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Fundamentals of herbal veterinary medicine

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Short round of self-introduction

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Registered herbal medicinal products

Registered herbal medicinal products

March 2024

Medicinal products that have completed the authorization procedure - GERMANY

Phytopharmaka	zugelassen	nachzugelassen	Summe
Monopräparate	487	234	721
Kombinationspräparate	63	78	141
Summe	550	312	862

Quelle: BfArM - Aktuelles - Statistik

HERBAL VETERINARY MED. PRODUCTS

country	2022	2024
Switzerland	2 from 2 manufacturer	1 from 1 manufacturer
Austria	11 from 6 manufacturer	9 from 4 manufacturer
Germany	21 from 7 manufacturer	17 from 3 manufacturer

Quelle: Vetidata and MedPlants4Vet

Simplified traditional registration in human medicine

- In the European Union EU Directive 2004/24/EC
- §§ 39a-d of the German Medicinal Products Act
- § 12 and § 12a of the Austrian Medicinal Products Act

- Simplified procedure
- Requirement: Proof that the medicinal product has been used for the requested indication for at least 30 years, at least 15 Years, in the EU.
- Monographs

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Political Background

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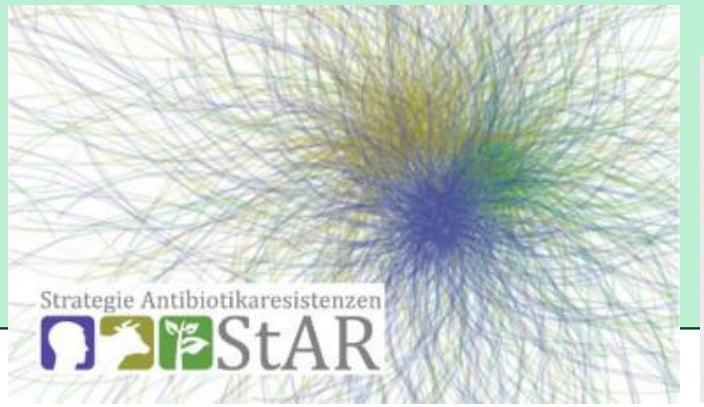

Political Background

EU-Regulation (EU) 2019/6

Preamble 12:
There is **insufficient information** to date on traditional herbal products used to treat animals in order to allow the setting up of a **simplified system**. Therefore, the possibility of introducing such a simplified system should be examined by the Commission based on the information provided by the Member States on the use of such products on their territory.

Article 157:
Commission report on traditional herbal products used to treat animals
The Commission shall report to the European Parliament and to the Council by **29 January 2027**, on traditional herbal products used to treat animals in the Union. If appropriate, the Commission shall make a legislative proposal in order to introduce a **simplified system for registering traditional herbal products used to treat animals**.
The Member States shall provide information to the Commission on such traditional herbal products within their territories.

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Launch of MedPlants4Vet - A COST Action

A COST Action is an interdisciplinary research network that brings together researchers, innovators and various stakeholders to investigate a topic of their choice for four years.

"In today's world, it is essential that research is networked, interdisciplinary, collaborative and data-intensive."

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Network of the COST-Action MedPlants4Vet

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Tunisia
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India
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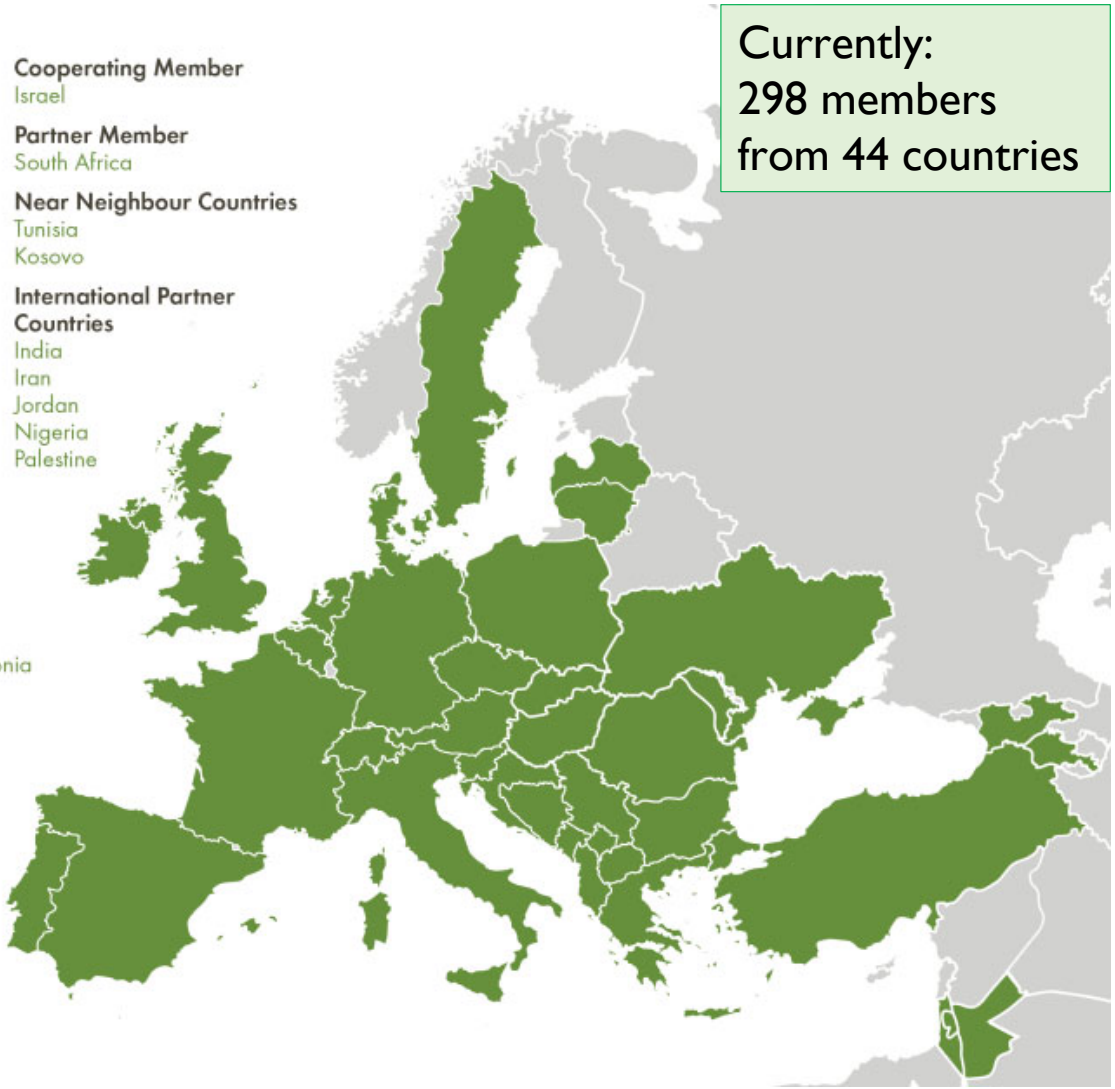

