A comparison of Chaffhaye and alfalfa hay on digestibility and glucose metabolism in mature, stock type horses

BY ASHLEY HANSEN

Problems with managing horses in confinement

Nutrient Requirement

Horse’s Individual Nutrient Needs

- Physiological Level
  - -Growing
  - -Reproductively Active
  - -Lactating
  - -Etc.
- Level of Work
- Body Weight

* Consistent Feedstuff is Important

(NRC, 2007)

Problems with managing horses in confinement

Nutrient Requirement

Fecal Output

Fecal Output and Disposal

- A horse defecates:

  37 lbs per day

  13,505 lbs per year

  (Fabian, 2001)

- Agricultural runoff is the

main cause of water quality problems

for lakes and rivers (USEPA, 1990)

Problems with managing horses in confinement

Nutrient Requirement

Fecal Output

Metabolic Issues

Equine Metabolic Challenges

Rapid intake of non-structural carbohydrate (NSC) can cause:

(Obel, 1948)

Irregularities in:

Insulin production

Glucose metabolism

→

Insulin Resistance

Laminitis

Founder

Equine Metabolic Syndrome

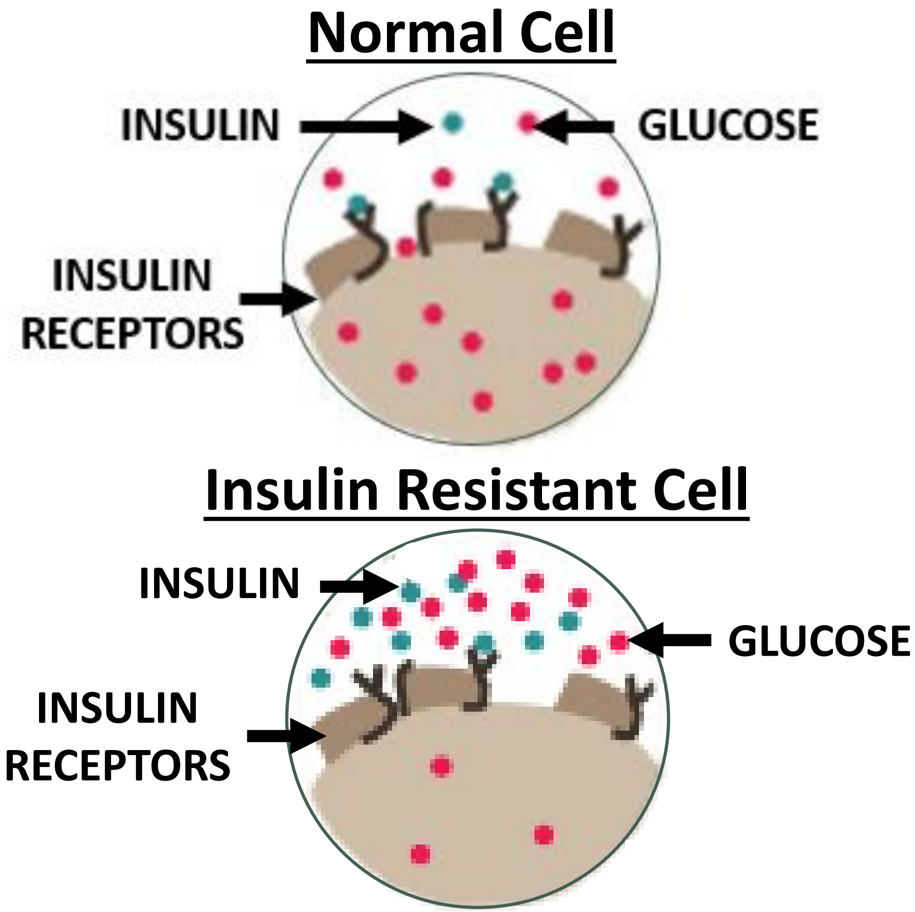
(Ralston, 1996; Treiber et al., 2005; Frank, 2009)

Insulin Resistance

⬆ Glucose Intake = ⬆ Insulin Production

Causes Insulin Receptors Shut Down

- Typically seen in obese horses and ponies (Longland & Byrd, 2006)



Laminitis/Founder

- Largely caused by high intake of NSC (Obel, 1948)

Increased Fermentation in Hindgut

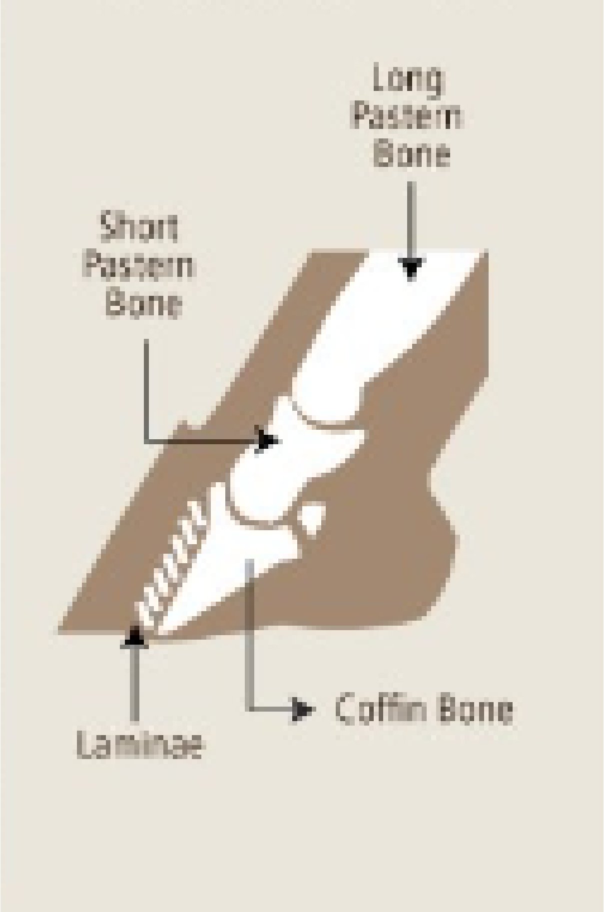
Drop in pH

Blood Acidosis

Reducing Glucose Uptake by Cell

Inflammation/Separation of Sensitive Laminae

(Garner et al., 1977)



Laminitis

Insulin Resistance

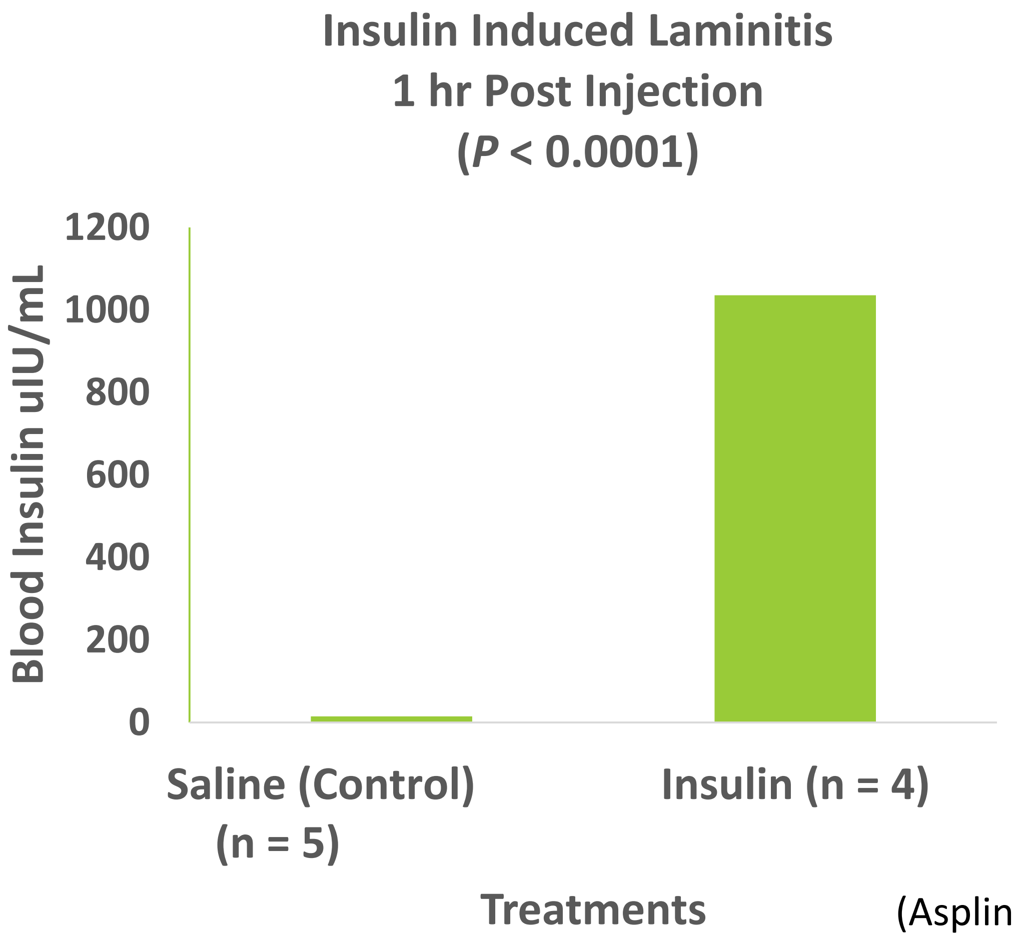
⇩

Low Glucose Uptake

⇩

Laminitis

All horses receiving insulin Developed laminitis in all 4 feet 72 h after administration (Asplin et al., 2007)



(Asplin et al., 2007)

Problems with managing horses in confinement

Nutrient Requirement

Water Intake

Fecal Output

Metabolic Issues

Water Intake

<u>Adequate water intake can prevent:</u>

Colic

(Thompson, 1992)

Choke

(Hillyer, 1995)

Ulcers

(MacAllister and Sangiah, 1993)

