Factors associated with immunoglobulin G concentration and specific antibody inhibition in bovine colostrum in NI

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Introduction

- Colostrum is the first secretion post parturition.
- Primary source of nutrients and immunity to newborn calf (naive immune system).
- Calf born aggamaglobulinemic
- IgG is the main antibody found in bovine colostrum

  (> 50 mg/mL - McGuirk and Collins 2004).
- Huge variability in colostrum quality

  < 1 to 200 mg/mL IgG (Morrill et al., 2012)

  4 to 235 mg/mL IgG (Gulliksen et al., 2008)

Introduction

- Colostrum contains antibodies specific to common scour causing pathogens.

  E.g. *E.coli K99+, c*oronavirus, and rotavirus
- 57% of pre-weaning calf mortality was a consequence of diarrhoea and most of these cases occurred in neonatal calves <1 month of age (USDA, 2007).
- Costs the UK industry approximately £33 per calf at risk (DEFRA, 2008).
- Increased risk of death (Gulliksen et al., 2009)
- Increased risk of delayed age at calving (Gulliksen et al., 2009)
- Reduced milk yield (Svensson and Hultgen, 2008)

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Objectives

1. Determine the variability of colostrum quality across 21 commercial dairy farms in Northern Ireland.

2. Identify factors associated with colostral IgG concentration and *E.coli K99*+, rotavirus and coronavirus inhibition.

Methods and Materials

- Colostrum samples collected from 21 commercial dairy farms across NI (n = 1239)
- Prior to analysis fat was removed from colostrum via centrifugation.
- Stored at -20°C
- Analysed for IgG concentration

(ELISA method, BioX Diagnostics, Jemelle, Belgium)

Methods and Materials

- A sub-set of samples were analysed for:

  *E.coli K99+(*n = 1239)

  Rotavirus (n = 384)

  Coronavirus (n = 384)

(ELISA method, BioX Diagnostics, Jemelle, Belgium).

- Measured using inhibition scores

  <20% inh = 0

  <40% inh = +

  <60% inh = ++

  <80% inh = +++

  <100% inh = ++++

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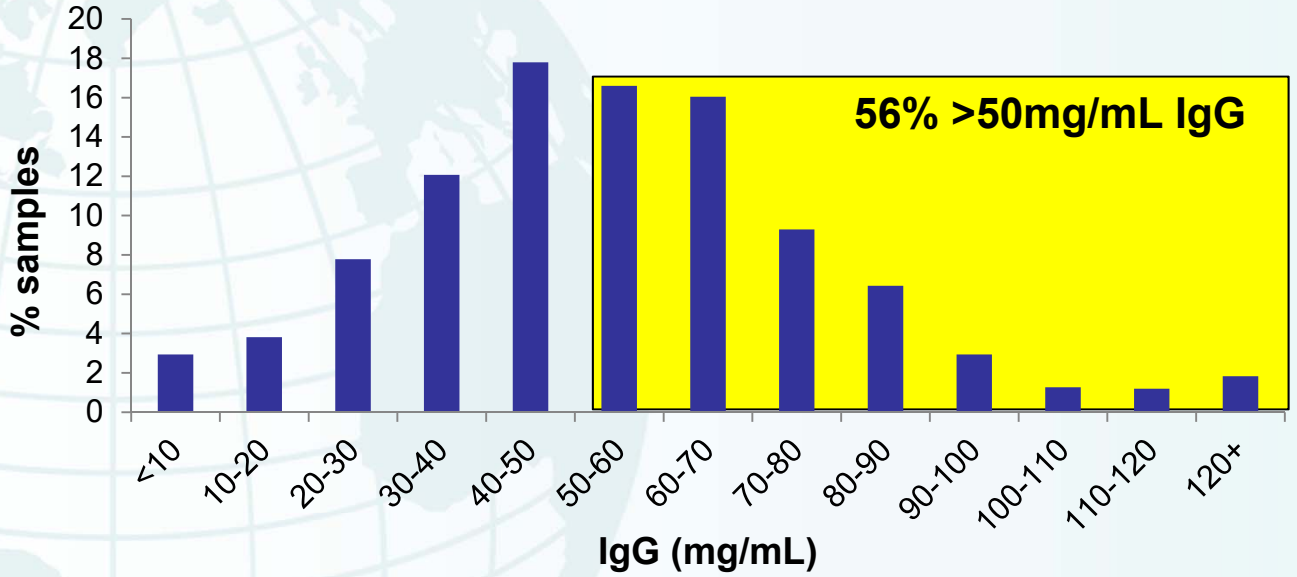
Statistical Analysis

