



The 75th EAAP Annual Meeting

1/5 September 2024 - Florence, Italy



Effects of undernutrition and hydroxytyrosol supplementation during last third of gestation on growth and physiological profiles of male beef offspring

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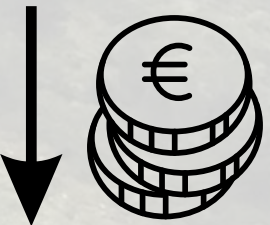
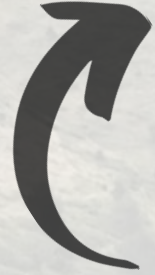
Introduction

PRODUCTIVITY OF SUCKLER COWS

NUTRITION

**ADAPTATION TO EXTENSIVE
CONDITIONS**

PERIODS OF UNDERNOURISHMENT





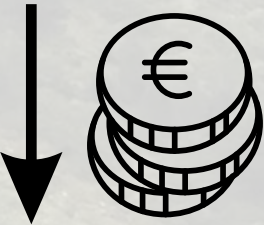
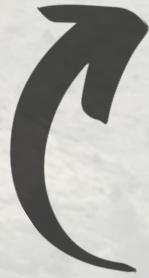
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PRODUCTIVITY OF SUCKLER COWS

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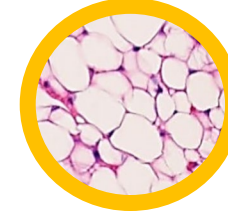


Introduction > Altered productive characteristics in offspring

Birth weight
LeMaster et al., 2017



Obesity
Symonds et al., 2003



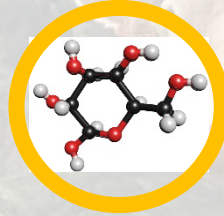
Feed intake
Ford et al., 2007



Antral follicles
Mossa et al., 2013



Glucose metabolism
Long et al., 2010



Mammary alveoli
Skibieli et al., 2018a,b



IGF-1 concentration
Maresca et al., 2020



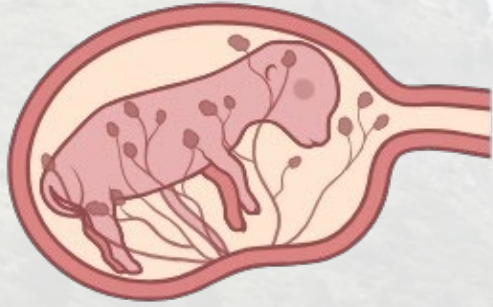
Transgenerational effects
Ford y Long, 2011



However, contradictory results may be found ...



Introduction



SUBNUTRITION (35%) IN THE FIRST THIRD OF PREGNANCY

- **PREVIOUS PROJECT** (Noya et al., 2019a,b,c; 2020; 2022; Serrano et al., 2020)
- Effects on calf development and metabolic status, with a **19% reduction in weaning weight** (Pirenaica breed)
- **12% reduction in slaughter weight**, reduced meat tenderness, increased fat deposition in the carcass and alteration of intramuscular fatty acid profile (Pirenaica breed), **CRUCIAL TO GUARANTEE BCS at calving and at breeding!!!**



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A negative energy balance during the peri-implantational period reduces dam IGF-1 but does not alter progesterone or pregnancy-specific protein B (PSPB) or fertility in suckled cows

A. Noya, I. Casasús, J.A. Rodríguez-Sánchez, J. Ferrer, A. Sanz*

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Long-term effects of early maternal undernutrition on the growth, physiological profiles, carcass and meat quality of male beef offspring

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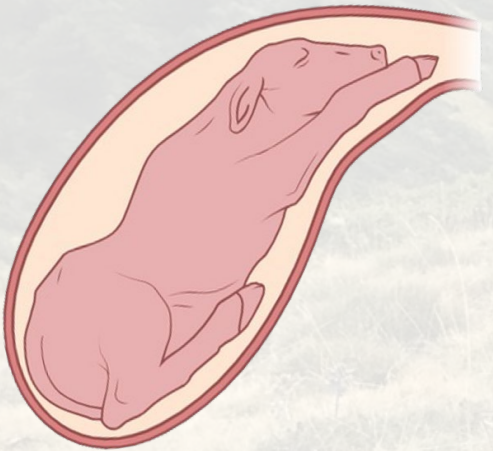


