Understanding Laying Hen Management

Animal Science 471 – Fall 2021

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Teaching Assistant: Thiago L. Noetzold

Introduction – Investigating Precision Feeding Pullet Rearing Strategies for Optimal Reproductive Body Composition

- Research conducted by Dr. Martin Zuidhof and Thiago Noetzold
  - Research Technician: Kim Thorsteinson
- Performed at the Poultry Research Centre, University of Alberta
- Student Involvement:
  - AN SC 471: Applied Poultry Science
  - Assisted with data collection
  - Performed statistical analysis on collected data to compare dietary energy level and feed restriction on various body composition and reproductive traits

Background

- Problem Statement: How can we improve layer management
- Feed Restriction
  - Management practice used during the bird's rapid growth phase
  - Goal is to maximize growth and subsequently production
  - Feed restriction common practice in broiler & broiler breeder industry to limit rapid growth rate (Straková *et al.*, 2006)
- Dietary Energy
  - Different levels of energy for different ages and situations
  - Current relevance with rising feed ingredient prices
- Photostimulation
  - Typically, around 20-22 weeks, occurred at 18 weeks for experiment
  - Birds must be sexually mature (Lei *et al.*, 2020)
  - Must be mature for photosensitive cells in the brain to be stimulated (Mobarkey *et al.*, 2010)

Why is it important?

- Deepens our understanding of laying hen production
- Our results could be used to improve the industry – lower production costs, increase efficiency, increase product yield, and profitability
- Feed is the largest production cost – important to understand to try to decrease feed costs
- Hands on experience for students
- Allowed students to expand their knowledge

Objective

- Research
  - Factors affecting metabolizable energy **(ME)** and physiological states of hens
  - Overall efficiency and productivity
- Students
  - Gained hands-on skills

Hypotheses

- Would reproductive efficiency and body composition be affected by the metabolic energy or feed allocation of the diet?
- Would body composition benchmarks such as lean tissue and fat level be associated with reproductive efficiency?
- If given a choice, would the birds in the choice group choose and have a preference to feed?
- Would birds from the choice group have superior reproductive efficiency compared to the other groups of birds?

Materials and Methods – Experimental Design

- Feed Allocation
    1. Ad libitum
    2. Feed Restricted
- Dietary Treatments within the Feed Restricted
    1. Low ME – 2,600 kcal/kg
    2. Standard ME – 2,800 kcal/kg (Control)
    3. High ME – 3,000 kcal/kg
    4. Choice – Able to choose between low, standard, high ME.
- Dietary treatments only during rearing phase and 5% into production.
- Trial Length – Data used till 23 weeks of age. Trial will continue to 90 weeks of age.

Materials and Methods

- Animals (Experimental Units)
  - Lohman Brown-Lite
    - Multi-Feeding System – 184 birds
    - Conventional System – 312 birds
- Housing
  - Location: Poultry Research Centre, Edmonton
  - Litter: Untreated pine shavings
  - Equipment: Precision feeding system, Mechanical Nest Box, Bell Drinkers
- Feed & Water
  - Mash diet – Formulated based on breed guidelines
  - Water provided ad libitum

Materials and Methods

- Equipment
  - Conventional Feeding
    - Representative of industry feeding
  - Precision Feeding System
    - RFID identification
    - Programmable Software
    - Feeding Chamber
    - Weighing Scales
  - Mechanical Nest Box
    - RFID identification
    - Weighing Scales

Precision Feeder

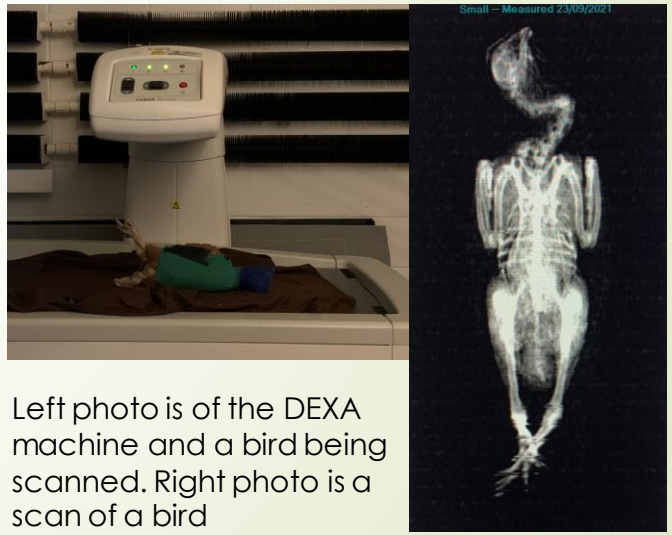
Conventional Feeder

Mechanical Nest Box

Materials and methods

- Data collection techniques
  - Dual Energy X-Ray Absorptiometry (DEXA)
    - Collects information on body composition
  - Specific Gravity test for egg quality
  - Tissue sampling and carcass composition analysis using wet lab chemistry
  - Behavioural observations

Photos of birds after dissection being prepared for wet lab analysis

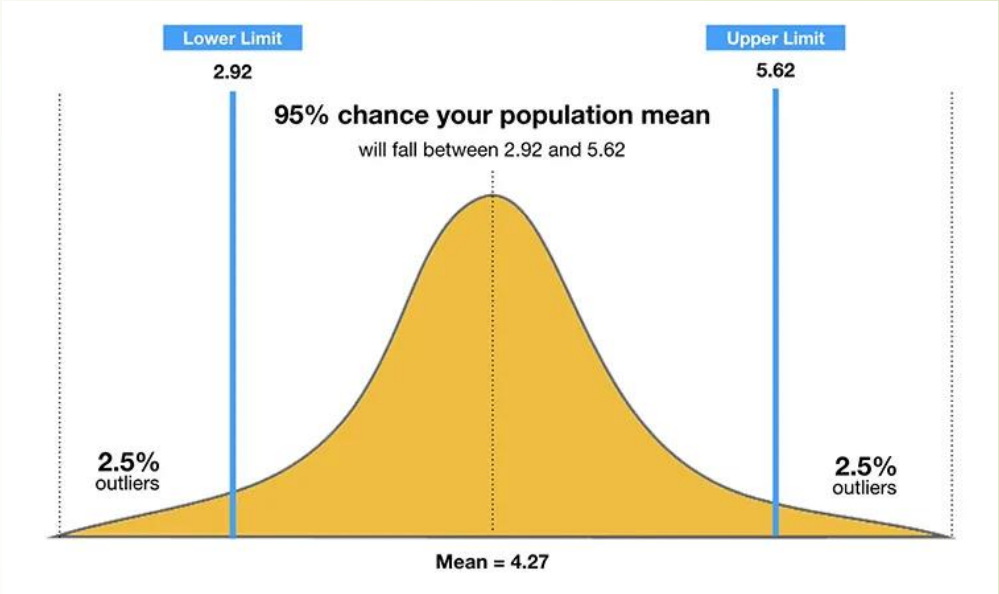


Left photo is of the DEXA machine and a bird being scanned. Right photo is a scan of a bird

Calista Laycraft

Statistical Analysis

- Done utilizing Excel
- H_0 - null hypothesis
  - No difference between treatments
- P-value= 0.05
- ANOVA
  - Determines if there is difference between any of the tested treatments
- T-test
  - Conducted if p- value from ANOVA <0.05
  - Tests differences between 2 individual treatments



P<0.05	P > 0.05
Reject H_0	Accept H_0
significant difference	insignificant difference

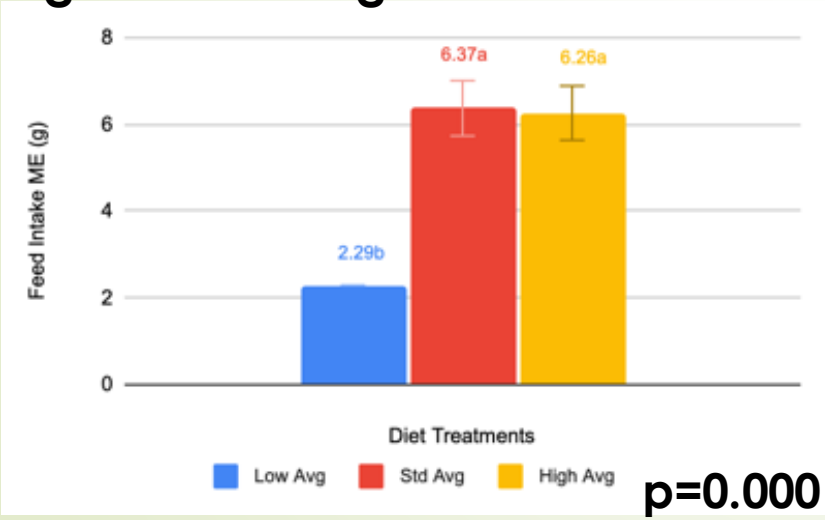
https://www.simplypsychology.org/confidence-interval.html

