

Colostrum yield is heritable and genetically correlated with immunoglobulins concentration in Holstein cows

#2213054

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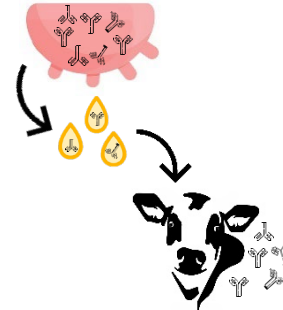
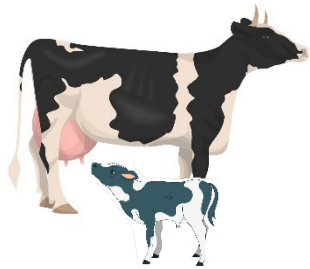


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Introduction

- **Colostrum** is the first secretion of the mammary gland after calving
- Provides newborn calves with **nutrients** and **immunoglobulins**, fundamental for their survival, health, growth and development



Introduction



- Administration to newborn calves is of paramount importance for **transfer of passive immunity**



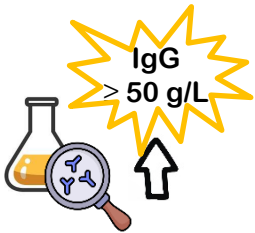
- Its **quality** is conventionally based on the **immunoglobulins G** (IgG) concentration



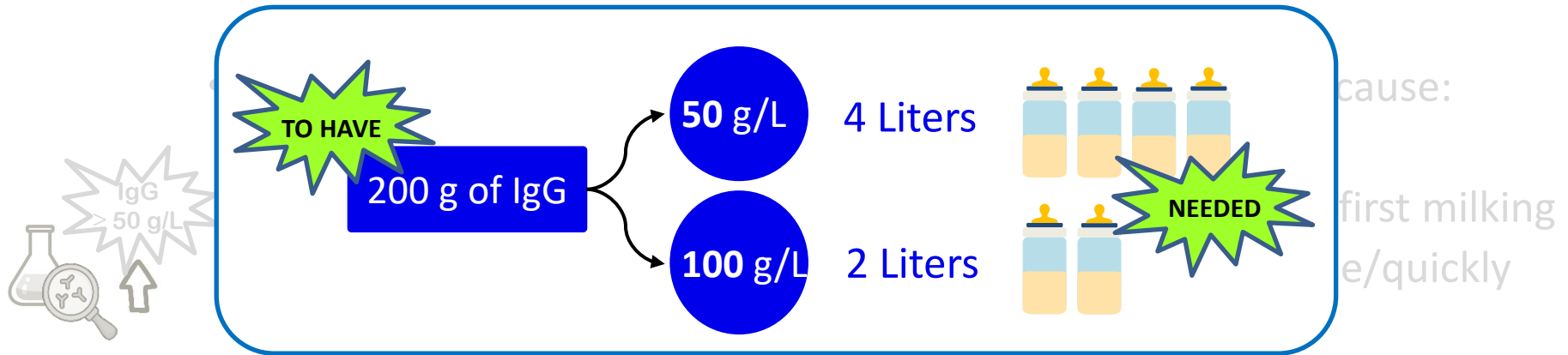
- At least **4 L** of good quality colostrum should be consumed **within 12 h from calving**

Introduction

- Ideally, an highly **concentrated secretion** is preferable, because:
 - Dairy cows often fail to produce enough colostrum at first milking
 - Sometimes the neonates refuse to consume 4 L in time/quickly



Introduction



Introduction

Colostrum: a way to improve calf health



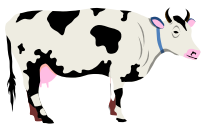
Diseases:

- ↑ mortality rate
- ↑ long-term effects on performance



Genetic selection for calf health is still under investigation, with first attempts currently ongoing in Canada

(Lynch et al., 2023 <https://doi.org/10.3168/jds.2023-23780>)



