1

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Set-up

- *Incidence of lameness in meat-type birds*
- *Causes of lameness in turkeys*
- *BCO in fast-growing poultry*
- *Effect of 1,25(OH)$_2$D$_3$ in BCO lameness*
- *How come?*

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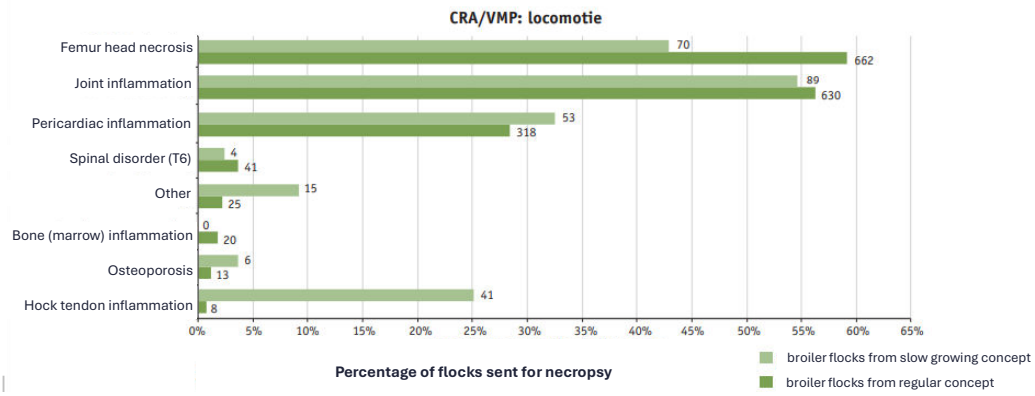
Result of necropsies in lame broilers (NL)



Number of broiler flocks (at barn level) notifications for locomotion problems (2020)
n = 1,165 (regular concept) and n = 177 (slow growing concept) which represented resp 60% and 40% of broiler production in NL

In 2020, femur head necrosis and joint inflammation has increased strongly in slow growing chickens

Source: Animal Health Services, Deventer (2021)

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Causes of lameness in meat-type birds

- *Genetic*
- *Environmental*
- *Nutritional*
- *Infectious*

- Bones
- Joints
- Tendons
- Ligaments

Incidence of broiler lameness (gait score >3 as this is considered painful):

- Sweden (2017):	14,5%
- France, Italy, UK, NL (2013):	15,6%
- Norway (2017, 2019):	19% - 24,6%
- UK (1992):	26% - 27,6%
- Denmark (2001):	30,1%

Less than 20% of turkeys were free from gait abnormalities at >16 wks of age (Costa et al. 2014)

Observable signs of leg problems:

In turkeys (Lilburn, 1994)	2-6%
In broilers	1-2%

Source: Oviedo-Randon (2009)

"The immature skeletal systems cannot withhold the rapidly increasing body mass" (i.e. breast meat)

Reviewed by Szafraniek et al (2022)

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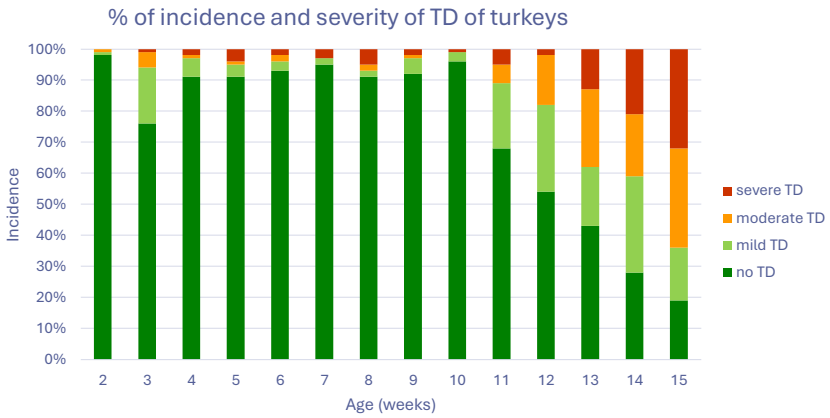
TD and turkey growth rate



TD incidence was related to growth rate: turkeys with highest incidence were 9.7% heavier

Source: Rath et al (1994)

