



# **PRESENCE of DEGRADATION COMPOUNDS**

*Maria Teresa Rodriguez Estrada*

*Matteo Bonoli*

*Giovanni Pignoli*

*Department of Food Science*

*University of Bologna, Italy*



## **MAIN CHEMICAL DEGRADATIONS OF FATS AND OILS USED IN ANIMAL FEEDING**

### **A) OXIDATION**

#### **➔ PRIMARY OXIDATION PRODUCTS**

- hydroperoxides ⇒ peroxide value (PV)

#### **➔ SECONDARY OXIDATION PRODUCTS**

- aldehydes, ketones ⇒ *para*-anisidine index (*p*-AV) & thiobarbituric acid reactive substances (TBARS)
- Oxidized fatty acids (OFA)
- Sterol oxidation products (cholesterol+phytosterols=SOPs)

### **B) POLYMERIZATION**

#### **➔ DIMERS and OLIGOMERS**

- from oxidation, frying and hydrogenation





## Feeding Fats Safety



### MAIN CHEMICAL DEGRADATIONS OF FATS AND OILS USED IN ANIMAL FEEDING

#### C) ISOMERIZATION

##### ➔ DOUBLE BOND ISOMERIZATION during REFINING and HYDROGENATION

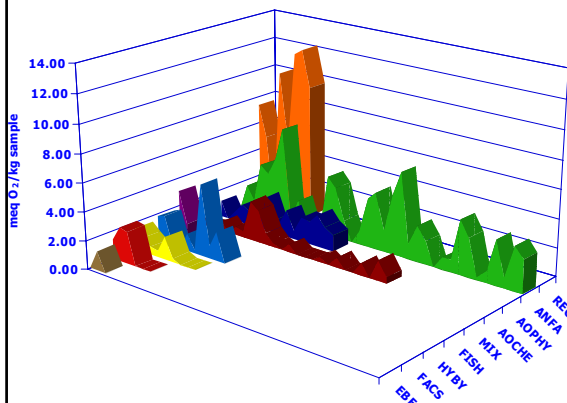
- from *cis*- to *trans*- > *trans* fatty acids (TFA)
- formation of conjugated linoleic fatty acid (CLA) isomers (9-11, 10-12 and 11-13) with different geometrical configurations (*cis, trans, trans, cis, cis, cis, trans, trans*) during oxidation or partial hydrogenation



## Feeding Fats Safety

### PV

Official ECC Method (Reg. 2568/91)



	N	AVERAGE	MIN	MAX
AOCHE veg	14	0.30	ND	1.46
AOCHE trop	3	0.40	0.18	0.62
AOCHE olive	6	1.14	ND	2.81
AOCHE anim	2	0.28	ND	0.55
AOPHY veg	4	0.88	ND	1.64
AOPHY trop	8	1.35	0.35	2.36
AOPHY olive	3	0.95	0.74	1.34
AOPHY anim	1	2.27		
ANFA	36	2.17	ND	6.81
RECY	8	7.64	ND	12.15
FISH	9	1.47	ND	5.10
MIX	10	1.33	ND	4.03
EBE	2	0.68	ND	1.36
LECI	8	ND		
HYBY	6	0.92	0.25	1.62
FACS	3	2.02	1.36	2.43

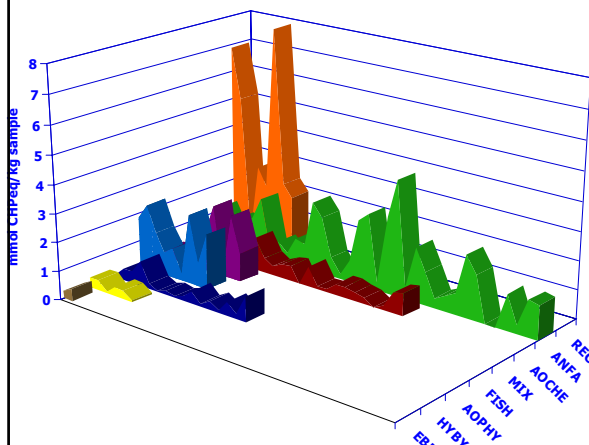




## Feeding Fats Safety

## PV Content

(Navas *et al.*, 2004)

