



WP 6
**Socio-economic impact of the
application of recycled fatty materials
in commercial feeds**

WP leader: SILO - M. Parini
Partners: Univ. Barc., SSOG, Univ Aut.Barc.

Duration: 3 months (32 to 34)

Deliverables

**D9 –“Document of conclusions about benefits and risks of
the use of recycled fatty materials in animal feeding”**



- 1) Evaluation of EU production volumes of
fatty by-products that can be used as
feedstuff**



Feeding Fats Safety



Proposal of differentiation between

Co-products

AOCHE- AOPHY- ANFA(*) – FISH LECI

*Primary industrial processes (refining; rendering)

*Used in EU-Countries in feeds

(*) ANFA limitations in Germany, or in special organic products lines)

Technical lipids

FACS – HYBY – MIX:
esterified oils; mono- & diglycerides

* Secondary ind. process, obtained from co-products

* Used in EU-Countries in feeds

* performing special nutritional functions

Waste materials

RECY - EBE

* banned (RECY)

* collected by companies authorized for wastes collection (RECY and EBE)

* not used in feeds because of

undesiderable substances (EBE)

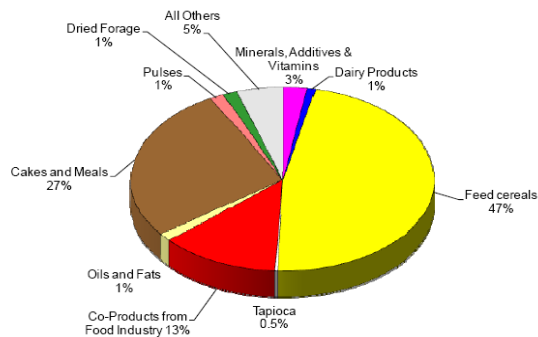


Feeding Fats Safety



FEFAC - FEED PRODUCTION

FEED MATERIAL CONSUMPTION BY THE EU FEED INDUSTRY
IN 2006 (Excl. GREECE, MALTA AND LUXEMBOURG)





Feeding Fats Safety



FEED PRODUCTION IN EU-COUNTRIES IN 2005

= 141,897,000 tons of feed

1% of oils = 1,418,000 tons

TAB. 14: INDUSTRIAL FEED MATERIAL CONSUMPTION IN THE EU (*) ()**

Industrieller Rohstoffverbrauch in der EU / Consumo industriale di materie prime nello UE /
Consommation industrielle de matières premières pour aliments des animaux dans l'UE

	1998	1999	2000	2001	2002	2003	2004	2005	2006 (***)
Feed Cereals / Geteide / Cereali / Cereales	50,477	50,246	51,141	54,334	56,311	55,602	66,303	66,818	67,117
Tapioca / Maniok / Manioca / Manioc	2,799	3,537	3,316	2,698	1,633	1,729	2,242	591	412
Co-Products from Food Industry / Nebenprodukte Nahrungsmittelindustrie / sottoprodoti dell'industria alimentare / Co-produits des industries agro-alimentaires	17,307	17,038	17,412	17,201	16,846	16,987	16,618	17,060	18,122
Oils and Fats / Ole und Fette / Grassi e olei / Huiles et graisses	2,152	2,255	2,151	1,936	1,932	1,958	2,169	2,010	2,033
Oilseeds and Meals / Ölsaaten und Schrote / Pansen / Tourteaux oléagineux	31,273	31,569	31,225	33,508	34,662	35,128	38,558	38,509	38,501
Pulses / Hülsenfrüchte / Proteaginoso / Protégineux	4,078	4,253	3,633	2,961	1,671	1,756	2,519	2,413	2,136
Animal Meals / Tiermehl / Farine animale / Farines animales	2,807	2,634	1,975	464	480	514	580	553	513
Dairy Products / Milchzeugnisse / Prodotti lattiero-caseari / Produits laitiers	1,618	1,517	1,433	1,316	1,317	1,290	1,301	1,307	1,250
Dried Forage / Trockenfutter / Forragio disidratato / Fourrages déshydratés	2,817	2,489	2,046	2,249	2,621	2,440	2,370	1,817	2,093
Minerals, vitamins, etc. / Mineralstoffe, Vitamine, usw. / Minerali, vitamine, etc. / Minéraux, vitamines, etc.	3,665	3,551	3,492	3,616	3,674	3,422	3,897	3,724	3,666
All Others / Verschiedenes / Vari / Divers	5,252	5,958	5,522	5,879	6,035	5,324	5,758	6,175	6,525
TOTAL	124,246	125,046	124,346	126,190	127,182	126,150	144,315	141,897	142,470

