
The science behind
LIFEFORCE™
from Alltech®
LIFEFORCE FORMULA
LIFEFORCE FORMULA
LIFEFORCE

LIFEFORCE – Customer Testimonials

- Mare in foster care with a BCS of barely 1.5 on the Henneke Scale.
- Started adding Lifeforce to her rations within a week of her arrival.
- Kept on Lifeforce during her recovery, and was able to achieve a BCS of nearly 4 in 2.5 months
- Lifeforce proved to be a valuable asset in her recovery.

“WINDY”

Mare - Arabian - 27 years old

Leisure Riding

BEFORE

“WINDY”

Mare – Arabian - 27 years old

Leisure Riding

AFTER – 8 WEEKS

“FANCY”

Mare - QH X - 27 years old

Barrel Racing

BEFORE

“FANCY”

Mare - QH X - 27 years old

Barrel Racing

AFTER – 9 WEEKS

"REGGIE"

Gelding – WB – 12 years old

Jumper

BEFORE

“REGGIE”

Gelding – WB – 12 years old

Jumper

AFTER – 10 Weeks

“MHS King Joules”

Gelding – Eventer- 6 years old

BEFORE

“MHS King Joules”

Gelding – Eventer- 6 years old

AFTER

Introduction

- normal gut function = combination of management and animal factors
- organic mineral supplementation
  - potential advantages in digestion, absorption and transfer to tissues
  - generally accepted – bioavailability > organic forms of minerals.
- Mycotoxin threat

Gut function

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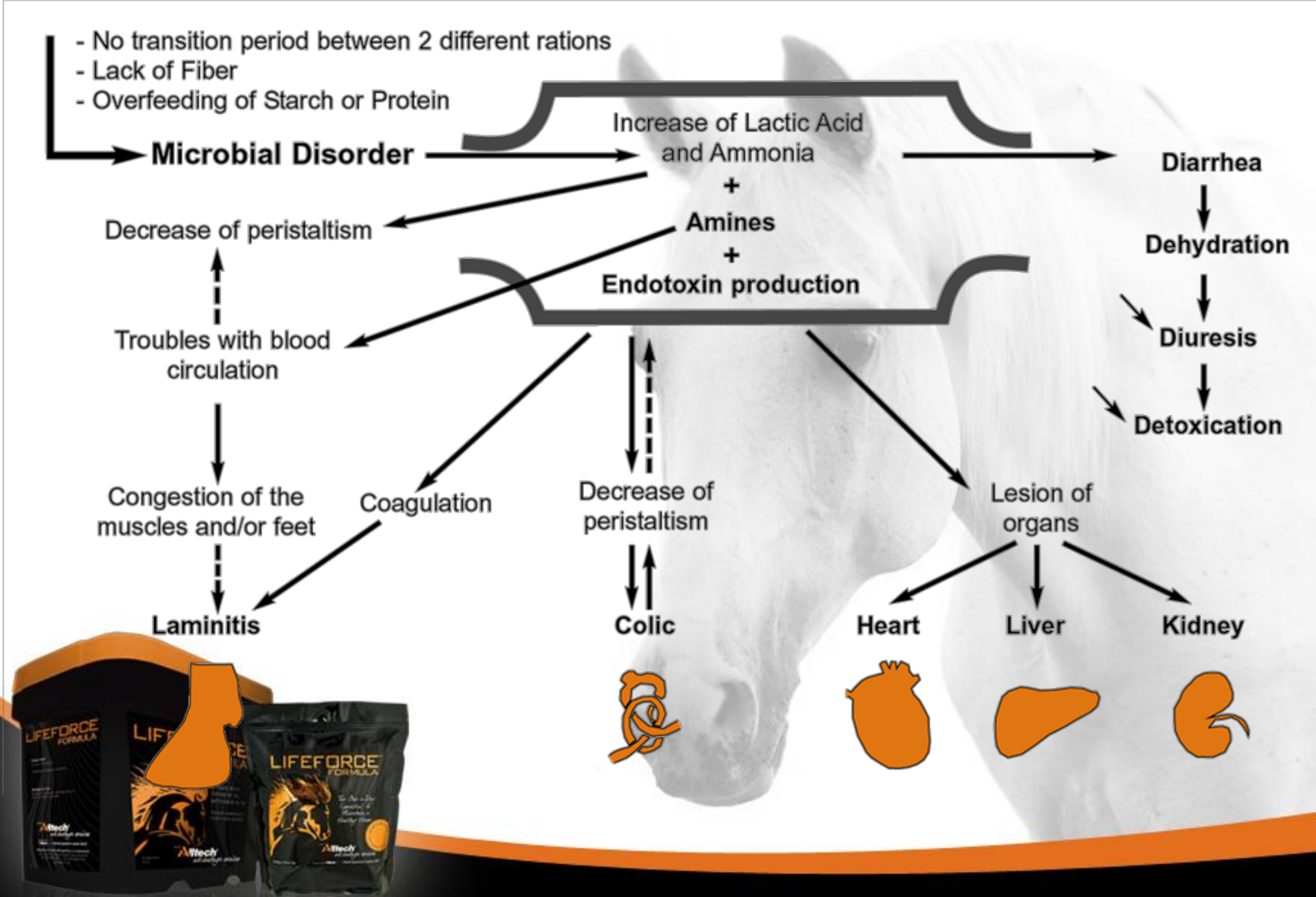

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Wolter, 1994

The Equine GI tract

- Horse – evolved requirement for minimum amount of dietary fibre
  - food source for micro-organisms

- Can digest very little starch at any one time
- ⇒ small intestine struggles to deal with > 3-4g starch per kilogram of body weight per meal (Potter *et al*., 1992)
  - Current recs = 1g/kg BW/meal (Vervuert, 2009)

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Disruption of normal gut function

- E.g. ↓ fibre and/or ↑ starch
  - ⇒ ↓ buffering capacity, caecal and blood pH
  - ⇒ acidosis
  - ⇒ bacterial endotoxins
- Acidosis = lowering of blood alkali reserves
  - sub-clinical vs. clinical
  - hard work + limited forage

Aim = stabilise gut environment

Yea-Sacc®1026

- Improved fibre digestion
  - Stimulates fibre-digesting bacteria
- Stabilises caecal/colon pH
  - Increased lactic acid-utilizing bacteria
  - Optimises beneficial microbial population
- Higher phosphorous availability

Yeast supplementation (SC)* increased the apparent digestibility (g/kg of DM) of ADF in both high fibre (HF) and high starch (HS) diets

	HF diet		HS diet	
Item	**HF+0**	**HF+SC**	**HS+0**	**HS+SC**
DM	600[b]	611[b]	690[a]	694[a]
OM	611[b]	623[b]	718[a]	716[a]
CP	698[b]	703[b]	756[a]	759[a]
NDF	340	376	353	362
ADF	**341[ab]**	**377[a]**	**315[b]**	**341[ab]**
Cellulose	332[ab]	359[a]	319[b]	327[b]
Hemicellulose	338	374	395	385

a, b - Means within a row with different superscript differ, ($P < 0.05$). *Yea-Sacc

Jouany et al, 2008

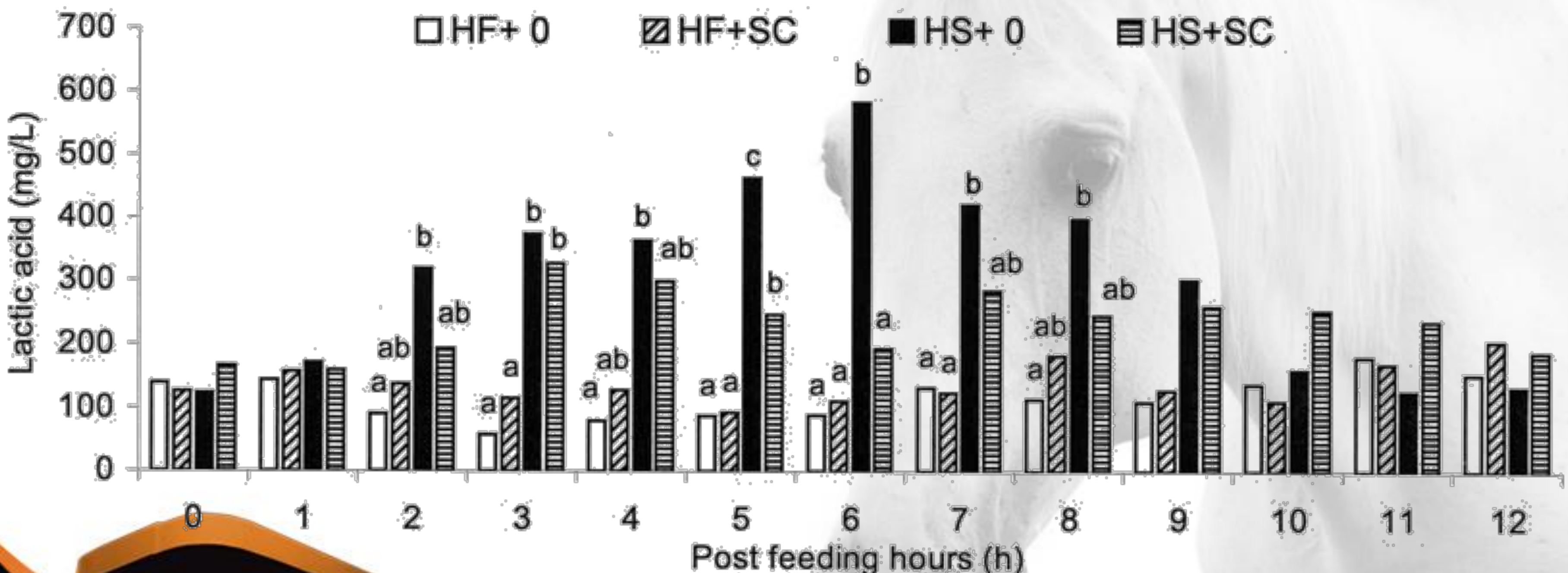
Effect of Yea-Sacc on fermentation characteristics in equine hindgut

Item and intestinal content	HF	HS	HS + SC
pH			
Caecum	7.15[a]	6.85[b]	7.01[c]
Colon	7.14[a]	6.79[b]	6.88[b]
Lactic acid (mg/L)			
Caecum	167.9[a]	407.7[b]	207.5[a]
Colon	116.5[a]	303.2[b]	235.7[c]

a, b, c - Least squares means within a row are different if superscript differ ($P < 0.05$).