Results and Discussion

Impact of Feeding Program on Metabolizable Energy **(ME)** Intake: Results

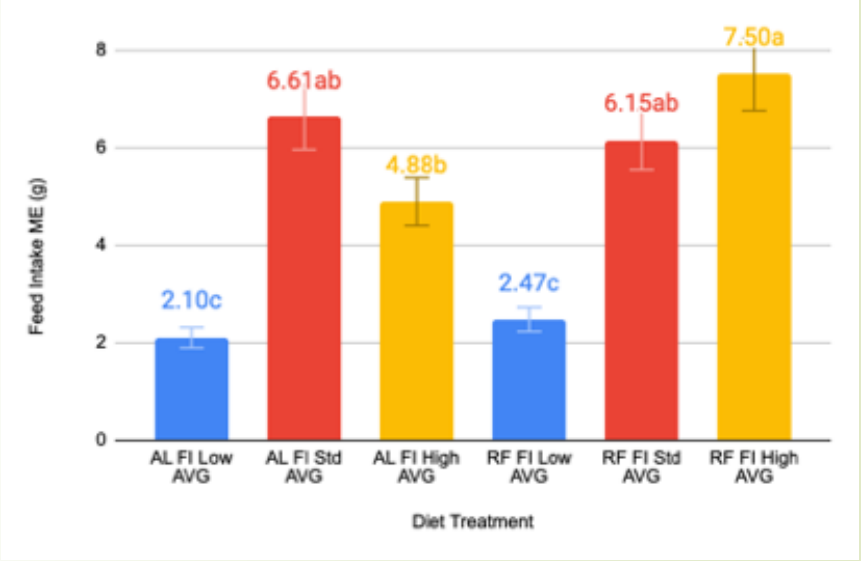
- Significant difference seen for High ME intake.
- Reject the null hypothesis

Figure 1: Average feed intake



p=0.000

Figure 2:Ad lib vs. Feed restricted



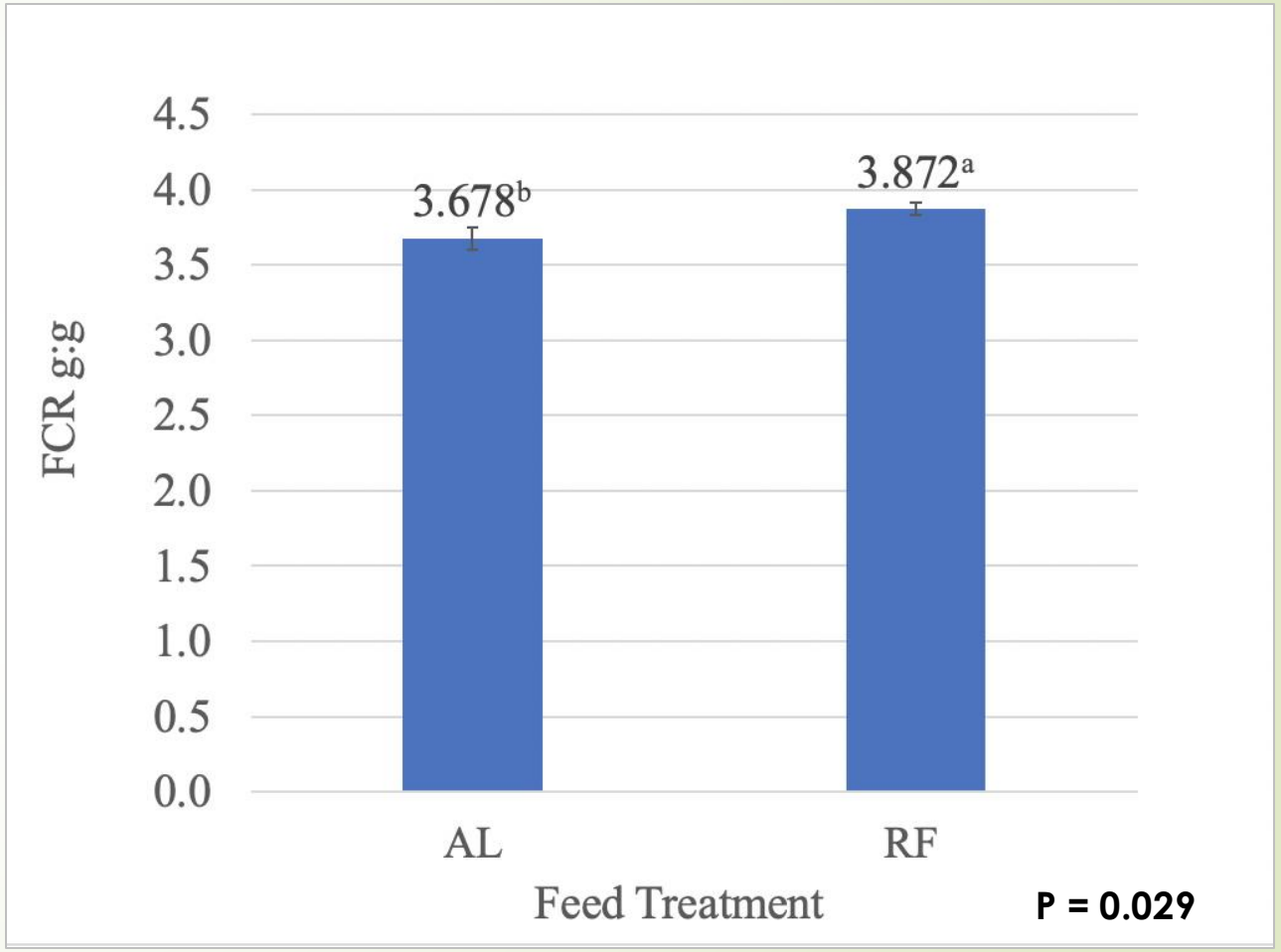
(High ME)p=0.047
(Low ME)p=0.596
(Std ME)p=0.703

Impact of Feeding Program on Metabolizable Energy (ME) Intake: Discussion

- Single-factor ANOVA results were significant ($p<0.05$)
  - Previous studies conducted showed that most poultry nutritionists favor the opinion that an animal could count its metabolizable energy calorie intake and will adjust its feed intake to accomplish this (Latshaw, 2008).
- Future research looking at the difference in feed intake related to different feed formulations.

Impact of Feeding Programs on Efficiency (FCR): Results

- Average Feed Conversion Ratio **(FCR)** during the rearing period (week 0 – 18)
- Significant difference between treatment groups
- **Feed restriction lowered efficiency and resulted in a 5.27% higher FCR than AL**



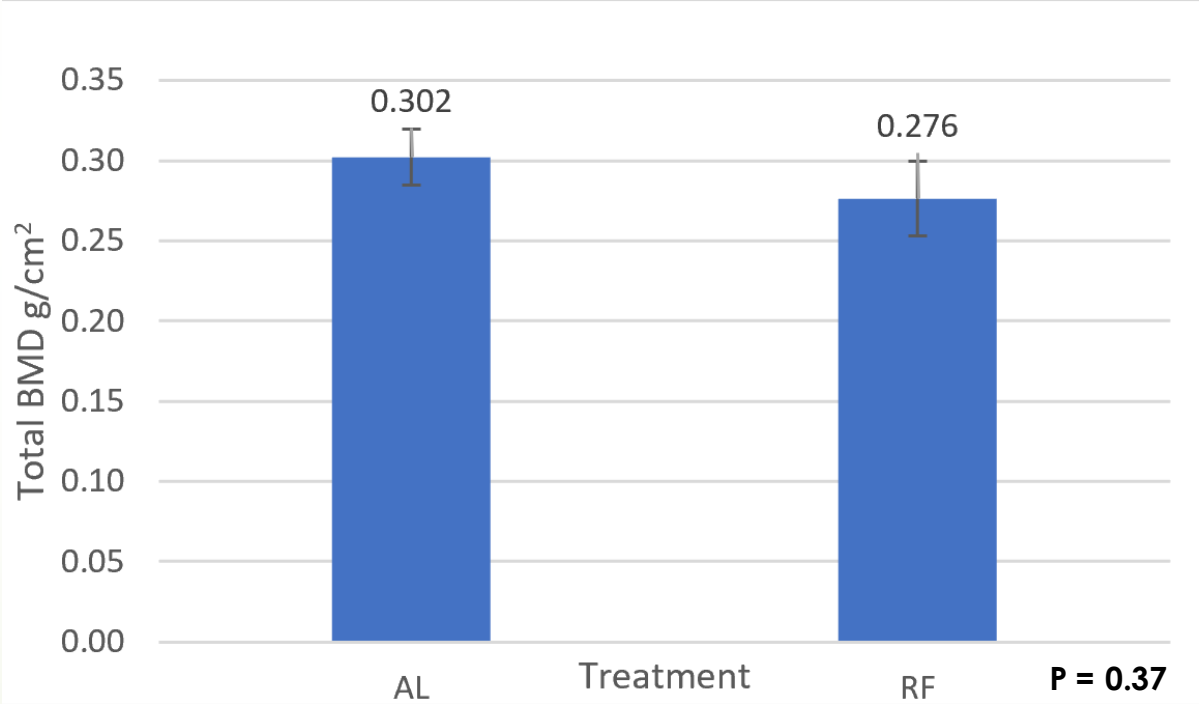
Emily Pichlyk

Impact of Feeding Programs on Efficiency (FCR): Discussion

- Reject null hypothesis (P= 0.029)
- Feed restriction showed a higher FCR (lower efficiency) compared to AL
- Sarica et al. (2009) found that ad-libitum fed layers consistently showed lower FCR in the rearing period than feed restricted birds
- Feed is the largest production cost
- FCR is important to try to minimize, as it leads to more efficient utilization of feed resources, greater output and higher profits, and reduced environmental impact