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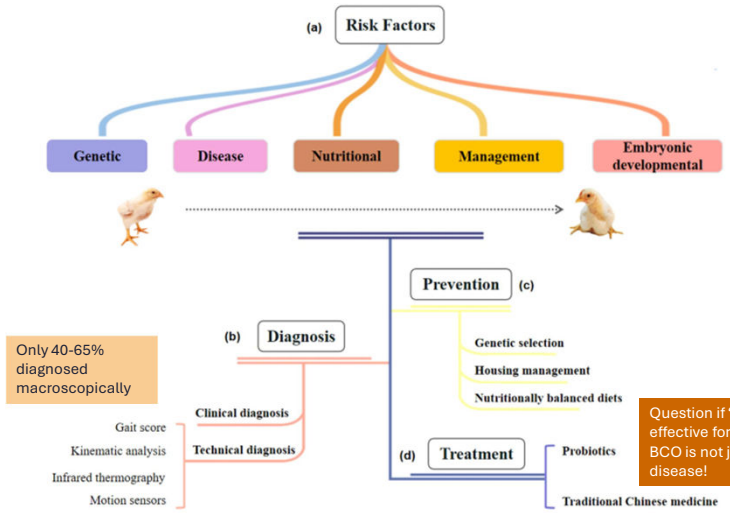
Lameness in poultry (summary)



- *Non-infectious*
  - *Tibial dyschondroplasia*
  - *Osteoporosis*
- *Infectious*
  - *Bacterial Chondronecrosis with Osteomyelitis (BCO)*
  - *Turkey Osteomyelitis Complex (TOC)*
  - *Bumble foot*
  - *Dyschondroplasia with osteomyelitis*

Question if 'treatments' are effective for BCO as BCO is not just a leg disease!

Review: Liu et al (2023)

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BCO in fast-growing poultry

- *BCO was first recognized in turkeys in Australia and USA (Nairn & Watson, 1972; Nairn, 1973)*
- *BCO is becoming the most common cause of lameness*
- *BCO can only be diagnosed by necropsy, where only max. 65% is observed macroscopically, leading to underestimated prevalence*
- *Suggested biomarkers based on cytokine, chemokine and FGF profile (Ramser et al, 2021) help to*
  - *understand the pathogenesis*
  - *find potential ways to alleviate BCO lameness*
  - *find treatments (likeliness to be able to)?*
- *BCO lameness is observed between d14 and d50, with peak incidence around d35*

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Staphylococcus aureus

- *Staphylococcus aureus is the most common bacterium isolated from BCO lesions*
- *S. aureus is an opportunistic pathogen, becoming virulent in case of reduced immune competence*
- *S. aureus is one of the most common bacteria in poultry houses, with greater numbers in the air at higher stocking density*
- *Surface proteins of S aureus have potent osteolytic effects (mediated by IL-1 and TNFα)*
- *Heterophils collected from broilers with osteomyelitis due to S. aureus had reduced chemotactic ability*

Source: McNamee and Smyth (2000)

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BCO in fast-growing poultry

- *Cell viability for primary chondrocyte cells (human fetal osteoblasts) was determined in vitro after exposure to plasma from*
  - *normal non-lame broilers*
  - *BCO-affected lame broilers*
- *Cell viability was sign. reduced by exposure to BCO plasma*
- *BCO resulted in increased serum levels of pro-inflammatory cytokines*
  - *IL-1β decreases chondrocyte proliferation and hyperthrophy*
  - *TNFα induces osteoclastogenesis*
- *Chicken primary chondrocyte cell viability was also reduced by TNFα, potentially shifting the balance between osteoblast and osteoclast and increase the sensitivity of the growth plate to infection and mechanical stress*
- *Fibroblast Growth Factor-23 expression is increased, but its receptor expression decreased in BCO birds*

Source: Ramser *et al* (2021)

