LE UNIVERSITÀ PER EXPO 2015
COMITATO SCIENTIFICO DEL COMUNE DI MILANO

Milano

EXPO 2015
I *botanicals* per la nutrizione e la salute: dal protocollo di Nagoya alla cooperazione internazionale
WORKSHOP SU INTEGRATORI ALIMENTARI
***Milano*, 13. Luglio 2015**

INSTITUT FÜR ANGEWANDTE BOTANIK

vetmeduni vienna

Herbal Medicinal Products and Feed Additives in Veterinary Medicine and Animal Nutrition

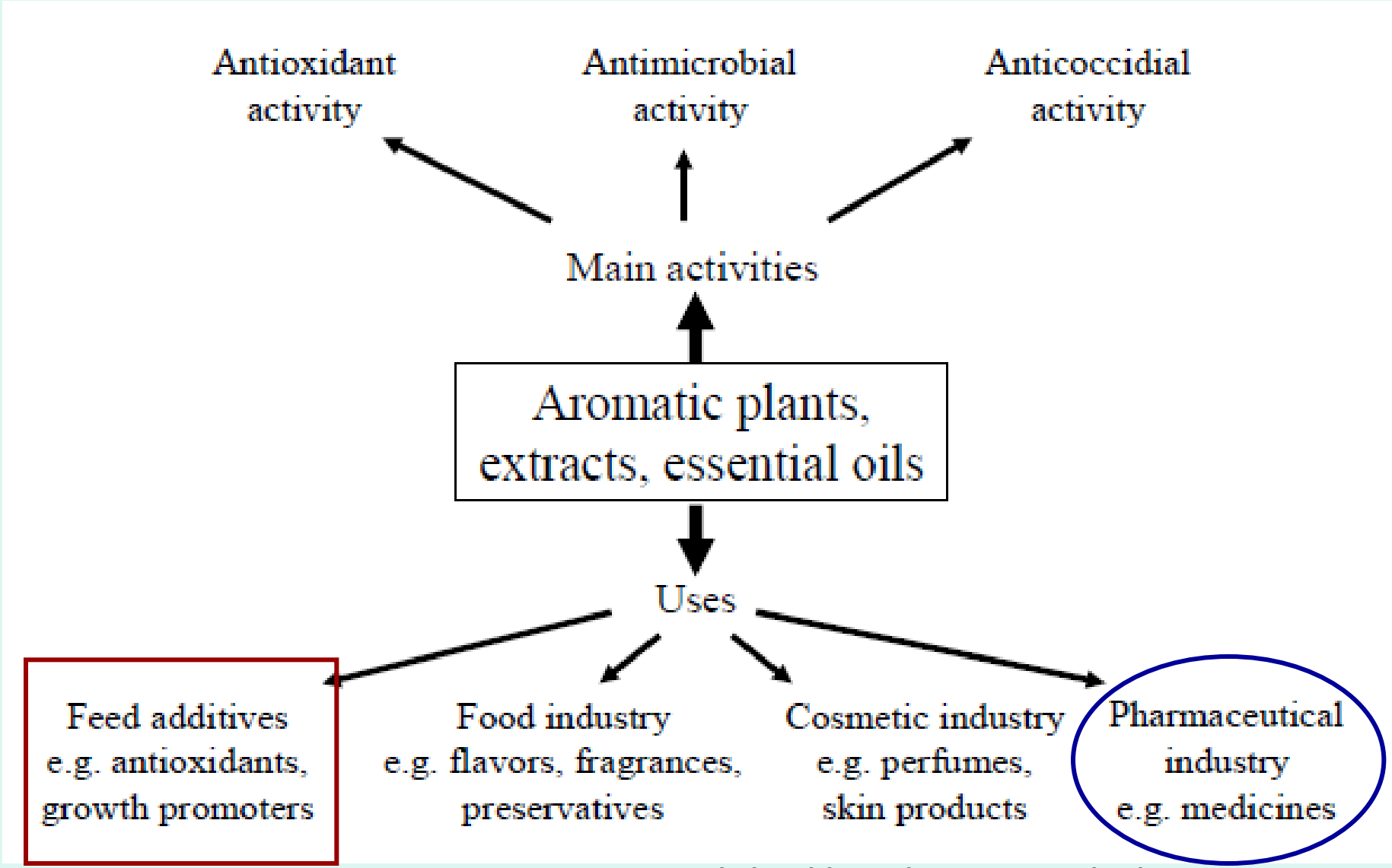
I botanicals nella medicina veterinaria e nell'alimentazione animale

Prof.em. Ch. FRANZ, Univ. of Veterinary Medicine Vienna

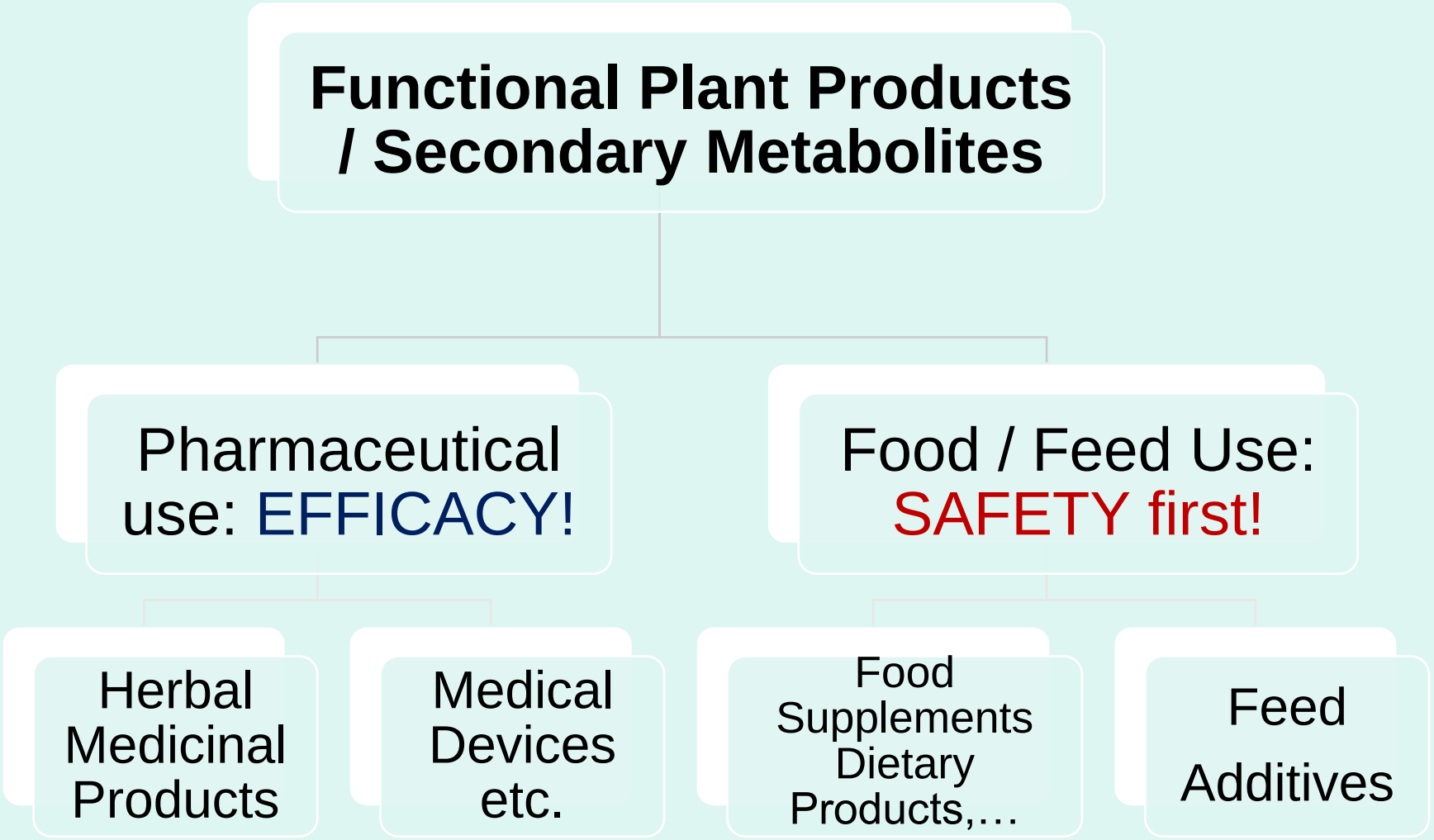




Activity, use and application of Functional Plant Products



Christaki et al., 2012 Agriculture 2 228-243


Functional Plant Products / Secondary Metabolites
Pharmaceutical use: EFFICACY!
Food / Feed Use: SAFETY first!
Herbal Medicinal Products
Medical Devices etc.
Food Supplements Dietary Products,…
Feed Additives

Feed Additives / Integrators

Regulation (EU) 1831/2003

Directive (EU) 834/2007, 889/2008

Guideline (EU) 429/2008

Medicinal Products

Guideline 2004/28/EU (Community Codex Veterinary Drugs)

Directive (EU) 726/2004 (Human- & Veterinary Medicinal Products)

Directive (EU) 834/2007, 889/2008

(Organic Production)

Farm Animals

Dir. (EU) 2377/90 (MRL-Values)

Dir. (EU) 834/2007 and 889/2008

(Organic Production)

Horses and Companion Animals

(Feed Additives: also EFSA responsible!)

Table 1. Most commonly used herbs and essential oils in traditional animal health care and livestock production in Austria and neighbouring countries

Latin name	Common name	Parts/products used
Achillea millefolium s.l.	Yarrow	Infusion
Arnica montana	Arnica	Extract
Boswellia sacra	Frankincense	Resin
Carum carvi	Caraway	Seed, essential oil
Citrus sp.	Citrus oil	Essential oil
Curcuma longa	Curcuma	Rhizome
Foeniculum vulgare	Fennel	Seed
Matricaria recutita	Camomile	Infusion, essential oil
Mentha sp.	Mint	Infusion, essential oil
Pimpinella anisum	Aniseed	Seed, essential oil
Pinus sp.	Turpentine	Essential oil, (oleo)resin
Salvia officinalis	Sage	Infusion, essential oil
Syzygium aromaticum	Cloves	Buds, essential oil
Zingiber officinale	Ginger	Rhizome

Modified after Zitterl-Eglseer *et al.*[2]

Franz et al. 2010, FFJ 25, 327

Herbal Medicinal Products in Veterinary Medicine

- ~ 20 registered products in Austria
- ~ 30 registered products in Switzerland
- ~ 30 registered products in Germany
- ? In other countries ?