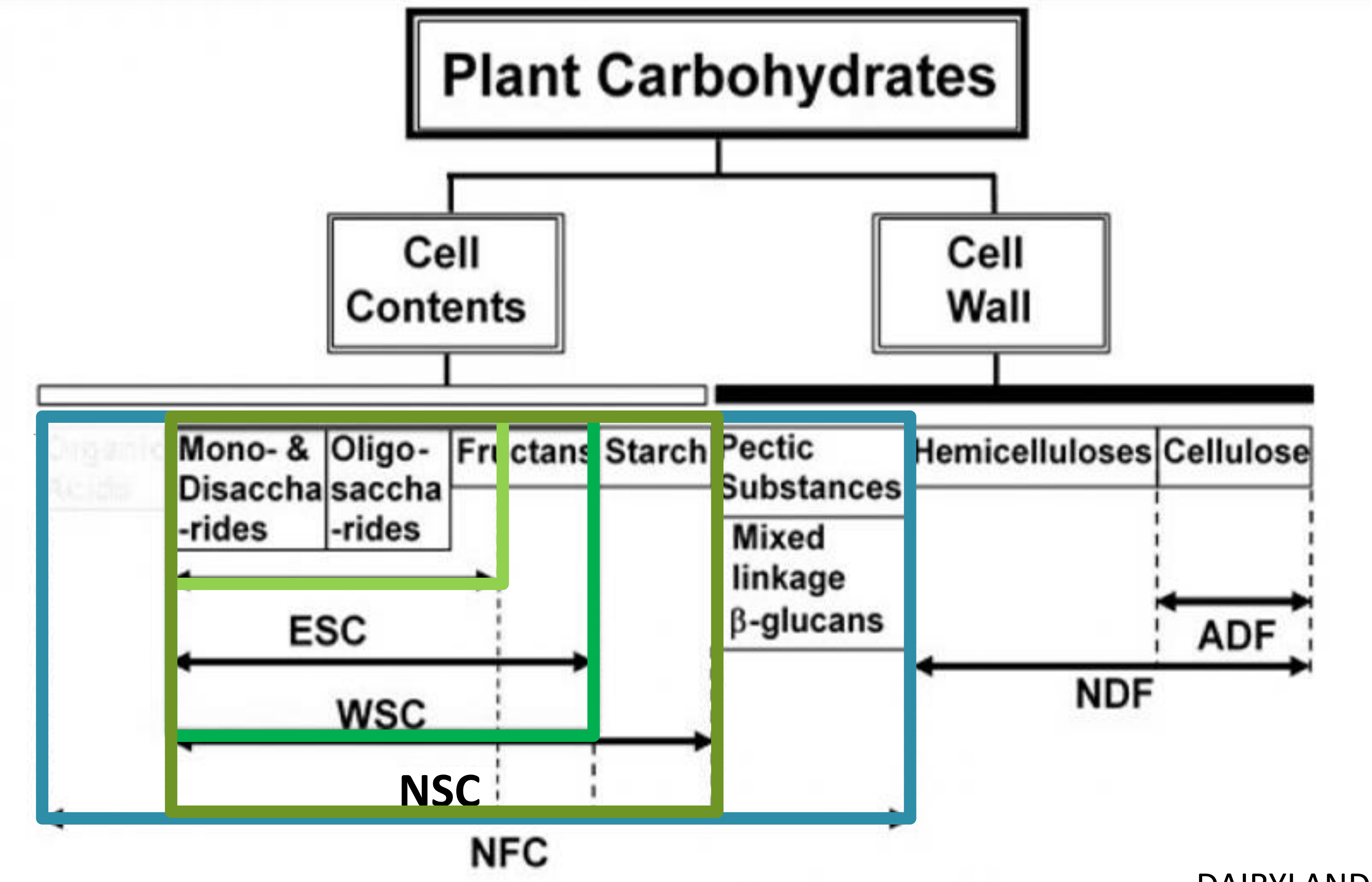
Feeding Higher Digestibility Forage

- ⬆ Utilization of Feed
- ⬇ Fecal Output
- ⬇ Impaction Colic

(Cohen et al. 1995)

Digestibility in horses can be affected by:

- ↓ Feeding Level = ↑ DM Digestibility
  (Pearson et al., 2001; Ragnarsson and Lindberg, 2009)
- ↓ Particle Size of Forage = ↓ DM Digestibility
  (Rodrique and Allen, 1960; Wolter et al., 1977; Sellers et al., 1982)
- ↓ Moisture Content = ↑ DM Digestibility
  (Olsson and Ruudvere, 1955; Uden et al., 1982; Moore-Colyer et al., 2003)
- ↑ Processing = ↑ DM Digestibility
  (Moore-Colyer et al., 2003; Muhonen, 2009)

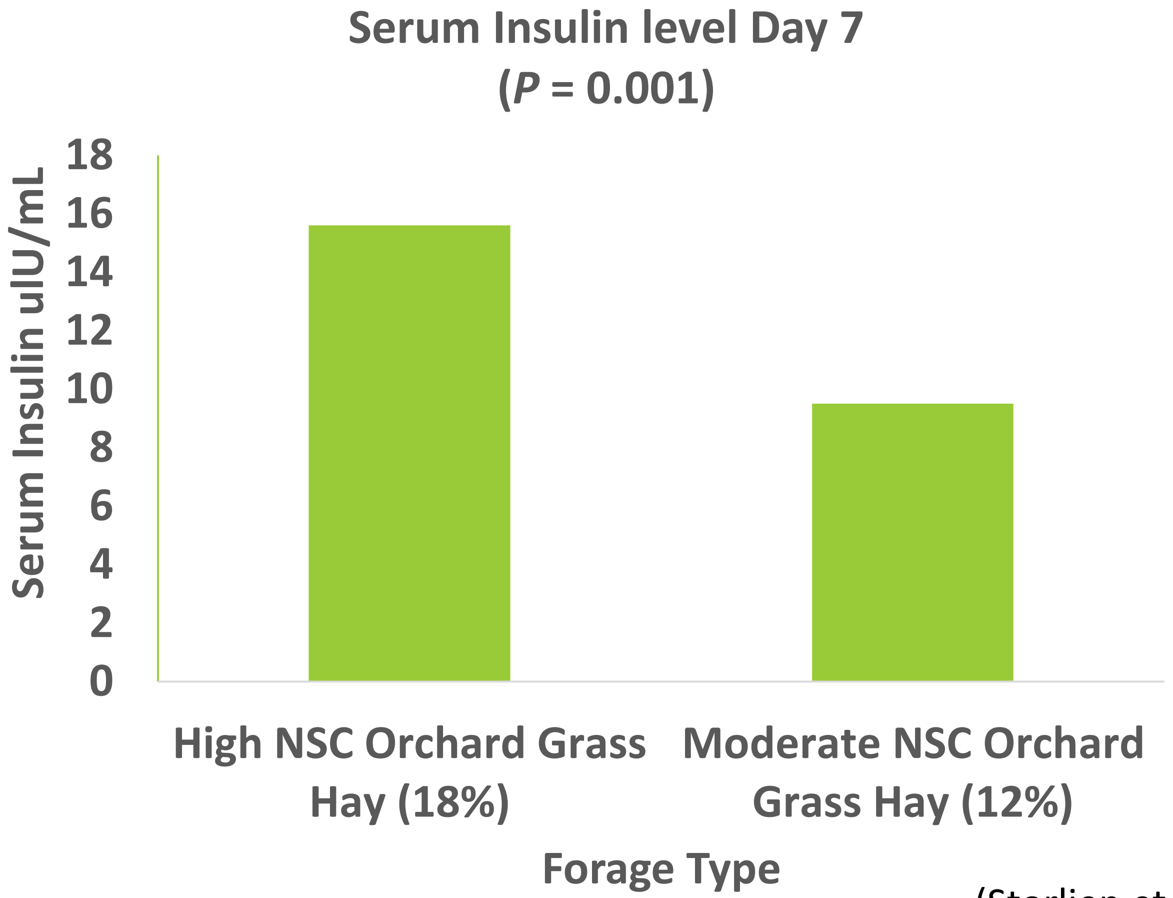


DAIRYLAND Laboratories, Inc.

Feeding forage with lower NSC

- High amounts of NSC can affect blood glucose levels and induce insulin resistance

(Storlien et al., 2000)



(Storlien et al., 2000)

How Haylages are Produced

- Low moisture silage- Haylage (40-60 % DM)
- 4 Steps:

  -harvesting

  -packing

  -covering

  -fermentation
- Molasses and inoculants often added (Kellems and Church, 2010)

Higher Digestibilites for Haylage/Silage in Horses

- Silage fed to horses had significantly higher DM, ADF, NDF and CP digestibilities when compared to dried hay (Moore-Colyer et al., 2003)

- DM, OM, NDF, and ADF higher digestibilities for horses fed silage than hay (Muhonen, 2009)

Lower WSC Concentration in Ensiled Forages

Ensiling process lowers WSC concentrations in silage when compared to dried hay (McDonald, 1991)

ITEM	Hay	Silage
WSC (g/kg DM)	157	140

*Harvested Simultaneously

(Muhonen, 2009)

ITEM	Hay	Haylage
WSC (g/kg DM)	101	71

*Harvested Simultaneously

(Muller and Uden, 2006)

CHAFFHAYE

PREMIUM FEED

Chaffhaye

Alfalfa Chaff

+ Molasses

+ Inoculants

(*Pediococcous pentosaceus* &

Propionibacterium freudenreichii)

<u>+ Fermentation</u>

= Chaffhaye

* Produced in irrigated field

Evaluation of nutrient intake, in situ disappearance, and fermentation characteristics of fermented Chaffhaye with alfalfa hay and prairie grass hay in steers

- 6 rumen fistulated steers
- *In situ* NDF disappearance (12 and 24 hour incubations) were greater ($P \leq 0.0001$) for Chaffhaye & alfalfa hay vs. grass hay diet
- 96 hour incubation the NDF disappearance for the Chaffhaye was greater ($P = 0.024$) than the alfalfa hay.

(Guantam et al., 2014)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Objective

To compare digestibility and metabolic response in mature stock-type horses fed Chaffhaye or dried alfalfa forage diets.

Hypothesis

- That Chaffhaye will be more readily digestible when compared to dried alfalfa in mature horses across most nutritive parameters and have lowered glucose and insulin response after a meal.

