The Effects of Different Transitioning Organic Pastures on Dairy Heifer Growth & Development

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Replacement Heifers

- Heifer designated to replace lactating cows that are leaving the herd
  - 1/3 of the average dairy herd is replaced each year

- Second largest expense on an operating dairy
  - No monetary gain until lactation

Developing Dairy Heifers

- Ideally, heifers bred at 55-65% of mature body weight (BW)
  - 45% - No reproductive cyclicity
  - 70% - Increased feed and labor costs
  - Heifers should be bred at 14 months
  - Calve by 24 months

- Costs decrease the quicker you reach breeding weight

Dairy Systems

Dairy Systems

Pasture

- Advantages:
  - Decrease in feed costs
  - Simplistic: Less labor and time
- Disadvantages:
  - Nutrition dependent upon time of year
  - Decrease in production gains
  - Increase in parasite load

Organic Dairying

- Requirements
  - Feed 100% organic feeds
  - Minimum of 30% of a ruminant's DMI must come from pasture during the grazing season
  - Grazing season length determined geographically
  - Antibiotic and parasiticide use are restricted
- Organic dairy production has become the fastest growing segment of U.S. Organic Agriculture (Anon, 2012)
- On average organic dairy systems have higher costs than conventional ($8.62/cwt of milk) (ARMS, 2016)

Why Organic?

- Most recent survey showed that organic producers receive $18.84/cwt of milk more than conventional (ARMS, 2016)

Organic	Minnesota	New York	Wisconsin	All States
Income	$34.87	$38.09	$35.13	$35.06
Costs	$18.56	$28.56	$21.41	$20.68
Profits	$16.31	$9.53	$13.72	$14.38
Conventional				
Income	$16.52	$16.80	$16.97	$16.22
Costs	$11.60	$13.21	$10.81	$12.06
Profits	$4.92	$3.59	$6.16	$4.16

Improved Pastures

Objective

- Determine the impacts that different transitioning organic pasture forages have on dairy heifer growth and reproductive development

Measurements

- Physical Measurements
  - Weight (kg)
  - Hip-height (cm)
- Serum Metabolites
  - Blood Urea Nitrogen (BUN)
  - Insulin-like Growth Factor-1 (IGF-1)
- Parasite Load
  - Fecal Egg Counts (FEC)
- Reproduction
  - Conception Rates at the end of the study

Physical Measurements

- Weight
  - Used to determine heifer growth status (% Mature Body Weight)
  - Many producers use weight to determine when heifers are ready to breed
- Hip-height
  - Another measurement to determine heifer stage of growth
  - Not used as frequently in research

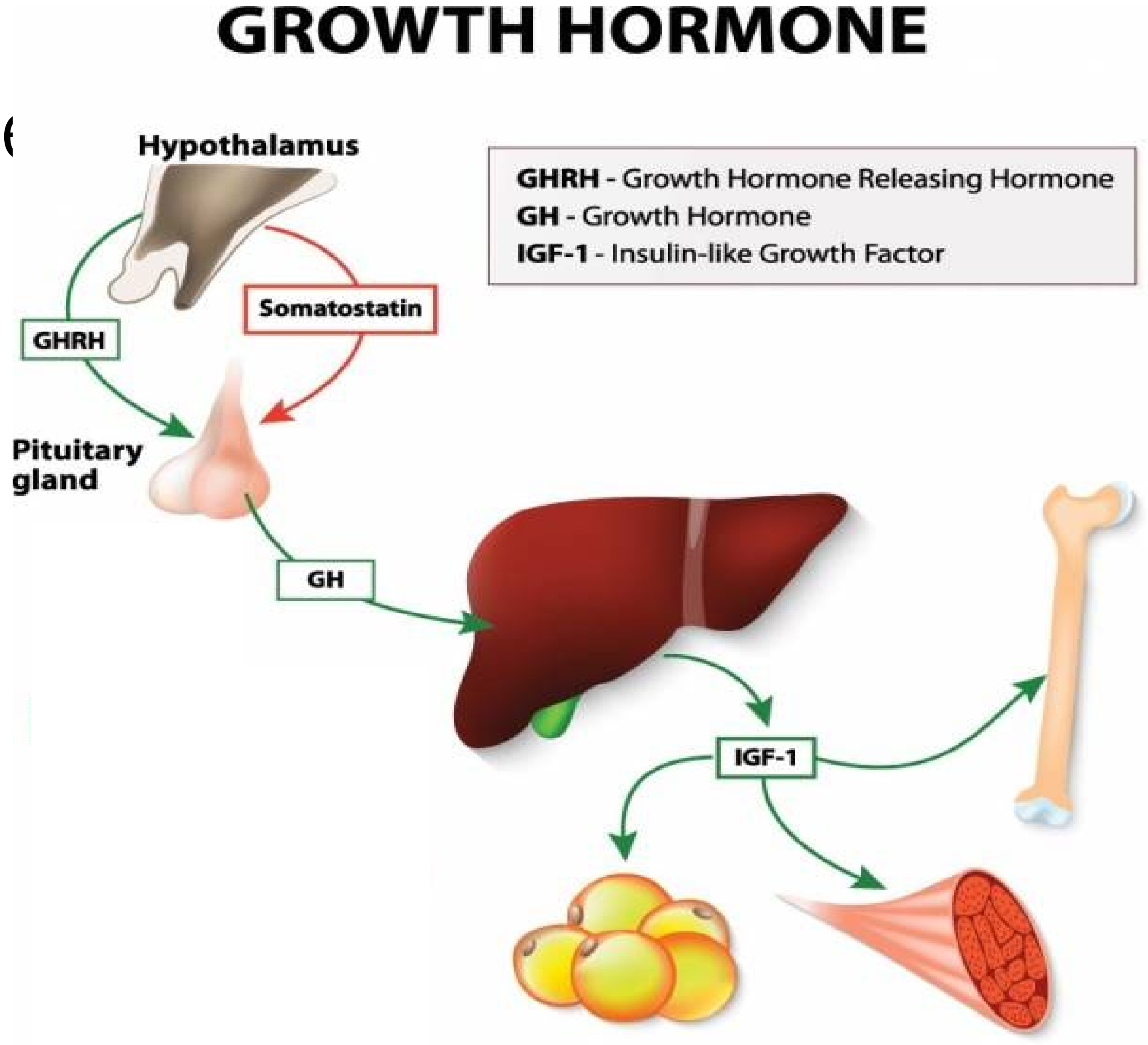
Photo Credit: Ronda Miller

Serum Metabolites – Blood Urea Nitrogen

- General indicator of heifer protein intake
  - Increased protein levels increase the amount of urea in the blood

- High BUN levels can be detrimental to reproduction
  - Lactating cows that had BUN levels > 19 mg/dL had a 20% decrease in pregnancy rate (Butler et al. 1996)
  - BUN levels < 15 mg/dL ideal for reproductive performance
  - BUN levels > 20 mg/dL detrimental to conception
    - (Rajala-Schultz et al. 2001, Ferguson et al. 1993)

Serum Me… th Factor-1



Serum Metabolites – Insulin-like Growth Factor-1

- IGF-1 concentrations are a measure of nutritional status
  - Indicator of energy balance (Kolver & Macmillan, 1994)
  - Negatively correlated with FEC (Diaz-Torga et al. 2001)

Parasite Load – Fecal Egg Counts

- Heavy protein loss and decreased rates of gain due to parasites can be a financial burden to livestock producers
  - Organic dairy producers may be more susceptible to parasite infection due to limitations on anthelmintic use
- FEC (eggs/gram) indicates heifer parasite load
  - Important for pasture animals



Reproduction – Conception Rates

- Herd fertility is essential to dairy sustainability
- Pasture-based systems can negatively impact conception rates in dairy cattle(Diskin, et al. 2006)
  - Partially due to high BUN levels
- Other grazing based research has found no difference of conception rates between conventionally and pasture fed cattle(Funston & Larson, 2011)
- Dairy grazing research is contradictory, more research is needed to determine the impacts that grazing has on dairy cattle reproduction

Hypothesis

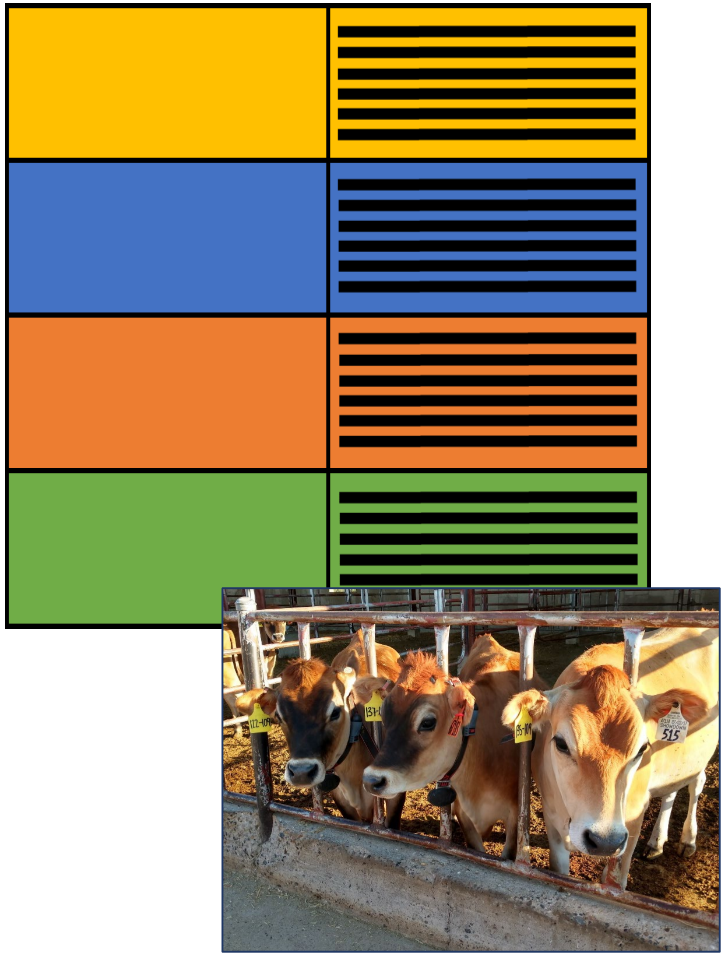
- The provision of mixed pastures (legume and grass mixtures) will result in improved growth and reproductive efficiency in developing dairy heifers when compared to heifers developed on monoculture grass pastures.