- Alternative products:
- dietetics, integrators, appetizers, ‚cosmetics', ‚…health care products' etc. …. =„parafarmaceutics"

Survey on Herbal Medicinal Products and Feed Additives / Dietary Products for Animals in Austria

(MSc Theses Vetmeduni Vienna 2012)

Species	HMPs	Feed Additives
Calendula officinalis	3	-
Crataegus oxyacantha	- (!)	2
Cynara scolymus/	-	5
Echinacea sp.	3	3
Harpagophytum procumbens	- (!)	4
Hypericum perforatum	- (!)	4
Matricaria recutita	2	5
Panax ginseng	1	3
Silybum marianum	- (!)	4
Thymus vulgare	-	6
Valeriana officinalis	- (!)	4
Zingiber officinale	-	3

Medicinal plants traditionally used to treat different disturbances of ruminants

Plant species	D	H/C	M	R	S	U	G
Pimp. anisum			+	++			++
Arnica mont.	++	(+)		(+)	(+)		(+)
Althaea off.	+	++	+	++	(+)	(+)	++
Quercus robur	++		+	+		++	++
Gentiana lutea	(+)	(+)	(+)	(+)		(+)	++
Foenicul. vulg.	(+)	(+)	+	++	+	(+)	++
Vacc. myrtillus						(+)	++

D:skin, H/C:.heart/circulation, M:mamma/udder, R:respiratory tract,
S: sensory organs, U: urogenital tract, G: gastrointestinal tract

- *Laudato M, Capasso R.:*
  Useful plants for animal therapy.
  OA Alternative Medicine 2013, Feb. 01; 1(1)1. OA Publ. London
- „…in this paper we have reviewed the herbal drugs most commonly utilized in domestic animals.“
- Cardiovascular system; Skin; Helminthiasis; Digestive apparatus; Respiratory app.; Reproductive app.; Additional uses (mastitis, milk production; Dogs and Cats: antiinflamm., anxiety, immunostimulants,…)
- 45 plant species mentioned, from *Allium sativum* to *Zingiber officinale,*
- 29 literature citations

Functional Products from Officinal Plants used in Veterinary Medicine

- **Companion Animals and Horses**
- **Tendency towards natural products in complementary medicine**

- **Farm Animals / Animal Fattening**
- Crisis of the food industry: mismanagement within the mass propagation of animals

Influence of the pumpkin seed extract on hyperplasia benigna of (male) dog prostate

Dog-Race	Age (years)	Weight (kg)	Main symptomes	Start-dose (x tabl./day)	After x month [dose]	Improvement after x weeks
Bernese mountain	5,5	45	blood in ejaculate	1	2 [1/week]	**4**
Bernese mountain	5,5	45	blood in ejaculate	1	2 [1/week]	**4**
Groenendal	3	25	micturition + defecation diffucult	1	-	**6**
Bernese mountain	6,8	58	blood in urine	1	3 [2/day]	**4**
Basset	7	28	blood after ejaculation	1	1 [2/day]	**12**
Wire-haired dachshund	11,5	9,5	blood after ejaculation	1	5 [2/day]	**4**
Wire-haired dachshund	7,5	9,5	blood after ejaculation	1	5 [2/day]	**4**
Beagle	5	5	blood after ejaculation	2	-	**12**

High compliance since symptom improvement was noticed after 1 – 3(!) months

(Schäfer-Somi et al. 2004)

Improvement of the lung function of horses suffering RAO/COPD by treatment with a botanical preparation (HMP)

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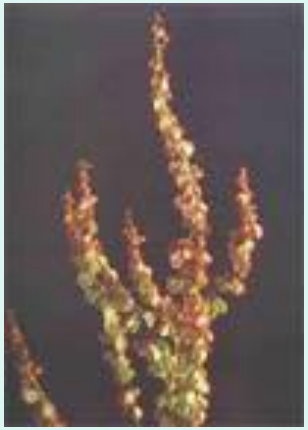
Primula veris L.

Sambucus nigra L.

Verbena officinalis L.

Gentiana lutea L.



Rumex acetosa L.

Anour, Leinker, van den Hoven; Veterinary Record (2005) 157, 733-736

Improvement of the lung function of horses suffering RAO/COPD by treatment with a botanical preparation (HMP)

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- 9 horses with RAO (recurrent airway obstruction) (=COPD)
- 2 groups (group 1: 2 x 15 tbl. Sinupret® forte;
- group 2: untreated)
- treatment for 14 days, then cross-over
- Histamin-challenge-test
- clinical examination, pulmonary function, blood, broncho-alveolar-lavage-fluid (BALF)

Anour, Leinker, van den Hoven; Veterinary Record (2005) 157, 733-736

Improvement of the pulmonar function of horses suffering RAO after treatment with Sinupret®

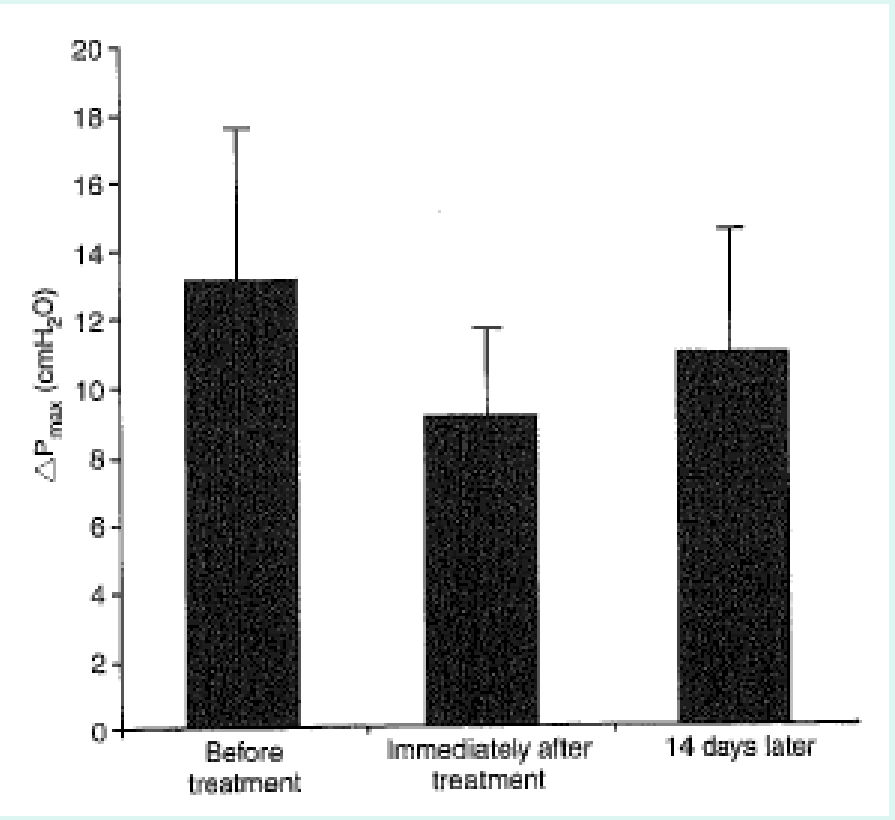
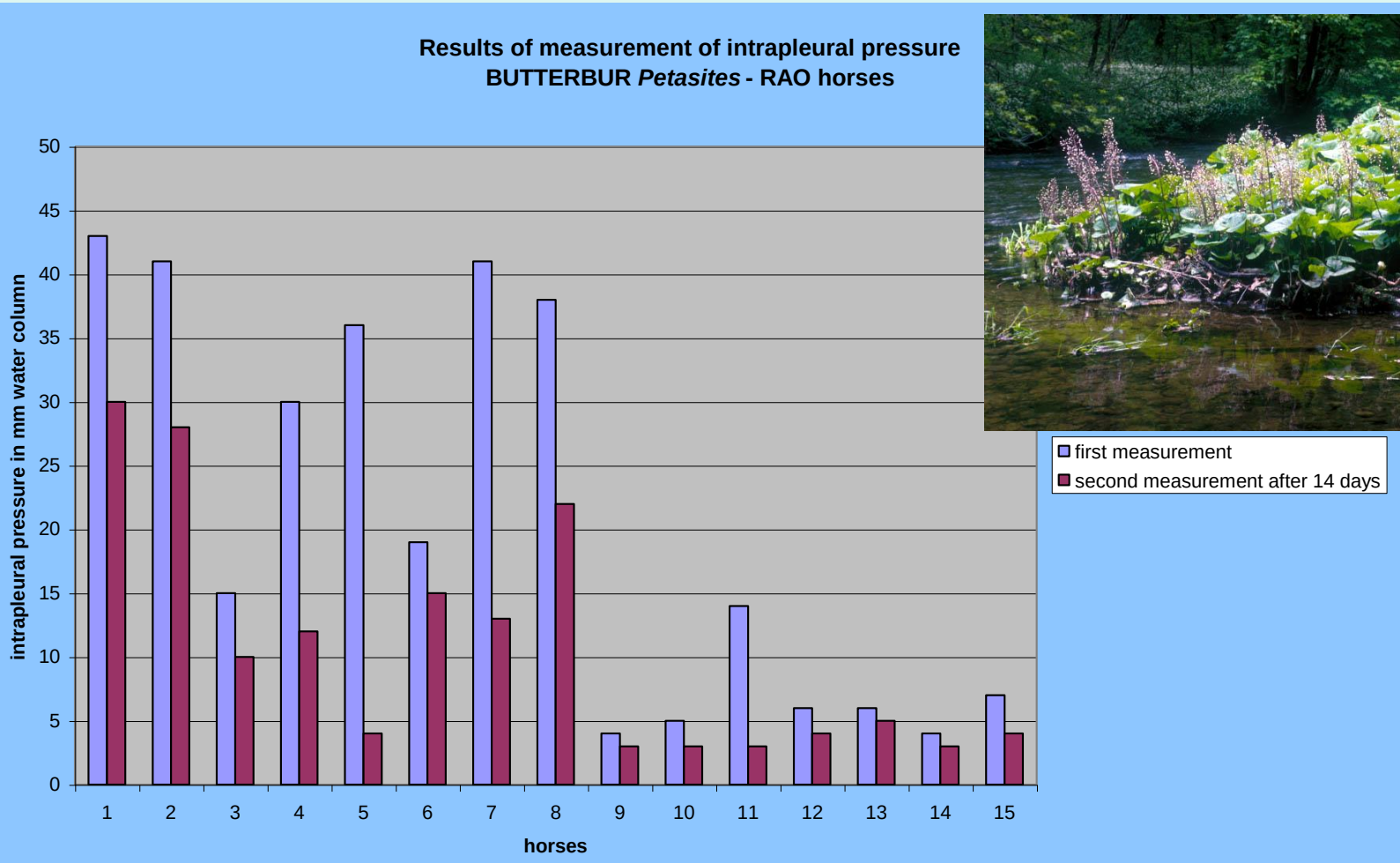


Figure 1: Mean (sd) maximal intrapleural pressure difference ΔP_{max} of five horses (group 1) before treatment with the botanical preparation, immediately after 14 days´ treatment, and 14 days later

Anour, Leinker, van den Hoven; Veterinary Record (2005) 157, 733-736

Treatment of horses suffering from RAO (COPD) with a *Petasites hybridus* extract (Ze 339)

