The colour in the barn! Does wavelength affect broiler production and welfare?

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Acknowledgments

- Dr. Bruna Franco
  - PhD student focusing on this work
  - This is a shortened version – please watch for Bruna's defense in the spring!
  - Thanks for the slides!
- Funding
  - NSERC Discovery Grant Funding
  - Aviagen NA

Previous literature

- Green and blue lighting (Rozenboim et al., 2014; Yang et al., 2015; Mohamed et al., 2017)
  a) Improved market body weight
  b) Improved feed efficiency
  c) Increased breast muscle deposition
- Yellow light (Kim et al., 2013)
  a) Improves body weight gain
  b) Improves feed consumption
- No differences! (Wathes et al., 1982; Praynito et al., 1997)

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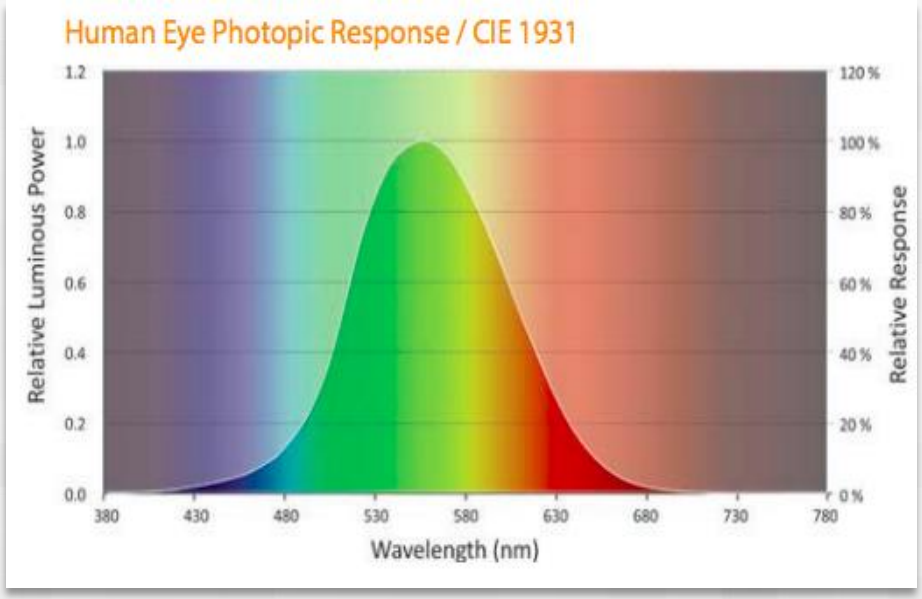
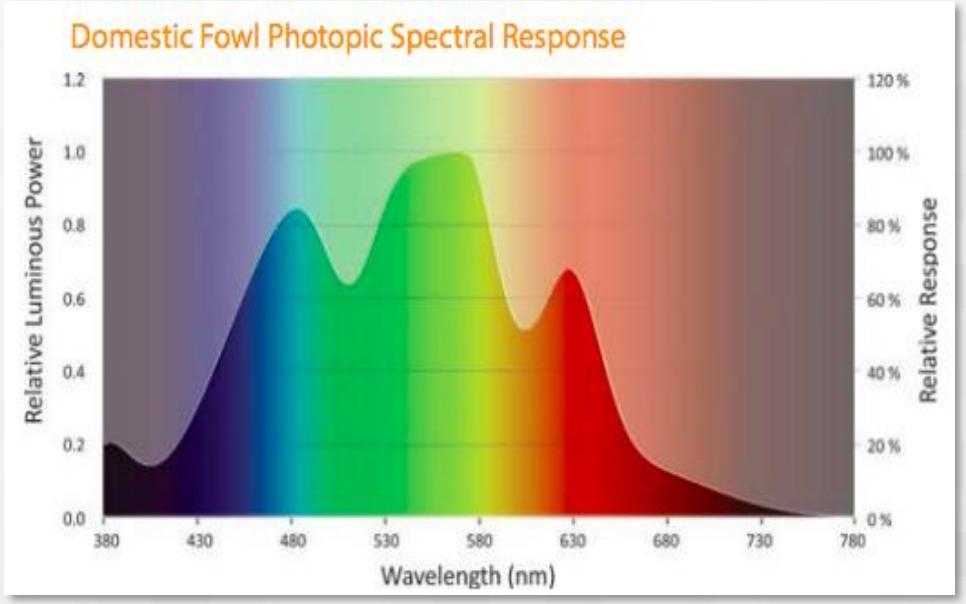
- Doesn't completely agree!
- Why? Avian visual ability different than humans!
- Rods vs cones



Human Photopic Response



Domestic Fowl Photopic Response

Spectral sensitivity of the domestic fowl (*Gallus g. domesticus*), Prescott and Wathes, 1999

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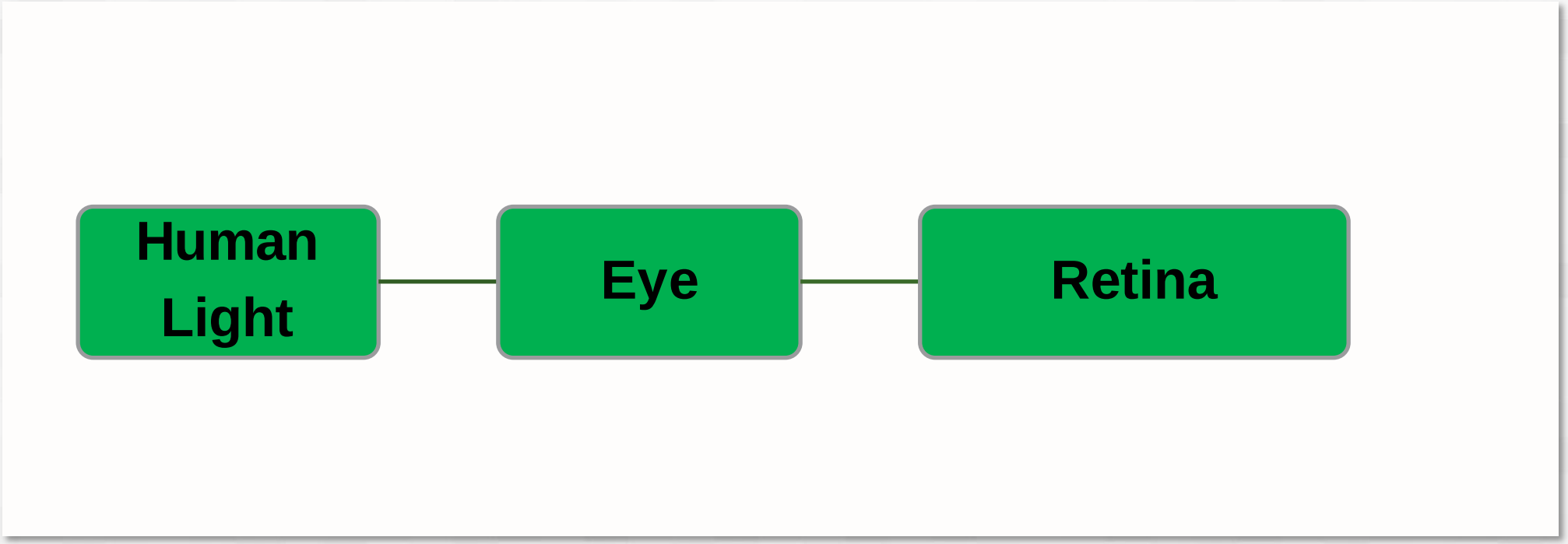
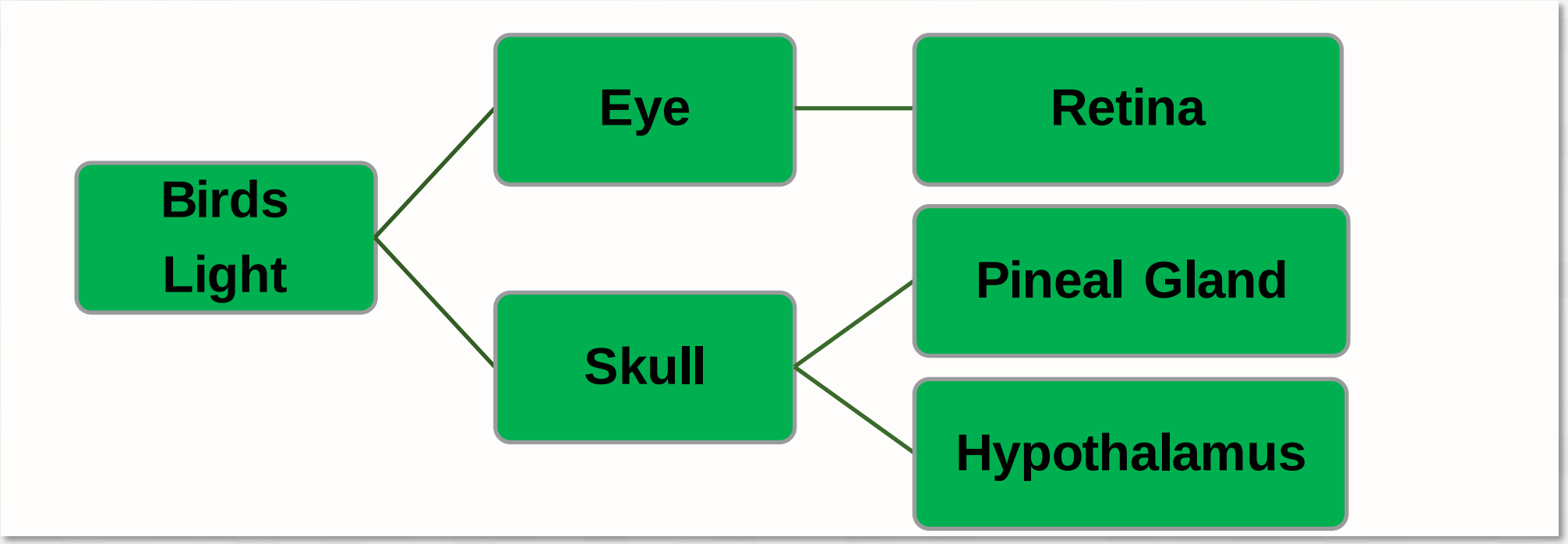
Background