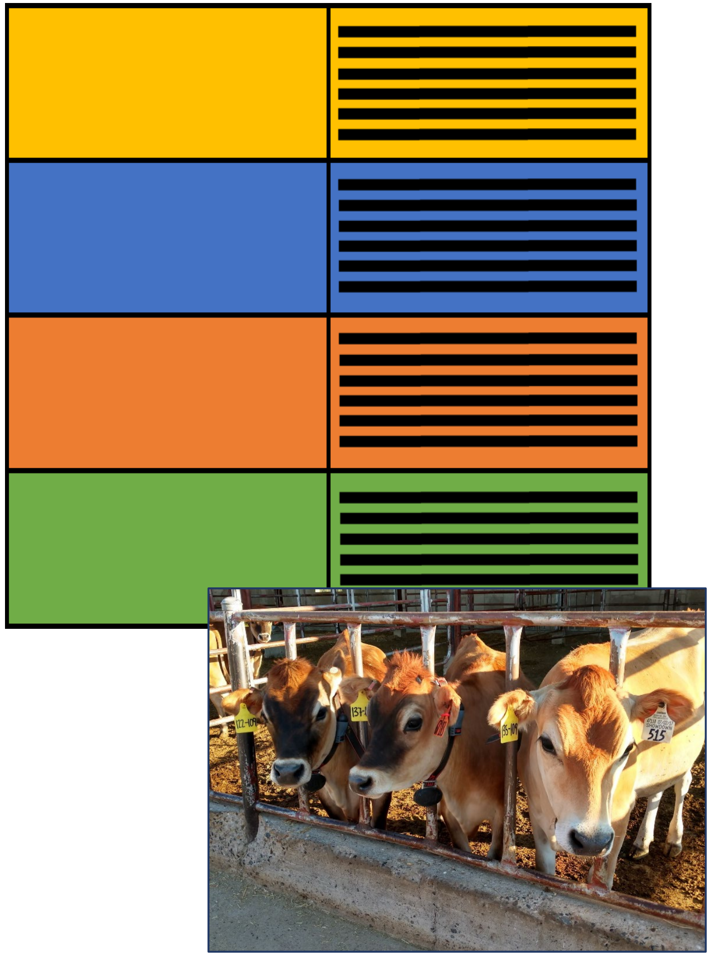
Materials & Methods

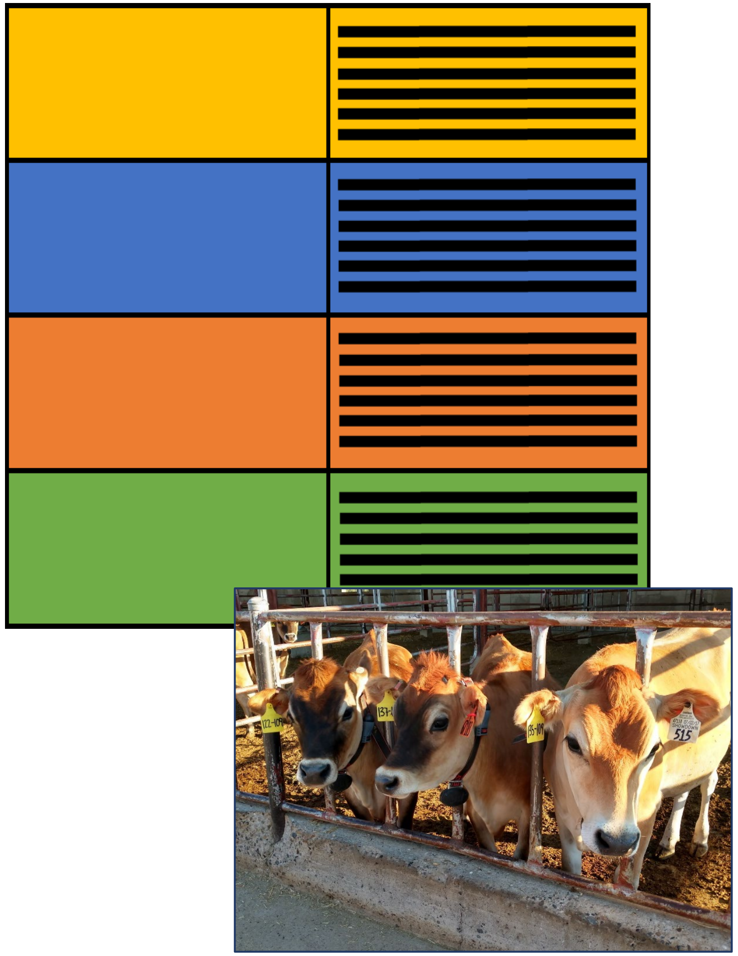
Materials & Methods

- Three-year period
- 210 yearling Jersey heifers
  - 2016 – 48 heifers
  - 2017 – 81 heifers
  - 2018 – 81 heifers
- Trial lasted for 105 days
- Initiated with a two-week grazing transition period
- Heifers were sampled then randomly assigned to a block and treatment

Blocks



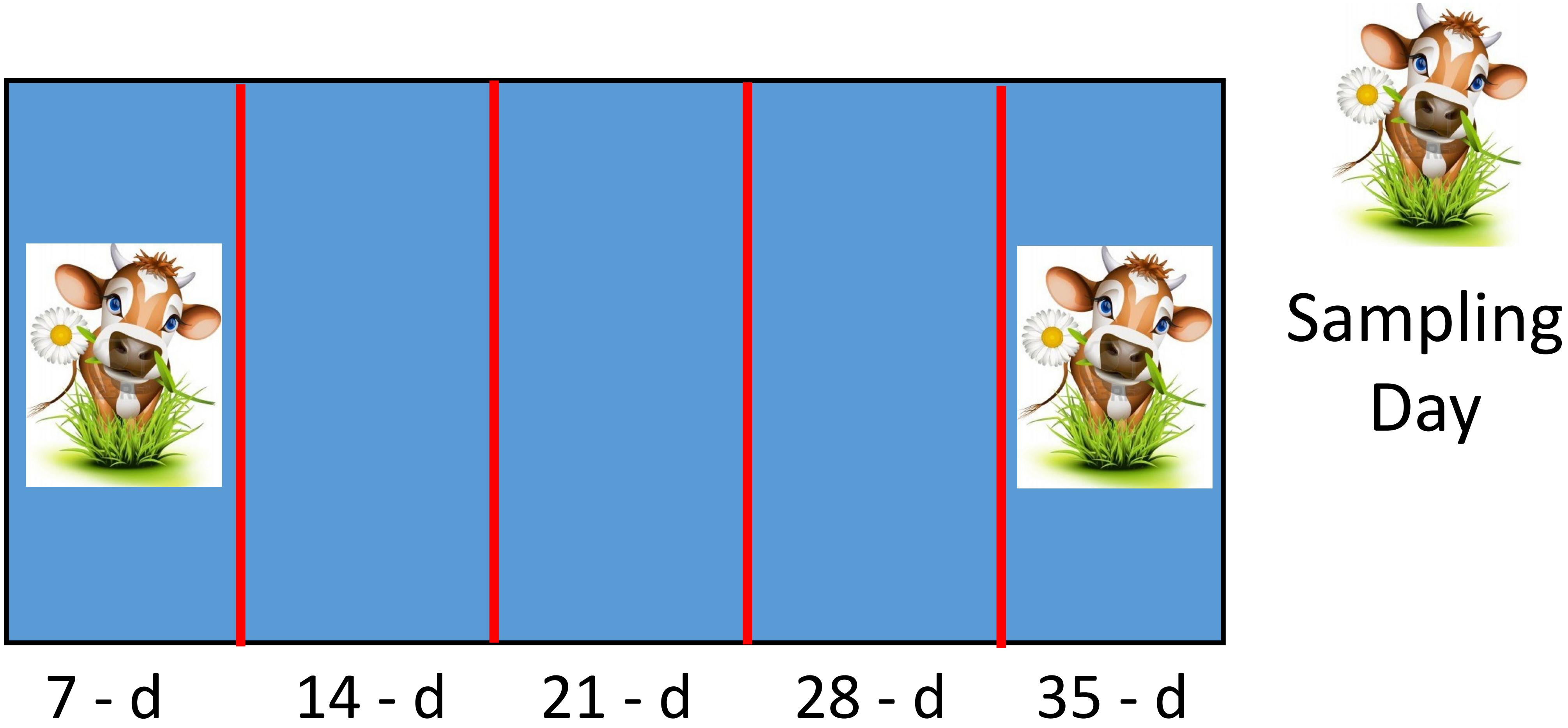




Treatments

Birdsfoot Trefoil

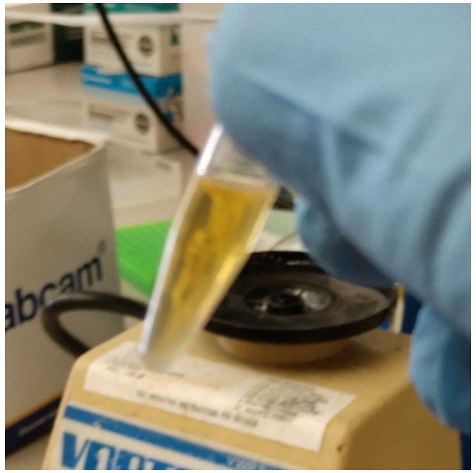
	(-)	(+)
Perennial Ryegrass		
Orchard Grass		
Meadow Brome		
Tall Fescue		


Sampling Day
7 - d
14 - d
21 - d
28 - d
35 - d

Experimental design

- Completely randomized design
- Experimental Unit: paddocks of 3 heifers (2 in 2016)
- Random Variables: Treatment, block, source of heifers, individual heifer, and year
- Fixed Effects: Treatment, Pasture
  - Treatment = 9 treatments used in the study
  - Pasture = MIX - pasture with BFT, MONO - pasture without BFT
  - Used to determine if the presence of BFT had an effect on heifer growth and development
  - Heifers receiving TMR were eliminated from pasture analysis

Serum Metabolite Profiling



IGF-1

BUN

Parasite Load

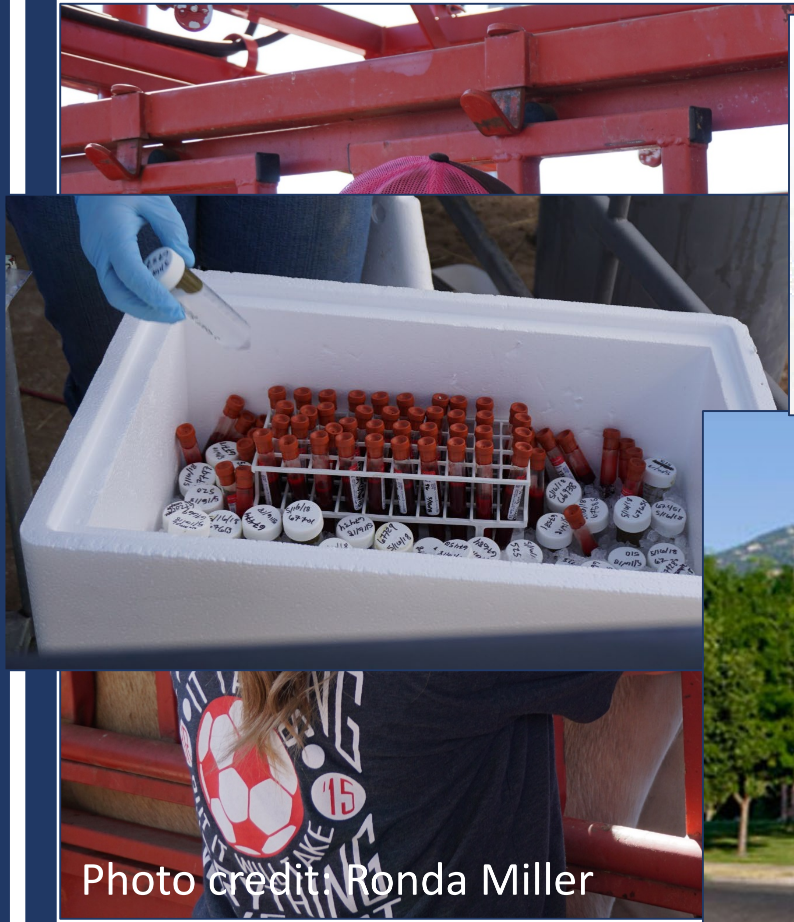


Photo credit: Ronda Miller

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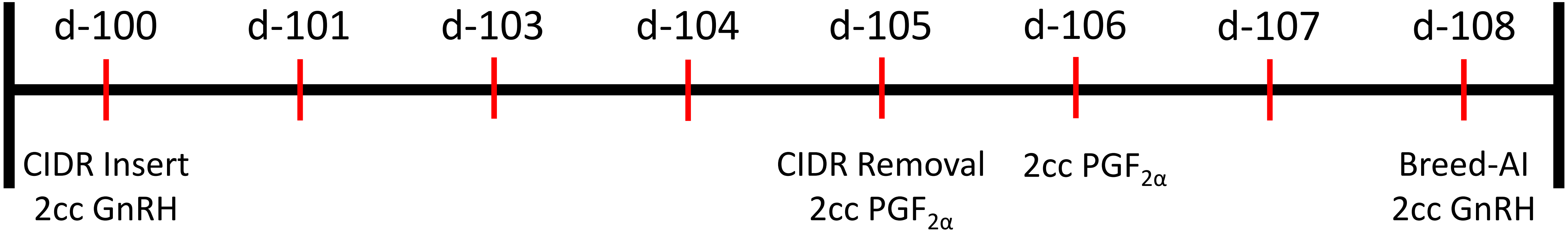
Reproduction

- A 5-day CIDR based, fixed time-AI protocol was used to observe conception rates (Below)
- After d-105 of the study heifers remained on treatments until 17-d post-breeding
- At 35-d post-breeding conception rates were determined by ultrasonography