Study Design

- All procedures were approved by NMSU IACUC
- Utilize 10 mature, stock type geldings
- Avg. Age: 13.8 y ± 8 y
- Avg. Weight: 553.2 kg ± 81 kg
- Crossover design

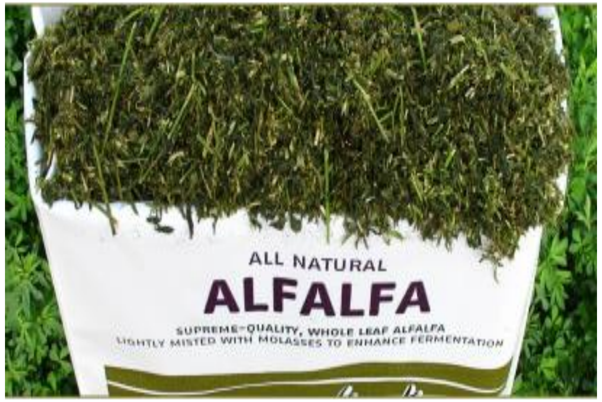
  -Groups were stratified by age and weight

Treatments

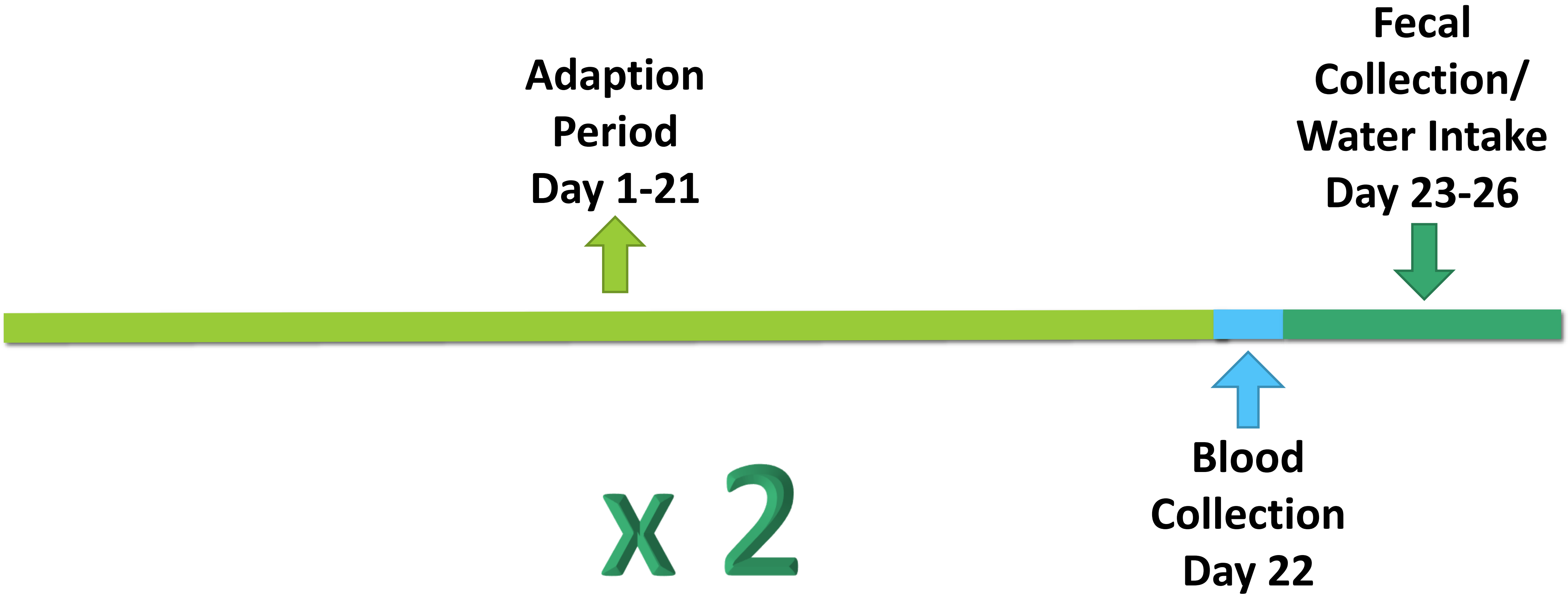
- 2 treatments:
  - -Chaffhaye and dried alfalfa hay
  - -Fed at 1.9% of BW (AF) per day

In order to feed like "Real-World" horse owner

- Diets were divided in 2 equal rations and fed in 12 hr intervals
- Orts were collected and recorded
- Ad libitum access to water & mineral block
- Water intake was recorded



Project Timeline



Dietary Adaption Period

- 21 Days
- Stalled with 2 h turnout/d
- Ensure palatability
- Microorganism adaption

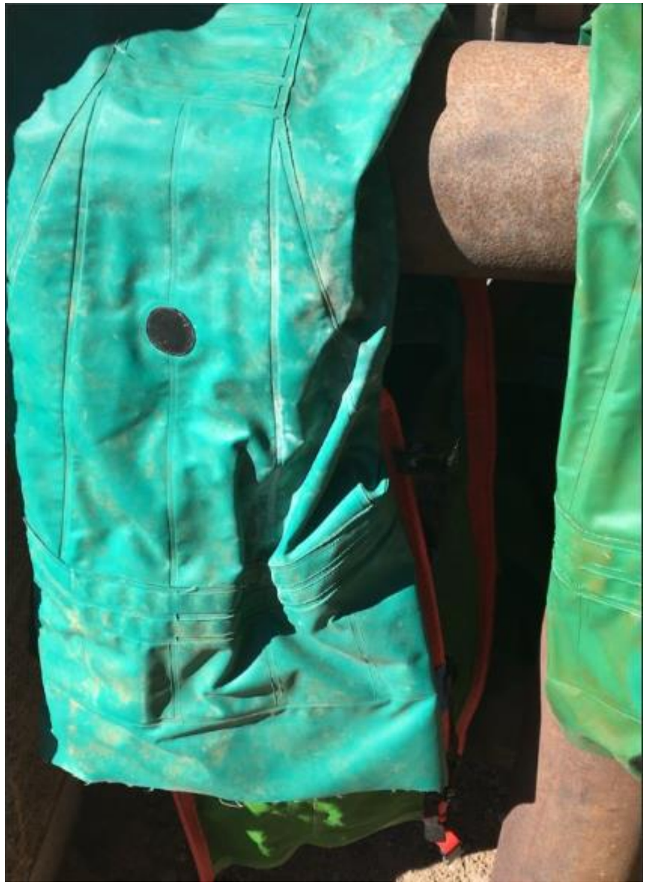
(Julliand, 2001)

Blood Collections

- Day 22
- Insert catheter 30 min before meal
- Blood samples: 0 (directly before meal) 30, 60, 120, 240, 360 min

Digestion Trial

- 4 days
- Total fecal collection harnesses
- Empty harnesses every 6 hours
- Mix contents
- Preserve 5% sub sample & freeze



Analyses

Forage

- DM, OM, CP, Crude Fat, NDF, ADF, NFC, WSC, ESC, Starch, Ash

Fecal

- DM, OM, CP, Crude Fat, NDF, ADF, NFC, Ash

Glucose Insulin:

- Glucose Serum- colorimetric analyses
- Insulin Serum- Immulite 1000 Assay
- Analyzed for AUC and PEAK

Statistical Analysis

- Mixed procedure SAS

  -Fixed effects:

  -Treatment (fiber source)

  -Period

  -Horse

  -No Random Effect

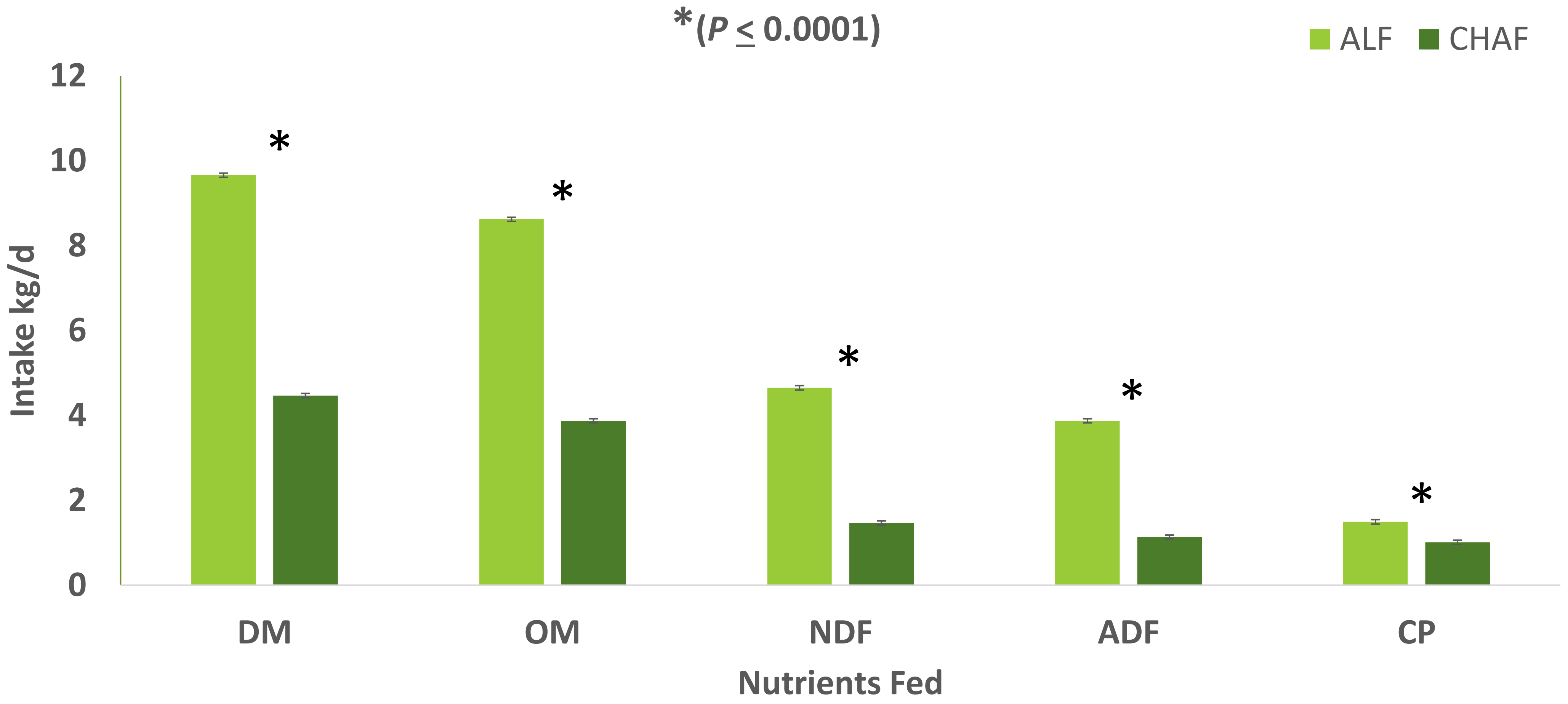
- Effects will be considered significant when $\alpha \leq 0.05$ and a trend $0.15 \geq \alpha \geq 0.05$

Table 1. Nutrient analysis of Chaffhaye[1] (CHAF) and alfalfa hay (ALF).