Background



- Long wavelengths (e.g. red) able to penetrate cranial tissues more than short wavelengths (e.g. blue)
  (Pang et al., 1974, Prescott and Wathes, 1999)
- Path of light reception may result in different behaviours and physiological responses

Result of differences

- Birds see different light intensities than we do, especially under coloured lighting!
- LUX light measure – based on human visual ability
- Because birds see better than we do under some wavelengths, LUX is **inappropriate measure of intensity**
  a) Studies comparing wavelength, and measuring intensity via LUX, may be confounding the experimental treatments
     - Wavelength AND intensity
  b) CLUX (corrected lux, or chicken lux) appropriate comparison

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Research Objectives

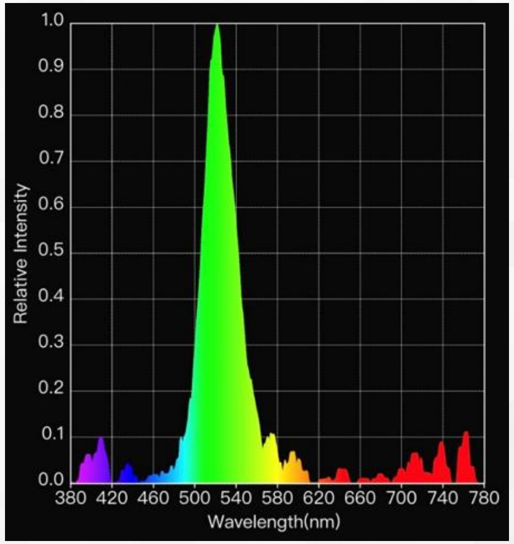
- **Determine effect of wavelength on the production/welfare of broilers**
  - **Blue [435-500nm]**
  - **Green [500-565nm]**
  - **White [400-780nm]**
- **Lighting created for us by Greengage Lighting**

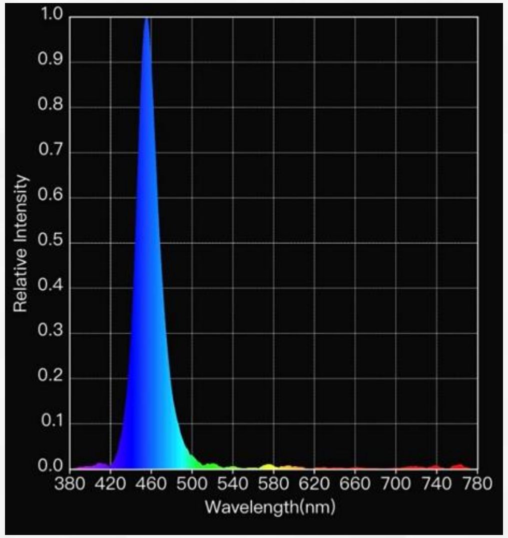
Experimental design

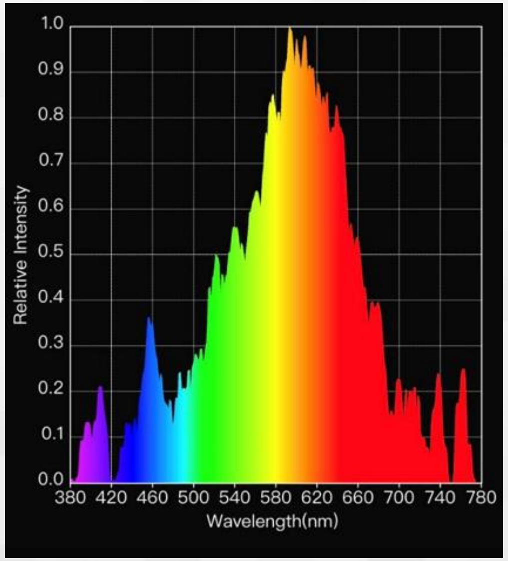
- Experiment was replicated twice
- 7,128 broilers per trial (total of 14,256)
- Treatments
  - 3 lighting wavelengths (colours)
  - 2 strains (Y-708 and E-708)
  - 2 genders
- 9 individually controlled rooms (3 rooms per wavelength)
- Rooms subdivided in 12 individual pens
- Stocking density - 31 kg/m^2

Lighting program

- Day 1 - 23L:1D; reduced gradually, day 5 - 16L:8D
- Light intensity (1-7 days):
    - Trial 1: 9.6 clux; trial 2: 14.3 clux (Hato® Gallilux Light Meter)
    - Equal between rooms/trial
- Light intensity on remaining weeks:
    - 9.6 clux
- Spectral outcome of lamps [Lighting Passport (Asensetek ®)]
- Dawn and dusk transitions (15 min)







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RESULTS: PRODUCTIVITY

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Body Weight (kg)

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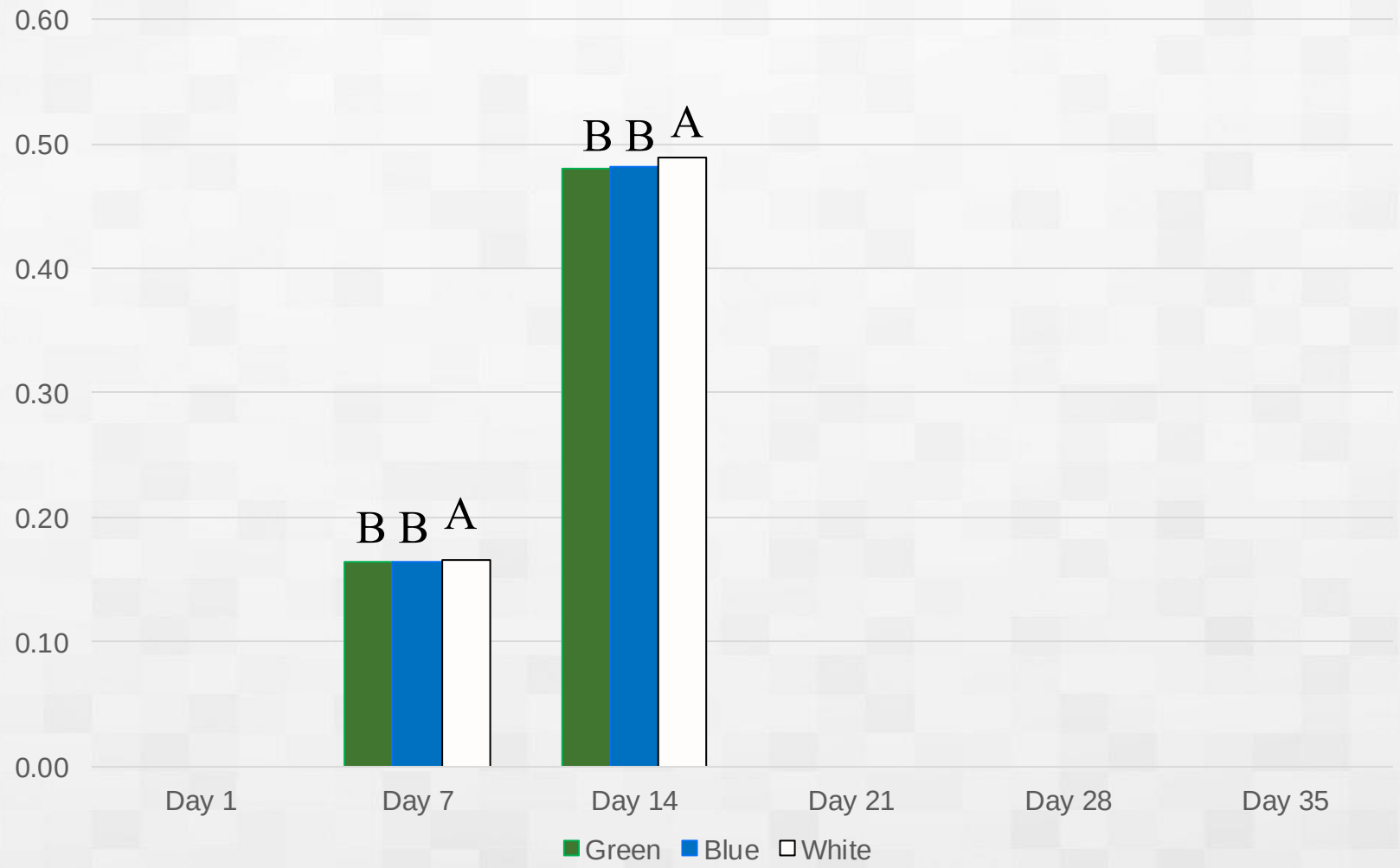
Body Weight (kg)