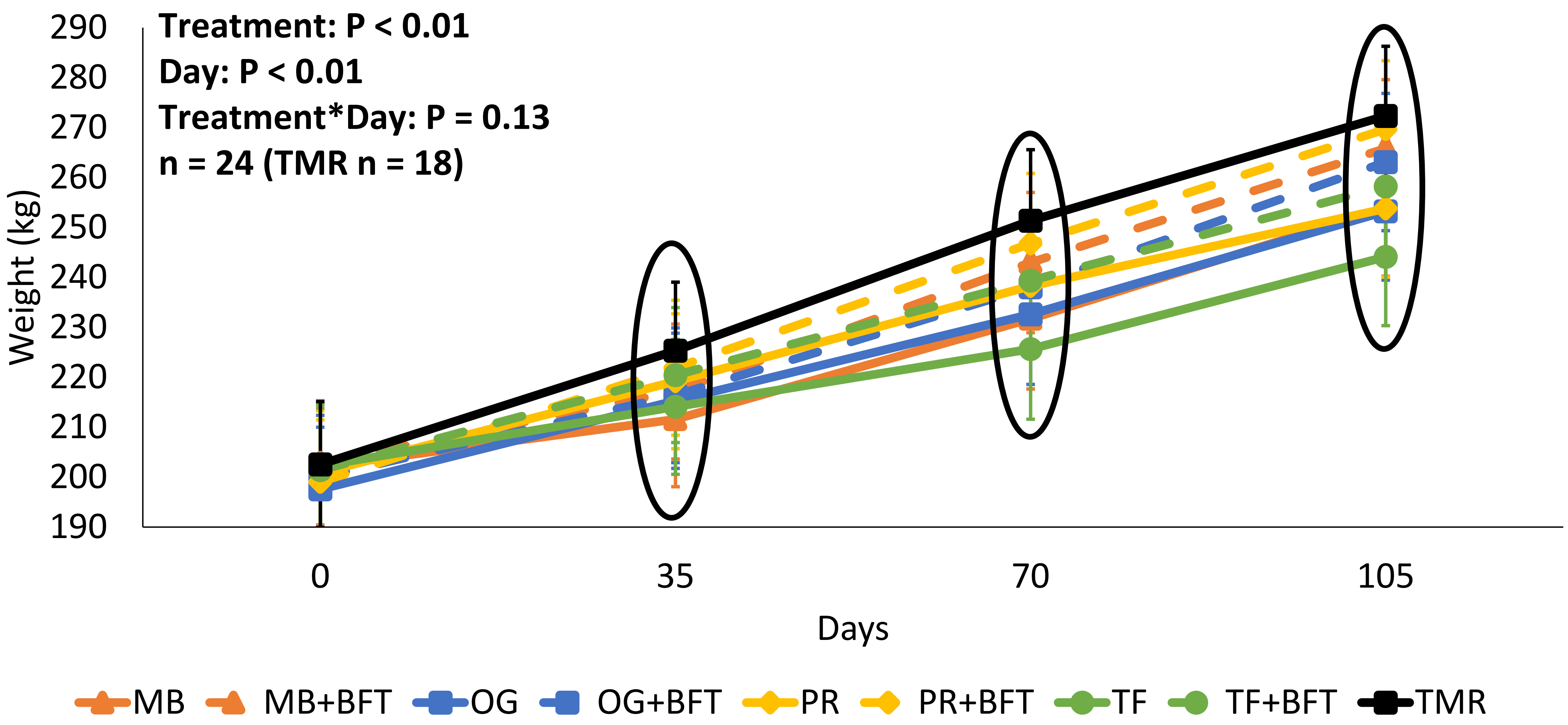


Statistical Analysis

- All analysis was done using SAS® version 9.4 (SAS Institute, Cary, NC).
- Repeated Measures analysis was completed using PROC MIXED
- Post-hoc mean comparisons with Tukey adjustments were used to determine differences between treatments
- Significance was determined at $P \leq 0.05$ for all comparisons

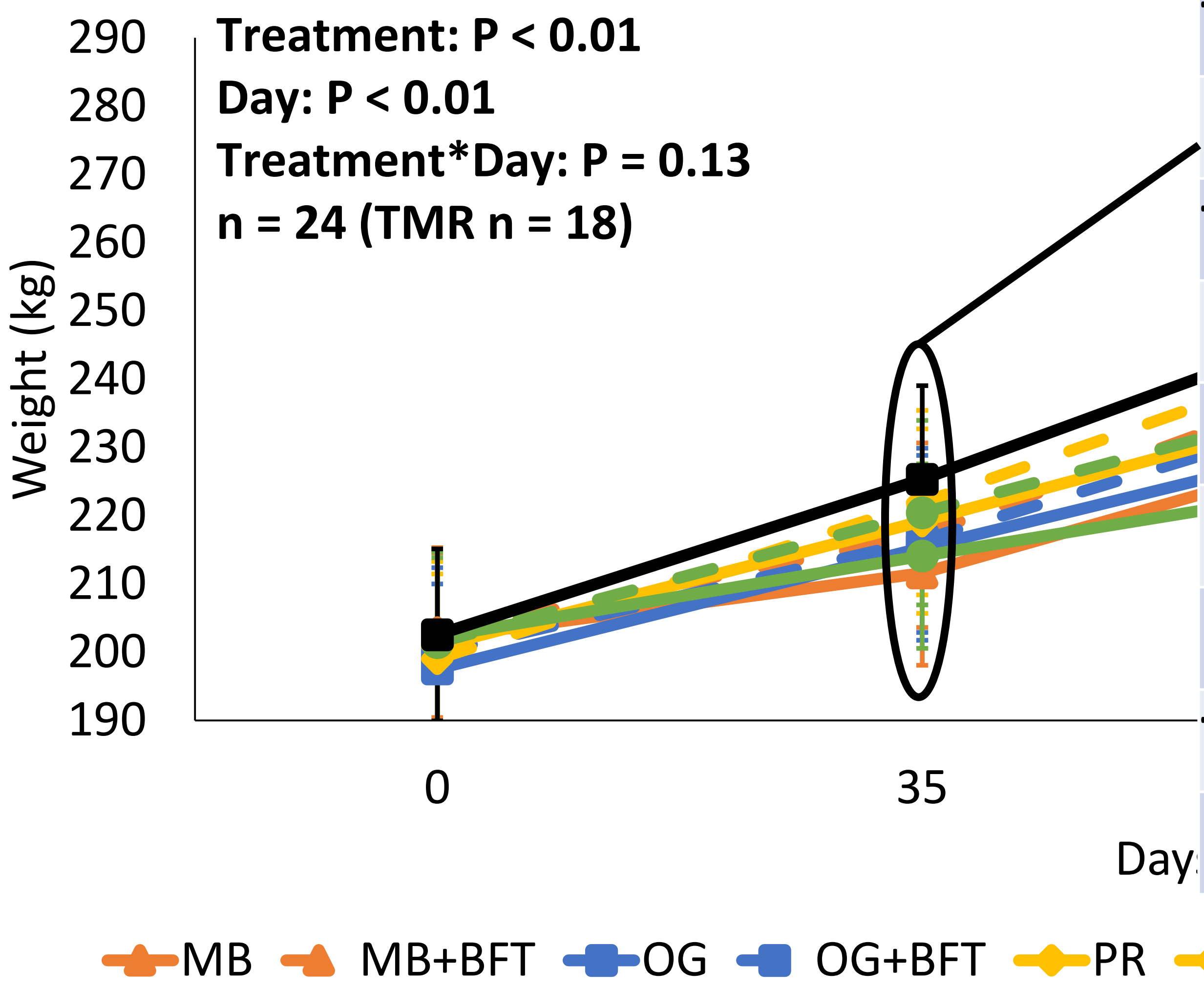
Results

Results - Weight



Superscripts indicate differences ($P < 0.05$)

Results - Weight



Trmt	Day-35	SEM
TMR	225.30[a]	13.73
PR+BFT	221.89[a]	13.52
TF+BFT	220.42[a]	13.52
PR	219.19[a]	13.52
MB+BFT	217.15[a]	13.52
OG+BFT	216.38[a]	13.51
OG	215.28[a]	13.52
TF	214.07[a]	13.52
MB	211.59[a]	13.52

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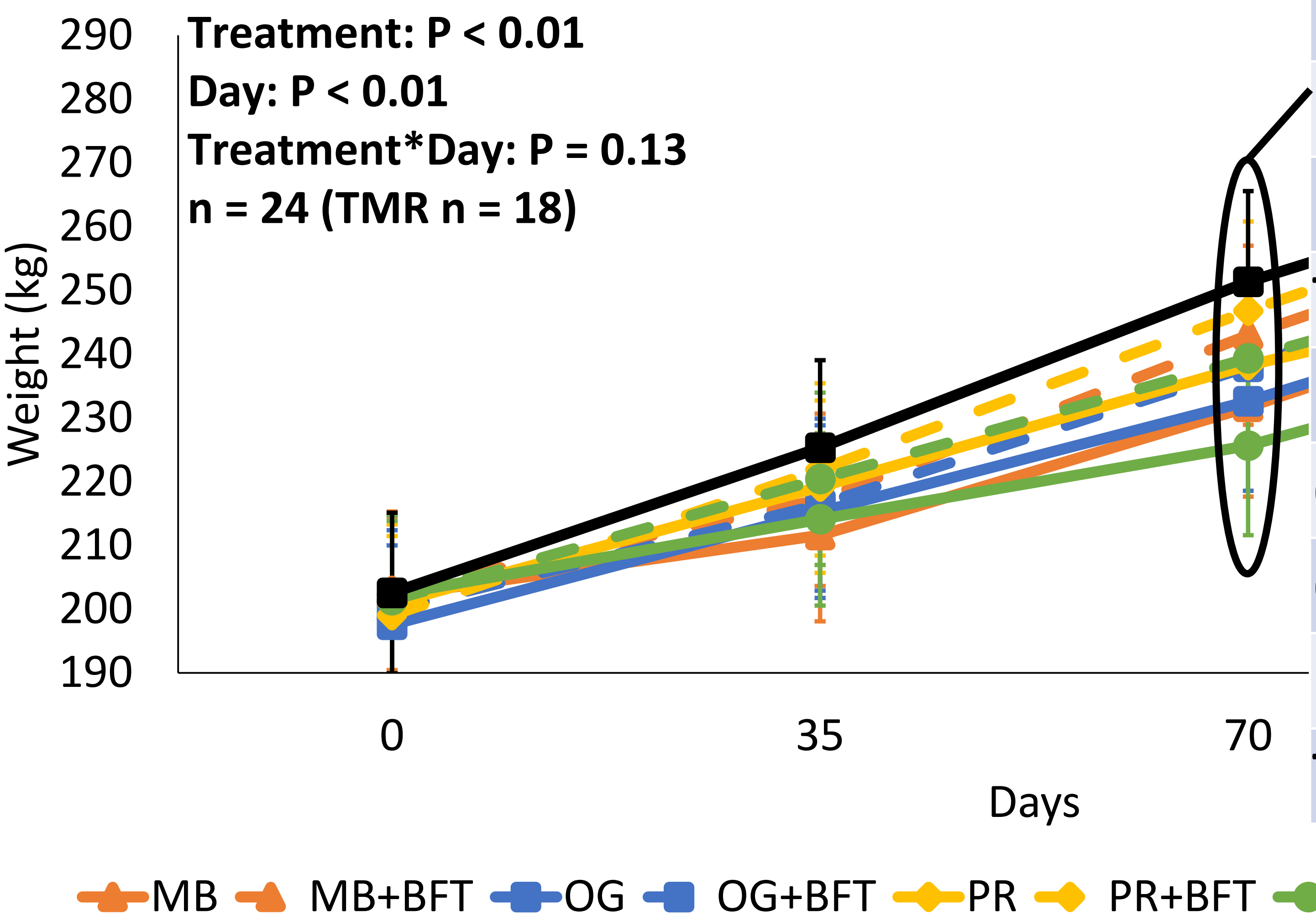
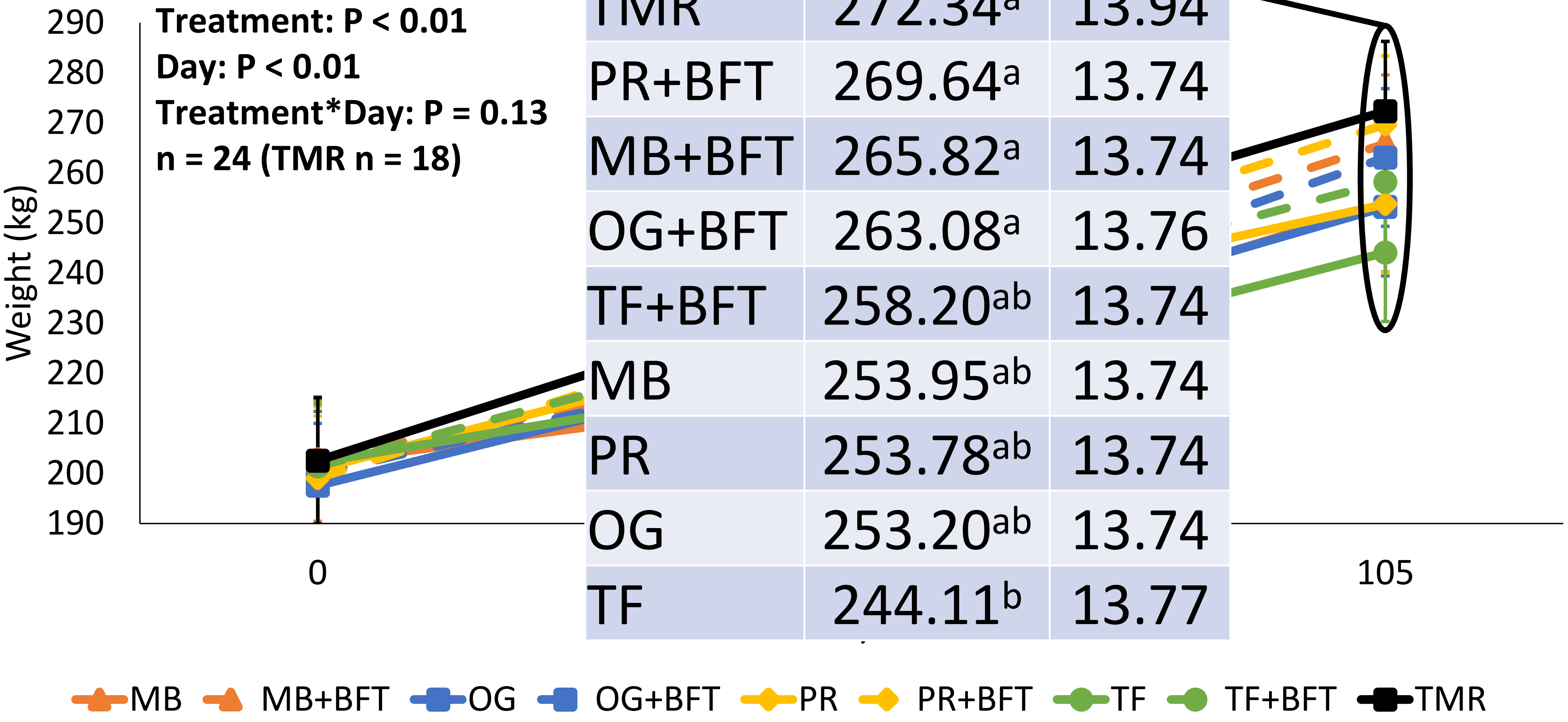
Results - Weight