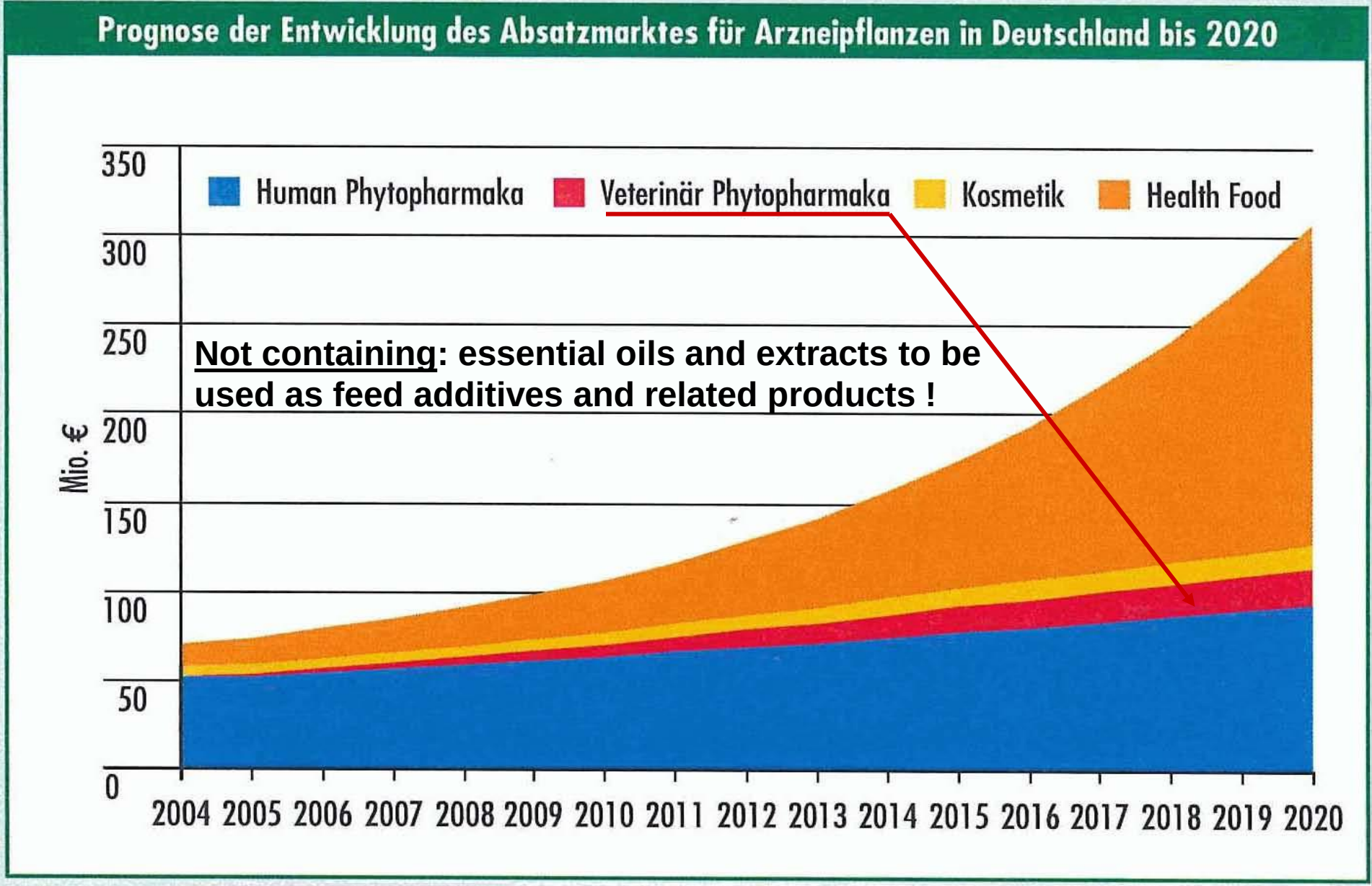
dosage: 25 tabl./d = 200 mg petasin/d



Rhizomes:

Petasines,
antiallergic,
spasmolytic,
analgesic

M. Kopp et al., Vet.-med. Univ. Vienna, unpubl.



Market development forcast for products on basis of medicinal and aromatic plants in Germany until 2020

Change of Paradigm in (Human and) Animal Nutrition

- until 1980ies: nutritive value (carbohydrates, fats/fatty acids, proteins/amino acids), ***reduction of anti-nutritive substances as e.g. tannins, essential oils and other secondary metabolites***

- followed by undigestible fiber, vitamins and minerals

- **last 20 years: functional plant products (secondary metabolites) with non-nutritive *additional* value / benefit!**

Functional Plant Products in Animal Health and Nutrition in Europe

- ***Crisis in food industry due to strange and negative developments in large scale livestock farming:***

- *unsuitable animal feed (resulting e.g. in BSE)*
- *antibiotic feed additives/growth promoters (resulting in resistances) (→ banned since 01.01.2006)*
- *illegal use of remedies (drug residues in food chain)*

Reason: economic constraints

quantitative performance in production
Pressure to reduce production costs

- ***Consumer expectations:*** *safe and healthy food!*

Functional Plant Products in Veterinary Medicine and Animal Nutrition

- **Solutions:**
- **Ban of Antibiotics as growth promotors (since 01.01.2006)**

- ***Substitutes?*** *Organic Acids, Probiotics,* ***Phytogenic Additives***
- ***Notification in accordance with Reg. EU 1831/2003: more than 800 plant extracts and essential oils!?***

- **Organic/Ecologic Production**, EU-Directive 2092/91 & 1804/99 **„...Phytotherapeutics (Herbal Medicinal Products) have to be applied preferably instead of synthetic farmaceuticals...“**

- ***But what's about disponibility of respective registered products???***

Solutions:

Substitutes of in-feed antibiotics and synthetic drugs?

Functional Plant Products as Feed Additives

- ***Phytogenics***
- Phytobiotics
- Phytochemicals
- Botanicals

Functional Groups of Additives / Integrators according to Annex I Reg. (EG) 1831/2003

1. *Technological Additives*
- Preservants
- Antioxidants

2. ***Sensorial Additives***

   Colorants
- **Flavourings (In this group almost all plant based products had been ‚notified'!)**

3. *Nutritive / Physiological Additives*
- Vitamins and „chemically defined substances" of similar activity

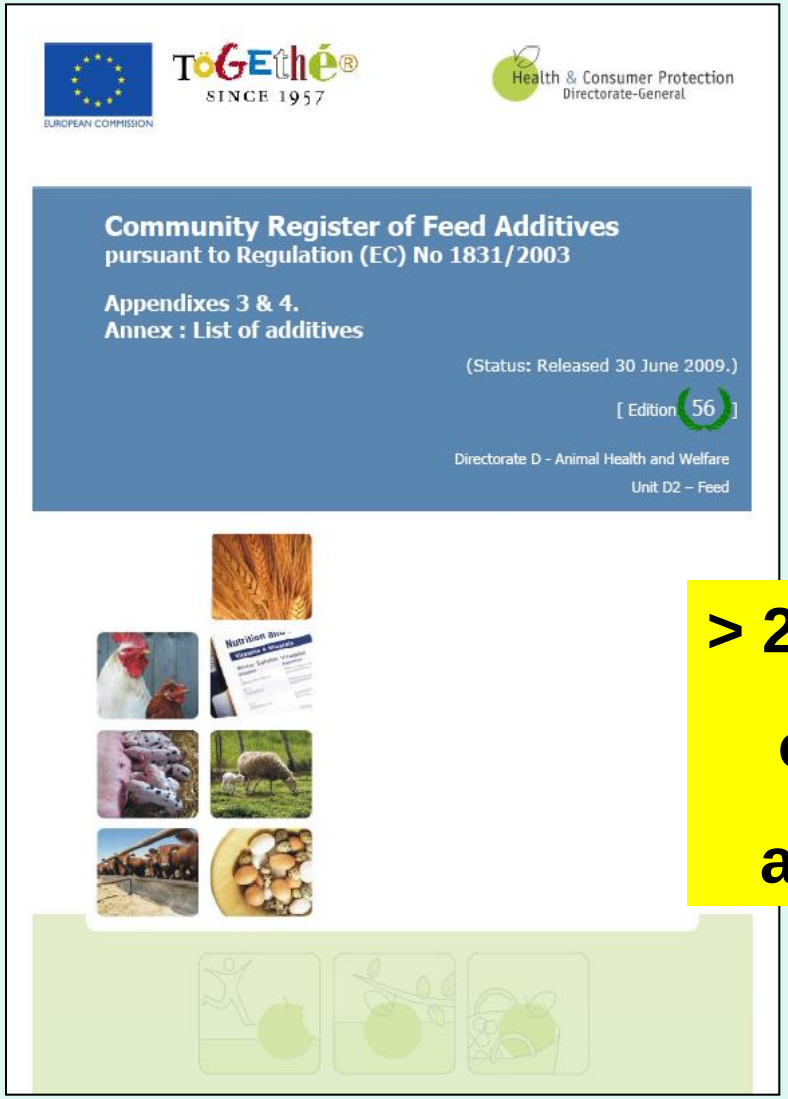
4. ***Zootechnical Additives***

   Digestion Promoters
- (very few registered products until now: e.g. ‚FRESTA f')
- Stabilizators of a ‚convenient' intestinal flora
- Other zootechnical additives

5. *Coccidiostatics, Histomonostatics*

Essential oils and plant extracts in animal nutrition

Community Register of Feed Additives pursuant to Regulation (EC) No 1831/2003



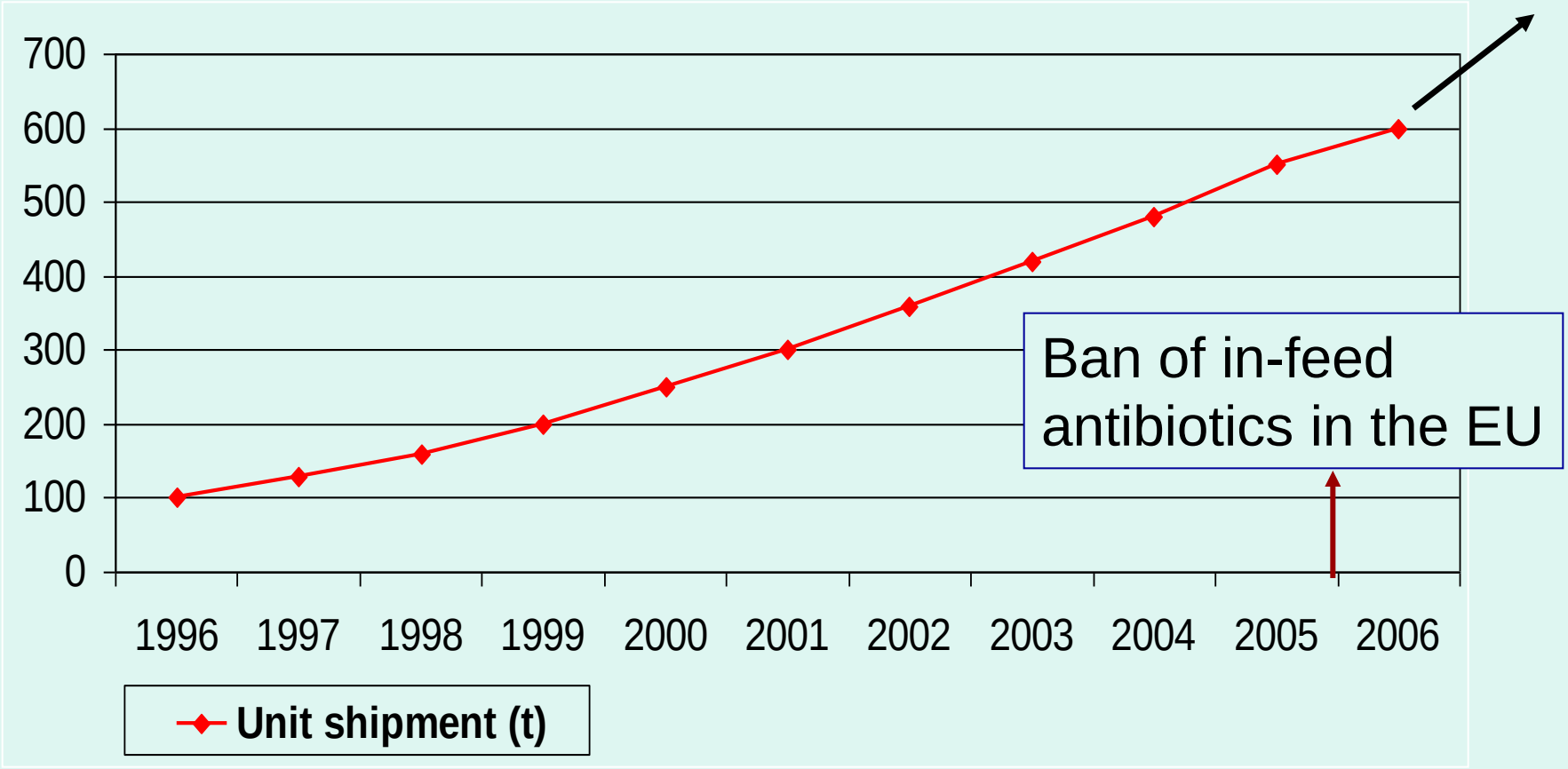
208th edition: published on 06 May 2015

> 200 Notifications of Plant Extracts and Essential Oils

http://ec.europa.eu/food/food/animalnutrition/feedadditives/comm_register_feed_additives_1831-03.pdf

