

IMPACT OF MYCOTOXINS ON THE COST OF BROILER PRODUCTION



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Special Nutrients

Livestock Asia 2015

Mold and Mycotoxin Contamination



In the field



Harvest



Transport and storage



Feed manufacturing



Feed delivery
and feeding



Mycotoxin Contamination



Corn

Milo

Wheat

Barley

Soya

Silage

Corn by-products

Wheat by-products

Rice by-products



Global reports from
total samples analyzed
in the last 3 years

+ 70 % contaminated
with one mycotoxin

+ 50 % contaminated
with more than one
mycotoxin

Mold

Mycotoxins



Aspergillus flavus

Aspergillus parasiticus

Penicillium sp.

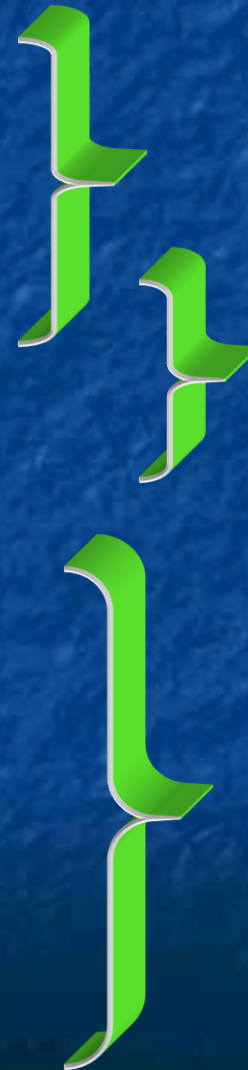
Aspergillus ochraceus

Fusarium roseum

Fusarium tricinctum

Fusarium moniliforme

Fusarium graminearum



Cyclopiazonic Acid

Aflatoxins

Citrinin

Ochratoxin

Trichothecenes

T-2 toxin

DAS diacetoxyscirpenol

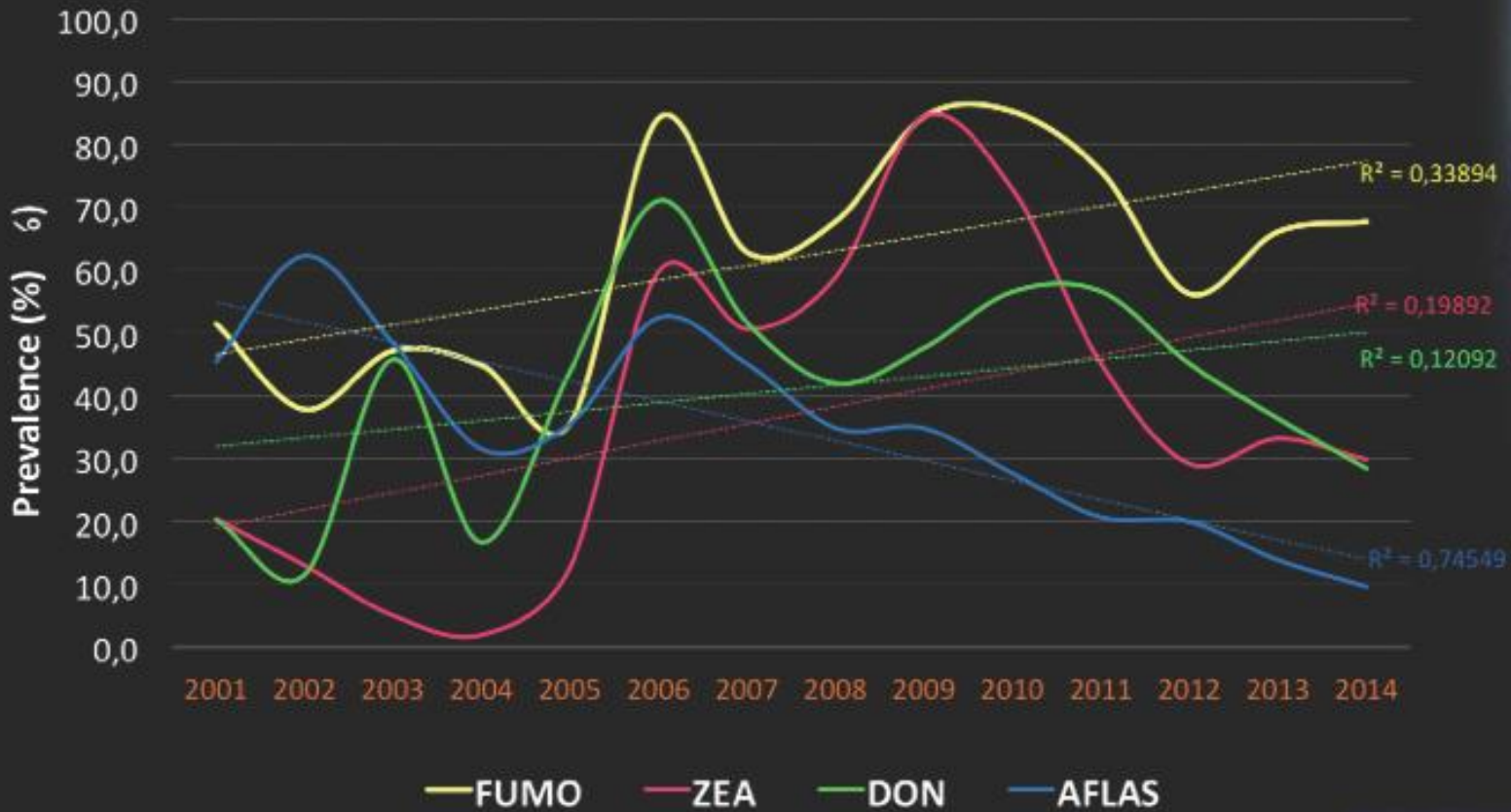
DON deoxynivalenol

Zearalenone

Fumonisin

BRASIL

Trends of the major mycotoxins 2001- 2014



LAMIC

Malaysia Raw Material Sources



- Argentina
- Brazil
- United States
- India
- Pakistan

Malaysia Mycotoxin Contamination Trend



LCMS/MS Analysis result

Mycotoxin positive sample %	Aflatoxin B1	DON	Ochr. A	Fumon. B1	T-2 toxin	ZEA
2009-2011 %	8.5	17.9	7.6	66.0	0.9	15.1
2012-2013 %	21.1	30.1	9.8	66.2	0.8	33.8
2014 %	22	28	3	94	0	32
2015 up to date %	3.2	62.9	0	88.7	0	67.7

ELISA

Mycotoxin positive sample %	Aflatoxins	DON	Ochrtxn	Fumos	T-2 toxin	ZEA
2009-2011 %	26.1	55.0	1.4	64.3	0.0	12.1
2012-2013 %	38.5	62.1	10.5	69.2	8.0	18.5
2014 %	16	57	0	70	13	28
2015 up to date %	8.4	62.6	4.7	83.2	7.5	15.0