Introduction



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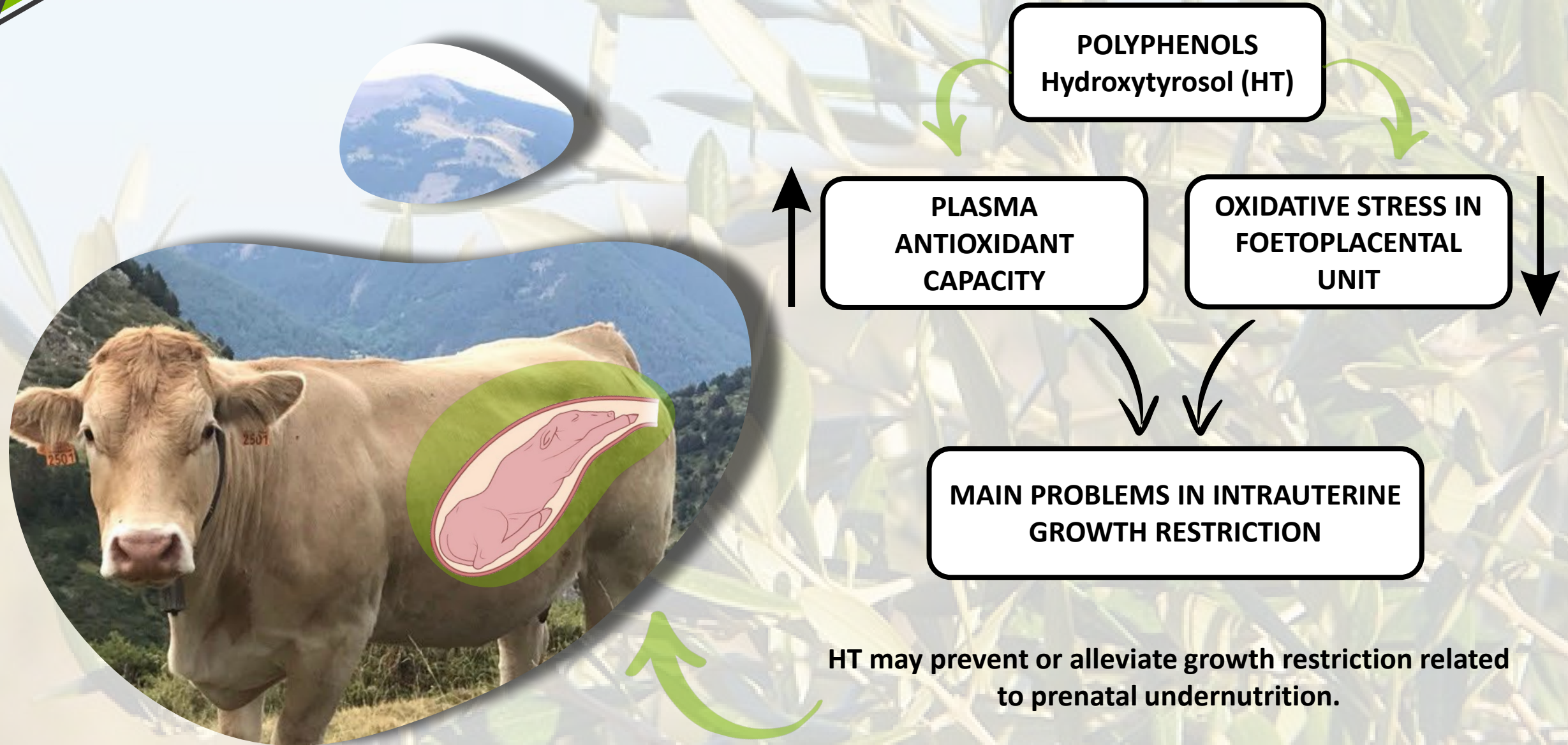


SUBNUTRITION (40%) IN THE LAST THIRD OF PREGNANCY

- **CURRENT PROJECT FETALNUT** (Noya et al., 2022; Escalera-Moreno et al., 2022-2024; López de Armentia et al., 2022-2024; Akesolo-Atutxa et al., 2023)
- **75% of foetal growth** occurs in the last third of gestation
- Effects on productive efficiency in beef cattle.