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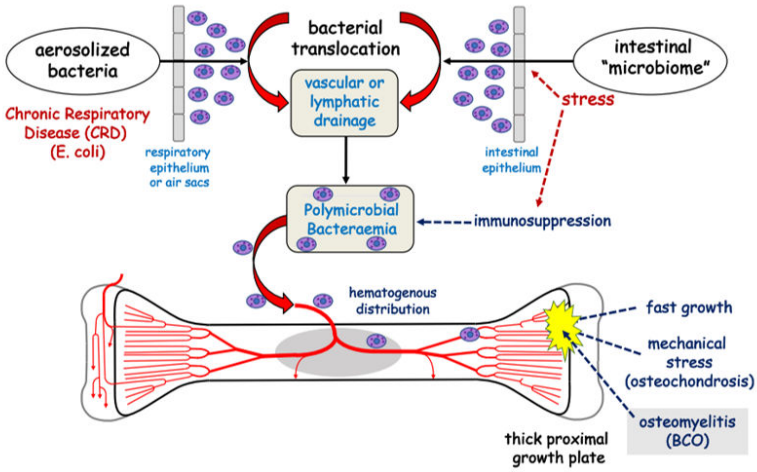
Bacterial lameness/ femur head necrosis



Source: Wideman (2015)

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Centers of body gravity

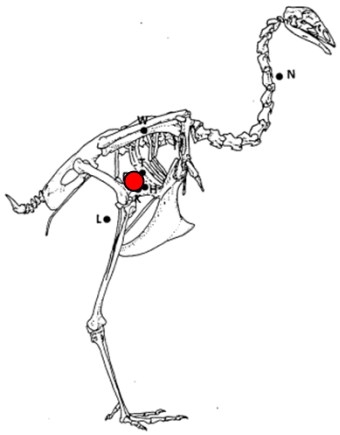

FIG. 5.—Centres of gravity for individual body segments (N, head and neck; W, wing; T, trunk; L, leg; B, whole body) and effective centres of gravity for the masses acting on the hip (H) and knee (K) of a traditional sized turkey.

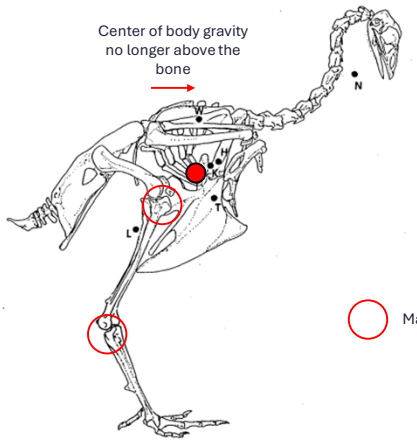

FIG. 6.—Centres of gravity of a broad-breasted turkey (abbreviations as for Fig. 5).

Source: Abourachid (1993)

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Effect of $1,25(OH)_2D_3$ on BCO lameness

Trial design

Animals: 1'560 day-old-male Cobb 500 (6 trt; 4 rep/trt; 50 broilers/rep), 56 birds/pen
Corn/soy-based diet (crumble in starter and pellet in finisher)

Housing: All birds on litter (wood shavings) pens, except for seeder birds
(pen size: 1.5 x 3m)

Treatments:

	Description
T1 Positive control (PC)	Infection source: wire flooring pens (2 pens with seeder birds)
T2 Negative control (NC)	Normal litter flooring
T3	Panbonis® at 50 g/t (0,5 mg/t $1,25(OH_2D_3)$)
T4	Panbonis® at 100 g/t (1,0 mg/t $1,25(OH_2D_3)$)
T5	Panbonis® at 200 g/t (2,0 mg/t $1,25(OH_2D_3)$)
T6	Basal diet from d1-28 and $1,25(OH_2D_3)$ at 1,0 mg/t from d29-56
T7	$1,25(OH_2D_3)$ at 1,0 mg/t from d1-28 and basal diet from d29-56

Duration: 0-56 days

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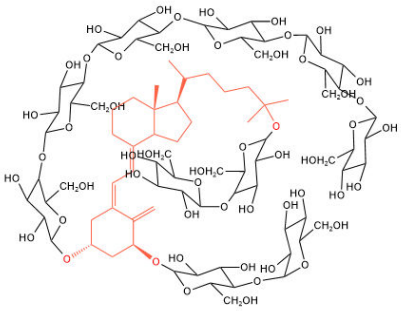
Panbonis® as the source of $1,25(OH)_2D_3$

Panbonis® 10 is a standardized formulation of *Solanum glaucophyllum* leaves containing 10 ppm of 1,25-dihydroxycholecalciferol equivalents (present as glycosides)



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$1,25(OH)_2D_3$ and BCO lameness

Seeder birds: mechanical and physiological stress wired flooring, feed and water at opposite sides

Treatment birds: housed on litter, each pen with own feed and water supply. Aerosol transmission model