Most of the positive samples were tested contain more than 1 mycotoxin

Concerning levels of mycotoxins in poultry



Mycotoxin	Regulations Recommendations UE - EUA	Levels Field Problems
Aflatoxin	< 20 ppb	5 ppb
T-2 Toxin	< 500 ppb	100 ppb
Fumonisin	< 5000 ppb	1000 ppb
Vomitoxina (DON)	< 1000 ppb	200 ppb
Ochratoxin	< 20 ppb	5 ppb

Mycotoxicosis



- **Type** of mycotoxins
- **Quantity** of mycotoxins
- **Combination** of mycotoxins
- **Age** of animal
- **Species** of animal
- **Time** of exposure
- **Nutritional and health** status
- **Interactions** direct or indirect

Mycotoxins Impact on Broiler's Cost

Animals exposed chronically to mycotoxins show affected performance with major economical losses due to:

- Cost of mold contamination
- Cost of immunosuppression
- Cost of productive performance
- Cost of carcass yield and quality

Cost of mold contamination

Mold contaminated ingredients and/or feed present lower nutritional value due to usage of some nutrients by the fungus



Energy value of corn contaminated with molds



Ingredient	Metabolizable Energy (kcal/kg)	Crude Protein %	Crude Fat %	Crude Fiber %
Normal Corn	3410	8.9	4.0	3.1
Corn with Molds 2 months at 25°C *	3252	8.3	1.5	3.4

Metabolizable Energy before mold contamination 3344 kcal/kg

Tindall, W., Salud y Nutrición Animal 4:5, 1983

Mold and the use of nutrients



Reduction in carbohydrates and lipids decreases corn metabolizable energy in about 4 to 5 %

$$\text{ME} = 3350 - 100$$

$$\text{ME} = \mathbf{3250} \text{ kcal / kg}$$

$$\text{ME} = 3350 - 150$$

$$\text{ME} = \mathbf{3200} \text{ kcal / kg}$$

Molds use highly digestible nutrients with the consequent reduction of grain density

