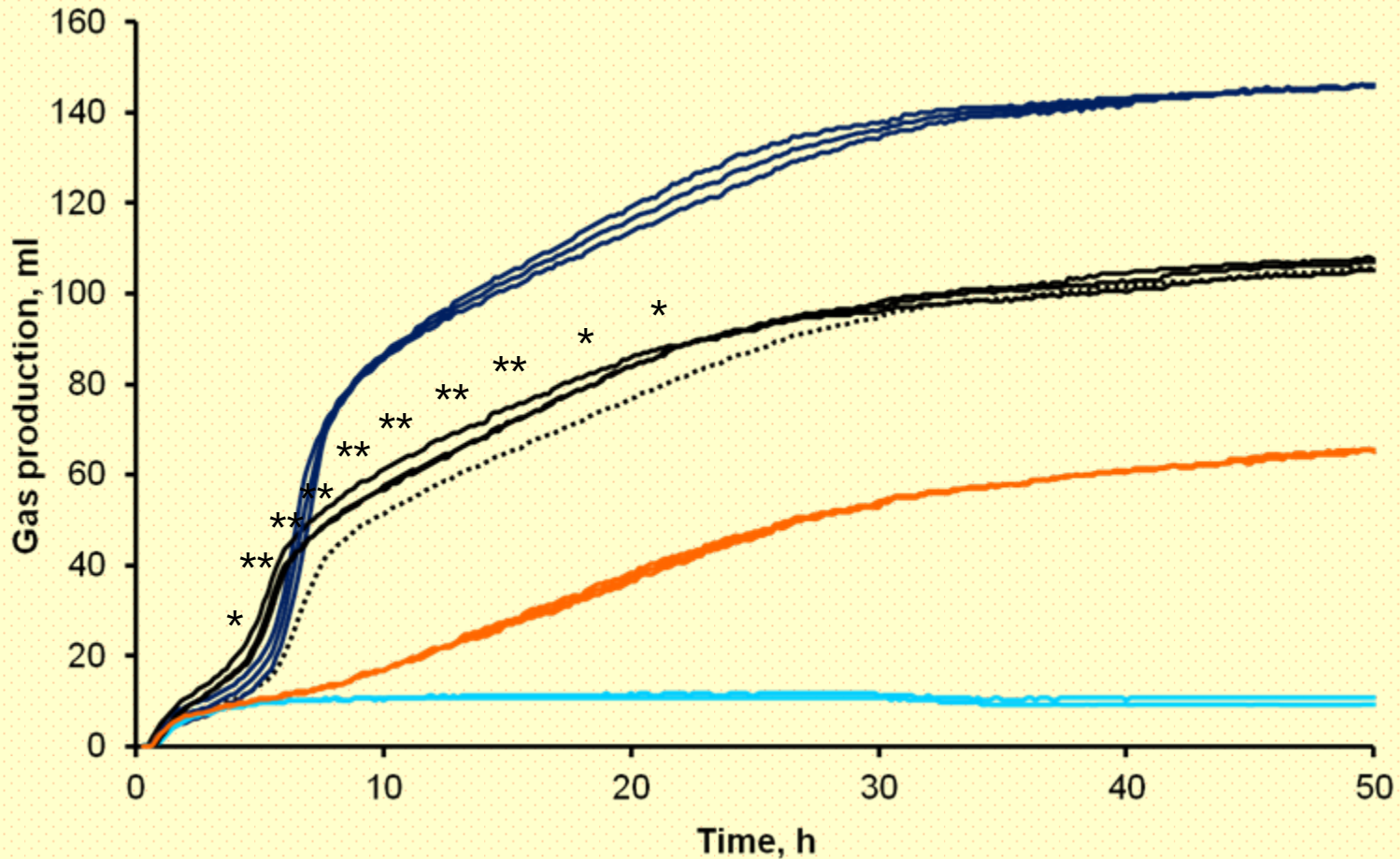
Silybum m. - Citrus pulp



* P<0.05

Kinetics of combination

