Supplemental Materials

A PBPK model to study the transfer of α-hexabromocyclododecane (α-HBCDD) to tissues of fast- and slow-growing broilers

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**S1: Literature review for the parameterisation of the model**

A set of parameters was established separately for fast-(FG) and slow-(SG) growing broilers. When the information was available, males (M), females (F) and as hatched (M&F) broilers were separately considered.

## Body weight and feed ingestion

Body weight at hatch (BW1, kg) and at slaughter (BW2, kg), age at slaughter (Age2, d), body weight (BW, kg) according to age (Age, d) and feed ingested daily (D Feed Ing, kg d-1) according to BW were parameterised using the data provided by breeders for Cobb 500 (Cobb-Vantress, 2017) and JA 657 (SARL Willems, 2017) for FG and SG broilers, respectively (Table S2.1).

Table S1.1: Parameters relative to body weight (BW, kg) and daily feed inestion (D Feed Ing, kg d-1)1

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Parameter2 | Unit | References | Strains | M | F | M&F |
| **FAST-GROWING** |
| Age1 | d | Cobb-Vantress (2017) | Cobb 500 | 0 | 0 | 0 |
| BW1 | kg | 0.042 | 0.042 | 0.042 |
| Age2 | d | 42 | 42 | 42 |
| BW2 | kg | 3.09 | 2.71 | 2.90 |
| Bgomp | d-1 | 0.0439 | 0.047 | 0.0453 |
| a intake | Dl | 0.301 | 0.245 | 0.273 |
| b intake | Dl | 0.513 | 0.612 | 0.556 |
| **SLOW-GROWING** |
| Age1 | d | SARL Willems (2017) | JA 657 | 0 | 0 | 0 |
| BW1 | kg | 0.05 | 0.05 | 0.05 |
| Age2 | d | 84 | 84 | 84 |
| BW2 | kg | 2.46 | 1.95 | 2.20 |
| Bgomp | d-1 | 0.0284 | 0.0293 | 0.0287 |
| a intake | Dl | 0.141 | 0.152 | 0.145 |
| b intake | Dl | 0.916 | 0.939 | 0.942 |

1 The equations are:  $BW=BW2 × \frac{BW2}{BW1}^{\frac{-\left(e^{-Bgomp × \left(Age2-Age1\right)}-e^{-Bg ×\left(Age-Age1\right)}\right)}{-1+e^{-Bgomp×\left(Age2-Age1\right)}}}$  (Méda et al., 2014) and $D Feed Ing = a intake × e^{(1-b intake × BW)}$

2 **Age1**, Initial age; **Age2**, Final age; **BW1**, Initial body weight; **BW2**, Final body weight; **Bgomp**, Growth rate at the inflection point of the Gompertz BW growth function (Precocity parameter); **a intake**, Slope of the allometric relationship between feed intake and body weight; **b intake**, Intercept of the allometric relationship between daily feed intake and body weight

## Growth of breast muscles, leg muscles, liver and blood

Data are presented in table S1.2.

Depending of the reference, the weight of breast and leg may include or not bone and skin. Besides, some data provide the weight of one muscle alone or consider only one part of the tissue (e.g. thigh or drumstick). Therefore, to adjust the allometric relationships between breast muscles and leg muscles some literature data were modified according to the following rules: breast is made of 70% meat (muscle), 20% bone and 10% skin (Shahin et al., 2005; Haïtook, 2006) and *Pectoralis major* represents 83% of breast muscles (Alnahhas et al., 2016; Tickle et al., 2014); leg is made of 65% meat (muscle), 25% bone and 10% skin, with 55% thigh and 45% drumstick (bone and skin included) (Shahin et al., 2005; Haïtook, 2006). Only data relative to the weight of the liver and the blood in FG broilers was available; it was applied to the two strains.

## Body lipids deposition and growth of storage fat (separable fat depots + skin)

Data are presented in tables S1.2 for body lipids deposition and S1.3 for storage fat growth.

In the current study, we define storage fat as a group of fatty tissues including separable fat depots (SFD), which gather abdominal, mesenteric, sartorial, gizzard, neck fat depots and skin. The growth of these fatty tissues was modelled in three successive steps. First, parameters of the allometric relationship between the weight of body lipids and body weight were adjusted for each strain. Secondly, an allometric relationship between the weight of abdominal fat and of body lipids was adjusted. Finally, the weight of SFD is estimated at 2 times the weight of abdominal fat (Ricard et al.,1983; de Crespo and Esteve-Garcia, 2002a) and the weight of skin at 2 times the weight of SFD (Haïtook, 2006) (i.e. 4 times the weight of abdominal fat). At the end, the weight of storage fat, is 6 times the weight of abdominal fat, the proportion of skin being 66% (prop Skin).