Feeding Program-Bone Mineral Density: Results

- BMD was measured during weeks 4-21
- No statistically significant difference between feeding methods

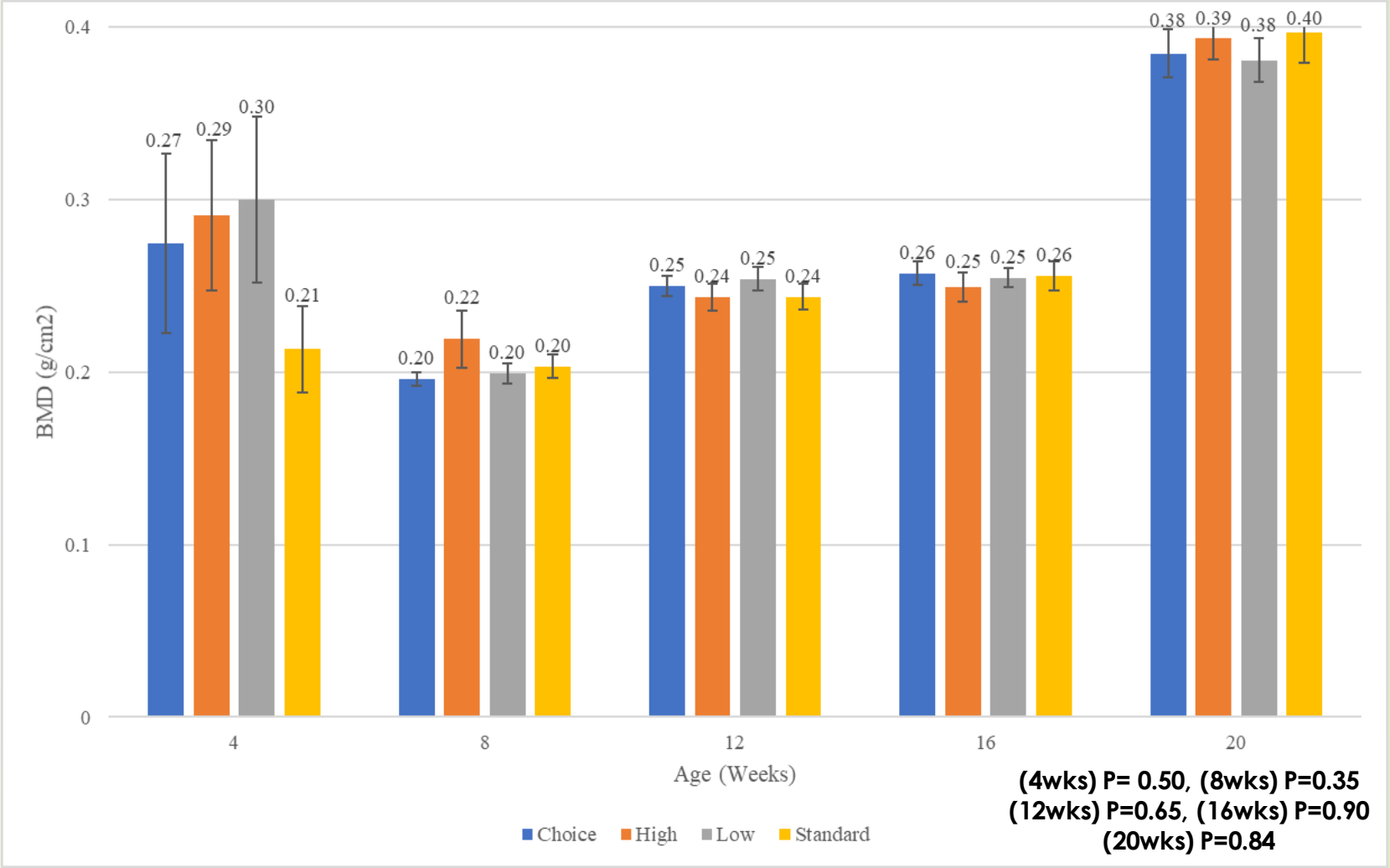


Calista Laycraft, Cole Schwengler

Dietary Energy Level & Bone Mineral Density

Results:

- Analyzed from 4 week of age to 20 weeks in 4-week intervals
- No significant difference found between treatment for any age group



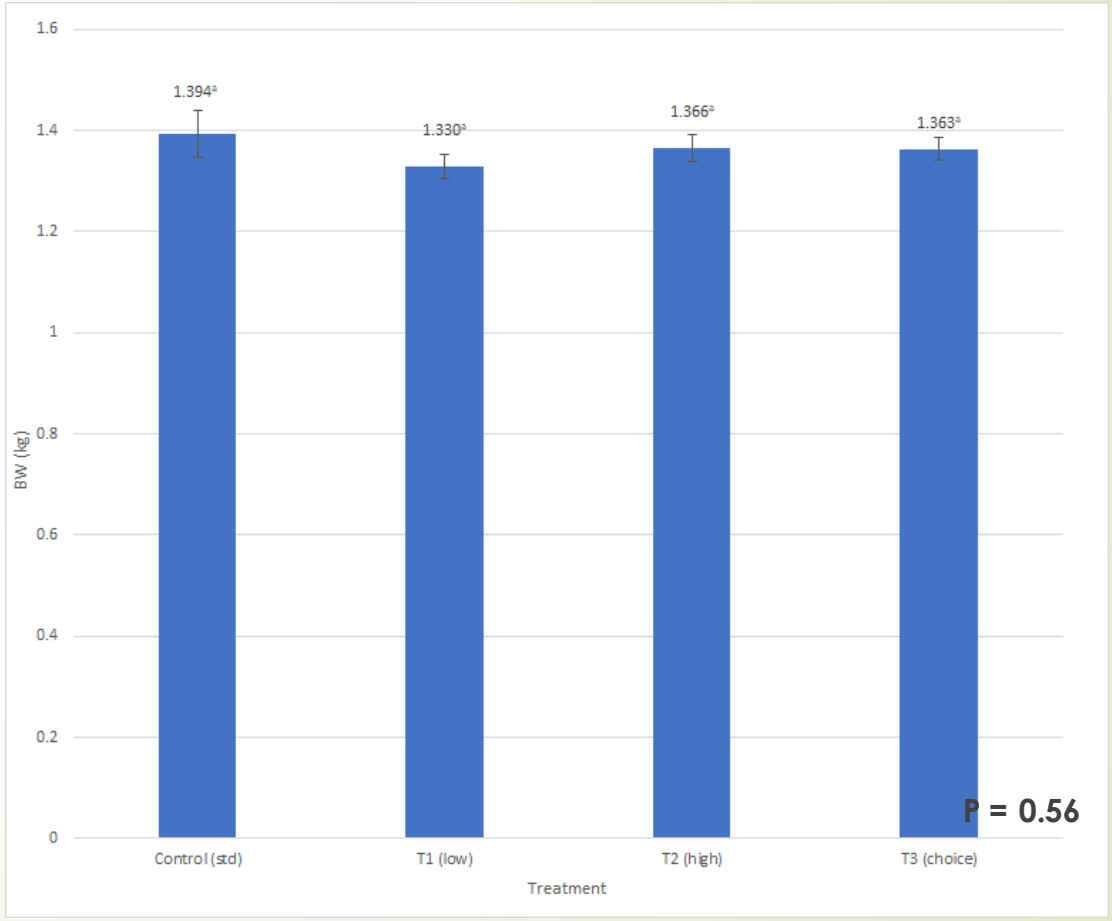
Rachael Deaver

Bone Mineral Density Discussion

- No significant difference on BMD
- Diets with lowered phosphorus (53%) and calcium (4.5%) = reduced BMD (Bello et al., 2020)
- Diets too energy dense may negatively impact bone density
  - Decreased bone weight, density and strength (3030 kcal/kg and 3194 kcal/kg) (Jiang et al., 2013)
  - Osteoporosis (Jiang et al., 2013; Kim et al., 2012)
  - Depressed blood calcium and phosphorus (Jiang et al., 2014)

Impact of Dietary Energy Level on Bodyweight at Photostimulation - Results

- Bodyweight measured on day 126, the date of photostimulation
- Mean body weight and standard deviation were plotted into a bar graph by trial group
- No statistical significance was found between treatments