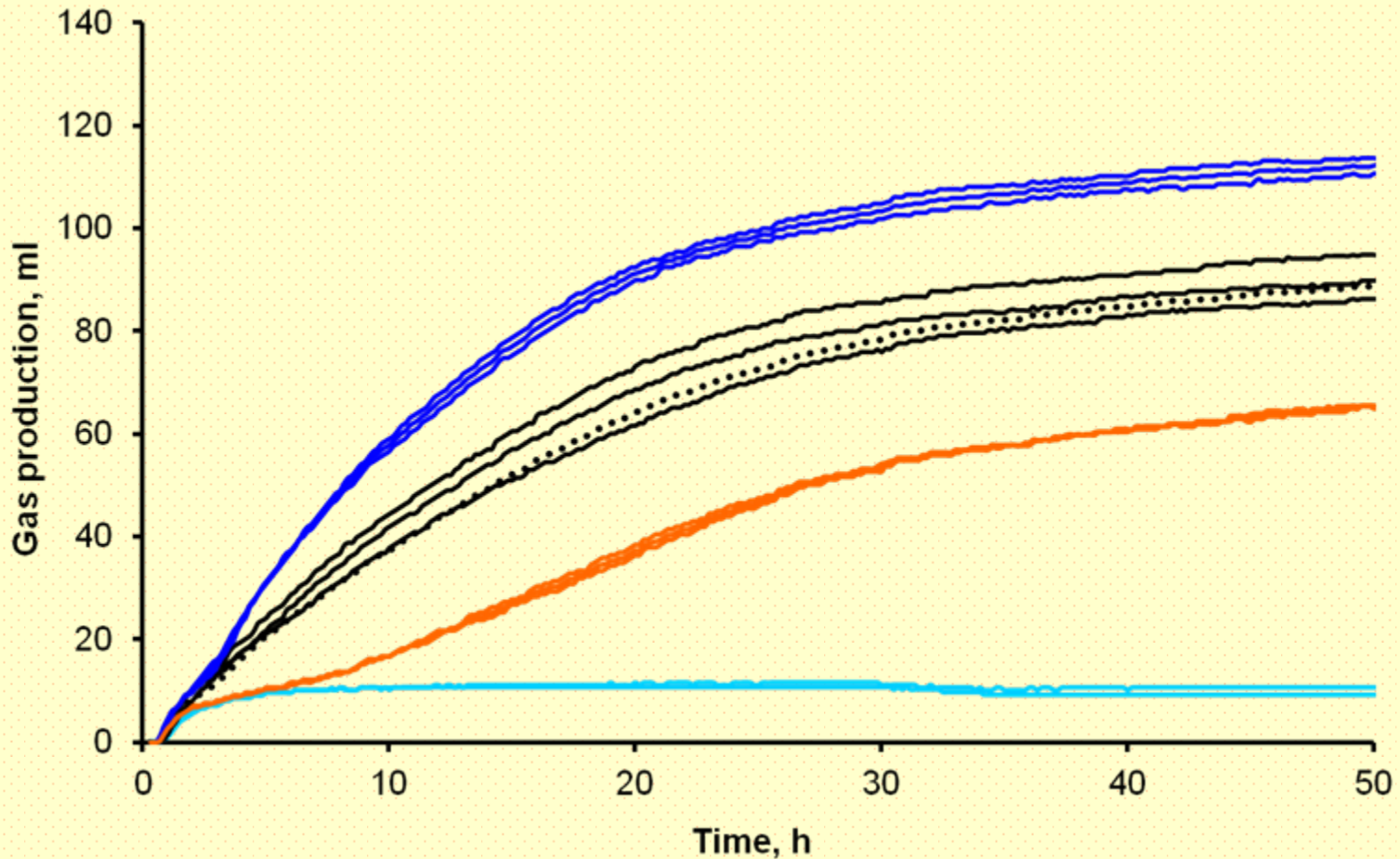
Silybum m. - Apple pomace



** $P < 0.01$; * $P < 0.05$