Currently:
298 members
from 44 countries

- Generating knowledge
- Generating joint perception
- Generating output

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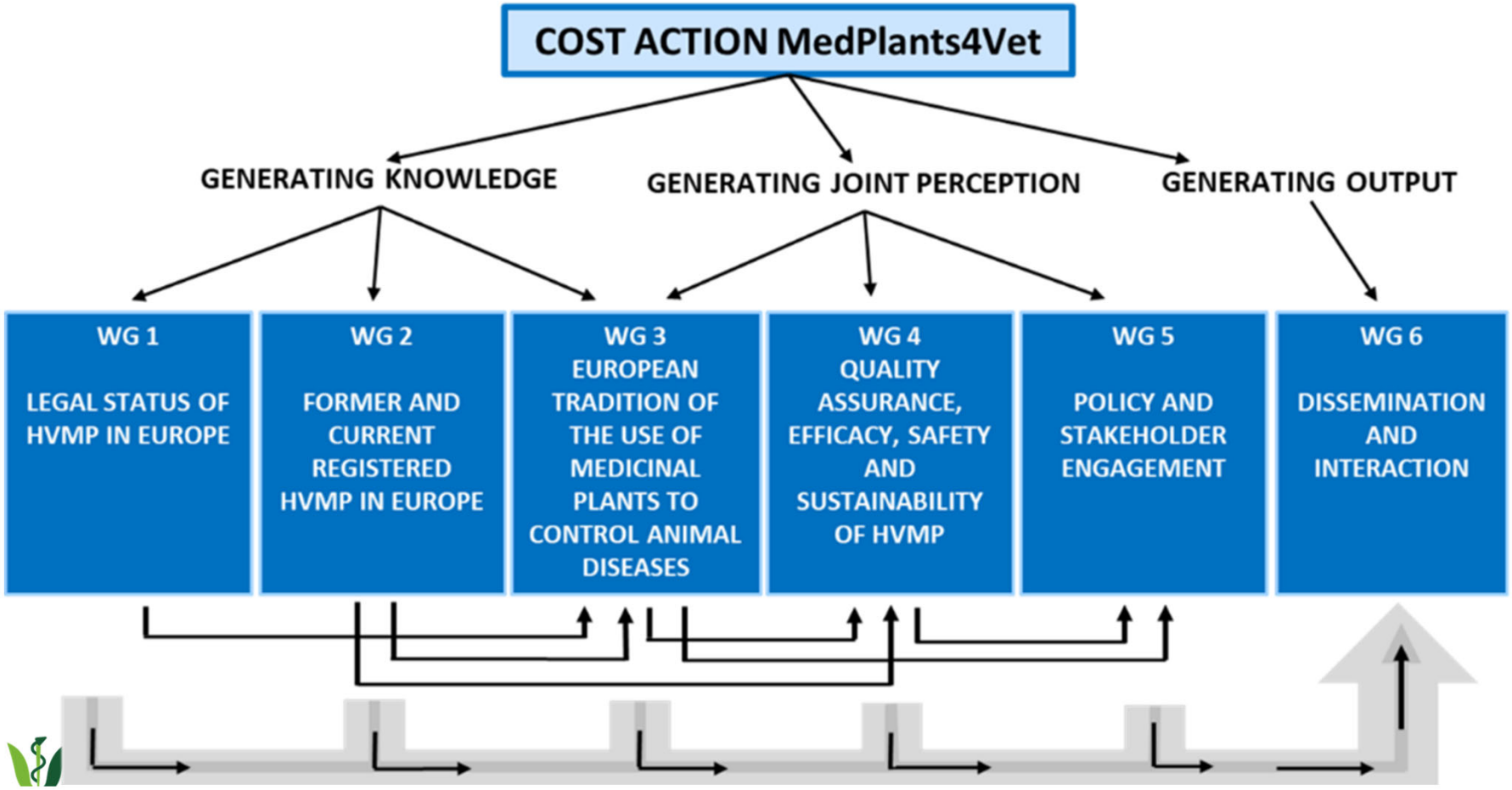
Network of the COST-Action MedPlants4Vet



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HVMP = herbal veterinary medicinal product

WG 1 LEGAL STATUS OF HVMP IN EUROPE

- Collection of current and former legislation on the authorisation, production and use of (traditional) herbal veterinary medicinal products for the treatment and prevention of animal diseases in the different countries.