Fatty acids in complete feed contaminated with molds

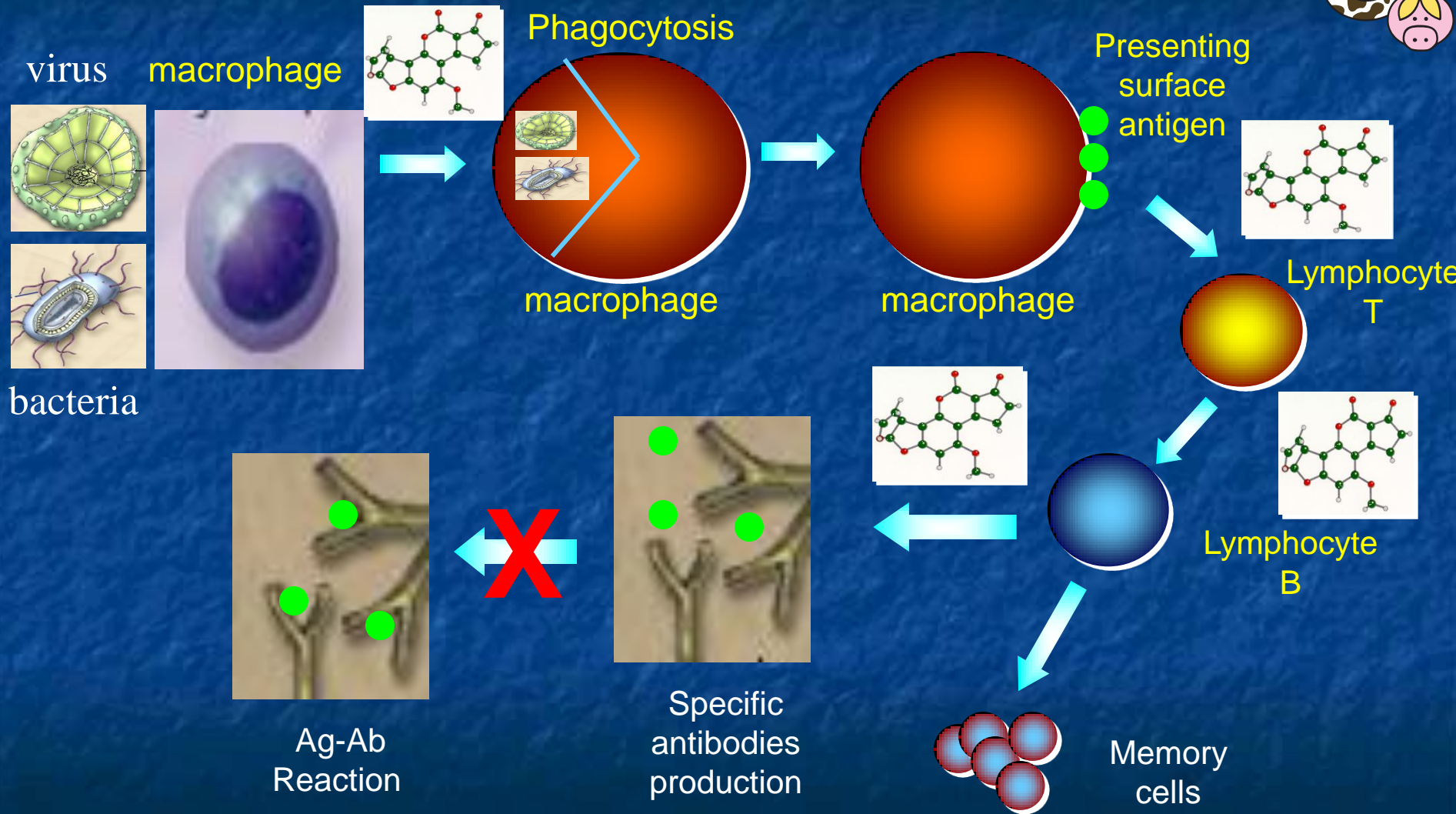
Broiler feed	Oleic %	Linoleic %	Linolenic %
Without molds	1.352 a	3.047 a	0.114 a
Low level molds	0.807 b	1.993 b	0.063 b
Medium level molds	0.682 c	1.725 c	0.053 c
High level molds	0.593 c	1.511 d	0.022 d

Feed moistened with water to 17% humidity.
Levels based on oxygen used. **Kilburn and Wyatt, 2005.**

Cost of immunosuppression

- Mycotoxins with major incidence in the immune system: aflatoxin B₁, ochratoxin A , T-2 toxin and fumonisin.
- Increase broiler susceptibility to a variety of infectious agents. Chronic infections are re-activated.
- Affect resistant to diseases through alteration in the defense mechanisms. Increase anti-coccidial doses of ionophors.
- Affect protecting capacity of vaccination programs (Gumboro - Newcastle - Bronchitis)

Immune Response



MYCOTOXIN CONTAMINATION

IMMUNOSUPPRESSION

Increased
vaccine
reaction

Poor response
to vaccination

Excess use of
antibiotics
in the farm

Uneven
growth

Poor
performance

Mycotoxins and uniformity in broilers



Post-vaccine reaction



Air sacs
with mucus



Is there a practical way to evaluate the immune system ?

- Ratio between bursa of Fabricius : spleen

The size of the bursa of Fabricius should be 2 to 2.5 times greater than the size of the spleen during the first 28 to 30 days of age.

Normal Immune System in 21 day-old broiler chickens



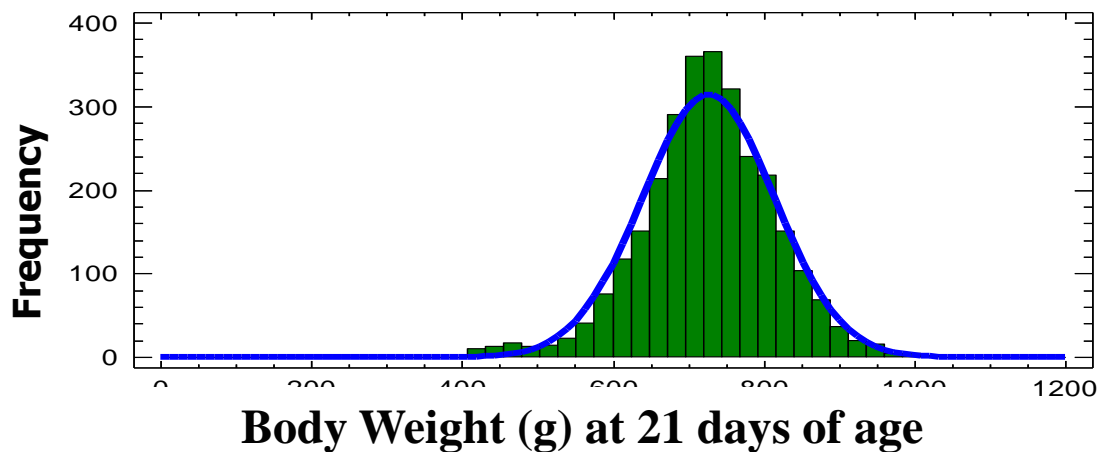
Affected Immune System in 25 day-old broiler chickens



Cost of productive performance

- **Aflatoxin** is the mycotoxin with the major negative impact on body weight gain in broilers; which is even worse when other mycotoxins are present simultaneously.
- **Aflatoxin, ochratoxin, T-2 toxin, fumonisin and DON** affect feed conversion in broiler chickens on average **0.05** (0.03 - 0.10), depending on the combinations of mycotoxins.
- **Aflatoxin, ochratoxin, T-2 toxin, fumonisin and DON** in field contaminations increase mortality on average **0.5%** and up to 1% in the presence of high levels of several mycotoxins at the same time.