(*) - Without Luxembourg, Greece and Malta / Ohne Luxemburg, Griechenland und Malta / Senza Lussemburgo, Grecia e Malta / Sans le Luxembourg, la Grèce et Malte
(**) - EU-25 as from 2004 / EU-25 seit 2004 / UE-25 dal 2004 / UE-25 depuis 2004
(***) - Estimates / Schätzungen / Stima / Estimación

Source / Quelle / Fonte: FEAPAC



Feeding Fats Safety



EVALUATION OF CO-PRODUCTS PRODUCTION VOLUMES IN 2005 – 2006 IN EUROPE

Co-products	Description of origin	Production volumes in 2005 in Europe (ton)	Info sources
AOCHE and AOPHY	Soybean oil refining	29.564	EU official web-site http://madb.europa.eu/mkaccdb2/statistical_form.htm
	Rape oil refining	69.474	"
	Sunflower oil refining	31.984	"
	Palm oil refining	101.564	"
	Coconut oil refining	21.150	"
	Olive oil refining	108.200	"
FISH ANFA	Fish rendering	589.000	IFFO statistics (International Fishmeal and Fish oil Organisation www.ifo.net)
	Meat rendering	2.057.000	EFPRA
LECI	Soybean oil de-gumming	80.000	EU official web-site http://madb.europa.eu/mkaccdb2/statistical_form.htm
	Sunflower oil de-gumming	83.000	"
TOTAL		2.809.000	



Feeding Fats Safety



EVALUATION OF WASTE MATERIALS PRODUCTION VOLUMES IN 2005 – 2006 IN EUROPE

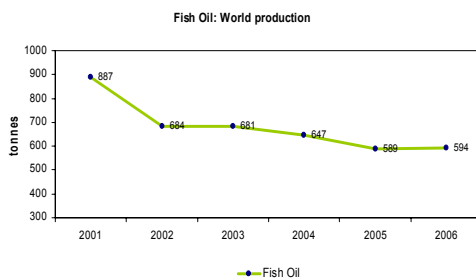
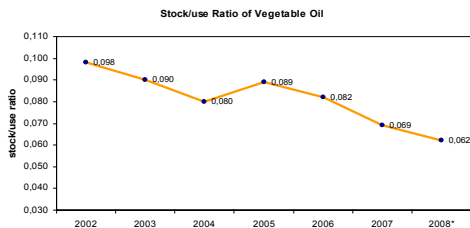
waste materials	Description of origin	Production volumes in 2005 in Europe (ton)	Info sources
EBE	Bleaching earths	20.900	EU official web-site http://madb.europa.eu/mkacddb2/statistical_form.htm
RECY	Cooking oil collection	400.000	Brokers



Feeding Fats Safety



TRENDS IN OILS / FATS STOCKS :



ANFA	2003	2004	2005	2006	2007*
	2.600.000	2.488.000	2.057.000	2.057.000	stable data



WP 6 WORK BOOK

2) Evaluation of costs of the recycling of co-products and waste materials in industrial sectors differing from feedstuffs production