→ comparing the way different countries deal, or dealt, with the administration of medicinal plants and herbal substances to control animal diseases.

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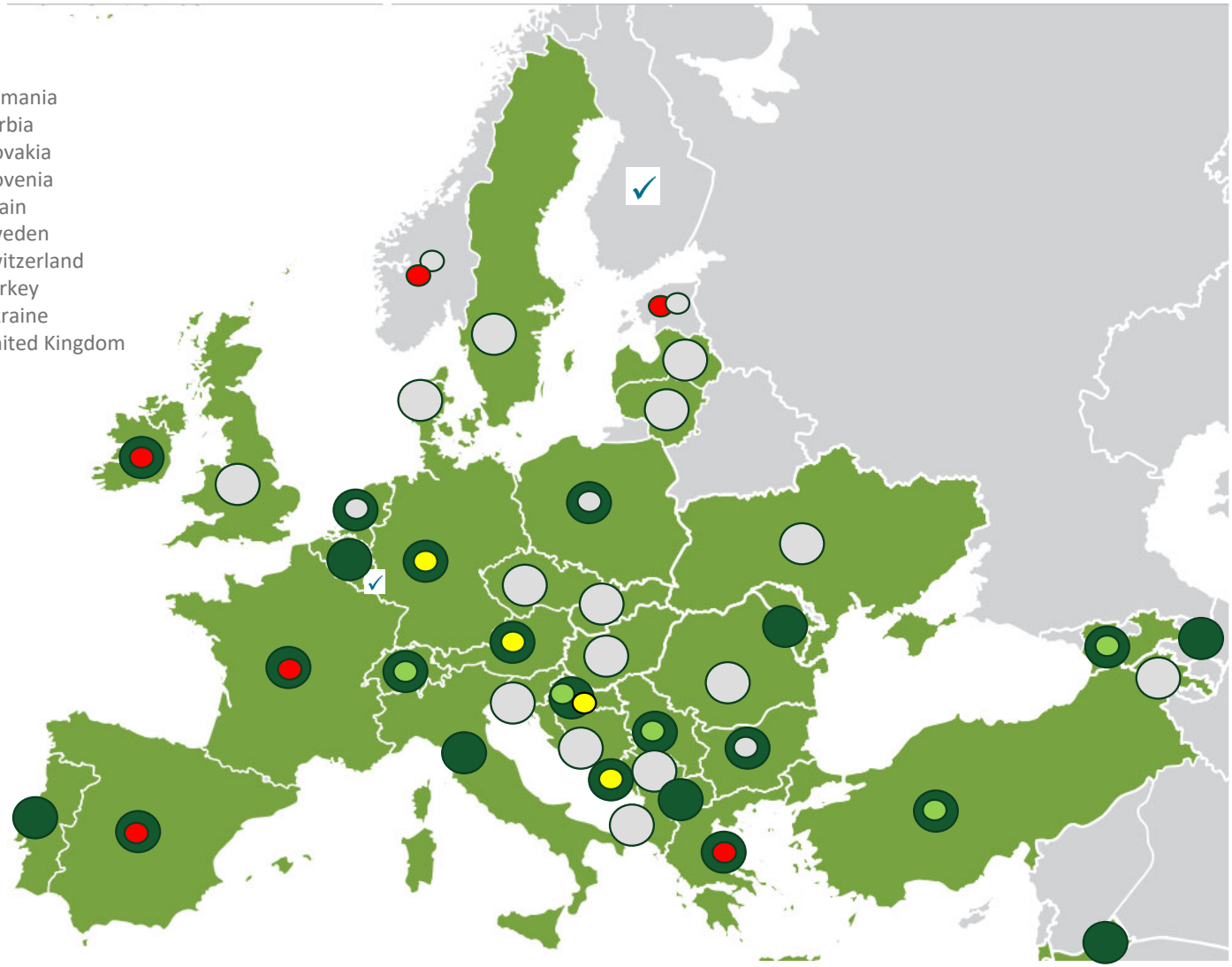
WG1 Members and feed back – status July 2024

- Albania
- Armenia
- Austria
- Belgium
- Bosnia and Herzegovina
- Bulgaria
- Croatia
- Cyprus
- Czech Republic
- Denmark
- Estonia
- Finland
- France
- Georgia
- Germany
- Greece
- Hungary
- Iceland
- Ireland
- Italy
- Latvia
- Lithuania
- Luxembourg
- Malta
- The Republic of Moldova
- Montenegro
- The Netherlands
- The Republic of North Macedonia
- Norway
- Poland
- Portugal
- Romania
- Serbia
- Slovakia
- Slovenia
- Spain
- Sweden
- Switzerland
- Turkey
- Ukraine
- United Kingdom

? non member, requested

✓ non member, confirmed

- data submitted trad. reg. recent
- data submitted trad reg. past
- data submitted trad. reg. never
- data submitted data unclear



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- WG1 member
- WG1 non member

WG 2 FORMER AND CURRENT REGISTERED HVMP IN EUROPE

- Establishment of an inventory of all currently (and as much as possible formerly registered) HVMP in European countries and beyond.

→ Systematic data on the herbal ingredients, indication (including target species) and dosage as well as duration of treatment.