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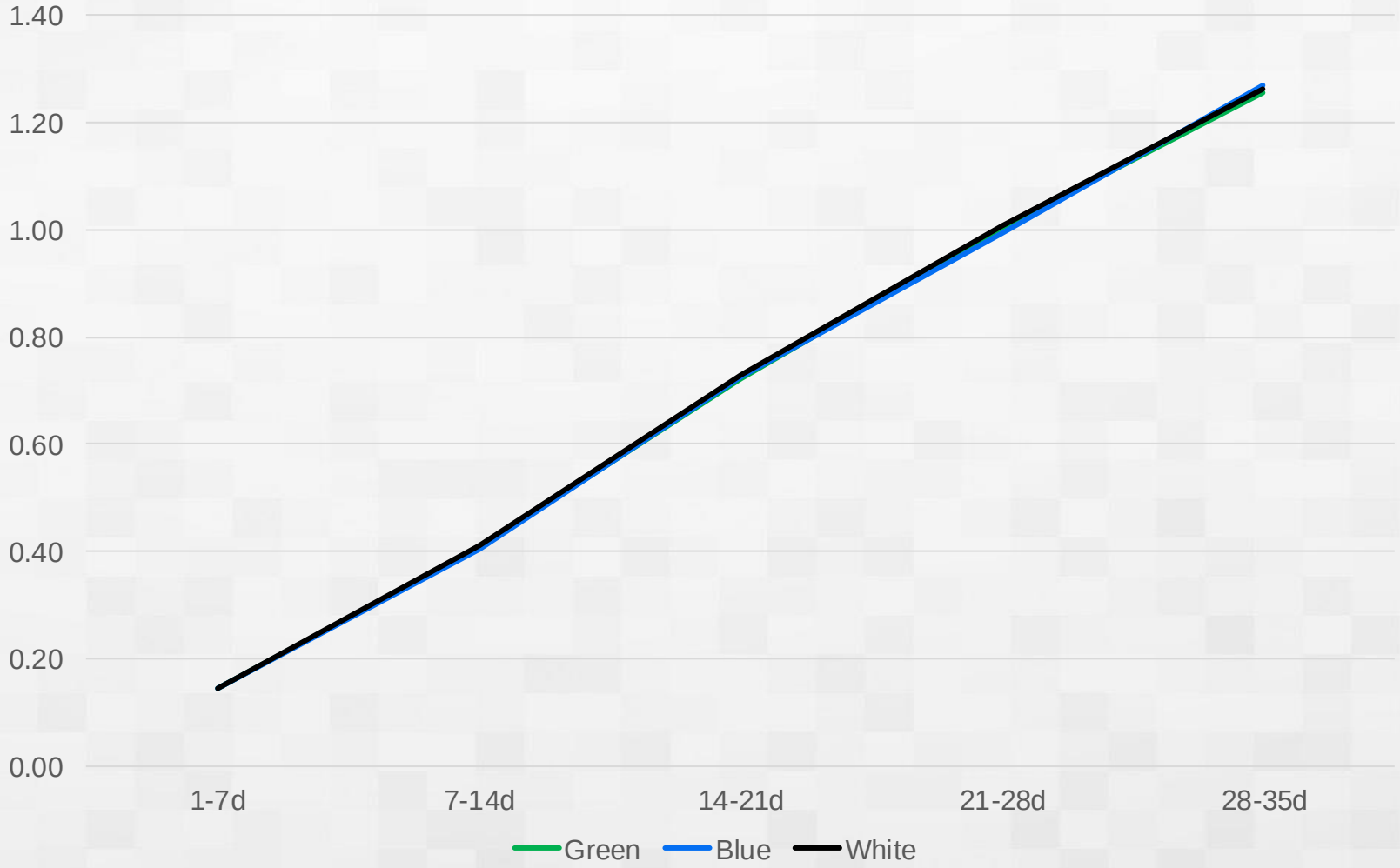
Feed intake (kg)



No effect of wavelength

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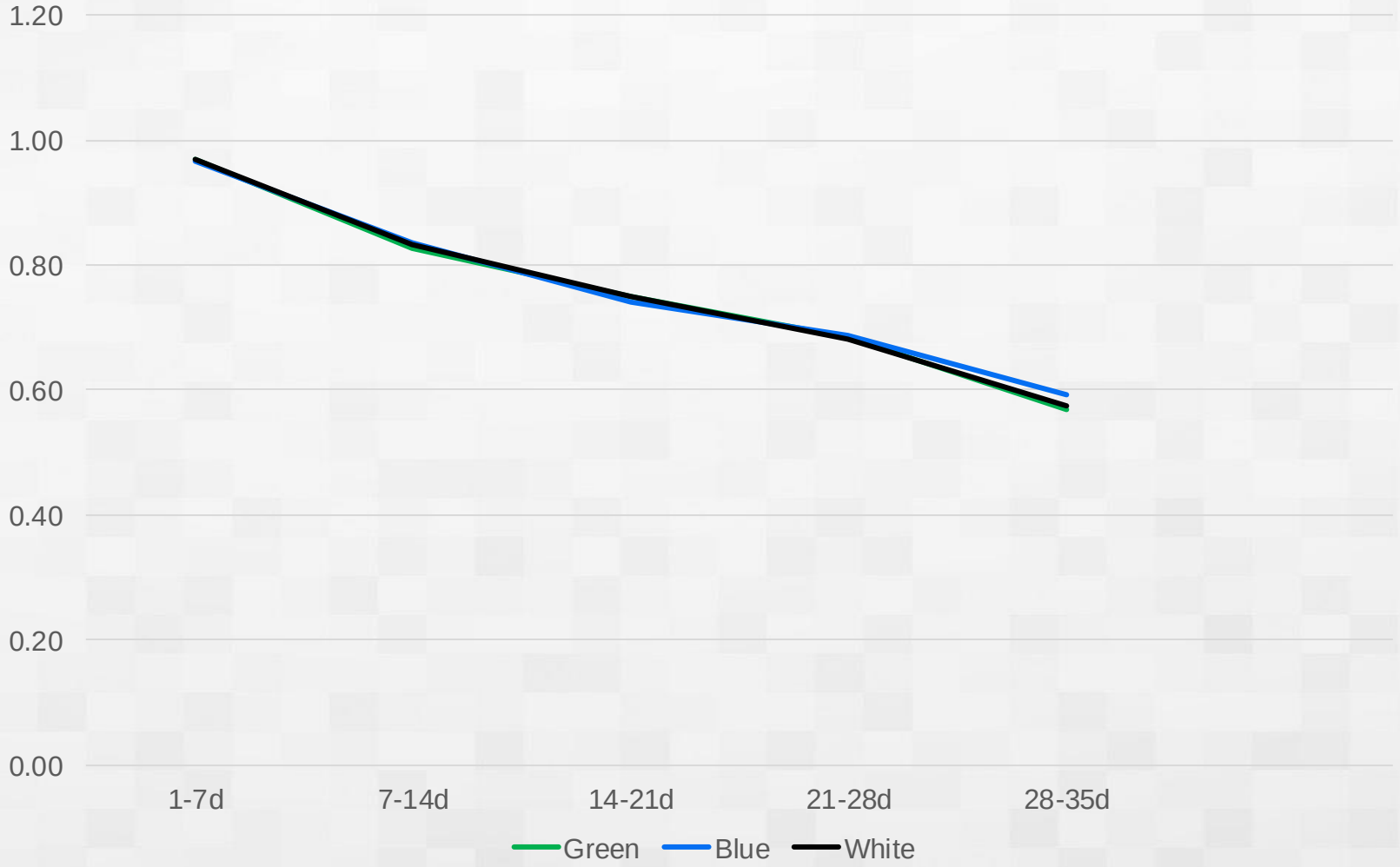
Gain to feed ratio



No effect of wavelength

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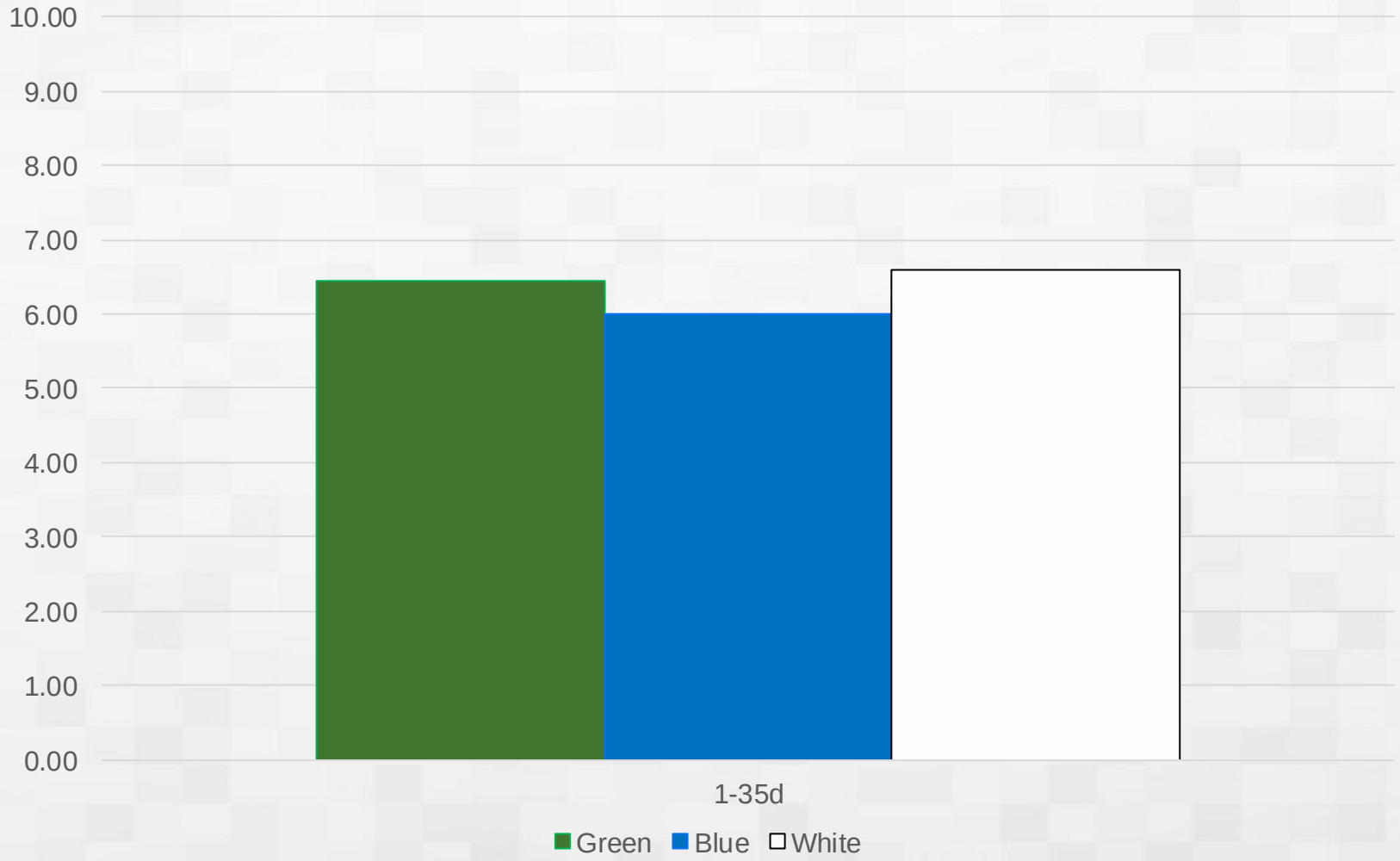
Mortality (percent of placed)