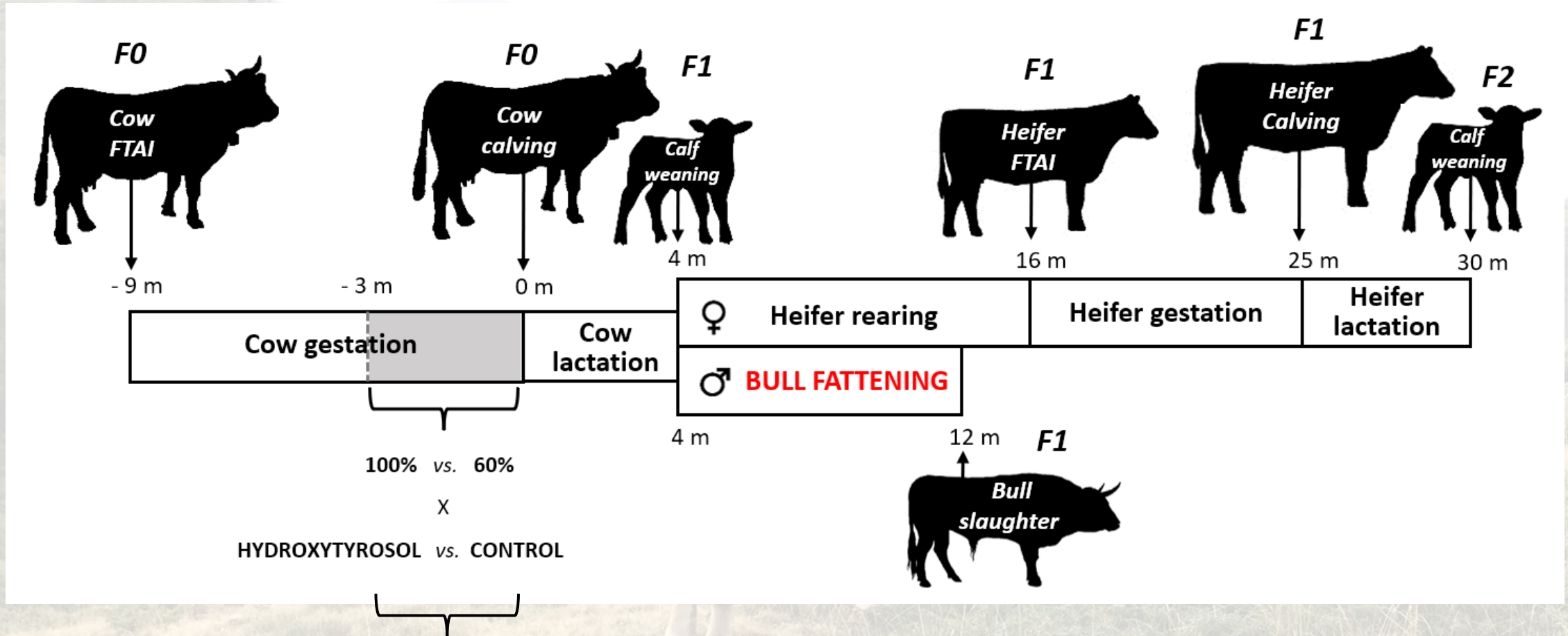


Introduction





Introduction > Project FETALNUT



Prenatal and postnatal development
Immune status / Oxidative stress / Lipid metabolism
Performance in mothers and their offspring

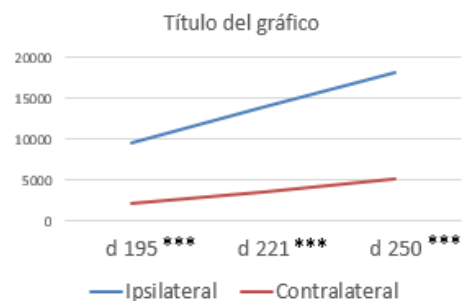


Introduction

López de Armentia et al., 2022 (EAAP)

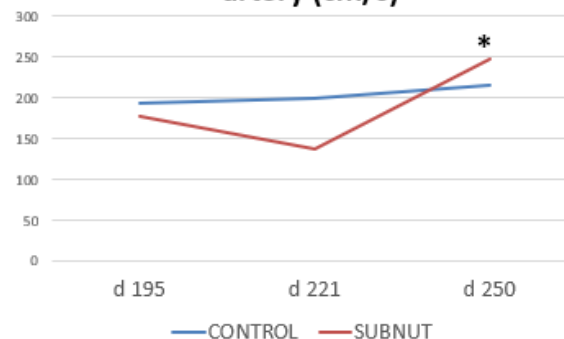
Results All parameters were dependent on the fetus location (* P<0.05; *** P<0.001)

Figure 1. Total blood flow (mL/min) ***



Ipsilateral uterine artery quadruples the blood flow compared to the contralateral one

Figure 2. Systolic velocity ipsilateral in uterine artery (cm/s)



Increase of systolic velocity from d 195 to d 250 higher in undernourished cows

Figure 3. Total uterine artery blood flow (mL/min)

	CONTROL	SUBNUT	
d 195	14095	10055	NS
d 221	21709	14103	*
d 250	23430	22647	NS

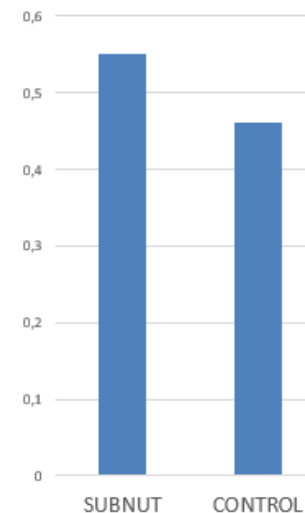
On d 221, total uterine artery blood flow was lower in undernourished cows

Figure 4. Area of the ipsilateral artery (cm²) ***



The area of the ipsilateral uterine artery increased as the pregnancy progressed

Figure 5. RI ipsilateral uterine artery d 250*



On d 250, ipsilateral uterine artery was higher in undernourished cows

CONCLUSION: Maternal undernutrition may be linked to a lower uterine artery blood flow

Introduction > Noya et al., 2022 (AERA)

Potential benefits of maternal Hydroxytyrosol supplementation during late pregnancy on calf growth

4 Results



Cow performance	Nutritional Requirements		Hydroxytyrosol (HT)		Breed	
	100%	60%	HT	Control	Parda (PA)	Pirenaica (PI)
LW (calving, kg)	660 ^a	613 ^b	631	642	631	642
BCS (calving, 1-5)	3.4 ^a	2.9 ^b	3.2	3.2	3.0 ^b	3.3 ^a
Interaction: Nut. Requirements x Breed			100%-PA	60%-PA	100%-PI	60%-PI
Milk yield (day 21, kg)			11.9 ^a	10.1 ^b	9.0 ^b	9.7 ^b