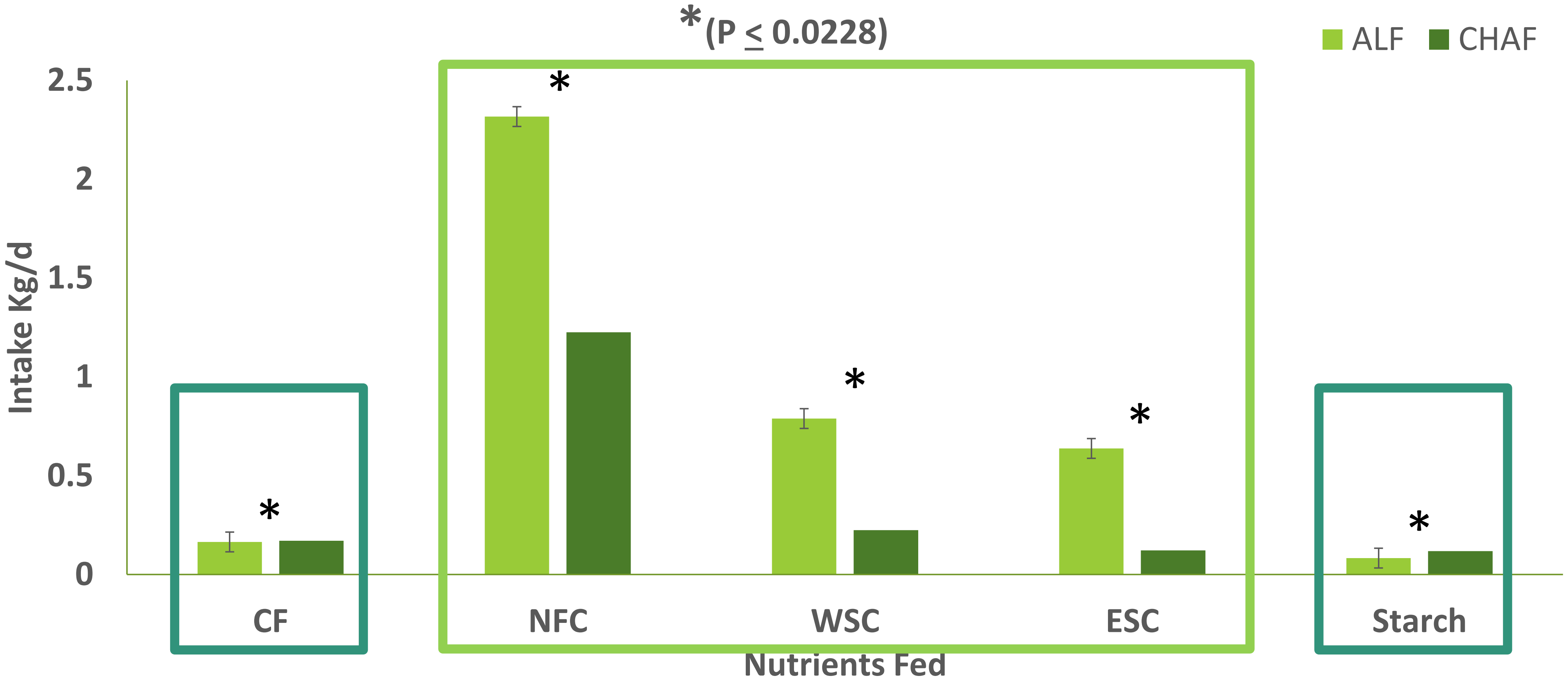
	Treatments			
	Period 1		Period 2	
Nutrient % (DM Basis)	ALF	CHAF	ALF	CHAF
DM	92.5	39	91.5	45
OM	81.7	25.7	80.7	31.7
NDF	52.5	33	43.7	32.7
ADF	44.9	24.8	35.2	25.9
CP	14.3	23.8	16.6	21.6
CF	1.7	3.8	1.7	3.8
Ash	10.76	13.35	10.76	13.35
NFC[2]	20.74	26.05	27.24	28.55
Starch	0.6	2.7	1.1	2.6
WSC	8.3	4.8	8	5.2
ESC	5.6	2.4	7.6	3
TDN	56	63	58	63

[1]Alfalfa haylage with cane molasses and dried fermentation product of *Pediococcous pentosaceus* and *Propionibacterium freudenreichii* in a sealed bag, Dell City, Texas Chaffhaye, Incorporated.
[2]NFC= 100% - (CP % + Fat % + Ash % + NDF %) (values on a DM basis).