No effect of wavelength

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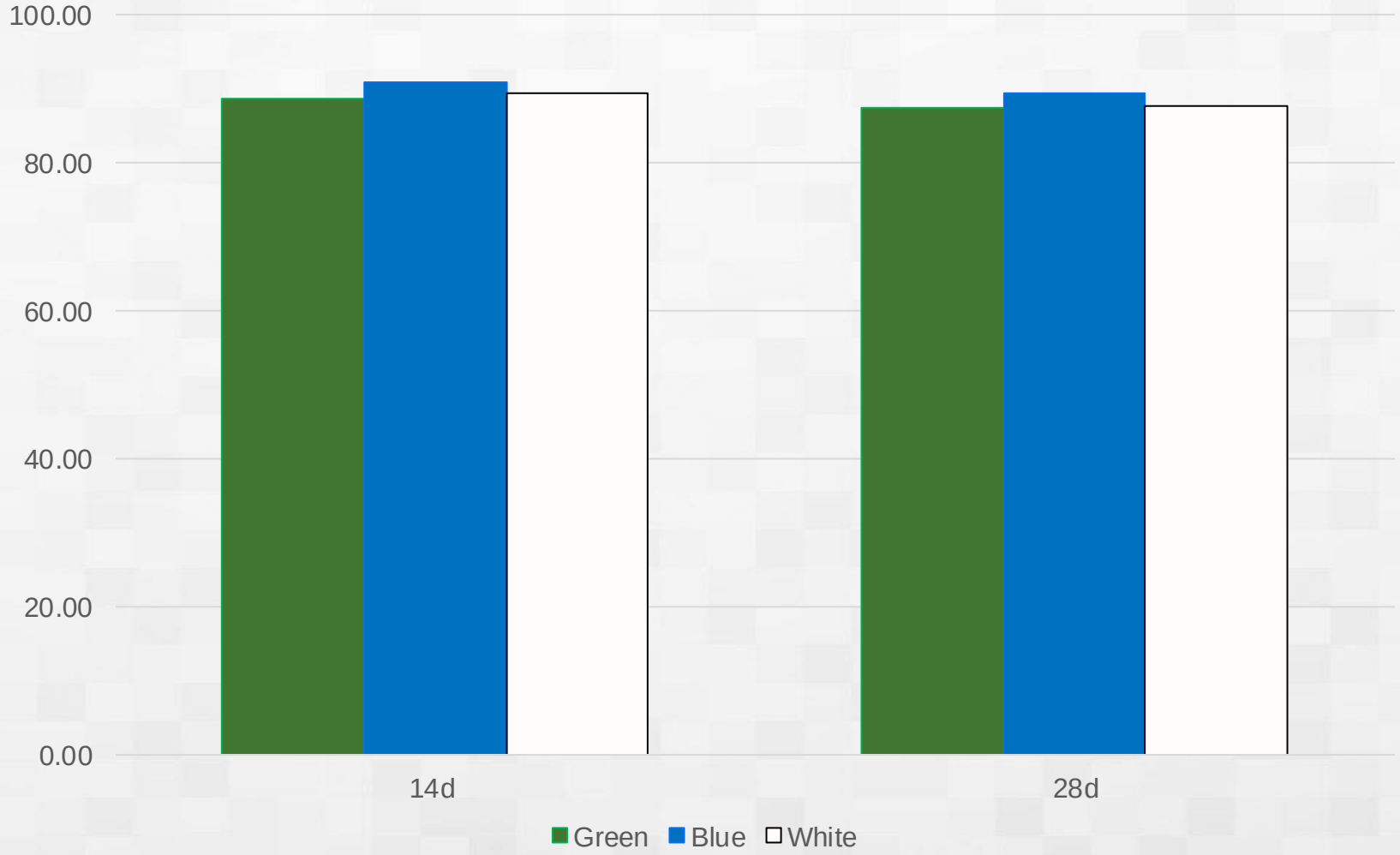
Flock uniformity (within 15% of average)



No effect of wavelength

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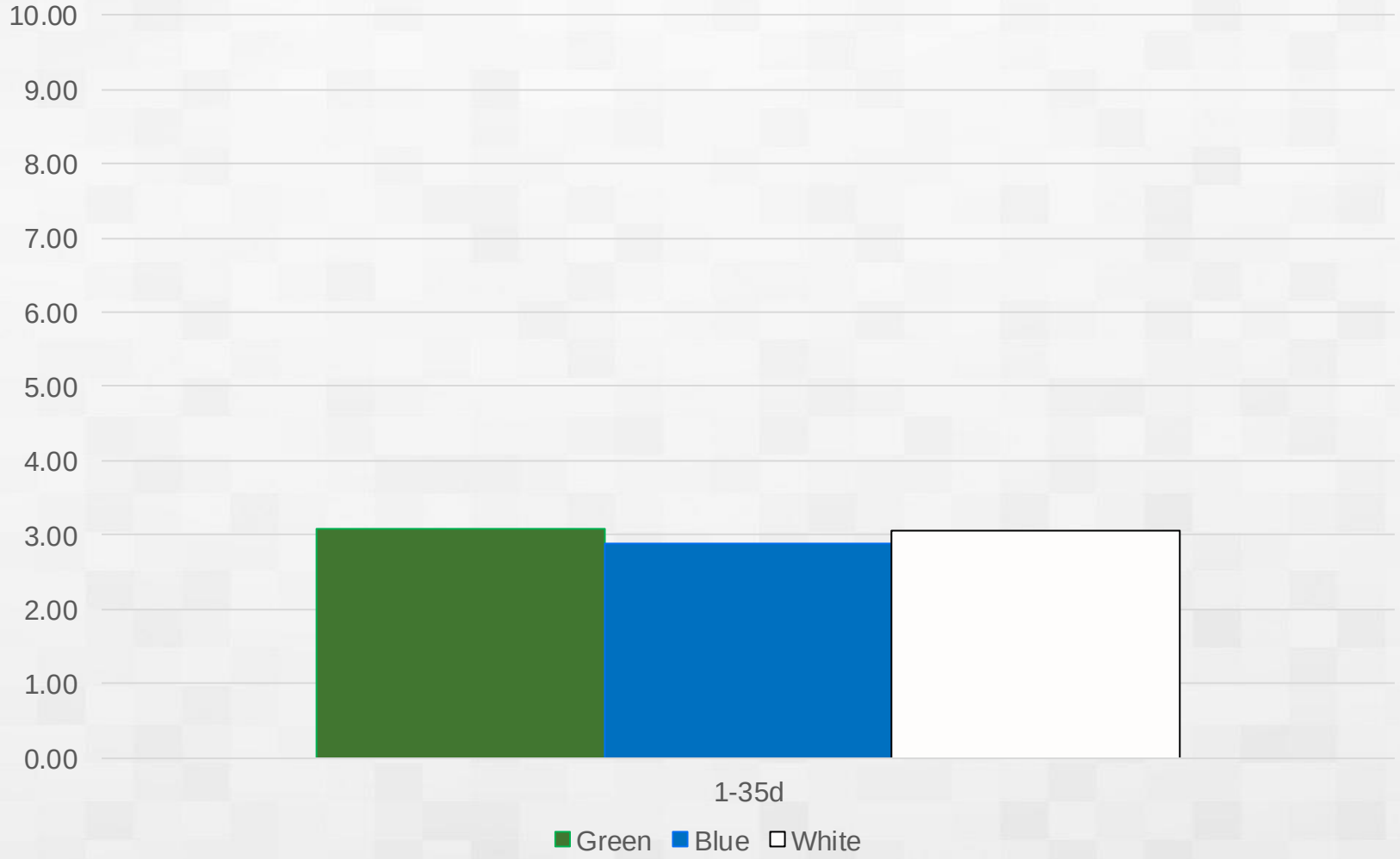
Scratches (percent of live birds tested)



No effect of wavelength

Summary – Production Data

- No effect of wavelength
  a) Growth rate
  b) Feed intake
  c) Feed efficiency
  d) Uniformity
  e) Mortality

Data collection

- ***Mobility***

  Birds were placed in an empty area and were individually encouraged to walk. The walking ability of birds was assessed in a score of 0 to 5 (Garner et al. (2002)).

- ***Footpad Dermatitis***

  Birds were assessed by the presence of hock burns with regard to the severity scale, scoring categories 0/1/2/3/4 (Welfare Quality ® Assessment (WQ) protocol for Poultry (2009)).

