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

#2213054

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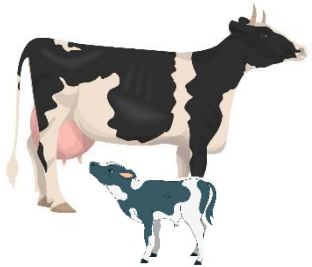
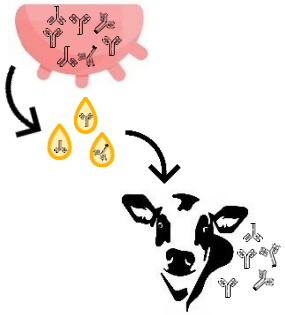
# Introduction

- **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

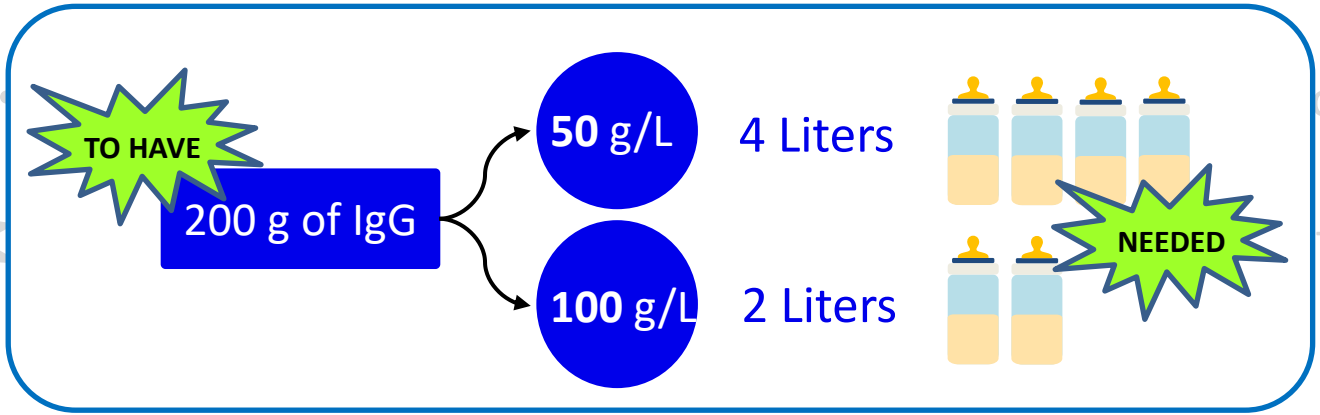
- At least **4 L** of good quality colostrum should be consumed **within 12 h from calving**

# 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





cause:

first milking

e/quickly

# 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)

ASReml®

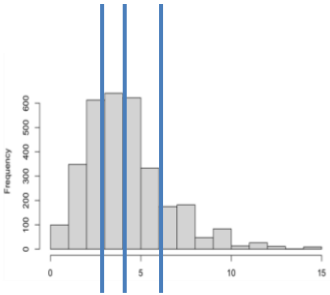
## *Analysis of IgG concentration*

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

$P_i$ 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

ASReml®

## *Heritability and genetic correlation*

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

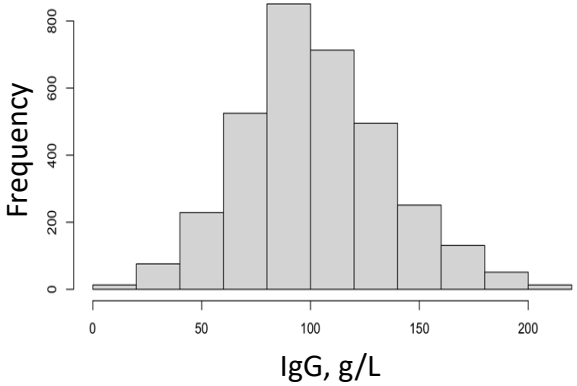
⇩

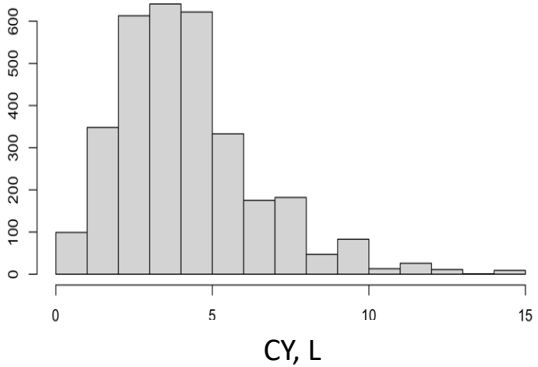
$$y_{ijkl} = \mu + P_i + S_j + (P \times S)_{ij} + h_k + a_l + e_{ijkl}$$

