Specialist Course on Lipids in Ruminants

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An integrative approach of lipid metabolism in dairy cows and goats: are the differences of nutritional regulation from mammary or ruminal origin?

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PhD, 1st year (2015-2018)

Milk and society

Fat

Consumer :
FA with positive effects on human health

Farmer :
Quantity of milk fat :
Production efficiency

- **Control the quantity and the composition of the milk fat**
- **Maintain the production efficiency**

Tool : Nutrition

In cows: diets which decrease the secretion of milk fat (MFD)

- **Diets rich in PUFA and starch:**
  - **Vegetable oils rich in 18:2n-6, 18:3n-3**
  - **Marine oils (EPA + DHA)**
- **Addition of C18:2 trans-10,cis-12 in the diet or post-ruminal infusion** (antilipogenic effect)

(Reviews of Chilliard et al., 2007; Shingfield et al., 2010)

Effect on milk fat content

Indirect comparison with MFD diets : suggest strong species effect

First direct comparison with MFD diets (Toral et al.,2015)

2 types of MFD diets	Vegetable Oil + Starch	Sunflower Oil (5%) + starch	Marine Oil (20:5n-3, 22:6n-3)	Fish Oil (2%) (20:5n-3, 22:6n-3)
	↓↓	↓↓ -31%	↓↓	↓↓ -31%
	= ↑		↓	
	= ↑	=	=	↓↓ -21%

Differences inter-species : dietary effect → NutriLip

PhD (2015-2018)

"An integrative approach of lipid metabolism in cows and dairy goats"

Objectives :

Identify regulatory mechanisms and markers of the different responses to the MFD diet and clarify the specificity of lipid metabolism in the rumen and the MG in these 2 species

Research questions: Are the specificities among species due to:

1/ ≠ Dietary effect on rumen microbiota and its functioning ?

2/ ≠ Dietary effect on lipid metabolism in the MG ?

3/ Link between rumen metabolism and eating behaviour?

Direct comparison

12 Alpin Goats and 12 Holstein Cows : multiparous, non pregnant, similar lactation stage

2 Latin Squares 4×4 : 4 periods of 4 weeks (09/03/16 – 05/07/16) , 4 diets

Diets : 45% Grass Hay ad libitum + 55% concentrate (supplemented or not) **: Daily adjustment**

Concentrate : → Control **(C)** (Starch : 32,7g/100g)
→ MFD 1 : Corn Oil - 5% DM + Starch (45,6g/100g) **(COS)**
→ MFD2 : Marine algae powder **(DHA)** - 1,5% DM
→ ↗ milk fat : C16 + C18 **(16+18)** - 3% DM

1st Latin Square : n = 12/species
Goats in individual box and cows in free stable
Data : Zootechnic, rumen and MG metabolism

2nd Latin Square : n = 4/species
Week 4 of each experimental period : 1 animal per treatment in respiratory chamber
Data : Quantitative digestive balance, CH4, feeding behaviour