**IDENTIFICATION OF INDUSTRIAL SECTORS USING
CO-PRODUCTS / WASTE MATERIALS**

Oleo-chemistry



Feeding Fats Safety



CO-PRODUCTS / WASTE MATERIALS in OLEOCHEMISTRY

Co-products Waste Materials	Obtained intermediate products	Main final products
AOCHE ANFA	Fatty acids	Soaps, resins, lubricant greases, fuel additives, esters, re-esterified fats for technical uses
	Glycerol	Cosmetics, pharmaceuticals, solvent flavors, polyesters, anti-dust agents, cooling fluids, anti-icing fluids, energy generation, carbon source for fermentation processes, feed, wetting agents, tobacco industry
AOPHY	Fatty acids	Soaps, resins, lubricant greases, fuel additives esters, re-esterified, fats for technical uses, squalene (from Olive oil feedstock only)
FISH	Hydrogenated lipids	Lubricating grease, long chain fatty acids
	Amides	Plastic materials
LECI		Cosmetics, pharmaceuticals, flavours, polyesters, emulsifiers, food additives for chocolate, soft drinks, creams, dessert, anti-dust agents, photographic applications
EBE RECY	Fatty acids	Soaps, resins, lubricant greases, fuel additives esters, re-esterified, fats for technical uses
	As they are	Chain saw lubricating products, concrete releasing agents, shoe polish
	Glycerol	Cosmetics, pharmaceuticals, flavors, polyesters, anti-dust agents, cooling fluids, anti-icing fluids, energy generation, carbon source for fermentation processes, feed, wetting agents, tobacco industry

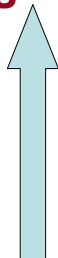


Feeding Fats Safety



IDENTIFICATION OF INDUSTRIAL SECTORS USING CO-PRODUCTS / WASTE MATERIALS

Energetic sector



- Bio-diesel
- bio-fuels for engines: cogeneration (starting from 2007)
- heating bio-fuels (starting from 2007)

Refined / semi-refined oils



Feeding Fats Safety



FORECASTS CONCERNING THE USE OF BIO FUELS FOR ENERGY PRODUCTION

From the report "Future of oleo chemistry in the 3rd Millenium"
presented at the International Congress

"Oleochemicals under Changing Global Conditions

25-27 February 2007 – HAMBURG

*" Country-specific goals for renewable energy from biomass between 2025 and 2050 vary from 30 to 50 percent of total energy consumption.(...) Forecasts for 2025 state that **20 to 30 % of arable land will be used for biomass production, mostly for the production of bio ethanol and bio diesel based on corn, sugar cane, wheat, sugar beet, coconut, palm oil, sunflower, oilseed rape, soybean ...**"*



Feeding Fats Safety



FORECASTS CONCERNING THE USE OF BIO FUELS FOR ENERGY PRODUCTION

To be used in the energy sector these **huge quantities of vegetable oils will have to be refined, originating big stocks of co-products for oleo-chemistry and feed industry.**

In the report we read: *"The next generation of bio refineries will use technologies to make products from plant materials that will be converted to multiple products – fine chemicals, oleo chemicals, bulk chemicals, polymers and bio-fuels. Bio-refineries will be effectively linked to the conventional chemical industry value chain creating new industries"*.

So, as a consequence of to longer term strategies for energy production, **huge amounts of fatty co-products and waste materials could be available**



Feeding Fats Safety



Comparison between refined oils and transformed co-products costs for energy production

REFINED OILS	Average price 2006	Average price 2007 (first 6 months)	TRANSFORMED CO-PRODUCTS/ WASTE MATERIALS	Average price 2006			Average price 2007 (first 6 months)		
				Bulletins price	Transf. cost	Total	Bulletins price	Transf. cost	Total
SOYBEAN OIL	587	649	Transf. EBE	280	200	480	300	200	500
SUNFLOWER OIL	665	724	Transf. RECY	350	100	450	400	100	500
PALM OIL	450	580	Transf. ANFA Tallow (FFA from 1% to 4%)	377	100	477	438	100	538



Feeding Fats Safety



Comparison between refined oils and transformed co-products costs

- The cost of transformed co-products / WASTE MATERIALS can be up-to 25% less than refined oils to be used as bio-fuels.
- Transformed ANFA, RECY and EBE can be used in energetic sector with economical convenience and environmental benefits.
- They result competitive towards refined oils for applications in energy production sector.