Trmt	Day-70	SEM
TMR	251.34[a]	14.22
PR+BFT	246.76[ab]	14.04
MB+BFT	242.94[ab]	14.04
TF+BFT	239.35[abc]	14.04
PR	238.24[abc]	14.04
OG+BFT	238.01[abc]	14.05
OG	232.61[bc]	14.04
MB	231.68[bc]	14.04
TF	225.65[c]	14.04

Superscripts indicate differences (P < 0.05)

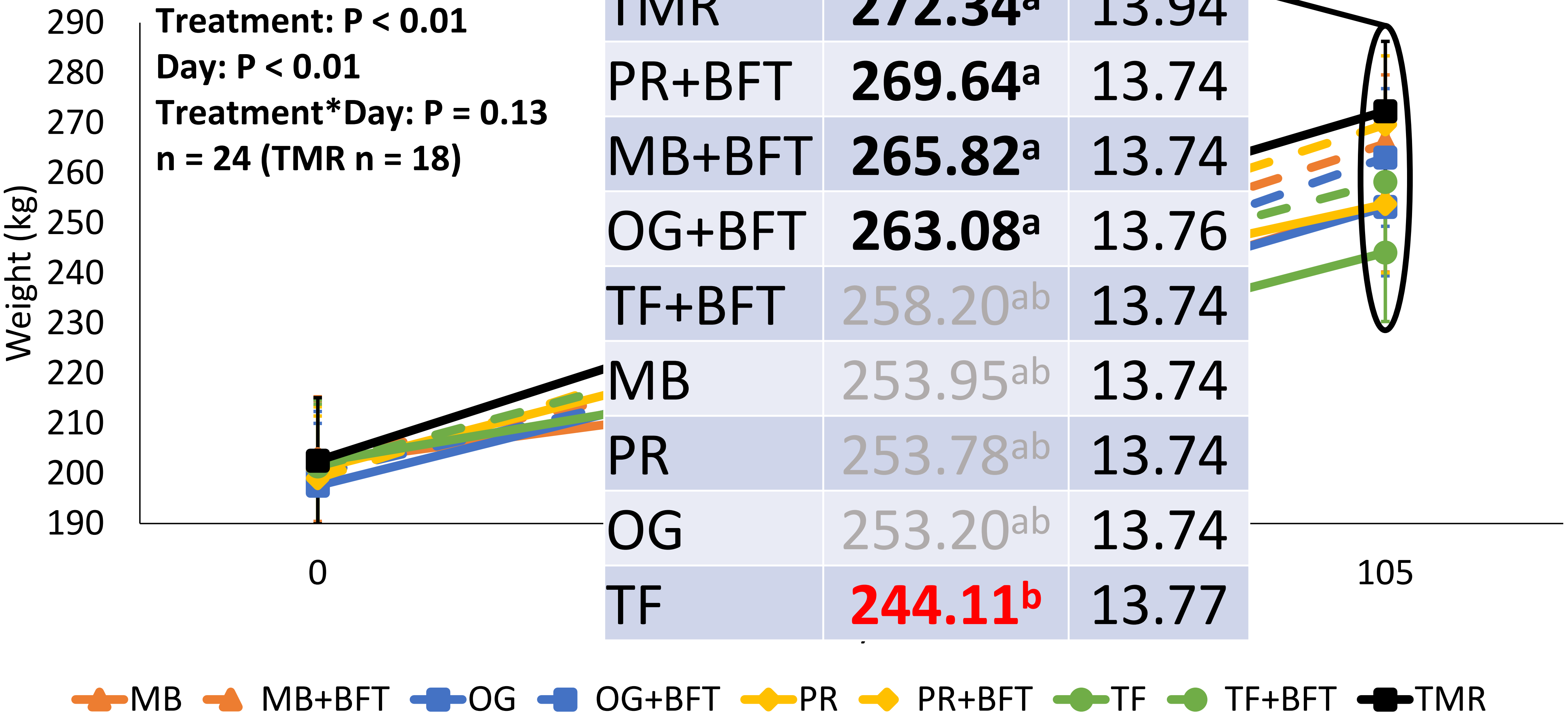
Results - Weight



Trmt	Day-105	SEM
TMR	272.34[a]	13.94
PR+BFT	269.64[a]	13.74
MB+BFT	265.82[a]	13.74
OG+BFT	263.08[a]	13.76
TF+BFT	258.20[ab]	13.74
MB	253.95[ab]	13.74
PR	253.78[ab]	13.74
OG	253.20[ab]	13.74
TF	244.11[b]	13.77

Superscripts indicate differences ($P < 0.05$)

Results - Weight



Trmt	Day-105	SEM
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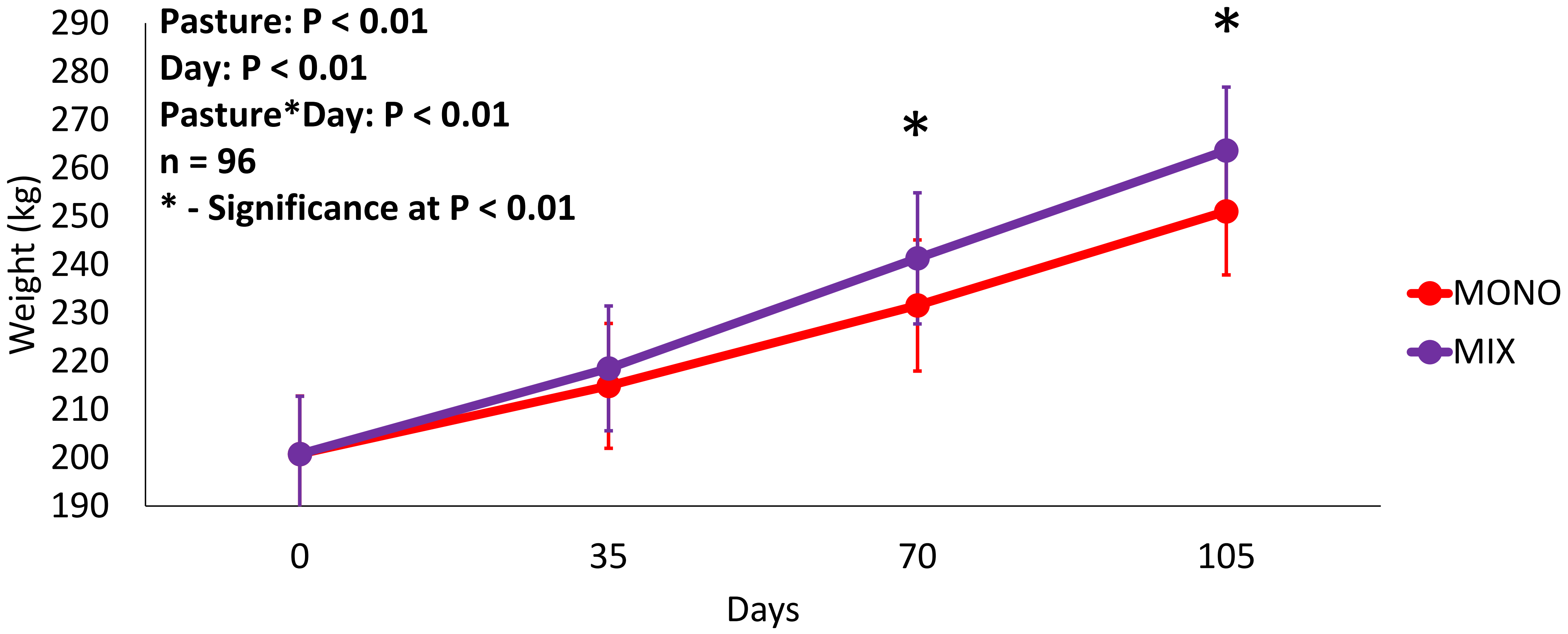
OG+BFT	**263.08^{a}**	13.76
TF+BFT	258.20^{ab}	13.74
MB	253.95^{ab}	13.74
PR	253.78^{ab}	13.74
OG	253.20^{ab}	13.74
TF	**244.11^{b}**	13.77

Results – Weight Gains (kg)

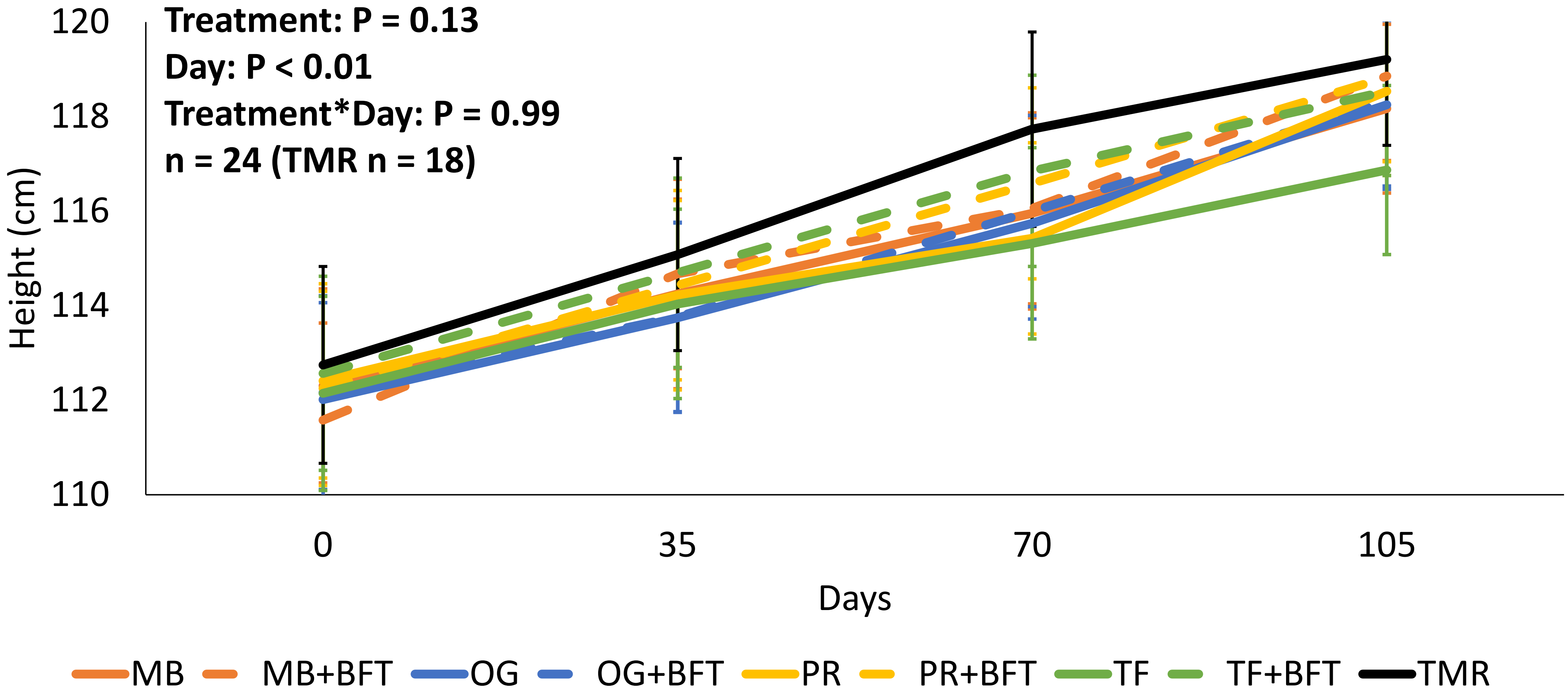
Superscripts indicate differences ($P < 0.05$)