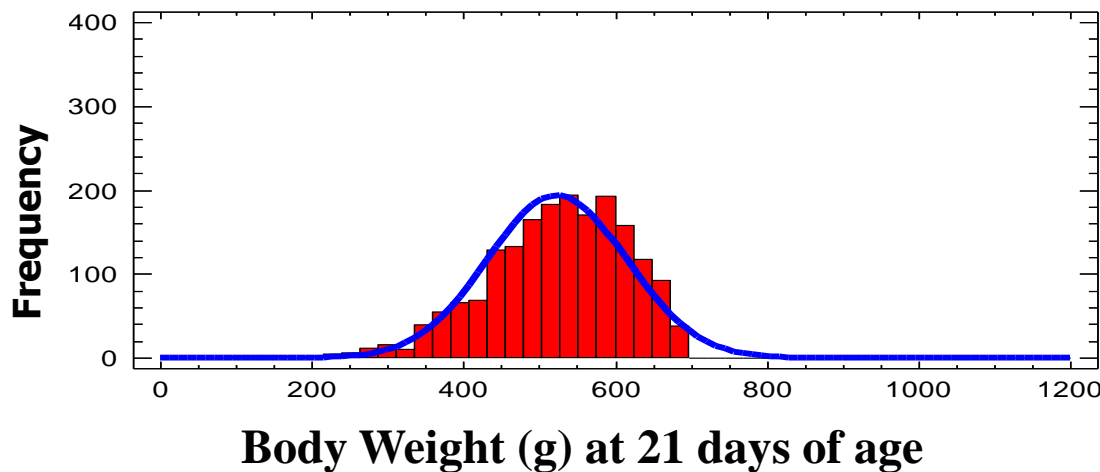
Aflatoxin and broiler weight / uniformity



$726.35 \pm 12.10\%$

Control

n= 2881



$523.77 \pm 17.47\%$

Afla 2.8 ppm

n= 1848

Effect of aflatoxin on growth



Normal
dieta

Aflatoxin
contaminated diet

Effect of aflatoxin on the activity of pancreatic digestive enzymes

Diet	Digestive Activity (units / g of dry weight)		
	Amylase	Trypsin	Lipase
Aflatoxin			
0 ppm	281	46.2	292
2.5 ppm	179 *	35.8 *	191 *