Medina et al. 2002

Supplementation of *S. cerevisiae* (SC)* diets reduced lactic acid production in the caecum



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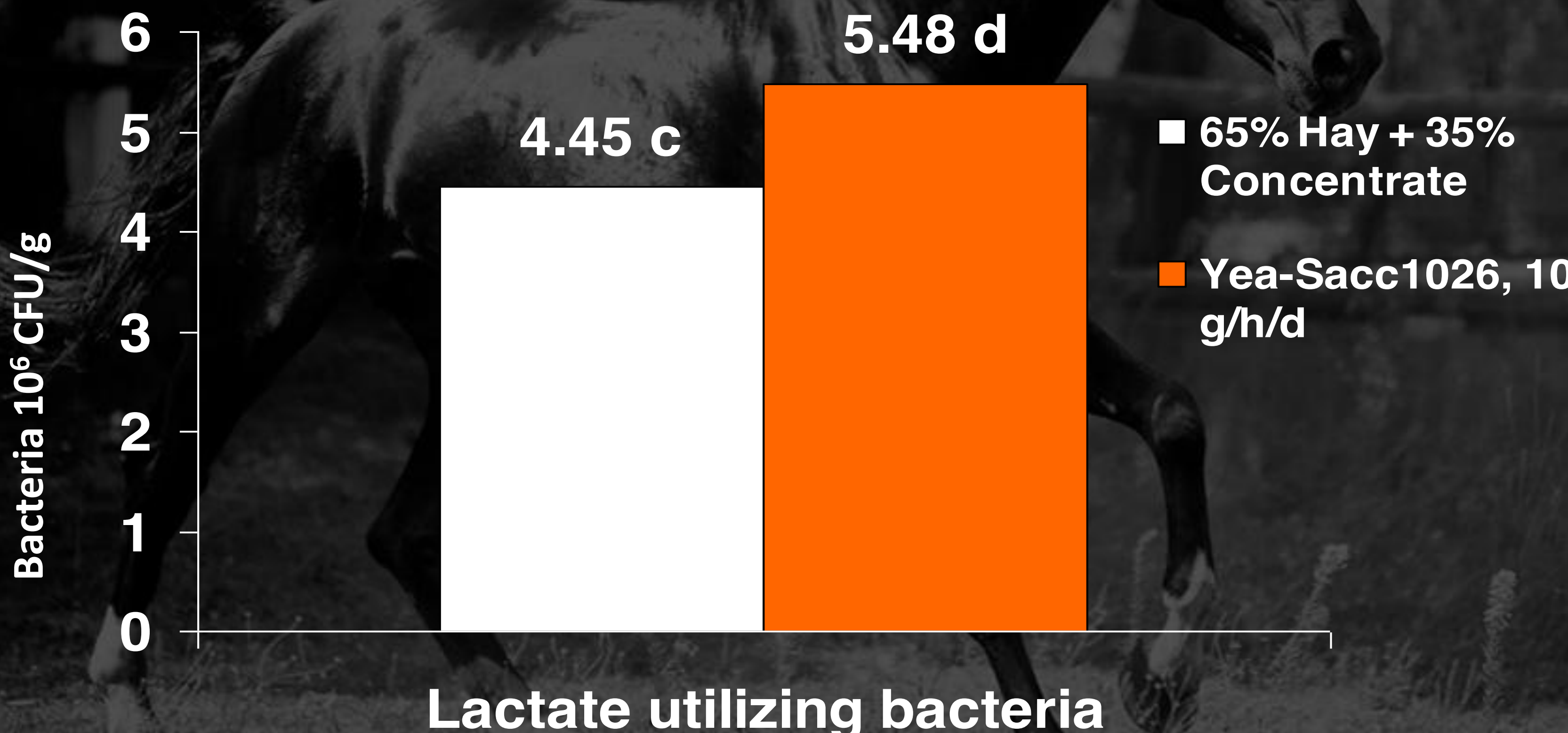
Medina et al, 2002

a, b, c - Within post feeding hours, bars without a common superscript letter differ ($P < 0.05$). *Yea-Sacc

Effect of Yea-Sacc®1026 on Lactic Acid



Moore et al., 1994

(^{c,d} P<0,06)

Effect of Yea-Sacc on fermentation characteristics in equine hindgut

	HF	HF + SC	HS	HS + SC
Acetate (mM)				
Caecum	50.9[a]	55.4[a]	43.4[b]	47.1[c]
Colon	68.1[a]	74.4[a]	60.2[b]	67.8[a]
Butyrate (mM)				
Caecum	3.64[a]	3.88[a]	4.07[b]	3.39[c]
Colon	6.27[a]	7.16[a]	9.28[b]	6.86[a]
Propionate (mM)				
Caecum	12.8[a]	13.8[a]	17.7[b]	18.6[b]
Colon	17.6[a]	16.8[a]	20.1[b]	22.9[c]
Total VFA (mM)				
Caecum	68.1	**73.9**	66.7	**70.0**
Colon	94.0	**100.7**	91.7	**99.8**

Medina et al. 2002

a, b, c -Least squares means within a row are different if superscript differ ($P < 0.05$)

Effect of Yea-sacc on detection of yeast in the hindgut

	HF+SC (log cfu/mL)	HS + SC (log cfu/mL)
Caecum	6.4	6.8
Colon	4.9	4.5

In un-supplemented horses, yeast numbers were below the level of detection

Jouany et al. 2009

Effect of Yea-sacc on hindgut microbial communities digestive capacity

Item	HF	HF+SC	HS	HS + SC
Lactic-acid utilizing bacteria (log_{10}cfu/mL)				
Caecum	6.5	7.0**	6.9	7.5**
Colon	6.5	6.5	7.2	6.7
Lactobacillus spp (log_{10}cfu/mL)				
Caecum	6.5	6.6	6.8	7.2*
Colon	6.1	6.2	6.7	6.8

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Yea-Sacc improves feed digestibility in lactating mares

Nutrient	**-YC**	**+YC**
DM	**70.1^{a}**	**79.4^{b}**
CP	**58.2^{a}**	**65.9^{b}**
ADF	47.8	51.1
NDF	**59.2^{a}**	**69.4^{b}**
Calcium	61.9	60.6
Phosphorous	*30.9^{a}*	*44.9^{b}*

Glade, 1991a

Means with superscripts are significantly different
a, b $P<0.01$; c,d $P<0.05$. *Yea-Sacc

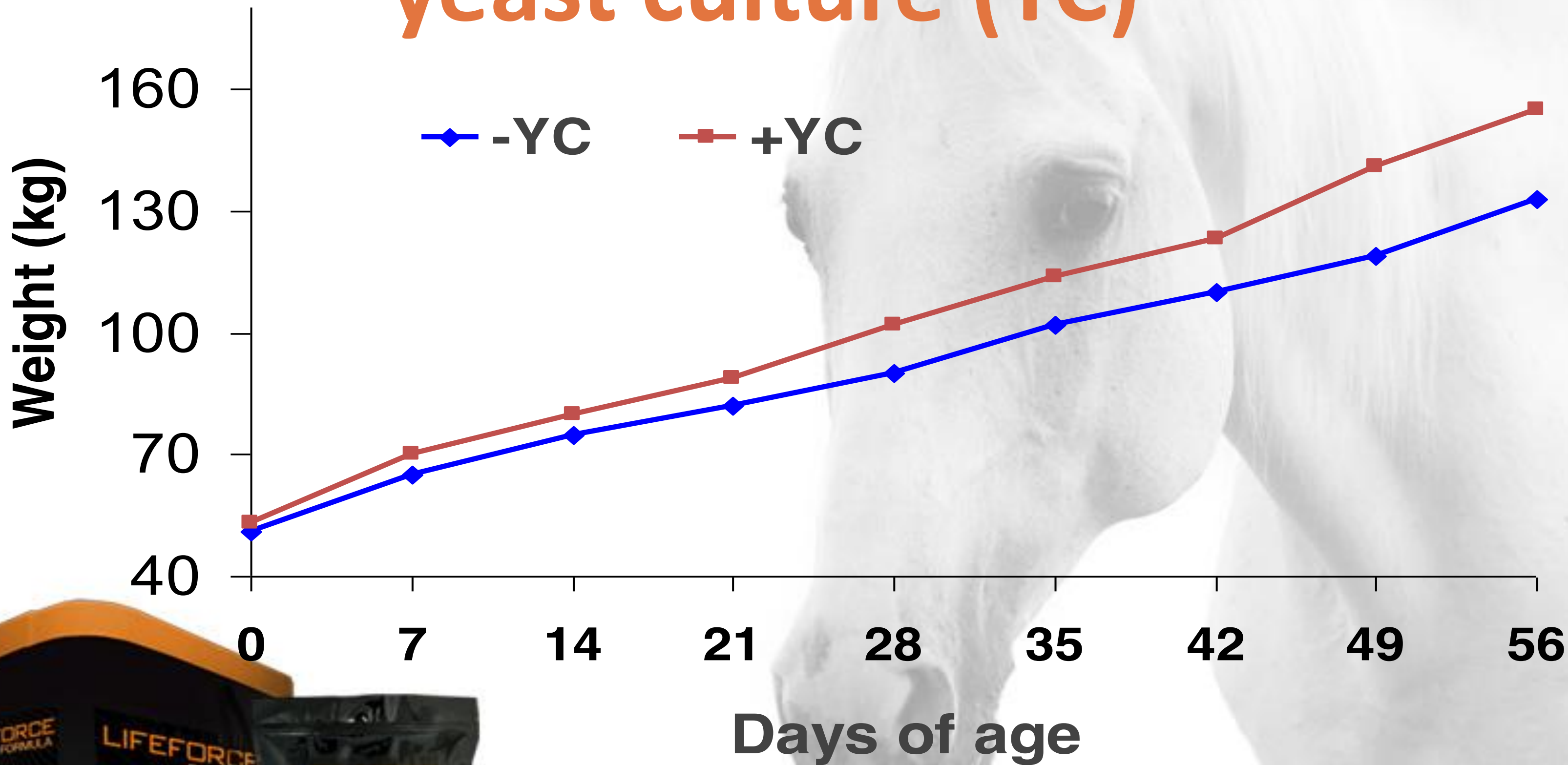
Resulted in increased milk and nutrient intake in nursing foals

	-YC	+YC
Mare's milk		
GE (Mcal/d)	60.61[a]	68.28[b]
Foal's intake		
Milk (kg/d)	14.58[a]	16.33[b]
GE (Mcal/d)	8.83[a]	11.11[b]
Average daily gain (kg/d)*	0.88[a]	1.20[b]

Glade, 1991a

*over first four weeks of life

Faster foal weight gain from mares fed a yeast culture (YC)*



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Glade, 1991c

Increased nutrient supply to yearlings

Nutrient	-YC	+ YC
apparent digestibility, % of intake		
DM	71.8	78.4
NDF	56.5	71.0
Hemicellulose	**51.4**[a]	**78.5**[b]
ADF	58.0	68.5
	% of digested N	
Retained	**12.6**[c]	**22.6**[d]

Means within a row without a common superscript differ significantly a, b (P<0.05) c, d (P<0.01). * Yea-Sacc

Glade and Biesik, 1986

Conclusions on yeast supplementation

Stabilized caecal/colon fermentation

- Reduces the negative effects of a high starch diet
- Reduces the risk of digestive disorders
- Helping to prevent colic and laminitis

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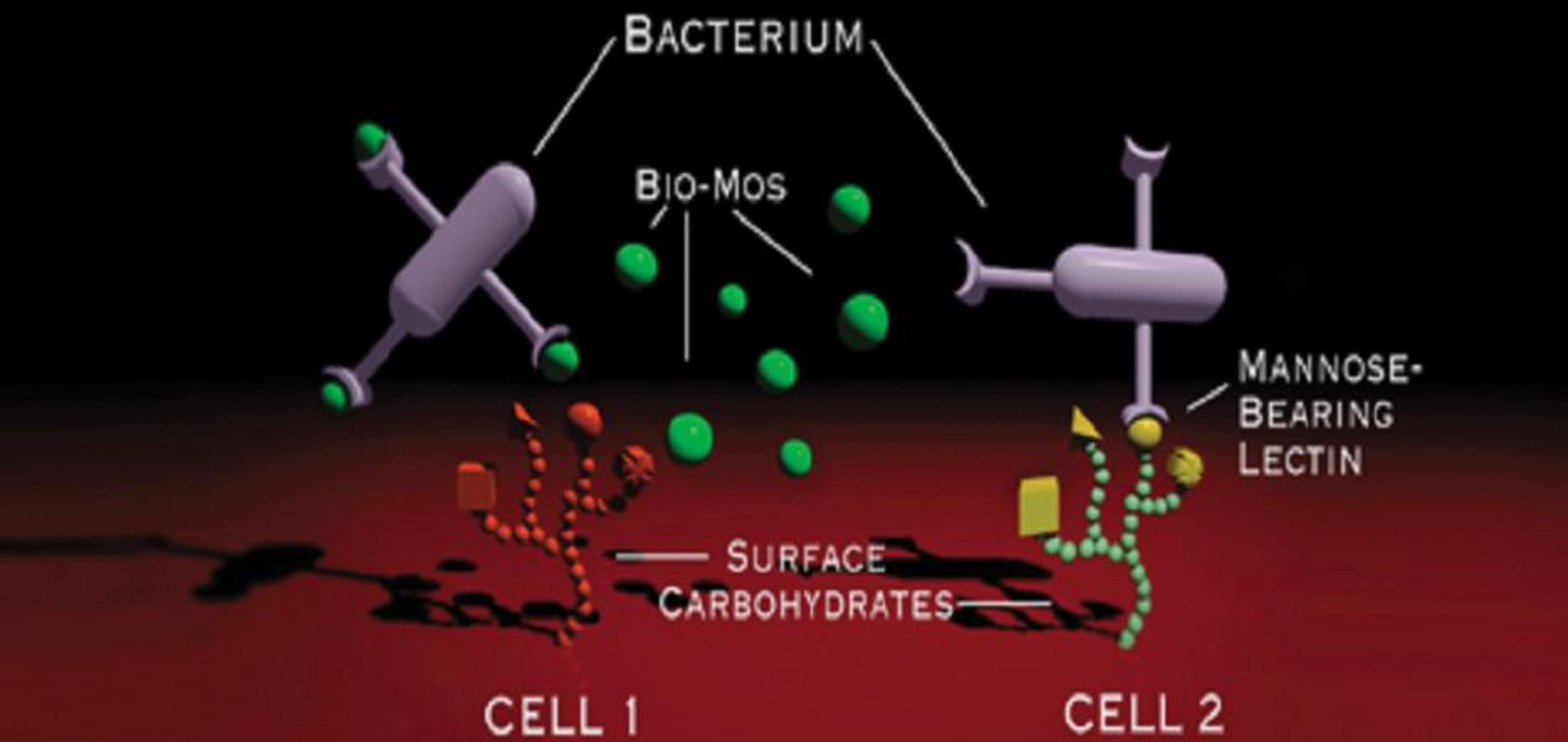
Another digestive problem….