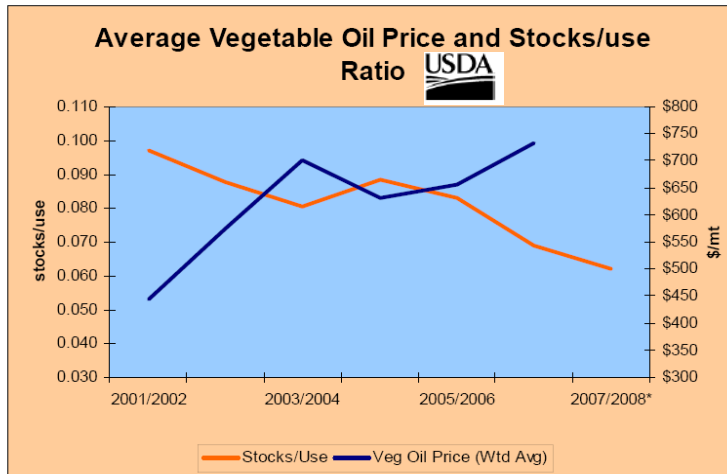


Feeding Fats Safety



ACTUAL TREND IN VEGETABLE OILS MARKET- USDA

Vegetable Oil Prices Expected to Rise With Tighter Oil Market in 2007/08.



Feeding Fats Safety



POSSIBLE SCENARIO

- Short term : vegetable oils stocks decrease and price increase
- Long term:
 - - increase of vegetable oils refining plants because of increase of demand for renewable energy resources → increase of fatty co-products availability
 - - decrease of cereals availability because of increase of demand for renewable energy resources → lack of energetic sources in the diets

It makes sense to consider co-products as an important nutritional energy source in feedstuff



WP 6 WORK BOOK

3) Evaluation of the costs of co-products direct application to feed production

4) Comparison of the costs for feed/meat production with co-products respect to the use of conventional fatty materials



PRICES COMPARISON CO-PRODUCT Vs VEGETABLE OILS

The co-product show competitive prices if compared with raw vegetable oils
Up to -40%

Vegetable oils	Average price 2006 Euro / ton	Average price first 6 months 2007 Euro / ton	Co-products	Average price 2006 Euro / ton	Average price first 6 months 2007 Euro / ton
Soybean oil	524	588	AOCHE / AOPHY from mixed seeds with min. iodine number 120	309	365
Palm oil	402	537	Palm AOCHE / AOPHY	333	375
Sunflower oil	534	599	AOCHE / AOPHY from mixed seeds (without iodine number indication)	292	350
GMO free soybean oil	544	608	Olive AOCHE /AOPHY	337	417
Coconut oil	522	659	Coconut AOCHE / AOPHY	330	380
			ANFA / Tallow (FFA from 1% to 4%)	377	438
			ANFA (FFA from 4% to 10%)	373	418
			FISH oil	581	630



Feeding Fats Safety



Comparison between nutritional efficiency of vegetable oils and co-products

J. Wiseman equation allows to compare the apparent metabolizable energy values (AME) or the digestible energy (DE) of crude oils vs co-products having similar fatty acid composition but different **Free Fatty acid content**

(info source: Wiseman publications on Poultry Science):

Chicken < 21 days: AME = $239 * \{38,112 + (-0,009 * \text{FFA gr/kg}) + [-15,337 * (0,506 * \text{Ratio Uns/Sat})]\}$

Chicken > 21 days: AME = $239 * \{39,025 + (-0,006 * \text{FFA gr/kg}) + [-8,505 * (-0,403 * \text{Ratio Uns/Sat})]\}$

Pigs 30 – 95 kg: DE = $239 * \{37,89 + (-0,005 * \text{FFA gr/kg}) + [-8,2 * (-0,515 * \text{Ratio Uns/Sat})]\}$

MIU (*) values: the energetic value obtained through Wiseman equation have Been multiplied by a coefficient corresponding to MIU value.

(*) Moisture, impurities, unsaponifiables



Feeding Fats Safety



Comparison of feed formula costs using crude Soybean oil or AOCHE from Soybean oil in chicken diets from 11 to 21/25 days (Prices of lipid supplement = prices of first 6 months of 2007)

	AME	% of inclusion	Average price (first 6 months 2007) Euro / ton	Total formula energetic value ME Kcal/kg	Total formula cost Euro / ton
Soybean oil : FFA : 2% MIU : 1%	8.963	4,12%	587	3.150	309,3
AOCHE from soybean oil FFA 60% MIU 3%	7.994	5,00%	364,5	3.150	301,5
The use of the co-product resulted in a formula cost decrease corresponding to about 2,5%					



Feeding Fats Safety



Comparison of feed formula costs with Palm oil or AOPHY from Palm oil in diets for pigs from 30 to 70 kg (Prices of lipid supplements = prices of first 6 months of 2007)