Aflatoxin reduces 35% digestive enzymes activity

Aflatoxin effect on bile volume and concentration



Aflatoxin in the diet	Volume ml	Concentration OD @ 625 nm
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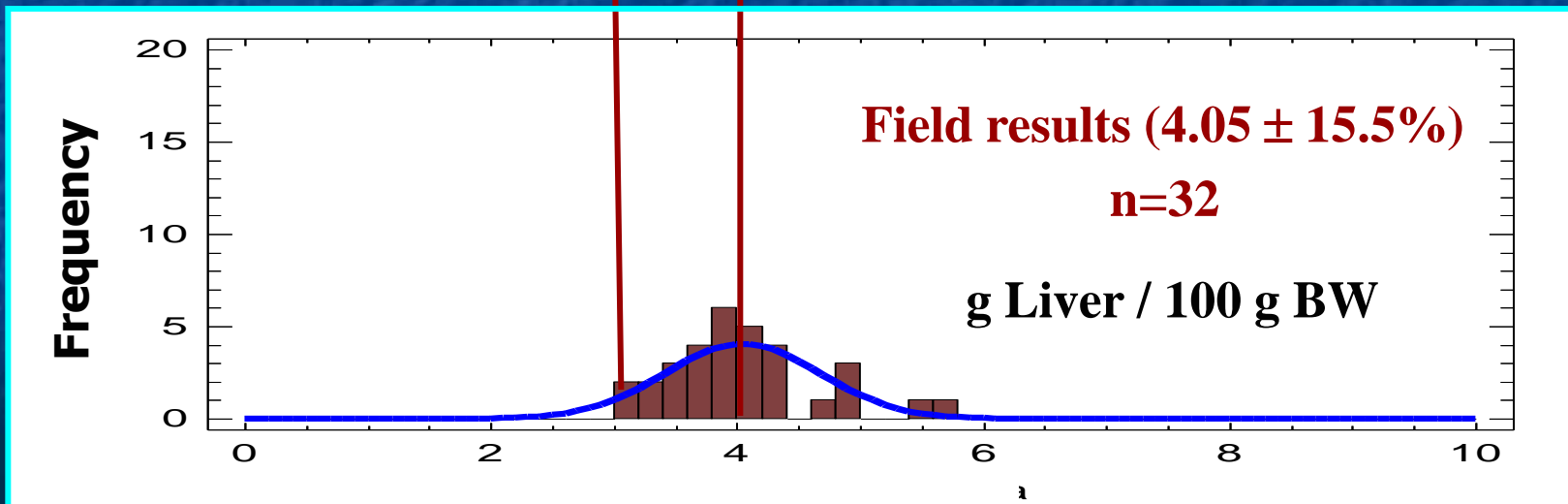
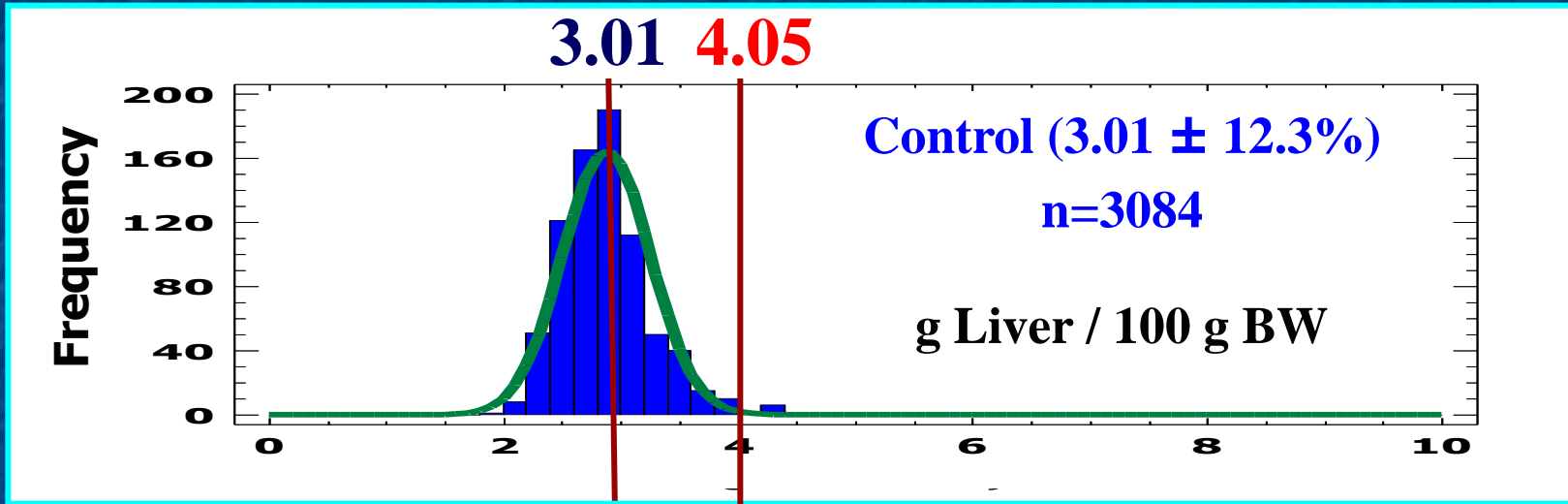
0 ppm	0.38	0.336
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2.5 ppm	0.61	0.149
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Increase quantity with diminish quality of bile salts
Bile salts very diluted without emulsification activity