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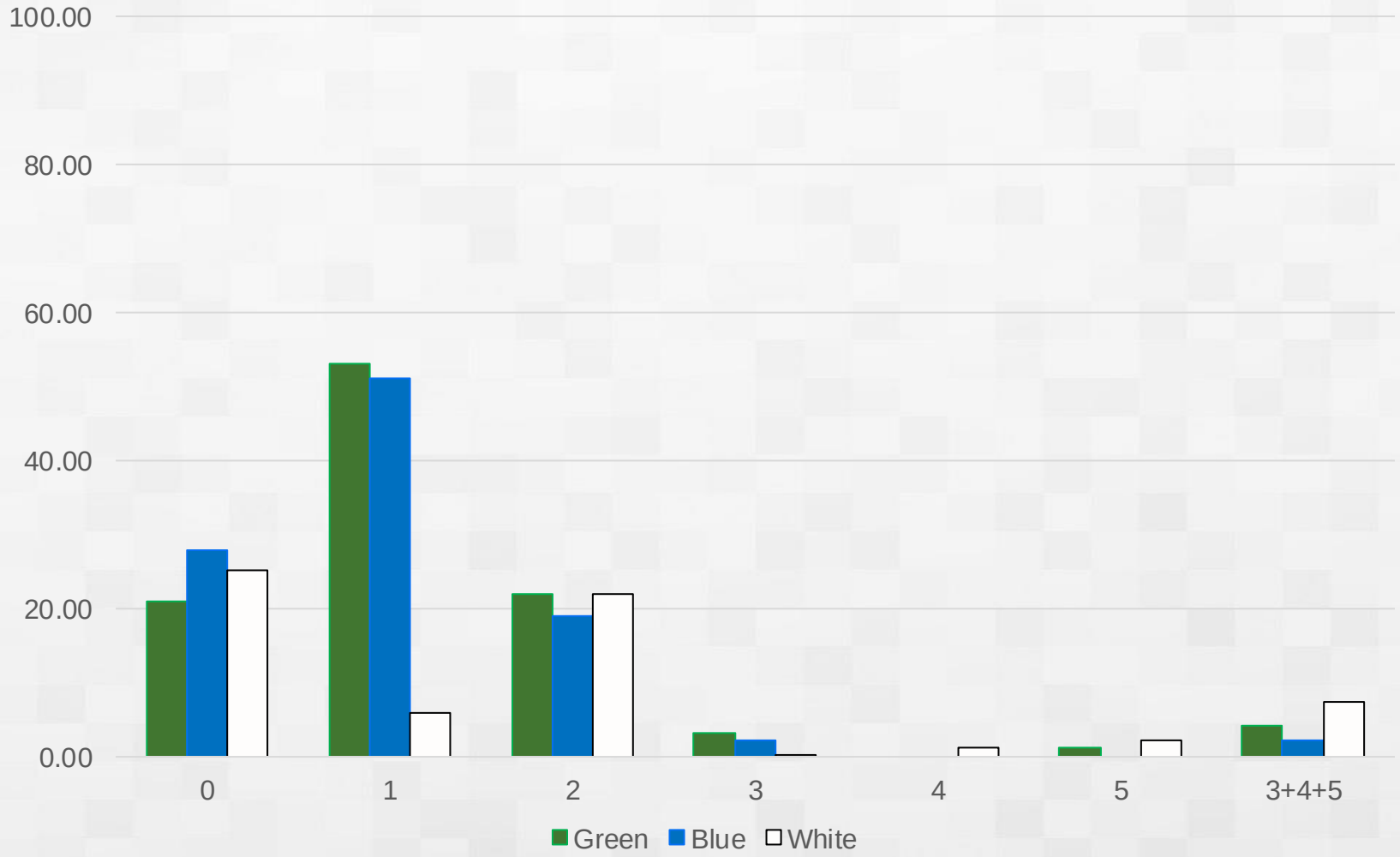
Gait score



No effect of wavelength

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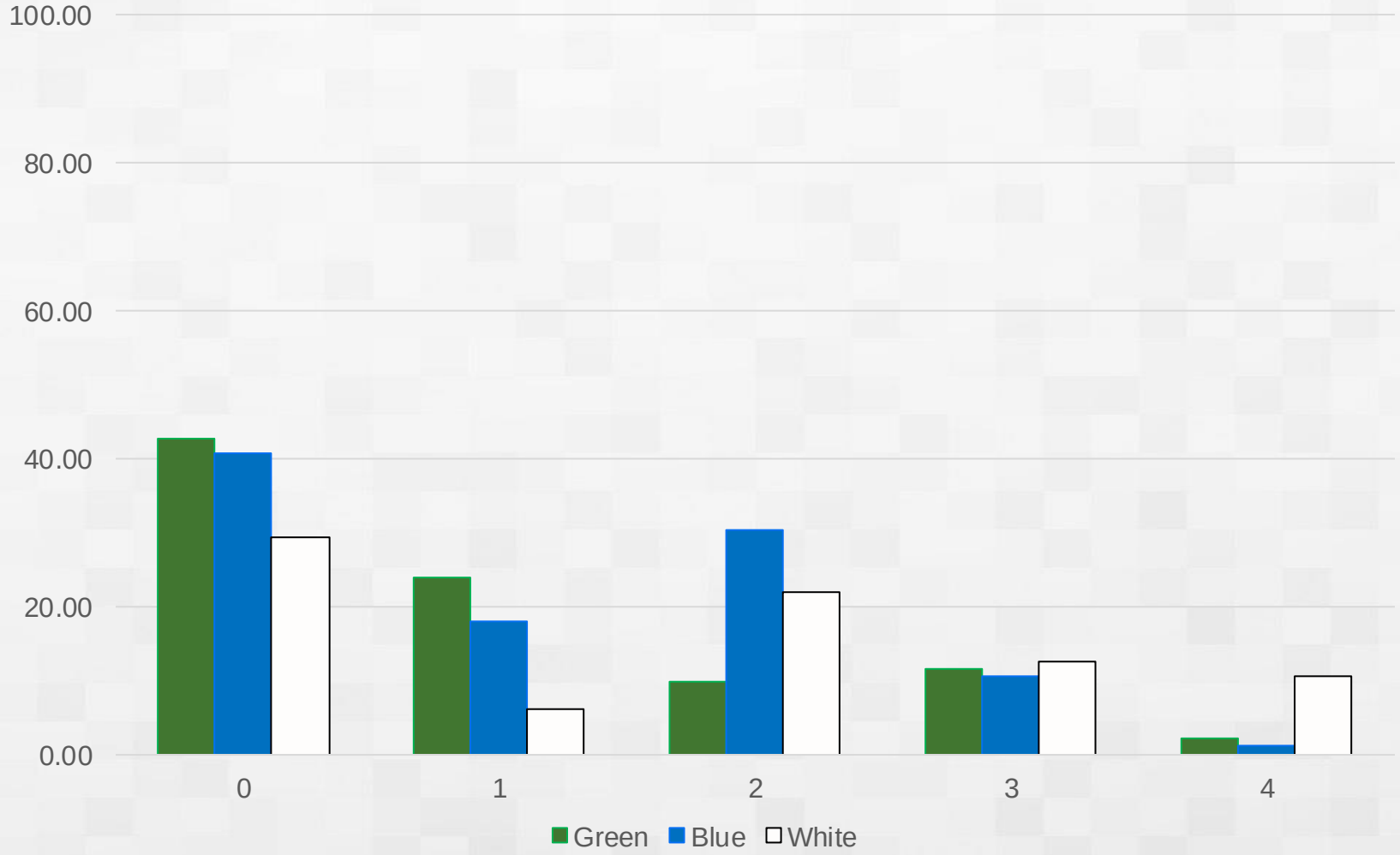
Foot pad dermatitis



No effect of wavelength

Summary – Lameness and Footpad Health Data

- No effect of wavelength
  a) Gait scores
  b) Lesion scores

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BEHAVIOUR (EXPRESSION, FEAR AND STRESS)

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Behavioural expression – 32 days of age

	Green	Blue	White	P value
Time at the feeder	7.20a	5.83b	4.91c	0.005

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Walking	3.41b	1.29c	8.15a	0.0001

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Walking No differences in gait score	3.41b	1.29c	8.15a	0.0001
Inactive No differences in gait score	75.65b	75.96a	72.81b	0.03
Dustbathing	0.18b	0.22b	0.32a	0.0001
Foraging	0.74b	1.22a	0.84b	0.0001

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Fear

- ***Tonic Immobility Test:***
  - Birds were placed on their back in a tonic immobility saddle and restrained for 15 seconds (Jones and Faure, 1981), latency to rise was measured
- ***Novel Object Test:***
  - Bright, multicolored, movable novel object was placed in the center of the pen, time monitored until 3 birds within the pen pecked the object (Hughes and Black, 2007)
- **R*esponse to Observer Test:***
  - Count the number of birds that move as a result of the passage of an observer (Schwean-Lardner et al., 2012)