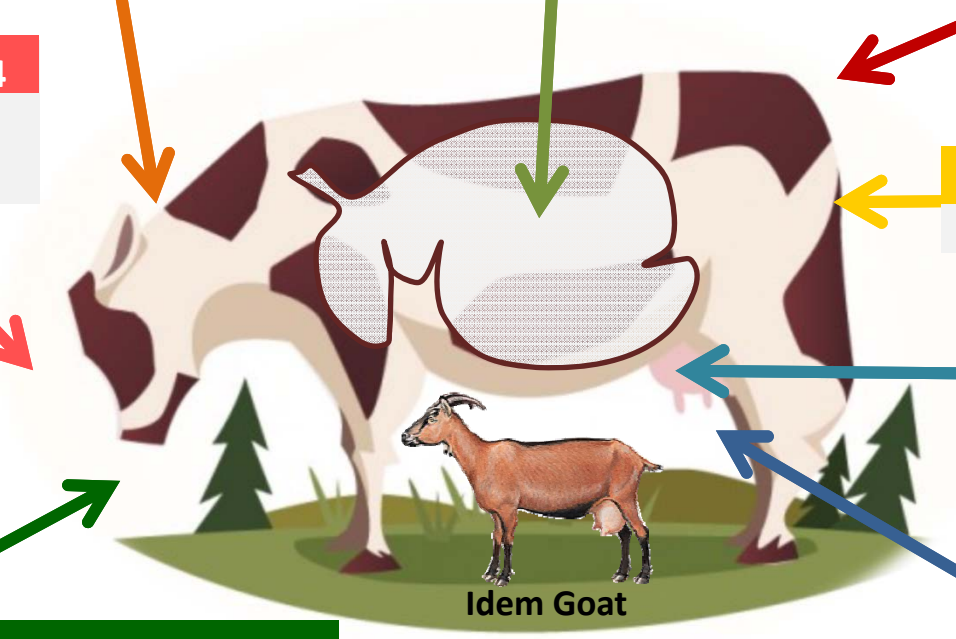
Sampling

Feeding Behaviour, n=4
-Ethosys collar (5 days)
-Direct observations
-Ingestion and rumination time

Rumen liquid, n=12
-In the morning Wk4 (before feeding) with œsophagus probe
-Microbes, fermentation parameters, FA

Blood, n=12
-In the morning (before feeding) :
-Blood metabolites, hormones and vitamins
-Analysis of lipid classes uptaken by MG (TAG, NEFA) and composition in FA

CH4 emissions, n=4
-Respiratory chambers
-5 days



Feces + urine, n=4
-Digestibility

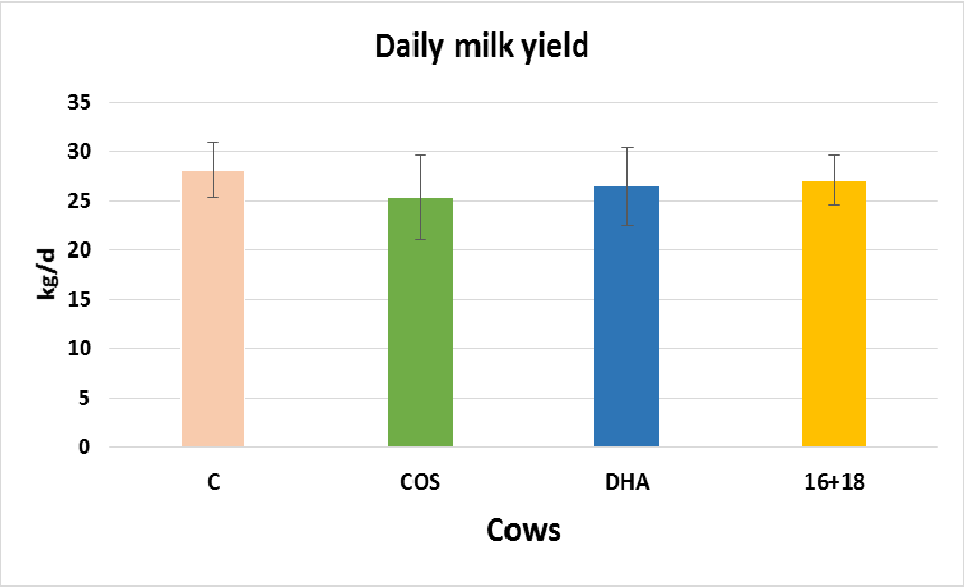
Mammary gland biopsy, n=12
-4 to 5h after feeding
-mRNA, proteins?