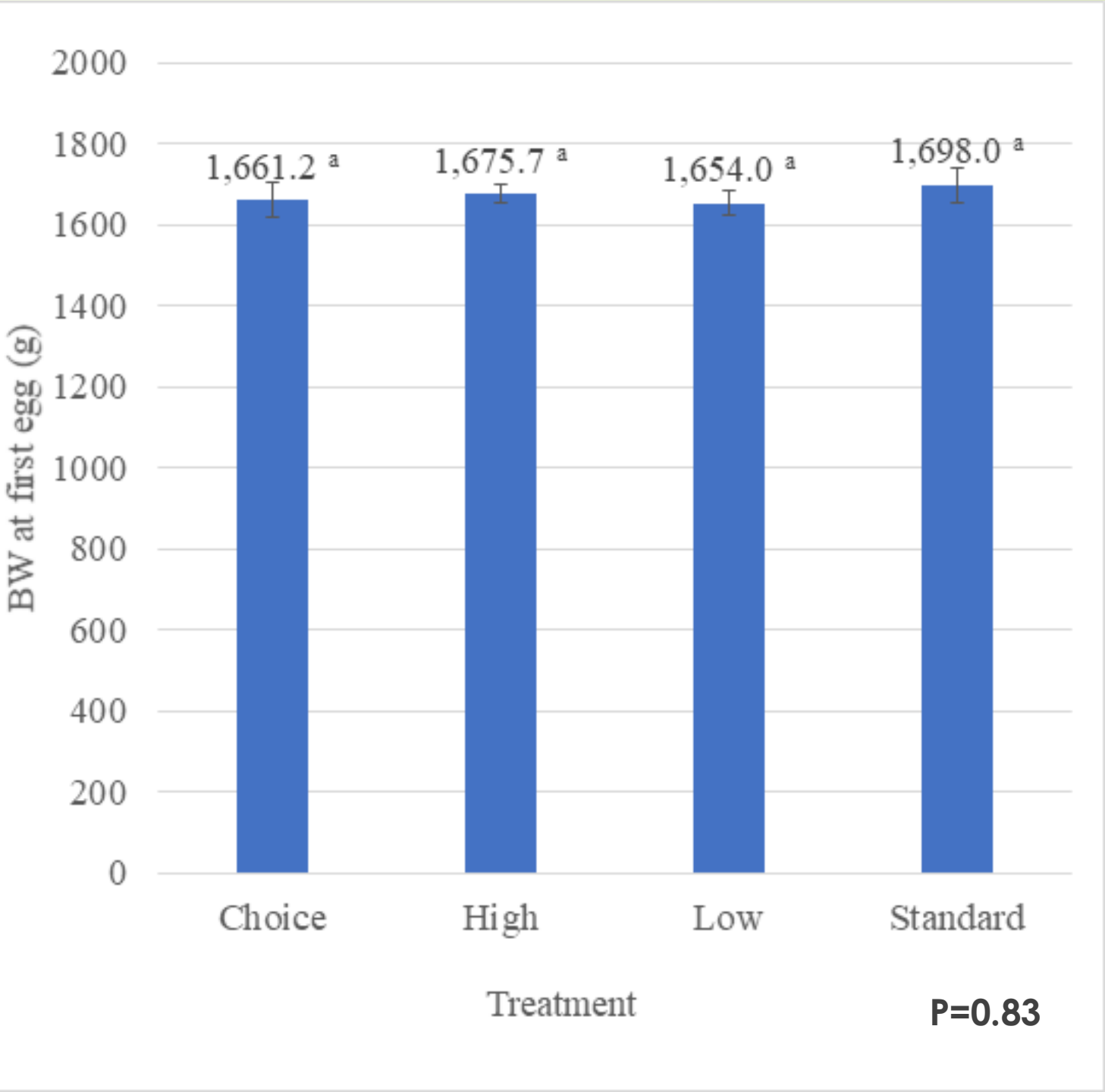


Impact of Dietary Energy Level on Bodyweight at Photostimulation - Discussion

- Bodyweight did not change based on the dietary treatment, so null hypothesis was accepted
- Feed is approximately 50-70% of total production costs, with higher nutrient dense feeds costing more than lower nutrient dense foods (Spring, 2013).
- Based on results, there is minimal gain to using a more energy dense feed leading up to photostimulation

Impact of Dietary Energy Levels on Body Weight at First Egg – Results

- Mean body weights at first egg were graphed against 4 dietary treatments.
- 10 randomized birds from each treatment.
- Single-Factor ANOVA: No statistical significance among the 4 treatments.



Alyanna Gotardo

Impact of Dietary Energy Levels on Body Weight at First Egg – Discussion

- Genetics differences: Broiler Breeders vs. Laying Hens (van der Klein et al., 2018)
- Age? vs. Bodyweight?:

Hens must meet threshold BW in order to achieve sexual maturation.

(Fattori et al.,1991)

Early maturing hens met the threshold body weight required for their first lays when the minimum age was met = laid earlier (younger)

Late maturing hens met the minimum age but not the minimum body weight = laid later (older)

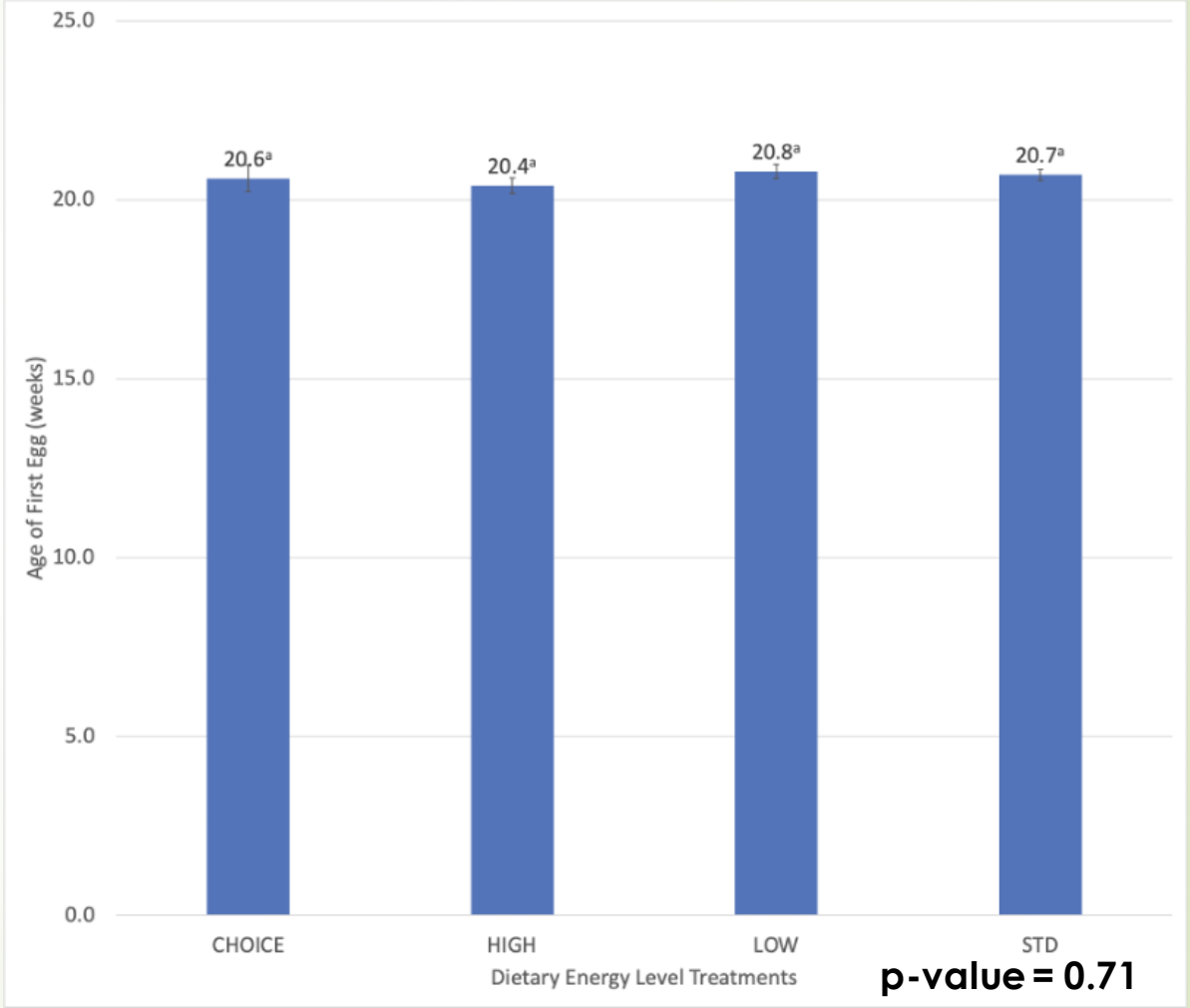
(Dunnington and Siegel, 1984)

Impact of Dietary Energy Levels on Age at First Egg - Results

- Mean of age (in weeks) of first egg plotted against varying levels of dietary energy levels
- Results from ANOVA tests were not statistically significant ($p > 0.05$)
- All t-test results had p-values over 0.05 ($p > 0.05$)