Photo: Alrubaye

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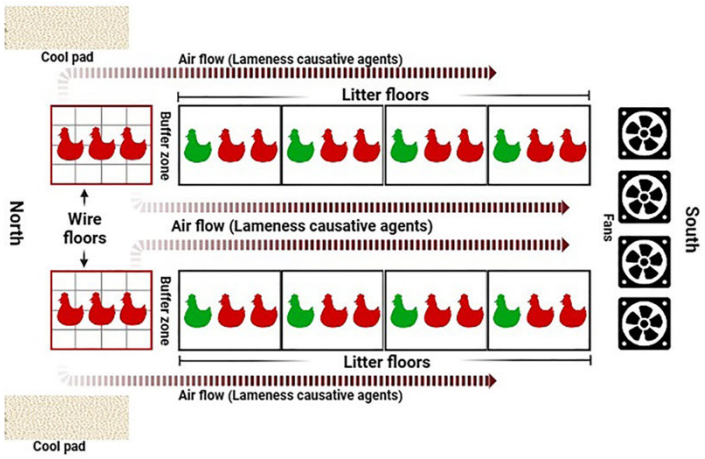
$1,25(OH)_2D_3$ and BCO lameness



Source: Alrubaye et al (2024)

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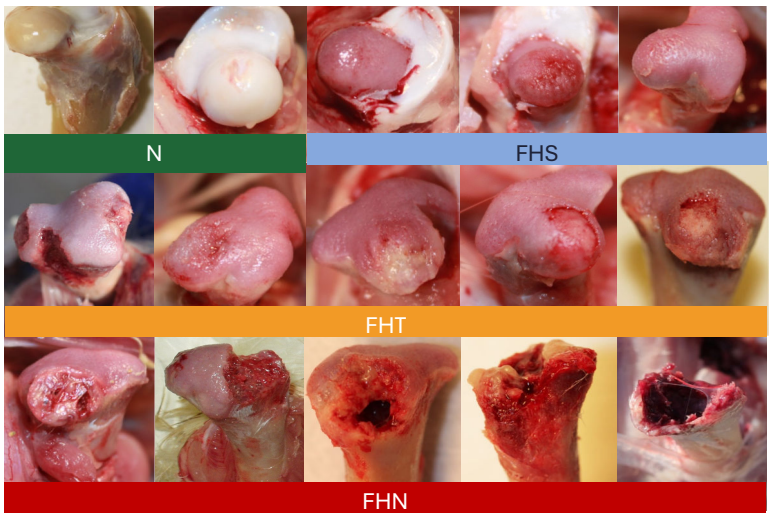
Progression of femoral BCO lesions



Source: Alrubaye

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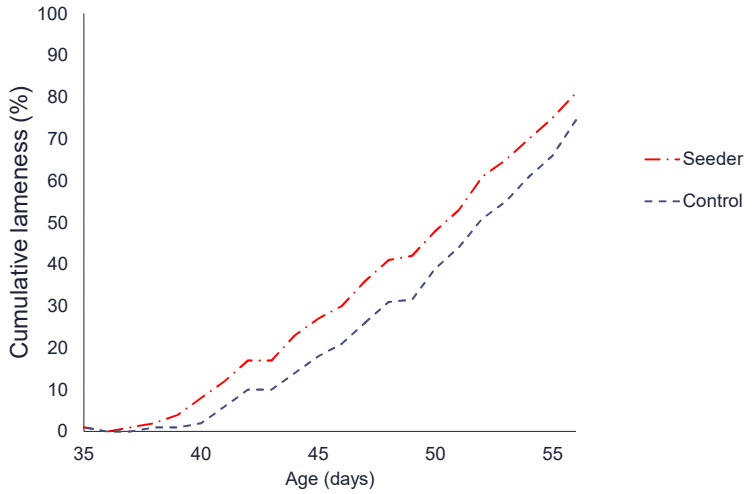
1,25(OH)$_2$D$_3$ and BCO lameness