	AME	% of inclusion	Average price (first 6 months 2007) Euro / ton	Total formula energetic value WIS DE –S Kcal/kg	Total formula cost Euro / ton
Palm oil: FFA 5% MIU 1%	7.765	3,43%	537	3.249	267,3
Palm AOPHY FFA 90% MIU 3%	6.593	4,50%	375	3.249	263,2
The use of the co-product resulted in a formula cost decrease corresponding to about 1,5%					



Feeding Fats Safety



Comparison of feed formula costs with crude Soybean oil or ANFA in diets for chicken from 11 to 21/25 days (Prices of lipid supplements = prices of first 6 months of 2007)

	AME of crude soybean oil kcal/kg	% of inclusion	Average price of lipid supplements (first 6 months 2007) Euro / ton	Total formula energetic value ME kcal/kg	Total formula cost Euro / ton
Soybean oil : FFA : 2% MIU : 1% Soybean oil	8.963	4,12%	587	3.150	309,3
Animal Fat FFA: 5% MIU: 1,5%	7.924	5,09	418	3.150	304,3

The use of Animal Fat resulted in a formula cost decrease corresponding to about 1,6%



Feeding Fats Safety



TECHNICAL LIPIDS Produced from co-products

Co-products	AOFHY	AOCHE	ANFA
	↓	↓	↓
Technical lipids produced from co-products	FACS	FACS	FACS
	HYBY (totally hydrogenated lipids)	HYBY (totally hydrogenated lipids)	HYBY (totally hydrogenated lipids)
	Esterified oils (in MIX category)	Esterified oils (in MIX category)	Esterified fats (in MIX category)
	Mono-diglycerides (in MIX category)	Mono-diglycerides (in MIX category)	Mono-diglycerides (in MIX category)



Feeding Fats Safety



TECHNICAL LIPIDS Produced from co-products

They can be produced also from crude vegetable oils, but the
final price would be significantly higher



Feeding Fats Safety



PRICES COMPARISON CO-PRODUCT Vs VEGETABLE OILS

The co-product have competitive prices if compared with raw vegetable oils

Up to -40%

Vegetable oils	Average price 2006 Euro / ton	Average price first 6 months 2007 Euro / ton	Co-products	Average price 2006 Euro / ton	Average price first 6 months 2007 Euro / ton
Soybean oil	524	588	AOCHE / AOPHY from mixed seeds with min. iodine number 120	309	365
Palm oil	402	537	Palm AOCHE / AOPHY	333	375
Sunflower oil	534	599	AOCHE / AOPHY from mixed seeds (without iodine number indication)	292	350
GMO free soybean oil	544	608	Olive AOCHE /AOPHY	337	417
Coconut oil	522	659	Coconut AOCHE / AOPHY	330	380
			ANFA / Tallow (FFA from 1% to 4%)	377	438
			ANFA (FFA from 4% to 10%)	373	418
			FISH oil	581	630



Feeding Fats Safety



FACS Physiological functions

FACS	Animal species	Functions	Effects
	Ruminants	To make fatty acids rumen-by-pass and, consequently, usable in ruminants	<ul style="list-style-type: none"> - To increase diet energy - To increase milk yield - To prevent weight losses - To help cows regain weight lost in early lactation. - To enrich the meat or the milk with oleic acid, omega 3, CLA, which are useful for human health
	Single-stomached species	To transform oils / fats into powder , to be used, for example, in farms where, for logistical reasons, it is difficult to use liquid oils or fats	<ul style="list-style-type: none"> - To increase diet energy - To enrich animal meat with oleic acid, omega 3, CLA, in case unsaturated FACS rich in this fatty acids are used
	Ruminants and single-stomached species	To supply a CLA source in powder form.	<ul style="list-style-type: none"> - To reduce body fat and produce healthier meat - To prevent weight loss, weight gain reduction and anorexia due to immune stimulation after vaccinations