^{a,b} Means within a row differ P < 0.05



Calf performance	Nut. Requirements		Hydroxytyrosol (HT)		Breed		Gender	
	100%	60%	HT	Control	Parda (PA)	Pirenaica (PI)	Male	Female
LW (day 0, kg)	47.2	48.2	49.1 ^a	46.2 ^b	51.5 ^a	43.9 ^b	49.7 ^a	45.7 ^b
ADG (d0 - d30, kg)	1.183	1.145	1.137	1.191	1.183	1.145	1.129	1.199
Interaction:								
Nut. Requirements x HT x Breed								
	100%-HT-PA	100%-Control-PA	60%-HT-PA	60%-Control-PA	100%-HT-PI	100%-Control-PI	60%-HT-PI	60%-Control-PI
LW (day 30, kg)	88.4 ^{ab}	92.8 ^a	93.6 ^a	91.2 ^a	89.5 ^{ab}	77.6 ^c	82.1 ^{bc}	82.5 ^{bc}

^{a,b,c} Means within a row differ P < 0.05

5 Conclusion

Despite HT supplementation had no evident effects on dam performance, its inclusion in the dam diet stimulated fetal growth with postnatal effects during lactation.

Acknowledgements: the staff of La Garcipollera Research Station, A14_20R – SAGAS, PID2020-113617RR-C21



7 communications of Project FETALNUT presented in EAAP 2024:

1 oral and 4 poster communications, in Session 4:

- Effects of undernutrition and hydroxytyrosol supplementation during last third of pregnancy on the immune status of suckler cows and their calves.
- Effects of undernutrition and hydroxytyrosol during last third of pregnancy on newborn vitality and cortisol levels on cow-calf pair.
- Interplay between pre-partum nutrition and hydroxytyrosol supplementation on calf behavior.
- Effect of age, undernutrition and hydroxytyrosol supplementation on metabolic stress markers during the last third of gestation in beef cattle.
- Undernutrition and hydroxytyrosol supplementation during the final third of gestation modulate immune response and redox balance in newborn beef calves.



1 oral communication, in Session 83:

- Effects of undernutrition and hydroxytyrosol supplementation during last third of gestation on growth and physiological profiles of male beef offspring.



1 poster communication, in Session 90:

- In vitro rumen fermentation of forage-based diets supplemented with hydroxytyrosol extracts.



Objectives

Effects of MATERNAL UNDERNUTRITION and HYDROXYTYROSOL (HT, antioxidant from olive leaves) during the last third of pregnancy on live weight (LW), average daily gain (ADG) and physiological profiles on MALE BEEF OFFSPRING during the fattening period (4-12 months of age)





Methodology

- **109 pregnant cows divided into four groups**, from week 28 of gestation to calving (w40):
Feeding level (100 vs. 60% requirements) **x HT** (Control vs. HT, for 0 and 178 mg HT/kg TMR)
- **N = 46 bulls** (25 Parda de Montaña (PA) and 21 Pirenaica (PI) breeds).
- Bulls **weighed monthly**.
- **Blood samples collected bi-monthly** to determine plasma concentrations of **glucose, fructosamine, urea, creatinine and IGF-1**.
- Data were analysed in **R** with a **mixed linear model** with feeding, HT, time and breed as fixed effects, and bull as random effect.



Results > Live Weight (kg)