Treatments	Heifer BW Gain	SEM	ADG (kg/d)
PR+BFT	70.54[a]	6.01	0.67
TMR	69.68[a]	6.62	0.66
OG+BFT	63.15[ab]	6.06	0.60
MB+BFT	62.90[abc]	6.01	0.60
TF+BFT	56.76[bcd]	6.01	0.54
OG	55.59[bcd]	6.01	0.53
PR	53.87[cd]	6.01	0.51
MB	51.81[d]	6.01	0.49
TF	40.80[e]	6.09	0.39

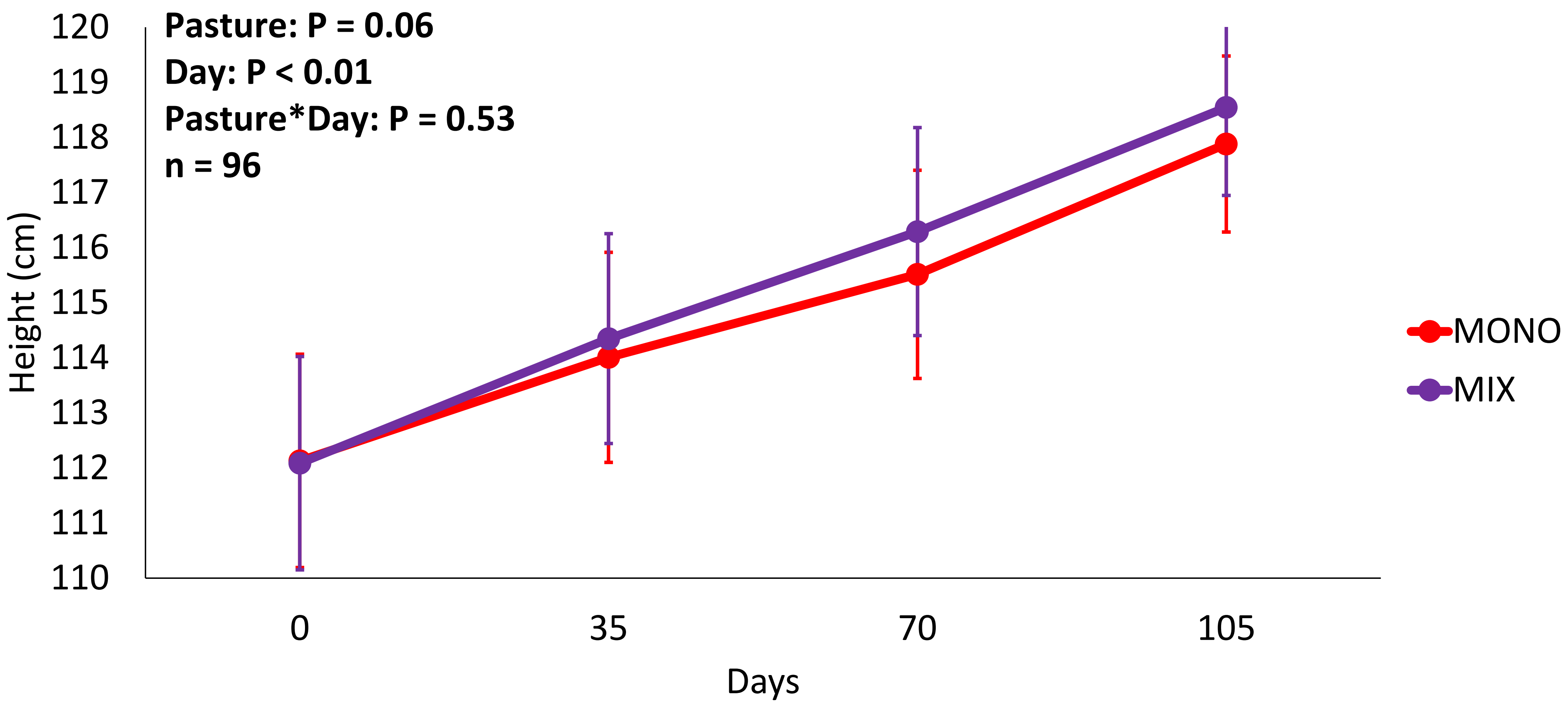
Results - Weight (kg)



Results – Hip-Height



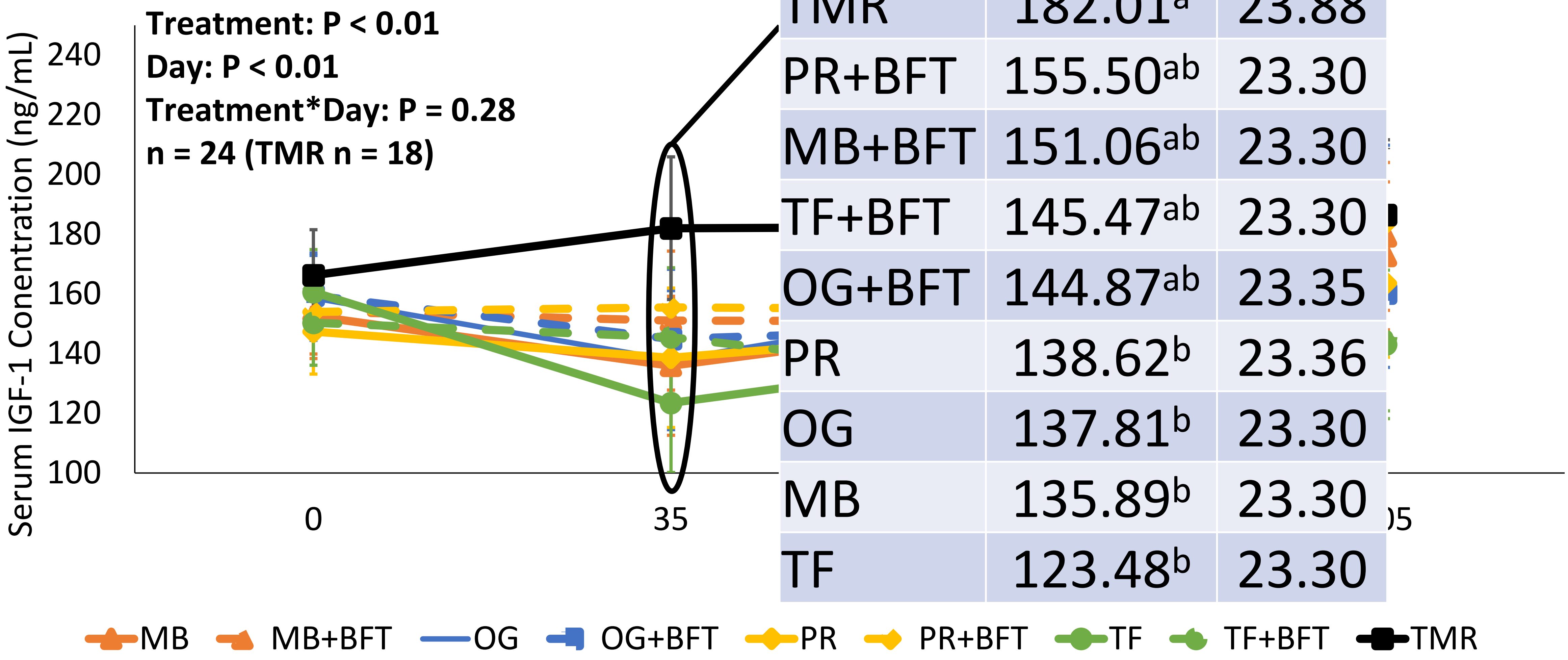
Results - Hip-Height



Industrial Applications – Physical Measurements

Superscripts indicate differences (P < 0.05)

Results - IGF-1

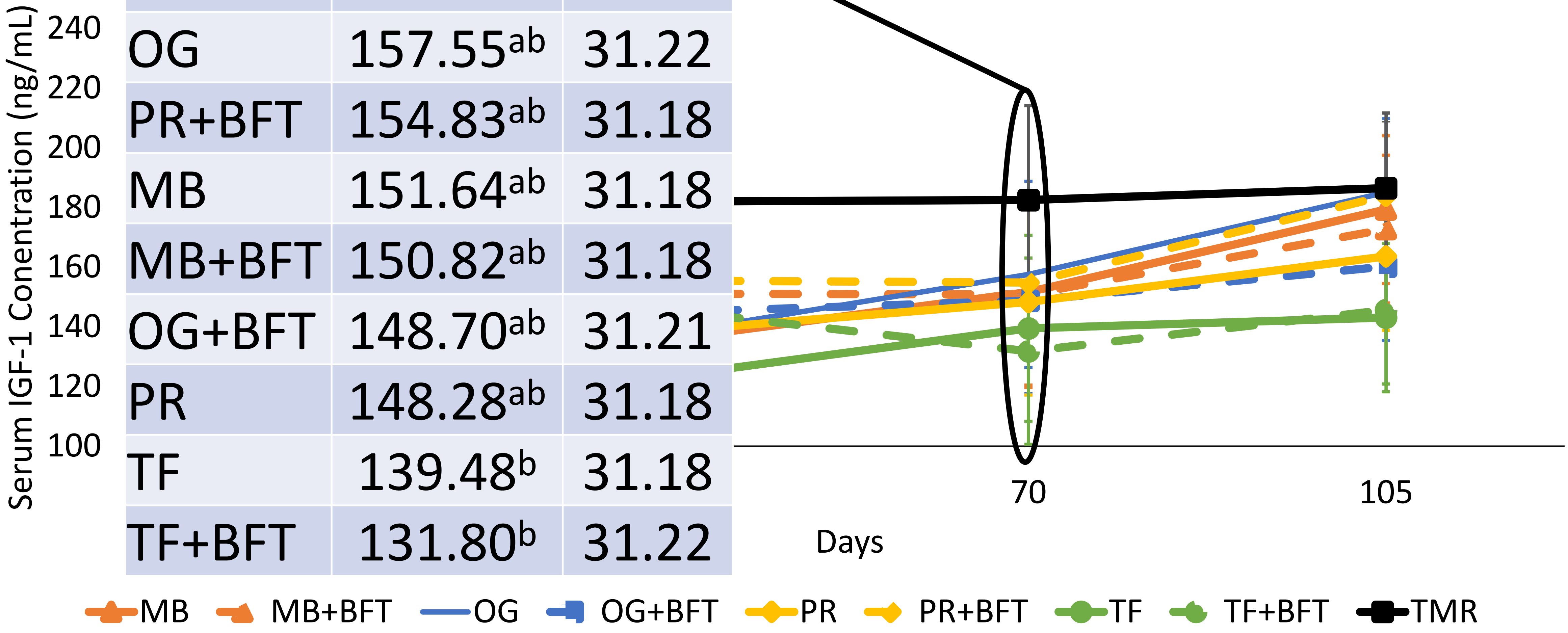


Trmt	Day-35	SEM
TMR	182.01^{a}	23.88
PR+BFT	155.50^{ab}	23.30
MB+BFT	151.06^{ab}	23.30
TF+BFT	145.47^{ab}	23.30
OG+BFT	144.87^{ab}	23.35
PR	138.62^{b}	23.36
OG	137.81^{b}	23.30
MB	135.89^{b}	23.30
TF	123.48^{b}	23.30

Superscripts indicate differences ($P < 0.05$)