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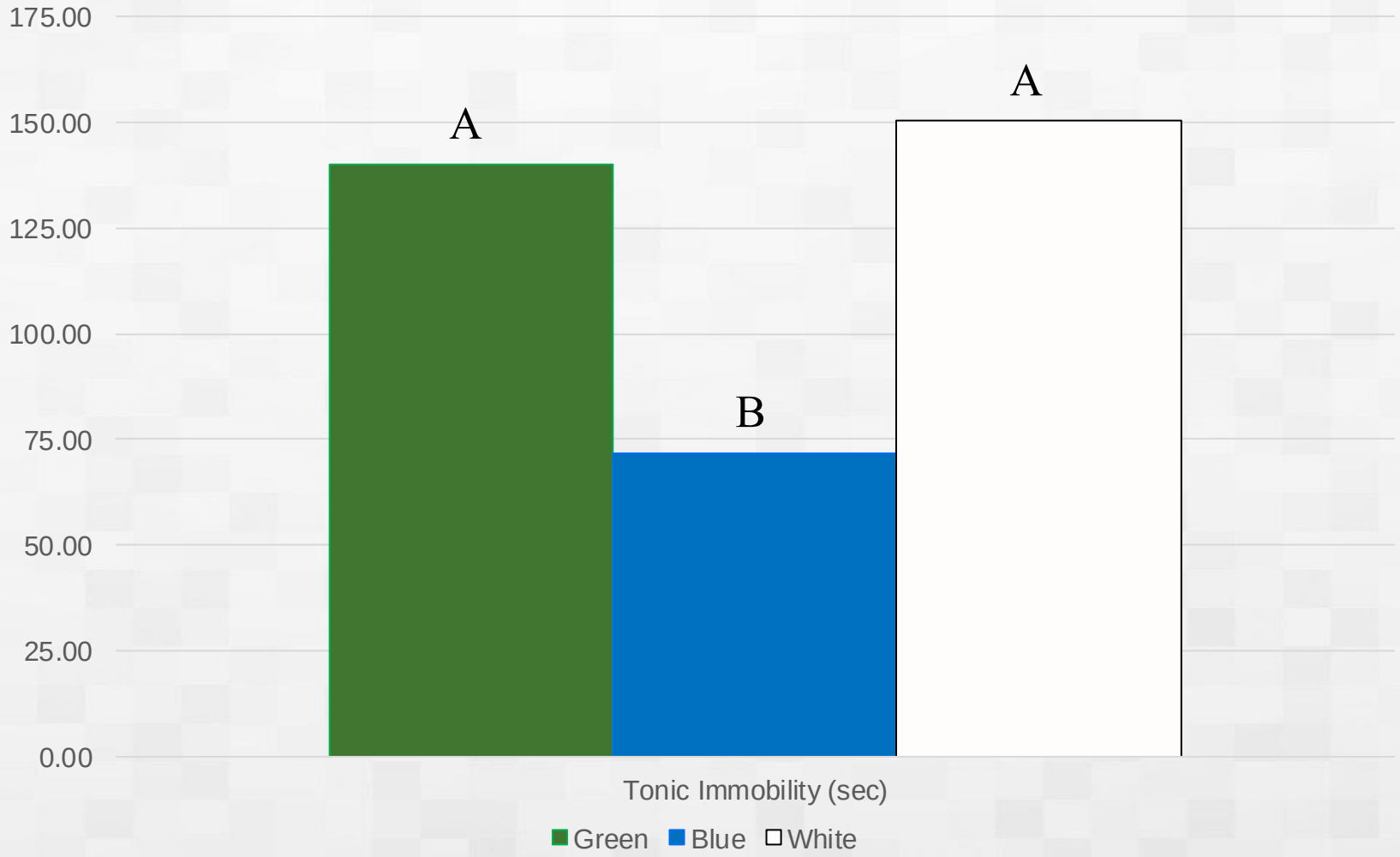
Fear



Longer tonic state correlates to higher fear levels

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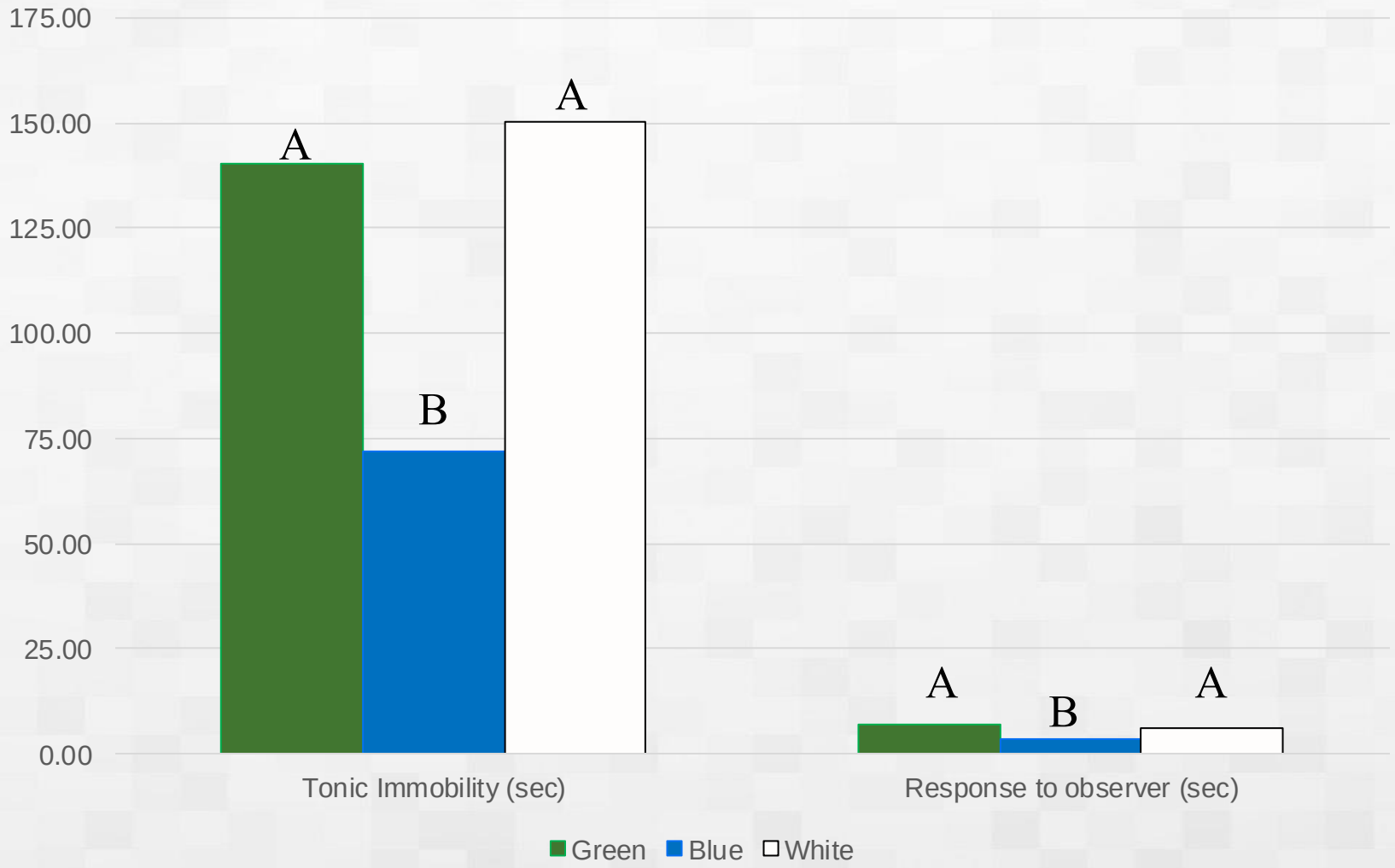
Fear



Higher percent movement away correlates to higher fear levels

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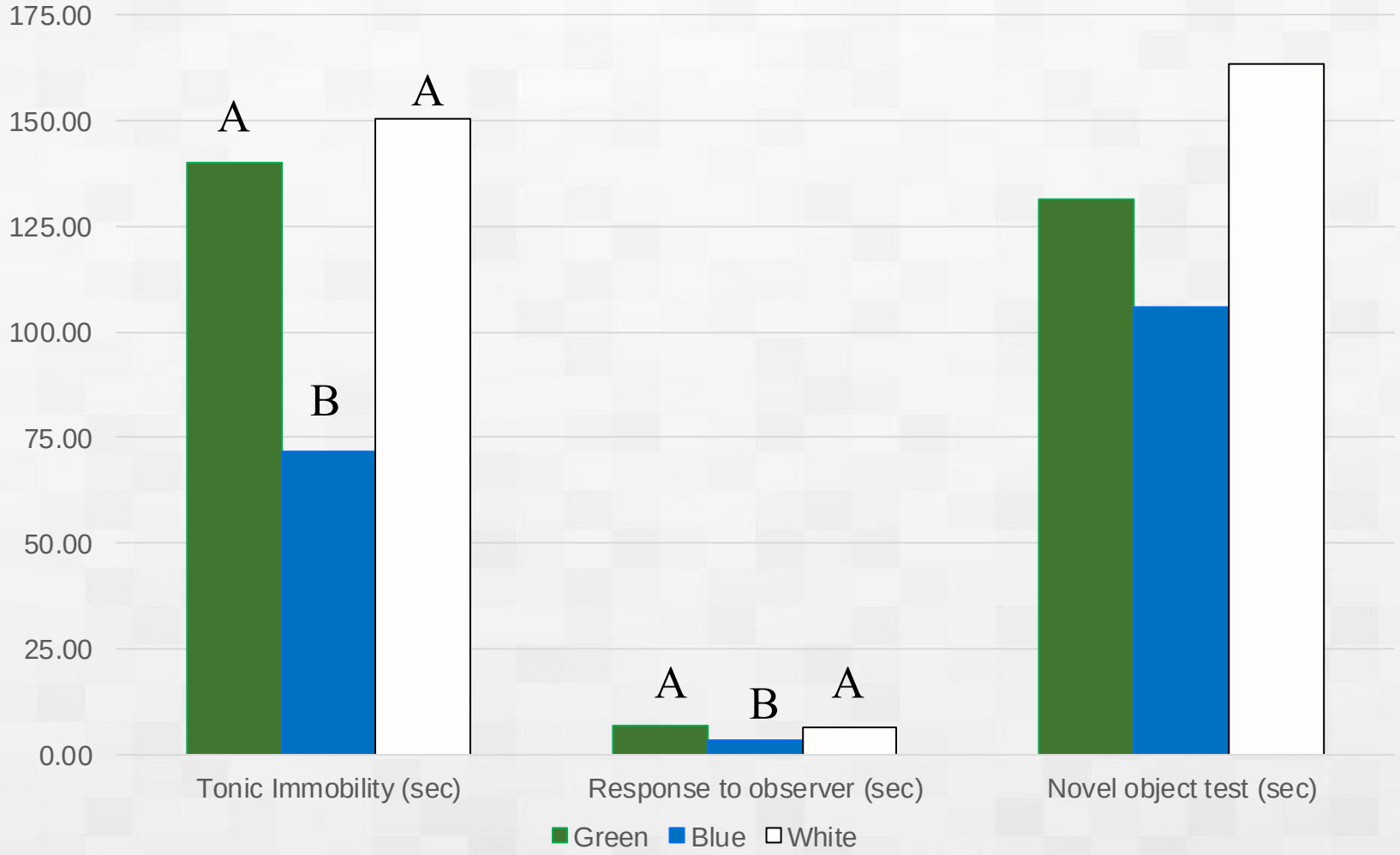
Fear