Total EU market and forecasts for essential oils as feed additives

Nutrition of farm animals



- H. Greathead, Proc. Nutr. Soc.2003, 62, 279-290

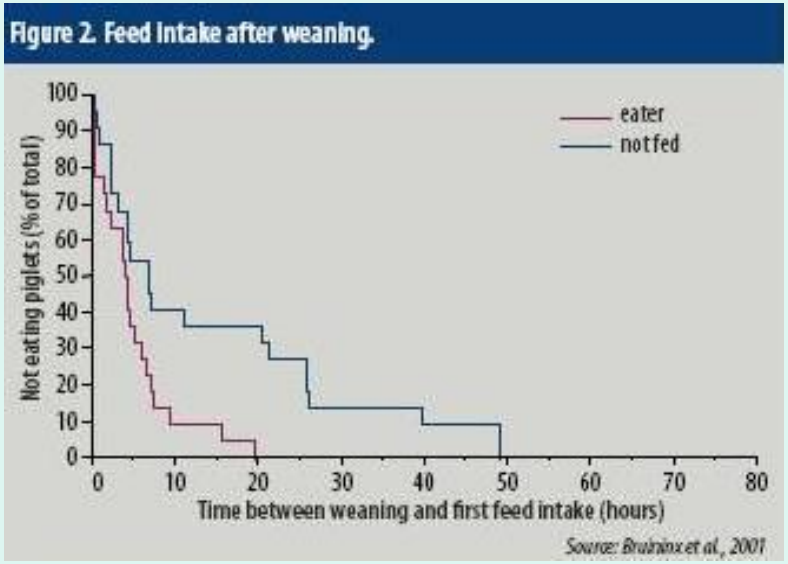
Claims of ‚Phytogenics' as Feed Additives

- **Claim 1: Improving feed flavour, palatability and feed shelf life**
- **Claim 2: Improving ‚performance'**
- **Claim 3: Antimicrobial activity**
- **Claim 4: Antioxidant activity, incl. products**
- **Claim 5: Anti-methanogenic and N-excretion reducing in ruminants**
- **Claim 6: further beneficial effect on animal physiology, e.g. health status, stable odour…**

W. Windisch, PL 38th ISEO 2007 Graz, modified and enlarged

Claim 1: Feed Flavourings and Palatability

- ***Adding of flavourings in feeding stuffs improves feed smell/taste and/or palatability in order to:***
  - ***Cover/mask variations in taste and smell caused by formulation changes***
  - ***Mask the taste of unpalatable raw materials or additives***
  - ***Improve early feed intake in young animals after weaning***
  - ***Brand differentiation of feeds, addiction effects, conditioning (!)***



FFAC discussion paper 2014, modified

Specific safety issues

FEEDAP: 109th Plenary Meeting (27-29 January 2015):

"A discussion took place regarding the presence of substances with genotoxic-carcinogenic properties, like ***estragole*** *and methyl* ***eugenol,*** *in feed additives. These substances are components of essential oils of botanical origin, like star anise oil and clove oil. The Panel stated that the intentional addition of such substances to the food chain via feed additives is not acceptable. This applies independently from the origin of the substances (chemical synthesis or botanical origin)."*

Plants of concern ?

- Impact of EFSA statement on botanical flavourings

~ 30% of botanicals are affected, some examples

Dossier	Plant	Additive	Substance	%
BDG01	Ocimum basilicum	Basil oil	Estragole Methyl eugenol	10 – 90 0 – 2.5
BDG02	Pimpinella anisum	Anise oil	Estragole	0 – 10
BDG02	Illicium verum	Anise star tincture	Estragole	0 – 6
BDG02	Foeniculum vulgare	Fennel tincture	Estragole	0 – 7
BDG04	Artemisia dracunculus	Tarragon oil	Estragole	70 – 90
BDG06	Laurus nobilis	Laurel leaves extract/oleoresin	Methyl eugenol	0 – 3
BDG06	Cananga odorata	Ylang-ylang oil	Methyl eugenol	0 – 2
BDG07	Pimenta racemosa	Bay oil	Methyl eugenol	1 – 3
BDG07	Pimenta dioica	Allspice oil	Methyl eugenol	2 – 10

Claim 2: Improving animal performance

- ***Studies on the effects of essential-oil-based feed additives on performance, ileal nutrient digestibility and selected bacterial groups in the gastrointestinal tract of piglets.***
  Maenner, K. et al., J. Animal Sci. 89, 2106-2012 (2011): „…the effectiveness of ess. oil mixtures as feed additives differs considerably depending on the constituents…“
- ***Effects of oregano essential oil with or without feed enzymes on growth, performance, digestive enzyme, nutrient digestibility, lipid metabolism and immune response of broilers fed on wheat-soybean meal diets.***
  Malayoglu, H.B. et al., Brit. Poultry Sci. 51, 67-80 (2010): „…essential oil at 250 mg/kg or 500 mg/kg feed had higher weight gain and better digestibility, espec. in combination with enzymes…“
- ***Effects of a phytogenic feed additive on growth performance and ileal nutrient digestibility in broiler chickens.***
  Arnaad A. A. et al., Poult. Sci. 90, 2811-2816 (2011): „…the digestibility of the nutrients was significantly higher in birds fed with PFAs…“ (?)

Table 6. Effect of aromatic herbs and essential oils as feed additives on the performance in poultry

Animals/feed additives	Dietary dose (g/kg)	Treatment effects (% difference to untreated control)				References
		Feed intake	Body weight	Daily weight gain	Feed conversion rate	
BROILERS						
Essential oils						
Anis	0.15	−1	+1		−1	Mayland-Quellhorst[29]
Carvacrol	0.2	+2		+2	−1	Lee *et al.*[30]
Cinnamaldehyde	0.1	−2		−3	0	Lee *et al.*[30]
Cinnamon	0.1	−4	−3		−1	Wald[31]
Clove leaf	0.1	−3	−4		+1	Wald[31]
Lemongrass	0.1	+1	−1		+2	Wald[31]
Oregano	0.15/0.3	−6/−3		−2/+1	−4/−2	Basmacioglu *et al.*[32]
Oregano	0.1/1.0	−1/+3	+8/+6		−9/−3	Halle *et al.*[33]
Oregano	0.1	−2	−1		−1	Wald[31]
Peppermint	0.1	−3	−2		−1	Wald[31]
Rosemary	0.15/0.3	0/−2		−1/+1	−1/−4	Basmacioglu *et al.*[32]
Thymol	0.1/0.2	+1/−5		+1/−3	−1/−3	Lee *et al.*[30]
Essential oil blend	0.024/0.048	−4/−5	0/0		−4/−6	Cabuk *et al.*[34]
Essential oil blend	0.075/0.15	−7/−7		−3/−1	−4/−1	Basmacioglu *et al.*[32]
Essential oil blend	0.036/0.048	+3/+2	−8/−8		−5/−4	Alcicek *et al.*[36]
Essential oil blend	0.024/0.048	−2/0	0/+14		−2/−12	Alcicek *et al.*[35]
Essential oil blend	1.0	−7	−3		−4	Halle *et al.*[37]
Essential oil blend		+2		0	+2	Westendarp *et al.*[38]
Aromatic herbs						
Garlic	1.0	−5	−5		0	Sarica *et al.*[39]
Oregano	5.0	+5		+7	−2	Florou-Paneri *et al.*[40]
Thyme	1.0	+1	+2		−1	Sarica *et al.*[39]
Thyme	1.0/10	0/−1	−3/−5	−2/−4	+3/+6	Haselmeyer[41]
Hops	0.25	+2	+5	+4	−3	Cornelison *et al.*[42]
TURKEYS						
Aromatic herbs						
Oregano	1.25	−5	+2			Bampidis *et al.*[43]
Oregano	2.5	−6	+1			Bampidis *et al.*[43]

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Peppermint	0.1	−3	−2		−1	Wald[31]
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Thymol	0.1/0.2	+1/−5		+1/−3	−1/−3	Lee *et al.*[30]
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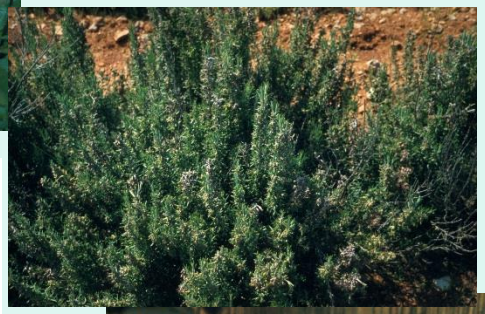
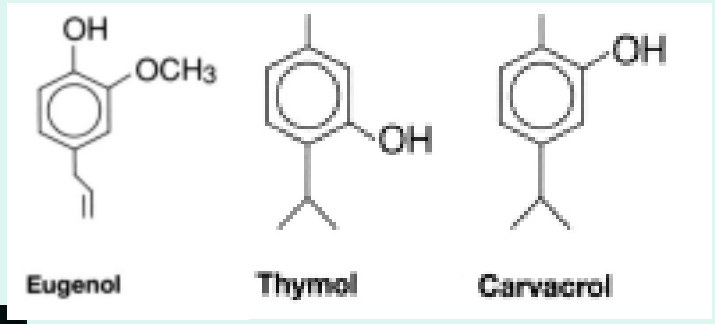
Feed conversion ratio improved by 2 – 4 %

Claim 3 and 4: Antimicrobial and antioxidant activity

- ***Essential Oils / Components***:





Requirements of the European Commission :

Reduction of the use of antibiotics in veterinary medicine and animal nutrition …to avoid resistances!

impro

safewastes

Replacing Antibiotics in Animal Feed

Minimum inhibitory concentration (MIC) of several essential oils and some compounds on selected microorganisms (in µL/mL)

(Pauli 1994, Deans 2000, Burt 2004, Penalver et al. 2005)

	Escherichia coli	*Salmonella typhimurium*	*Staphylococcus aureus*	*Listeria monocytogenes*	*Bacillus cereus*
Rosemary	4,5-10,0	>20,0	0,4-10,0	0,2	0,2
Sage	3,5-5	10-20	0,75-10	0,2	
Oregano	0,5-1,2	1,2	0,5-1,2		
Thyme	0,4-1,2	0,45-20	0,2-2,5	0,2-0,5	
Clove	0,4-2,5	>20,0	0,4-2,5	0,3	
Lemongrass	0,6	2,5	0,6		
Limonene	0,70				
Carvacrol	0,1-5,0	0,2-0,25	0,2-0,45	0,4-0,5	0,25
Thymol	0,10-0,45	0,06	0,17-0,25	0,20-0,45	0,35-0,45
Geraniol	0,15		0,35	1,25	0,35
Eugenol	0,55		0,75	0,55	0,30

Specific antimicrobic and antioxidant plants used as additives/integrators in animal feed (2)

	Tratto respiratorio	Tratto gastrointestinale	Skin/Cute
Origanum sp.	X	X	
Calendula off.			X
Rosmarinus off.		X	X
Salvia officinalis	X	X	
Achillea mill.	X	X	X
Nigella sativa	X	X	X
Echinacea sp.	X		X
Plantago lanc.	X	X	X
Thymus vulg.	X	X	X

Diarrhea-prophylaxis in piglets by use of *Origanum sp.* essential oils

(S.C. Kyriakis et al. 1998)

	Control	250 g/t	500 g/t
		Oregano-Oil	
Average weight (kg)	3,65	4,02	4,67
Daily feed uptake (g)	327	330	364
Feed conversion rate (kg / 1 kg)	1,80	1,67	1,64
Diarrhoea (n)	7,1	4,3	3,1
Mortality (%)	11,1	2,8	0,0

Observation Period: day 1-21 after weaning

Plant Species commercialized as „*Oregano*“

Source: Franz, Ch. et al.:

“Assessment of plants/herbs, plant/herb extracts and their naturally or synthetically produced components

as “additives” for use in Animal production”

CFT/EFSA/FEEDAP/2005/01

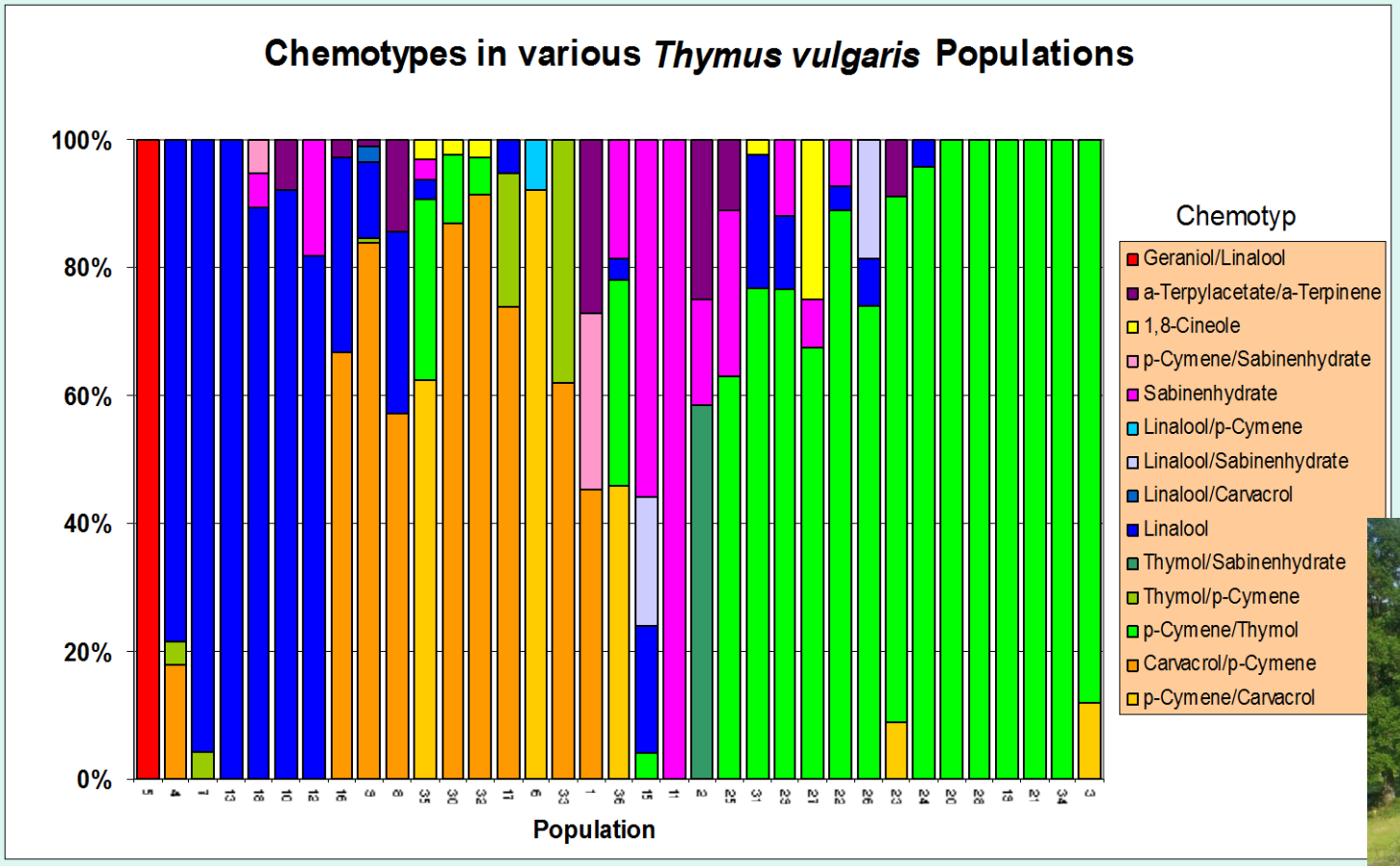
EFSA Monogr. *Origanum* - different Species called „Oregano“

Table 1. Species used commercially in the world as oregano

Family	Species	Commercial name/s found in literature
Labiatae	*Calamintha potosina* Schaf.	oregano de la sierra, oregano, origanum
	Coleus amboinicus Lour. (syn. *C. aromaticus* Benth)	oregano, oregano brujo, oregano de Cartagena, oregano de Espana, oregano Frances
	Coleus aromaticus Benth.	oregano de Espana, oregano, origanum
	Hedeoma floribunda Standl.	oregano, origanum
	Hedeoma incona Torr.	oregano
	Hedeoma patens Jones	oregano, origanum
	Hyptis albida H.B.K.	oregano, origanum
	Hyptis americana (Aubl.) Urb. (*H. gonocephala* Gris.)	oregano
	Hyptis capitata Jacq.	oregano, origanum
	Hyptis pectinata Poit.	oregano, origanum
	Hyptis suaveolens (L.) Poit.	oregano, oregano cimarron, origanum
	Monarda austromontana Epling	oregano, origanum
	Ocimum basilicum L.	oregano, origanum
	Origanum compactum Benth. (syn. *O. glandulosum* Salzm, ex Benth.)	oregano, origanum
	Origanum dictamnus L. (*Majorana dictamnus* L.)	oregano, origanum
	Origanum elongatum (Bonent) Emberger et Maire	oregano, origanum
	Origanum floribundum Munby (*O. cinereum* Noe)	oregano, origanum
	Origanum grosii Pau et Font Quer ex letswaart	oregano, origanum
	Origanum majorana L.	oregano
	Origanum microphyllum (Benth) Vogel	oregano, origanum
	Origanum onites L. (syn. *O. smyrneum* L.)	* Turkish oregano, oregano, origanum
	Origanum scabrum Boiss et Heldr. (syn. *O. pulchrum* Boiss et Heldr.)	oregano, origanum
	Origanum syriacum L. var. syriacum (syn. *O. maru* L.)	oregano, origanum
	Origanum vulgare L. subsp. *gracile* (Koch) letswaart (syn. *O. gracile* Koch, *O. tyttanthum* Gontscharov)	oregano, origanum
	Origanum vulgare subsp. *hirtum* (Link) letswaart (syn. *O. hirtum* Link)	oregano, origanum
	Origanum vulgare subsp. *virens* (Hoffmanns et Link) letswaart (syn. *O. virens* Hoffmanns et Link)	oregano, origanum, oregano verde
	Origanum vulgare subsp. *viride* (Boiss.) Hayek (syn. *O. viride*) Halacsy (syn. *O. heracleoticum* L.)	* Greek oregano, oregano, origanum
	Origanum vulgare L. subsp. *vulgare* (syn. *Thymus origanum* (L.) Kuntze)	oregano, origanum
	Origanum vulgare L.	oregano, orenga, Oregano de Espana
	Poliomintha longiflora Gray	oregano
	Salvia sp.	oregano
	Satureja thymbra L.	oregano cabruno, oregano, origanum
	Thymus capitatus (L.) Hoffmanns et Link (syn. *Coridothymus capitatus* (L.) Rchb.f.)	* Spanish oregano, oregano, origanum
Verbenaceae	*Lantana citrosa* (Sm all) Modenke	oregano xiu, oregano, origanum
	Lantana glandulosissima Hayek	oregano xiu, oregano silvestre, oregano, origanum
	Lantana hirsuta Mart. et Gall.	oreganillo del monte, oregano, origanum
	Lantana involucrata L.	oregano, origanum
	Lantana purpurea (Jacq.) Benth.& Hook. (syn. *Lippia purpurea* Jacq.)	oregano, origanum
	Lantana trifolia L.	oregano, origanum
	Lantana velutina Mart.&Gal.	oregano xiu, oregano, origanum
	Lippia myriocephala Schlecht.&Cham.	oreganillo
	Lippia affinis Schau.	oregano
	Lippia alba (Mill) N.E. Br. (syn. L. involucrata L.)	oregano, origanum
	Lippia Berlandieri Schau.	oregano
	Lippia cordiostegia Benth.	oreganillo, oregano montes, oregano, origanum
	Lippia formosa T.S.Brandeg.	oregano, origanum
	Lippia geisseana (R.A.Phil.) Soler.	oregano, origanum
	Lippia graveolens H.B.K.	* Mexican oregano, oregano cimarron, oregano, origanum
	Lippia helleri Britton	oregano del pais, oregano, origanum
	Lippia micromera Schau.	oregano del pais, oregano, origanum
	Lippia micromera var. *helleri* (Britton) Moldenke	oregano
	Lippia origanoides H.B.K.	oregano, origano del pais
	Lippia palmeri var. *spicata* Rose	oregano
	Lippia palmeri Wats.	oregano, origanum
	Lippia umbellata Cav.	oreganillo, oregano montes, oregano, origanum
	Lippia velutina Mart. et Galeotti	oregano, origanum
Rubiaceae	*Borreria* sp.	oreganos, oregano, origanum
Scrophulariaceae	*Limnophila stolonifera* (Blanco) Merr.	oregano, origanum
Apiaceae	*Eryngium foetidum* L.	oregano de Cartagena, oregano, origanum
Asteraceae	*Coleosanthus veronicaefolius* H.B.K.	oregano del cerro, oregano del monte, oregano del campo
	Eupatorium macrophyllum L. (syn. *Hebeclinium macrophyllum* DC.)	oregano, origanum

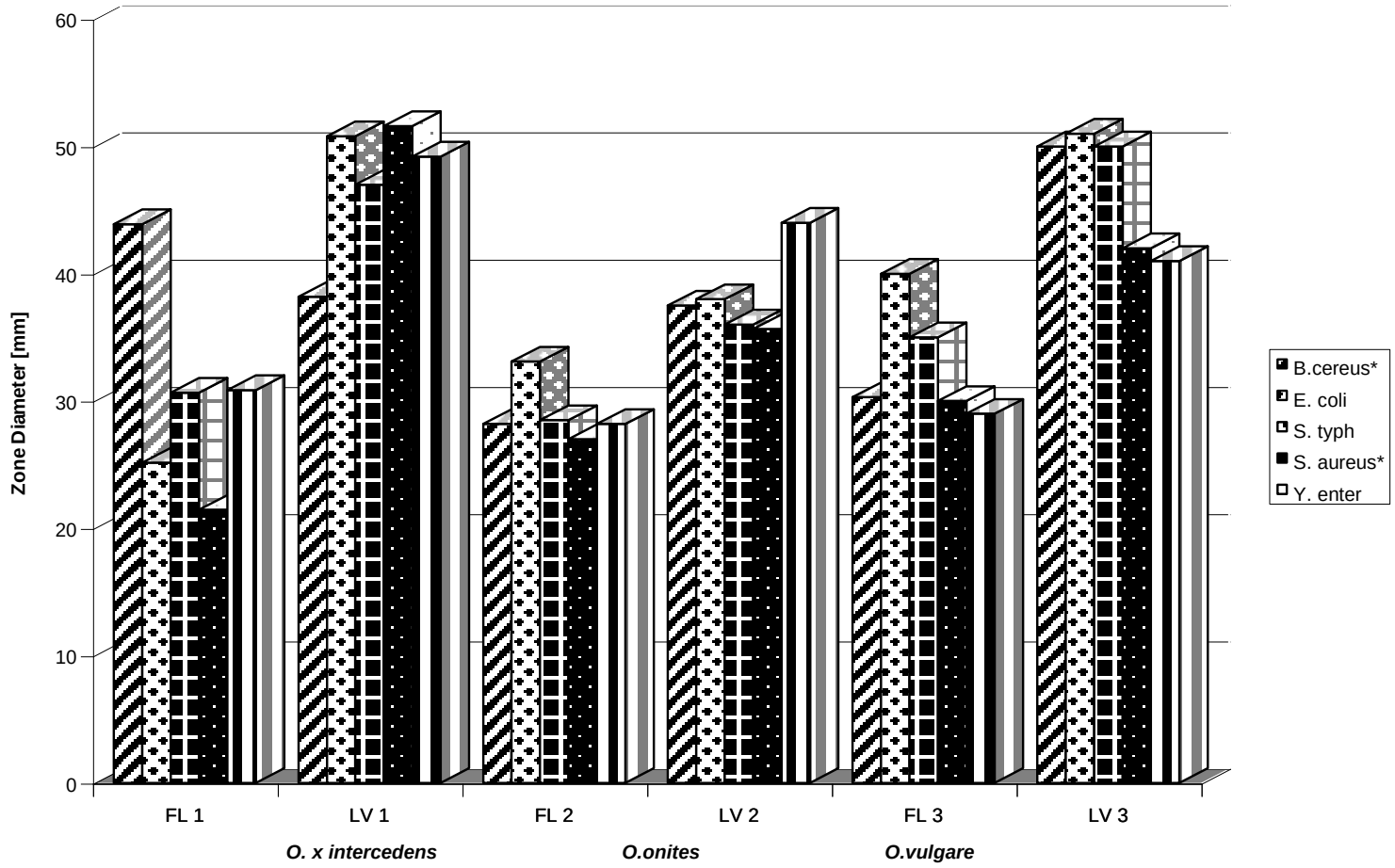
* Species of main economic importance according to Lawrence and Reynolds (1984)