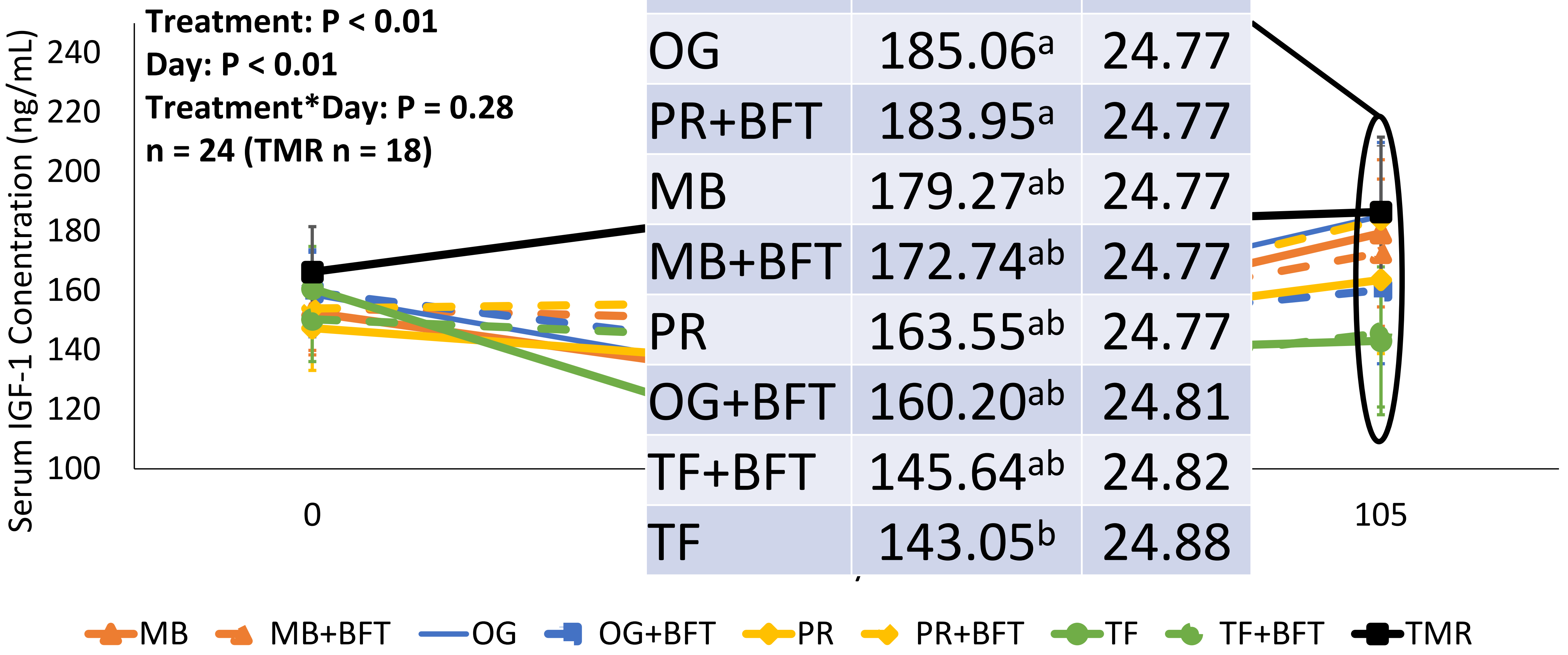
Resu

Trmt	Day-70	SEM
TMR	182.50[a]	31.57
OG	157.55[ab]	31.22
PR+BFT	154.83[ab]	31.18
MB	151.64[ab]	31.18
MB+BFT	150.82[ab]	31.18
OG+BFT	148.70[ab]	31.21
PR	148.28[ab]	31.18
TF	139.48[b]	31.18
TF+BFT	131.80[b]	31.22



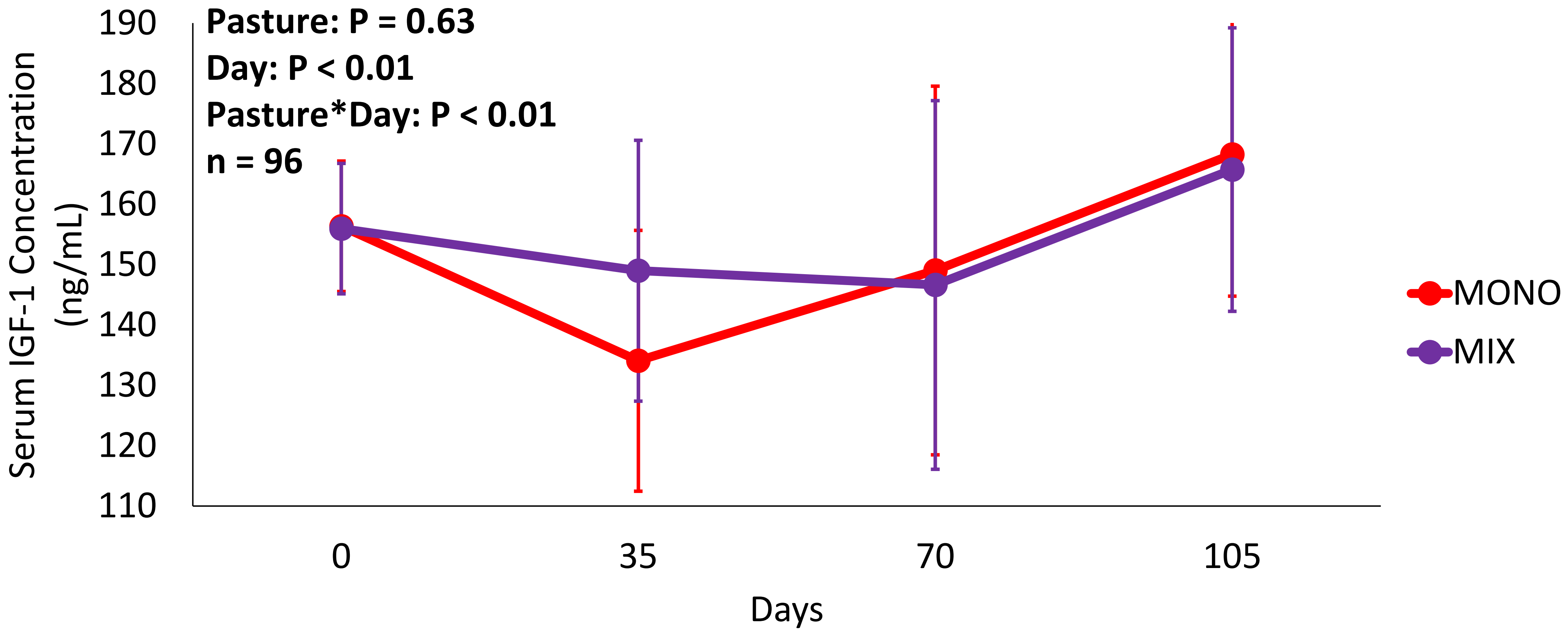
Superscripts indicate differences ($P < 0.05$)

Results - IGF-1



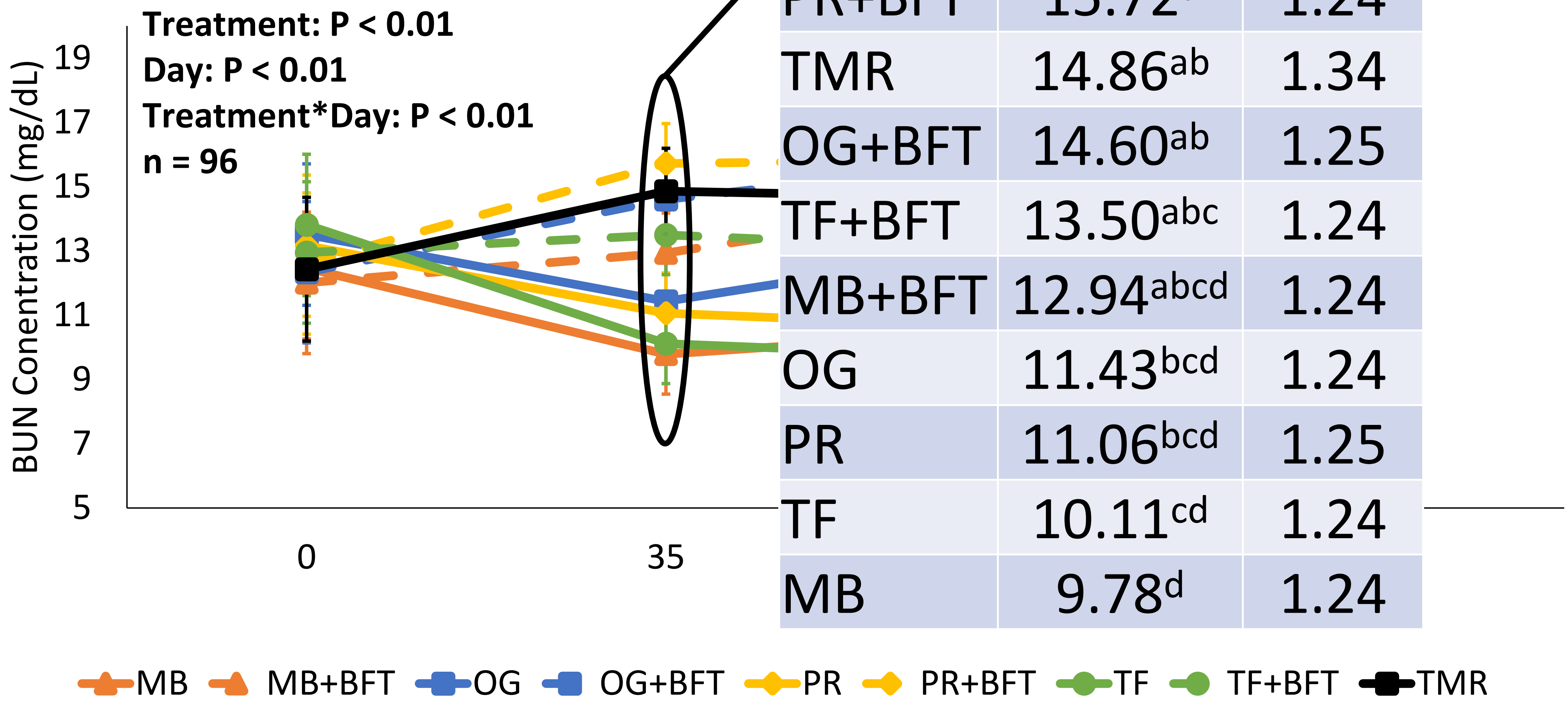
Trmt	Day-105	SEM
TMR	186.43[a]	25.24
OG	185.06[a]	24.77
PR+BFT	183.95[a]	24.77
MB	179.27[ab]	24.77
MB+BFT	172.74[ab]	24.77
PR	163.55[ab]	24.77
OG+BFT	160.20[ab]	24.81
TF+BFT	145.64[ab]	24.82
TF	143.05[b]	24.88

Results – IGF-1



Results - BUN

Superscripts indicate differences (P < 0.05)

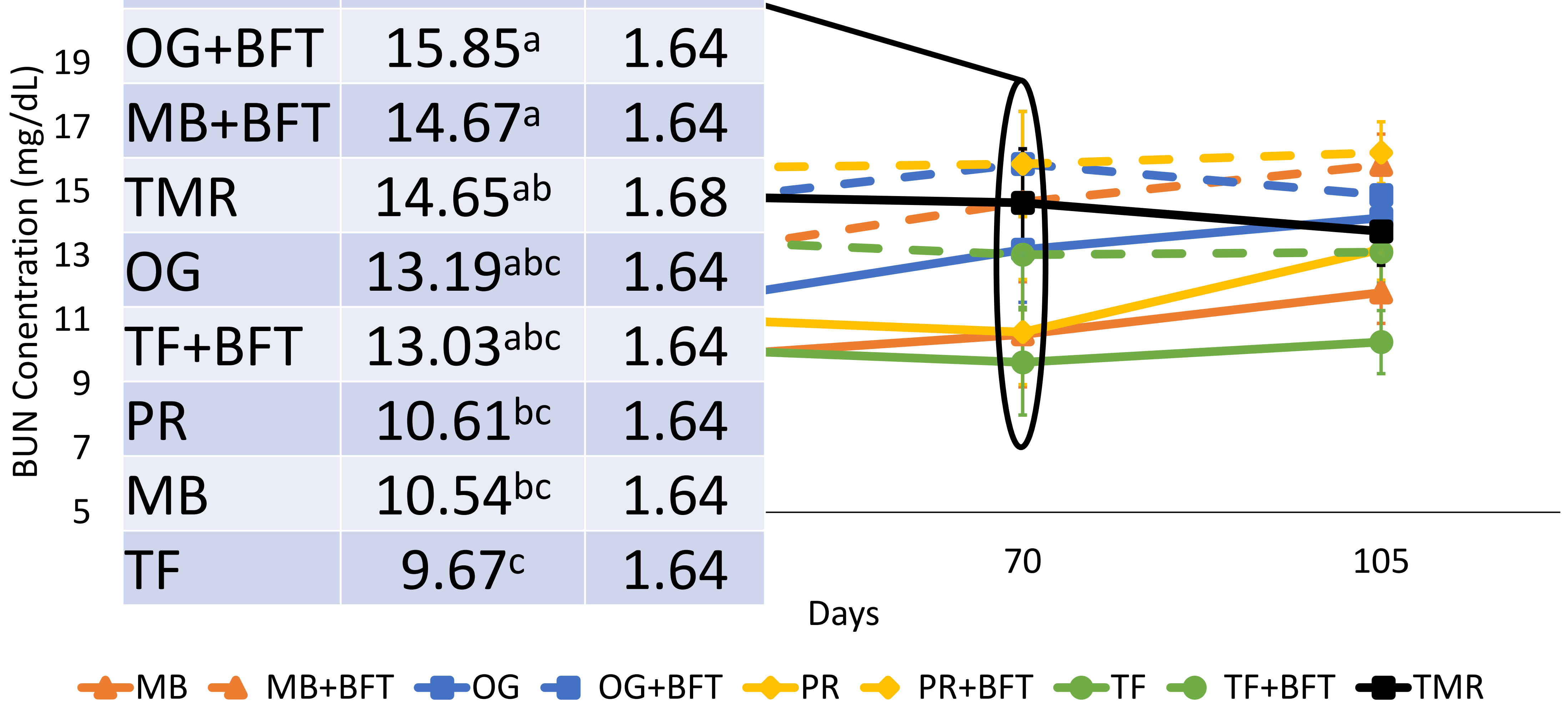


Trmt	Day-35	SEM
PR+BFT	15.72[a]	1.24
TMR	14.86[ab]	1.34
OG+BFT	14.60[ab]	1.25
TF+BFT	13.50[abc]	1.24
MB+BFT	12.94[abcd]	1.24
OG	11.43[bcd]	1.24
PR	11.06[bcd]	1.25
TF	10.11[cd]	1.24
MB	9.78[d]	1.24