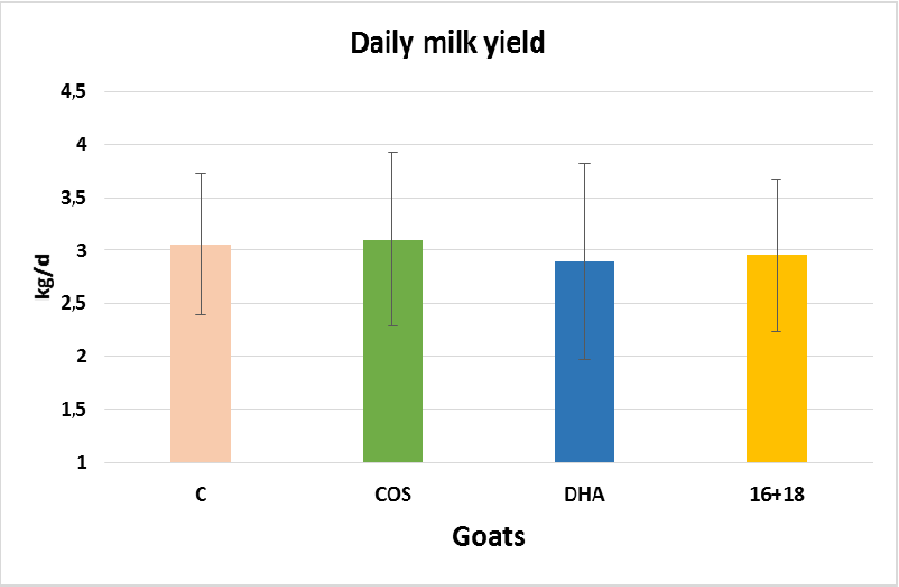
Milk, n= 12
-Milk yield, Fat %, Protein %, Cells, Lactose %
-Composition in FA, measure of LPL activity, Vitamins content

Ingestion Control, n=12
-Daily adjustment of proportion Grass Hay/Concentrate : **Cow = Goat**