Biodiversity of essential oils of *Thymus vulgaris*



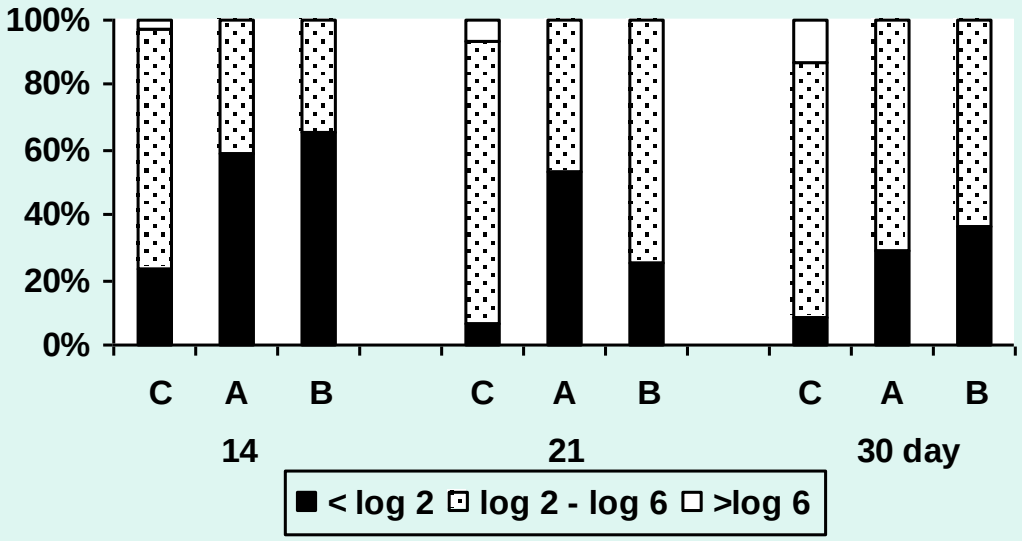
Ogni barra rappresenta una popolazione

Antibacterial activity of *Origanum sp.*

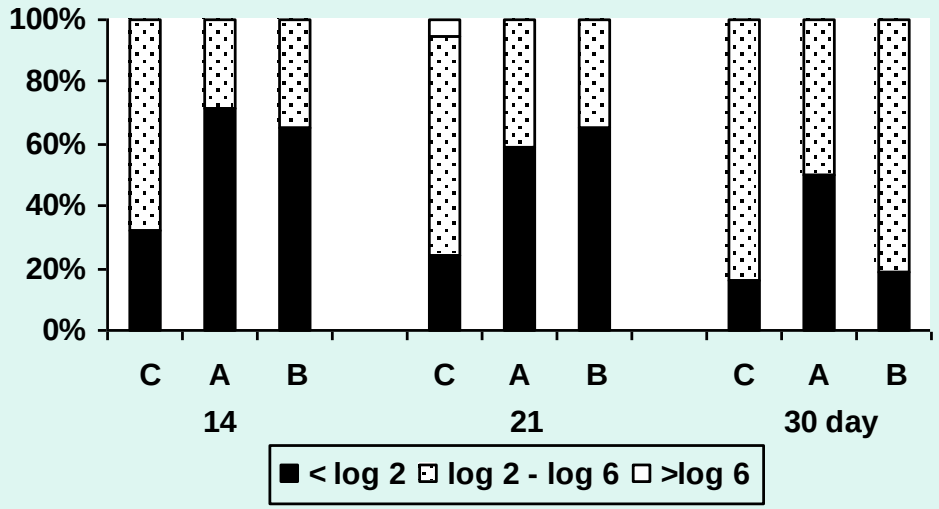


Source: Final Report EU-Project FAIR-CT96-1914

Relative frequency of Clostridium-perfringens-concentrations in the jejunum and caecum of broilers in dependence of essential oil compounds as feed additives



A= thymol, eugenol, curcumin, and piperin
B= thymol, carvacrol, eugenol, curcumin, and piperin
C= Control

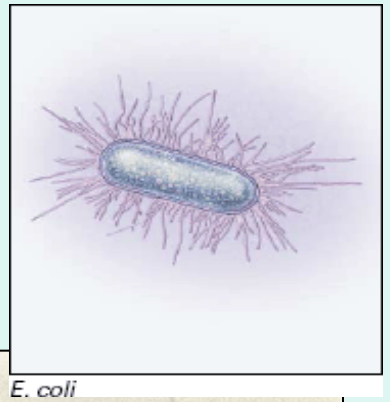


Mitsch et al., Poultry Sci. 2004

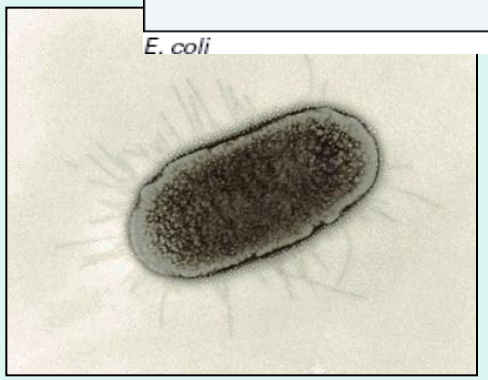
Reasons for binding / damage of the microorganisms:

- ***Destruction of cell membranes***

  (but: concentration in feed high enough?)



E. coli

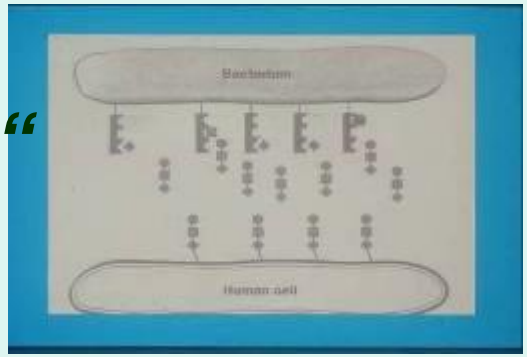


- ***Disturbing the fimbri formation of bacteria by ess.-oil-components***

  (S.A. Burt et al., Appl.Environ.Microbiol. 2007)

- ***Inhibition of adherence at the gut mucosa by „competitive binding“***

  (L.B. van Alphen et al., PLoS One 2012)

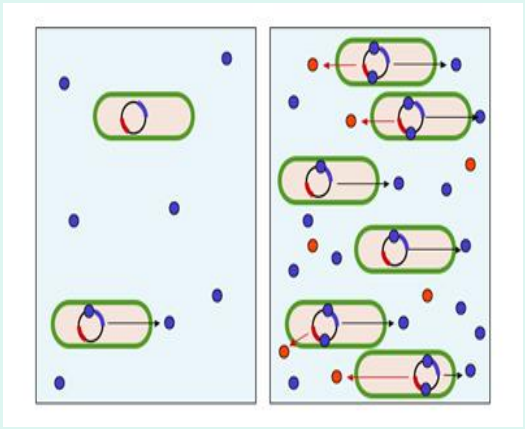


Quorum Sensing Inhibition (QSI)

- ***Quorum Sensing*:** capacity of the bacterials to measure the population density by means of chemical comunication. Some genes will be activated only as soon as a certain cell density is surpassed (virulence gene expression as answer to signal molecules; resulting in e.g. motility, adhesion, toxin formation)
- ***Quorum Sensing Inhibition*:**

  Interference with QS and suppression of bacterial virulence, e.g. by essential oil components (clove oil, carvacrol,…)

(Khan, M.S. et al., Lett. Appl. Microbiol. 2009;
Müller, A.S., Plan A – Performing Nature Sympos. Bangkok 2014)



Cells in low density: only signal molecules high density: also toxines

Effect of several plant products *in-vivo* on prevention of *E. coli* adhesion in the GIT of weaned piglets

- **6 groups à 12 piglets:**
  1) neg. control
  2) +yeast product = pos. control
  3) +SW7 *(Cucurbita pepo)*
  4) +SW11 *(Echinacea purp.)*
  5) +sesame seed expeller
  6) +thymol/carvacrol (*Origanum*)
- **treatment from day 2 to 22 days post-weaning**
- **at day 7 piglets were inoculated orally with ETEC** (*E. coli* O149 K91 + K88ac +(F4ac))

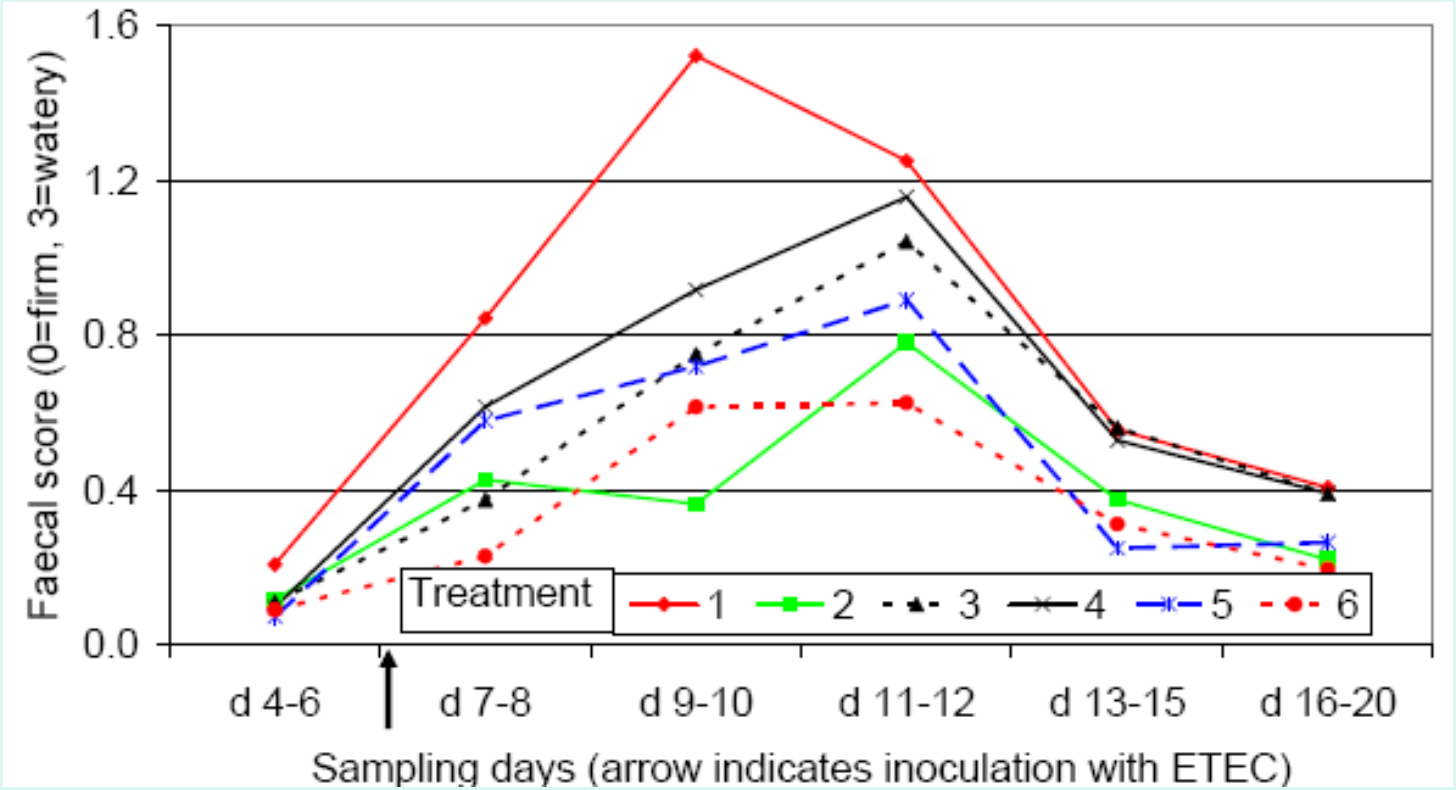
SW7 / SW11:
Materials of the EU project **S**afe**w**astes.