Feeding Fats Safety



HYBY- Total Hydrogenation Physiological functions

HYBY	Animal species	Functions	Effects
	Ruminants	<p>To make lipid supplements rumen-by-pass and consequently usable in ruminants</p> <p>To protect amino-acids against rumen bacteria and to perform a slow release of them in the intestine</p> <p>To protect essential oils, organic and short chain fatty acids during the transit through the rumen;</p>	<ul style="list-style-type: none"> - To increase diet energy - To increase amino-acids availability and, consequently, the performance - To improve gut health by modulating intestinal micro-flora, performing anti-bacterial effect, stimulating villi development
	Single-stomached species	<p>To protect amino-acid performing their slow release in the gut</p> <p>To protect essential oils, organic and short chain fatty against a quick absorption, performing their slow release in the gut</p>	<ul style="list-style-type: none"> - To increase proteins digestibility and, consequently, the performance - To improve gut health by modulating intestinal micro-flora, performing anti-bacterial effect, stimulating villi development
	Specifically referred to Pigs	<p>To supply a complete saturated dietary lipid supplement</p>	<ul style="list-style-type: none"> - To reduce poly-unsaturated fraction of pigs deposit fat as required for ham production



Feeding Fats Safety



MONO- and DIGLYCERIDES (MIX) Physiological functions

Mono- and diglycerides (in MIX category)	Animal species	Functions	Effects
	Single-stomached species	Emulsifying action	<ul style="list-style-type: none"> - To enhance micelles formation, improving oils / fats digestibility
	Specifically for calves and piglets	Emulsifying action	<ul style="list-style-type: none"> - To emulsify the lipid fraction of powder milk-replacer during mixing in water (powder milk is in fact dissolved in water to obtain a nutritive liquid "artificial" milk for young animals)



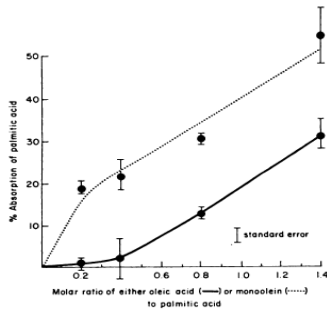
Feeding Fats Safety



MONO- and DIGLYCERIDES (MIX) Physiological functions

In the study of R.L. Garrett - R.J. Young "Effect of Micelle Formation on the Absorption of Neutral Fat and Fatty Acids by the Chicken" Journal of Nutrition - 1974

the efficacy of oleic and linoleic acid in enhancing palmitic acid absorption has been compared with that of monoglycerides of oleic acid (mono-oleins) and of linoleic acid (mono-linoleins)



Lipid mixture	In vivo absorption %	
	Monoglyceride	Palmitic acid
Palmitic acid (P)		-3 +/- 3,6
1-Monoolein + P ⁽¹⁾	99 +/- 2,5	28 +/- 3,1
2-Monoolein + P ⁽¹⁾	100 +/- 1,2	24 +/- 0,7
1-Monolinolein + P ⁽¹⁾	96 +/- 0,7	24 +/- 1,0

⁽¹⁾ Molar ratio of monoglyceride to palmitic acid 0.8:1

⁽²⁾ Mean \pm SE of three individually caged cockerets with ligated pancreatic ducts.



Feeding Fats Safety



ESTERIFIED OILS (MIX) Physiological functions

ESTERIFIED OILS (in MIX category)	Animal species	Functions	Effects
	Single-stomached species	Lipid supplement with energetic value equivalent to that of crude oils, with economical advantages	- To increase diets energetic value
	Specifically for piglets	To supply a randomized oil with an amount of palmitic acid in position 2 of the triglyceride.	- To improve metabolic functions and growth performance of piglets



Feeding Fats Safety



ESTERIFIED OILS (MIX) Physiological functions

Sows milk fatty acids contain 20-30% palmitic acid, of which approximately 70% is bound to the sn-2 position of the milk triacylglycerol. In the study of Sheila M. Innis and others: *"Formula containing randomised fats with palmitic acid (16:0) in the 2-Position increases in the 2-position of plasma and chylomicron triglyceride in Formula-fed piglets to levels approaching those of piglets fed Sow's milk"* - Journal of Nutrition 1997 - it was demonstrated that randomized oils with palmitic acid in pos.2 can significantly improve the health status and the performance in piglets if compared with non-randomized oils

**Growth performance results at 18 days of piglet fed
randomised or non randomised lipid supplement**

	Co-randomized palm olein and canola oil	Native canola + palm oil	Delta
Weight gain / kg	0,214	0,192	+ 11%