Dietary energy levels didn't affect age at first egg

Means of the treatment groups are not significantly different

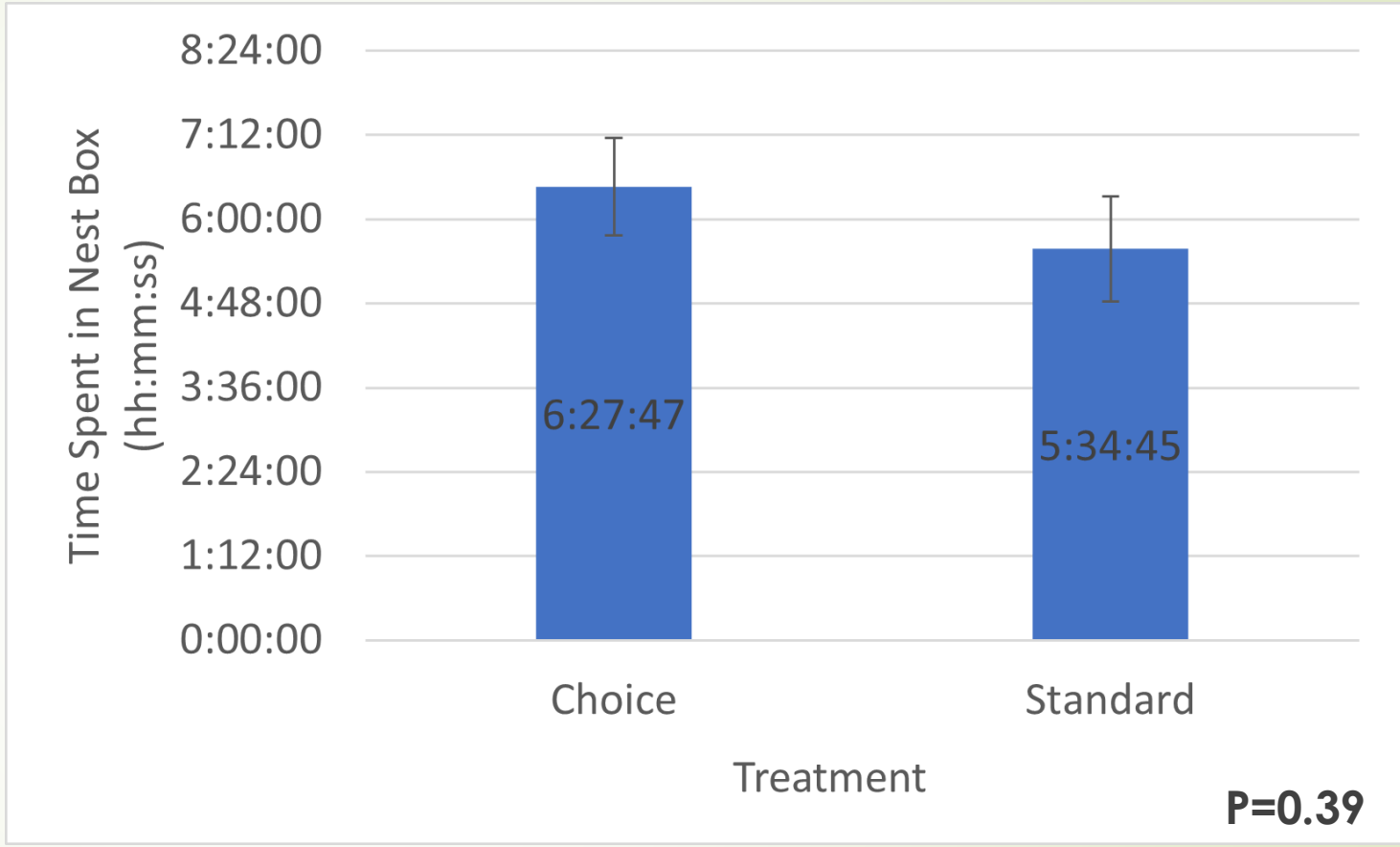


Impact of Dietary Energy Levels on Age at First Egg - Discussion

- An indicator that bird has reached sexual maturity (Yannakopoulos et al., 1995)
- Comparison to other similar studies:
  - Age of first egg was not affected by feeding fat supplemented diet (Hoyle and Garlich, 1986)
  - Level of dietary protein does not influence sexual maturity (Lilburn et al., 1986)
  - Must reach a minimum age and body weight before commencing egg production (Dunnington and Siegel, 1983)
- Further statistical analysis → reporting age in days
- No recommendations can be provided at this time

Nesting Behaviour –2 Diets Results

- Standard and choice
- Nesting behaviour: total time spent in the nest box
  - Nest boxes recorded RFID, entry, exit, eggs laid
- Data from 20-23 weeks of age, little to no data before that
- No significant difference (p=0.39)



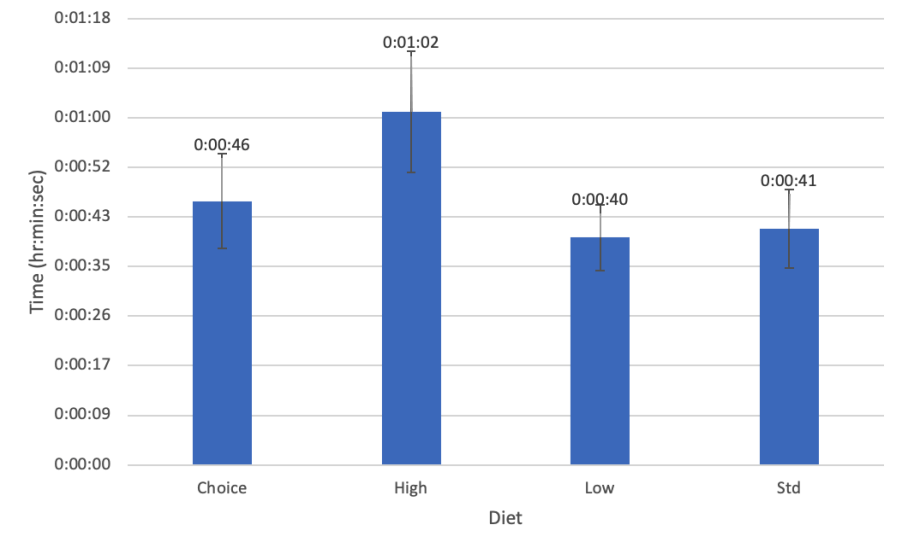
Nesting Behaviour –2 Diets Discussion

- Precision feeding in broilers study (Hadinia et al. 2019)
  - Correct energy and nutrient requirements for sexual maturity and laying has the potential to increase egg production
  - Subsequently the time spent in the nest boxes would also increase
- Precision feeding to incorporate a variety of diets and phase feeding (Moss et al. 2021)
  - Multiple diets over the hen's lifetime can better meet nutritional requirements
  - Daily changes in diets to always meet the hen's needs
  - Increases egg production and nesting time

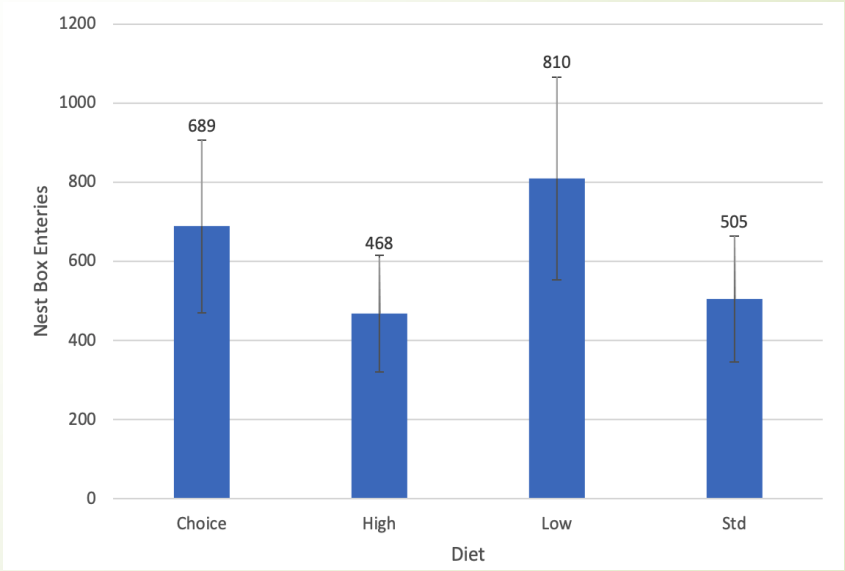
Nesting Behaviour – 4 diets

- Low, Standard, High, and Choice diet
- Nest Entries and Time Spent in Nest Box
- Data used in the analysis