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 |



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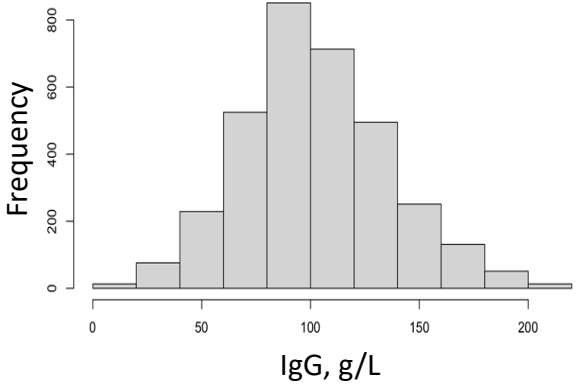
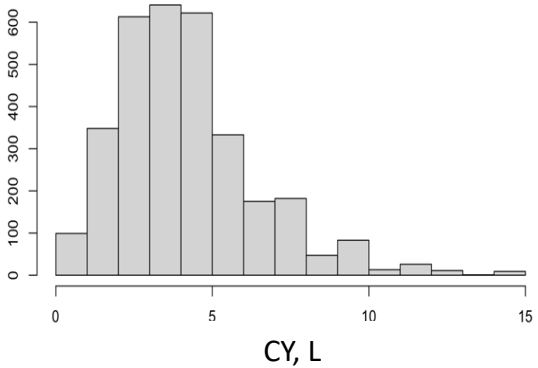
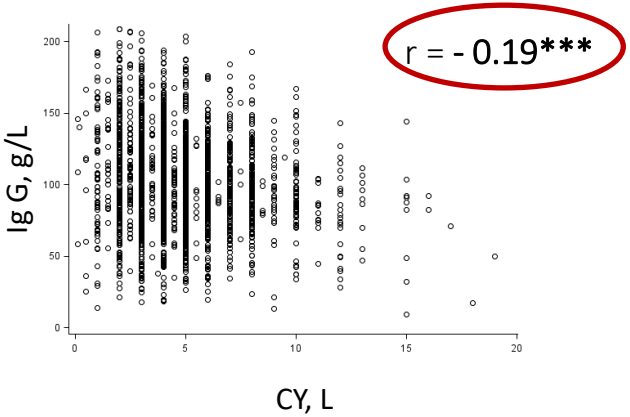



**Pearson's correlation**



# 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 |

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**COLOSTRUM NEEDED**

**TO HAVE**

200 g of IgG at 1st meal

# Results

**ANOVA IgG:**

| CY class | LSM IgG, g/L | SE |
|---|---|---|
| A (≤ 3 L) | 110.02[a] | 2.31 |
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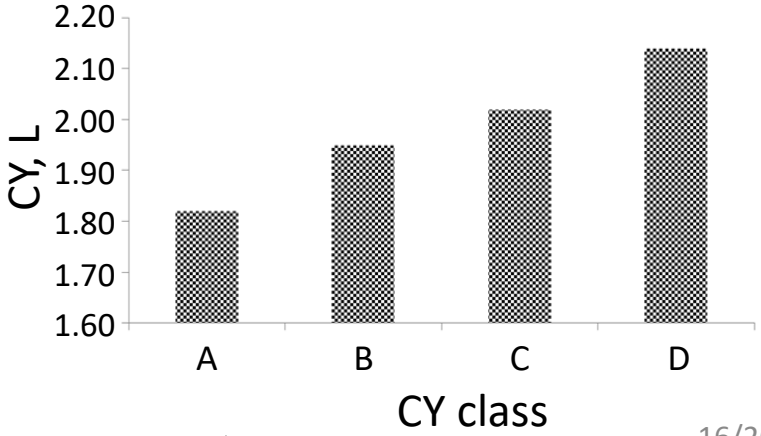