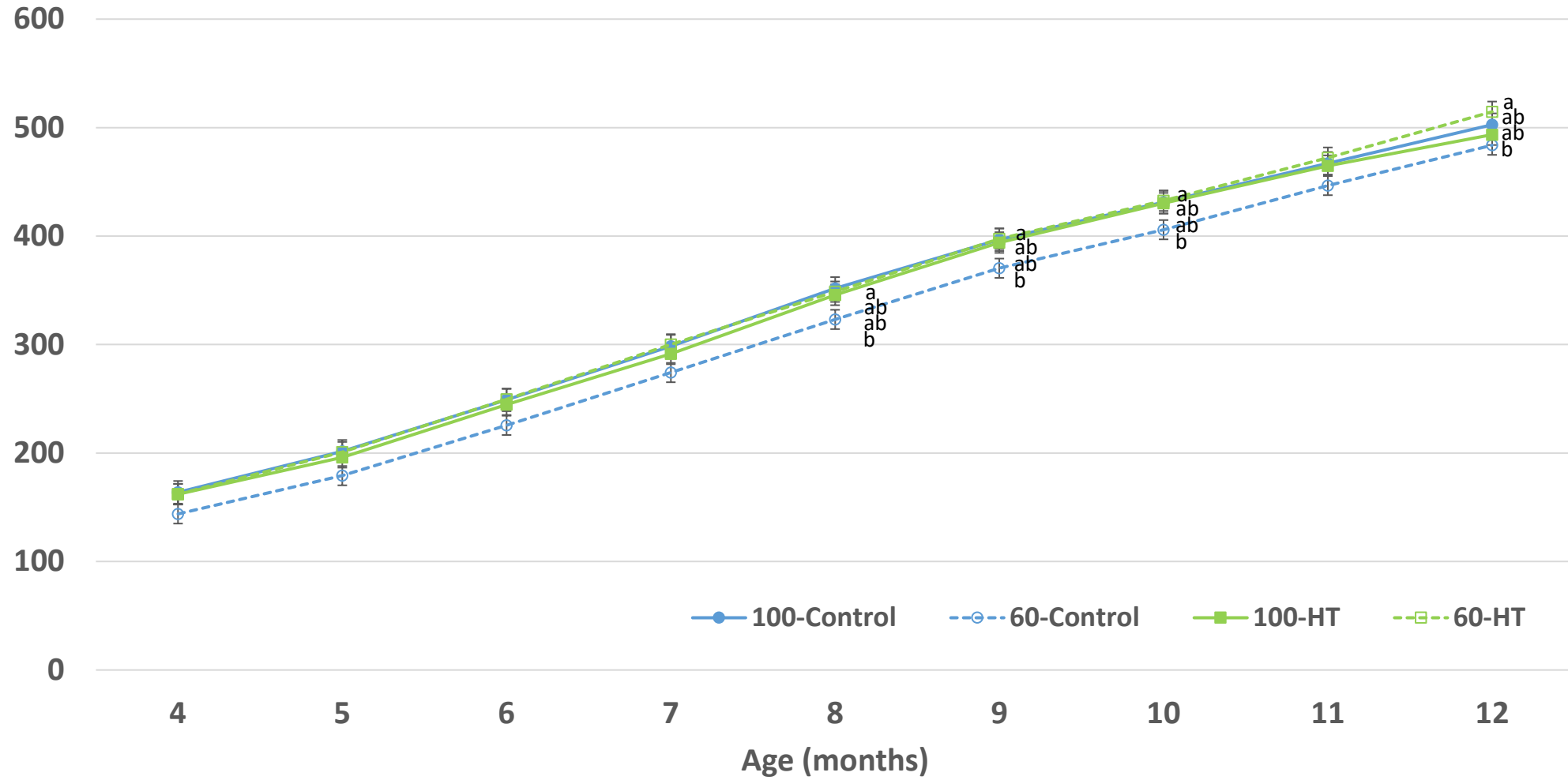


Figure 1. Liveweight (LW) of bulls during the fattening period according to the interaction of maternal nutrition and hydroxytyrosol (HT). a,b Means at a given age differ at P < 0.05.



Results > Live Weight (LW) and Average Daily Gain (ADG)

Table 1. Growth performance of bulls during the fattening period
a,b Means within the same row differ at $P < 0.05$

	Maternal nutrition x Hidroxitirosol (HT)			
	100-C	60-C	100-HT	60-HT
Fattening period (days)	235	236	237	235
Age of slaughter (days)	355	353	356	356
LW (Kg)				
At birth	49.5	47.3	50.4	50.4
Start of fattening	164	144	162	162
End of fattening	503 ^{ab}	484 ^b	493 ^{ab}	514 ^a
ADG (Kg)	1.55	1.55	1.57	1.65

+ 30 kg

60-HT bulls had a higher LW at slaughter
than 60-Control

HT increased the LW at slaughter of bulls
born from cows undernourished in the
last third of gestation.



Results > Physiological profiles

Glucose (mmol / L)

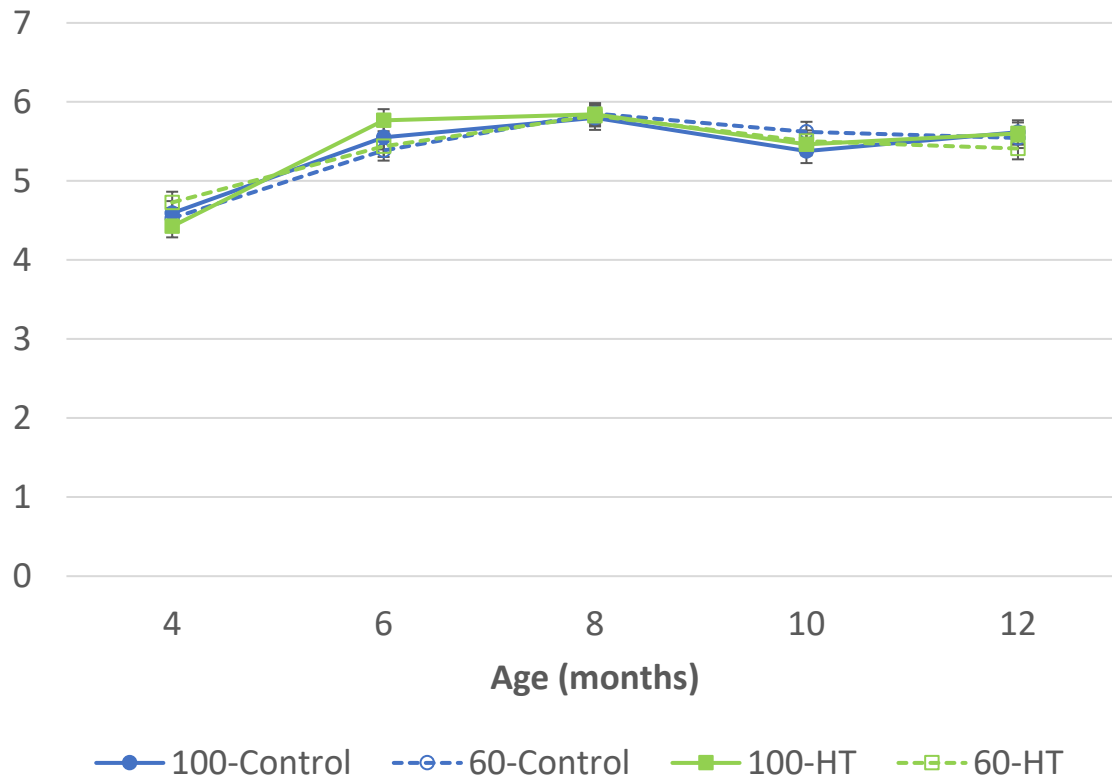


Figure 2. Evolution of glucose levels of bulls during the fattening period according to the interaction of maternal nutrition and HT.