safewastes

- A. W. Jongbloed et al., 2007

Effect of several plant products *in-vivo* on prevention of *E. coli* adhesion in the GIT of weaned piglets

- **faecal score worst in neg.control, best in pos.control**



- Lelystad, Netherlands - A. W. Jongbloed et al., 2007

Feeding sheep with distillation residues of Rosemary

- 36 female sheep, 3 groups (control, 10%, 20% distilled plant material substituted), 8 months (coinciding with gestation and lactation)

> diet did not modify daily weight gain ratio

> 11 polyphenols were identified in lamb meet (methanolic extraction, HPLC)

> in both experimental groups: rosmarinic acid ↑, carnosol ↑, carnosic acid ↑; antioxidant activity (DPPH) ↑

➢ **administration of rosemary leaves from distillate**

> does not modify animal performance

> improves antioxidant stability of lamb meat

M. J. Jordan, M. I. Monino, C. Martinez, J. A. Sotomayor, M. Quilez: Planta med. 2007

Lamb meat (M. deltoideus): polyphenole profile (mg/kg fresh meat) after nutrition with distillation residues from rosemary and thyme (Jordan et al. 2007)

	M. deltoideus		
	Control	**10%**	**20%**
Caffeic acid	1,47 ± 0,03 ^{a}	1,41 ± 0,053 ^{a}	1,41 ± 0,047 ^{a}
Ferulic acid	0,77 ± 0,007 ^{a}	0,79 ± 0,059 ^{a}	0,55 ± 0,030 ^{a}
Coumaric acid	0,85 ± 0,006 ^{a}	0,86 ± 0,031 ^{a}	0,86 ± 0,008 ^{a}
Naringine	2,42 ± 0,038 ^{a}	2,42 ± 0,027 ^{a}	2,43 ± 0,041 ^{a}
Hesperidine	2,54 ± 0,030 ^{a}	2,64 ± 0,097 ^{b}	2,58 ± 0,036 ^{ab}
Rosmarinic acid	**0,00 ± 0,000** ^{a}	**1,17 ± 0,007** ^{b}	**1,09 ± 0,220** ^{b}
Apigenin	0,08 ± 0,005 ^{a}	0,08 ± 0,005 ^{a}	0,07 ± 0,022 ^{a}
Luteolin	0,36 ± 0,110 ^{b}	0,27 ± 0,025 ^{a}	0,29 ± 0,046 ^{ab}
Genkwanin	0,03 ± 0,029 ^{a}	0,05 ± 0,074 ^{a}	0,02 ± 0,009 ^{a}
Carnosol	**2,41 ± 0,526** ^{a}	**5,17 ± 1,823** ^{b}	**4,77 ± 0,841** ^{b}
Carnosic acid	**7,09 ± 0,531** ^{a}	**23,85 ± 4,385** ^{b}	**18,46 ± 2,612** ^{c}

Effect of hydrolized pectines on the health status of piglets: the „*Carrot Soup Story*“

(Jugl et al. 2002)

Nutrition with pectines of carrots (0,1% of the diet, material: boiled dried carrot chips)

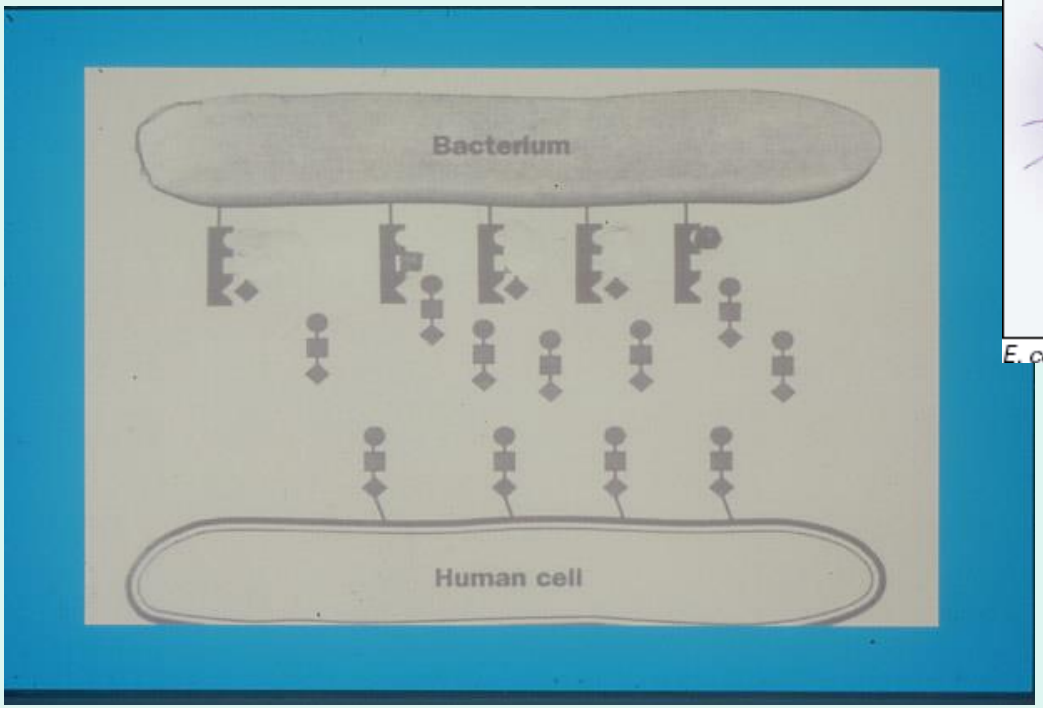
Suinetti: n = 183

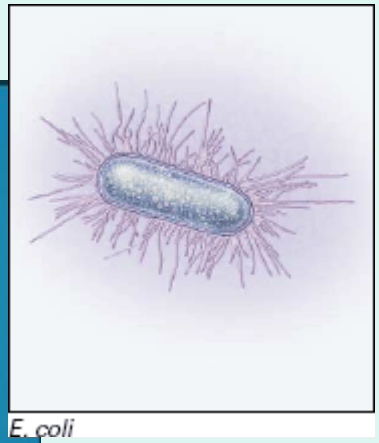
	Diarrhea	without Diarrhea
Control	50 %	50 %
Tylosinphosphate	24.6 %	75.4 %
Pectine (gal.-ac.)	14.7 %	85.3 %

From Moro‘s Carrot Soup to Immunonutrition

Oligosaccharids (glucoronicacids, hydrolitic products of the cellular wall of plants) have the capacity to block the adesion of several bacterials as receptor analogues to the flagelli/fimbri

Guggenbichler 2002

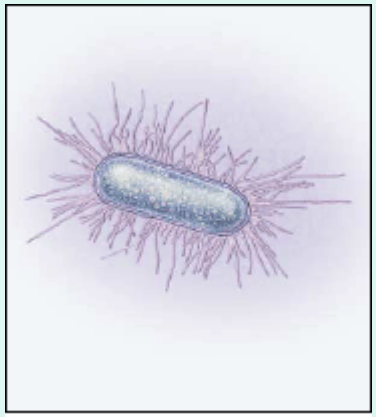



E. coli

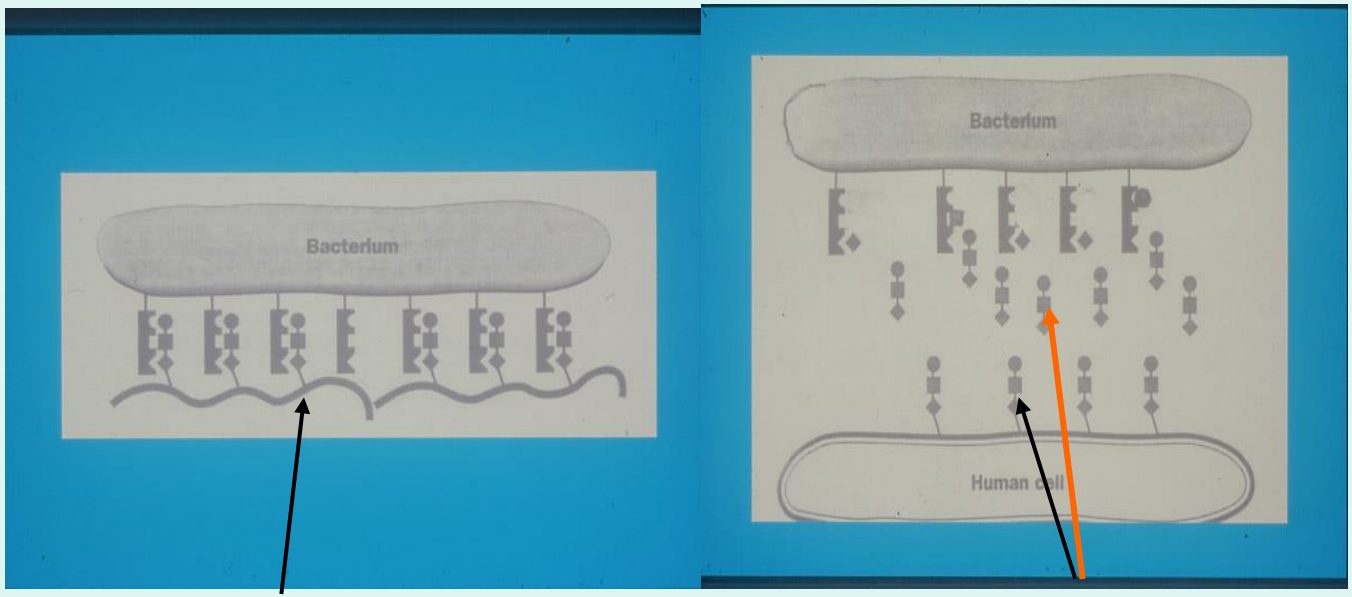
Microorganisms with adhesive potential to carbohydrates (Guggenbichler & Jurenitsch, 2004)

- E. coli (ETEC, EPEC, EHEC,
- fimbrious E. coli)
- Salmonella spp.
- Klebsiella spp.
- Enterobacter spp.
- Aeromonas hydroph.