Longer approach time correlates to higher fear levels

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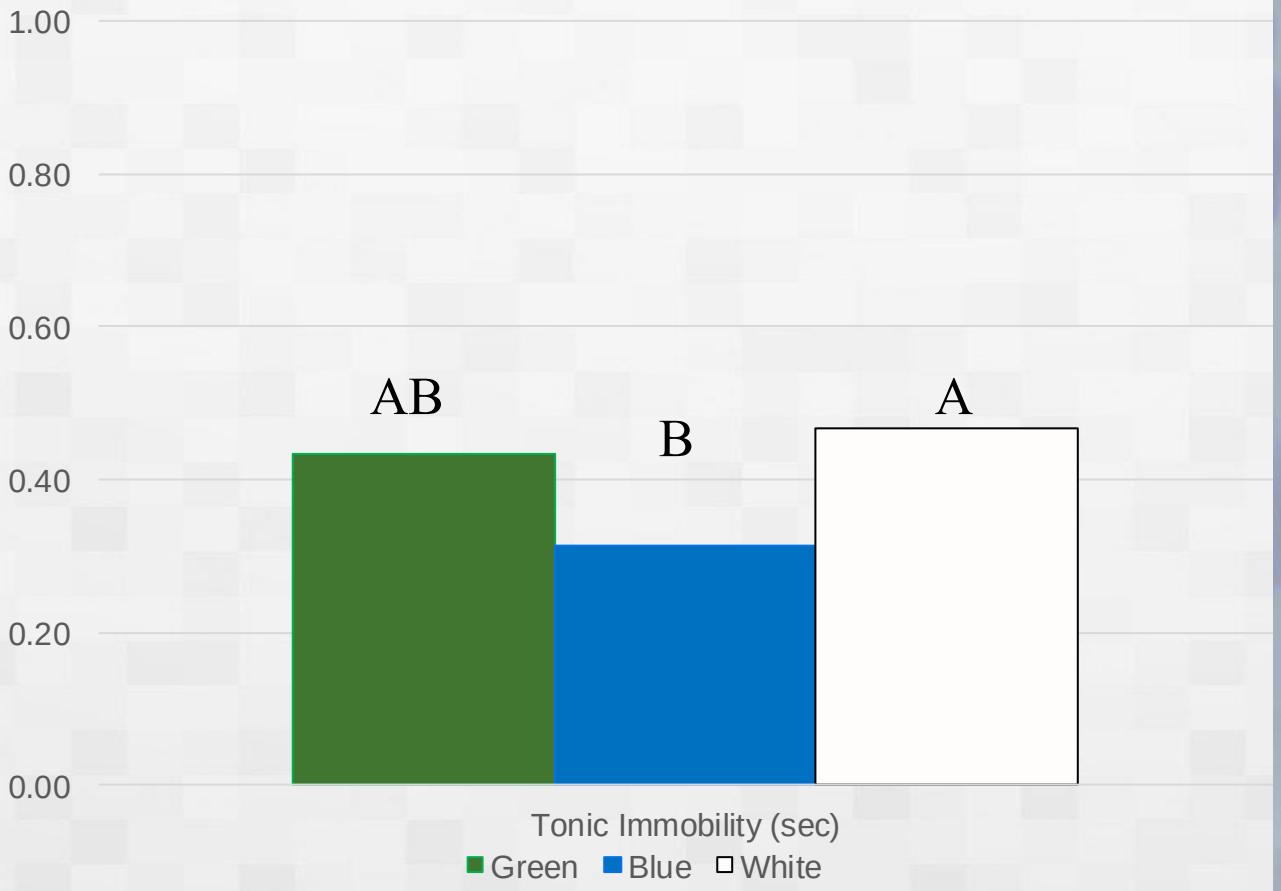
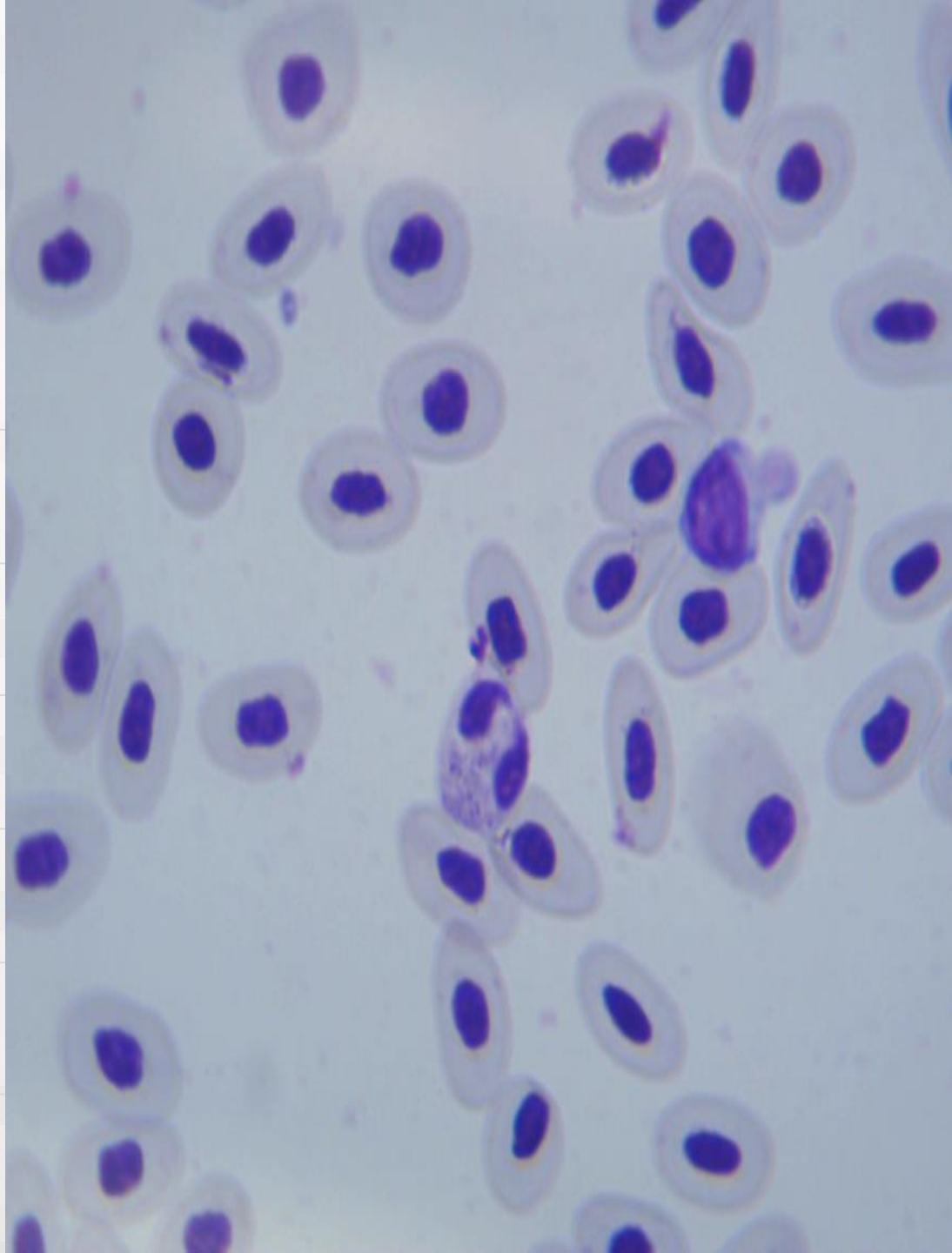
Stress

- *Heterophil to lymphocyte (H:L) ratio*



Higher ratio indicates higher stress



Summary - behaviour

- Some changes to activity patterns
  a) Blue light birds – less active
  b) White light birds – spend more time at the feeder
- Blue light birds
  a) Less fearful
  b) Less stressed

- ADDITIVITY OF STRESSORS!

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DOES BEHAVIOURAL CHANGES RELATE TO EYE HEALTH?

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Eye measurements

- Alteration in shape and size could influence vision functionality
- Birds were euthanized and eyes were enucleated
- Weights and dimensions were collected:
    - Corneal diameter, mediolateral diameter, dorsoventral diameter and anterioposterior size.