Fructosamine (mmol / L)

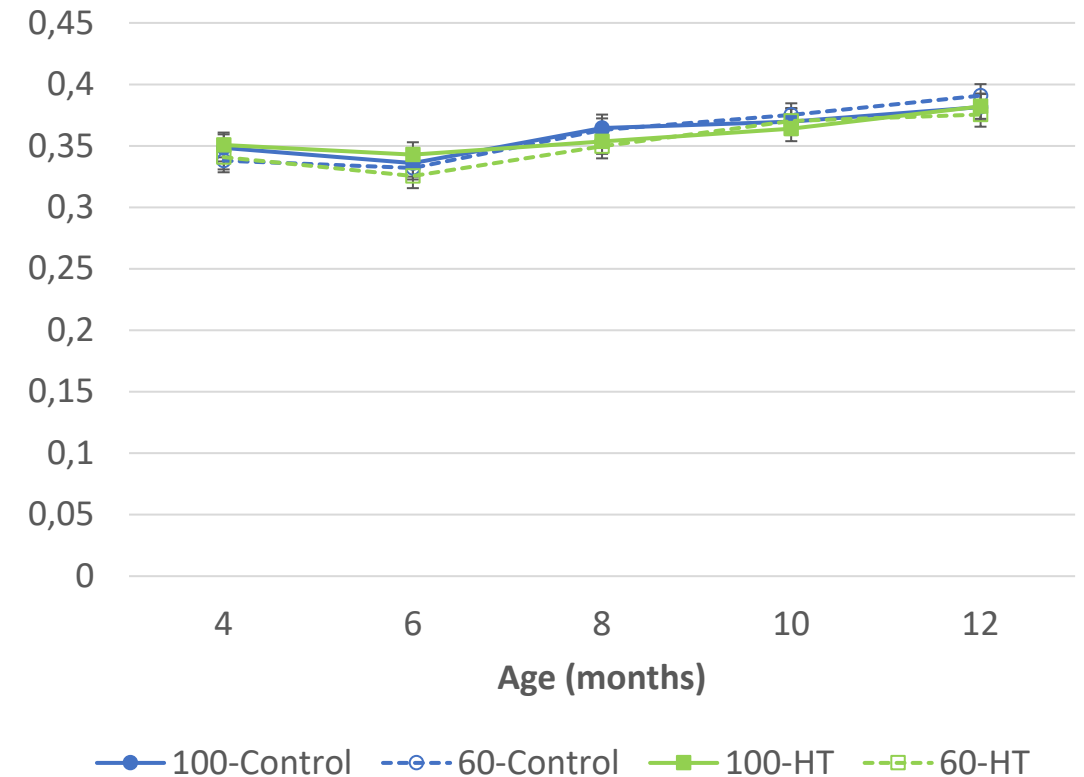


Figure 3. Evolution of fructosamine levels of bulls during the fattening period according to the interaction of maternal nutrition and HT.



Results > Physiological profiles

Urea (mmol / L)