Relative liver weight: a tool for aflatoxin detection in the field

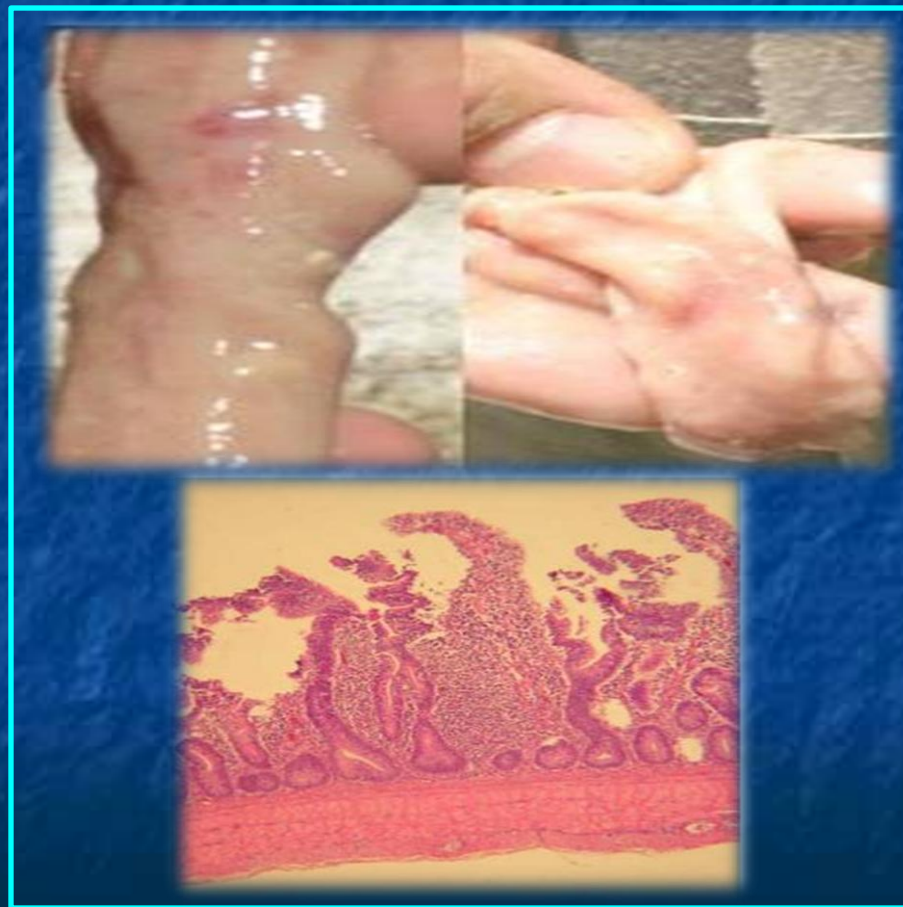


Effect of T-2 + fumonisin + DON on intestinal integrity of broiler chickens

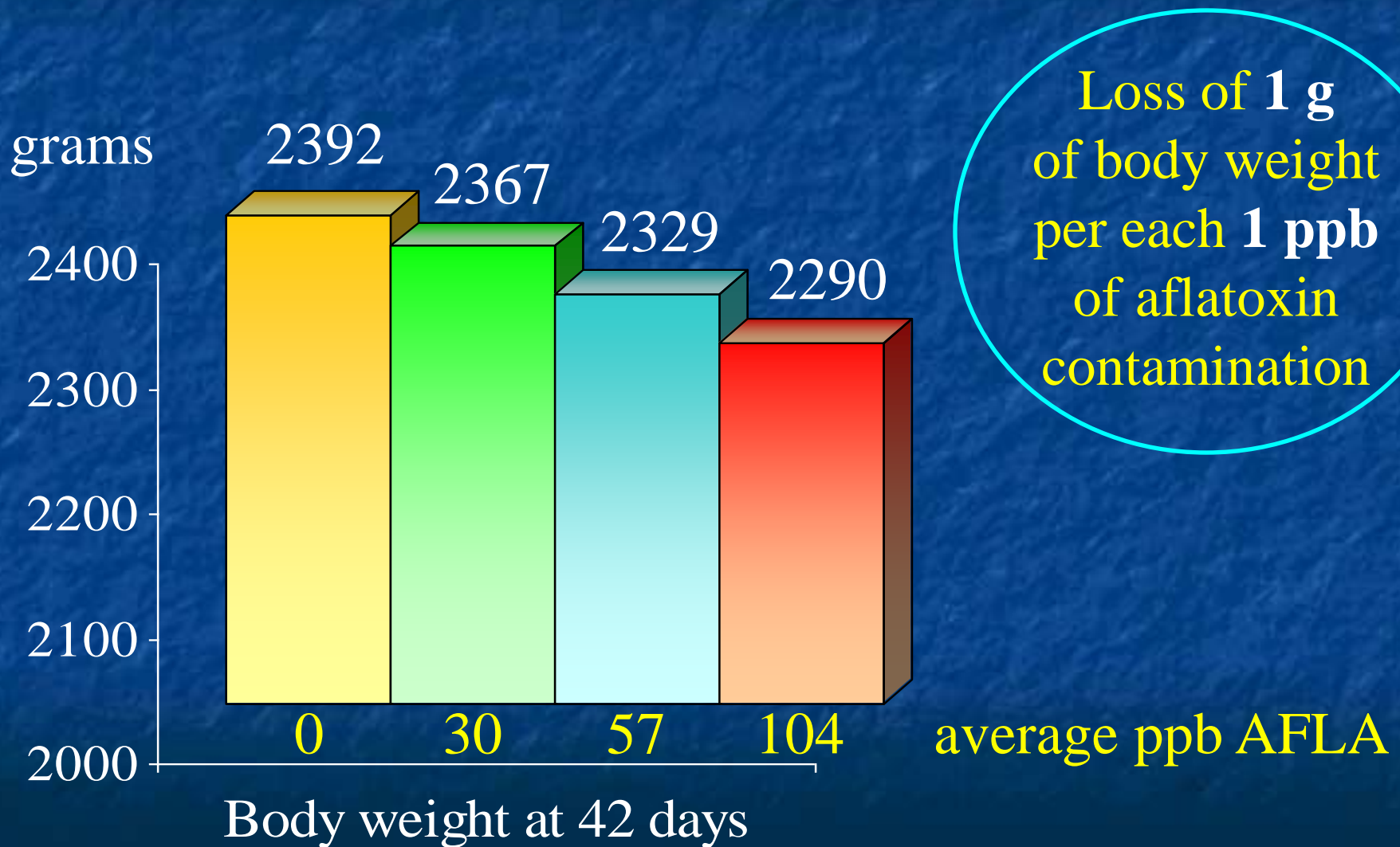
Normal Diet



Contaminated Diet



Field mycotoxins and body weight gain



Cost of carcass yield and quality

- **Aflatoxin** and **fumonisin** create the major negative impact on carcass quality (bruises - hematomas - lacerations) which result in condemnations. Field contaminations can generate on average **0.55%** (0.36 - 0.78%) condemnations
- **Aflatoxin**, **T-2 toxin**, **fumonisin** and **DON** diminish skin pigmentation in broilers, with a reduction on average of **1 - 3 degrees** of the Roche color fan.
- **Aflatoxin**, **ochratoxin** and **fumonisin** increase liver size, making the liver fat and friable, impossible to sale. There is a reduction on liver sales of at least **1%**.