Table S1.2: Parameters relative to the allometric relationship between breast muscles, leg muscles, liver and blood weight (W Tissue, kg)1 or body lipids weight (W BL, kg)2 and body weight (BW, kg)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sex | References | Data |   | a tissue or a BL |   | b tissue or b BL |   | *P* Sex |
| Type | Number |
| **FAST-GROWING** |
| **Breast muscles** |   |   |   |   |   |   |   |   |   |   |   |   |
| F | Danisman and Gous (2013) | Individuals | 31 |  | 1.30 | ±0.01 | \*\*\* |  | -1.96 | ±0.01 | \*\*\* |  | *0.41* |
| M | 29 |  |  |  |
| **Leg muscles** |   |   |   |   |   |   |   |   |   |   |   |  |
| F | Danisman and Gous (2013) | Individuals | 32 |  | 1.06 | ±0.00 | \*\*\* |  | -1.99 | ±0.01 | \*\*\* |  | *0.29* |
| M | 32 |  |  |  |
| **Body lipids** |   |   |   |   |   |   |   |   |   |   |   |  |
| F | Danisman and Gous (2013) | Individuals | 22 |  | 1.25 | ±0.04 | \*\*\* |  | -2.22 | ±0.03 | \*\*\* |  | *\*\*\** |
| M | 21 |  | 1.19 | ±0.02 | \*\*\* |  | -2.33 | ±0.02 | \*\*\* |  |
| M&F | 43 |  | 1.21 | ±0.06 | \*\*\* |  | -2.32 | ±0.04 | \*\*\* |  |  |
| **SLOW-GROWING** |
| **Breast muscles** |   |   |   |   |   |   |   |   |   |   |   |   |
| F | Eleroglu et al. (2014); Méda et al. (2015) | Means | 21 |  | 1.17 | ±0.07 | \*\*\* |  | -2.47 | ±0.06 | \*\*\* |  | *Not assessed* |
| M | 21 |  |  |  |
| **Leg muscles** |   |   |   |   |   |   |   |   |   |   |   |   |
| F | Eleroglu et al. (2014); Méda et al. (2015) | Means | 21 |  | 1.15 | ±0.02 | \*\*\* |  | -1.99 | ±0.02 | \*\*\* |  | *Not assessed* |
| M | 21 |  |  |  |
| M&F | Aderibigbe et al. (2013); Fanatico et al. (2005); Küçükyılmaz et al. (2014) | 12 |  |  |  |
| **Body lipids** |   |   |   |   |   |   |   |   |   |   |   |  |
| F | Carrasco et al. (2014); Henn et al. (2014) | Mean | 12 |  | 1.31 | ±0.02 | \*\*\* |  | -2.13 | ±0.03 | \*\*\* |  | *\*\** |
| M | 12 |  | 1.21 | ±0.02 | \*\*\* |  | -2.26 | ±0.03 | \*\*\* |  |
| M&F | 24 |  | 1.26 | ±0.02 | \*\*\* |  | -2.2 | ±0.02 | \*\*\* |  |  |
| **FAST & SLOW-GROWING** |
| **Liver** |   |   |   |   |   |   |   |   |   |   |   |   |
| F | Danisman and Gous (2013) | Individuals | 27 |  | 0.79 | ±0.02 | \*\*\* |  | -3.55 | ±0.02 | \*\*\* |  | *0.59* |
| M | 26 |  |  |  |
| **Blood** |   |   |   |   |   |   |   |   |   |   |   |   |   |
| F | Medway and Kare (1959) | Means | 8 |   | 0.84 | ±0.02 | \*\*\* |   | -2.6 | ±0.02 | **\*\*\*** |  | *0.84* |

1The equation is: $W tissue = e^{b tissue} × BW^{a tissue}$

2The equation is: $W BL = e^{b BL} × BW^{a BL}$

Table S1.3: Parameters relative to the allometric relationship between the weight of abdominal fat (W AF, kg) and the weight of body lipids (W BL, kg)1