- Genstat 16th edition, (VSD International, 2015).
- REML - uni and multivariate analysis (LMM methodology).
- Farm was fitted as a random effect and the explanatory variables as fixed effects.
- P value < 0.15 from the REML and had a minimum of 900 observations was considered as a candidate for the multivariable models.
- GLMM analysis performed on specific antibody inhibition, using a binomial distribution and farm ID as a random factor

Results



IgG concentration

- Mean ± SD = 55 ± 25.5 mg/mL
- Range = 1.4 to 204 mg/mL

Factors affecting IgG concentration

Univariate Analysis

- Season of calving
- Parity
- Dry period length (wks)
- Calculated 305d milk yield
- Time from parturition to colostrum collection (h)
- Pre-partum salmonella vaccination

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Season of calving (P≤ 0.01)

Variable	IgG (mg/ml)
Season of calving	
Autumn	52.1[a]
Spring	53.3[a]
Summer	52.3[ab]
Winter	58.9[b]

Previous studies:

- Gulliksen et al. (2008)
- Conneely et al. (2013)

These differences may be due to changes in the environment and production system, as different seasons have weather differences and consequently influence the housing and feed type provided to the animals.

Parity (P≤ 0.001)

Parity	IgG (mg/mL)
1	49.3[a]
2	50.1[a]
3	54.3[b]
4	55.5[b]
5+	65.9[c]

- Morrill et al., 2012
- Conneely et al., 2013

Dry period length (P ≤ 0.001)

Dry period (wks)	IgG (mg/mL)
Less than 8	52.4[a]
8 to less than 12	57.2[b]
12 to less than16	57.1[ab]
Greater or equal to 16	61.2[b]

- Rastani et al. (2005) found short unplanned dry period to have negative effect on IgG concentration.
- Annen et al. (2004) – 0 versus 60d (45% lower in IgG)

Previous lactation milk yield (305d)

- Significant association between IgG concentration and 305 d milk yield (P = 0.003).
- 4.32 + 0.001693 * Milk yield
- Pseudo r^2 = 0.11
- Colostral IgG concentration greater from cows with greater previous 305d milk yield.

Time to colostrum collection

(P≤ 0.001)

Time to colostrum collection (hr)	IgG (mg/ml)
<0.5	58.7[a]
<1	56.4[a]
<3	56.2[a]
3-6	55.4[a]
6-12	54.1[a]
12-24	45.9[b]

- Conneely et al. (2013) >IgG at 3-6hr and <IgG between 18-21hr.

- Morin *et al.* (2010) reported a 3.7% decline every hr post calving.

Salmonella immunisation

- 52% of cows were vaccinated against Salmonella.
- Vaccinated animals had a greater (P = 0.015) colostral IgG concentration (58.7mg/mL) compared to non-vaccinated animals (51.1mg/mL).
- Further exploration required on the effects of pre-partum vaccination on colostrum quality.