- Diarrhoea in young animals
  - poor hydration status and ill thrift
- feeding of antibiotics as a prophylactic = restricted in some countries
- Mannanoligosaccharides (MOS)
  - derived from yeast outer cell wall
  - capacity to bind pathogenic bacteria
  - Prevents adherence to/colonisation of gut lining

Pathogen adsorption mechanism

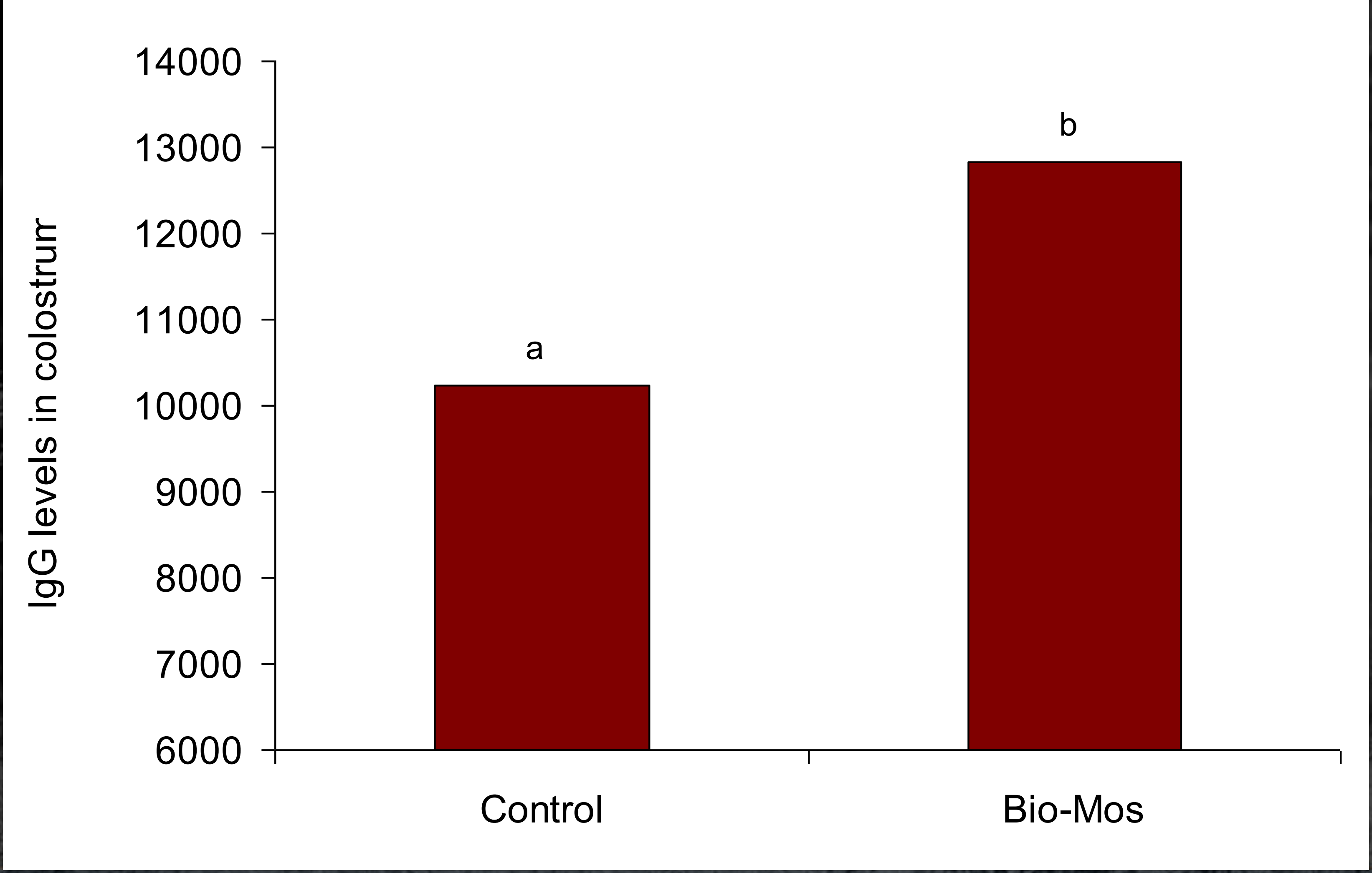


Bacteria attach to epithelial cells via lectins that recognize certain sugars

Many enteric pathogens attach via Type I fimbria which recognize mannose

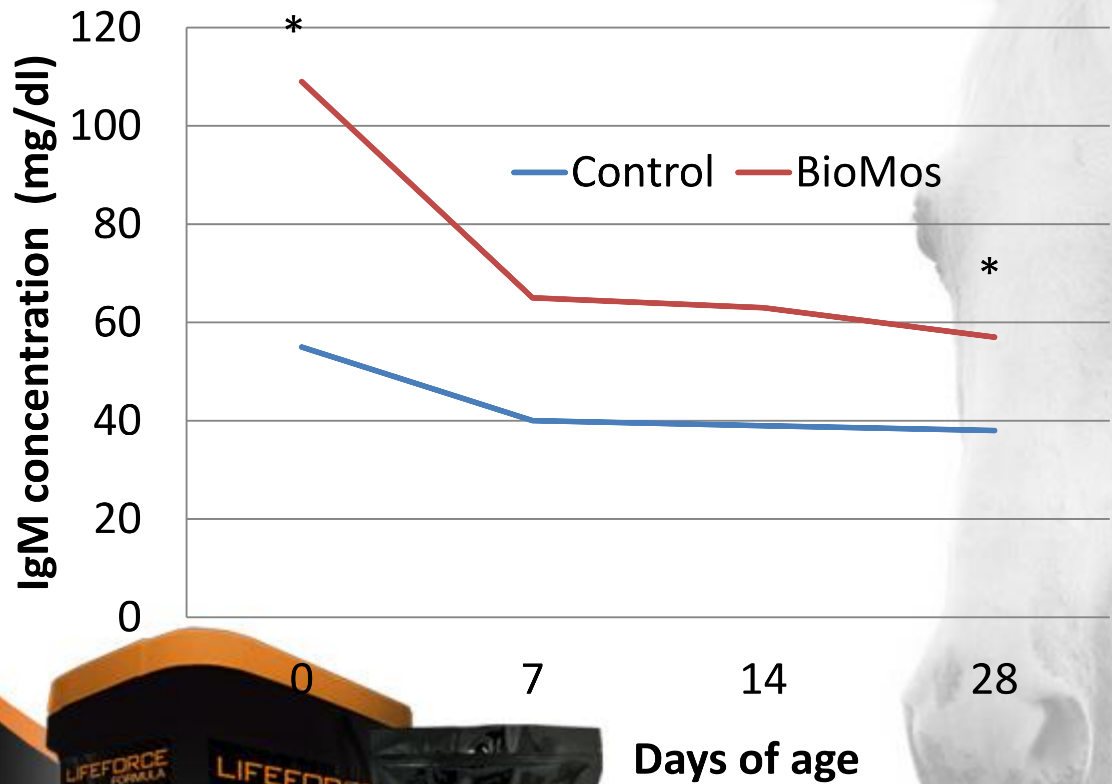
The effect of MOS on immune response of mares

[a,b] $P<0.05$



Ott et al., 2004

Effect of BioMos on foal serum IgM concentration



Diarrhoea cases severe enough to justify treatment		
	No	Yes
Control	1	5
Bio-Mos	5	0

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Ott, 2002

Mineral nutrition

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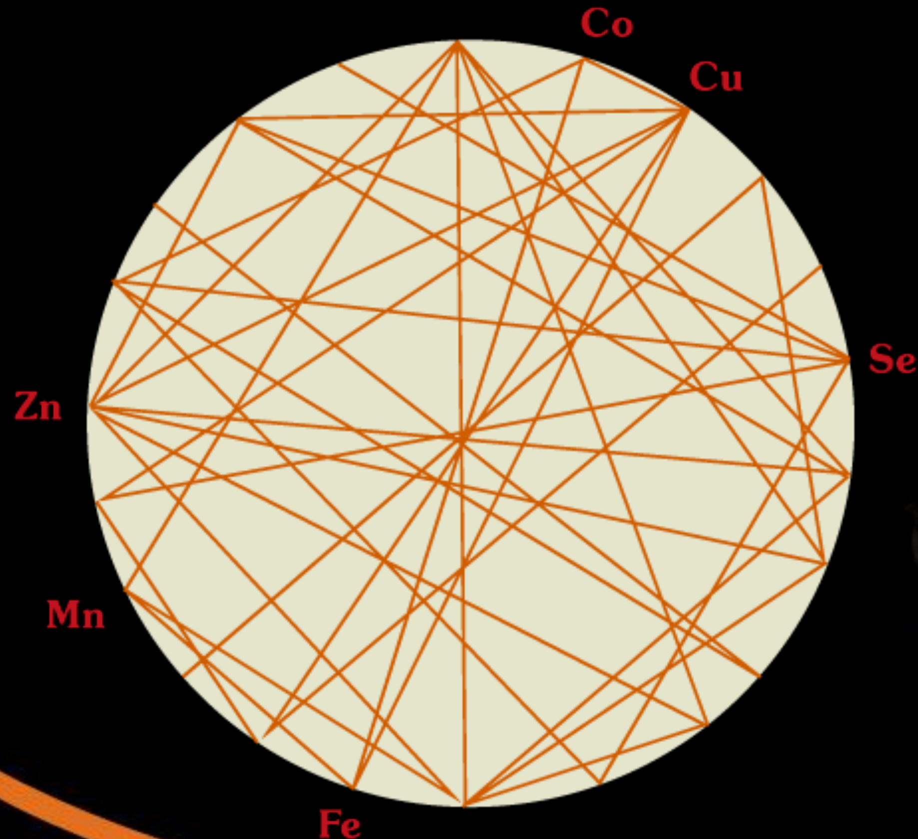
Environmental mineral interactions: Common problem on many horse farms



Known mineral interactions (Miller, 1979)

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Common interactions that reduce mineral availability