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sex | References | Data |   | a AF |  | b AF  |  | *P* Sex |
| Type | Number |  |  |
| **FAST-GROWING** |
| F | Crespo and Esteve-Garcia (2002a); Grisoni et al. (1990) | Means | 8 |  | 1.44 | ±0.04 | \*\*\* |  | -1.36 | ±0.10 | \*\*\* |  | *0.19* |
| M | Alleman et al. (2000); Cherry et al. (1987); Gereart et al. (1990); Gereart et al. (1993); Grisoni et al. (1990); Leclercq (1983); Pym et al. (2004) | 35 |
| **SLOW-GROWING** |
| F | Eleroglu et al. (2014); Méda et al. (2015); Wang et al. (2013) | Means | 20 |  | 1.66 | ±0.06 | \*\*\* |  | -0.94 | ±0.11 | \*\*\* |  | *0.29* |
| M | Eleroglu et al. (2014); Jondreville et al. (2017); Méda et al. (2015) | Means | 20 |  |  |  |

1The equation is: $W AF = e^{b AF} × W BL^{a AF}$

The weight of Storage fat (Separable fat depots + Skin) is 6 times the weight of abdominal fat. It is calculated as $W Storagefat = e^{b Storagefat} × W BL^{a Storagefat}$, with a Storagefat = a AF and b Storagefat = ln(6)+ b. Storage fat is made of 66% Skin (prop Skin) and 34% SFD (1 - prop Skin)

## Concentration of total and neutral lipids in the tissues

Data are presented in tables S1.4.

Unfortunately, except for blood, the kinetics of lipids concentration, and *a fortiori* the proportion of classes of lipids (tryglycerides, free and esterified cholesterol, phospholipids), in tissues of broilers from hatching to slaughter is almost inexistent in literature. Therefore, we used the data from the experiment of Jondreville et al. (2017) to evaluate the accumulation of α-HBCDD in fast and slow-growing broilers from hatching to slaughter at 42 and 84 days of age, respectively. According to these data (Table S2.4), tissues total lipids concentrations are similar in the two strains, except for leg muscles. Besides, these concentrations are constant from hatching to slaughter, except for abdominal fat, the total lipids concentration of which linearly increases within 21 and 42 days in FG and SG broilers, respectively and remains constant up to slaughter. The proportion of neutral lipids (triglycerides + esterified cholesterol) in total lipids is similar in the two strains and is constant from hatching to slaughter.

Table S1.4: Parameters relative to the total lipids concentration in tissues and the proportion of neutral lipids in total lipids

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Tissue | Strain | References |   | SFD lipid conc age (day) |   | SFD lipid conc ini (kg kg-1) |   | Tissue lipid conc (kg kg-1) |   | a Tissue neut lipid (kg kg-1) |
| Breast | FG&SG | Jondreville et al. (2017) |   |   |   |   |   | 0.0127 |   | 0.62 |
| Leg | FG | Jondreville et al. (2017) |   |   |   |   |   | 0.034 |   | 0.78 |
|   | SG |   |   |   |   |   | 0.054 |   |   |
| Liver | FG&SG | Jondreville et al. (2017) |   |   |   |   |   | 0.0535 |   | 0.55 |
| Blood | FG&SG | Rouckova et al. (2004); Baéza et al. (2015a and b); Jondreville et al. (2017) |   |   |   |   |   | 0.0040  |   | 0.32 |
| Abdominal fat (SFD) | FG | Jondreville et al. (2017) |   | 14 |   | 0.600 |   | 0.900 |   | 1 |
| SG |   | 28 |   | 0.400 |   |   |   |   |
| Skin | FG&SG | Nir et al. (1988); Grey et al. (1989) |   |   |   |   |   | 0.400 |   | 1 |

**SFD lipid conc age**, Age at which lipids concentration in separable fat depots gain stops increasing; **SFD gain lipid conc ini**, Initial concentration of lipids in separable fat depots; **Tissue lipid conc**, Total lipids concentration in the tissue; **a Tissue neut lipid**, proportion of neutral lipids in total lipids

## Hematocrit, perfusion rate of the tissues and cardiac blood flow

Data are presented in tables S1.5.

For lack of information in literature, we included data collected not only in broilers but also in layers. Mean values were used in the model.