Selection could also focus on **the dam**: Colostrum traits (yield and quality) play a role in calf immunity and may be extremely variable



Introduction

To improve colostrum yield (CY) and colostrum quality (=IgG concentration)



- ❖ Intermediate optimum for CY
- ❖ high IgG

**Is smart genetic selection for both traits meaningful?
Feasible?**

Objectives

- Evaluate the IgG concentration in cows of different productivity level (CY)
- Estimate the heritability (h^2) of CY and its genetic correlation with IgG



Materials and Methods



Experimental design

- 2,693 Holstein cows
- 60 farms in North-East Italy
- May 2022 - March 2023
- Parity from 1 to 9



Data available

- Colostrum yield at 1st milking (≤ 6 h from calving)
- 120 mL of colostrum for NIRS prediction* of IgG (g/L)
- 1 obs/cow

*Franzoi et al. 2022 *Food Chem.* ($R^2_{\text{external validation}}=0.83$)

Materials and Methods



Aim 1. Evaluate the IgG concentration in cows of different productivity level (CY)

Analysis of IgG concentration

$$y_{ijklm} = \mu + P_i + S_j + C_k + (P \times C)_{ik} + (P \times S)_{ij} + h_l + a_m + e_{ijklm}$$

P_i

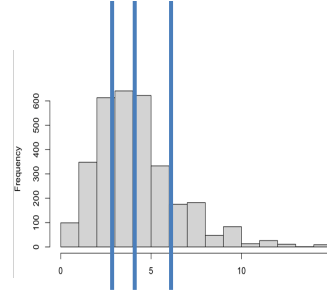
Parity of the cow (1, 2, 3, 4 and ≥ 5)

C_k

Class of CY defined by quartiles (≤ 3 , 3 – 4, 4 – 6, > 6 L)

S_j

Calving season (Dec-Feb; Mar-May; Jun-Aug; Sep-Nov)



h_l

Herd

a_m

Animal

Materials and Methods



Aim 2. Estimate the heritability (h^2) of CY and its genetic correlation with IgG



Heritability and genetic correlation

$$y_{ijklm} = \mu + P_i + S_j + \cancel{C_k} + \cancel{(P \times C)_{ik}} + (P \times S)_{ij} + h_l + a_m + e_{ijklm}$$



$$y_{ijkl} = \mu + P_i + S_j + (P \times S)_{ij} + h_k + a_l + e_{ijkl}$$

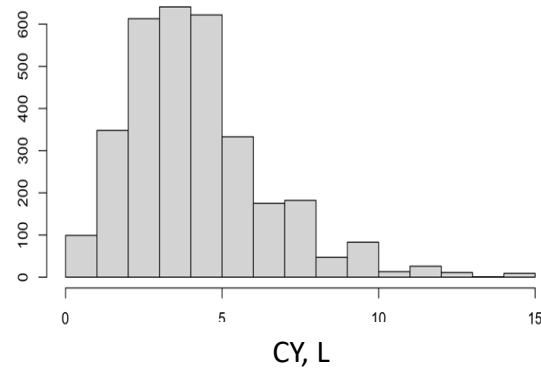
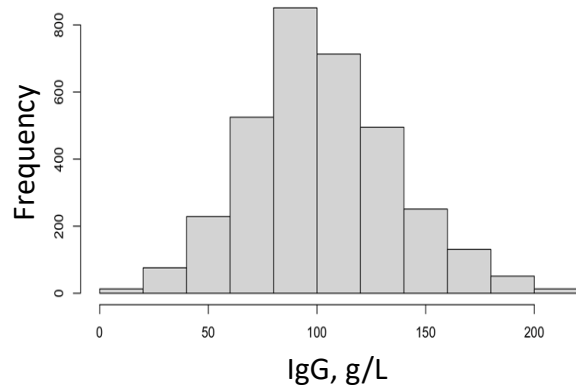
Pedigree info
(19,699 individuals):