Factors affecting IgG

Multivariate model

- Parity
- Time to colostrum collection

Parity (P≤ 0.001; SED=2.7)

Variables	
Parity (n = 1215)	IgG (mg/mL)
1	50.8[a]
2	52.0[a]
3	55.3[a]
4	55.3[a]
5+	68.0[b]

Time to colostrum collection

(P≤ 0.01; SE = 3.2)

Time to colostrum collection (h) (n=1172)	IgG (mg/mL)
< 0.5	59.0[b]
< 1	60.2[b]
< 3	56.5[b]
3- 6	55.9[b]
6 -12	57.3[b]
12 - 24	48.8[a]

Results

Mean specific antibody inhibition (%)

Vaccinated animals

- ***E.coli*** *K99+* 85.9% (-16.8 – 98.2%)
- **Rotavirus** 32.5% (-16.4 – 92.3%)
- **Coronavirus** 53.9% (-6.6 – 95.4%)

- Non-vaccinated animals
- ***E.coli*** *K99+19.8% (-17.9 – 97.8%)*
- **Rotavirus** 15.9% (-5.4 – 47.3%)
- **Coronavirus** 44.7% (-13.2 – 93.1%)

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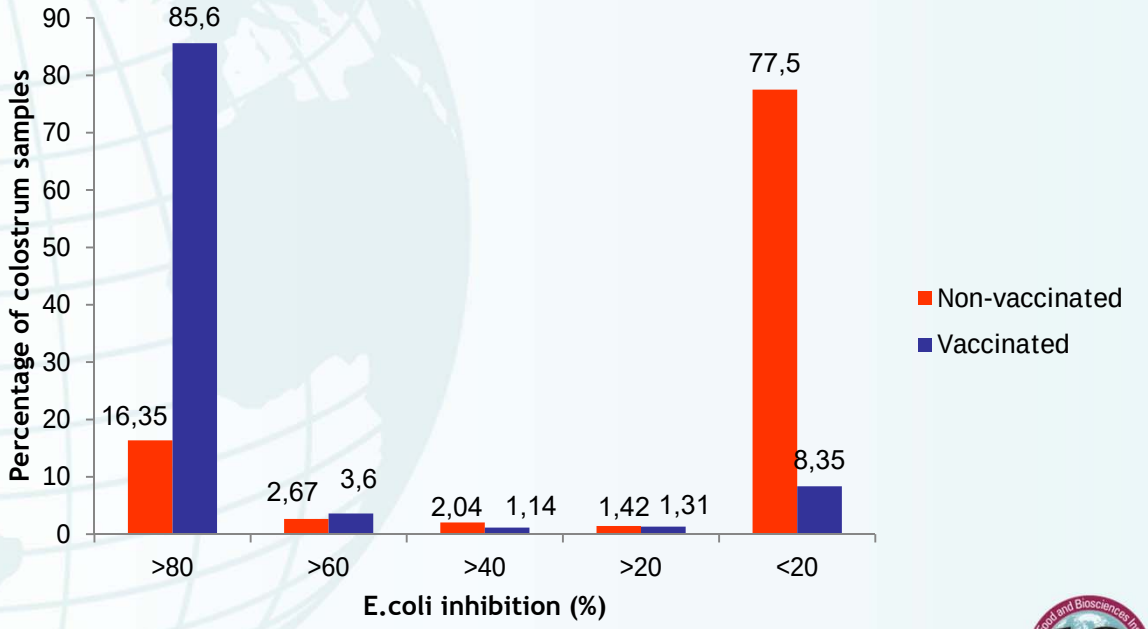
Effect of vaccination on colostral *E.coli K99+* inhibition