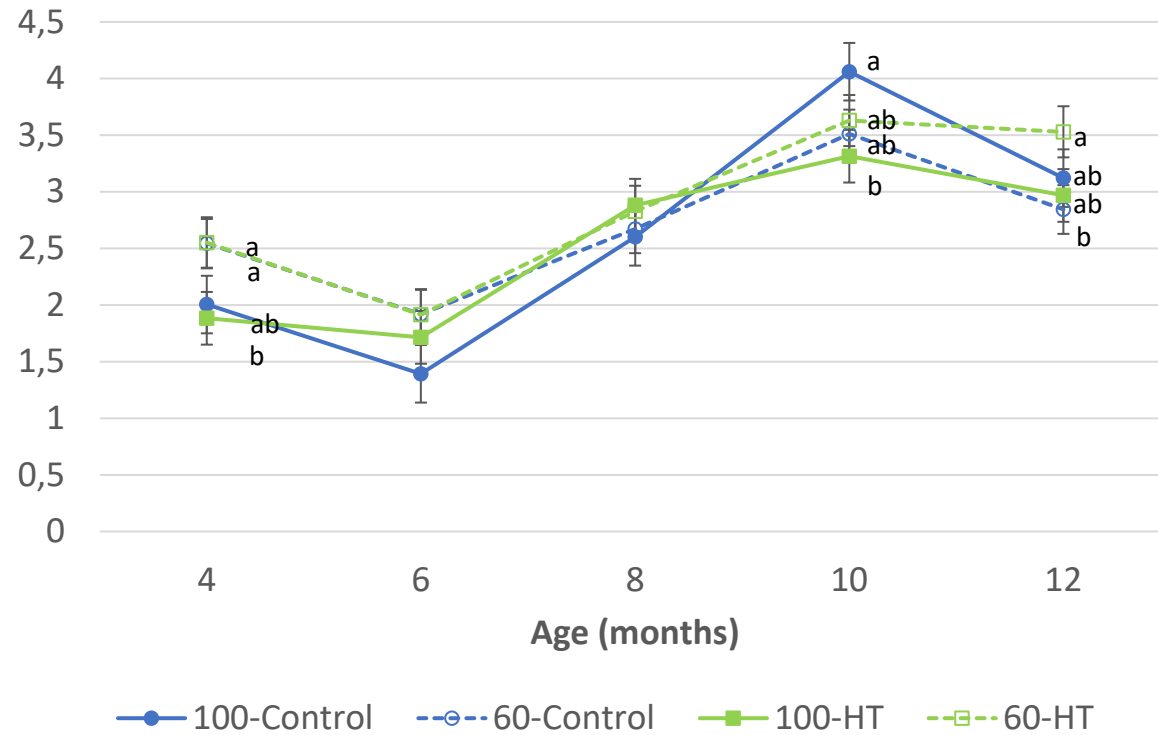


Figure 4. Evolution of urea levels of bulls during the fattening period according to the interaction of maternal nutrition and hydroxytyrosol (HT).
a,b Medians at a given age differ $P < 0.05$. **POSTER SESSION 90**

Creatinine (mmol / L)

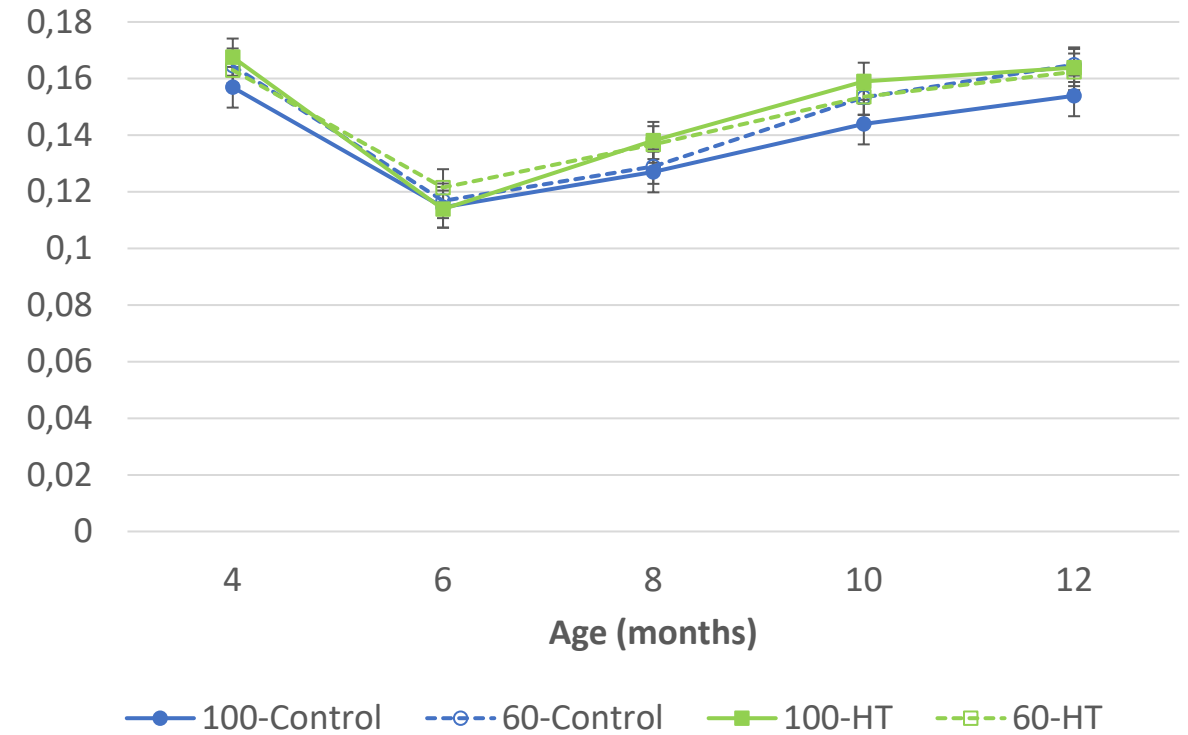


Figure 5. Evolution of creatinine levels in bulls during the fattening period according to the interaction of maternal nutrition and hydroxytyrosol (HT).



Results > Physiological profiles

IGF-1 (ng / mL)