Aflatoxin lesions: capillary fragility with petechial hemorrhages



Condemnation Problems



Effect of mycotoxins on broiler chicken processing



Treatments	Condemnation (%)		
	Legs	Wings	Breast
Control	0	0	0
Aflatoxins	8.68	27.17	2.91
Fumonisin	0.80	15.56	1.86

Dr. Mallmann 2008 LAMIC

Effect of aflatoxin on coagulation and prothrombin time in chickens



Aflatoxin B1 ppm	Coagulation Time seconds	Prothrombin Time seconds
0	252	13.3
0.625	233	14.0
1.25	281 *	14.0
2.5	383 **	16.6 *
5.0	419 **	22.1 **
10.0	556 **	26.2 **

Cost of carcass yield and quality

Fatty and friable liver
inadequate for sale



Liver is 3% of body weight
1% inadequate for sale

Lack of pigmentation
in the skin of broilers



Reduction of 1-3 degrees
in Roche color fan

Economical losses due to molds and mycotoxins

Less
energy
in feed

Less
body weight
gain

Less
carcass yield
and poorer
quality

Poorer
feed
conversion

More
culls and
mortality

Immuno-
suppression



Mycotoxin Contamination

Average mycotoxins in broiler feeds in five Mexican integrations to evaluate economic losses. Price of chicken: **U\$ 2.00 / kg**

Mycotoxin analyses using immuno-assay kits

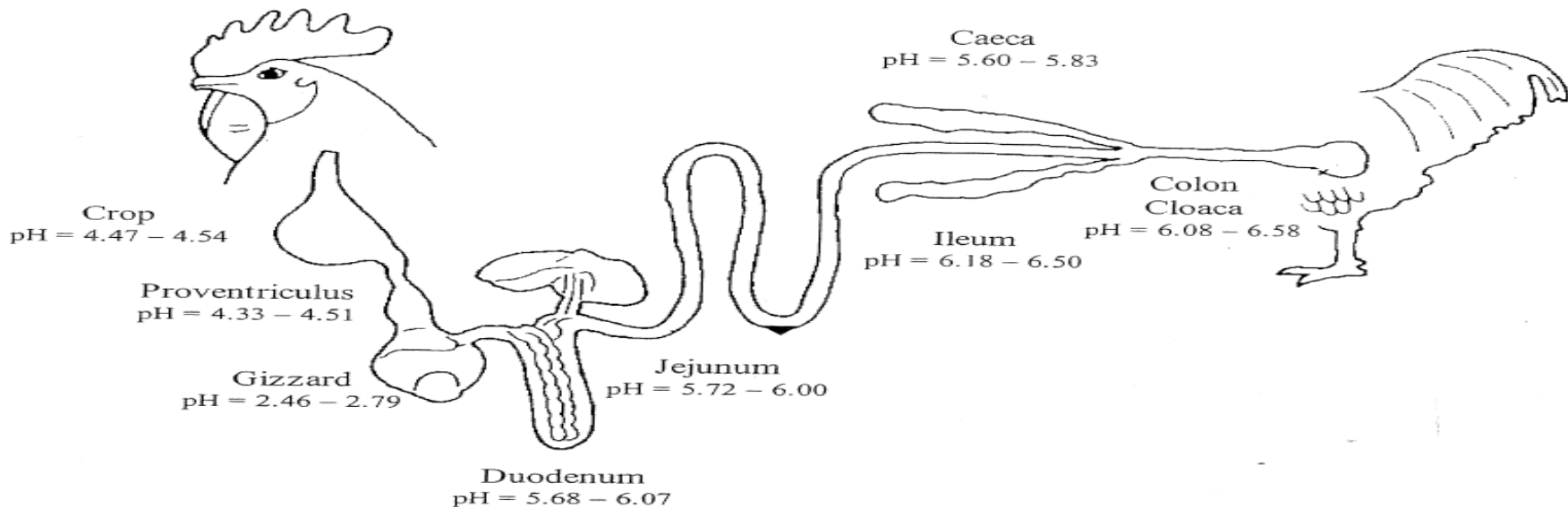
	AFLA ppb	T - 2 ppb	OCRA ppb	ZEA ppb	FUM ppb	DON ppb
Average	48	61	6	220	2700	510
Range	2 - 71	9 - 84	0 - 23	50 - 322	280 - 5630	60 - 810

Economical losses due to molds and mycotoxins



Indirect Cost of Mycotoxins

Necrotic Enteritis



	Proximal GIT	Small Intestine	Distal GIT
pH	3 - 5	6 - 7	7
Bacterial density cfu/g	10^3 to 10^5	10^8 to 10^9	10^{10} to 10^{12}
Microbial population	Acid tolerant	Gm+ Facultative Aerobes	Anaerobes
Digesta passage rate	+++	++	+
Main species	Lactobacilli	Lactobacilli Clostridia Streptococcus Enterococcus	Clostridia Lactobacilli Bacteroides Coliforms Fecal Strep

Necrotic Enteritis Contributing Factors

Dietary ingredients

- Inclusion of cereal grains rich in water soluble non-starch polysaccharides such as **wheat, barley or rye** without effective enzymes. Increase intestinal mucus secretion.
- High levels of **soybean meal, lupin or beans** due to the high levels of oligosaccharides. *Clostridium* but not chickens have enzymes to utilize these type of saccharides.