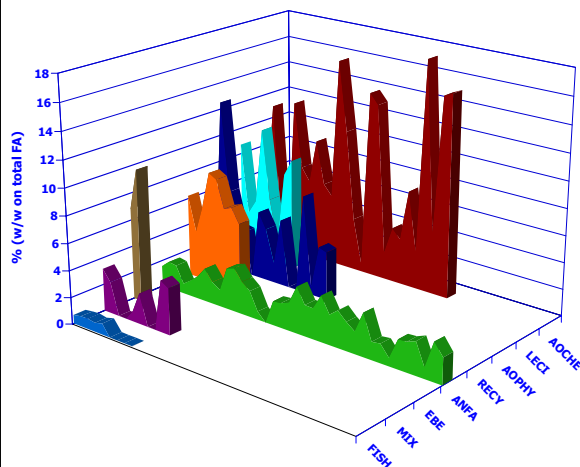


	N	AVERAGE	MIN	MAX
AOCHE veg	14	0.36	ND	0.80
AOCHE trop	3	0.15	0.09	0.25
AOCHE olive	6	0.74	0.31	1.28
AOCHE anim	2	1.21	0.32	2.09
AOPHY veg	4	0.45	0.08	0.88
AOPHY trop	8	0.18	0.02	0.43
AOPHY olive	3	0.36	0.05	0.88
AOPHY anim	1	0.48		
ANFA	36	1.17	ND	4.08
RECY	8	3.61	0.15	7.85
FISH	9	1.44	0.26	2.44
MIX	10	0.82	0.04	2.44
EBE	2	0.34	0.26	0.41
LECI	8	ND		
HYBY	6	0.24	0.05	0.37
FACS	3	Not soluble		



## Feeding Fats Safety

## OFA



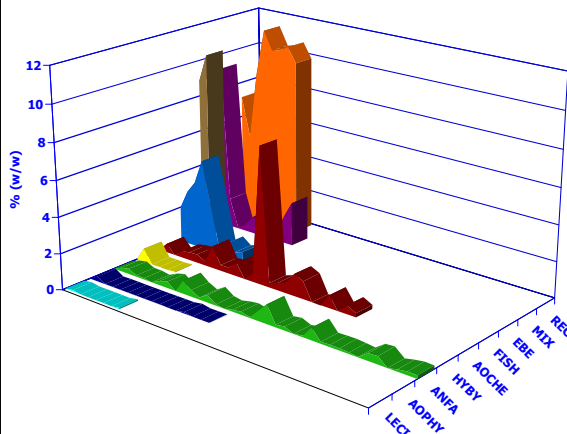
	N	AVERAGE	MIN	MAX
AOCHE veg	14	10.62	2.94	17.39
AOCHE trop	3	1.62	0.54	2.20
AOCHE olive	6	6.00	3.48	9.31
AOCHE anim	2	2.35	0.71	3.98
AOPHY veg	4	7.48	3.66	12.81
AOPHY trop	8	2.33	ND	5.13
AOPHY olive	3	2.97	1.55	3.98
AOPHY anim	1	0.69	0.69	0.69
ANFA	36	2.00	ND	3.51
RECY	8	6.21	3.61	8.46
FISH	9	0.41	ND	0.83
MIX	10	1.59	ND	3.86
EBE	2	8.36	6.81	9.91
LECI	8	6.20	1.84	10.29
HYBY	6	ND		
FACS	3	ND		