Feeding Fats Safety



POSSIBLE SCENARIO

➤ Short term : vegetable oils stocks decrease and price increase

➤ Long term:

- - increase of vegetable oils refining plants because of increase of demand for renewable energy resources → increase of co-products availability
- - decrease of cereals availability because of increase of demand for renewable energy resources → lack of energetic sources in the diets

It makes sense to consider co-products as an important nutritional energy source in feedstuff



WP 6

5) Evaluation of the costs of introduction of suitable technology changes in the process of obtaining and refining of these co-products, in order to improve the contamination/degradation characteristics of each fatty substance



DEGRADATION CHARACTERISTICS Table of costs for OXIDATION improvement

Co-product	Origin of co-products	Causes of oxidation	Methods to avoid degradation	Costs for technological improvements
AOCHE AOPHY	Olive Vegetable and tropical oils	Natural antioxidants prevent oxidation Oxidation was low in analysed samples The main causes of oils oxidation in general are: Silos / reactors, piping in iron No vacuum Pumps without hermetic seal which causes air insufflations	Use of storage silos, piping, reactors (of crude oil and of AOCHE) In stainless steel AISI 304. Use of vacuum in all processing steps, where possible Pumps with hermetic seal	Not needed The cost of equipment in stainless is considerably higher than the cost of the same equipment in iron. For example, in Italy a 100 ton storage silo in Iron has an average cost of 40.000 Euros, while the cost for AISI 304 version is 55.000 Euros It has to be considered that AISI 304 is not corroded through; iron is rapidly corroded through FFA. Considering the difference in equipment duration and the consequent amortization, we can conclude that the equipment extra-cost referred per ton of product is negligible
ANFA		Meat and bones are not conserved with a perfect cold chain system	Improve cold chain system	



Feeding Fats Safety



DEGRADATION CHARACTERISTICS Table of costs for OXIDATION improvement

Co-product	Origin of co-products	Causes of oxidation	Methods to avoid degradation	Costs for technological improvements
LECI	Vegetable oils	The main use of lecithin is the production of pharmaceutical, cosmetic and industrial products. Before to be used in these applications, lecithin has to be refined/processed, the starting oxidation level is not a negative characteristic for industrial application. So it is difficult to suggest the introduction of special methods for the very limited quantities used in animal feeds.	Refining	Not needed 100 Euro / ton
FISH (oil)	Fish	Oxidation levels were high in analysed samples. Oxidation risks are similar to ANFA category, at a higher extent, due to the high content of oxidable poli-unsaturated fatty acids , and due to the fact that fish oil is produced from waste fish tissue that, in many cases are not stored in correct conditions.	Due to the high oxidation levels, fish oil for animal nutrition should be semi-refined or refined	100 – 120 Euros / ton



Feeding Fats Safety



DEGRADATION CHARACTERISTICS ISOMERIZATION (TRANS FA) improvement

The isomerization (**TRANS FATTY ACIDS**) of oils and fats is mainly due to the following processes:

- * deodorization
- * hydrogenation

and depends also on the unsaturation degree of the lipids.



Feeding Fats Safety



DEGRADATION CHARACTERISTICS ISOMERIZATION (TRANS FA) improvement

Deodorization

Trans amount increases directly proportionally:

- to **temperature** increase, which can be included in a range of 204 – 230°C.
- the **duration** can range from 1 to 4 hours; the general industrial

deodorization conditions are: 230°C and 2 hours.

According to the study “**Deodorization of vegetable oils: prediction of trans Polyunsaturated fatty acid content**” (Z. Kemény and others – AOCS Press – 2001 – n° 9, vol 78) linolenic acid was the most sensible to isomerization into trans fatty acids. Depending on fatty acid composition of lipids, it is possible to predict (and to reduce) the trans fatty acid content in oils due to deodorization.