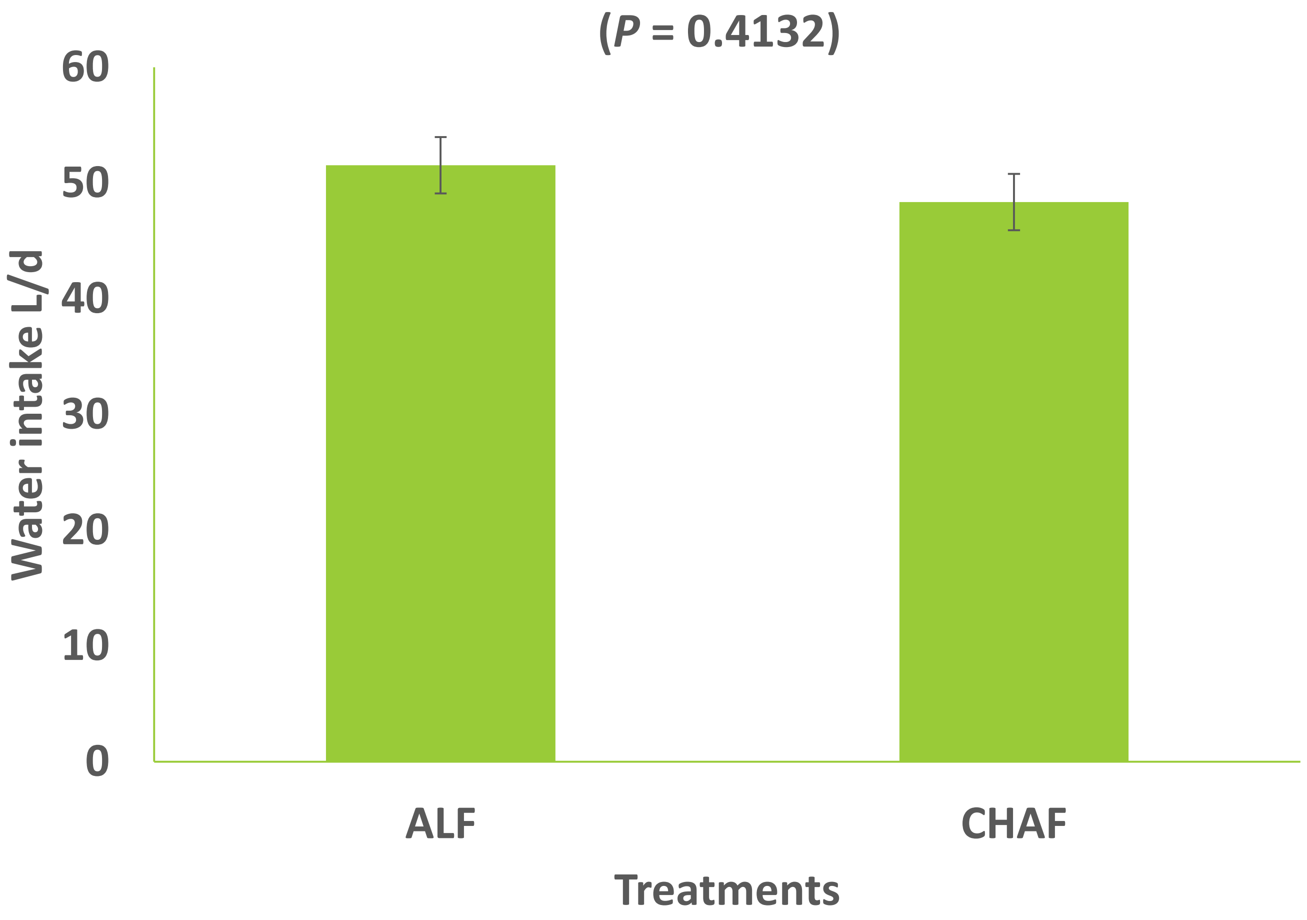
Nutrient Intake Results



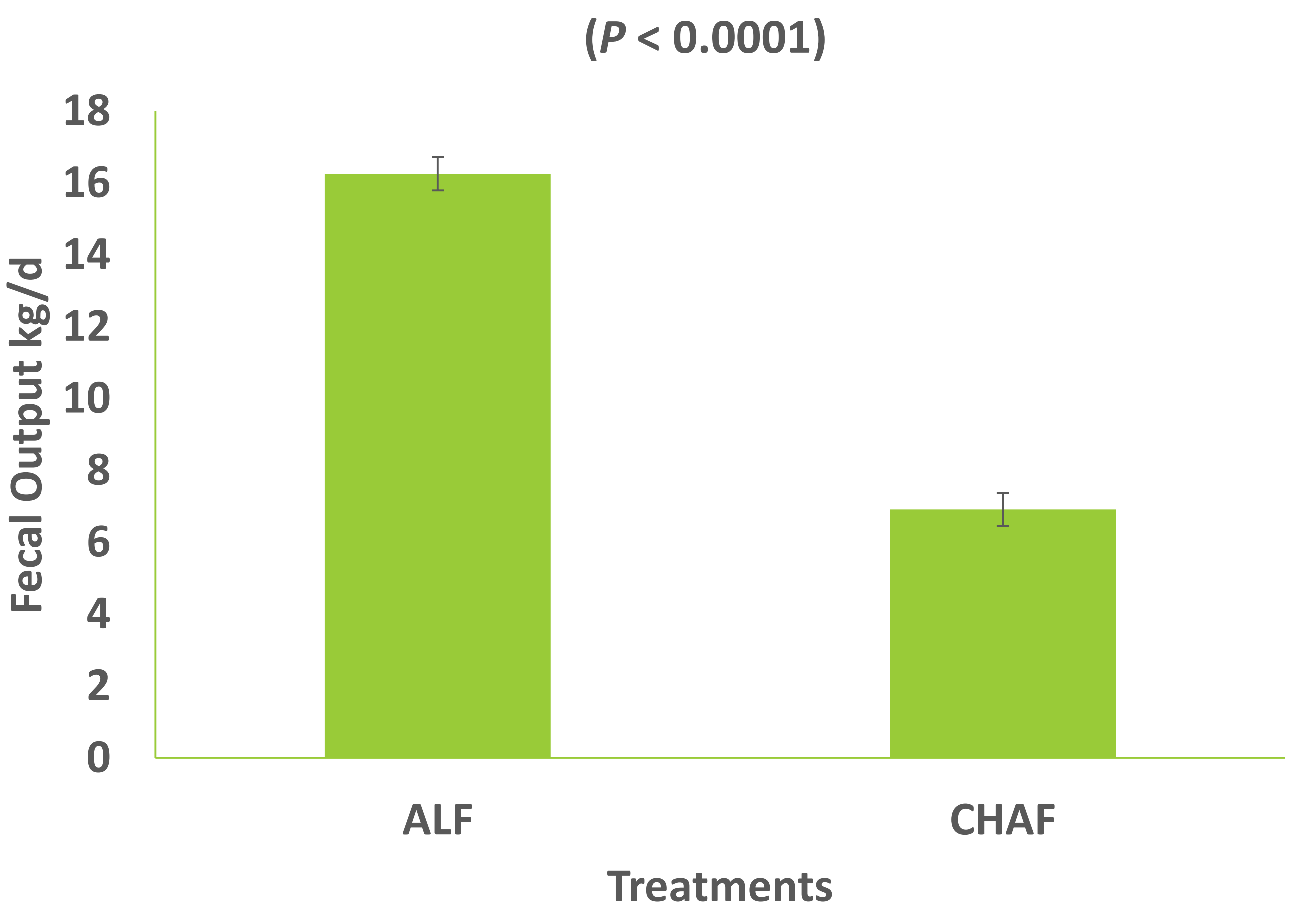
Nutrient Intake Results Cont.