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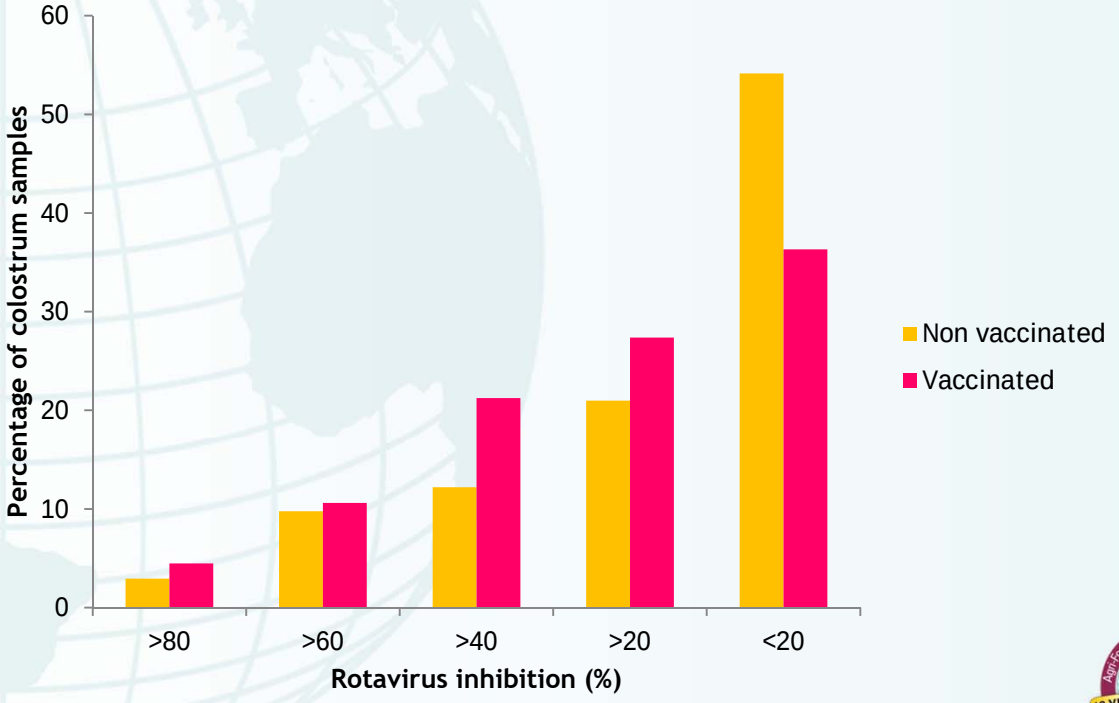
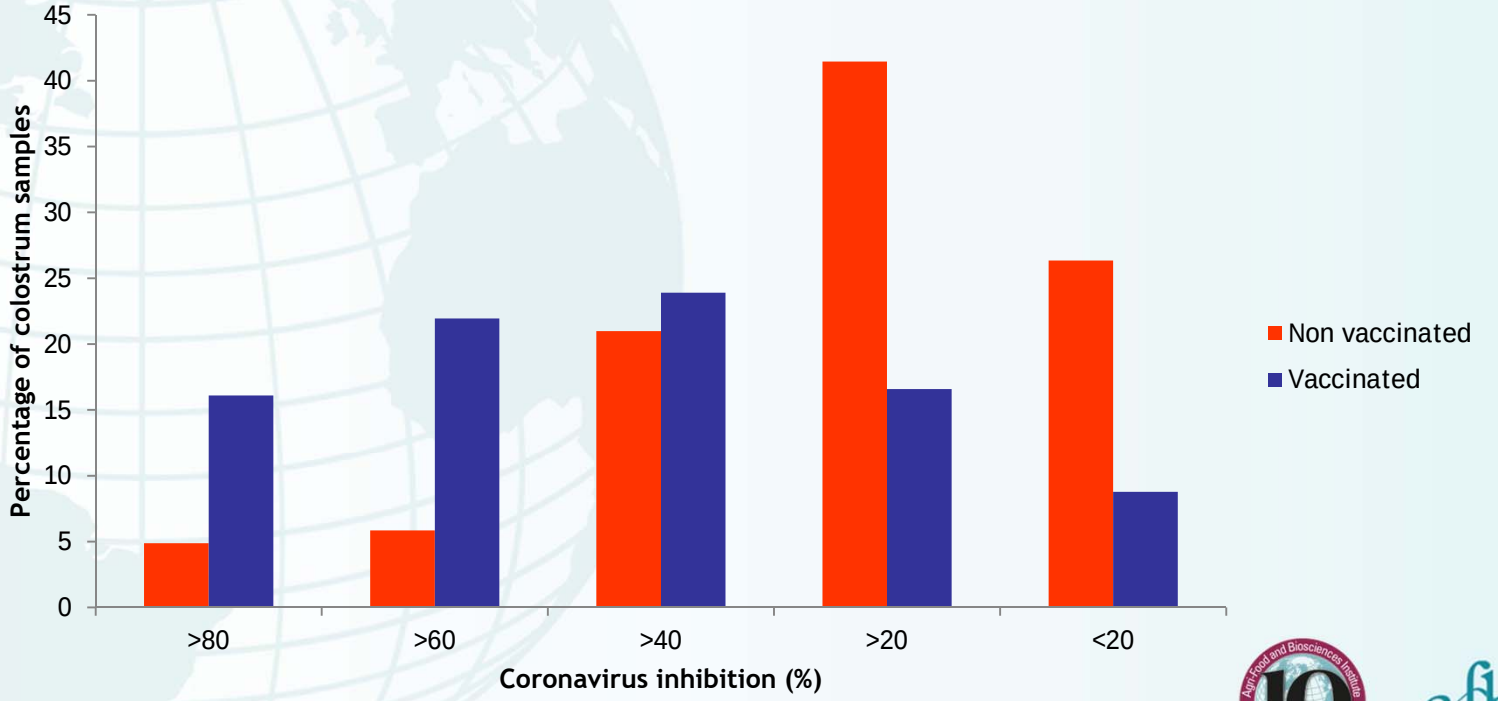
Effect of vaccination on colostral Rotavirus inhibition