Table S1.5: Blood haematocrit (Ht, %) and volumic mass (mVblood, g L-1) and to tissues perfusion rate (L kg-1 d-1)

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Tissue | Criteria | Unit | References | Strain | Data |  | Min | Max | Mean | SD |
| Type | Number |  |
| Blood | Ht | % | Alimohamadi et al. (2014); Deaton et al. (1969); Shapiro et al. (1999); Wideman and Tackett (2000); Wideman et al. (1998, 1999) | Broilers FG | Means | 24 |  | 22.7 | 34.8 | 27.4 | 2.9 |
| Blood | mVblood | g L-1 | Medway and Kare (1959) | Layer | Means | 7 |  | 1.042 | 1.046 | 1.044 | 0.001 |
| Liver | Perfusion rate | L kg-1 d-1 | Boelkins et al. (1973); Merrill et al. (1981); Sapirstein and Hartman (1959); Weidner et al. (1982) ; Wolfenson et al. (1978, 1981); Wolfenson (1986) | Layer | Means | 7 |  | 778 | 1728 | 1133 | 374 |
| Breast | Perfusion rate | L kg-1 d-1 | Sapirstein and Hartman (1959); Wolfenson et al. (1978, 1981); Wolfenson (1986) | Layer | Means | 4 |  | 86 | 216 | 139 | 56 |
| Leg  | Perfusion rate | L kg-1 d-1 | Sapirstein and Hartman (1959); Wolfenson et al. (1981); Wolfenson (1986) | Layer | Means | 3 |  | 137 | 216 | 190 | 46 |
| Skin | Perfusion rate | L kg-1 d-1 | Weidner et al. (1982); Wolfenson et al. (1978, 1981); Wolfenson (1986) | Layer | Means | 6 |  | 43 | 216 | 104 | 64 |

1The daily plasma flow to each tissue (Q tissue, L d-1) is calculated as its weight (W tissue, kg) multiplied by the tissue perfusion rate (Tissue perf, L d-1 kg-1), accounting for haematocrit: $Q tissue = W tissue × Tissue perf × (1-Ht)$

Table S1.6: Parameters relative to cardiac plasma flow1

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| References | Strain | Data |   | a Q |   | b Q |
| Type | Number |
| Merrill et al. (1981); Moynihan and Edwards (1975); Niezgoda et al. (1982); Sapirstein and Hartman (1959); Stebel and Wideman (2008); Vogel and Sturkie (1963); Weidner et al. (1982); West et al. (2010); Wideman (1999); Wideman and Tackett (2000); Wideman et al. (1998, 1999, 2005); Wolfenson et al. (1981) | Broilers & layers | Means | 27 |   | 0.856 | ±0.175 | \*\*\* |   | 5.55 | ±0.14 | \*\*\* |

1 Cardiac blood flow is an allometric relationship of body weight (BW, kg) (Dzialowski and Crossley, 2015) and cardiac plasma flow (TQ, L d-1) is calculated accounting for haematocrit (Ht): $TQ = e^{b Q} × BW^{a Q} × (1-Ht)$

# S2: Sensitivity analysis

A local sensitivity analysis was implemented to evaluate the relative importance of some model parameters on assimilation efficiencies (AE, Table S3.1) and accumulations ratios in lipids (ARlip, Table S3.2).

The absolute value of the normalized sensitivity coefficient (NSC) was calculated to distinguish the relative importance of model parameters:

$$NSC=\frac{∆r}{r}×\frac{p}{∆p}$$

where *p* is the model parameter, *△p* is the variation in the model parameter, *r* is the model output, and *△r* is the variation in the model output. In this study, parameters varied according to different ranges selected by the expertise of the authors. A parameter was considered influential if NSC reached a minimum absolute value of 0.25 (Leavens et al., 2012). A positive NSC indicates that an increase (respectively a decrease) in the parameter implies an increase (respectively a decrease) of the output.

Table S2.1: Normalized sensitivity coefficient (NSC) for assimilation efficiencies (AE) in tissues for as-hatched fast-growing broilers1