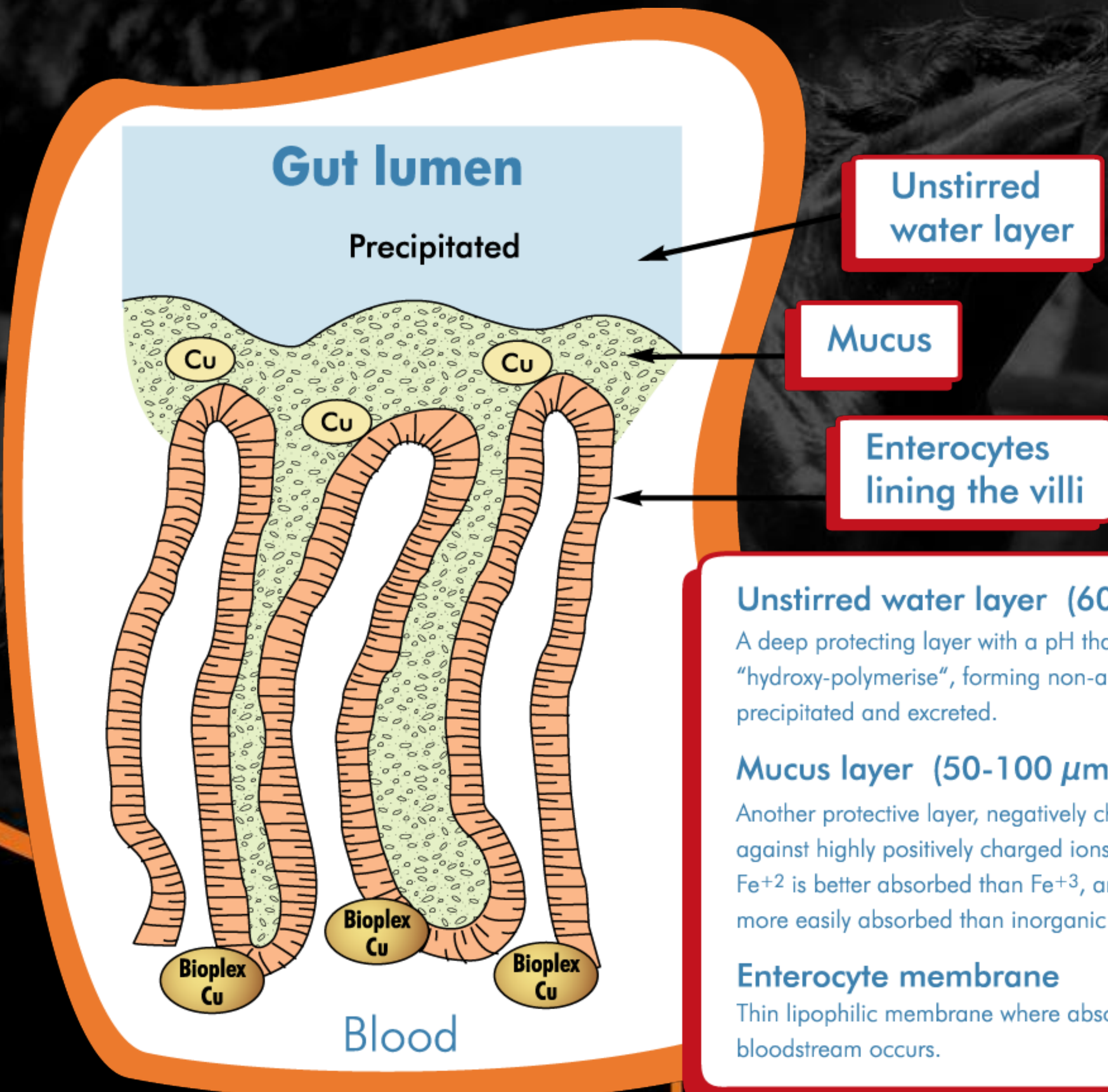
- Iron: interferes with Cu, Zn, Cr
  - Many pastures are high in Fe
- Cu and Zn compete for absorption sites
- High Ca binds trace minerals
- High P interferes with Mg, Mn, Zn and Ca
- Sulphur, sulphate: reduce Cu, Zn absorption
- Molybdenum: reduces Cu absorption

Mineral absorption

- Specific pathways and feedback mechanisms controlling mineral absorption not yet fully clear

However…..

- Most trace minerals require bonding with protein-based carrier



Unstirred water layer (600 μm)

A deep protecting layer with a pH that causes certain ions to "hydroxy-polymerise", forming non-absorbable complexes that are precipitated and excreted.

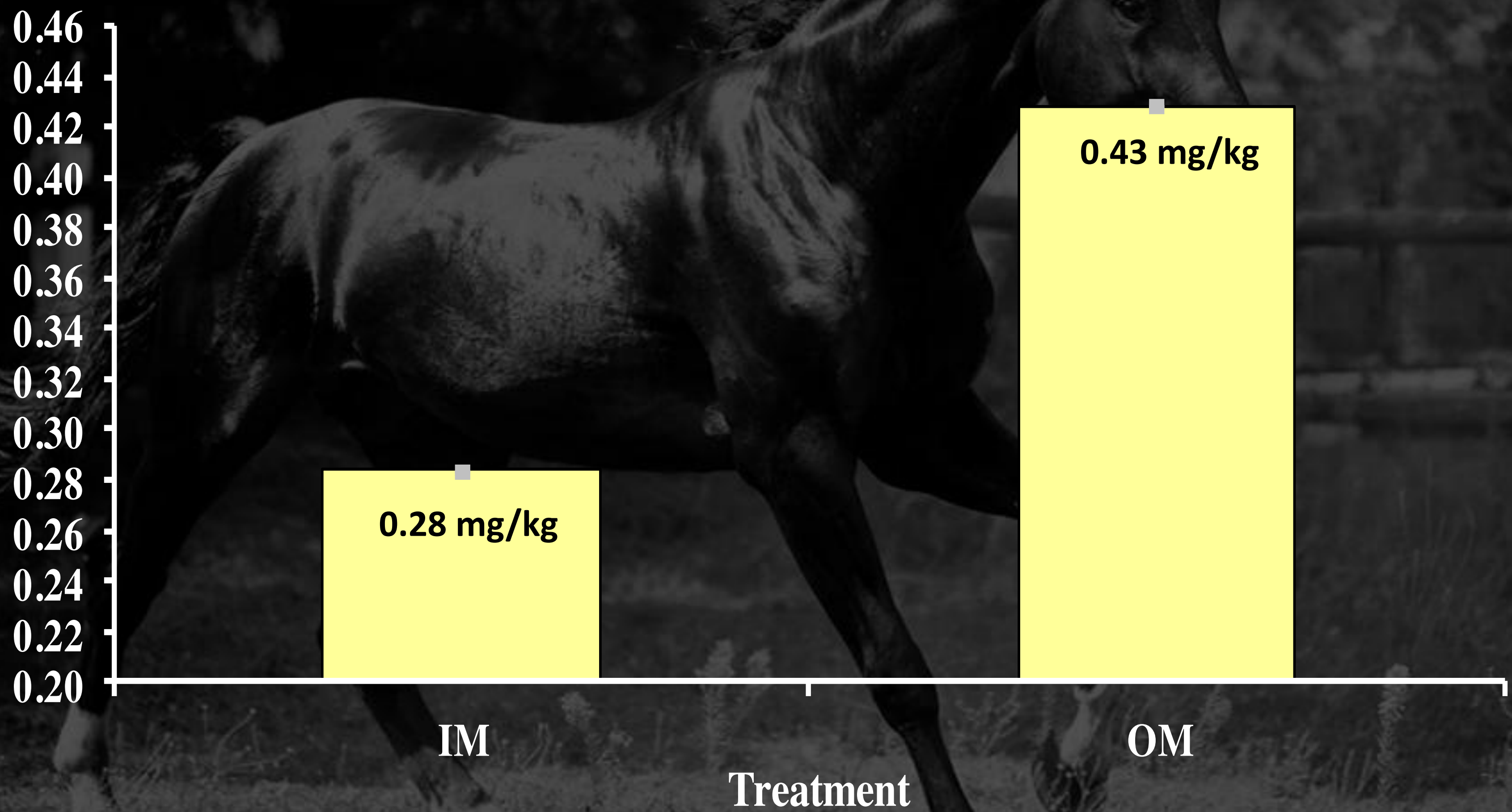
Mucus layer (50-100 μm)

Another protective layer, negatively charged, to act as a barrier against highly positively charged ions such as Al^{+3}. This is why Fe^{+2} is better absorbed than Fe^{+3}, and why Bioplex minerals are more easily absorbed than inorganic ions.

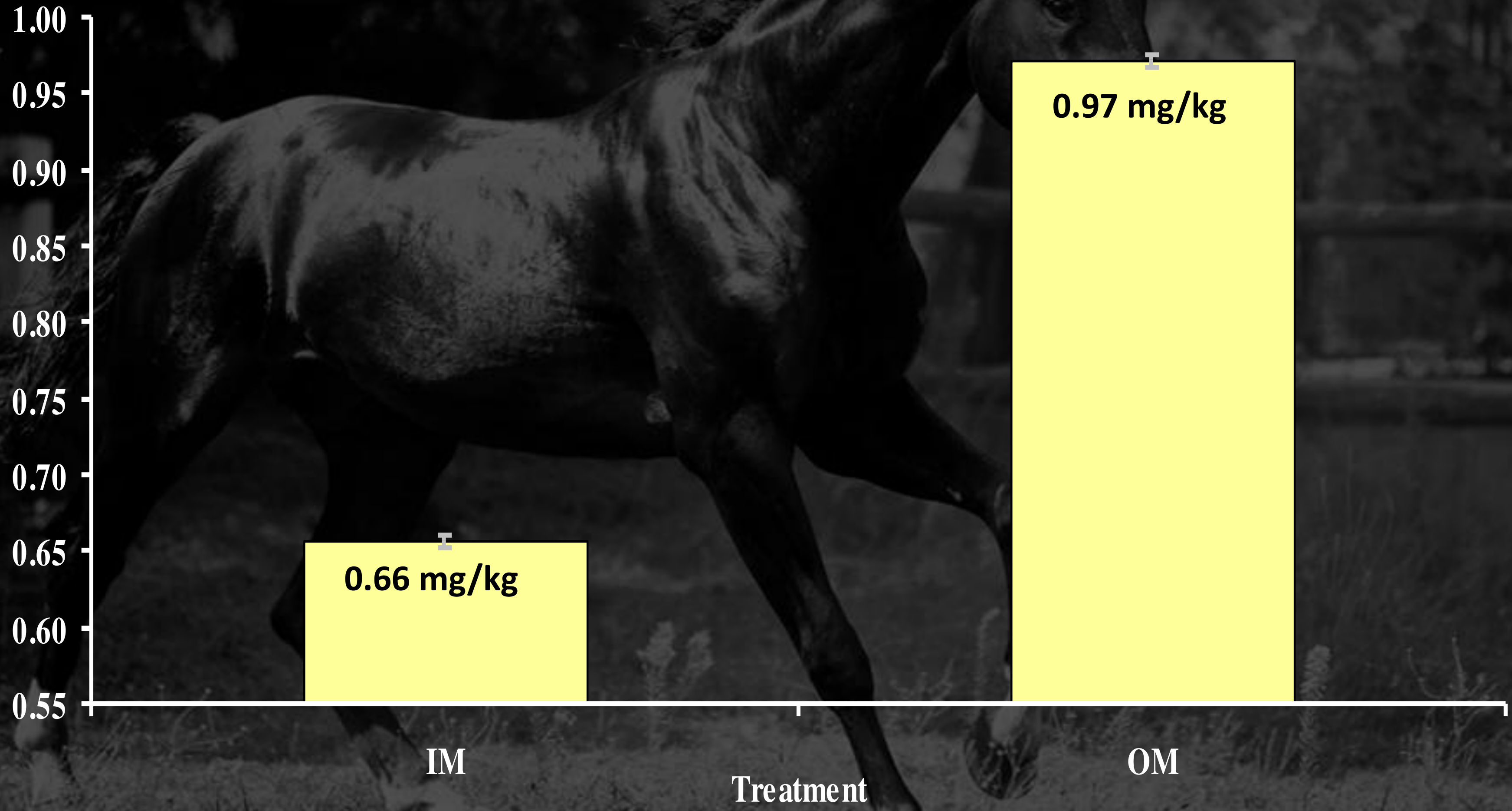
Enterocyte membrane

Thin lipophilic membrane where absorption into the bloodstream occurs.

