

# "FEEDING FATS SAFETY" Project. Characterisation of feeding fats coming from by- or co-products from the food chain. Quality and safety for meat production. (<http://www.ub.edu/feedfat/>)



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## Introduction and Objectives of the Project

FEEDING FATS SAFETY is a 6th EC Framework Programme Research Project, with the participation of nine partners, which started on January 2005 and will end at March 2008. Its primary aim is to fit animal nutrition requirements with a high level of safety and quality of some types of meat production, on the basis of the use of fats coming from by- or co-products of the food chain. This aim must be adequate to consumer satisfaction and health demands, and with environmental protection. There is a lack of information about different aspects related to these fats, and the project wanted to answer to the following questions:

- Are fat by- or co-products materials really safe for animal production?
- What are the main chemical characteristic of these fats?
- How contribute these fats to the global intake of contaminants (dioxins, PCB, PBDE, PAH) through the diet?
- Which are the effects of these fats on lipid quality and stability of meat (oxidation, FA composition, *trans* FA)?
- What are the suitable analytical controls to assess quality and safety of fats?
- Are consumers confident respect to these meat production systems?
- How could standardisation and policy control of these fats be improved?
- Are these fats really available, useful and profitable for fat and feed producers?

## Part I: Characterisation of Fat co- and by-products

### Fat samples

**Acid oils from chem refining** (n=25) AOCHE  
**Acid oils from phys refining** (n=16) AOPHY  
**Lecithins** (n=8) LECI  
**Recycled cooking oils** (n=8) RECY  
**Animal fats** (n=36) ANFA  
**Oils from bleaching earths** (n=2) EBE  
**Fish oils** (n=9) FISH  
**Hydrogenated fat by-products** (n=6) HYBY  
**Fatty acids calcium soaps** (n=3) FACS  
**Miscellaneous** (n=10) MIX

\* Moisture, Acid value, Fatty acid composition, *Trans* fatty acids, Conjugate linoleic acid, Total cholesterol content, Sterol composition, Tocopherols and tocotrienols,  
 \* FTIR spectra for classification purposes

### Analyses performed

\* Sterol oxidation products, Fatty acid oxidation products, Polymer content, Mono- and diacylglycerols, Peroxide value (volumetric and FOX colorimetric), TBA value, *p*-Anisidine value  
 \* Dioxins (PCDD/Fs) and dioxin-like PCBs (DL-PCBs), Polycyclic Aromatic Hydrocarbons (PAH), PBDE

### Chemical properties of feeding fats

**AOCHE and AOPHY**  
 Characterized by very high Acid Values, but some differences exist, since AOPHYs show higher AV and lower %MG+DG. Sterol content is much higher for AOCHE than for AOPHY, but that of tocopherols and tocotrienols is much lower. Low Peroxide Values in both cases. But we found *p*-Anisidine values above the rest of categories except FISH.  
**HYBY and ANFA apart**, AOPHY showed the highest levels of *trans* FA (max values around 4%).  
 AOCHE and AOPHY showed high levels of CLA, in comparison with the rest of categories, except ANFA and FISH.  
**AOPHY** also showed particularly high levels of sterol oxidation products.

**LECITHINS**  
 Characterized by very high *p*-polyunsaturated fatty acids. High Acid values were found (average 50 mg KOH/g), in comparison with the rest of categories except acid oils. Very high levels of sterols were found, but intermediate values of tocopherols and tocotrienols.

**ANIMAL FATS**  
 FA composition and *trans* FA content was related to the animal species. CLA could be a very good marker for ruminant fats.  
 High variability in Cholesterol content, which may depend more on tissues used than on animal species.  
 Very low levels of tocopherols and tocotrienols.  
 Very low Acid Values and %MG+DG, and very low levels of oxidation.

**FISH OILS**  
 FA composition typical of fish oils, but with high variability, particularly in *n*-3 PUFA. High levels of CLA were found. Tocopherol levels higher than ANFAs and tocotrienols levels lower, negligible or not detected.  
 Low Acid Values and %MG+DG, but higher than ANFA.  
 Low Peroxide Values, but high *p*-Anisidine values (mean ≈ 73) and intermediate polymer contents (mean ≈ 2%).