Preliminary results :
Dietary treatments have not effect on daily milk yield

Intra-species



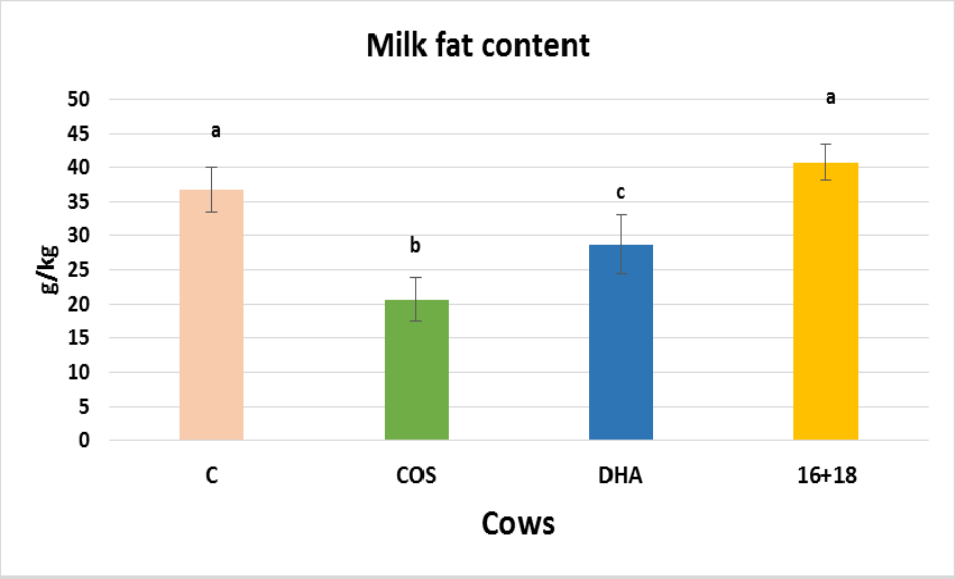


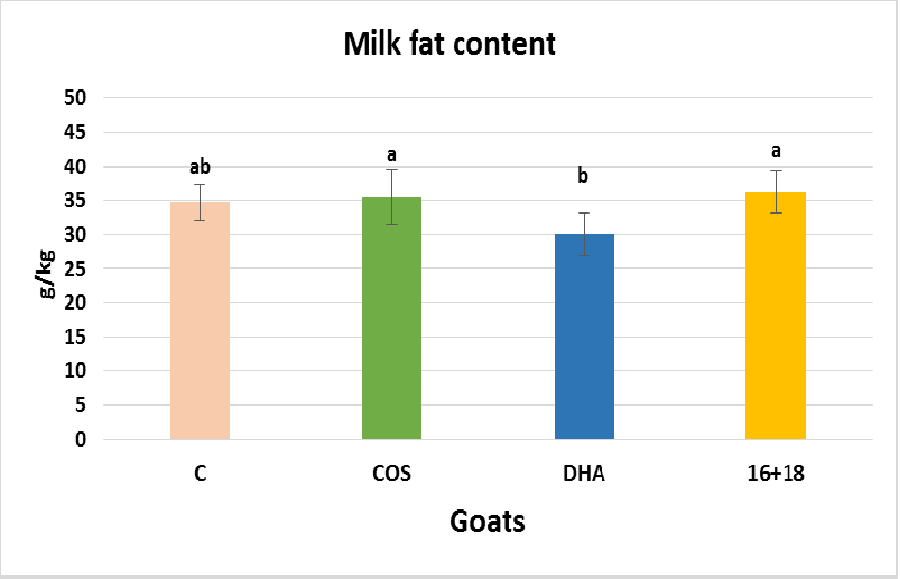
Preliminary results :