Effect of Cu Source on overall mean apparent daily Cu balance (mg/kg BW; P < .001)



Effect of Zn source on apparent daily Zn balance (mg/kg BW; P < .001)



Antioxidant defence

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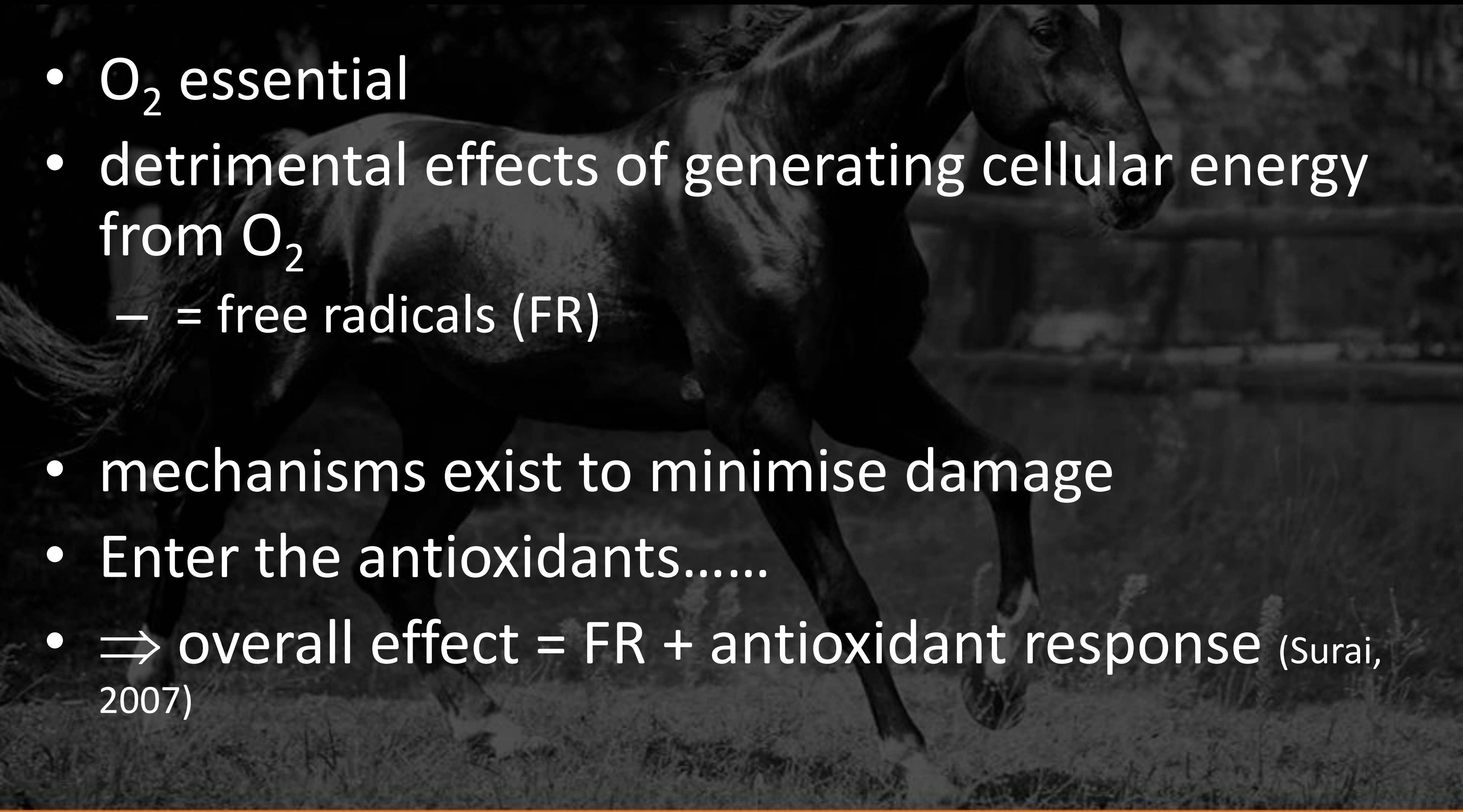
Antioxidant function – the dreaded free radicals…

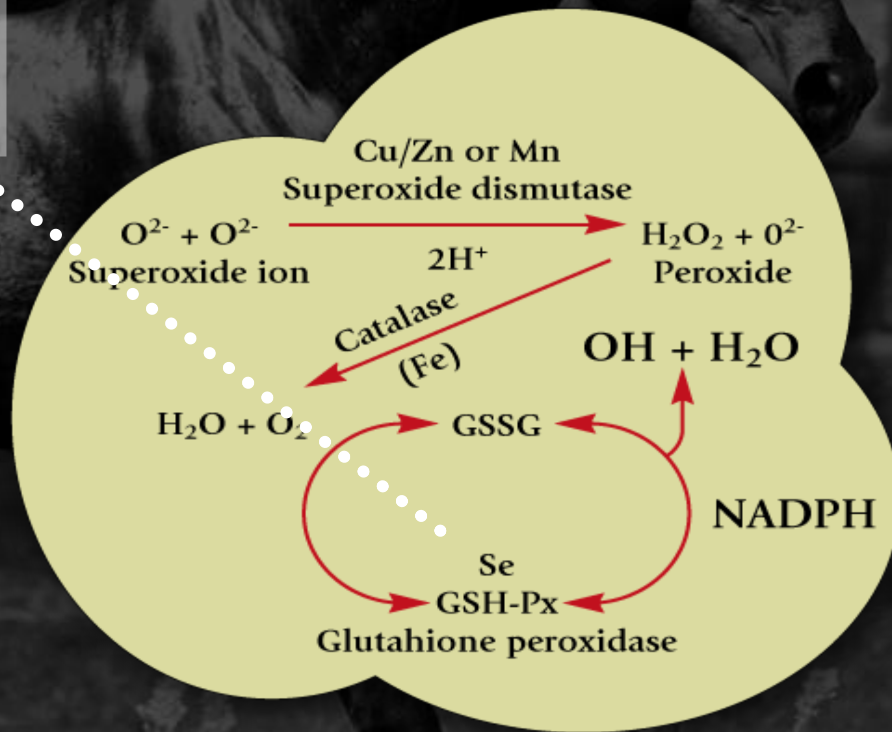


- O_2 essential
- detrimental effects of generating cellular energy from O_2
  - = free radicals (FR)

- mechanisms exist to minimise damage
- Enter the antioxidants……
- $\Rightarrow$ overall effect = FR + antioxidant response (Surai, 2007)

Maintaining optimal antioxidant function

Zn, Cu, Mn, Fe, Se =
co-factors for anti-oxidant enzymes



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Selenium (Se) – physiological roles

- Antioxidant
  - Component of selenoproteins
  - e.g. GSH-Px
- Thyroid metabolism
  - Iodothyronine deiodinase = converts T_4 to T_3
  - Mood
- Regulation of gene expression
  - nutrigenomics
- Immunocompetence
  - Innate and acquired
- Male fertility
  - Sperm structure and integrity

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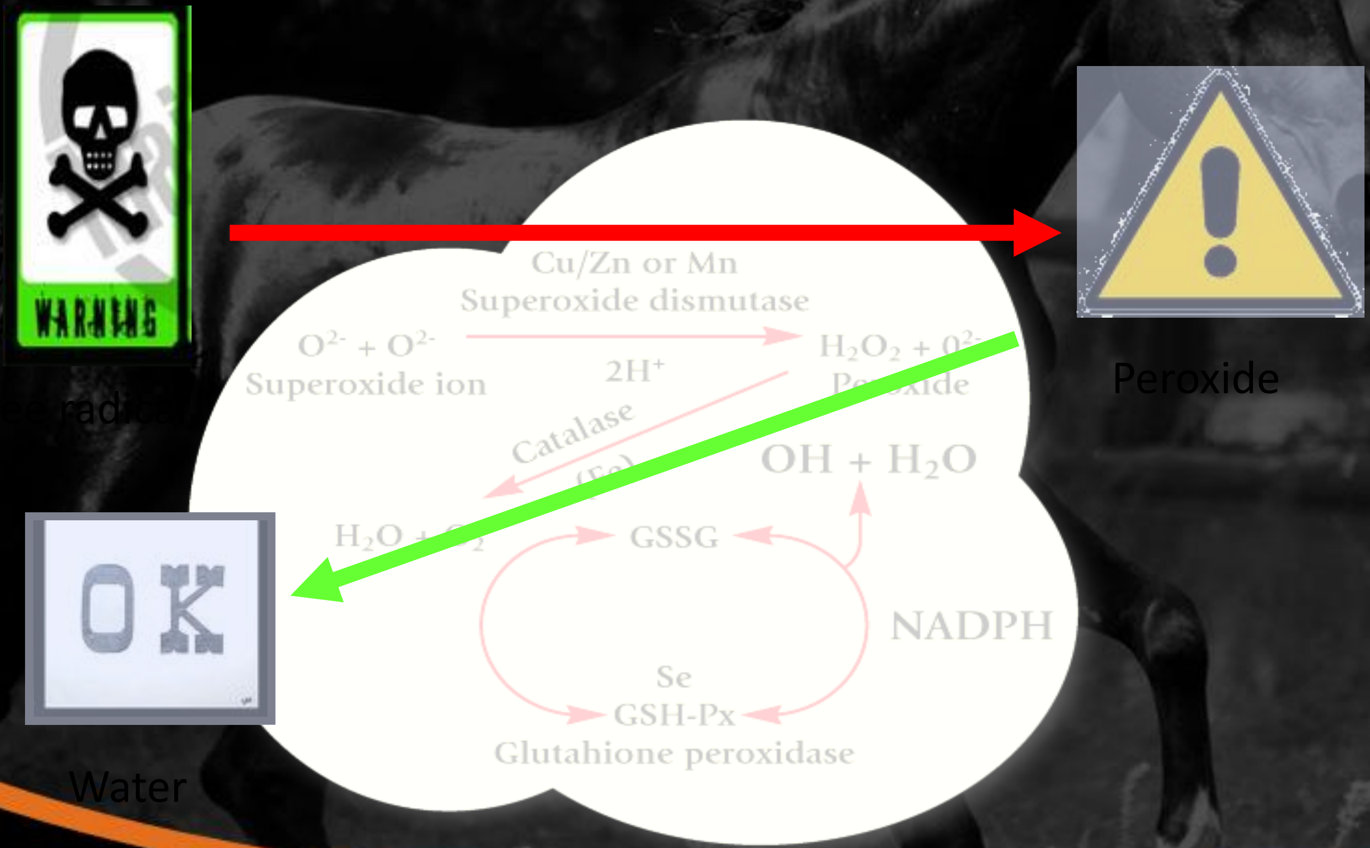
Selenium = key antioxidant



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The natural mineral cycle…

Se, Cu, Zn, Mn reserves – foaling, lactation, performance, disease challenges

Stored in body tissues

NOT stored in body tissues!