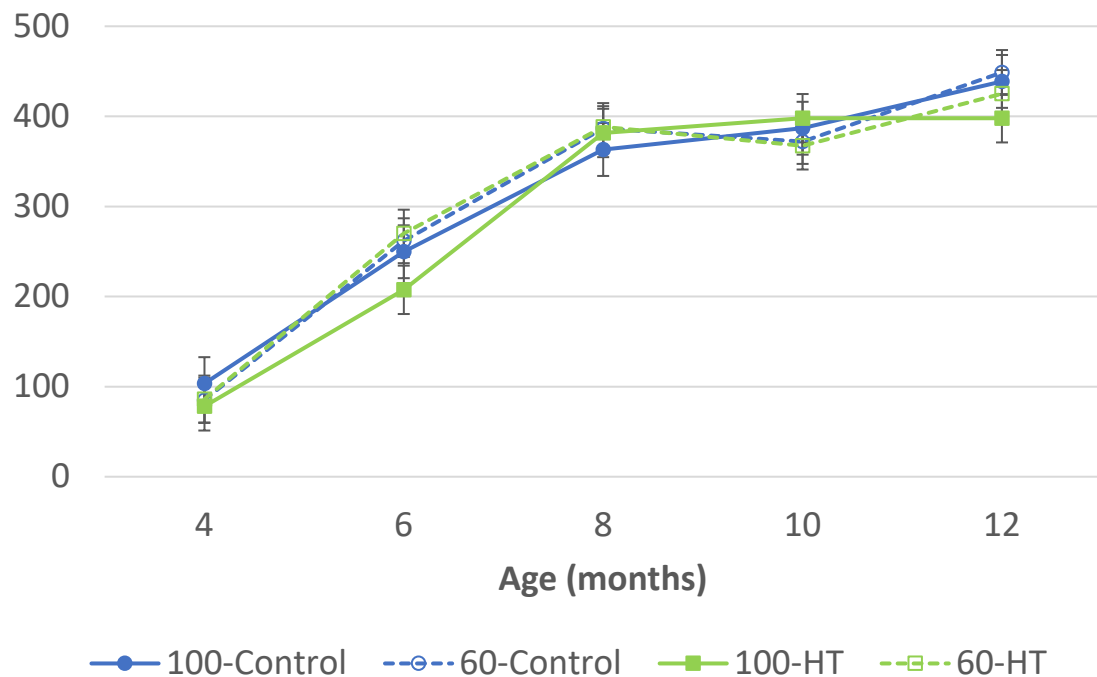


Figure 6. Evolution of IGF-1 levels of bulls during the fattening period according to the interaction of maternal nutrition and hydroxytyrosol (HT).

IGF-1 (ng / mL)

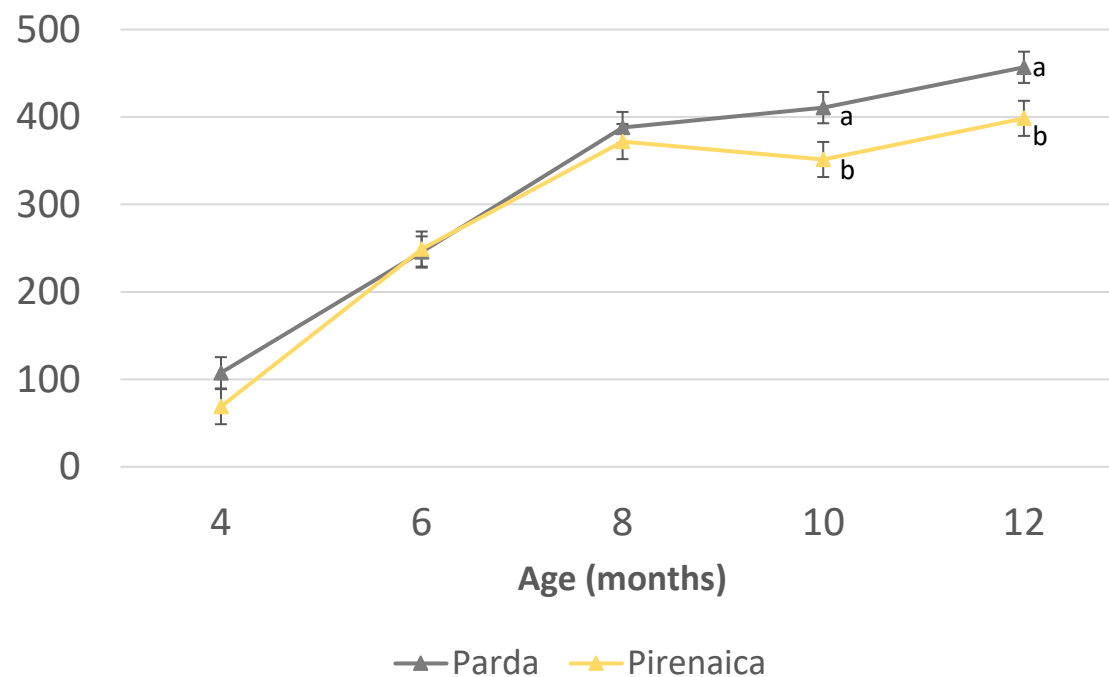


Figure 7. Evolution of IGF-1 levels of steers during the fattening period according to breed. a,b Means at a given age differ P < 0.05.



Conclusions

- Undernutrition and hydroxytyrosol inclusion in the last third of gestation **affected live weight at slaughter** and **urea metabolism** of bulls.
- The rest of metabolites (**glucose, fructosamine and creatinine**) and **IGF-1 were not affected** by subnutrition or hydroxytyrosol inclusion.
- Analyses of bull **morphology, reproductive function** (testosterone, testicular parenchyma and histology, ...), **fat metabolism** (NEFA, subcutaneous fat, adipocyte diameter, leptin, adiponectin levels), **gene expression, carcass and meat quality, and epigenetic modifications** are ongoing.



With all in mind, take management decisions to allow animals to express their full potential.



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- Plant biotechnology company ECONATUR



Acknowledgements





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THANK YOU





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Research project “Fetal undernutrition and hydroxytyrosol supplementation in a beef production system” funded by Ministerio de Ciencia, Innovación y Universidades (Government of Spain)

Other 6 communications from FETALNUT presented at the 75th EAAP Annual Meeting