- Helicobacter
- H. influenzae
- S. pneumoniae
- Meningokokki
- B. pertussis
- C. albicans
- Rotaviruses



E. coli



Receptor at epithelial cells: Glykolipid with 1 molecule Glucose and 3 molecules Galactose in Globoserie

„Good morning, climate pig!“

(…due to methane emission)

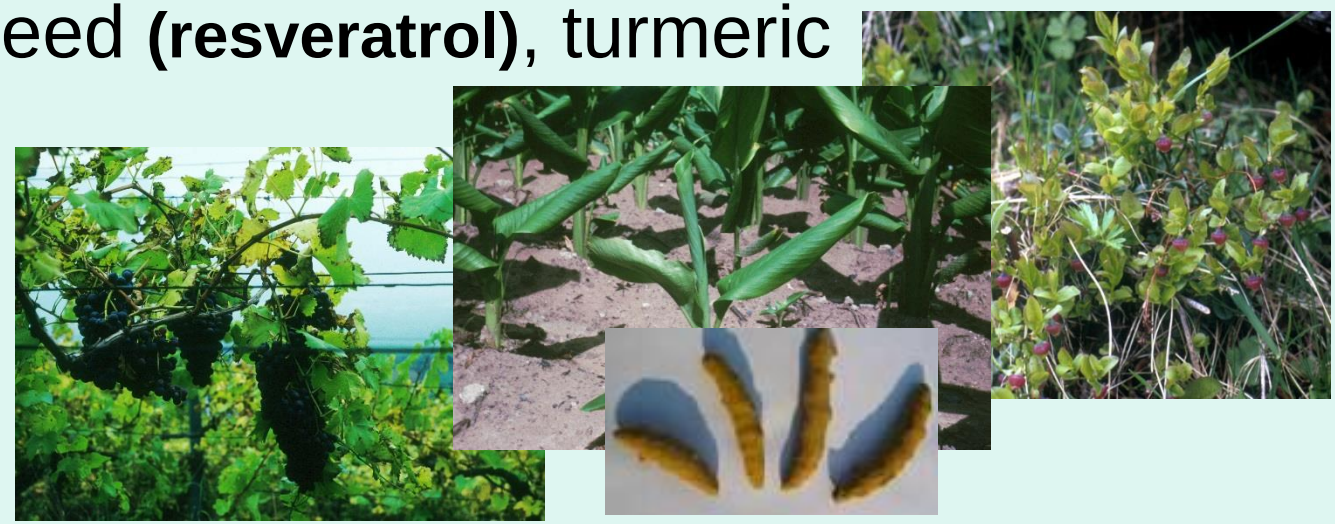
INSTITUT FÜR ANGEWANDTE BOTANIK

vetmeduni vienna

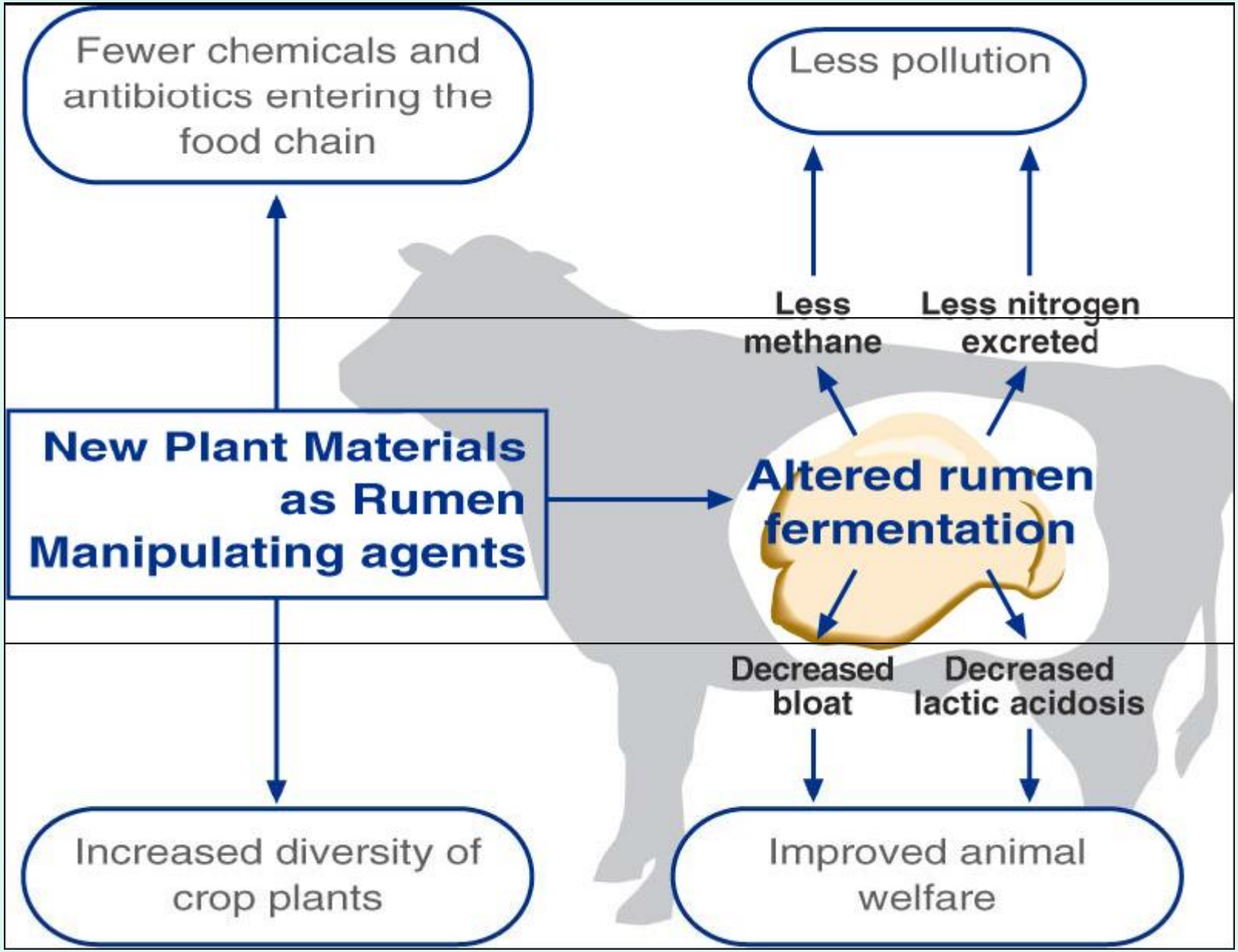
Claim 5: anti-methanogenic and N-excretion reducing in ruminants

- **Methane reduction by plant pigments and antioxidants in rumen fluid involves modification or degradation of the active compounds.**
  Becker, P.M., van Wikselaar, P.G., Ilgenfritz, J., Franz, C., Zitterl-Eglseer, K.: Wiener Tierärztl.Mschr. ***100*****,** 295-305 (2013)

  plant pigments: bilberry **(epi-/catechin)**, tomato, grape seed **(resveratrol)**, turmeric



The „Rumen-Up“ Project (Wallace et al.)



Rumen-up Conclusions:

- **Approx 500 plants and extracts tested on fermentation, methane, proteolysis, protozoa, lactic acid, bloat *in vitro:***
- ***Most promising plant species (of 23 positive):***

Knautia arvensis
(scabiosa)

Bellis perennis
(‚daisy‘)

espec. reduction of
Methane production:

Rheum nobile
Sikkim rhubarb

Gentiana asclepiada

Claim 5: anti-methanogenic and N-excretion reducing in ruminants

- In-vitro screening of selected feed additives, espec. plant essential oils, for rumen methane mitigation:

„A significant reduction ($P<0.05$) in methane production was observed with eight essential oils (up to 75% reduction) when compared to their resp. controls… The current study identified some potent dietary ingredients that can assist in developing novel feed additives for methane mitigation from the rumen.“

Z. Durmic et al. J. Sci. Food Agric. 2014

zoey.durmic@uwa.edu.au

Claim 6: further beneficial effects on animal physiology, e.g. health status, stable odour…

e.g.

- **Repellents: to prevent against flees, ticks,…**
- **Antiinflammatory agents**
- **Digestive agents: against flatulence, colic; reduction of ammonia and ‚odorous compounds‘**
- **Influence on transport mechanisms, barriers, metabolism, macrophage infiltration,…**

Essential Oils and Inflammation

- Infection with intestinal pathogens → inflammatory response in the host animal
  (NFkB → cytokines → COX2 → prostaglandines → …)

- Turmeric, oregano, thyme and rosemary oil, isothiocyanates a. o. induce endogenous antioxidant enzymes → reducing COX2 etc.

  (K. Mueller et al., Brit. J. Nutr. 2012)

Silymarin in veterinary medicine

- **Silymarin in periparturient <u>dairy cows</u>**
- (30 lactating dairy cows, 2 groups (control, treated), 10 g silymarin per day (extract mixed with water and administered orally): 3 weeks before to 3 weeks after calving)
- **>** BCS, blood parameters, milk parameters, lactation curve, liver biopsies
- better lipidic mobilization in liver
- better health condition
- lower BCS loss
- noticeable impact on milk yield
- no influences on milk quality
- no silybin residue found in milk (HPLC detection limit 10ppb)
- milk safety parameters maintained

- **> feeding an antioxidant + hepatoprotective substance** in this period is **useful for prevention of liver disease, improvement of milk quality and sustaining higher milk production**

- D. Tedesco, ICS-UNIDO Meeting Trieste July 2007

Silymarin in veterinary medicine

- **Silymarin in <u>sowes</u>**
- **> hepatoprotector in the periparturient period**

- **Silymarin in <u>poultry</u>** (Aflatoxin in feed)
- **>** mean body weight, daily feed consumption, blood parameters, liver histology
- **> antihepatotoxic** (Aflatoxin in feed)

- D. Tedesco, ICS-UNIDO Meeting Trieste July 2007

Herbs and Herbal Products as Additives in Animal Nutrition

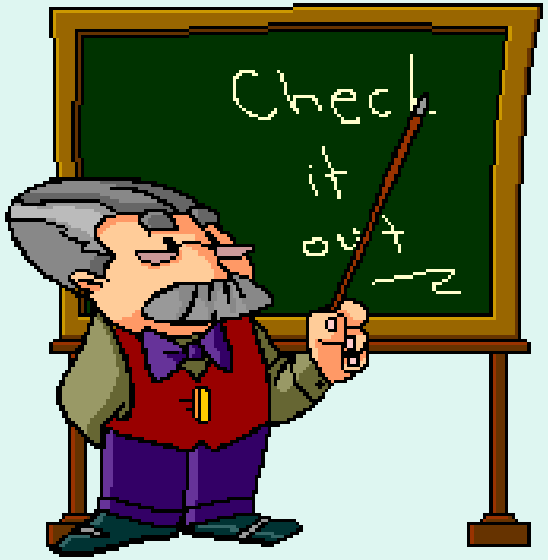
- Definitions: plants/herbs – extracts – distillates – pure compounds
- Parameters: mainly animal performance, *‚product driven‘* = economically driven, daily weight gain, feed intake, feed conversion rate
- Deficiencies: *‚activity driven‘* results, espec. ADME (absorption, distribution, metabolism, excretion); antimicrobial/antioxidant activities, ‚non-productivity‘ health benefits / effects
- Majority of publications based on commercial products without substance:effect-relation

…therefore of low scientific relevance

Take-home-message:

- Plant extracts and essential oils are successfully applied in animal nutrition, espec. in pigs and poultry, also in ruminants (and fish), but quite often on empiric basis only
- There are some recent data on the effect of extracts and e.o‘s, especially mode of action of essential oils
- More scientific/research data are needed to be able for science-based nutrition recommendations
- Supply chain management and quality assurance?
- Multidisciplinary research is required on:
  - Bioavailability and effect/efficacy
  - metabolism
  - „mode of action“

Which Animal will have the best benefit?



…and thank you for listening!