Necrotic Enteritis and Fumonisin

- Control diet vs Fumonisin contaminated diet with 18.6 mg Fumo B1+B2 / kg feed
- 34 birds/pen, 3 pens per treatment

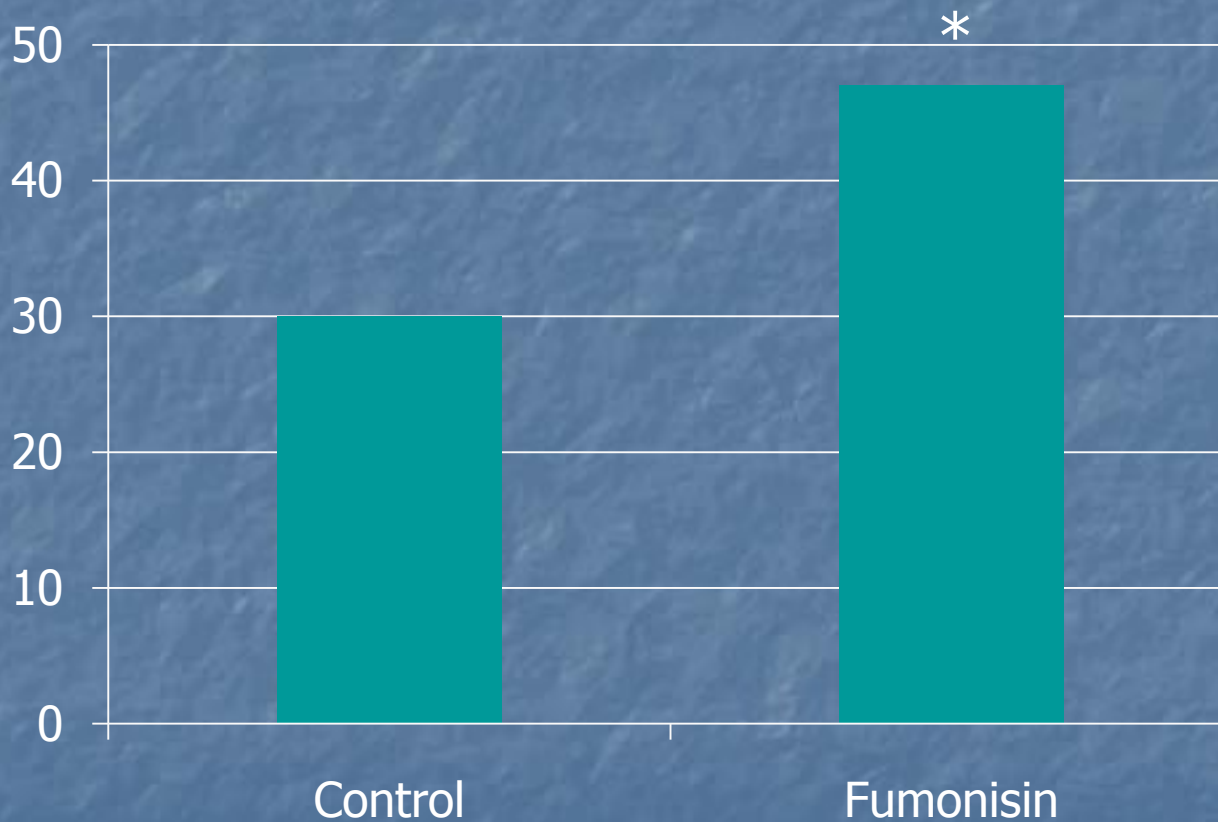
Gunter Antonissen, PhD Thesis
WVPC, 2015

Necrotic Enteritis and Fumonisin

- increase Sa/So ratio without effect of BW
- Changes in intestinal morphology: ileal villus height / crypt depth (497 vs 397 and 155 vs 131)
- Induce microbiota shift (ileum) : reduction of *Lactobacillus* and increase of *Clostridium perfringens*

Gunter Antonissen, PhD Thesis
WVPC, 2015

Necrotic Enteritis and Fumonisin



% Chicken with Necrotic Enteritis

Most critical prevention period in broilers



■ First 21 days of life

❖ Maximum growth

Week 1 weight increases: 242 %

Week 2 weight increases: 142 %

Week 3 weight increases: 88 %

❖ Skeletal development

❖ Maximum digestive system relative weight (15 days)

❖ Development of immune system and lymphoid organs

❖ Maximum metabolic activity



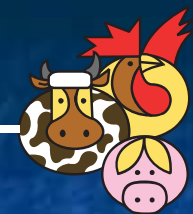
Practical solution alternatives



Practical solution alternatives are limited to

- Cleaning the grain(s) and good storage management
- Liver protection and increase production of glutathione
- **Mold inhibitors**
- **Anti-Mycotoxins Additives (AMA)**

Mycotoxins prevention and control



Grain cleaning



Liver protection



- Some nutrients such as choline, vitamin E, selenium and methionine have a hepatoprotector activity.
 - ❖ **Choline** participate in lipids mobilization.
 - ❖ **Vitamin E** and **Selenium** have antioxidant effect.
 - ❖ **Methionine** above the nutritional requirement increase the levels of glutathione in liver; which forms irreversible complexes with toxins.

Mycotoxins Prevention and Control



■ Mold inhibitors

Organic acids or their salts (propionic acid)

Treatment of the grain and/or feed

Corrosives

■ Anti-Mycotoxin Additives

Effective

Wide spectra

Use at the correct dosage



THANK YOU!