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WG2 Members and feedback – status July 2024

Number of participants: 76
Countries and territories represented (26):

Albania, Austria, Azerbaijan, Belgium, Bosnia and Herzegovina, Czech Republic, Denmark, Germany, Ireland, Italy, Jordan, Kosovo*, Moldova, Montenegro, Nigeria, North Macedonia, Poland, Portugal, Romania, Serbia, South Africa, Spain, Sweden, Switzerland, Tunisia, Turkey

- data submitted for currently registered HVMPs
- data submitted for formerly registered HVMPs
- data submitted – no registered HVMPs found
- data submitted data unclear
- no small circle – no submitted any data so far

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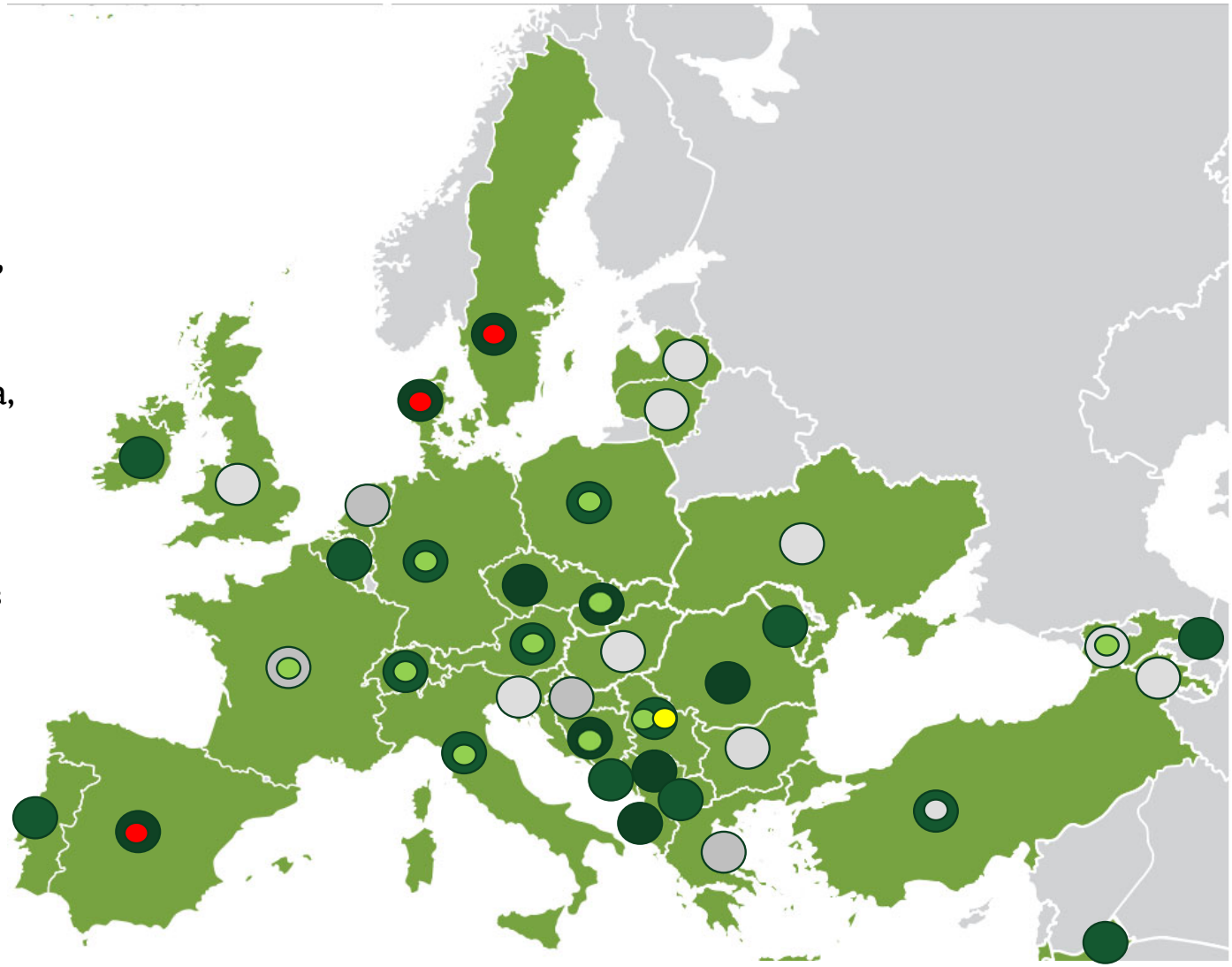
- WG2 member
- WG2 non member