Cows :
COS and DHA : ↓ milk fat content/Control

Goats :
No effect of lipid suppl. on milk fat content

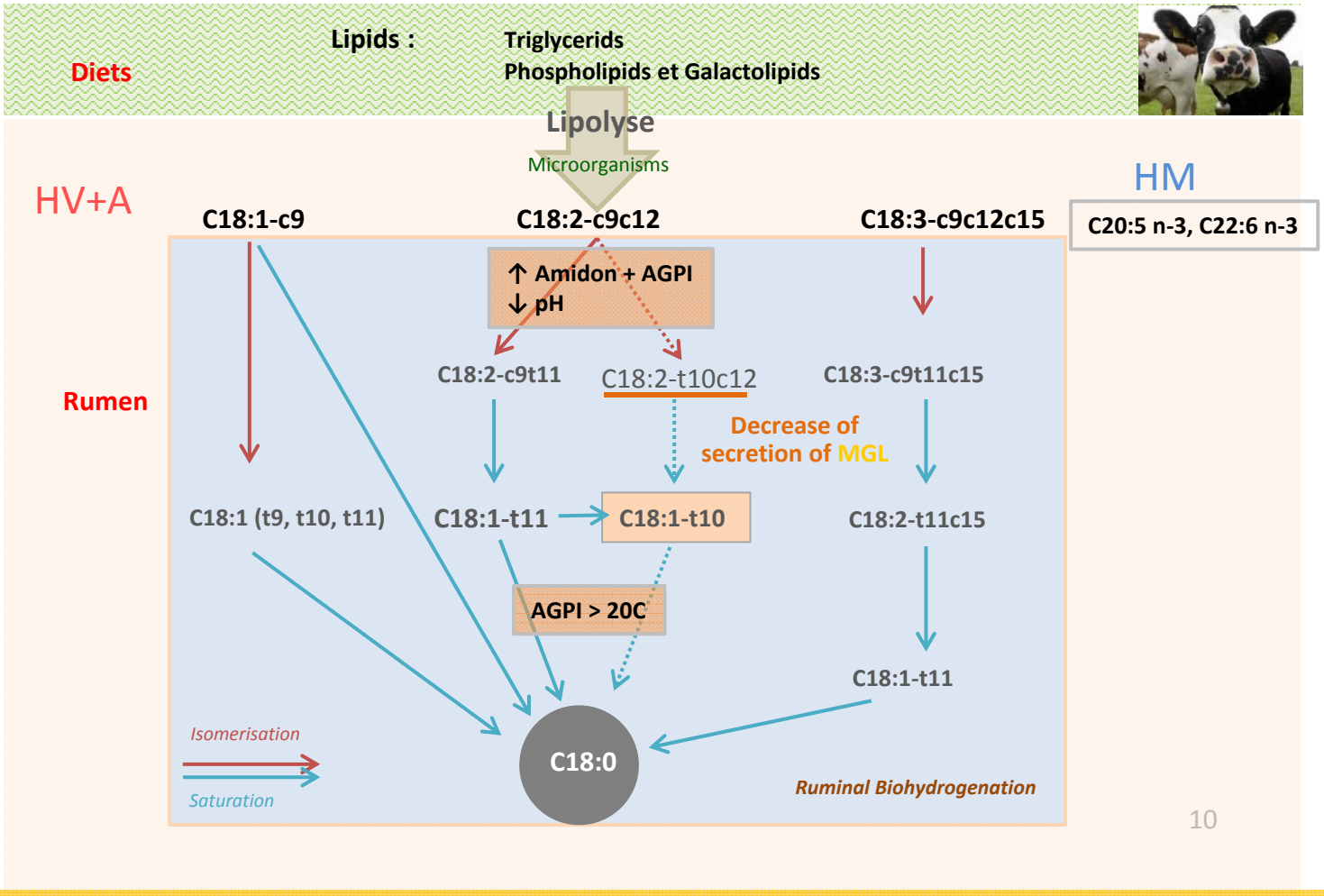
Intra-species





Thanks for your attention

BH in the Rumen



BH Theory : In particulary food conditions:

- **Alteration of PUFA biohydrogenation pathway in the rumen**
- **Production of specific FA inhibitors of milk fat synthesis**

(Bauman et Griinari, 2001, 2003, 2004)

1.5 Résultats d'une 1ère étude de comparaison In Vivo Vaches – Chèvres (2012)

		H T (5%) + A		H P (2%)	
Réponses		**VACHE**	**CHEVRE**	**VACHE**	**CHEVRE**
Zoot *(Toral et al. 2015)*	**TB**	↓↓ **-31%**	=	↓↓ **-31%**	↓↓ **-21%**
	AG lait	↑ CLA t10,c12 ↑↑C18:1 t10	↑ CLA t10,c12 ↑ C18:1 t10	↓ C18:0 ↓ C18:1 c9 ↑↑↑ C18:1 t (x5)	Idem vache (- de t10)
Rumen *(Toral et al. 2016)*	**Para. fermentaires**	↓ C4, ↓↓ C2/C3, ↑↑C3	**Idem vache, 2.5X NH3**	↓ C2/C3, ↑C3	**Idem vache, 2.5X NH3**
	Microbes ▪ **bactéries (pool) (ADNg T-RFLP)** ▪ **protoz. (partiel)**	**Pour un même régime les microorganismes affectés sont ≠ selon les espèces et ≠ selon régimes** ↓ 60%	↓ 60% **(2,5 X + /Vache)**	Δ des classes	Δ des classes, (**2,5 X + /Vache**)
	AG	**Variations AG (*t*10,*c*12-CLA, *t*10 18:1) proches des observations lait.**		**↓ 18:0 et ↑ des AG trans-18:1 plus importante chèvre**	
GM	**ARNm candidats**	**En cours de dépouillement : ≠ ARNm selon espèces et peu selon régimes (tps prélvt/repas et traite ?)**			
Mét. Interm. (Plasma)		**Classes et composition lipides plasma : préciser mécanismes transport AG dans plasma et captage par GM (réalisé dans cadre thèse avec C. Delavaud)**			

Modèle original pour comprendre et identifier l'origine mammaire ou ruminale et les mécanismes associés : à poursuivre et compléter => Cpt Alim et étude plasma