Results



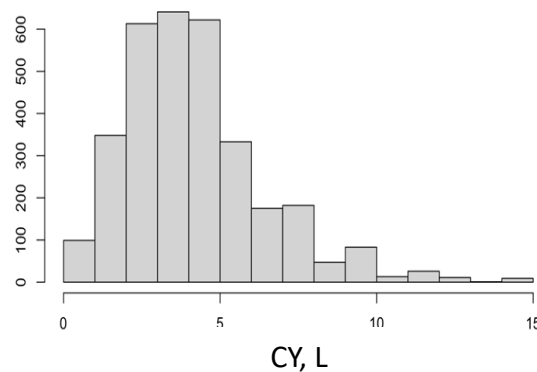
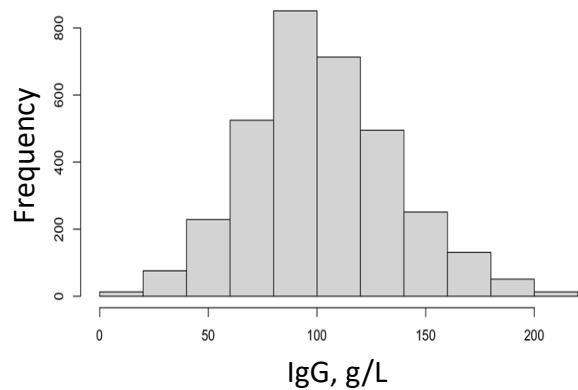
Trait	Mean	SD	Range	CV, %
IgG, g/L	102.16	33.62	2.07–209.96	32.90
CY, L	4.63	2.28	0.10–15.00	49.20



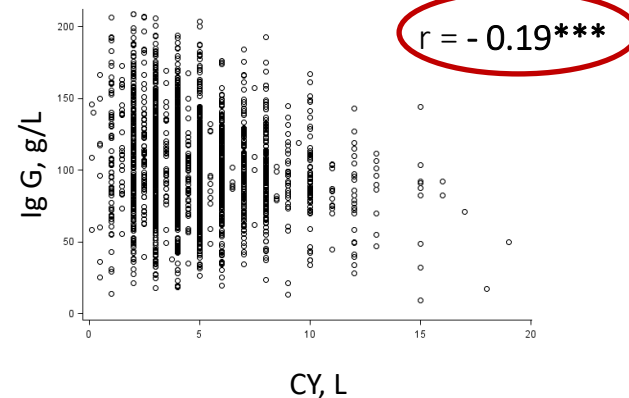
Results



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Pearson's correlation



Results



**ANOVA
IgG:**

CY class	LSM IgG, g/L	SE
A (≤ 3 L)	110.02 ^a	2.31
B (3–4 L)	104.45 ^b	2.51
C (4–6 L)	99.18 ^c	2.51
D (> 6 L)	93.71 ^d	2.54