**RECY and EBE**  
 EBES are characterised by a quite high Acid Values and % MG+DG, while RECY show very low values.  
 EBES show much higher sterol content than RECY, but there are no differences for tocopherol and tocotrienol contents.  
 RECY showed high oxidation and polymer (mean, 9%) values. EBE showed similar polymer content but much lower oxidation values.  
 Both categories showed intermediate but consistent CLA contents (120-230 mg/100g)

**FACS and HYBY**  
 Characterised by high % SFA, although HYBY > FACS  
 HYBY show quite high Acid values (Palm Fatty Acid Distillates are usually the raw material)  
 FACS are much more rich in sterols, but much less rich in tocopherols and tocotrienols  
 HYBY showed quite variable *trans* FA values (1.9-9.4%) and negligible contents of CLA

### Contents of Dioxin/DL-PCB

Only 1 FISH oil exceeded max levels of dioxins and 2 fish oils exceeded maximum levels of dioxins+PCB  
 2 HYBY and 5 AOPHY exceeded both the maximum level of dioxins and that of dioxin+DL-PCB  
 1 AOCHE exceeded the maximum level of dioxins

	PCDDs/PCDFs (pg WHO-TEQ/g)	PCDDs/PCDFs and DL-PCBs (pg WHO-TEQ/g)
FISH	0.40-10.98	1.87-42.47
ANFA	0.05-1.75	0.15-1.59
AOCHE	0.07-1.08	0.21-1.35
AOPHY1	0.13-2.28	0.35-6.82
LECI	0.05-0.13	0.07-0.17
SBE	0.44-1.13	1.01-0.79
RECY	0.11-0.82	0.16-0.88
HYBY	0.28-1.74	0.64-1.14

### Contents of PAH

3 groups of feeding fats could be established according to their level of high molecular weight PAH (BF, BaP, BeP, Per, IP, DA, BP):  
 - Very low (<0.5 - 2 ng/g): FISH, HYBY, LECI  
 - Very low but potentially at risk: ANFA, EBE, FACS, MIX, RECY  
 - Low to very high: AOCHE (max = 340 ng/g), AOPHY (max = 190 ng/g)  
 Table shows the distribution of samples according to their content of Benzo(a)pyrene:

[BaP] ng/g	< 2 ng/g	2-20 ng/g	> 20 ng/g	Total
ANFA	33	3		36
AOCHE	10	13	2	25
AOPHY	5	10	1	16
EBE	1	2		3
FACS	1	2		3
FISH	3			3
HYBY	5	1		6
LECI	8			8
MIX	3	1		4
RECY	4	1	1	6

A system of classification of these fat categories has been proposed by using FTIR spectroscopy (Gasperini et al., Eur. J. Lipid Sci Technol 109, 2007, 673-681)

## Part II: Effect of feeding fats in animals and meat

From the results obtained in the Part 1, we chose two fat sources with the high (HO) and low (LO) level of oxidation; two fat sources with high (HT) and low (LT) level of *trans* fatty acids; two fat sources with high (HP) and low (LP) level of PAH; and two fat sources with high (HC) and low (LC) level of contaminants (dioxins, dioxin-like PCB, PBDE). With these fat materials we organised 4 production trials (both in rabbit and chicken) including 3 different feed treatment each, according to the annexed table. Finally, we performed a last experiment with increasing spiked levels of the 4 types of contaminants, in order to determine more precisely their corresponding transfer rates.

### 4 animal trials (trans FA, Oxidation, PAH, Dioxin-PCB) (H = high level; L = low level)

H <sub>Oxi</sub>	H <sub>Trans</sub>	H <sub>PAH</sub>	H <sub>Diox-PCB</sub>
50% H <sub>Oxi</sub> + 50% L <sub>Ox</sub>	50% H <sub>Trans</sub> + 50% L <sub>Trans</sub>	50% H <sub>PAH</sub> + 50% L <sub>PAH</sub>	50% H <sub>Diox-PCB</sub> + 50% L <sub>Diox-PCB</sub>
L <sub>Oxi</sub>	L <sub>Trans</sub>	L <sub>PAH</sub>	L <sub>Diox-PCB</sub>

### 5th animal trial: 4 spiked levels x 4 contaminant types (PBDE, PAH, DIOXIN, DL-PCB)

### Composition and oxidation

FA composition in meat changes according to the corresponding composition of the oil and feed used. However, some differences are observed in the animal response according to the species and the type of fat:

-Chicken meat reflect better the FA composition of the oils and feeds when they are more polyunsaturated (particularly for fish oils), as compared to the rabbit meat.