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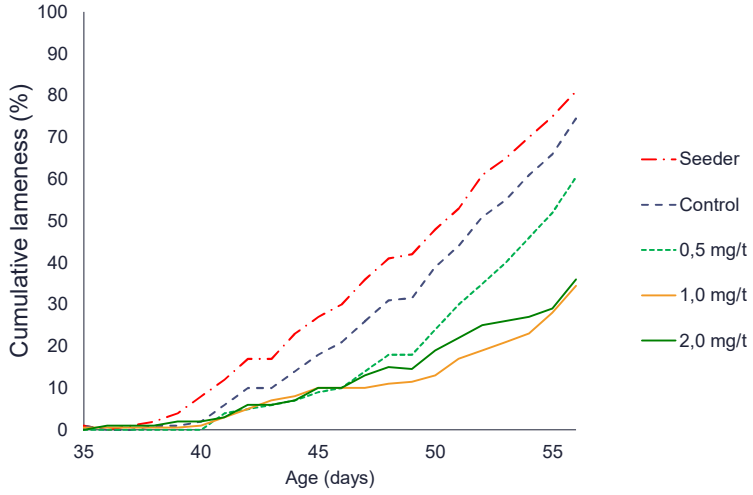
1,25(OH)$_2$D$_3$ and BCO lameness



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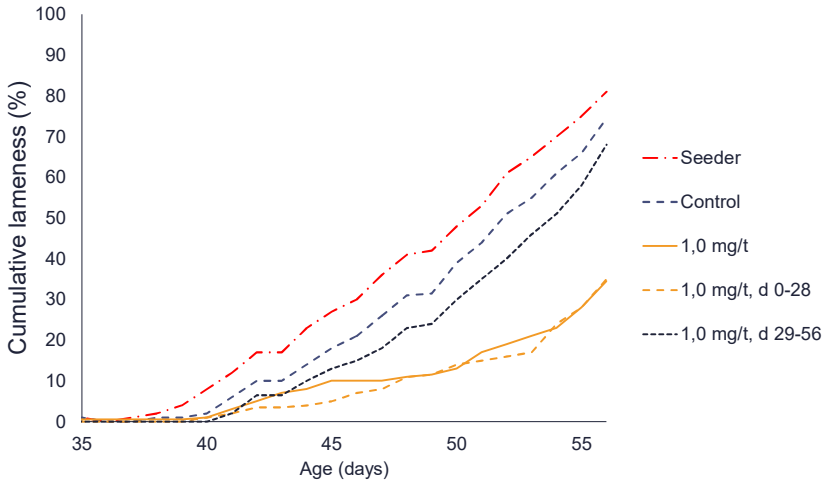
1,25(OH)$_2$D$_3$ and BCO lameness



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1,25(OH)$_2$D$_3$ and BCO lameness

- *Bacterial lameness is evident in heavy weight broilers and needs to be prevented at a very early age*
- *1 to 2 mg/t 1,25(OH)$_2$D$_3$ (i.e. 100 and 200 g/t Panbonis®) is effective reducing lameness by more than 50%*
- *1 mg/t 1,25(OH)$_2$D$_3$ (i.e. 100 g/t Panbonis®) during the first half of the production period (28 d) is adequate*

Bird body weights at end of trial:

Table 3. Average body weights of clinically healthy birds from each treatment on 56 d of age.

Treatments	Average weight[1] (kg)	SEM
BCO source in wire	4.28[a]	0.13
Diet 1 – Negative control	4.53[a]	0.06
Diet 2: 0.5 mg/t	4.59[a]	0.12
Diet 3: 1.0 mg/t	4.88[b]	0.08
Diet 4: 2.0 mg/t	4.69[a]	0.14
Late feeding of Diet 3	4.94[b]	0.15
Early feeding of Diet 3	4.82[b]	0.12

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Potential modes of action of $1,25(OH)_2D_3$

- *$1,25(OH)_2D_3$ stimulates production of antibacterial peptides, like cathelicidins and β-defensins, by a.o. macrophages which defend against S. aureus*
- *Increased FGF-23 secretion in BCO affected birds reduces 1α-hydroxylase activity (vitamin D activation in the kidney), which is compensated by dietary $1,25(OH)_2D_3$ supply*
- *$1,25(OH)_2D_3$ can enhance collagen maturation and stimulate bone calcification*
- *$1,25(OH)_2D_3$ alleviates air sacculitis in turkeys after immune suppression*
- *Improved epithelial integrity (intestinal and respiratory) preventing bacterial translocation*

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Early 1,25-dihydroxyvitamin D_3-glycosides supplementation: an efficient feeding strategy against bacterial chondronecrosis with osteomyelitis lameness in broilers assessed by using an aerosol transmission model

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Questions?

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