Results



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200 g of IgG
at 1st meal



Results

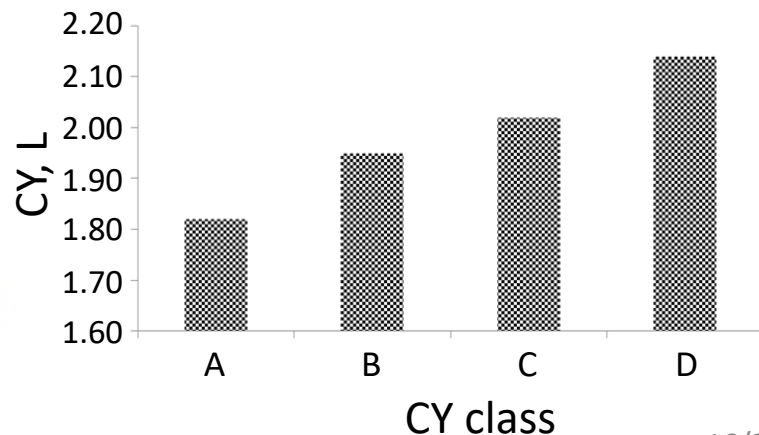


**ANOVA
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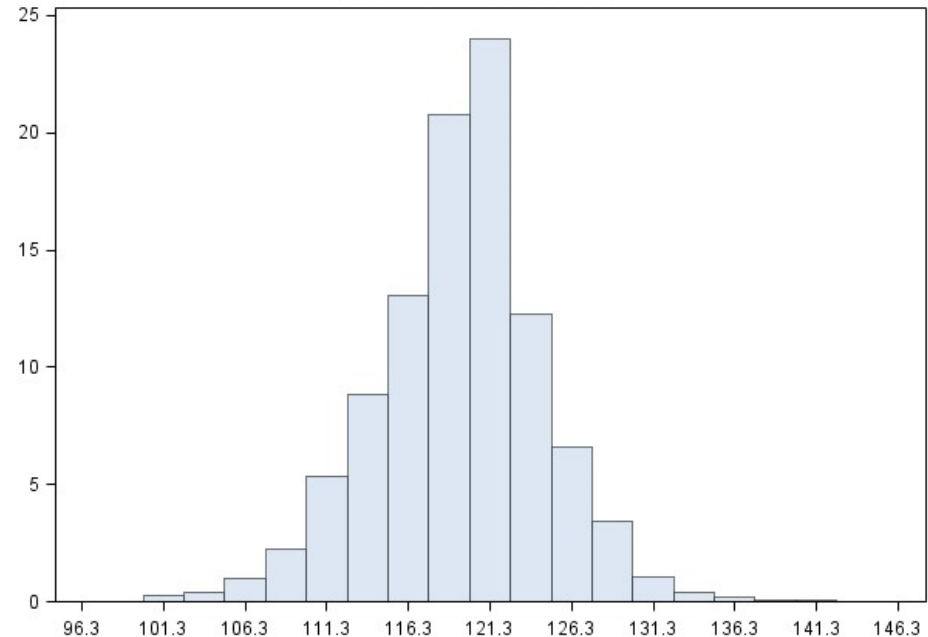
Trait	Heritability	r_a	r_p
IgG, g/L	0.22 (0.05)	-0.35 (0.23)	-0.26 (0.03)
CY, L	0.07 (0.03)		

Results



Bulls ranking for IgG

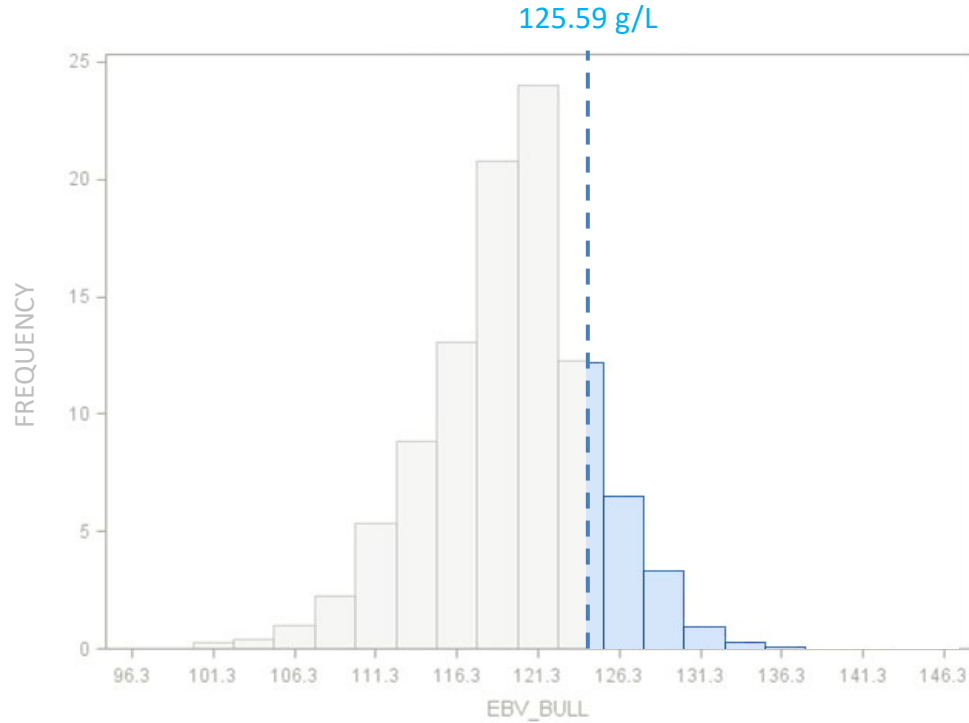
Percentile		EBV (g/L)
100%	Max	147.36
99%		131.90
75%	Q3	122.353
50%	Median	119.861
25%	Q1	116.495
1%		106.07
0%	Min	95.93