No reserves for times of metabolic stress

Converted to organic mineral by plant

Feeding inorganic minerals breaks the cycle

Selenium yeast

- Many studies = greater incorporation of Se as selenoproteins/amino acids from selenium yeast

- Mahan, 2000
- Junpier *et al*., 2006
- Pagan *et al*., 1999
- Rock *et al.,* 2001

- May also be benefits regarding toxicity

Effect on selenium status

plasma & whole blood selenium

- Serum Se concentration higher with equal admin organic vs. inorganic suppl. in mares and their foals (Selplex).
  - *Janicki et al 2001*
- Whole blood Se concentration higher with organic (selenium yeast) vs. inorganic source (3mg/kg dm) (Selplex)
  - (Calamari *et al.*, 2008)
- No similar effects seen with SeMet
  - (Richardson *et al.*, 2006)

Selenium Balance in Exercising Horses

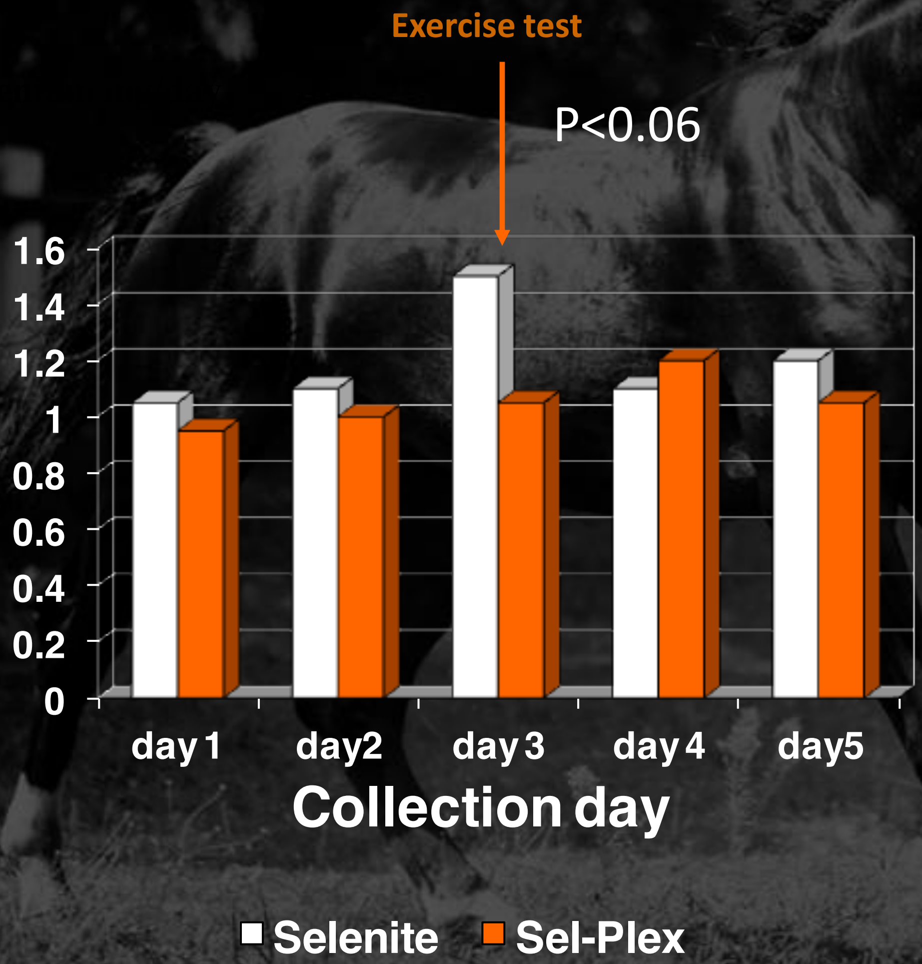
- Four trained horses receiving 2.9 mg Se/day from selenite or selenium yeast (Sel-Plex). – Hay plus conc. feed

- Selenium balance determined in a total collection study (5 days – feed, urine & feces).

- Response to exercise evaluated by measuring whole blood, plasma and urinary Se before and after a competition exercise test and at 4 and 24 hrs post-exercise.

Pagan *et al* 1999

Urinary Selenium Excretion Following Exercise



- Increased urinary excretion of Se following exercise with inorganic vs. organic sources ($p<0.05$).

Summary

- Support for Se supplementation for all horses
- Some evidence for enhanced Se retention & status from organic forms
- Further evidence would strengthen this assertion
- Analysis of more sensitive biomarkers of Se functional capacity

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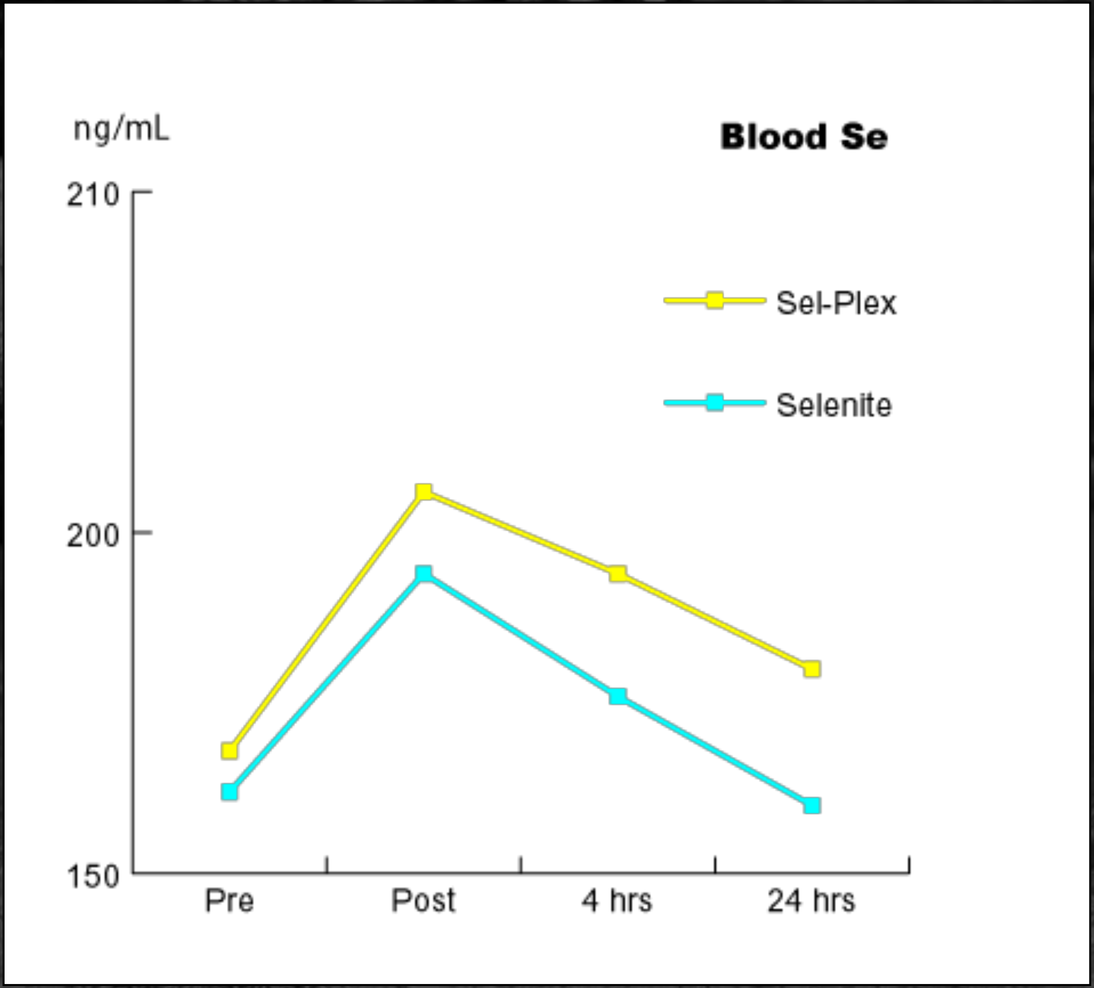
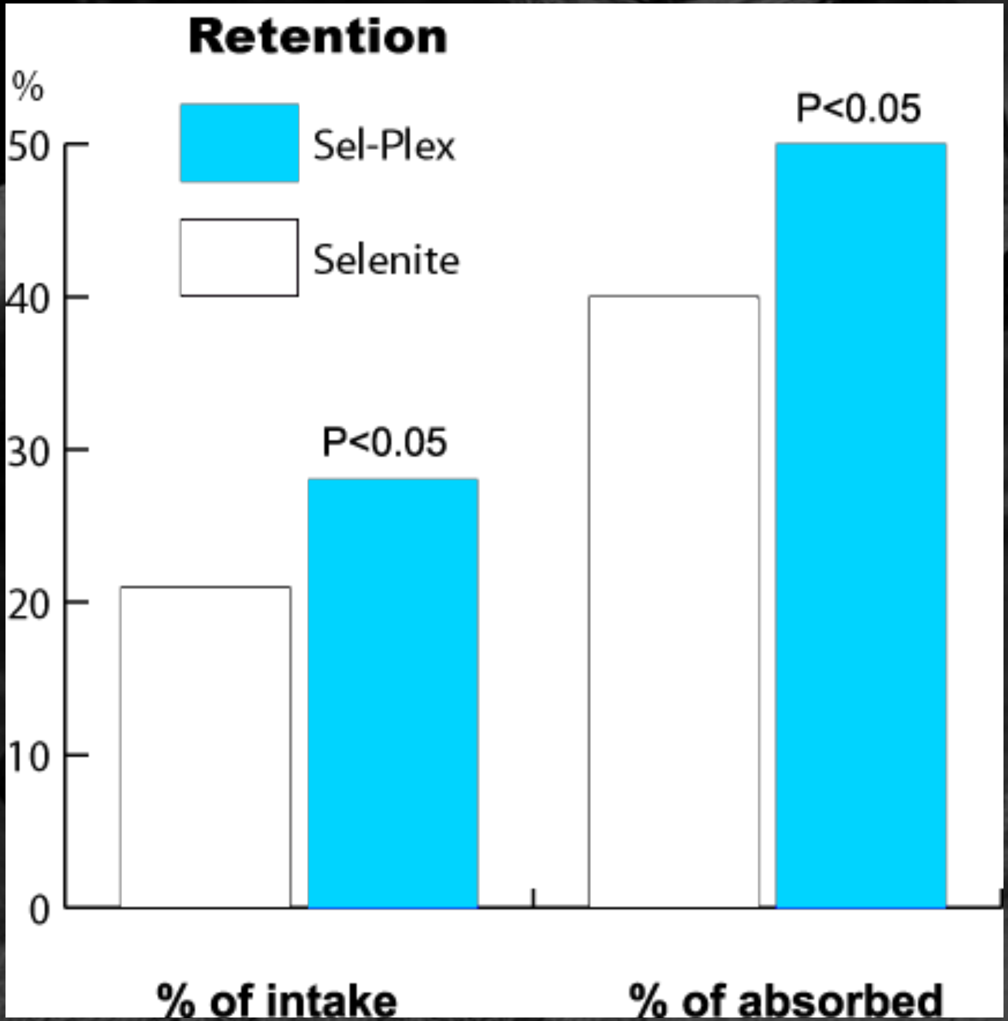
Horses given Se yeast had a more positive Se balance

- Selenium mobilized at exercise onset
- Blood Se remains elevated in Sel-Plex-fed horses



Pagan et al., 1999

Higher selenium retention with Se yeast



Pagan et al., 1999

Selenium – what is normal?

- Random analysis of 12 horses (Nottingham Vet School)
  - only 1/12 horses had ‘normal’ (1.67 – 2.03μM) plasma selenium levels
  - 3/12 = ‘at risk’ from muscular dystrophy problems
  - believed that these results would be mirrored on a larger scale
- In the US - 202 horses
  - values ranged from 50 – 260ng/ml
  - normal is considered 130 – 160ng/ml.

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A word about selenium toxicity

- NaSe = toxic to mammals over certain levels
- Horses appear very sensitive
- Feed Additive Directive 70/524/EC:
  - max supplementation = 0.5mg/kg in complete feeds with current dietary recommendations at 0.1mg/kg of the ration

21 Polo horse deaths linked to Sodium selenite

- "Chemist mistakenly added too much sodium selenite" – *The Guardian*
- "prescription had requested 0.5 mg of sodium selenite per millilitre of horse supplement, but the chemist had mistakenly included 5 mg" - *La Nación*

Mycotoxins

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Mycotoxins

- 2° fungal metabolites
- contaminate feeds
- Leading to.....
  – poor condition
  – Lethargy
  – Depression
  – Lameness
  – Death (Smith and Girish, 2008).