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter2 | Value | Variationrange (%) | AE |
| Body | Breast | Leg | Plasma | Liver | Skin | SFD | Storagefat | Other tissues |
| Growth and feed intake |  |  |  |  |  |  |  |  |  |  |  |  |
| BW2 | 2.90 | -20 | 20 | **0.32** | 0.18 | -0.01 | **-0.27** | **-0.37** | **0.81** | **0.81** | **0.81** | **-0.67** |
| a intake | 0.27 | -20 | 20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| a storagefat | 1.44 | -10 | 10 | -0.23 | 0.06 | 0.07 | 0.06 | 0.09 | **-1.45** | **-1.42** | **-1.43** | **2.26** |
| Prop Skin | 0.66 | -20 | 20 | -0.08 | 0.03 | 0.03 | 0.03 | 0.08 | **1.11** | **-1.99** | **-0.55** | **0.88** |
| Total lipids |  |  |  |  |  |  |  |  |  |  |  |  |
| a2 BL | 1.21 | -10 | 10 | **0.62** | **-0.98** | **-0.95** | **-0.98** | **-0.96** | **1.16** | **1.19** | **1.18** | **-0.30** |
| Breast lipid conc | 0.01 | -20 | 20 | 0.00 | **1.00** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -0.05 |
| Leg lipid conc | 0.03 | -20 | 20 | 0.00 | 0.00 | **1.03** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -0.10 |
| Plasma lipid conc | 0.00 | -20 | 20 | 0.03 | 0.03 | 0.03 | **1.03** | -0.01 | 0.03 | 0.03 | 0.03 | 0.03 |
| Liver lipid conc | 0.05 | -20 | 20 | **-0.54** | **-0.55** | **-0.54** | **-0.55** | **0.42** | **-0.54** | **-0.53** | **-0.54** | **-0.57** |
| Skin lipid conc | 0.40 | -20 | 20 | 0.07 | -0.02 | -0.03 | -0.02 | -0.07 | **1.01** | -0.05 | **0.44** | **-0.71** |
| SFD gain lipid conc fin | 0.90 | -20 | 10 | 0.08 | -0.02 | -0.03 | -0.02 | -0.07 | -0.05 | **0.98** | **0.50** | **-0.81** |
| Neutral lipids |  |  |  |  |  |  |  |  |  |  |  |  |
| a Breast neut lipid | 0.62 | -20 | 20 | 0.01 | **0.99** | -0.01 | -0.01 | 0.00 | -0.01 | -0.01 | -0.01 | -0.01 |
| a Leg neut lipid | 0.78 | -20 | 20 | 0.02 | -0.01 | **0.99** | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 |
| a Plasma neut lipid | 0.32 | -20 | 20 | 0.03 | 0.03 | 0.02 | **1.03** | -0.01 | 0.02 | 0.02 | 0.02 | 0.03 |
| a Liver neut lipid | 0.55 | -20 | 20 | **-0.55** | **-0.56** | **-0.56** | **-0.56** | **0.43** | **-0.55** | **-0.55** | **-0.55** | **-0.56** |
| a Storagefat neut lipid | 1.00 | -20 | 0 | **0.33** | **-0.34** | **-0.34** | **-0.34** | **-0.34** | **0.70** | **0.70** | **0.70** | **-0.34** |
| a Other neut lipid | 0.80 | -20 | 20 | 0.17 | -0.11 | -0.12 | -0.11 | -0.08 | -0.13 | -0.14 | -0.13 | **0.88** |
| Irrigation of tissues |  |  |  |  |  |  |  |  |  |  |  |  |
| Prop Storagefatperf | 0.30 | -60 | 60 | 0.01 | -0.03 | -0.02 | -0.03 | -0.02 | 0.04 | 0.03 | 0.03 | -0.03 |
| Breast perf | 140 | -40 | 200 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Leg perf | 190 | -50 | 150 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Liver perf | 1200 | -40 | 50 | 0.02 | 0.03 | 0.03 | 0.03 | 0.00 | 0.02 | 0.01 | 0.02 | 0.03 |
| Skin perf | 100 | -60 | 100 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| SFD perf | 100 | -60 | 100 | 0.00 | -0.01 | 0.00 | -0.01 | 0.00 | 0.00 | 0.01 | 0.01 | -0.01 |
| a Q | 0.86 | -10 | 10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 |
| HBCDD |  |  |  |  |  |  |  |  |  |  |  |  |
| HBCDD abs coef | 0.90 | -20 | 10 | **1.00** | **1.00** | **1.00** | **1.00** | **1.00** | **1.00** | **1.00** | **1.00** | **1.00** |
| CLin | 9.60 | -30 | 30 | **-0.28** | **-0.28** | **-0.28** | **-0.28** | **-0.29** | **-0.28** | **-0.28** | **-0.28** | **-0.28** |
| CLip | 12.00 | -30 | 30 | **-0.28** | **-0.28** | **-0.28** | **-0.28** | **-0.29** | **-0.28** | **-0.27** | **-0.28** | **-0.28** |
| Diff Faeces coef | 200 | -50 | 100 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Diff Storagefat coef | 200 | -50 | 100 | 0.01 | -0.03 | 0.00 | -0.03 | -0.02 | 0.04 | 0.03 | 0.03 | -0.03 |
| Other parameters |  |  |  |  |  |  |  |  |  |  |  |  |
| Dig lipid | 0.84 | -10 | 10 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |

1 Red: |NSC| ≥ 0.25; Blue: 0.1 ≤ |NSC| < 0.25; Black: : 0.05 ≤ |NSC| < 0.1; Grey: |NSC| < 0.05.

2 See Table 1 in the paper for the description of parameters.

3 Separable fat depots.

Table S2.2: Normalized sensitivity coefficient (NSC) for accumulation ratio in lipids of tissues (ARlip) for as-hatched fast-growing broilers1

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter2 | Value | Variationrange (%) | ARlip |
| Body | Breast | Leg | Plasma | Liver | Skin | SFD3 | Storagefat | Other tissues |
| Growth and feed intake |  |  |  |  |  |  |  |  |  |  |  |  |
| BW2 | 2.90 | -20 | 20 | **-0.40** | **-0.62** | **-0.58** | **-0.62** | **-0.67** | **-0.44** | **-0.44** | **-0.44** | **-0.61** |
| a intake | 0.27 | -20 | 20 | **1.00** | **1.00** | **1.00** | **1.00** | **1.00** | **1.00** | **1.00** | **1.00** | **1.00** |
| a storagefat | 1.44 | -10 | 10 | -0.23 | 0.06 | 0.07 | 0.06 | 0.09 | 0.04 | 0.05 | 0.05 | 0.05 |
| Prop Skin | 0.66 | -20 | 20 | -0.08 | 0.03 | 0.03 | 0.03 | 0.08 | 0.11 | -0.05 | 0.03 | 0.01 |
| Total lipids |  |  |  |  |  |  |  |  |  |  |  |  |
| a2 BL | 1.21 | -10 | 10 | **-0.67** | **-0.98** | **-0.95** | **-0.98** | **-0.96** | **-0.69** | **-0.68** | **-0.68** | **-0.98** |
| Breast lipid conc | 0.01 | -20 | 20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Leg lipid conc | 0.03 | -20 | 20 | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Plasma lipid conc | 0.00 | -20 | 20 | 0.03 | 0.03 | 0.03 | 0.03 | -0.01 | 0.03 | 0.03 | 0.03 | 0.03 |
| Liver lipid conc | 0.05 | -20 | 20 | **-0.54** | **-0.55** | **-0.54** | **-0.55** | **-0.56** | **-0.54** | **-0.53** | **-0.54** | **-0.55** |
| Skin lipid conc | 0.40 | -20 | 20 | 0.07 | -0.02 | -0.03 | -0.02 | -0.07 | 0.01 | -0.05 | -0.02 | -0.01 |
| SFD gain lipid conc fin | 0.90 | -20 | 10 | 0.08 | -0.02 | -0.03 | -0.02 | -0.07 | -0.05 | -0.01 | -0.03 | -0.01 |
| Neutral lipids |  |  |  |  |  |  |  |  |  |  |  |  |
| a Breast neut lipid | 0.62 | -20 | 20 | 0.01 | **0.99** | -0.01 | -0.01 | 0.00 | -0.01 | -0.01 | -0.01 | -0.01 |
| a Leg neut lipid | 0.78 | -20 | 20 | 0.02 | -0.01 | **0.99** | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 |
| a Plasma neut lipid | 0.32 | -20 | 20 | 0.03 | 0.03 | 0.02 | **1.03** | -0.01 | 0.02 | 0.02 | 0.02 | 0.03 |
| a Liver neut lipid | 0.55 | -20 | 20 | **-0.55** | **-0.56** | **-0.56** | **-0.56** | **0.43** | **-0.55** | **-0.55** | **-0.55** | **-0.56** |
| a Storagefat neut lipid | 1.00 | -20 | 0 | **0.33** | **-0.34** | **-0.34** | **-0.34** | **-0.34** | **0.70** | **0.70** | **0.70** | **-0.34** |
| a Other neut lipid | 0.80 | -20 | 20 | 0.17 | -0.11 | -0.12 | -0.11 | -0.08 | -0.13 | -0.14 | -0.13 | **0.88** |
| Irrigation of tissues |  |  |  |  |  |  |  |  |  |  |  |  |
| Prop Storagefatperf | 0.30 | -60 | 60 | 0.01 | -0.03 | -0.02 | -0.03 | -0.02 | 0.04 | 0.03 | 0.03 | -0.03 |
| Breast perf | 140 | -40 | 200 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Leg perf | 190 | -50 | 150 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Liver perf | 1200 | -40 | 50 | 0.02 | 0.03 | 0.03 | 0.03 | 0.00 | 0.02 | 0.01 | 0.02 | 0.03 |
| Skin perf | 100 | -60 | 100 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| SFD perf | 100 | -60 | 100 | 0.00 | -0.01 | 0.00 | -0.01 | 0.00 | 0.00 | 0.01 | 0.01 | -0.01 |
| a Q | 0.86 | -10 | 10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 |
| HBCDD |  |  |  |  |  |  |  |  |  |  |  |  |
| HBCDD abs coef | 0.90 | -20 | 10 | **1.00** | **1.00** | **1.00** | **1.00** | **1.00** | **1.00** | **1.00** | **1.00** | **1.00** |
| CLin | 9.60 | -30 | 30 | **-0.28** | **-0.28** | **-0.28** | **-0.28** | **-0.29** | **-0.28** | **-0.28** | **-0.28** | **-0.28** |
| CLip | 12.00 | -30 | 30 | **-0.28** | **-0.28** | **-0.28** | **-0.28** | **-0.29** | **-0.28** | **-0.27** | **-0.28** | **-0.28** |
| Diff Faeces coef | 200 | -50 | 100 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Diff Storagefat coef | 200 | -50 | 100 | 0.01 | -0.03 | 0.00 | -0.03 | -0.02 | 0.04 | 0.03 | 0.03 | -0.03 |
| Other parameters |  |  |  |  |  |  |  |  |  |  |  |  |
| Dig lipid | 0.84 | -10 | 10 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |

1 Red: |NSC| ≥ 0.25; Blue: 0.1 ≤ |NSC| < 0.25; Black: : 0.05 ≤ |NSC| < 0.1; Grey: |NSC| < 0.05.

2 See Table 1 in the paper for the description of parameters.

3 Separable fat depots.

# S3: Evaluation of the model

Once the parameters were adjusted, the model was evaluated based on the experimental data (Jondreville et al., 2017; Omer et al., 2017). Results are presented in Figure S3.1 and Table 3.2.

Figure S3.1: Simulated and observed α-HBCDD concentration1 and enantiomeric fraction (EF)2 in tissues of slow-growing (SG) and fast-growing (FG) broilers3. Parameters of the linear regressions Simulated vs. Observed are given in Table 3.2.

Values are means ± standard deviation (n=4) in all tissues except in plasma (n=1 pool).

1Expressed as ng g-1 lipid weight (from Jondreville et al., 2017).

2Calculated as the concentration de (+)-α-HBCDD divided by the sum (+)-α- and (-)-α- HBCDD (from Omer et al., 2017).

3Broilers are exposed through a 38 ng g-1 α-HBCDD feed. A: SG broilers were exposed during 84 days or exposed during 42 days and decontaminated during 42 days; B: FG broilers were exposed during 42 days.

A – Slow-growing broilers

 

B – Fast-growing broilers

 

|  |  |
| --- | --- |
| Regression line |  |
| Observations |  |

Table S3.2: Parameters1 of the linear relationship between simulated and observed α-HBCDD concentration2 and enantiomeric fraction (EF)3 in tissues of slow-growing (SG) and fast-growing (FG) broilers.

|  |  |  |
| --- | --- | --- |
| α-HBCDD concentration |  | EF |
| **SG4** |
|  | a | *P* | RSD | R² |  |  |  a |  P | RSD | R² |
| Breast | 1.05 | ±0.09 | <0.001 | 15 | 0.88 |  | Breast | 0.980 | ±0.007 | *<0.001* | 0.01 | 0.81 |
| Leg | 1.06 | ±0.08 | <0.001 | 47 | 0.94 |  | Leg | 0.982 | ±0.004 | *<0.001* | 0.01 | 0.89 |
| Plasma | 1.64 | ±0.12 | <0.001 | 11 | 0.79 |  | Plasma | 0.985 | ±0.016 | *<0.001* | 0.02 | 0.45 |
| Liver | 1.83 | ±0.30 | <0.001 | 45 | 0.66 |  | Liver | 0.989 | ±0.012 | *<0.001* | 0.02 | 0.93 |
| SFD | 0.90 | ±0.06 | <0.001 | 50 | 0.94 |  | SFD | 0.991 | ±0.005 | *<0.001* | 0.01 | 0.90 |
| **FG4** |
|  | a | *P* | RSD | R² |  |  |  a | *P* | RSD | R² |
| Breast | 0.82 | ±0.05 | *<0.01* | 5.4 | 0.98 |  | Breast | 1.008 | ±0.006 | *<0.001* | 0.01 | 0.99 |
| Leg | 0.79 | ±0.16 | *0.05* | 59 | 0.74 |  | Leg | 1.004 | ±0.004 | *<0.001* | 0.00 | 1.00 |
| Plasma | 1.07 | ±0.19 | *0.03* | 13 | 0.80 |  | Plasma | 1.026 | ±0.016 | *<0.001* | 0.01 | 0.81 |
| Liver | 1.38 | ±0.60 | *0.15* | 69 | 0.90 |  | Liver | 1.019 | ±0.012 | *<0.001* | 0.01 | 0.97 |
| SFD | 0.90 | ±0.05 | *<0.01* | 23 | 0.98 |  | SFD | 1.006 | ±0.004 | *<0.001* | 0.00 | 0.99 |