Results



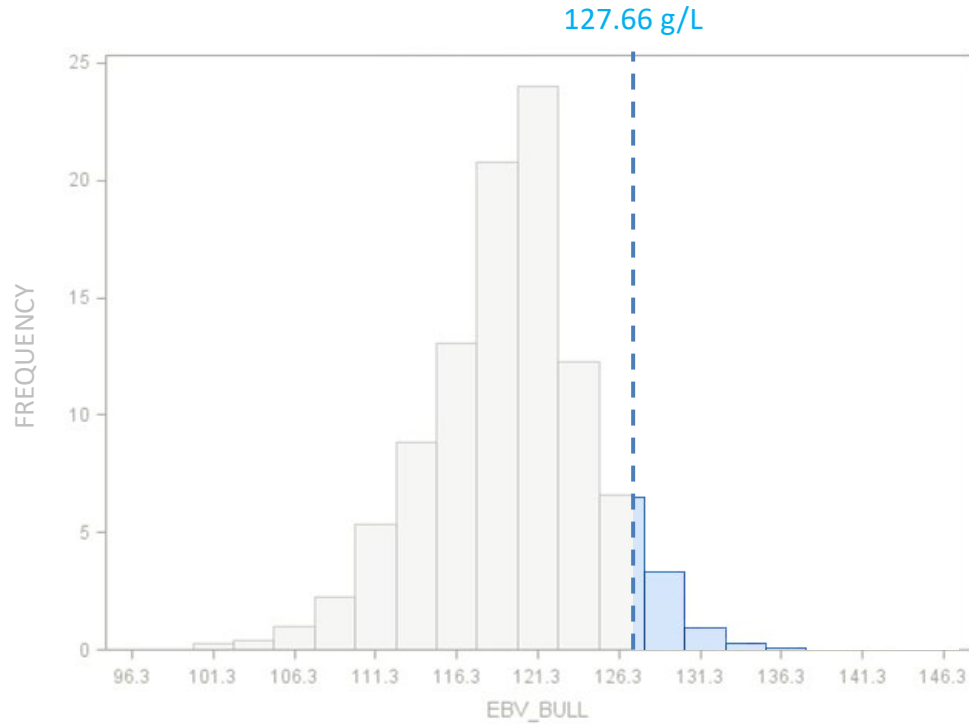
Best 10%



Results



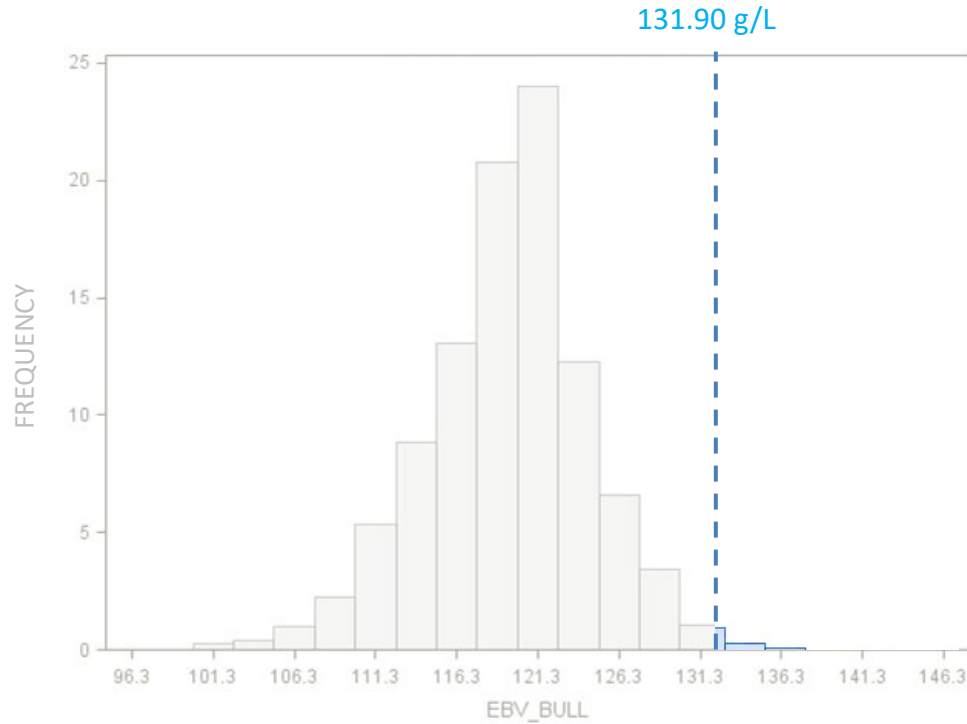
Best 5%



Results



Best 1%



Results



Retrospective investigation on performance of the offspring of the top 10% bulls

Top 10%	n daughters	Mean	SD	Min	Max
IgG, g/L	631	118.23	33.43	31.93	208.49
CY, L	607	4.62	2.37	0.10	15.00

Remaining ones	n daughters	Mean	SD	Min	Max
IgG, g/L	2044	97.05	31.34	9.20	208.59
CY, L	1952	4.69	2.27	0.12	15.00

Results



Retrospective investigation on performance of the offspring of the top 10% bulls

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**Observed
difference =
21.2 g/L of IgG**



Conclusions

- CY is variable and heritable in dairy cows
- Optimizing at the same time quality (IgG) and quantity (CY) of colostrum delivered by cows at the first milking is achievable through selective breeding
- A proper index should consider their antagonistic association to ensure a response in both traits in the right direction

Official selection index