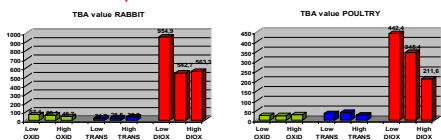
-In contrast, rabbit tends to reflect better the FA composition of the oil when it is more saturated (i.e., PFAD and hydrogenated PFAD).

*Trans* FA and CLA meat contents varied according to the feed contents, and different patterns were found for each animal species. A content of 10% *trans* FA in the high level fat added to the feed led to 3% (over total FA) content in rabbit meat and 4% in poultry meat with skin.

Levels of Cholesterol Oxidation Products in meat and liver showed very slight differences according to the feed treatment.

Regarding TBA values, very low levels were observed for all meats, except for meats coming from fish oils diets (dioxin trial):

-Rabbit meat showed much higher TBA values than chicken meat, maybe related to the lower tocopherol content observed in rabbit meat.



### Contaminants transfer to meat

#### Contents of PAH in MEAT and LIVER

N, Acy, Ace, Fe, Phe, A, Fluo, Pyr, BaA, Trp+Chrys, BbF+BkF, BeP, BaP, Per, IP, DaA+DaC, BP  
 Transfer rate to meat and liver for the High feed level of PAH gave values <2 ng/g (upper limit), both in POULTRY and RABBIT. Levels of hydroxylated metabolites in plasma bile and urine are still under analysis

#### Content of PBDE in MEAT and LIVER

BDE 47, BDE 99, BDE 119 and BDE 153  
 Negligible amounts were found in all meat and liver samples: total PBDE <2 ng/g

#### Content of Dioxin & DL-PCB in MEAT

Some feeds under regulated MAXIMUM levels could lead to meats with levels exceeding the corresponding MAX levels

Broiler Feeds:				Rabbit Feeds:			
pg WHO-TEQ/g	Broiler Feed LC	Broiler Feed MC	Broiler Feed HC	pg WHO-TEQ/g	Rabbit Feed LC	Rabbit Feed MC	Rabbit Feed HC
PCDDs/Fs	0.11 (0.01)	0.19 (0.02)	0.44 (0.03)	0.05 (0.01)	0.10 (0.01)	0.18 (0.02)	0.41 (0.03)
DL-PCBs	0.00 (0.00)	0.01 (0.00)	0.02 (0.00)	0.00 (0.00)	0.01 (0.00)	0.02 (0.00)	0.04 (0.00)
Total	0.11 (0.01)	0.20 (0.02)	0.46 (0.03)	0.05 (0.01)	0.11 (0.01)	0.20 (0.02)	0.45 (0.03)

Maximum levels for compound feedingstuffs (COMMISSION DIRECTIVE 2006/13/EC, 3 February 2006): \*0.75 pg WHO-TEQ/g PCDD/Fs + 1.5 pg WHO-TEQ/g PCDD/Fs + DL-PCBs  
 ALL FEEDS under the MAX. levels, except Diox + DL-PCB value in POULTRY "High Diox"

#### Poultry Meat with skin

pg WHO-TEQ/g	Broiler LC	Broiler MC	Broiler HC
PCDDs/Fs	1.11 (0.02)	1.89 (0.03)	4.43 (0.05)
DL-PCBs	0.00 (0.00)	0.01 (0.00)	0.02 (0.00)
Total	1.11 (0.02)	1.90 (0.03)	4.45 (0.05)

Exceeding the MAXIMUM levels

Maximum levels for meat and meat products of poultry and farmed game (COMMISSION REGULATION (EC) N° 199/2006, 3 February 2006):  
 \* 2 pg WHO-TEQ/g fat PCDD/Fs + 4 pg WHO-TEQ/g fat PCDD/Fs + DL-PCBs

#### Rabbit Meat

pg WHO-TEQ/g	Rabbit LC	Rabbit MC	Rabbit HC
PCDDs/Fs	1.12 (0.02)	0.20 (0.01)	0.75 (0.01)
DL-PCBs	0.00 (0.00)	0.01 (0.00)	0.02 (0.00)
Total	1.12 (0.02)	0.21 (0.01)	0.77 (0.01)

All rabbit meats under the MAX. levels