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Review of effects of mycotoxins in horses

Mycotoxins in Farm Animals, 2008: 47-70 ISBN: 978-81-7895-312-0
Editors: Isabelle P. Oswald and Ionelia Taranu

3 The effects of feed borne mycotoxins on equine performance and metabolism

T. K. Smith and C. K. Girish
Department of Animal and Poultry Science, University of Guelph
Guelph, N1G 2W1, Canada

9. Conclusions

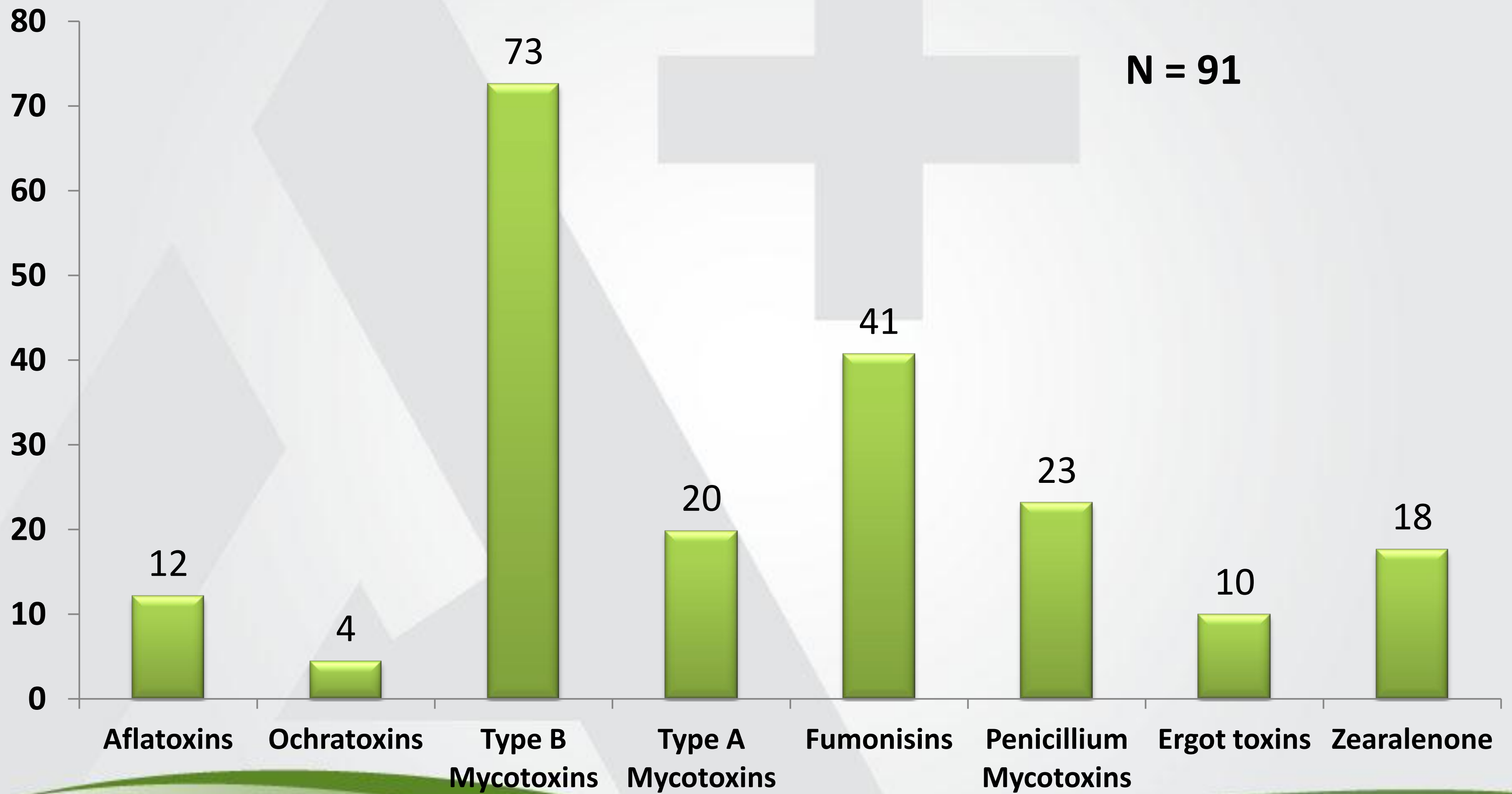
Equines are sensitive to most of the mycotoxins that have been reported in field outbreaks and controlled experiments. They are the most susceptible species to fumonisin toxicity. Horses of all ages are susceptible to feed-borne mycotoxins. Mycotoxins have been shown to affect various physiological systems including digestive, respiratory, reproductive and nervous systems. Despite vigilant management and efficient quality control systems, contamination of horse feed with mycotoxins may be unavoidable. Equines may be more sensitive to naturally contaminated feedstuffs because of the presence of multiple mycotoxins and complex interactions between them causing severe adverse effects. Mycotoxins may cause significant economic losses to equine industries because of their adverse effects on performance, neurological status and reproduction. Inclusion of contaminated feedstuffs in equine diets should, therefore, be avoided. An improved understanding of the toxicokinetics of mycotoxins in equines is important for the development of preventative and therapeutic strategies to reduce the adverse effects of mycotoxins.

Mycotoxins cause significant economic losses to equine industries because of their adverse effects on performance, neurological status and reproduction.

Mycotoxin exposure

- aflatoxins, zearalenone and fumonisins.
- ↑ feeding of haylage = highlighted threat
- avoiding contamination = difficult
- testing = expensive (and variable!)
- mycotoxin adsorbent
  - low effective inclusion rate
  - stablity over a wide pH range
  - high capacity and affinity
- glucomannan oligosaccharide

% of Samples Positive for Mycotoxins



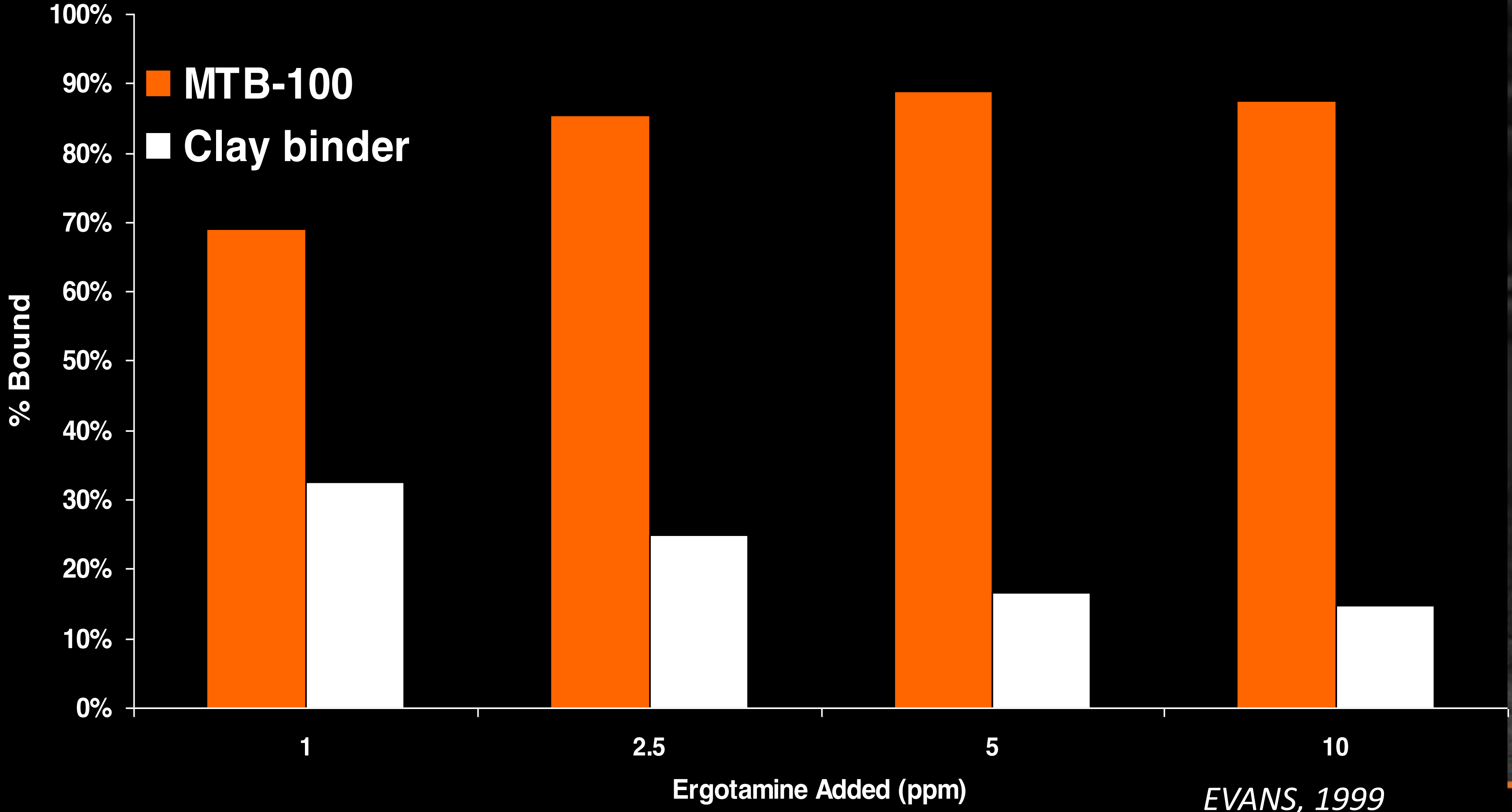
Multiple Mycotoxins For Entire Dataset

Number of mycotoxins	% Samples
0	12.09
1	27.47
2	13.19
3 to 5	32.97
5 to 10	13.19
>10	1.10

The effect of mycotoxins on feed intake in horses

	Average daily intake, kg		
Group	**0-7 days**	**7-14 days**	**14-21 days**
Control	2.80	2.80	2.80
Mycotoxins	1.03	1.01	0.96
Mycotoxins + Mycosorb 0.2%	1.81	1.60	1.52

Mycosorb's ability (1 kg/tonne) to bind ergotamine in the presence of 4 different concentrations



EVANS, 1999

The green stuff

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Algae and horses

- Anti-inflammatory properties
- Potential modification of glycaemic response
- Semen quality

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Reduction of pro-inflammatory compound

- Prostaglandin E2 (PGE_2)
  - Key mediator in inflammatory reaction
  - Vasodilator
- *n*-3 PUFA known to modulate inflammatory reaction in other species
- Hall *et al*., 2004 – corn oil ↑ PGE2 compared with fish oil
  - Potential benefits of fish oil wrt inflammatory diseases
- Ross *et al*., 2011 – PGE_2 lower in joint fluid with EPA/DHA

DHA reduced deterioration in motility following storage

Effect of feeding a DHA-enriched nutriceutical on the percent reduction in motility, compared to fresh samples (mean ± S.D.) of cooled and frozen–thawed semen (n = 8 per sample)

Semen sample	Motility[a]	Control	Nutriceutical-fed	*P*-value
24 h cooled	↓TMOT (%)	23 ± 16	22 ± 12	0.78
	↓PMOT (%)	29 ± 26	20 ± 18	0.33
48 h cooled	↓TMOT (%)	45 ± 21	30 ± 11	0.06
	↓PMOT (%)	48 ± 30	32 ± 18	0.05
Frozen thawed	↓TMOT (%)	73 ± 7	68 ± 9	0.04
	↓PMOT (%)	73 ± 12	67 ± 16	0.03

[a] Percent decrease in sperm motility i.e., decrease in total sperm motility (↓TMOT), decrease in progressive sperm motility (↓PMOT), from motility in fresh samples.

