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Nutritional approach and microbiome in poultry

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Nutritional approach and microbiome in poultry



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Nutritional Dynamics

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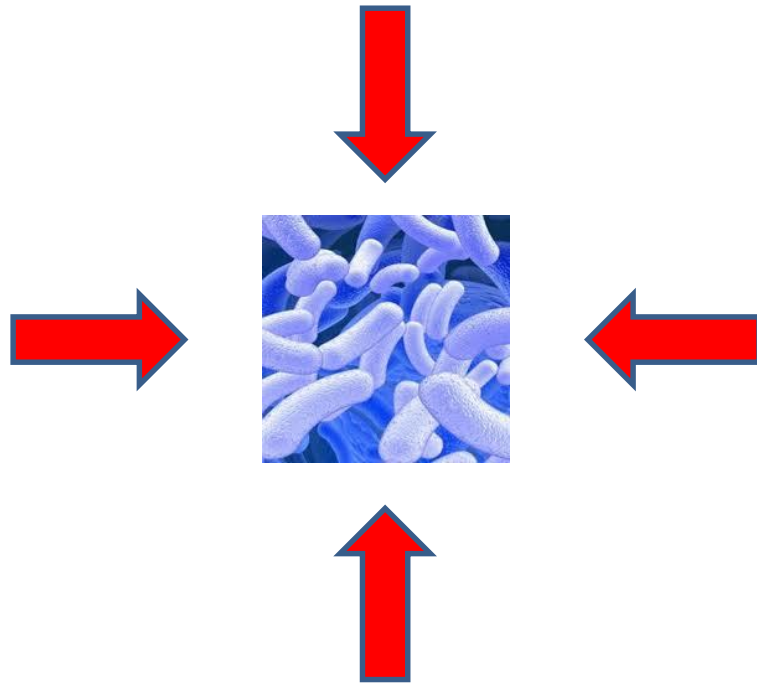




1. Factors regulating microbiota
2. **Dietary factors** regulating digestive microbiota



1. Factors regulating microbiota



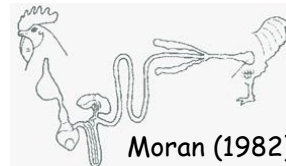
Factors regulating microbiota (1)

- Environment of first days : first contact with bacteria
Hatcher, eggshell
Human handling
Boxes for transportation
First feed and water
Litter

- Age :
Quantitative increase
Increase in complexity

- Digestive segments

- Anticoccidial drugs
- Feed additives
- Feed compounds
- Diet structure / Technological treatments
- Water



Gabriel et al 2006, 2014; Oakley et al 2014; Stanley et al 2014; Shaufi et al 2015

Factors regulating microbiota (2)

- Nervous system
- Stress
- Rearing environment

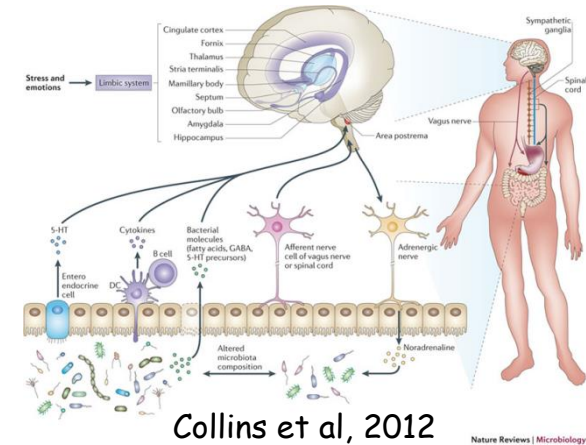


- Host genetics



- Maternal nutrition

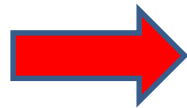
Interactions between Microbiota Intestine Brain

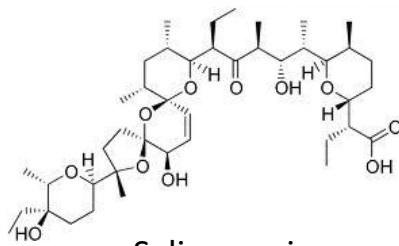


Torok et al. 2011; Guardia et al., 2011; Gabriel et al, 2014; Stanley et al. 2014; Mignon-Grasteau et al, 2015

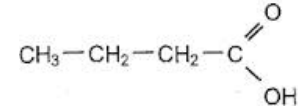


2. Dietary factors regulating digestive microbiota





Salinomycine



2.1. Anticoccidial drugs

2.2. Feed additives

2.3. Feed compounds

2.4. Diet structure / Technological treatments



Feed additives

Additives studied* in poultry

* With publications in Web of Science and PubMed

Organic acids

Carbohydrates (Prebiotic, 'Fibre', MOS)

Probiotic and symbiotic

Enzymes : Digestives (Polysaccharidase, Phytase, Protease)

Plant / Plant extracts

Amino acids

Vitamins

Clay

Charcoal

Minerals, trace elements

Bacteriocin

Bacteriophage and their enzymes (Endolysine, ...)

Antimicrobial peptides

...