Time Spent in Nest Box



Nest Box Entries



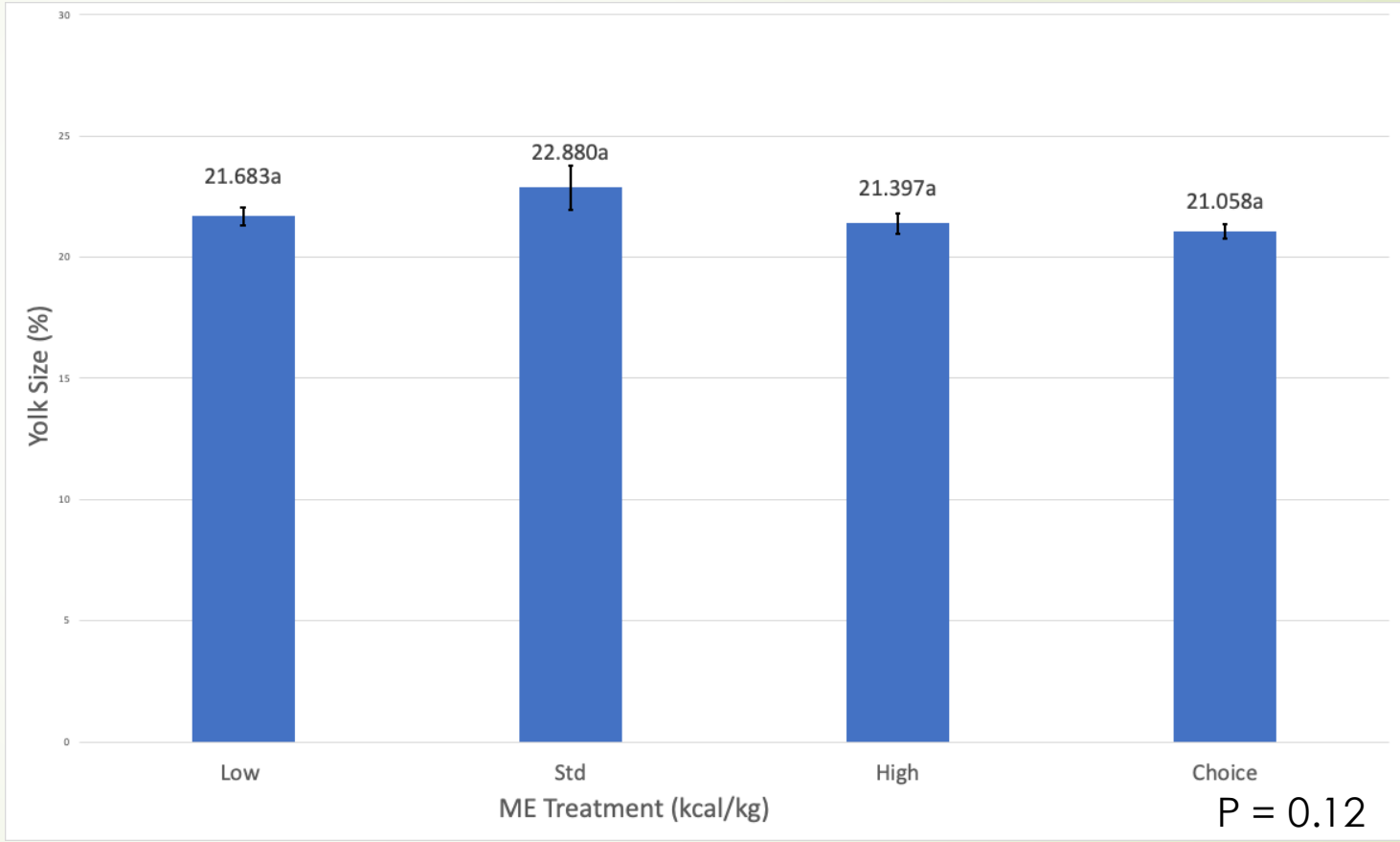
Nesting Behaviour – 4 diets

- ANOVA tests showed no significant difference ($P > 0.05$)
- Similar results were found in a three diet trial ranging from 2800-3000 kcal/kg (Jalal et al., 2016)
- ME requirements for birds hinges considerably on genetics (Sakomura, 2004)
  - Therefore, diet energy levels may have compounding effects on FCR genetics (Braastad & Katle, 1989)
- Further studies could be done to see the amount of nest entries over one week intervals, using 40 birds per treatment for the different diets

Comparison of diet treatments on time spent in nests and number of nest entries over 5 weeks	
Time in Nest	Nest Entries
ANOVA P-value	ANOVA P-value
0.215	0.303

Impact of Dietary Energy Levels on Egg Composition - Results

- Four dietary treatments
- Yolk % of egg
- Results not statistically significant using ANOVA
  - P = 0.12
- Average yolk percentage was also not statistically significant comparing paired treatments
  - All t-test p-values > 0.05



Michaela Steele

Impact of Dietary Energy Levels on Egg Composition - Discussion

- Egg composition and egg yolk proportion are more so dependent on
  - Age – Age increase = Increase in yolk proportion (Jiang & Sim, 1991; Hartmann et al., 2000)
  - Egg weight – Egg weight increase = Increase in yolk index (Sekeroglu & Altunas, 2009)
  - Selection – Bird line and trait heritability/selection = change in yolk proportion (Hartmann et al., 2000)
  - Feed intake – Low feed intake = Decrease in yolk percentage (Li et al., 2010)

- Adjusting the dietary energy level may have drastic effects on egg quality, especially in relation to the cholesterol found in the yolk (Mirbod et al., 2016)

Aidan Krips

Impact of Feeding Programs on Egg Composition - Result

- Multi-Feeding System: two treatments for feed allocation levels: ad libitum and feed restricted

- Egg compositions: egg weight (g), egg yolk %, eggshell %, and specific gravity(kg/cm³)

- **Result from ANOVA test show:**

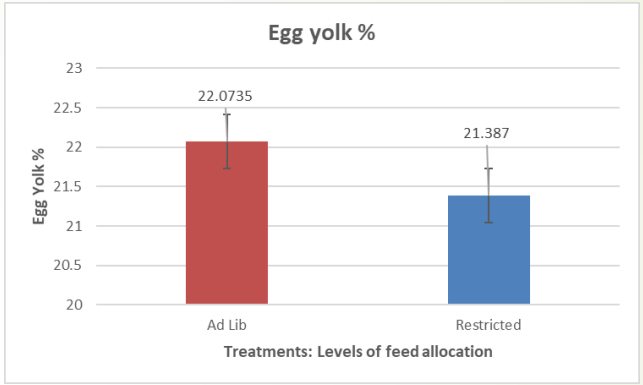
Not significant (p-value >0.05) - egg weight and egg yolk %

Significant (p-value < 0.05)- eggshell % and specific gravity

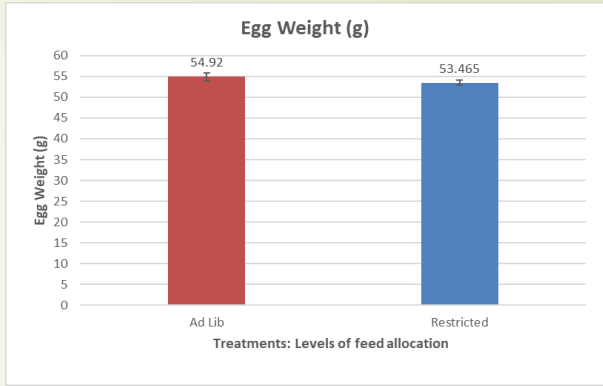
- **Interpretation of the results:**

Feed restriction improve the eggshell quality

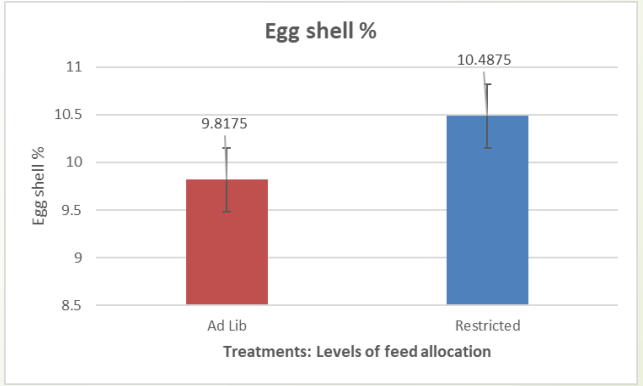
- increase in both eggshell % and specific gravity (thicker eggshell)



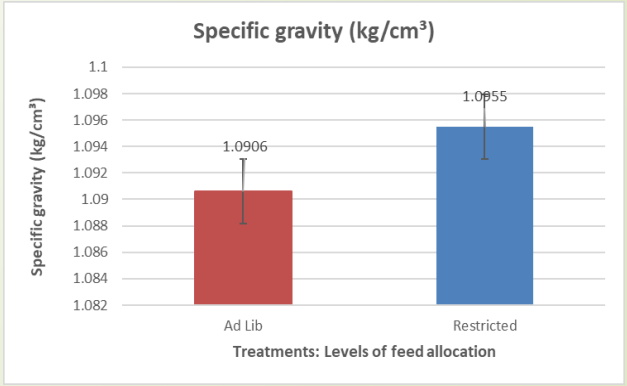
Egg yolk %
P-value: 0.127



Egg weight
P-value: 0.190



Eggshell % P-value: 0.0009



Specific gravity P-value: 0.0001

Min Chieh (Ruby)