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Brinsko *et al*., 2004

Beneficial effects on progressive sperm motility after cold storage

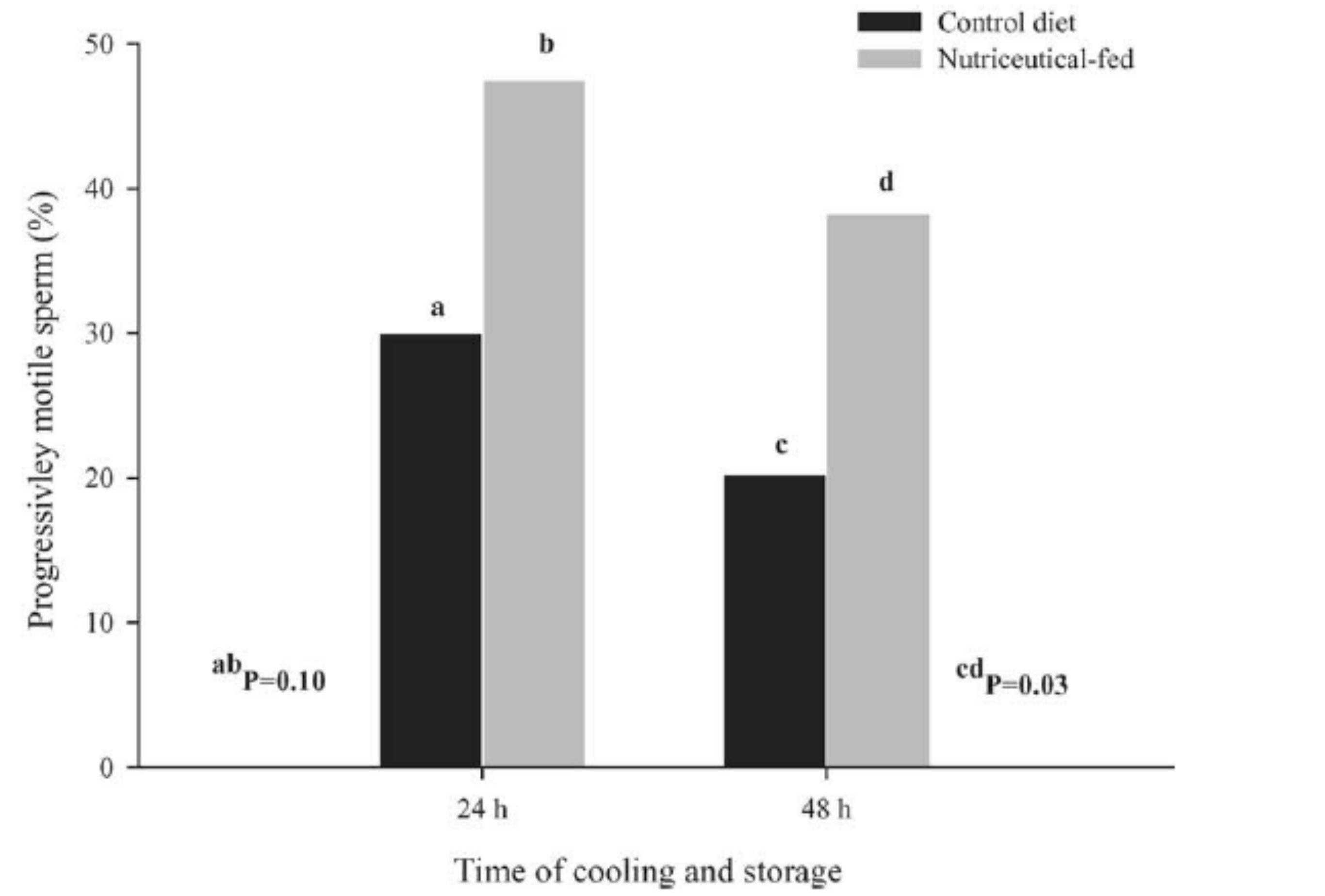
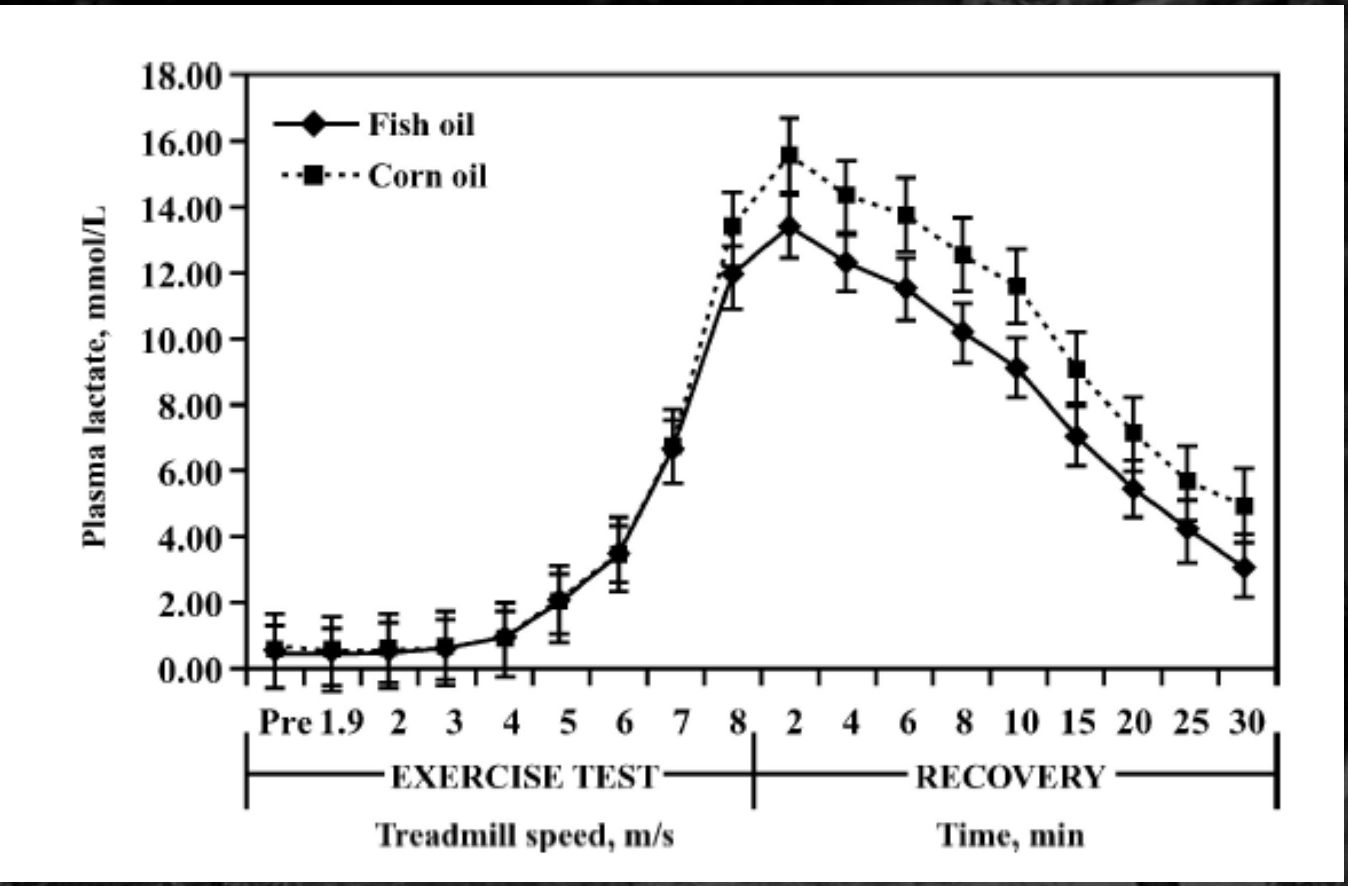


Fig. 1. Effect of feeding a DHA-enriched nutriceutical on semen of stallions having <40% progressive sperm motility after 24 h of cooling and storage (n = 4).

Brinsko *et al.*, 2004

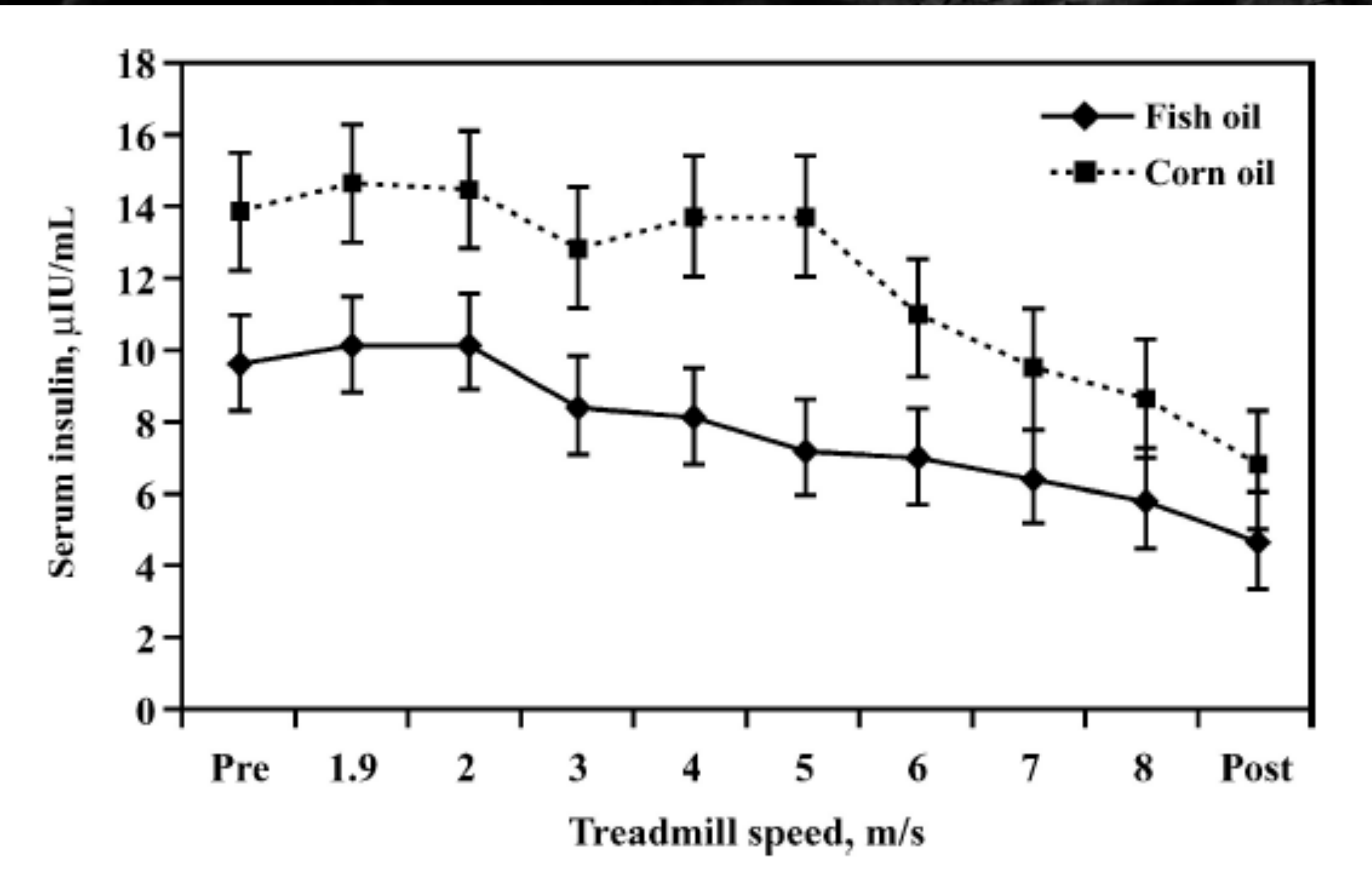
Recovery following exercise



- Mirrored by lower heart rates
- Lower heart rate – longer to fatigue

O'Connor *et al.*, 2012

Increased glucose:insulin ratio



Potential higher insulin sensitivity

O'Connor *et al.*, 2012

Changes to Lifeforce from Alltech

3 Formulations of LIFEFORCE –

- 3 Formulations of LIFEFORCE to recognise different segments & applications:

  Lifeforce Focus: for the Leisure Horse in low activity

  Lifeforce Formula: for the Breeding Horse & Leisure horse in moderate activity

  Lifeforce Elite: for Competition Horses & those in high activity

- Product available end July 2012

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LIFEFORCE – Details & Messaging

	LIFEFORCE Focus	LIFEFORCE Formula	LIFEFORCE Elite
Packaging	White Lid & Label	Orange Lid & Label	Black Lid & Platinum Label
Focus	Leisure riders	Breeding/ Development	Performance horses in stress situations
Messages	Preventative Care Gut Health	Mare & Foal Immunity Optimise development	Anti-inflammatory Digestive Health Antioxidant

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Conclusion

Biotechnology can be a valuable tool for improving the productivity of our horses

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from Alltech®

Thank you