Superscripts indicate differences ($P < 0.05$)

Resu

Trmt	Day-70	SEM
PR+BFT	15.85[a]	1.64
OG+BFT	15.85[a]	1.64
MB+BFT	14.67[a]	1.64
TMR	14.65[ab]	1.68
OG	13.19[abc]	1.64
TF+BFT	13.03[abc]	1.64
PR	10.61[bc]	1.64
MB	10.54[bc]	1.64
TF	9.67[c]	1.64



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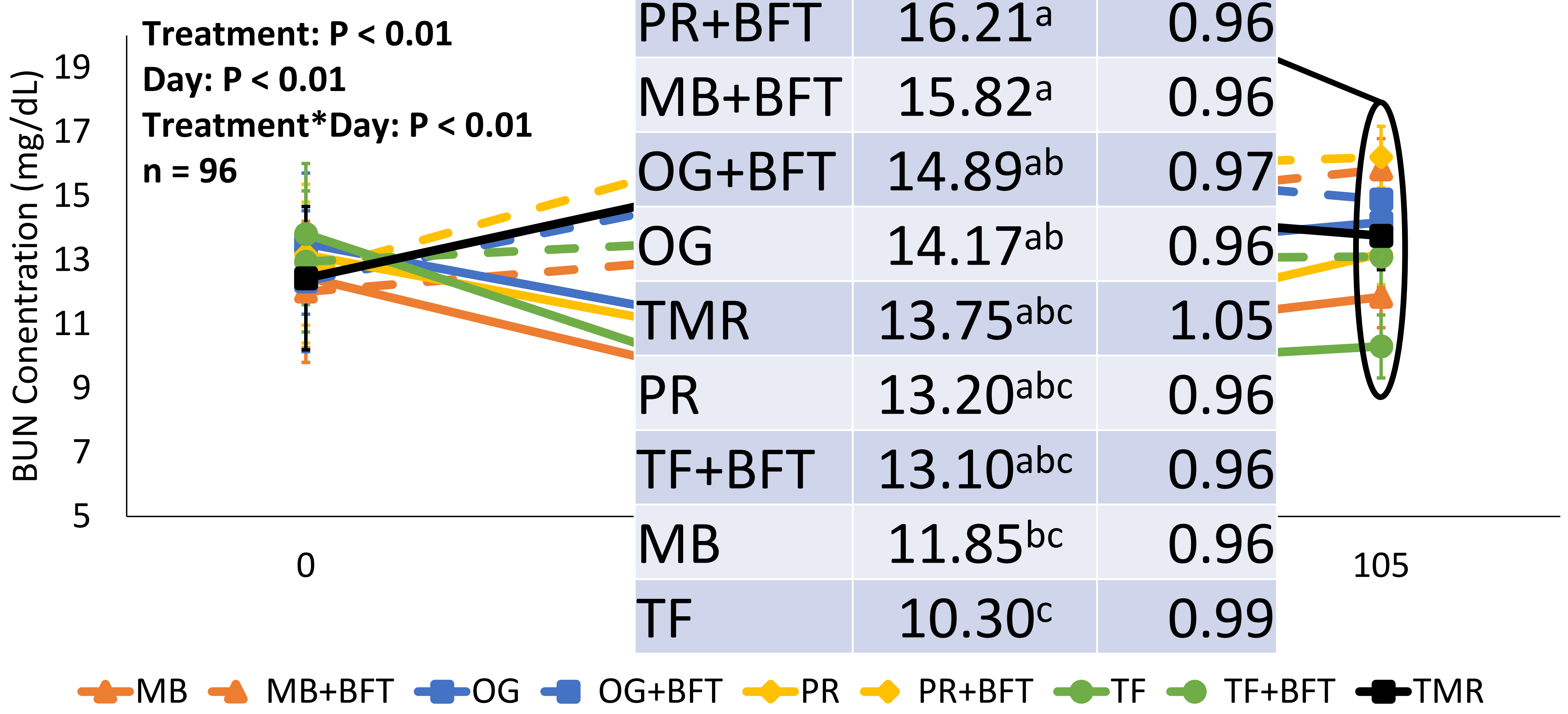
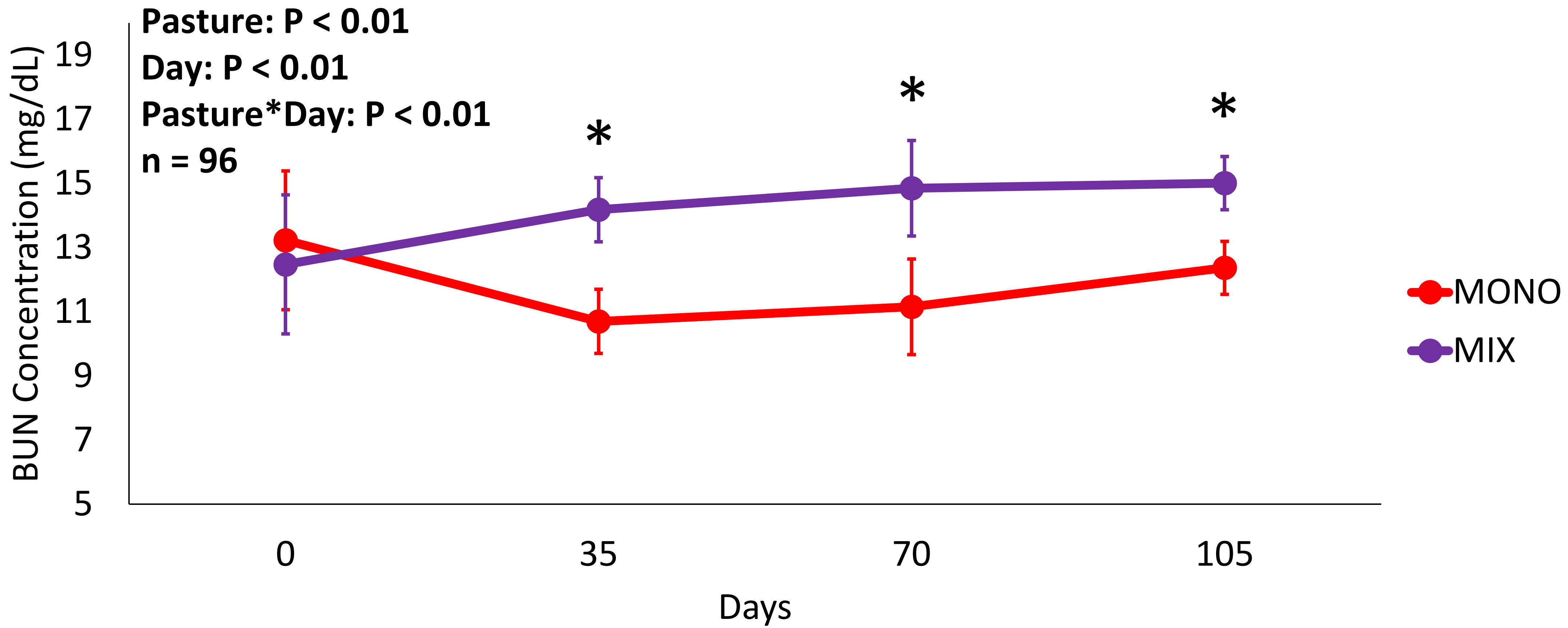
Results - BUN



Trmt	Day-105	SEM
PR+BFT	16.21^{a}	0.96
MB+BFT	15.82^{a}	0.96
OG+BFT	14.89^{ab}	0.97
OG	14.17^{ab}	0.96
TMR	13.75^{abc}	1.05
PR	13.20^{abc}	0.96
TF+BFT	13.10^{abc}	0.96
MB	11.85^{bc}	0.96
TF	10.30^{c}	0.99