WG 3 EUROPEAN TRADITION OF THE USE OF MED. PLANTS TO CONTROLL ANIMAL DISEASES

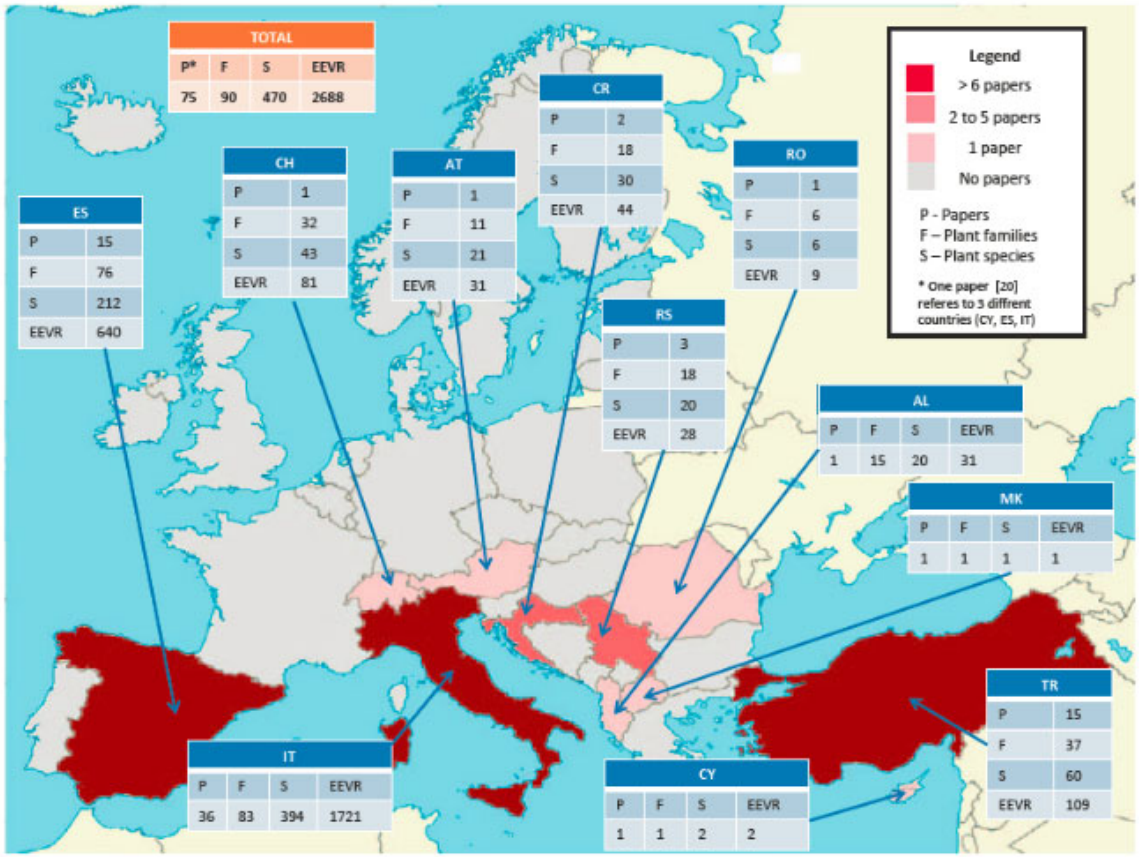
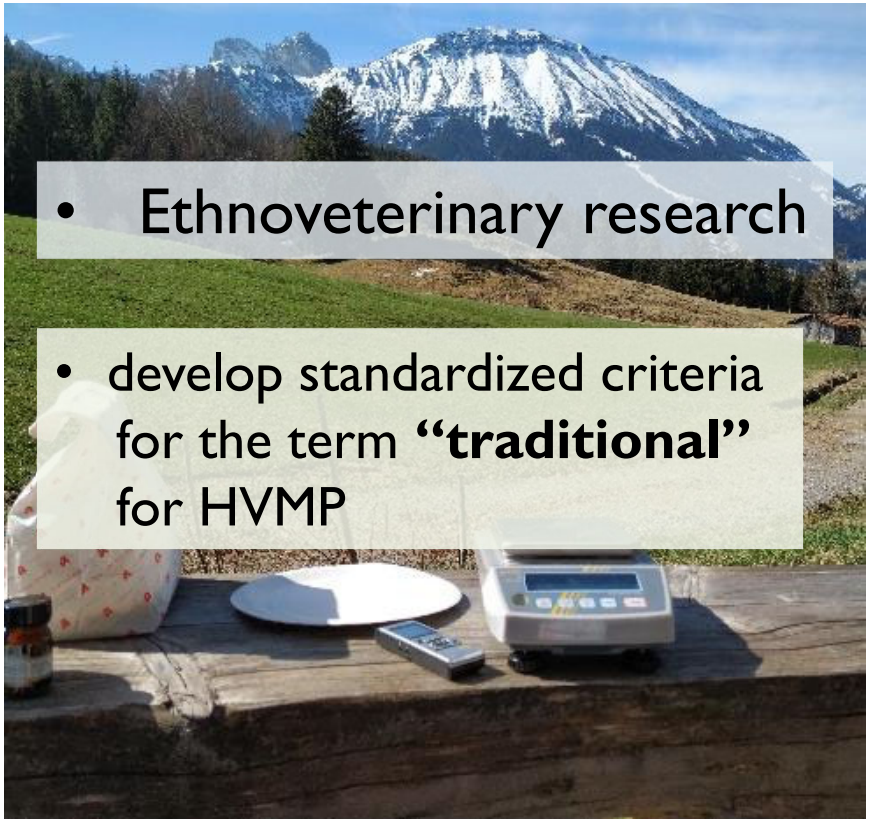


Fig. 2. European map of ethnoveterinary research. AL = Albania; AT = Austria; CH = Switzerland; CR = Croatia; CY = Cyprus; RO = Romania; IT = Italy; MK = Macedonia; RS = Serbia; TR = Turkey.

Mayer et al., 2014



WG 4 SAFETY, QUALITY ASSURANCE, RISK ASSESMENT AND SUSTAINABILITY OF HVMP

- review the existing legal frames for the quality assurance, risk assessment, safety and sustainability of HVMP

- develop: a) criteria for those issues
  b) methodology for experimental trials
  c) a scheme for monographs

- plant list
- a systematic approach that serves as a guide for a quality management system

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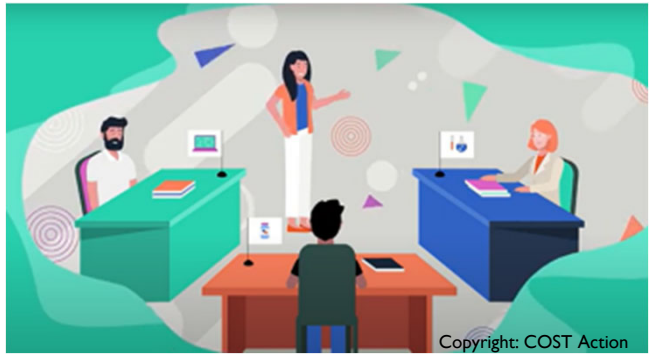
WG 5 POLICY AND STAKEHOLDER ENGAGEMENT

Collecting insights of various stakeholder representatives to enable better understanding and to elaborate a joint perception of HVMP.