Feeding Fats Safety



DEGRADATION CHARACTERISTICS ISOMERIZATION (TRANS FA) improvement

Oil type	Deodorizer	Temp (°C)	Time (h)	DI (%) (C18:2)		DI(%) (C18:3)	
				Ind.	Theo.	Ind.	Theo.
Sunflower	A	200	1.5	0.06	0.04	–	–
Sunflower	A	210	2.0	0.14	0.11	–	–
Sunflower	A	227	1.5	0.24	0.28	–	–
Sunflower	B	223	2.0	0.24	0.28	–	–
Sunflower	B	223	2.0	0.23	0.28	–	–
Sunflower	B	225	3.5	0.73	0.57	–	–
Sunflower	C	223	2.0	0.24	0.28	–	–
Sunflower	D	222	2.0	1.01	0.26	–	–
Sunflower	D	225	2.0	1.15	0.33	–	–
Sunflower	E	238	1.5	0.76	0.62	–	–
Sunflower	E	240	1.5	0.91	0.72	–	–
Canola	B	215	2.0	0.40	0.15	1.93	3.23
Canola	B	220	3.5	0.37	0.39	6.04	7.64
Canola	C	200	2.0	0.00	0.05	0.73	1.18
Canola	C	226	2.0	0.21	0.35	5.10	6.43
Canola	F	243	2.0	1.30	1.17	18.52	17.04
Canola	F	246	2.0	1.69	1.43	20.82	19.96
Soy	C	210	2.0	0.09	0.11	1.57	2.33
Soy	C	226	2.0	0.37	0.35	5.50	6.43
Soy	C	227	2.0	0.33	0.38	5.70	6.83
Soy	D	225	2.0	1.50	0.33	20.70	6.05



Feeding Fats Safety



CONTAMINATION CHARACTERISTICS ISOMERIZATION (TRANS FA) improvement

Partial Hydrogenation

- HYBY samples showed the highest values of trans FA.
- During hydrogenation, fatty acids double bonds are opened forming an **adduct with nickel**.
- Not all the unsaturated fatty acids are saturated
- So, the adduct is broken and the fatty acids re-forms a double bond.
- The unwanted trans fatty acid form is thermodynamically favoured.
- **These degradation products can not be avoided during partial hydrogenation.**
- **This consideration does not concern totally hydrogenated lipids.**

Suggestion: to avoid partially hydrogenated lipids in animal nutrition



Feeding Fats Safety



DEGRADATION CHARACTERISTICS Table of costs for PHA improvement

Co-product	Origin of contamination	Methods to avoid contamination	Actual situation in the Industry	Methods to remove contaminants from co-products	Costs for contaminants removing process
AOCHE and AOPHY	Drying of seeds / nuts / through direct flame before oils extraction process	Drying materials avoiding contact with exhaust. Use indirect heated air flow	The general trend is to replace the direct flame process with hot air drying	Filtration using 1 – 3% of active carbons	From 10 to 20 Euros / ton. This cost has been estimated considering the usual filtration costs in oil processing industry including the extra-costs of active carbons



Feeding Fats Safety



FINAL REMARKS

* comparison of costs of iso-energetic formulas containing co-products or conventional oils

* not only dietary energetic sources such as conventional oils and fats, but also cereals are used in increasing amounts for bio-fuels production, causing increasing oils prices

the use of co-products such as vegetable AOCHE, AOPHY and ANFA are economically interesting alternatives for feed and meat producers if compared with conventional oils such as soybean and palm oil



Feeding Fats Safety



FINAL REMARKS

the costs for the introduction of:

* good manufacturing practices

* technological changes to avoid / reduce

- degradation (Oxidation / Trans fatty acids during deodorization)

- contamination compounds: PAH, when necessary.

are in general moderate and in some cases the implementation of a good manufacturing practice only is enough to solve the problem.

it makes sense to spend efforts to optimise the use of safe fatty co-products as dietary energy sources in animal nutrition.



FINAL REMARKS

Technical lipid such as FACS, HYBY (intended as totally hydrogenated lipids) and MIX (intended as monoglycerides, diglycerides and esterified lipids), according to international scientific publications that they meet special physiological or logistical requirements, which in certain situations, could not be fulfilled neither by crude / refined conventional oils/fats nor by un-transformed co-products.

Technical lipids can be produced using crude, refined oils/fats or co-products with significant differences in costs, depending on the initial raw materials.

The price of co-products in the first 6 months of 2007 resulted to be 30 to 43% lower than of crude oils, from which they derive. So, if technical lipids are produced from co-products instead of from crude oils/fats, the processing costs are compensated by lower raw materials cost and the products' final price can be lower for feed and meat producers and finally the consumers.