## Feeding Fats Safety

## POLYMERS

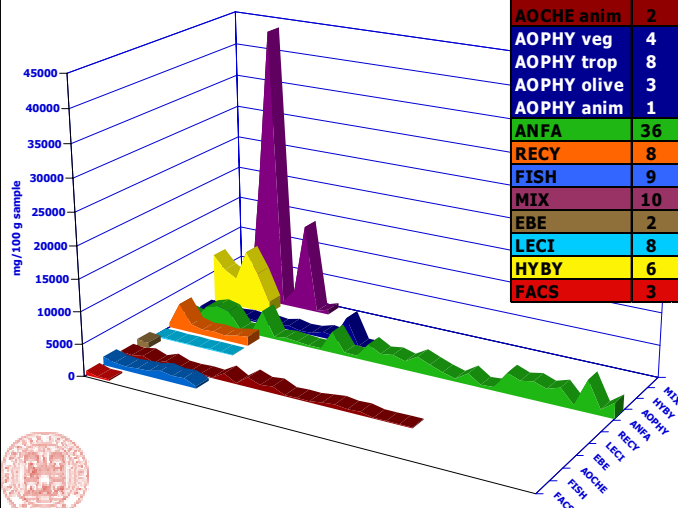


	N	AVERAGE	MIN	MAX
AOCHE veg	14	0.30	ND	0.76
AOCHE trop	3	0.32	ND	0.59
AOCHE olive	6	0.76	0.25	1.25
AOCHE anim	2	4.06	0.50	7.62
AOPHY veg	4	0.09	ND	0.27
AOPHY trop	8	ND		
AOPHY olive	3	ND		
AOPHY anim	1	ND		
ANFA	36	0.22	ND	1.08
RECY	8	9.15	4.98	11.27
FISH	9	2.06	0.36	5.06
MIX	10	1.72	ND	9.17
EBE	2	9.61	8.82	10.40
LECI	8	0.02	ND	0.08
HYBY	6	0.13	ND	0.75
FACS	3	Not soluble		



## Feeding Fats Safety

## trans-FA



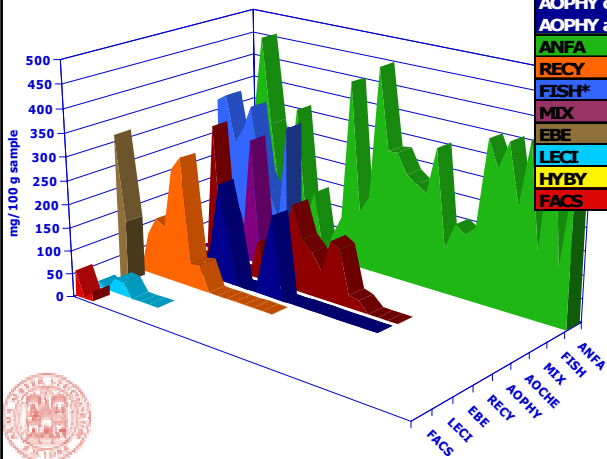
	N	AVERAGE	MIN	MAX
AOCHE veg	14	484.82	115.32	1525.07
AOCHE trop	3	349.34	99.36	808.77
AOCHE olive	6	302.27	99.36	701.05
AOCHE anim	2	936.11	817.08	1055.14
AOPHY veg	4	386.38	ND	672.09
AOPHY trop	8	405.05	ND	955.45
AOPHY olive	3	397.68	231.11	697.61
AOPHY anim	1	4059.96	4059.96	4059.96
ANFA	36	1675.60	304.27	4956.28
RECY	8	1436.54	642.83	4199.56
FISH	9	950.34	374.92	1380.77
MIX	10	8276.56	105.64	43689.36
EBE	2	978.60	909.37	1047.83
LECI	8	104.42	36.54	162.03
HYBY	6	5900.60	1856.21	9378.43
FACS	3	380.74	224.84	666.18





## Feeding Fats Safety

## CLA



	N	AVERAGE	MIN	MAX
AOCHE veg	14	TR	ND	309.79
AOCHE trop	3	TR	ND	TR
AOCHE olive	6	TR	ND	132.07
AOCHE anim	2	156.35	126.37	186.33
AOPHY veg	4	TR	ND	187.84
AOPHY trop	8	TR	ND	77.90
AOPHY olive	3	108.59	ND	211.82
AOPHY anim	1	179.27	179.27	179.27
ANFA	36	220.42	ND	459.12
RECY	8	119.66	ND	275.96
FISH*	9	241.11	85.45	333.55
MDX	10	TR	ND	273.39
EBE	2	223.59	131.78	315.40
LECI	8	TR	ND	TR
HYBY	6	ND	ND	ND
FACS	3	TR	ND	TR