1) Scientists from academia (incl. GA, EAAP, ...)
2) Industry and pharmaceutical companies (incl. EUROPAM, ...)
3) Practitioners (veterinarians, farmers, animal owners)
4) National and international organisations (incl. nat. reg. authorities)



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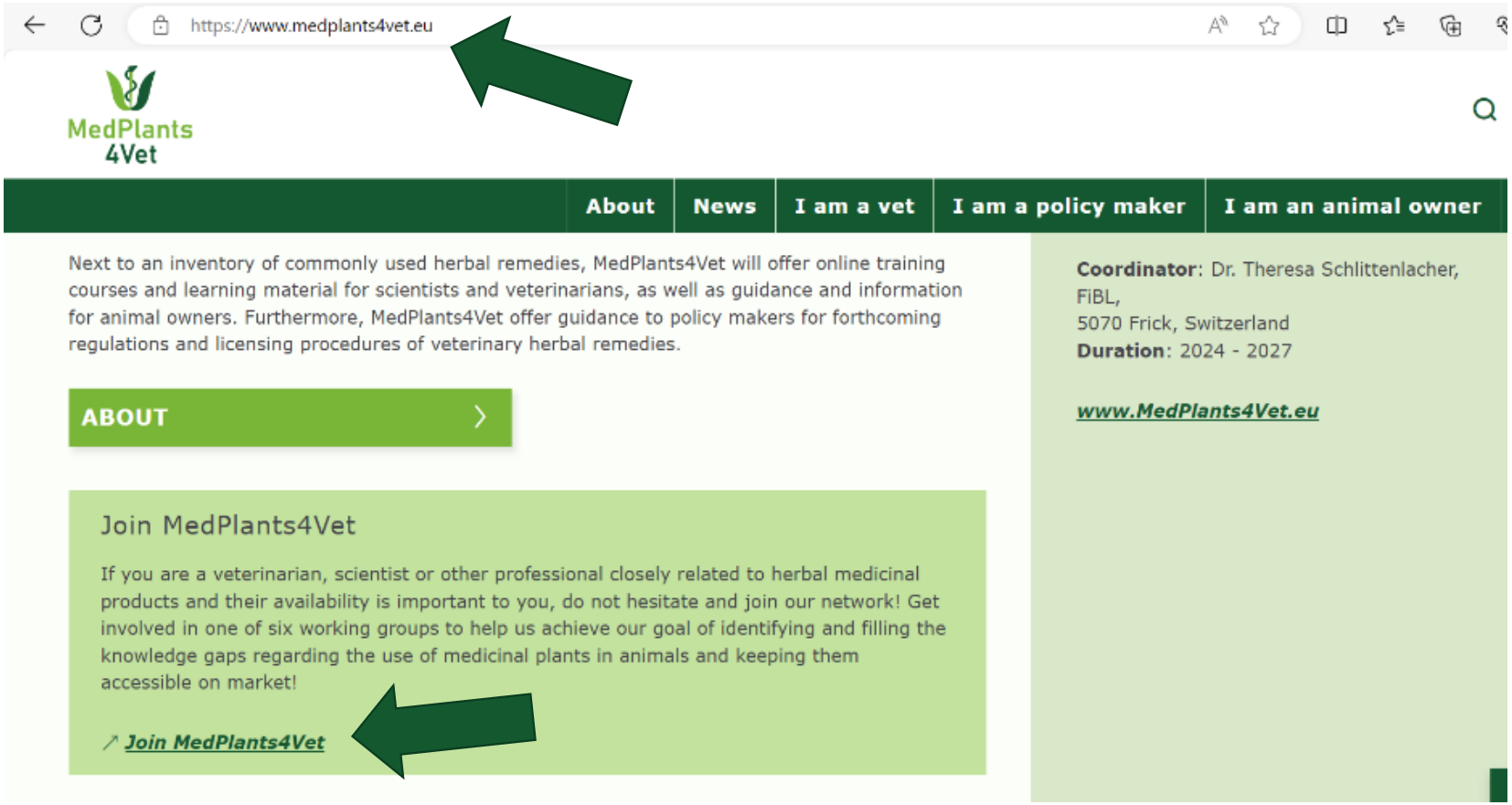
WG 6 DISSEMINATION AND INTERACTION

- drive MedPlants4Vet interactions
- broadcast the outcomes of all WGs activities