	EBV IgG	Spearman corr.	EBV CY	Spearman corr.
Production, functionality, type	PFT	0.24*	PFT	-0.31**
Economic and functional	IES	0.30**	IES	-0.33**
	ICSPR	0.28**	ICSPR	-0.30**
	Milk	0.38***	Milk	-0.48***
	Kg fat	0.30**	Kg fat	-0.39***
	Kg pro	0.42***	Kg pro	-0.48***
	% fat	0.01 ^{ns}	% fat	-0.09 ^{ns}
	%pro	0.28**	%pro	-0.28**
Functional udder	ICM	-0.01 ^{ns}	ICM	-0.16 ^{ns}
	SCC	0.05 ^{ns}	SCC	-0.11 ^{ns}
	Fertility	0.05 ^{ns}	Fertility	-0.03 ^{ns}
	Longevity	0.015 ^{ns}	Longevity	-0.25*
	Maternal calving ease	0.16 ^{ns}	Calving ease	-0.21*
	Feet & Legs	0.01 ^{ns}	Feet & legs	0.15 ^{ns}





Considerations and perspectives

- Calf health data are needed and collection is recommended for future development of an index
- Such calf health index should take into account also colostrum (dam side)
- Often colostrum of various dams is pooled, pasteurized and then administered to calves
- Non always a parallelism between mother colostrum and calf health (pooled colostrum)

Thank you for the attention

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