Impact of Feeding Programs on Egg Composition- discussion

Compare with past studies:

- **Eggshell** - limitng feeding on laying hens produced lightly stronger eggshell than fed Ad libitum (Kang et al., 1996)

- Ad libutum- heavy egg production accelerate the aging of egg shell formation mechanism which caused a rapid decline of shell quality

- **Egg weight** -

Qualitative FR by skip a-day at middle age of development: higher egg weight (Tesfaye et al. 2009)

Quantitative FR as slight as 2.5%: reduction in egg weight (Scott et al., 1999)

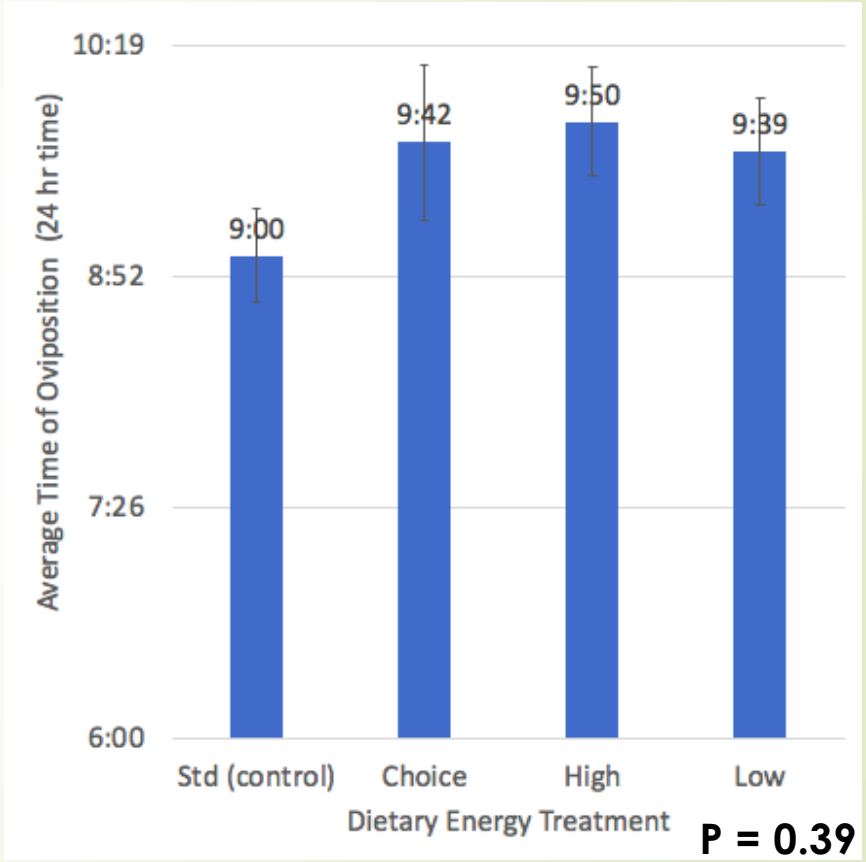
Recommendation for the hatching egg sector: FR increases hatchability and decreases early embryonic mortality by the positive relation with specific gravity.

Further refinement of the experiment:

- Use different proportion of (quantitative) FR apply to see if there is direct proportion reduced in egg weight or change in egg compositions

Results for the Impact of Dietary ME Levels on Egg-Laying Times

- Four treatments for dietary ME: low, standard, high, and choice
- Results were not statistically significant (P = 0.39) - analyzed using one-way ANOVA
- Mean laying times were not significantly different from one another across the four treatments



Reillee Duperron

Discussion of Results for Dietary ME vs. Egg-laying Time

- Opposing results from feeding higher vs lower ME and how they affected egg production: increase vs. decrease (Mathlouthi et al. 2002, Ciftci et al.'s 2003)
- No research found on dietary ME affecting laying time: hypothesized no difference in laying times

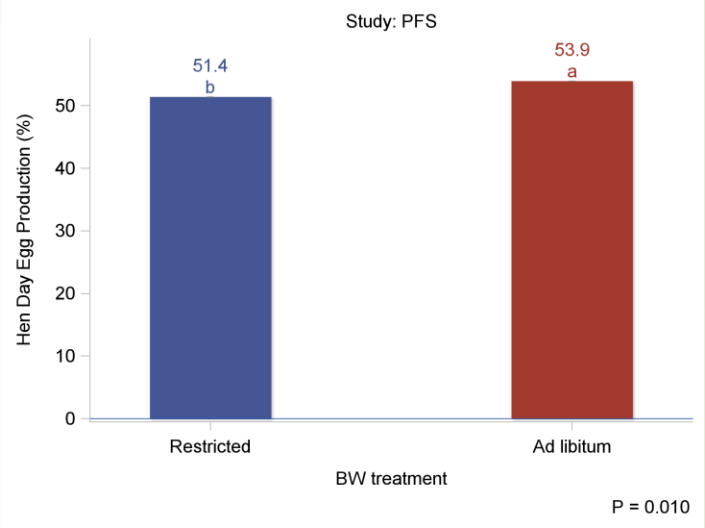
  Supported by P = 0.39 - no industry changes

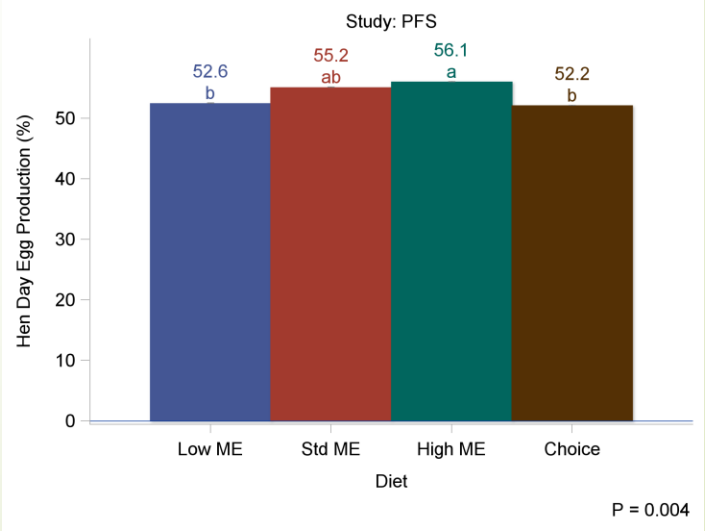
Research: later into production period to see how results are affected

- Future research: could improve efficiency in egg-collection and cycling

Impact of Dietary Energy Levels and Feeding Program on Egg Production: Results

- Recorded from week 19-25 of age
- Feeding program significantly affects early egg production (p=0.010)
- Metabolizable energy of diet significantly affects early egg production (p=0.004)





Brian Birkenhagen

Impact of Dietary Energy Levels and Feeding Program on Egg Production: Discussion

- Hen's fed a diet containing lower dietary energy will reduce egg production by 2% across the laying period (Valkonen et al., 2008)
- A restriction diet of 85% ME intake will reduce egg production by 5% during the 19-26 week laying period (de Persio et al., 2015)
- Restriction feeding programs will reduce early egg production by nearly 3% during the 19-25 week laying period (p=0.010)
- Increasing dietary metabolizable energy intake will increase the early egg production during the 19-25 week laying period by up to nearly 4% per a hen (p=0.004)
- To maximize early egg production, an ad libitum feeding program with a high dietary energy feed should be given to a flock

Brian Birkenhagen

Conclusions

Brian Birkenhagen

Importance to Industry

- Feed cost can take up 60% of the total cost of production (Almedia et al., 2018)
  - Bag of 25kg broiler complete grower cost $18.73 (Alberta Agriculture and Forestry, n.d.)
- A dozen of eggs cost $2.61 as of July 2020 (Egg Farmers of Alberta, n.d.)
  - Making a single egg worth $0.22
- Finding a balance between producing efficient birds and lowering production cost without impacting animal health and welfare

Recommendations

- Similar results across treatments could implement feed restricted or lower energy dense diets to lower feed cost
  - Feeding different diets did not benefit or harm
    - Bone mineral density
    - Nesting behavior
    - Laying times
    - Bodyweight at photostimulation
- Although feeding restricted or lower dense diets were found in this study to impact
  - Egg production
    - Restricted/Lower ME caused a reduction
  - Efficiency
    - Restricted/Lower ME raised FCR
  - Shell Quality
    - Restricted increased shell percentage and thickness