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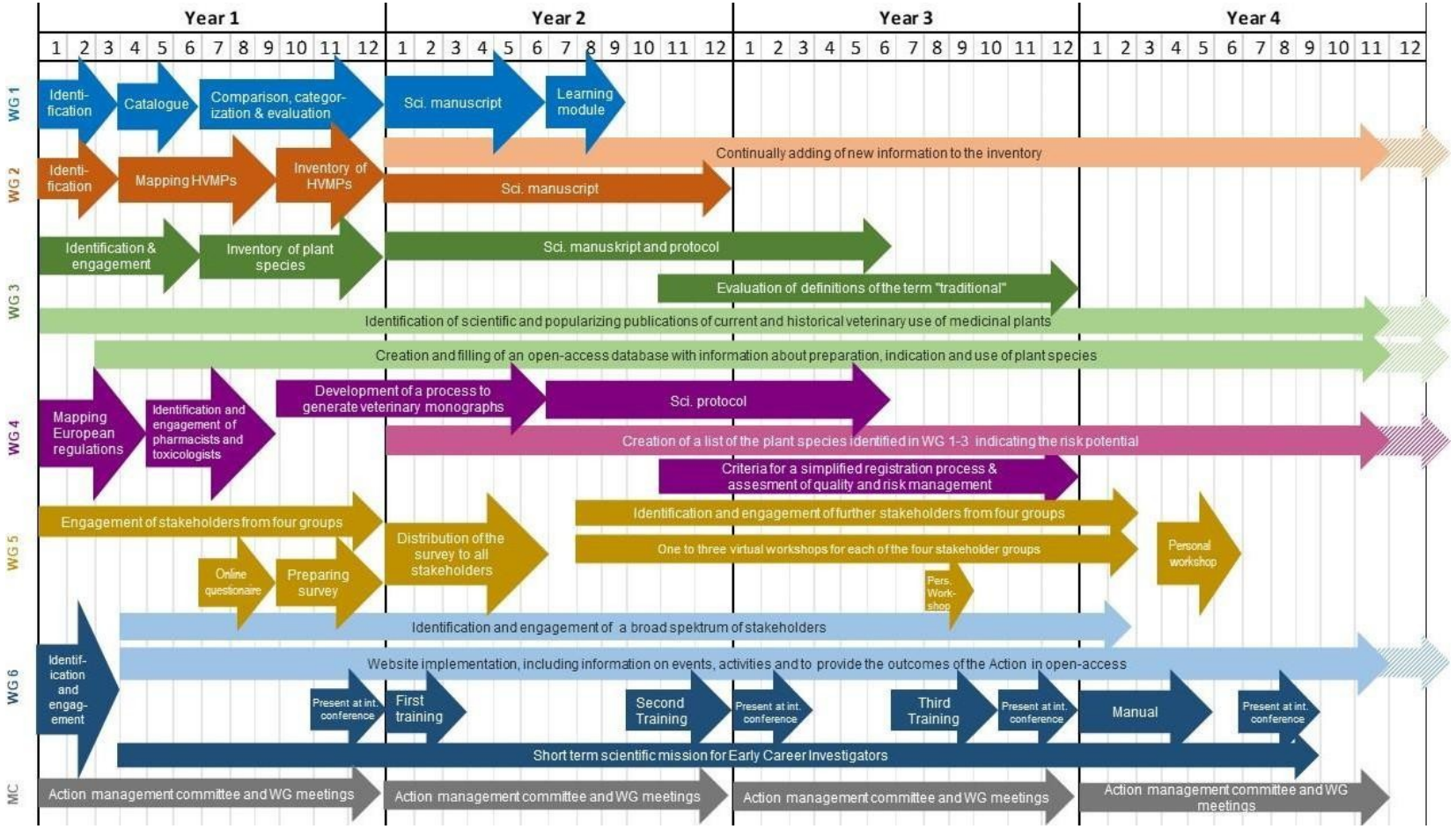
Gantt Chart



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TAKE HOME:

MedPlants 4Vet is an interdisciplinary and international network

Contact options:

- https://cost.eu/actions/CA22109/
- https://www.medplants4vet.eu/
- **E-Mail:**
  theresa.schlittenlacher@fibl.org
  michael.walkenhorst@fibl.org

… A **report on traditional herbal products for the treatment of animals** must be submitted to the European Commission by **January 2027.**

Mentimeter exercise

1. When you close your eyes and think about herbal veterinary medicine, what do you assocciate?

   (words' cloud)

2. Why people (societies) turn to herbal veterinary medicine?

   (open question)

3. What are the best sources of herbal veterinary medicine knowledge?

   (scoring provided answers)

Plant ingredients

Primary plant ingredients:

- fat
- protein
- carbohydrates

Plants need them for:

- storage of energy – constructive substances for plants
- feeding

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Plant ingredients

Secondary plant ingredients:

- substances in small amounts that fulfill specific and very diverse „jobs“ for the plants
- why do they do this?

Plants cannot run (away)!

- Protection against diseases (bacteria, fungi, viruses), insects and other herbivores
- Communication
- Sex and multiplication

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Plant ingredients

Secondary plant ingredients:

- chemically very diverse
- plants and their extracts are always complex mixtures of substances of diverse chemical structure
- but these complex mixtures are advantageous for many aspects, for example, regarding the development of antimicrobial resistance.
- „Multi Target Drugs“

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Plant ingredients

Secondary plant ingredients:

For example polyphenols:

- ❑ phenolic acid (aroma)
- ❑ flavonoids (colour)
- ❑ bitter substances

Diverse biological activities:

- ❑ antimicrobial
- ❑ anti-inflammatory
- ❑ antioxidative
- ❑ immune modulative

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Some aspects of the broarder context of veterinary phytomedicine

- Importance of humans and their animals for the planet
- Antimicrobial resistence
- Organic Husbandry
- Evidence based medicine