(Vermette et al., 2016)

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Results

Eye measurements

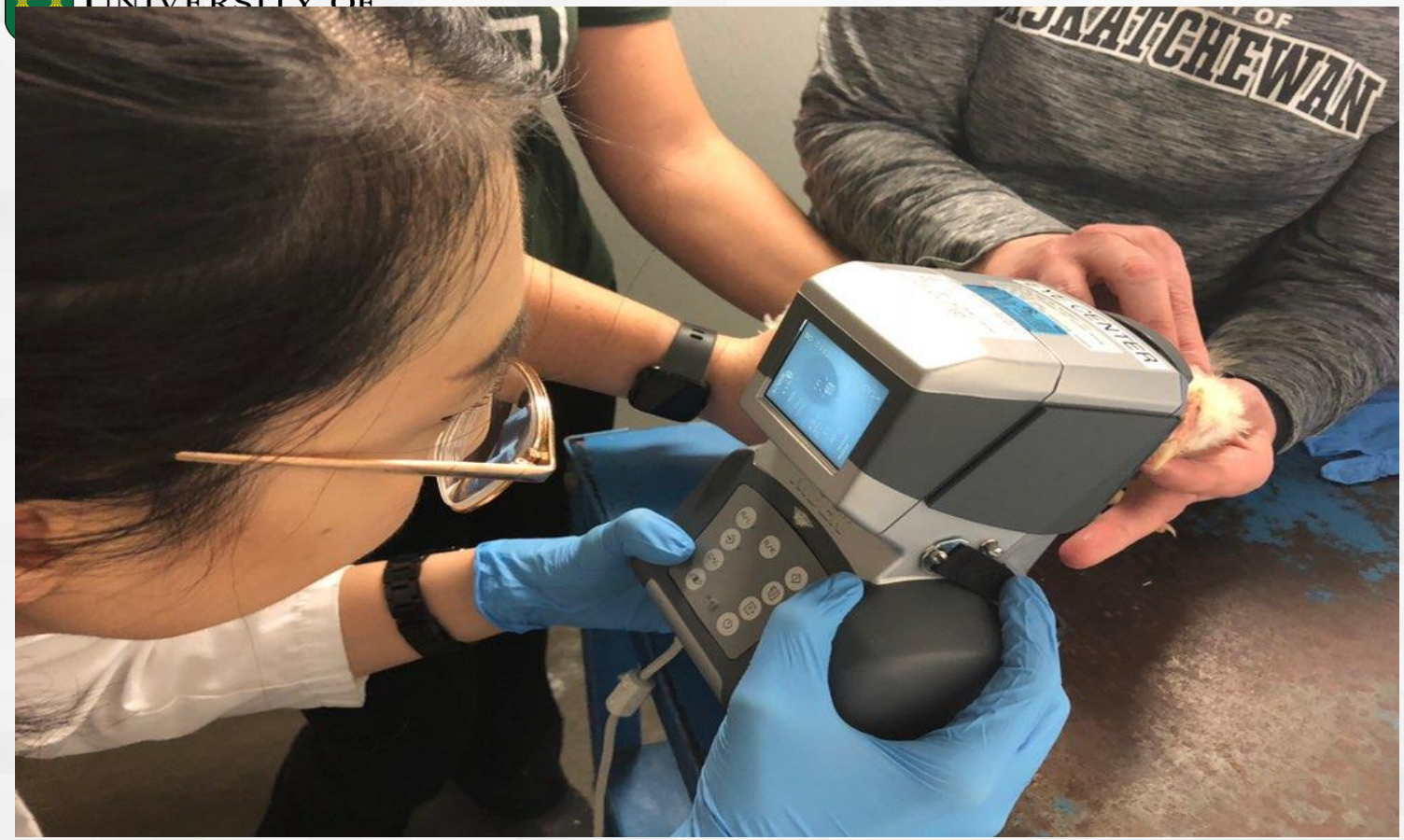
Table 2. Effect of different wavelength on left eye weight and dimensions at 17 days of age.

	Light				
Measure	Blue	Green	White	P-value	SEM
Eye wt. (g)	1.12	1.14	1.16	0.13	0.001
Eye wt./body wt. (%)	0.03	0.03	0.03	0.51	0.236
Corneal dia. (mm)	6.40	6.39	6.42	0.95	0.029
DV dia.[1] (mm)	13.94	14.06	14.19	0.22	0.073
ML dia.[2] (mm)	13.92	13.94	14.16	0.14	0.060
AP depth[3] (mm)	11.57	11.66	11.52	0.78	0.067

[1] Dorso-ventral (DV) diameter

[2] Medio-lateral (ML) diameter

[3] Anterior-posterior (AP) depth



- Assessment using an autorefractor *(Royal University Hospital, U of S)*
- Detects if eye properly focuses an image

Refraction Index

(Leis et al., 2017, Li et al., 2019)

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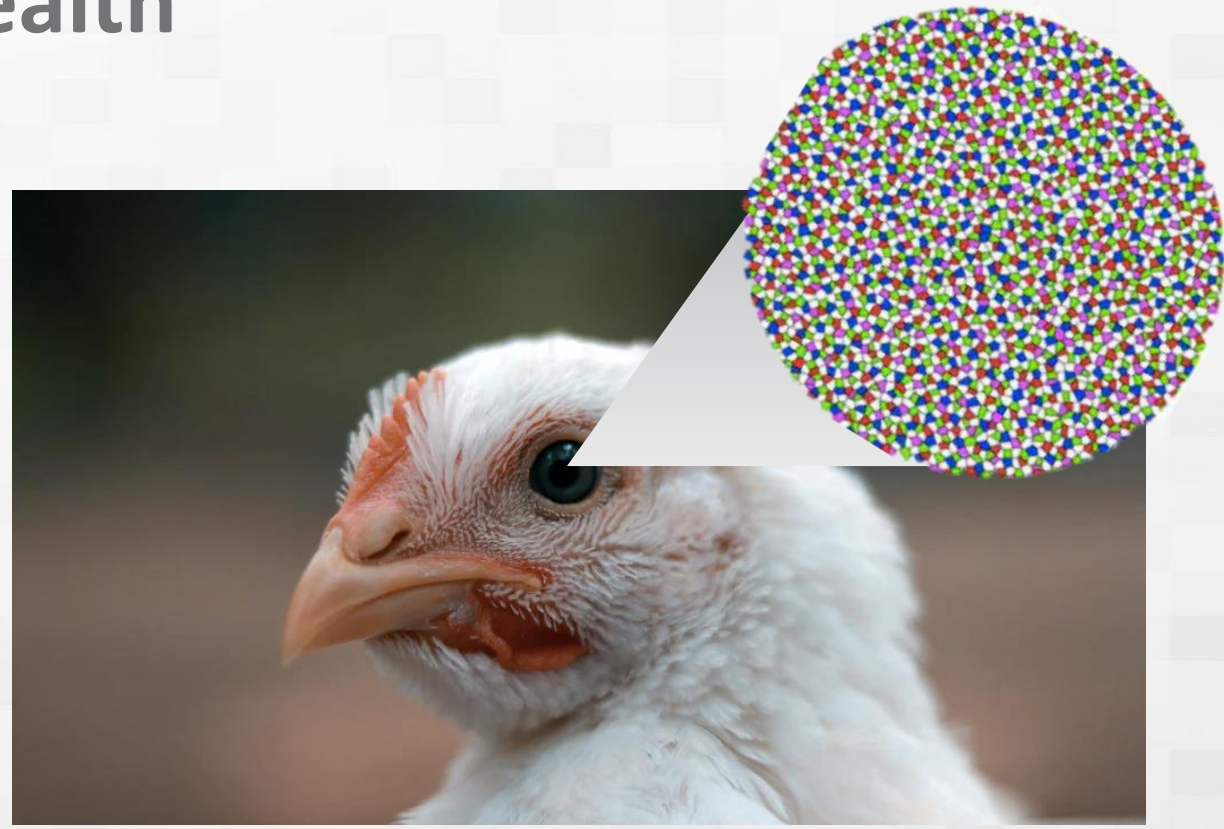
Results

Eye health

Table 1. The effect of different wavelength on intraocular pressure (mmHg) at 21 days of age.

	Light				
	Blue	Green	White	P-value	SEM
IOP	8.58	8.83	8.88	0.74	0.122

Chromatic PLR, slit-lamp and fundus assessment of birds did not reveal any abnormality



No effect of wavelength

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Results

Refraction index

Table 3. Effect of different wavelength on results from autorefractor assessment on broilers at 26 days of age.

	Light				
	Blue	Green	White	P-value	SEM
Sphere	0.625[a]	0.083[ab]	-0.020[b]	0.01	0.1032
Cylinder	0.604	0.458	0.667	0.62	0.0651
Axis	121.58	114.50	117.83	0.91	6.8692

[a, b] Means with common letters do not differ significantly (P≤0.05)

Spatial Vision

- Birds under BL or WL went under a grating acuity test at 3 different distances: 50, 75 and 100 cm
- Determine if birds were able to discriminate details of the visual scene

(DeMello et al., 1992, Bittner, 2012)

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Results

Spatial vision

Table 4. The effect of wavelength on visual acuity of broiler chickens at 29 days of age

	50 cm			75 cm			100 cm		
	Blue	White	P-value	Blue	White	P-value	Blue	White	P-value
Average time to approach (sec)	8.6[b]	15.8[a]	0.03	5.9[b]	27.1[a]	0.006	11.7	13.2	0.42
Success rate (%)	91.7	91.7	1.0	91.7	66.7	0.16	91.7[a]	50.0[b]	0.03

[a, b] Means with common letters do not differ significantly (P≤0.05)

Conclusions

- Our results (ensuring light intensity is the same across treatments) indicate that
  a) Utilizing monochromatic light for broiler production does not improve growth rate, feed efficiency, or flock uniformity in a well-managed flock
  b) Mortality levels do not differ under different light wavelengths
  c) Ability to see may differ slightly!
  d) Behavioural expression changes a bit – birds are less active under blue compared to white light
  e) Fear and stress levels are much lower under blue light!

Should you switch?

- Lowering fear and stress improves bird welfare
  a) Additivity of stressors?
  b) If birds are not growing to potential, changing to blue/green may improve productivity
- Work environment?

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