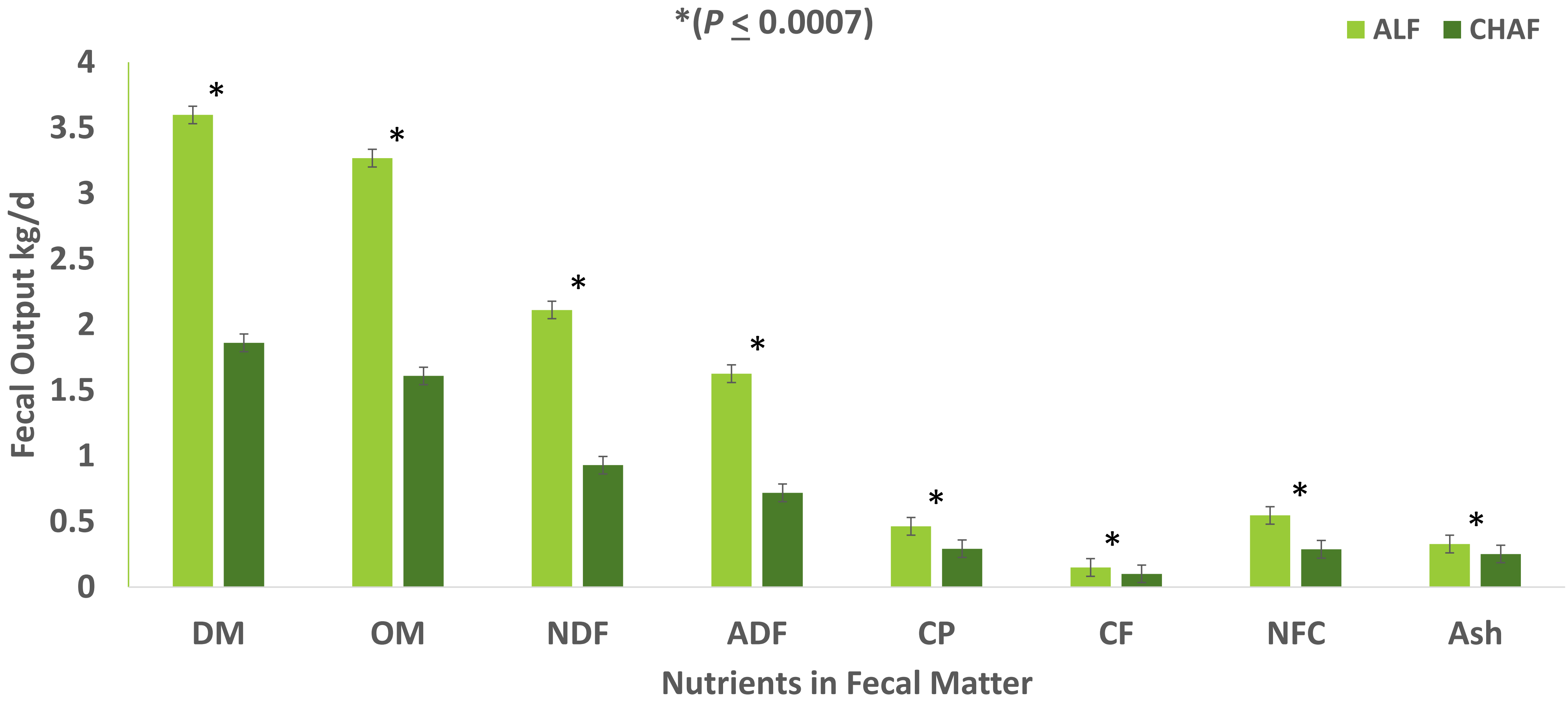
Water Intake Results



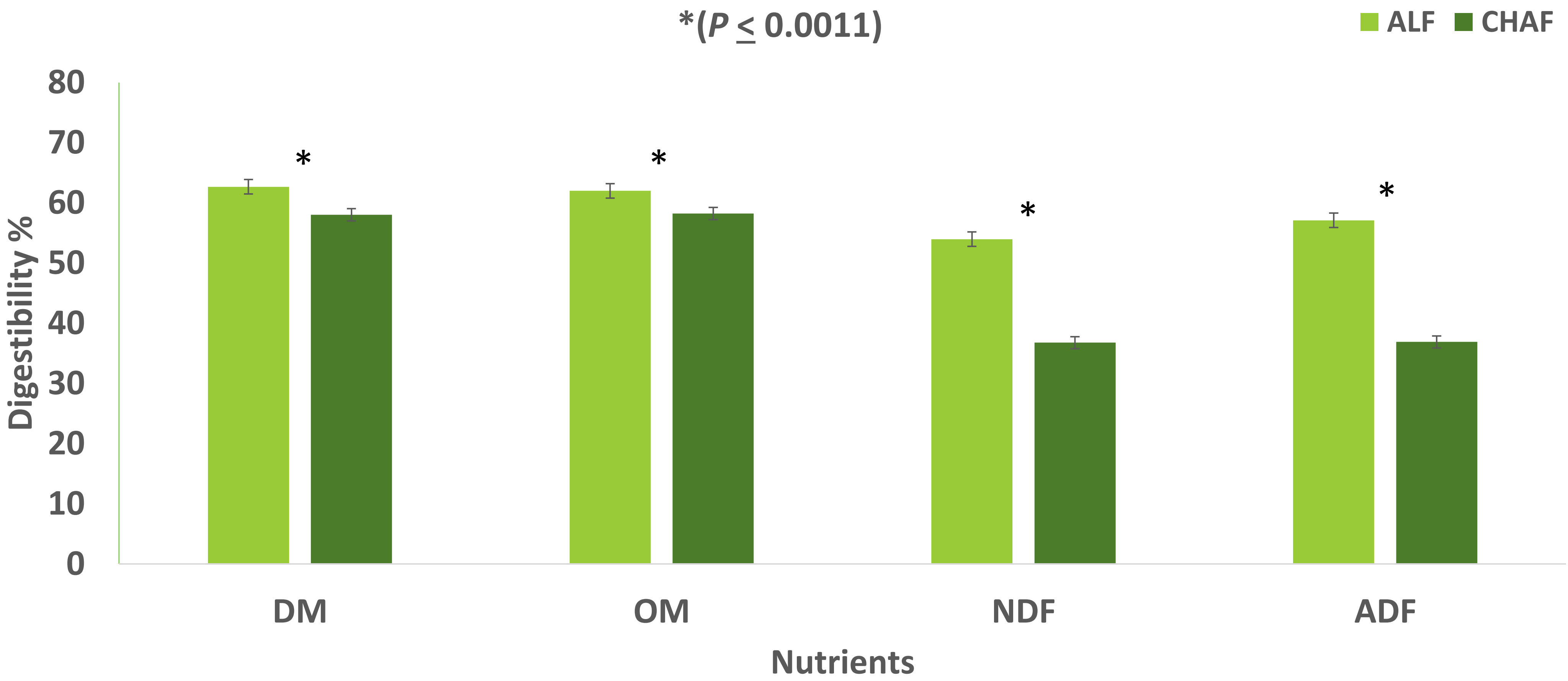
Wet Total Fecal Output Results



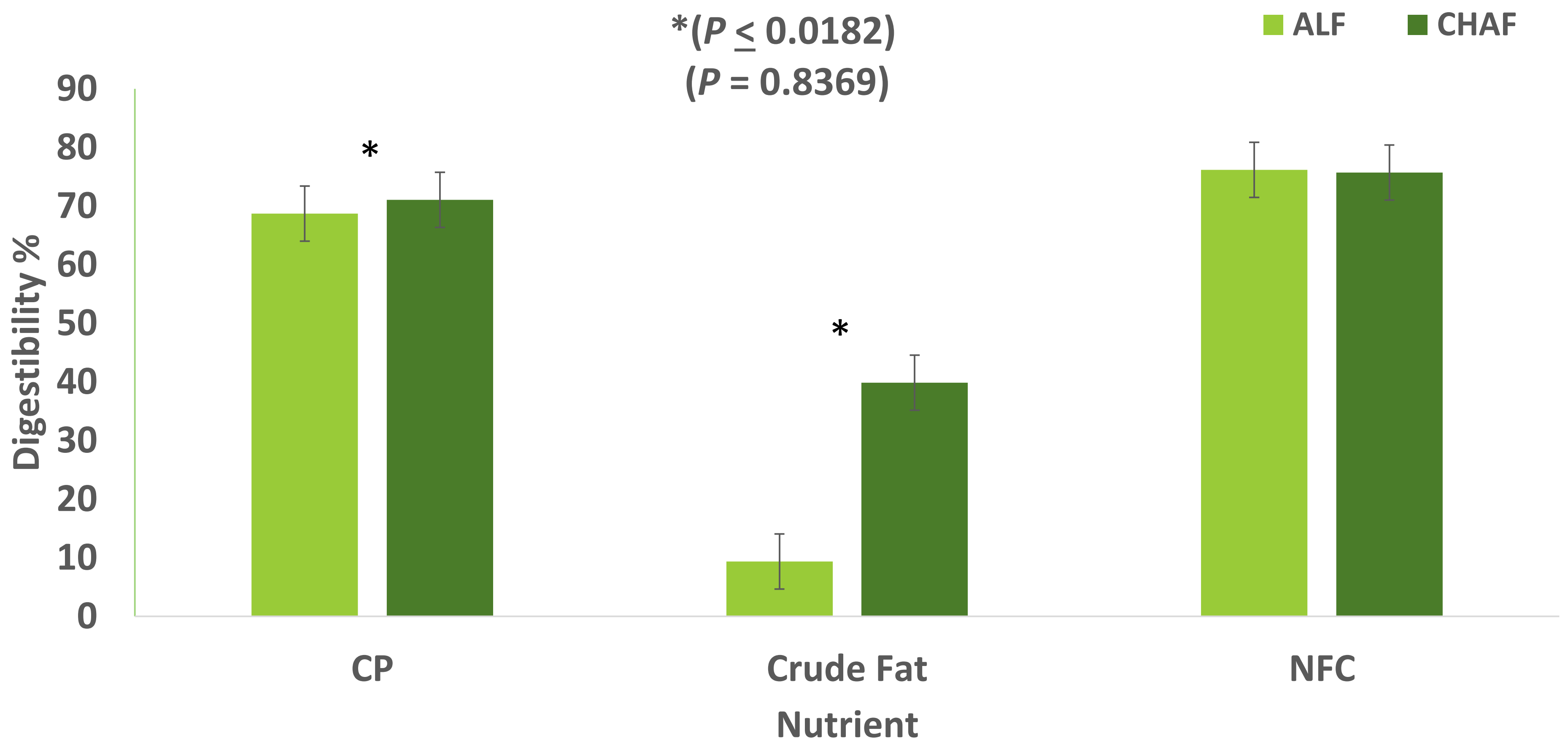
Fecal Output Results



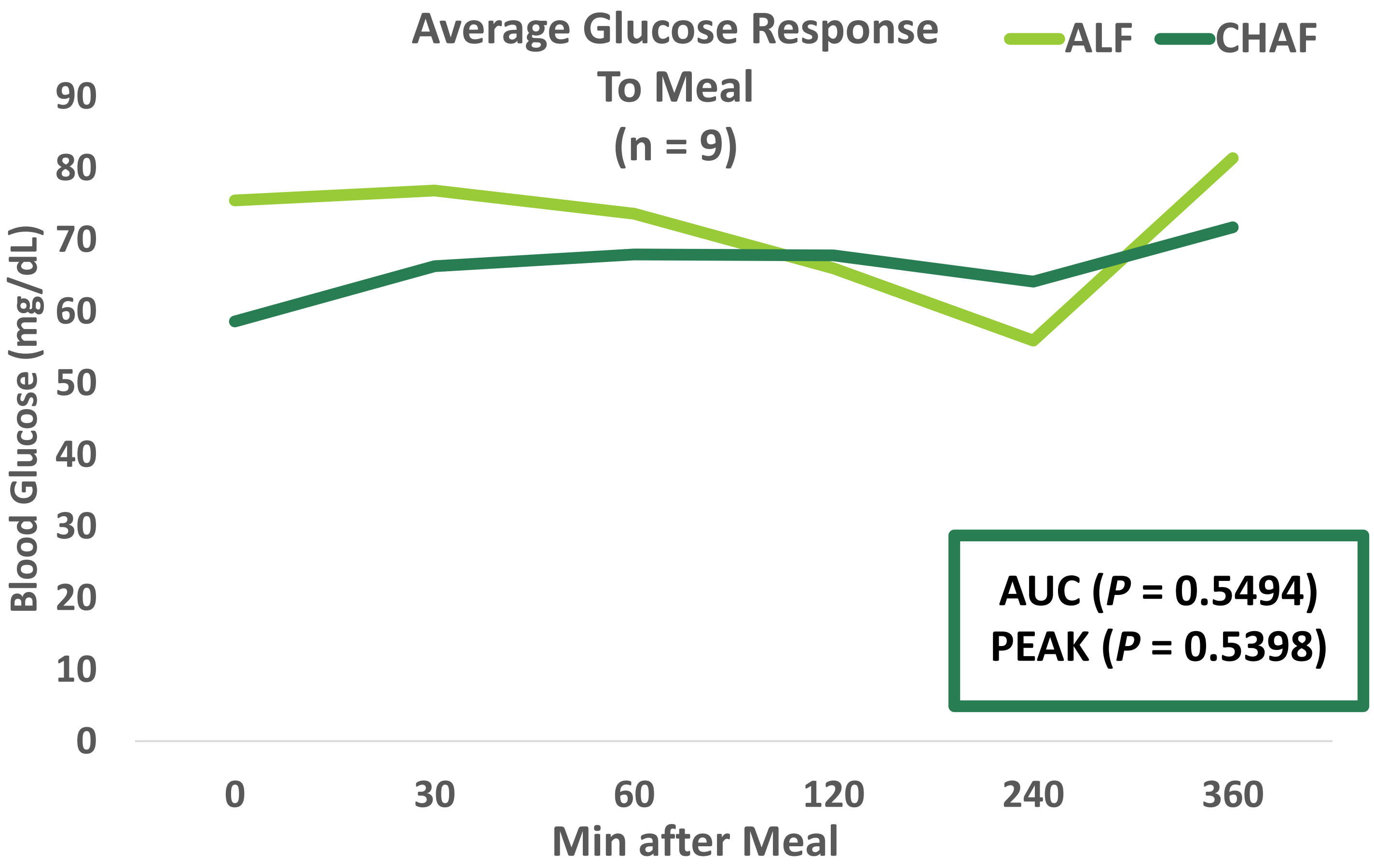
Digestibility Results



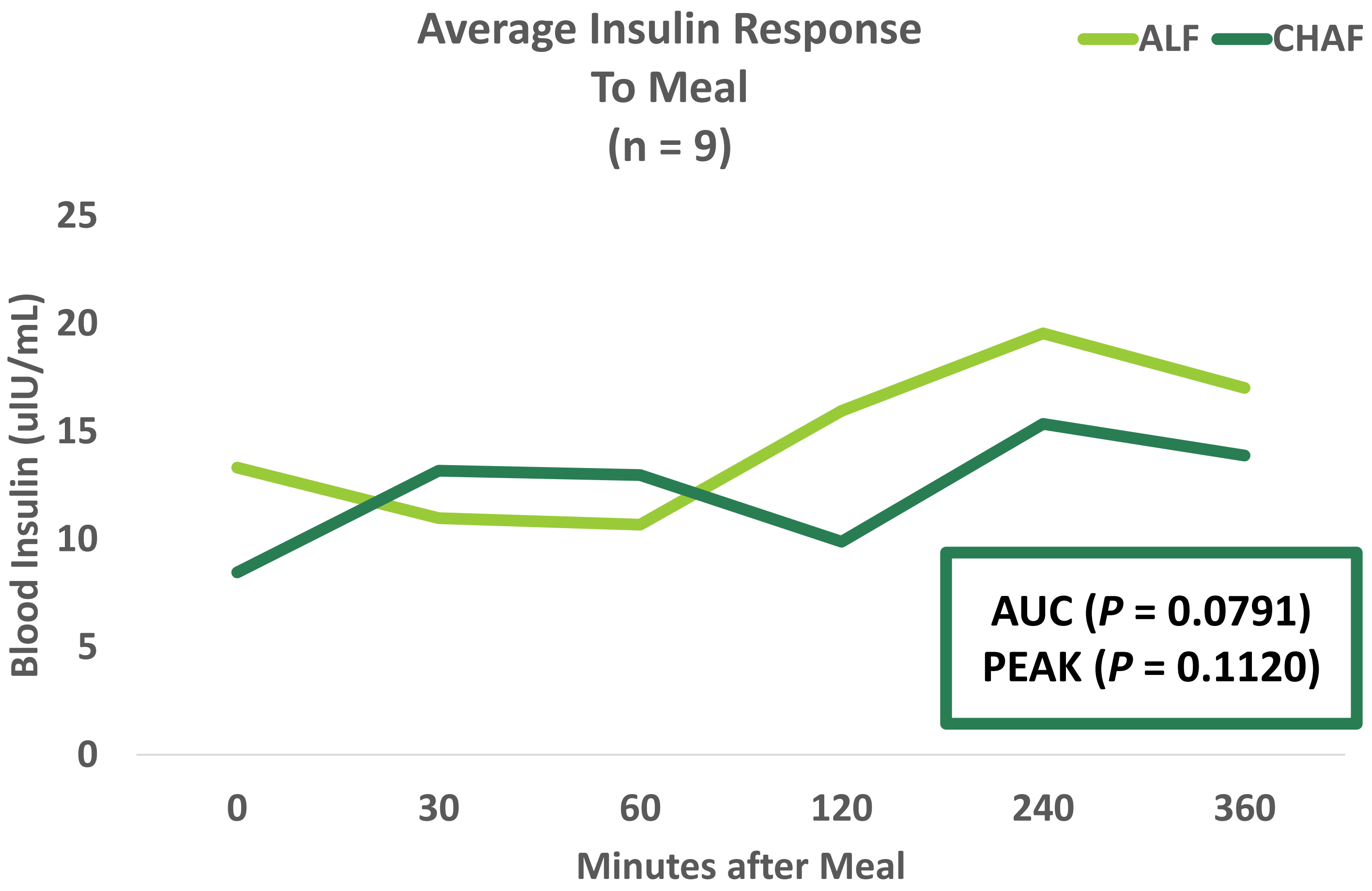
Digestibility Results