1Simulated = a × Observed; P, probability; RSD, residual standard deviation; R², coefficient of determination

2Expressed as ng g-1 lipid weight (from Jondreville et al., 2017)

3Calculated as the concentration de (+)-α-HBCDD divided by the sum (+)-α- and (-)-α- HBCDD (from Omer et al., 2017)

4Broilers are exposed through a 38 ng g-1 α-HBCDD feed. SG broilers were exposed during 84 days or exposed during 42 days and decontaminated during 42 days; FG broilers were exposed during 42 days.

# S4: Comparison of the two strains

According to production statistics, FG-broilers at slaughter are aged 35 to 55 days and weigh 1.8 to 3.4 kg, while FG-broilers are aged 81 to 95 days and weigh 1.9 to 3.5 kg (A. Travel, pers. comm.). The statistics also provide feed efficiency (FE, defined as the ratio of BW at slaughter to feed ingested) intervals (0.44 to 0.69, and 0.25 to 0.48 in FG- and SG-broilers respectively). Once BW and age at slaughter are introduced in the model, feed ingested and, in turn, FE can be calculated. The pairs of age and BW at slaughter leading to FE outside the ranges were discarded. The resulting ranges are presented in Table S4.1. The animals were exposed through feed from hatching to slaughter.

Table S4.1. Main characteristics of fast- (FG) and slow-growing (SG) broilers at slaughter1.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|   |  | FG |   | SG |
|  |  | Min | Max |   | Min | Max |
| Age (day) |  | 36 | 54 |   | 81 | 95 |
| Body weight (kg) |  | 1.8 | 3.4 |  | 1.9 | 3.5 |
| Body lipids (g kg-1 BW) |  | 111 | 127 |  | 131 | 153 |
| Feed intake (kg) |  | 2.86 | 6.86 |  | 5.71 | 8.74 |
| Feed efficiency |  | 0.444 | 0.688 |   | 0.262 | 0.470 |

1 As hatched (Production statistics)

Figure S4.2. Accumulation ratio (ARlip)1 of α-HBCDD in tissues of fast- (FG) and slow-growing (SG) broilers2 according to their age (Age, day) and body weight (BW, kg) at slaughter.



**ARlip Breast (FG)** = 1.05 + 0.0252 × Age - 0.315 × BW

**ARlip Breast (SG)** = 1.75 + 0.00756 × Age - 0.616 × BW + 0.0538 × BW²



**ARlip Leg (FG)** = 3.80 + 0.0802 × Age - 1.03 × BW

**ARlip Leg (SG)** = 6.04 + 0.0240 × Age - 2.05 × BW + 0.179 × BW²



**ARlip Skin (FG)** = 6.23 + 0.0869 × Age - 1.62 × BW + 0.0961 × BW²

**ARlip Skin (SG)** = 7.85 + 0.0258 × Age - 2.26 × BW + 0.187 × BW²

1Ratio of the concentration of α-HBCDD in the tissue (µg kg-1 lipid weight) to its concentration in feed (µg kg-1)

2The characteristics of the broilers are detailed in Table 3. They were exposed through feed from hatching to slaughter.

# S5: Impact of the duration and source of α-HBCDD exposure

Figure S5.1. Simulated kinetics of α-HBCDD burden (µg) in Breast, Leg and Skin of fast-growing broilers1 ingesting 172 µg α-HBCDD according to different modalities of exposure2.

1As hatched; age at slaughter, 42 d; body weight at slaughter, 2.9 kg

2Exposure through the daily ingestion of 57.3 µg α-HBCDD during 3 days from 12 to 14 (A), 19 to 21 (B) or 26 to 28 (C) days of age



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