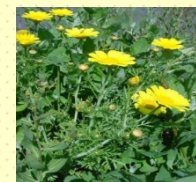
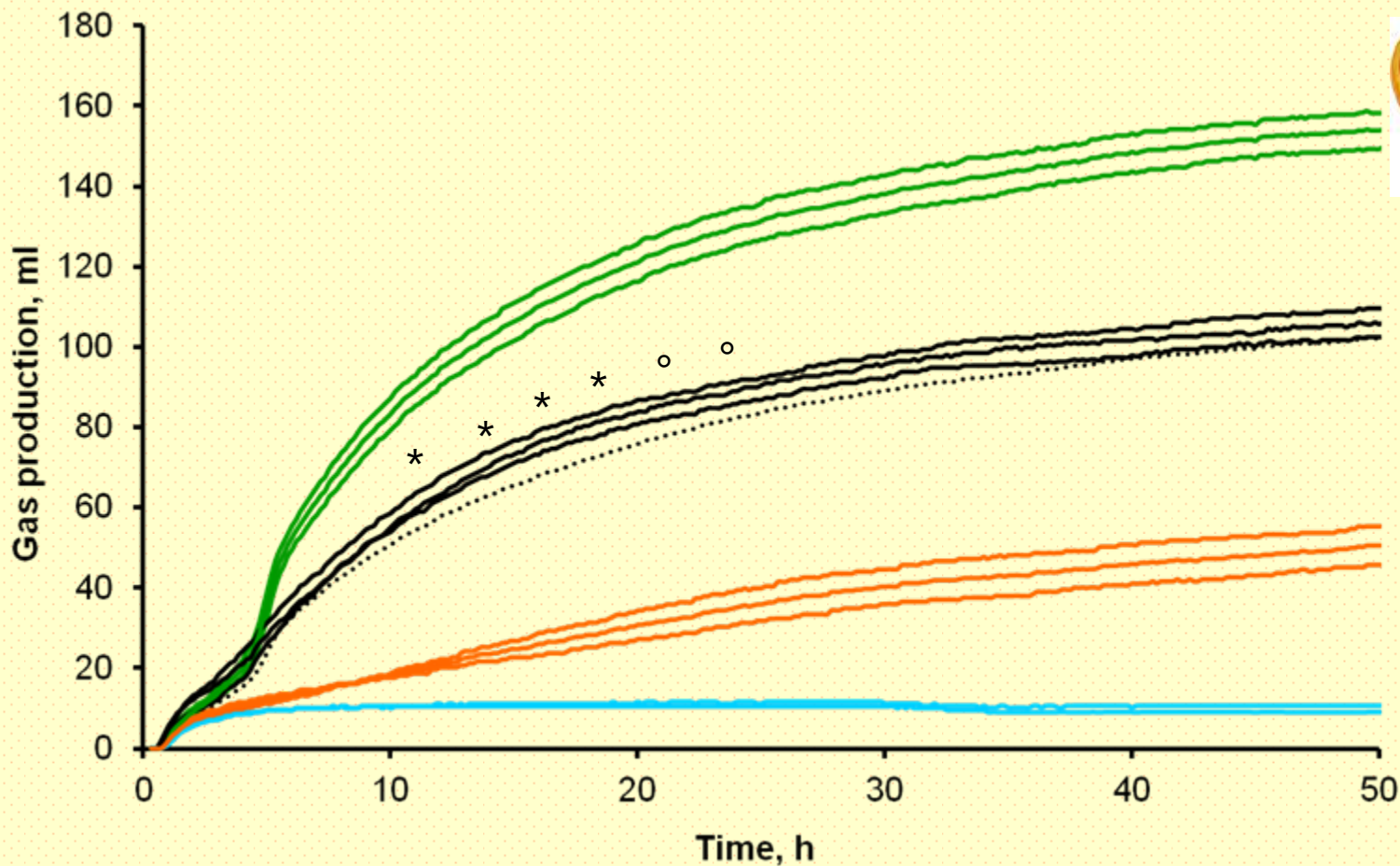
Kinetics of combination