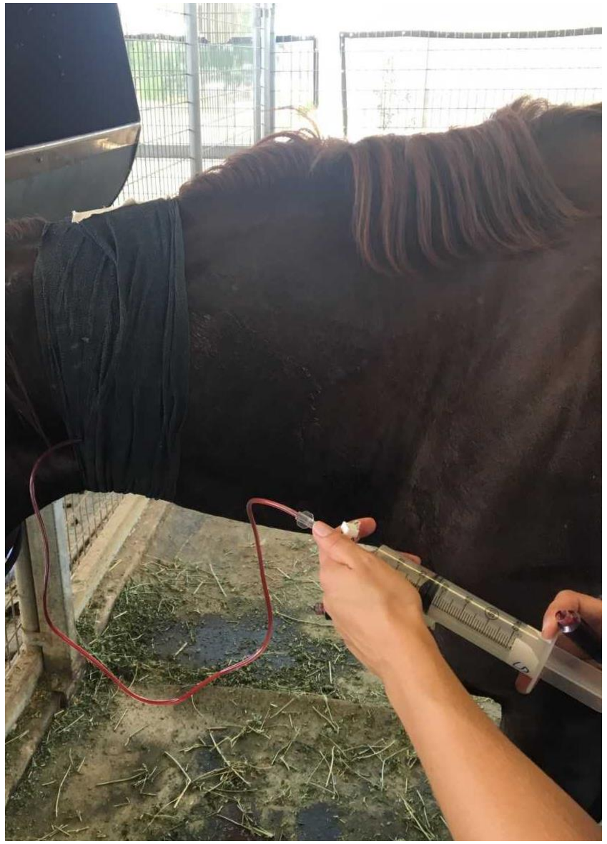


Glucose Results



Insulin Results





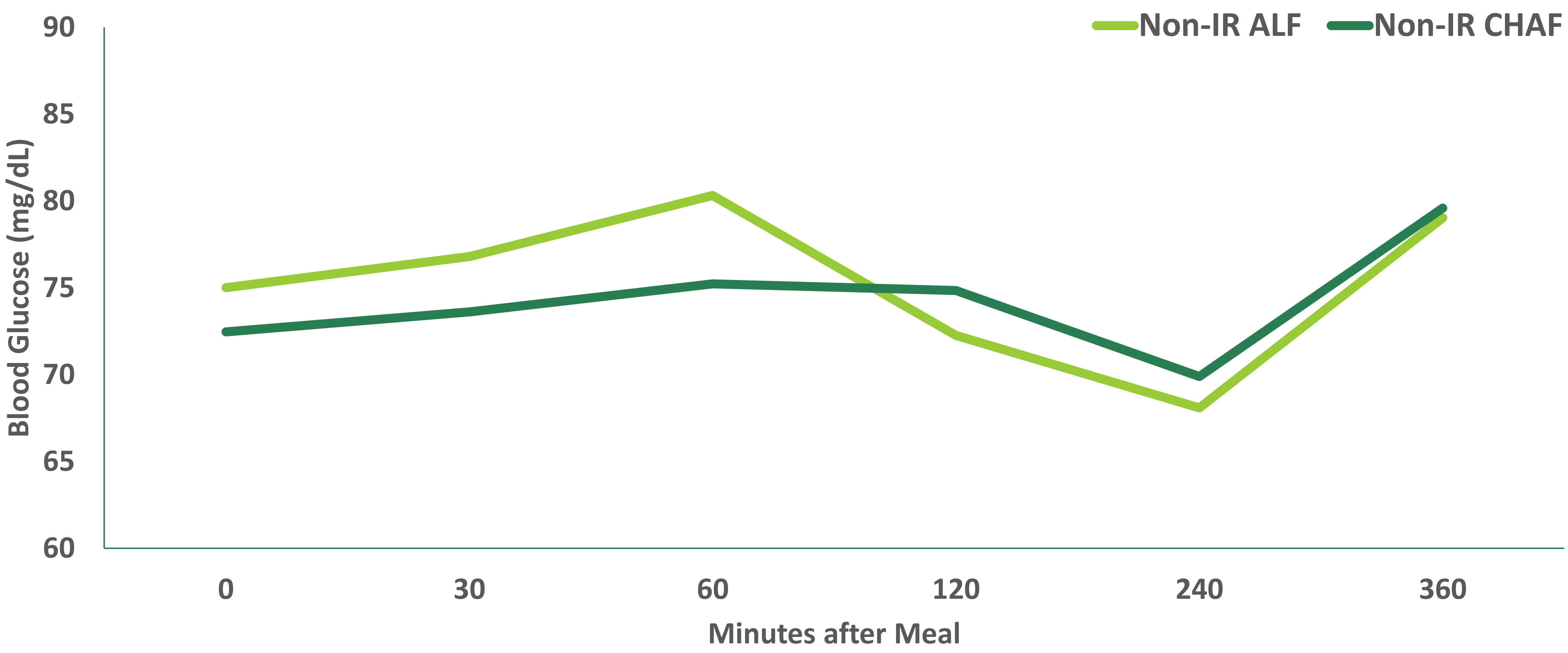
Horses with Insulin Resistance

- Two horses were discovered on this project to be generally accepted as IR

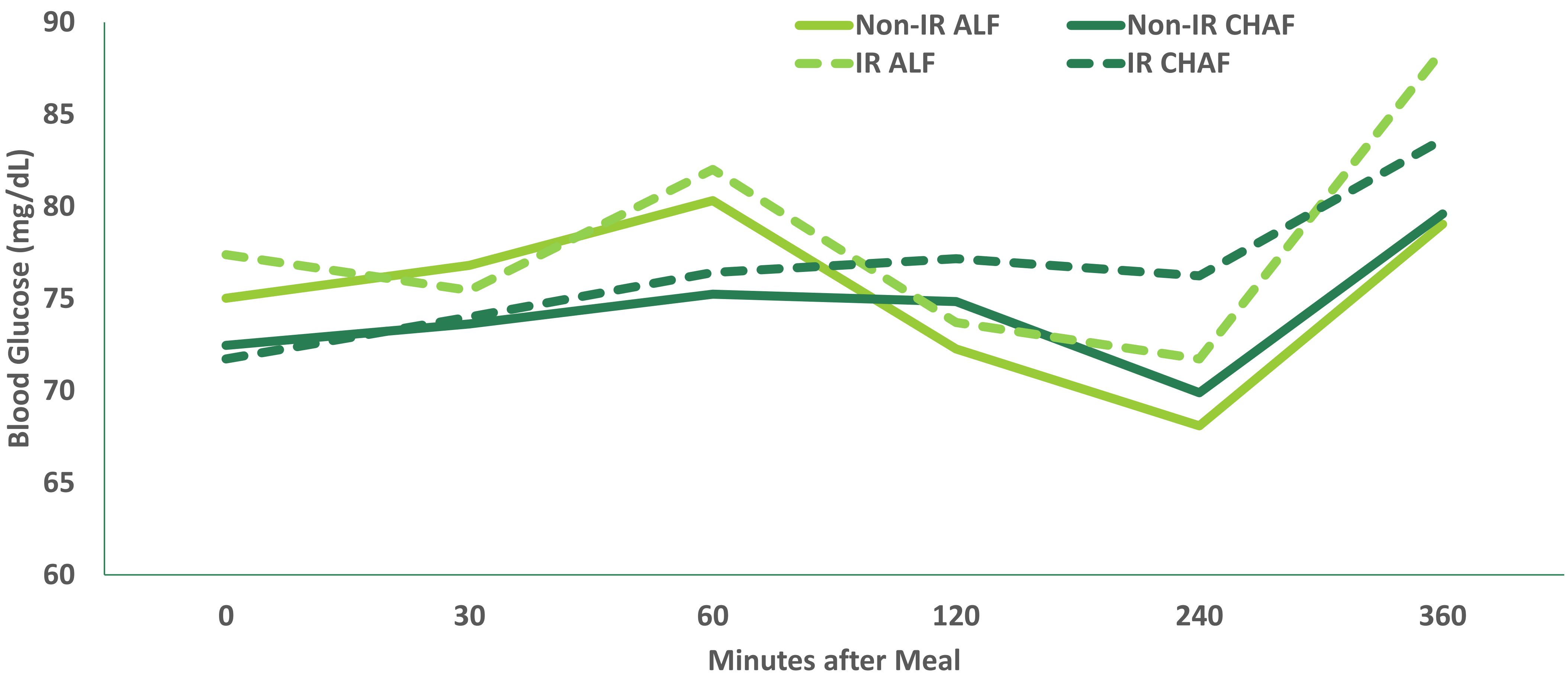
- Resting blood INS concentration of 6 times higher than counter parts.
(Frank et al., 2006)