Carissa Racher

Limitations

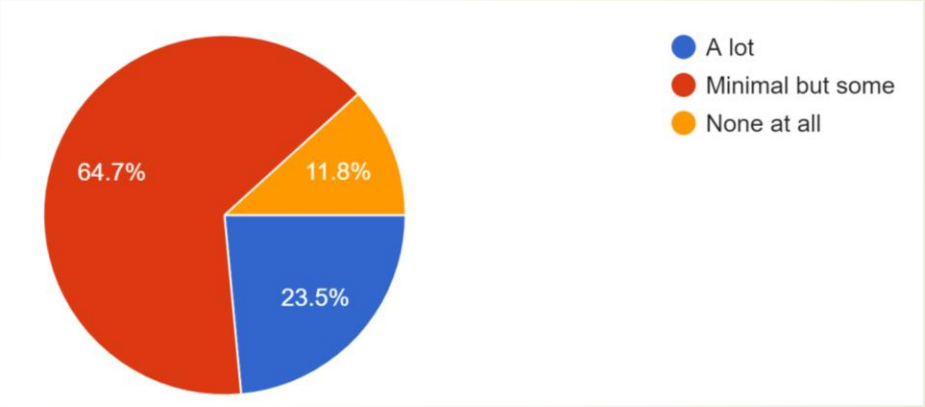
- Small sample size
  - Preliminary trial; may not be fully representative of commercial populations
  - Data consistent with previous studies
- Data taken early in study – not at peak laying
- Graduate students will be building on this study in laying hens
  - Thiago Noetzold
  - Jo Ann Chew

Melissa Dowling

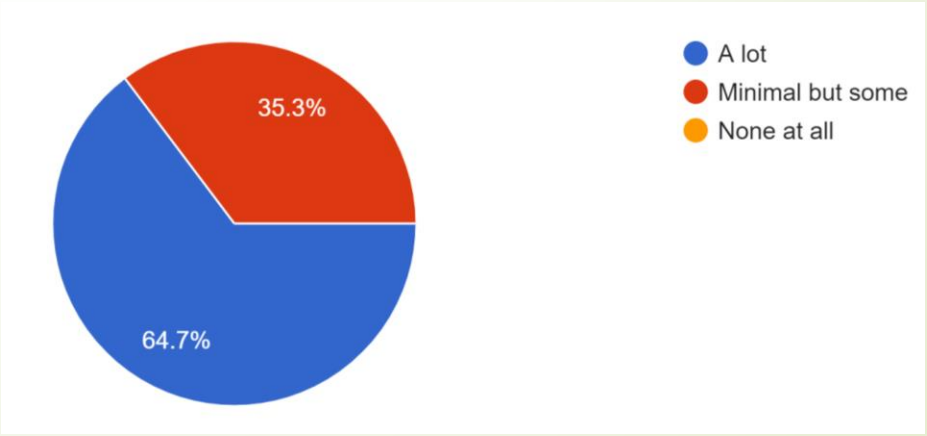
Reflection

https://hatchachick.ca/chick-products/p/latemidmay

How much poultry experience did you have prior to this class?

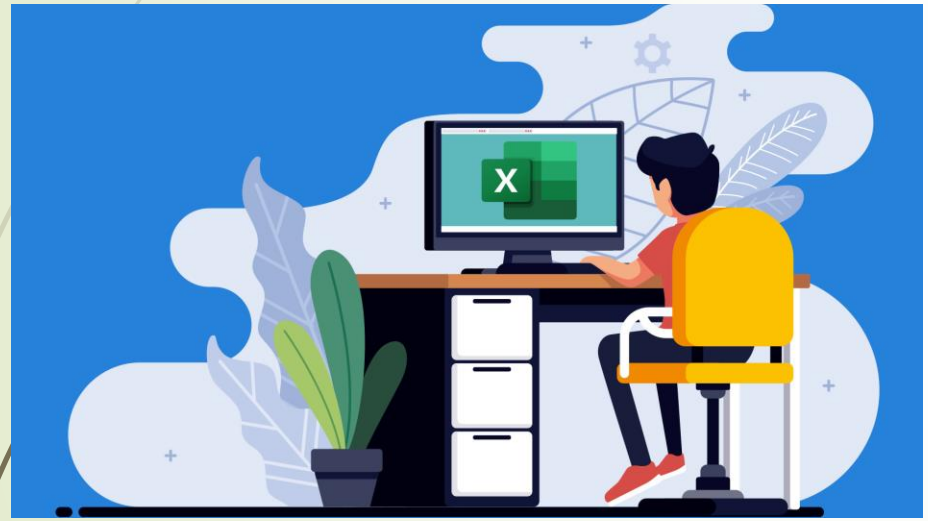


How much knowledge of the poultry industry did you gain from this class?



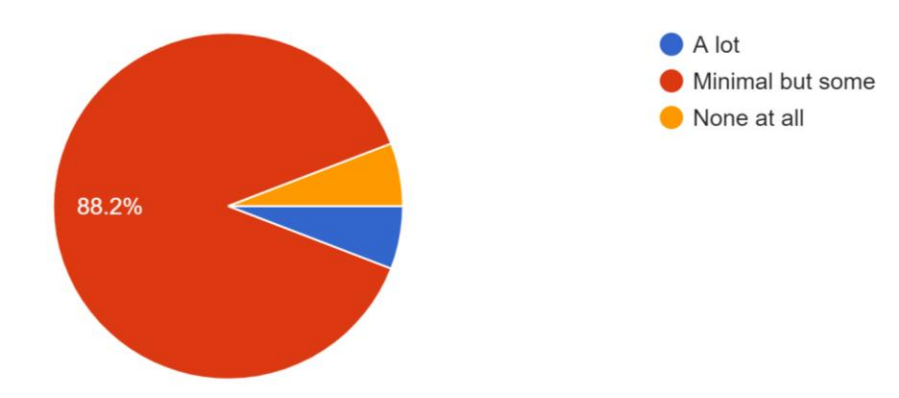
Calista Laycraft & Brian Birkenhagen

Reflection

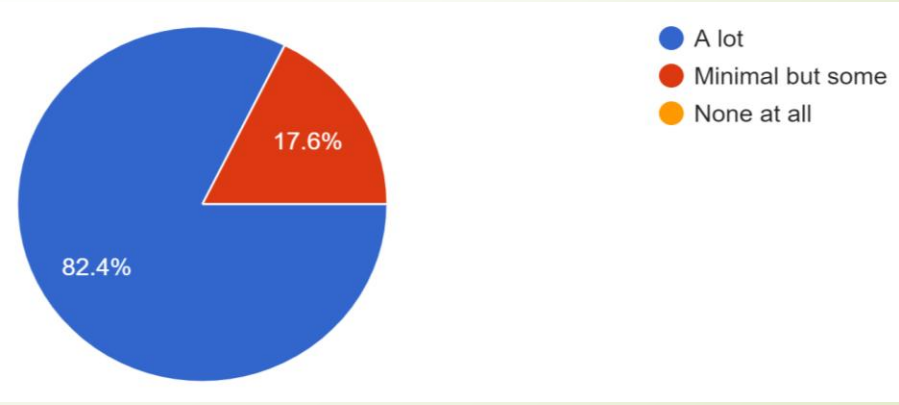


https://findingclarity.ca/blog/why-excelling-at-excel-is-important-for-your-accounting-job/

How much Excel and statistical analysis experience did you have prior to this class?



How much knowledge of Excel and statistical analysis did you gain from this class?



Calista Laycraft & Brian Birkenhagen

Reflection

https://lohmann-breeders.com/strains/lohmann-brown/

What new skills did you gain from this experience?

- Learned many new excel techniques and shortcuts for analyzing large amounts of data
- Many new skills from the hands-on portion of the class such as blood collection, palpating hens, X-raying hens, dissection techniques, and general handling

What did you learn in this class that you feel may be useful in the future?

- Poultry handling along with behaviour and welfare standards
- Restraint of chickens
- Excel shortcuts
- Understanding research methods, data collection, and analysis
- Blood collection and dissections in poultry

Calista Laycraft & Brian Birkenhagen

Reflection

Photos taken by students during the hands-on experience

What insights into poultry research did the hands-on portion of this project give you?

- Bulk data collection
- How many different measurement techniques can be used to measure the same data (ex. body composition)
- The number of hours that must be incorparated into a successful research project

Calista Laycraft & Brian Birkenhagen

Reflection

Photo taken by students during the hands-on experience.

What did you enjoy the most from this experience?

- Hands-on experience and all the time spent at the PRC
- Collaborating with students / partners
- The enhanced appreciation I now have for poultry

What moments did you find the most challenging about this experience?

- Time management
- The statistical analysis of raw research data
- Online communication (with partners, class, and teaching staff)
- Forming a plan regarding the research project

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Reflection

https://www.backyardchickens.com/threads/your-chicken-pictures-needed-for-the-byc-2013-calendar.701435/page-51

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What are some obstacles the class had to overcome in making this presentation?

- Completely working online, communicating online
- Very tight timeline to coordinate information
- Combining the creative ideas of so many unique individuals into a single presentation

What advice would you give another group that has to complete this task?

- Use online resources! Such as, google forms, discord, etc.
- Ask lots of questions!
- Start as early as you can!
- Have clear communication, trust in each other's skills, and be patient as everyone has different schedules
- Choose an aspect of the presentation you're comfortable with

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Alberta Agriculture and Forestry

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