Seal et al, 2013; Cheng et al, 2014

Effects of additives reported in literature

Alone or in combination (synergy)

Results

Growth performances

Feed intake
Growth
Feed conversion

Variable responses

Beneficial effects
No effect
Harmful effects



Mortality

Gut health (whose **microbiota**)

Immunity

Product quality

Effects + on microbiota
No effect on animal

According to conditions

Product Composition / Dose / Mode of application

Animal Genetic, sexe / Age / Physiological state

Rearing conditions

Diet composition



Diet composition



→ Indigestible compounds

→ **Substrates** for the growth of microbiota



Different bacteria have different substrate preferences

→ Diet has a **great potential impact** on the digestive microbiota



Nutrient composition

Carbohydrates

Proteins

Lipids

Minerals

Carbohydrates

Water soluble non-starch polysaccharides

Rye / corn

↑ Anaerobe counts

Wagner et Thomas (1978)

Wheat , barley / corn

↑ Bacterial counts

Mathlouthi et al (2002)

Wheat , barley, rye / corn

→ *C. perfringens*

Annett et al (2002), Jia et al (2009)

Barley, oat, wheat / commercial

Change in dominant microbiota (Seq 16S) Ludvigsen et al (2016)

Rk : Environment modify non-dominant microbiota

High fiber diet

DDGS*, wheat bran / Corn, soybean

*Dry distillers grains with solubles

Changes in microbiota (Seq 16S)

Walugembe et al (2015)



Protein source and level (1)



Fishmeal / Soybean meal (protein level : 40%)

→ *C. perfringens* Drew et al (2004)

Fishmeal (protein level 33%) / Control diet (protein level : 21.5%)

Changes in microbiota (Seq 16S) Wu et al (2014), Stanley et al (2014)

Fishmeal / Soybean meal (protein level : 23%)

→ *C. perfringens* Drew et al (2004)

Protein level : 40% vs 23% (Fishmeal or Soybean meal)

→ *C. perfringens* Drew et al (2004)

Protein source and level (2)

Soybean meal



High concentrations of raffinose family oligosaccharides

→ May stimulate gut fermentation Zdunczyk et al (2015)

Rapeseed meal / Soybean meal

Change in SCFA and biogenic amines

Qaisrani et al (2014)



Sunflower meal

↓ Caecal SCFA (Turkey)

Juskiewicz et al (2010)



Protein source and level (3)

Lupin seed meal

Change in microbiota counts

Rubio et al (1998)



Pea seed meal

Pea (15%) / Control (soybean)

Change in microbiota fingerprint (T-RFLP)

↑ SCFA content

Pea level (15 to 30%)

↓ Butyrate in caeca

Konieczka et al (2014)

Czerwinski et al (2010)



Fermented cottonseed meal / Soybean meal

Changes in microbiota counts / Fingerprint

Sun et al (2013)

Lipids

Dietary fat source : animal / vegetal

Beef tallow / Soybean oil

Changes in microbiota counts

Danicke et al, 1999



Lard and tallow / soybean oil

→ ↑ *C. perfringens* Knarreborg et al (2002)

Palm kernel fatty acid distillers or lard / Soybean oil

↑ Total organic acid Jozefiak et al (2014)

Medium chain fatty acids / Soybean oil, animal fat

Changes in microbiota (Microarray) Van der Hoeven-Hangoor et al (2013)

W-3 fatty acids (alpha-linolenic acid) (Flaxseed oil)

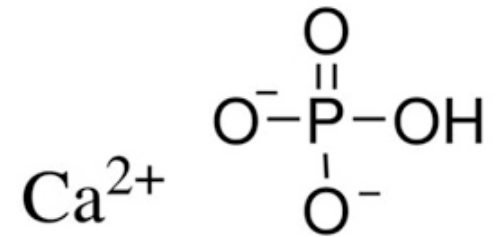
Changes in microbiota (Seq 16S) Lee et al (2016)



Minerals

Ca and digestible P levels

Changes in microbiota counts / SCFA



Ptak et al (2015)

Diet structure : Particule size

Whole wheat / ground wheat

↓ *Salmonella Typhimurium*

Bjerrum et al (2005)

↓ *Clostridium perfringens*

Engberg et al (2004)

Change in microbiota counts

Gabriel et al (2003), Engberg et al (2004), Bjerrum et al (2005), Gabriel et al (2008)



Coarse grinding / Fine grinding

↓ Branched chain fatty acids

Qaisrani et al (2014)

Change in microbiota counts

Singh et al (2014)

Technological treatments

Thermal treatments

Change in bacterial counts and SCFA

Boroojeni et al (2014)

Pelleting

↑ SCFA
Change in microbiota counts

Engberg et al (2002)



↑ SCFA
↑ Salmonella Typhimurium

Huang et al (2006)

Extrusion

Change in SCFA

Konieczka et al (2014)

Regulation of digestive microbiota by diet

Nutrient composition

- Carbohydrates
- Proteins
- Lipids
- Minerals

Diet structure : Particule size

- Whole / ground grains
- Coarse / Fine grinding

Technological treatments

- Thermal treatments
- Pelleting
- Extrusion



Thanks for your attention