Effect of vaccination on colostral Coronavirus inhibition



Pre-partum vaccination

Variable	Probability of >60% *E.coli* inhibition	SE	P-Value
Vaccinated against *E.coli K99*+, rota and coronavirus			< 0.001
No	0.22	0.03	
Yes	0.81	0.02	

•Timing of vaccination important:

E.coli K99+ inhibition was greatly reduced (P ≤ 01) in colostrum when vaccinated at 0-3 wks pre-calving compared to earlier in the dry period.

Pre-partum Vaccination

Rotavirus inhibition

- Vaccination had no effect (P = 0.12) rotavirus inhibition achieving >60%.
- Timing of vaccination was insignificant (P = 0.77).

Coronavirus inhibition

- Cows vaccinated had a greater (P ≤ 0.01) probability (46%) of achieving >60% coronavirus inhibition than non-vaccinated cows (6%).
- Timing of vaccination was insignificant (P = 0.2)

Factors affecting *E.coli K99+* inhibition

Univariate analysis

- **Season of calving** (P ≤ 0.05) – Greatest probability of achieving (55%) >60% *E.coli K99+* inhibition in winter.

- **Dry period length** (P ≤ 0.001) – Greatest probability of achieving (45%) >60% *E.coli K99+* inhibition at 8-16 wks pre calving.

- **Timing of BVD vaccine** (wks pre partum) (P ≤ 0.01) – Greatest probability (74%) of achieving >60% *E.coli K99+* inhibition at 16-30 wks pre-calving.

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Conclusion

- Colostral IgG concentration was extremely variable between cows and herds, 44% of samples below threshold for good quality.
- Always test colostrum before discarding.
- Collect and feed colostrum ASAP post parturition.

Conclusion

- Pre-partum vaccination has positive effect on inhibition levels against scour causing pathogens.
- Timing of vaccination must be adhered to ensure efficient use of vaccine.
- Factors associated with specific antibody concentration:

  Season of calving

  Timing of vaccination

  Dry period length

Thanks for your attention!

Any questions?

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