Silybum m. - Tomato peels



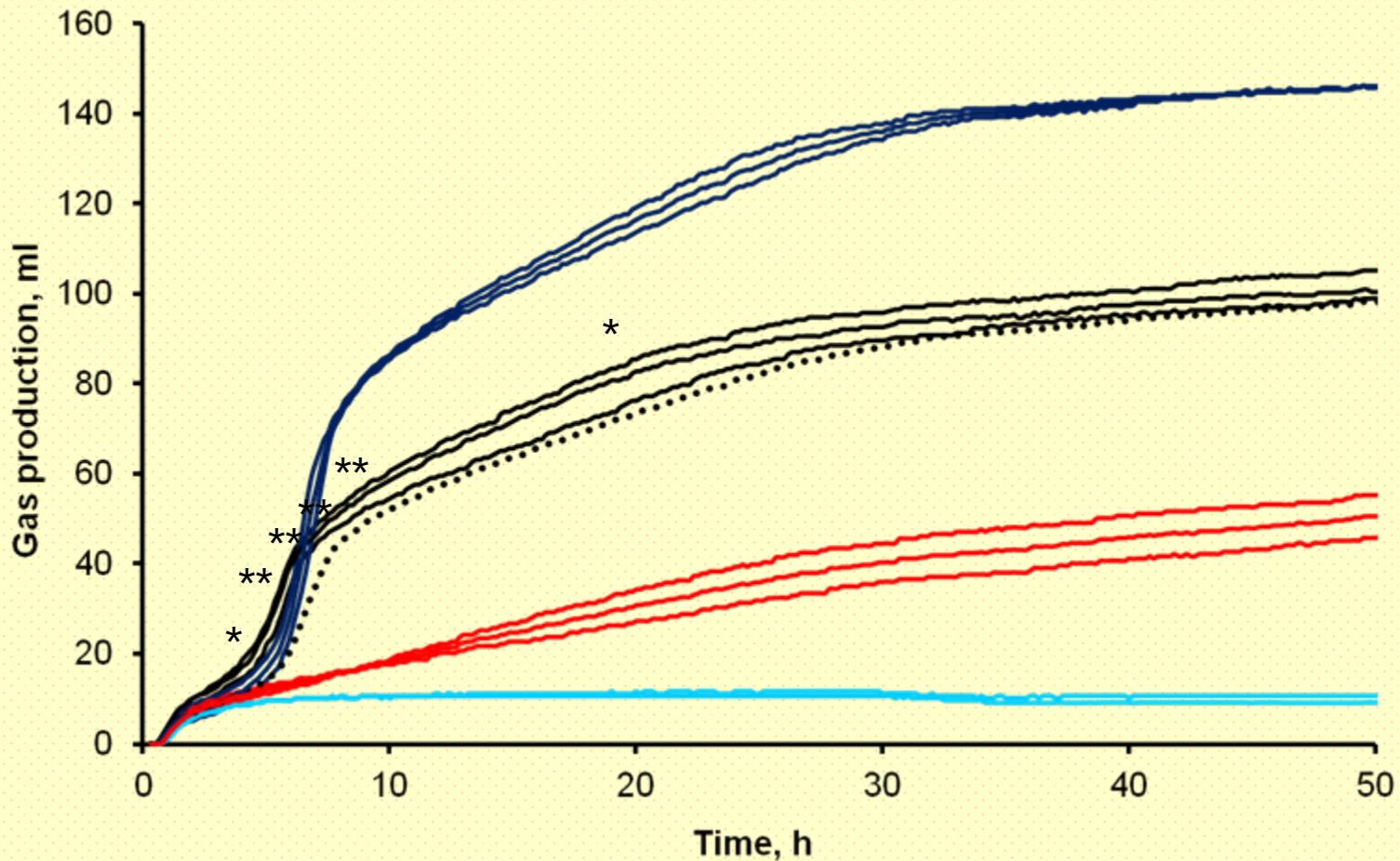
Kinetics of combination

Chrysanthemum c. - Citrus pulp



Kinetics of combination

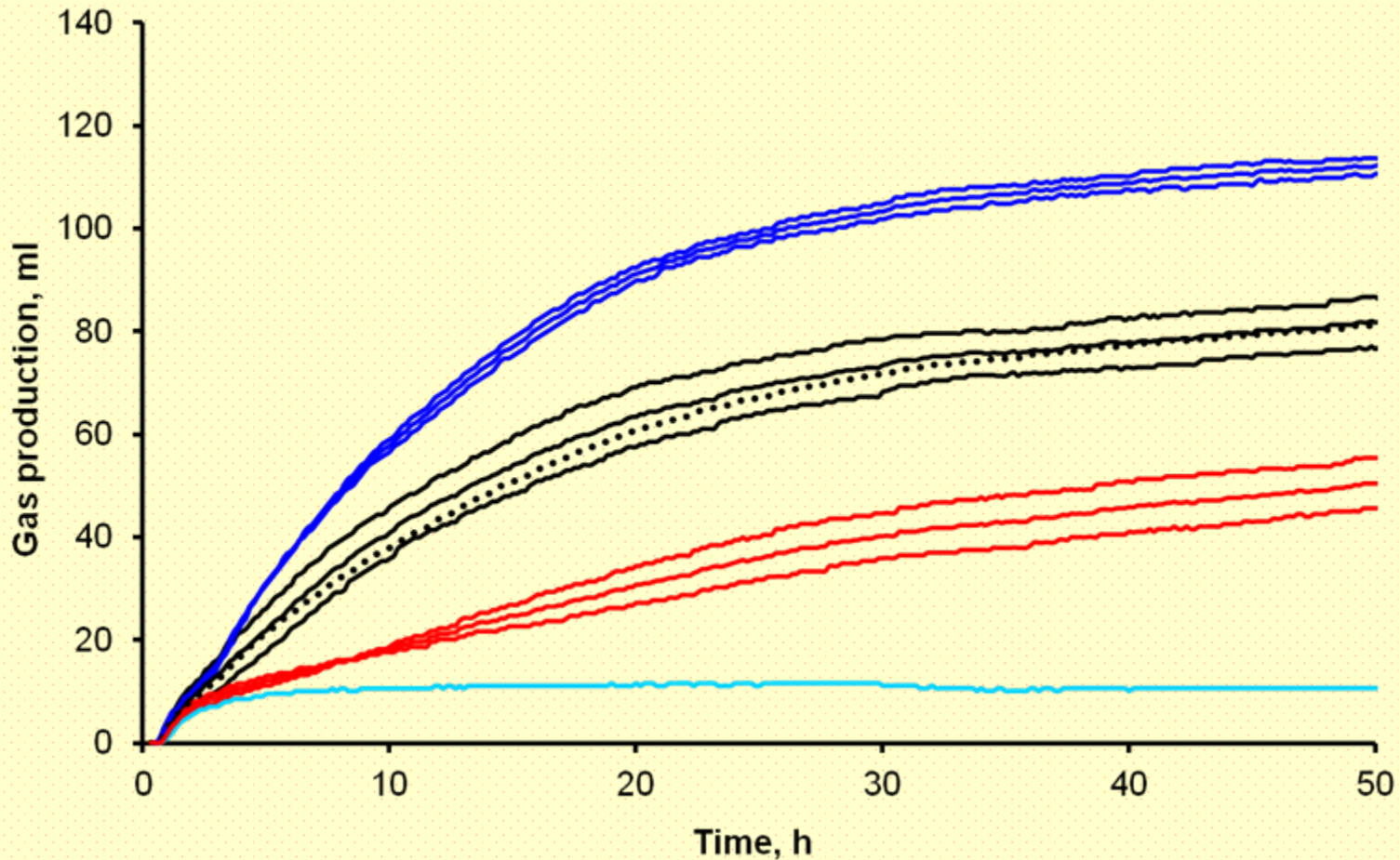
Chrysanthemum c. - Apple pomace



** P<0.01; * P<0.05

Kinetics of combination

Chrysanthemum c. - Tomato peels



* $P < 0.05$

Differences between measured and expected GP values

	Gas Production at:				GP parameters:	
	6h, ml	12h, ml	24h, ml	48h, ml	A, ml	T ^{1/2} , h
- SM+CP	+5	+7* +12%	+7°	+4	+2	-1.4° -10%
- SM+AP	+10** +40%	+10* +18%	+6	+4	+4	-2.0* -40%
- SM+TP	+2	+2	+1	+1	+0	-0.4
- CC+CP	+5	+7* +12%	+7°	+4	+1	-1.7* -15%
- CC+AP	+7* +26%	+7° +12%	+4	+2	+3	-1.4° -26%
- CC+TP	+2	+3	+2	+1	+0	-1.0
SEM	3	4	4	4	3	0.7

** P<0.01

* P<0.05

° P<0.10

Conclusions

- ▶ The combination of feeds with different fermentability evidenced positive associative effects, the size of these effects was substrate dependent;
- ▶ Generally, the associative effect appeared up to the first 12 h of incubation thereafter it slowly decreased till to disappear;
- ▶ This suggests that the association of by-products with roughages increased the rate of feed fermentation but did not changed the potential degradability of feed;
- ▶ Conventional methods that evaluate in vitro feed degradability at 48 h (T&T, 1963; van Soest, 1966) do not detect these effects.

Thank you
for your
attention