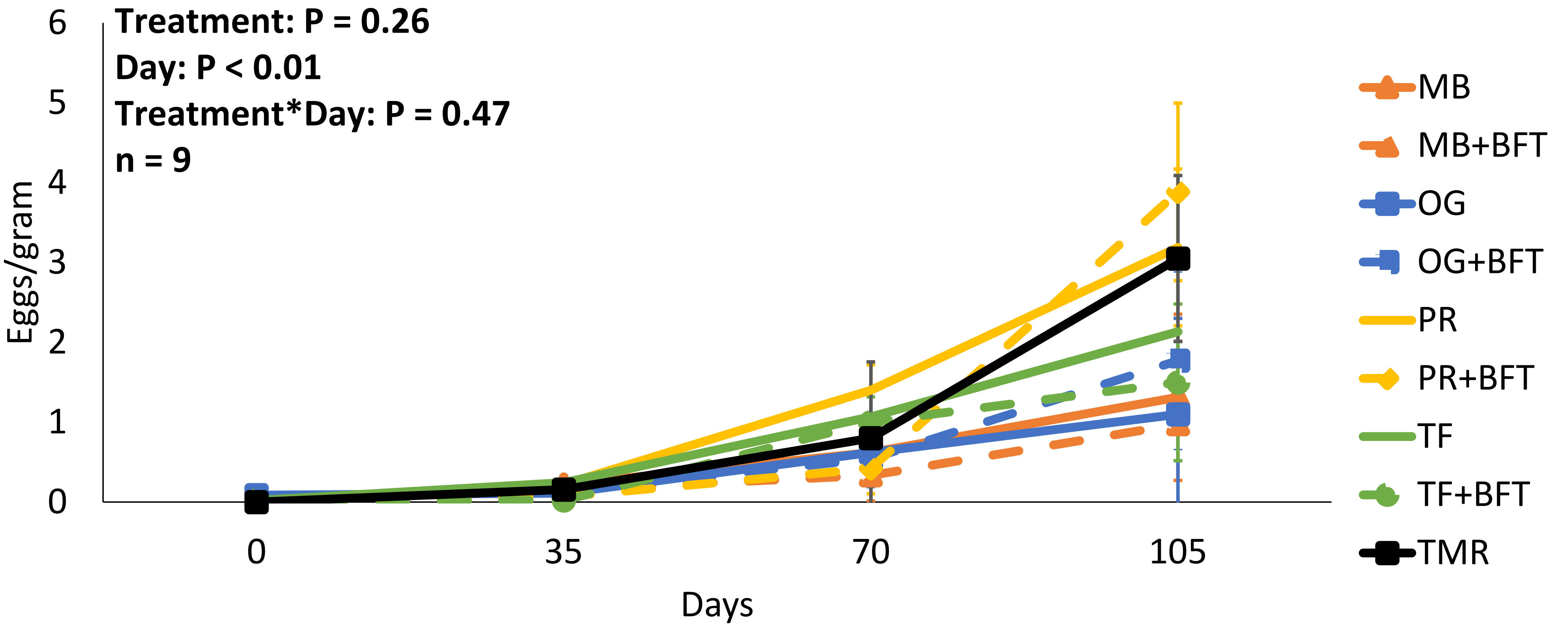
Results - BUN



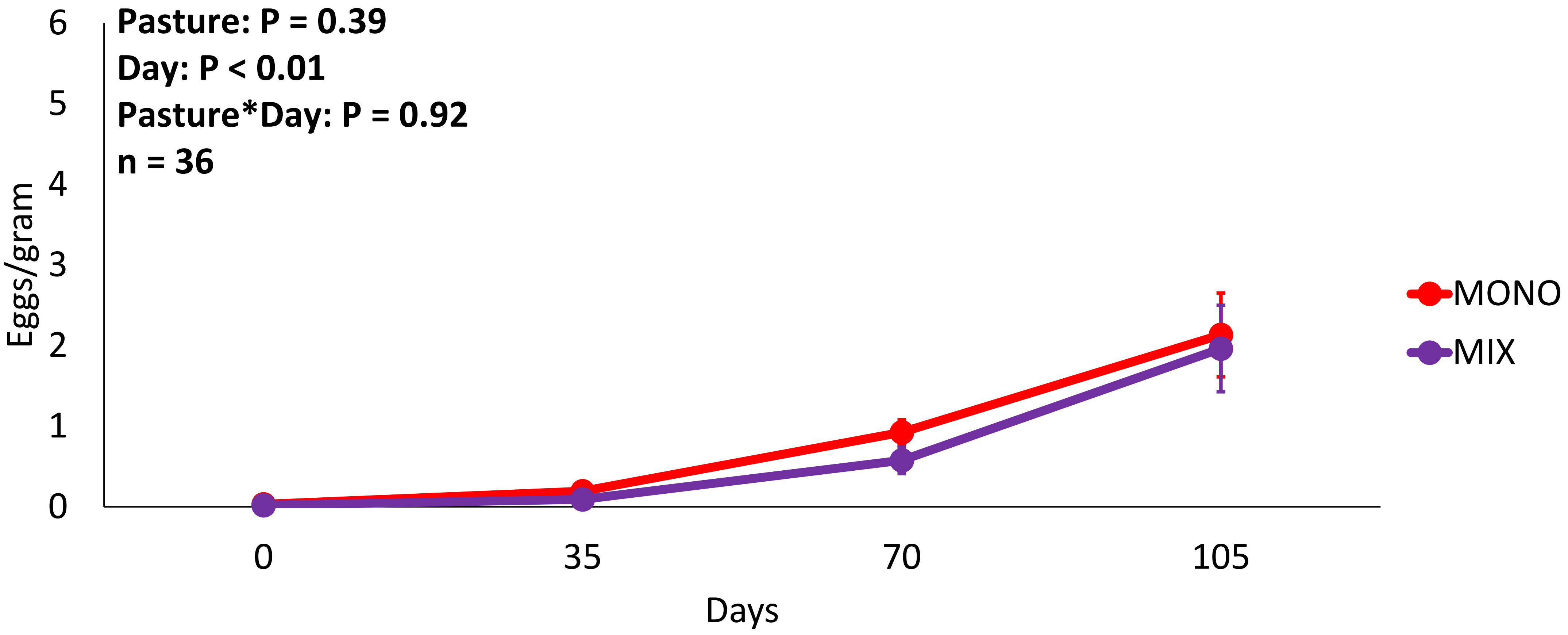
*-Significance at P < 0.01

Industrial Applications – Serum Metabolites

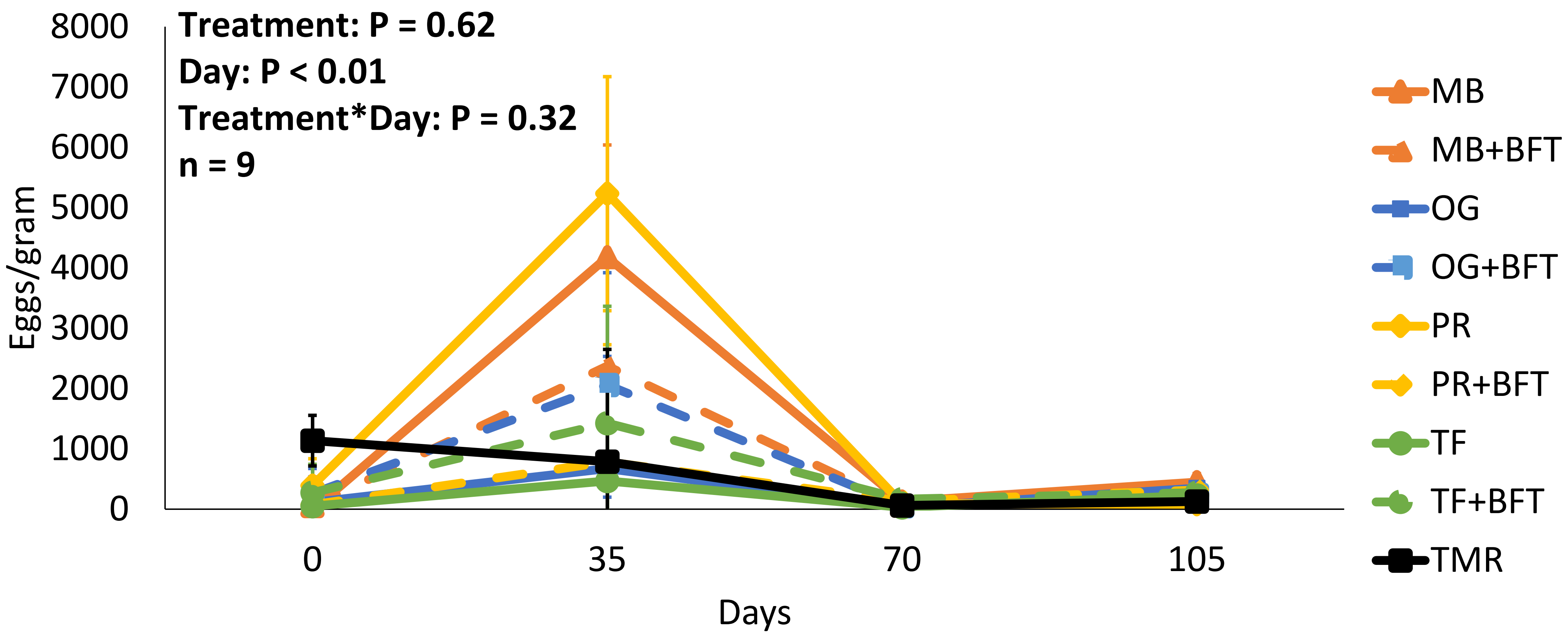
Results – FEC 2017



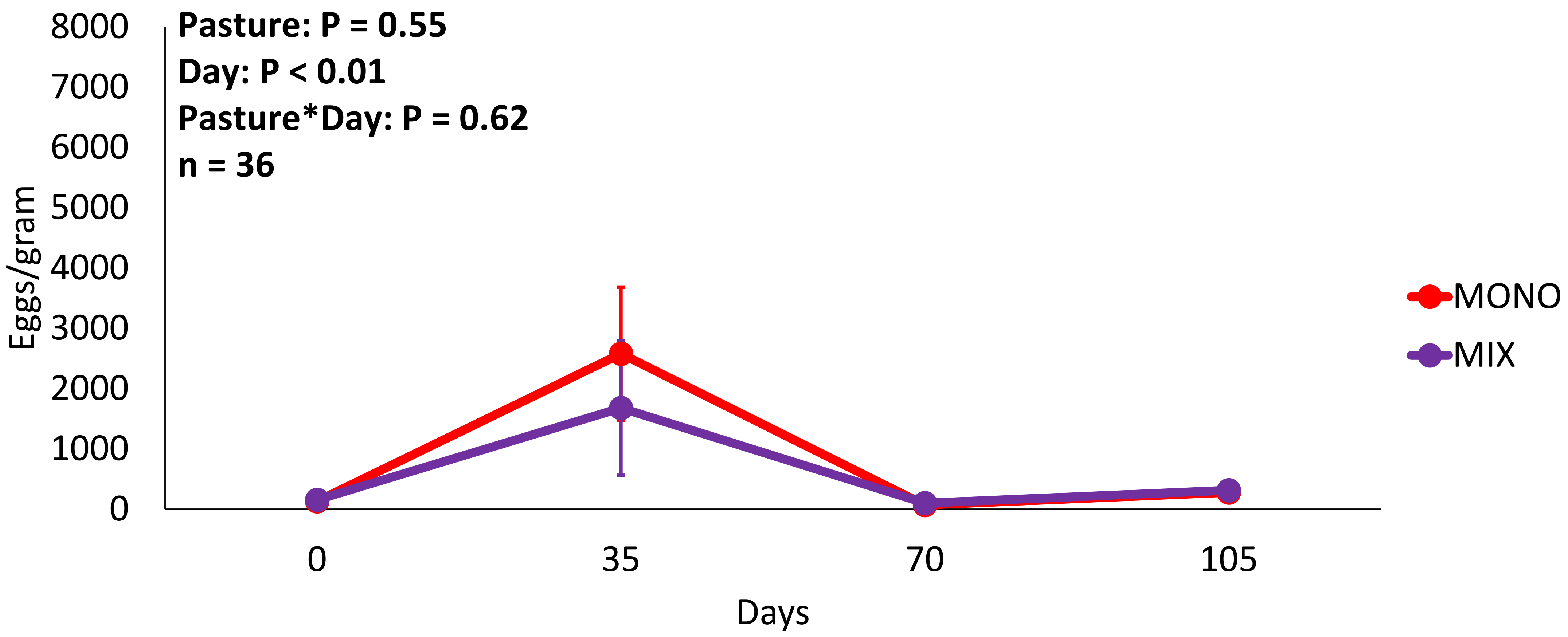
Results – FEC 2017



Results – FEC 2018



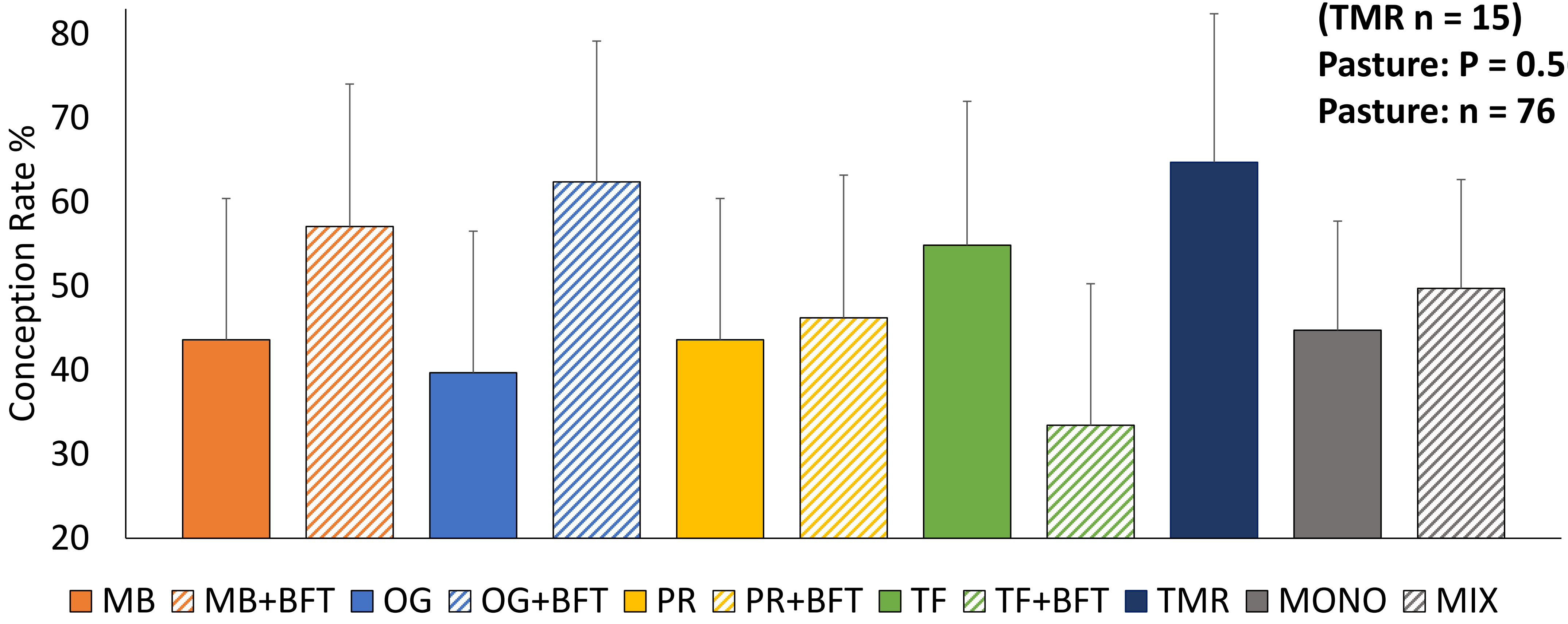
Results – FEC 2018



Industrial Applications – Parasite Load

Results – Conception Rates

Treatment: P = 0.67
Treatments: n = 19
(TMR n = 15)
Pasture: P = 0.56
Pasture: n = 76



Industrial Applications – Reproduction

Conclusion

- Treatment had an effect on heifer body weight, weight gains, BUN concentrations, and IGF-1 concentrations
- Heifer receiving MIX pastures had higher body weights, weight gains, and BUN concentrations than heifers receiving MONO pastures
- Treatment and pasture had no effect on heifer hip-height, FEC, or conception rates

Acknowledgements

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USDA United States Department of Agriculture National Institute of Food and Agriculture

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UTAH AGRICULTURAL EXPERIMENT STATION
UtahStateUniversity

- Thanks to my family and friends for their help and support

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