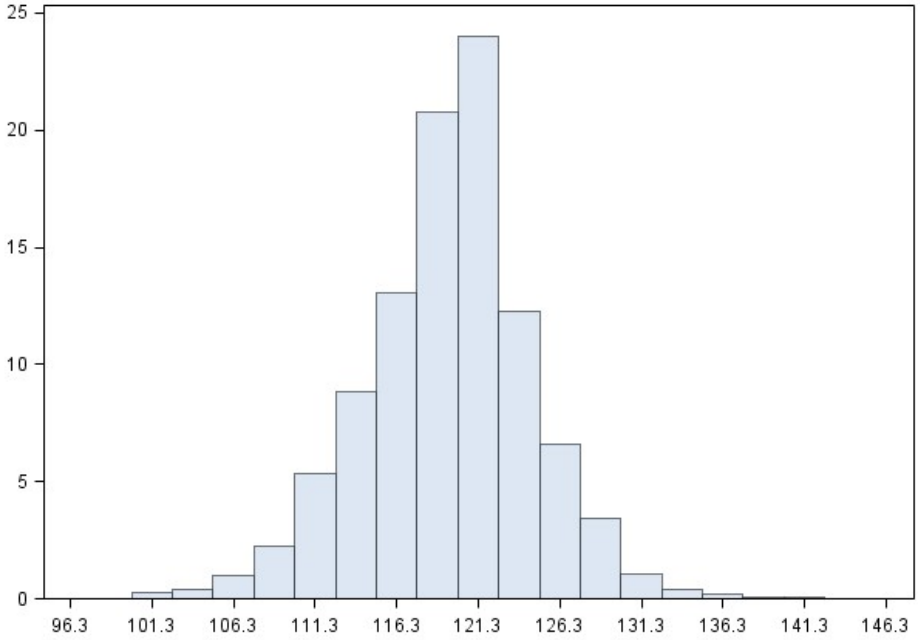
# Results

| 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

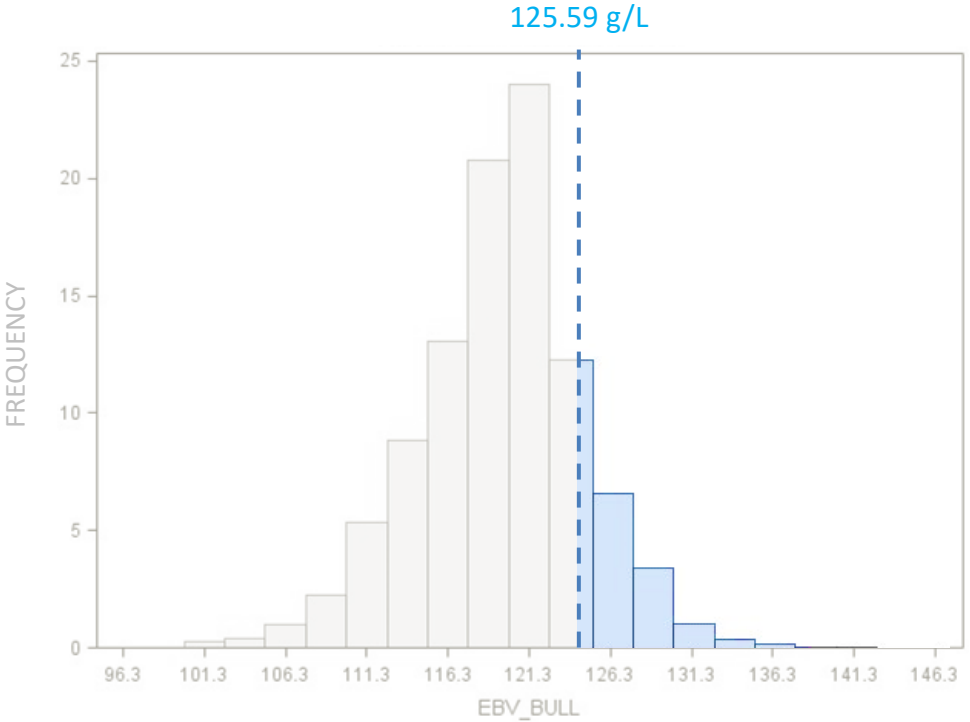
## Bulls ranking for IgG

| 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 |



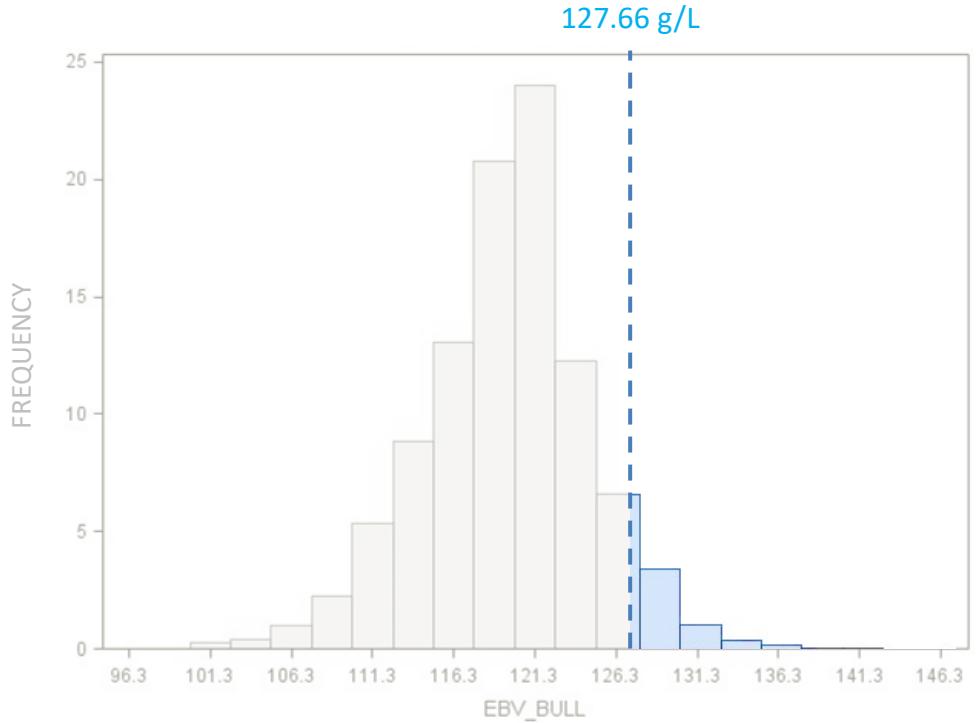
# Results

**Best 10%**



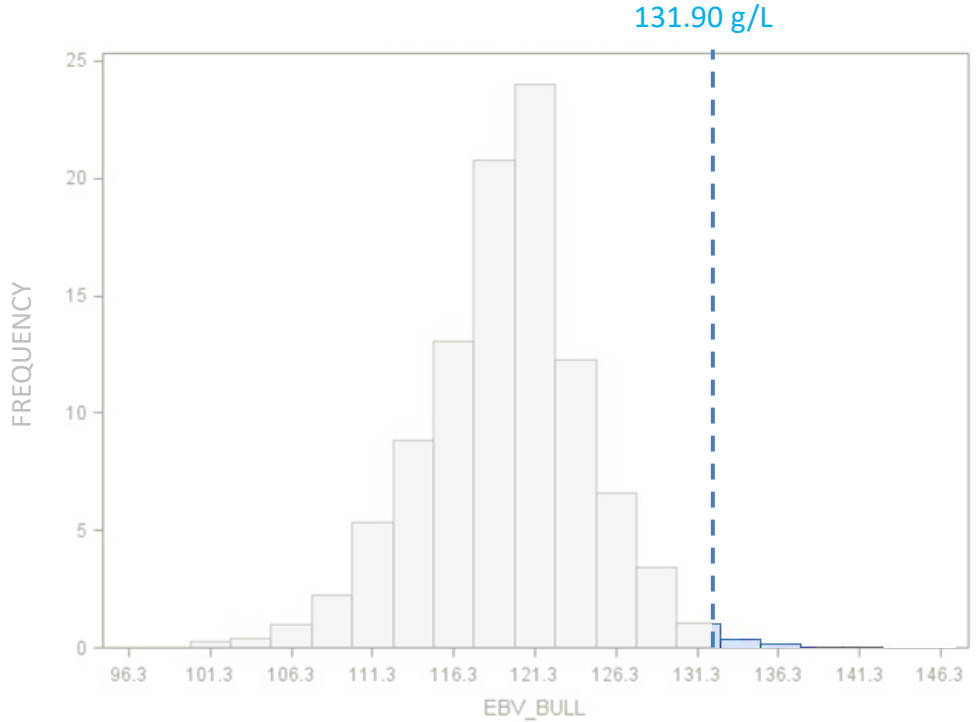
# Results

**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**

| Top 10% | n daughters | Mean | SD | Min | ax |
|---|---|---|---|---|---|
| IgG, g/L | 631 | **118.23** | 33.43 | | |
| CY, L | 607 | 4.62 | 2.37 | | |

| Remaining ones | n daughters | Mean | SD | | ax |
|---|---|---|---|---|---|
| IgG, g/L | 2044 | **97.05** | 31.34 | 9.20 | 208.59 |
| CY, L | 1952 | 4.69 | 2.27 | 0.12 | 15.00 |

**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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