- Evaluated on a case study basis

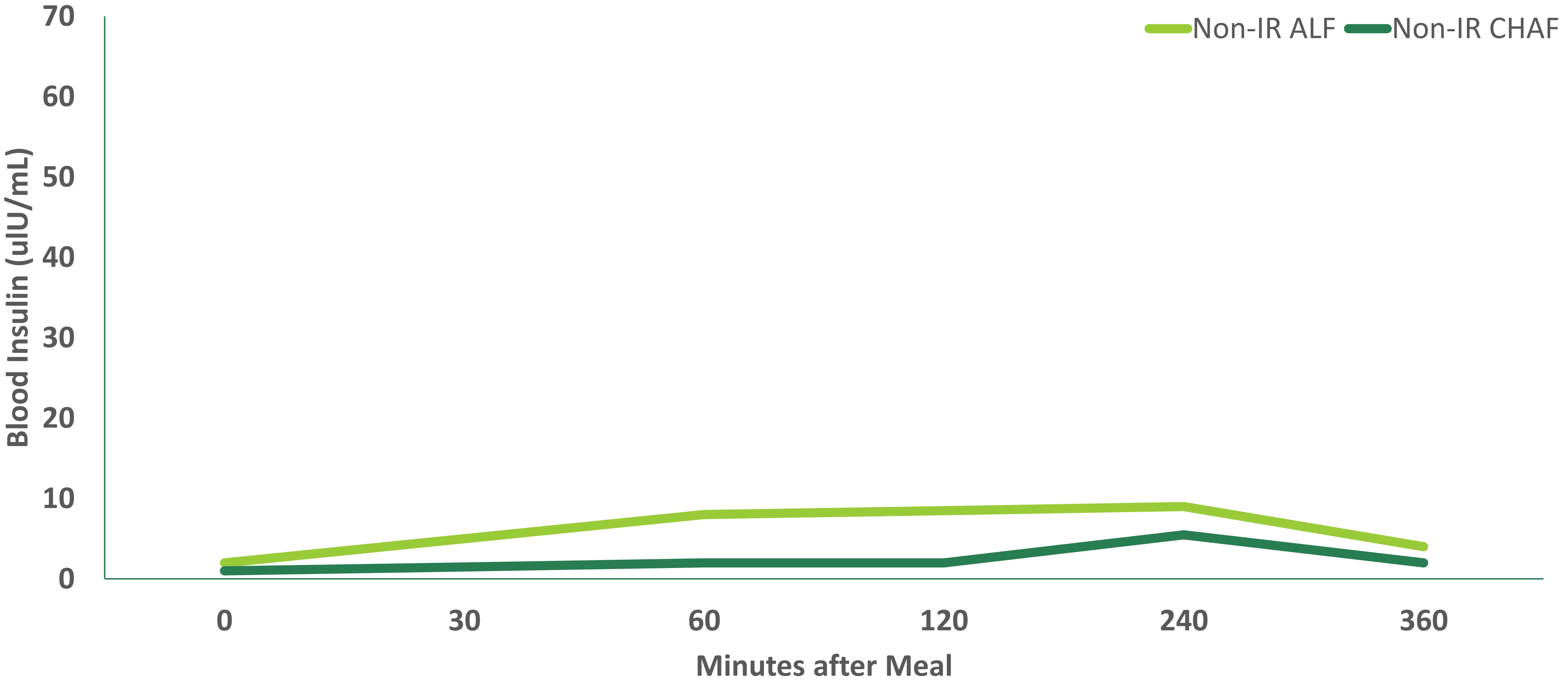
Glucose Response to Meal



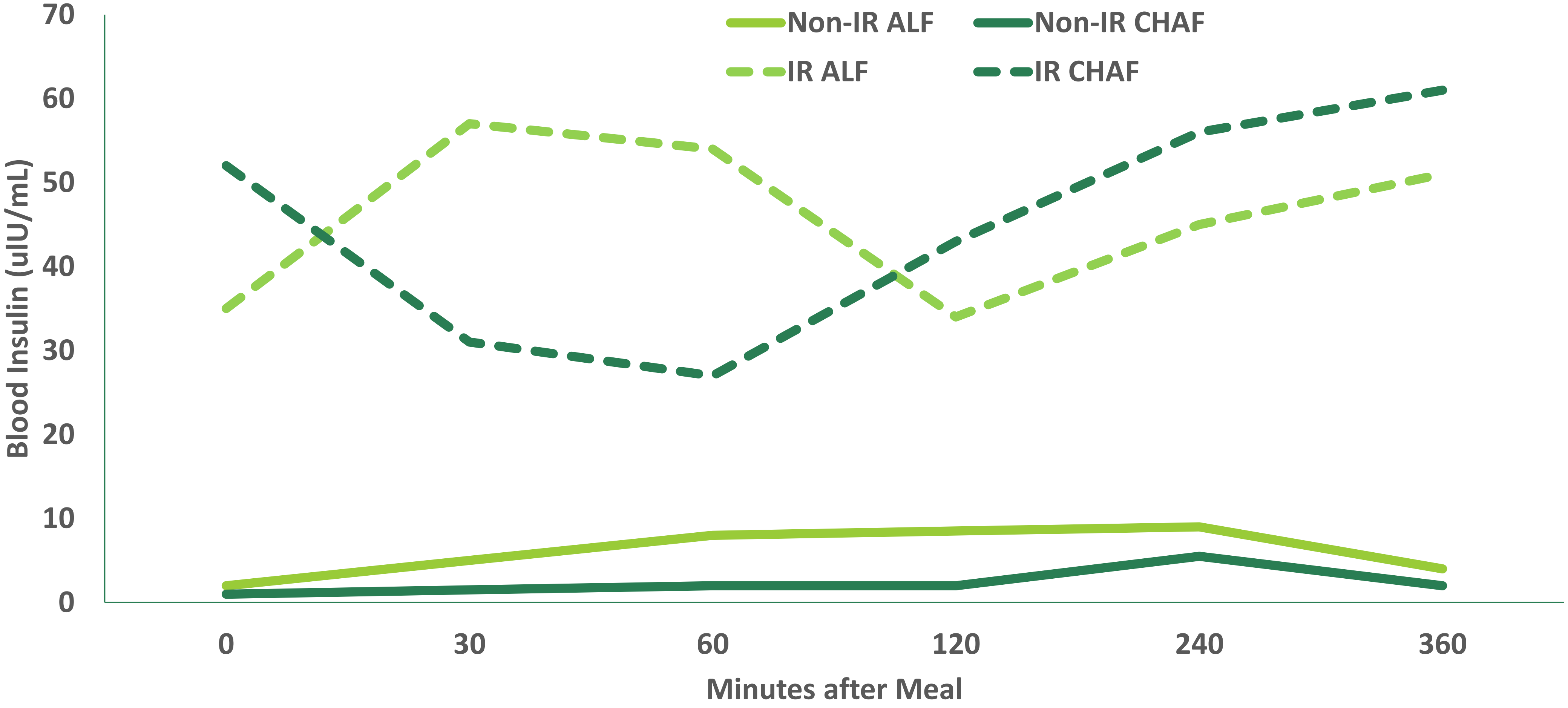
Glucose Response to Meal



Insulin Response to Meal



Insulin Response to Meal



Digestibility Discussion

ALFALFA HAD:

- DM, OM, NDF & ADF Digestibility than CHAF

  (Disagreeing with previous research: Moore-Colyer et al., 2003; Muhonen, 2009)

This could be due to:

- Moisture = Longer Rate of Passage

  (Olsson and Ruudvere, 1955; Uden et al., 1982; Drogoul et al., 2000; Drogoul et al., 2001)

- Fiber length = Longer Rate of Passage

  (Wolter et al., 1974; Sellers et al., 1982; Morrow et al. 1999)

Digestibility Discussion

CHAFHAYE HAD:

- CP and Crude Fat Digestibility

  (Agrees with previous research; Moore-Colyer et. al., 2003)

This could be due to:

Increased availability for absorption in small intestine due to fermentation

(Van Weyenberg et al., 2006)

Metabolite Discussion

ALFALFA & CHAFFHAYE HAD:

Similar Glucose Metabolism

(Agrees with previous research: Deboer et al., 2017)

This could be due to:

Horses were able to regulate GLU levels through insulin- Even IR horses (Deboer et al., 2017)

Metabolite Discussion

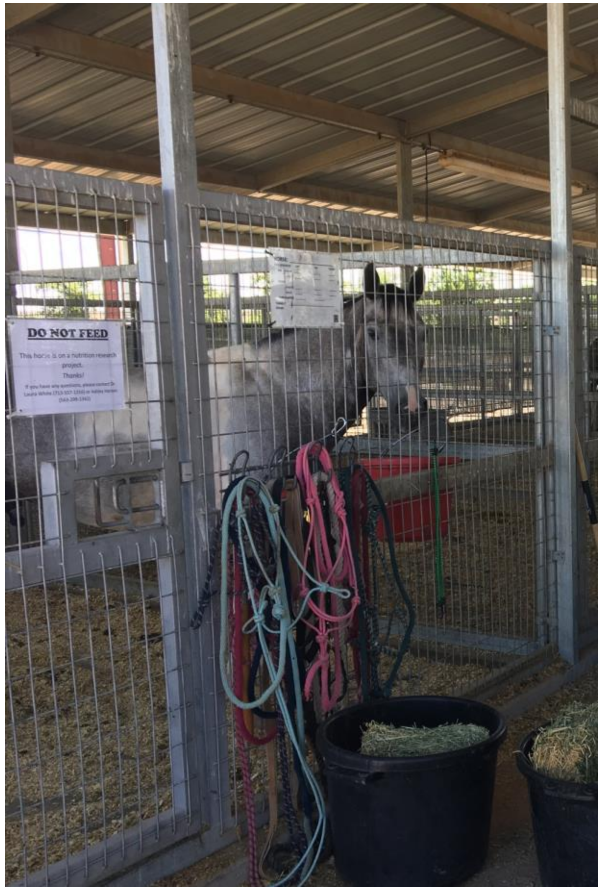
<u>CHAFFHAYE HAD:</u>

- ↓ Insulin AUC and PEAK

<u>This could be due to:</u>

- ↓ Overall DM intake
- ↓ NFC (WSC and ESC) content

(Storlien et al., 2000; Staniar et al., 2014)



Nutrient Requirement- Implications

CHAF had higher CP and CF digestibilities

<u>CHAF could assist:</u>

- Horses that have high CP and CF requirements or are high energy

ALF had higher DM, OM, NDF, and ADF digestibilities

<u>ALF could assist:</u>

- Horses requiring a high energy diet or prone to colic

Problems with managing horses in confinement

Nutrient Requirement

Water Intake

Fecal Output

Metabolic Issues

Fecal Output-Implications

CHAF had lower wet fecal output

CHAF could reduce:

- Cost of manure cleanup
- Disposal challenges
- Environmental effects

Problems with managing horses in confinement

Nutrient Requirement

Water Intake

Fecal Output

Metabolic Issues

Metabolic Issues-Implications

CHAF had lower WSC and ESC concentration

& tended to have a lower insulin response

<u>CHAF could assist:</u>

- Preventing metabolic diseases
- Horses prone/with metabolic diseases

Problems with managing horses in confinement

Nutrient Requirement

Water Intake

Fecal Output

Metabolic Issues

Water Intake- Implications

No significant differences

- Considering water from feed:

  -CHAF intake 6-10 L per day

<u>CHAF could reduce:</u>

- Colic, choke, ulcers
- Digestibility of forage

Problems with managing horses in confinement

Nutrient Requirement

Water Intake

Fecal Output

Metabolic Issues

A Big Thank You!

My Family

My Lab:
Dr. White
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Dustin Gaskins

My Committee:
Dr. Loest
Dr. Turner
Dr. Hodnett

Graduate Students

Judging Team








Questions?