## Feeding Fats Safety



### CORRELATIONS between DEGRADATION PRODUCTS

➡ **CONSIDERING ALL ANALYTICAL DATA from DIFFERENT CATEGORIES** ⬅

➡ **THE TWO ANALYTICAL METHODS OF PV DISPLAY A GOOD CORRELATION ( $r^2=0.758$ )**

- differences according to the categories (good correlation in ANFA and FISH, poor correlation in AOPHY and AOCHE)

➡ **POSITIVE CORRELATION: Tot TFA vs trans C18:1**





## Feeding Fats Safety



### **CORRELATIONS between DEGRADATION PRODUCTS**



**CONSIDERING SEPARATELY THE DATA of EACH CATEGORY**



<b>AOCHE</b>	OFA <i>vs</i> C18:2, OFA <i>vs</i> C18:2+C18:3, Tot TFA <i>vs trans</i> C18:1
<b>AOPHY</b>	OFA <i>vs</i> polymers, Tot TFA <i>vs trans</i> C18:1
<b>LECI</b>	Tot TFA <i>vs</i> each <i>trans</i> fatty acid class ( $r^2 \approx 0.8$ )
<b>RECY</b>	Oxidation $\Rightarrow$ <i>p</i> -AV <i>vs</i> polymers, OFA <i>vs</i> polymers, OFA <i>vs</i> C18:2, OFA <i>vs</i> C18:2+C18:3
	Isomerization $\Rightarrow$ Tot TFA <i>vs trans</i> C18:1, Tot TFA <i>vs trans</i> C18:3
<b>ANFA</b>	CLA <i>vs</i> Tot TFA, CLA <i>vs trans</i> C18:1, Tot TFA <i>vs trans</i> C18:1



## Feeding Fats Safety



### **CORRELATIONS between DEGRADATION PRODUCTS**



**CONSIDERING SEPARATELY THE DATA of EACH CATEGORY**



<b>FISH</b>	Oxidation $\Rightarrow$ <i>p</i> -AV <i>vs</i> OFA, <i>p</i> -AV <i>vs</i> TBARs, <i>p</i> -AV <i>vs</i> polymers, TBARs <i>vs</i> polymers
	Isomerization $\Rightarrow$ Tot TFA <i>vs trans</i> C18:1, Tot TFA <i>vs trans</i> C18:3
<b>HYBY</b>	Tot TFA <i>vs trans</i> C18:1
<b>FACS</b>	Tot TFA <i>vs trans</i> C18:3
<b>MIX</b>	Oxidation $\Rightarrow$ PV <i>vs</i> OFA, PV <i>vs p</i> -AV, <i>p</i> -AV <i>vs</i> OFA
	Isomerization $\Rightarrow$ Tot TFA <i>vs trans</i> C18:1, Tot TFA <i>vs trans</i> C18:2





# CONCLUSIONS

- ➔ **THERE ARE LARGE VARIATIONS IN THE CONTENT OF LIPID DEGRADATION PRODUCTS IN THE FEEDINGS FAT SAMPLE CATEGORIES OF DIFFERENT ORIGINS IN EUROPE**
  
- ➔ **THESE DIFFERENCES DEPEND ON:**
  - ➔ **THE NATURE AND QUALITY OF THE OIL/FAT USED AS RAW MATERIAL**
  - ➔ **THE DEGREE OF UNSATURATION OF THE OIL/FAT**
  - ➔ **THE PRESENCE OR ABSENCE OF NATURAL ANTIOXIDANT (tocopherols, tocotrienols and polyphenols)**
  - ➔ **THE TYPE OF TECHNOLOGY USED FOR THEIR PRODUCTION**
  - ➔ **THE PROCESSING CONDITIONS (time, temperature, pressure, catalizer, etc.)**