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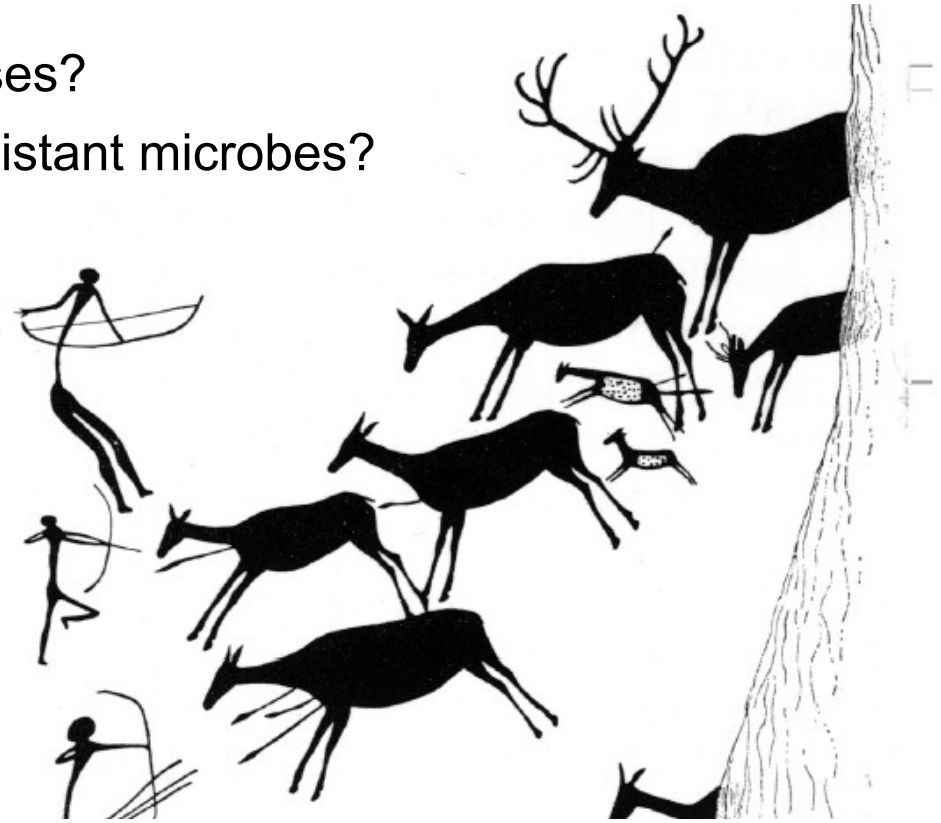
Do they have infections?

- Do they have infectious diseases?
- Do they carry antimicrobial resistant microbes?



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Live weight mass of all human, livestock and companion animals compared to all other landliving vertebrates inclusive birds

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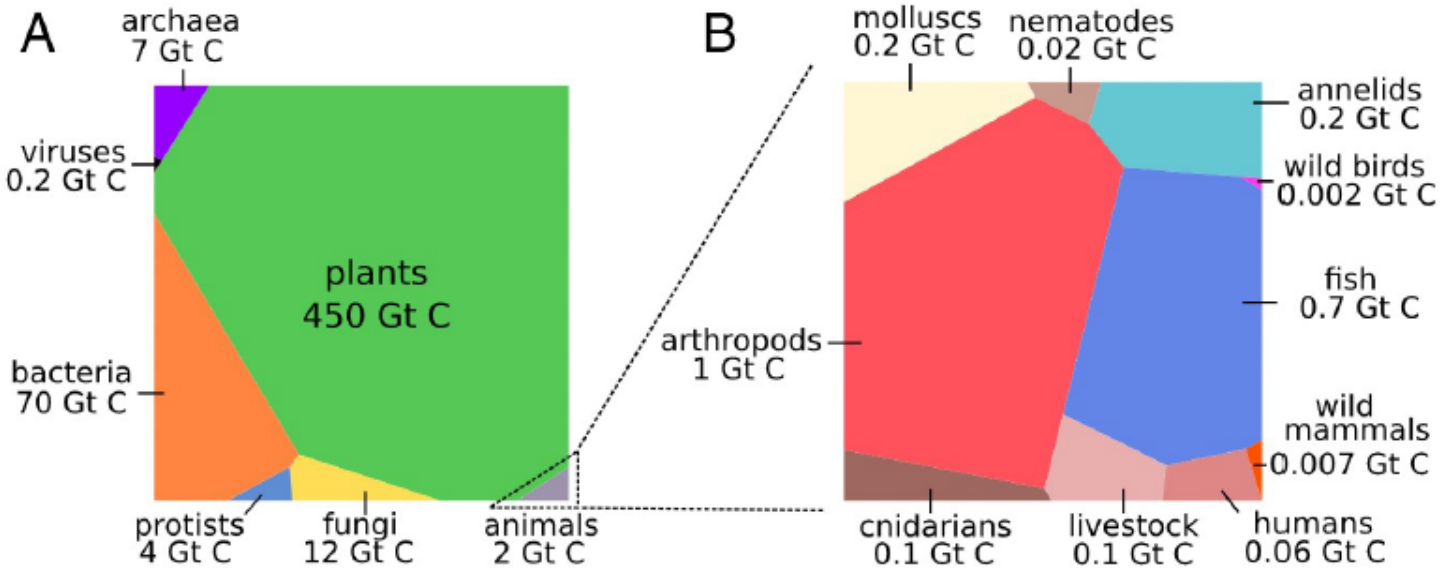
A few current population figures (in Gt C)



Bar-On et al. 2018

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Worldwide human and livestock population (Mio)

Human	7.980	477 M t live mass
Cattle	1.500	750 M t live mass
Small ruminants	2200	133 M t live mass
Pigs	785	78 M t live mass
Poultry	25.600	26 M t live mass

FAO STAT, 2020

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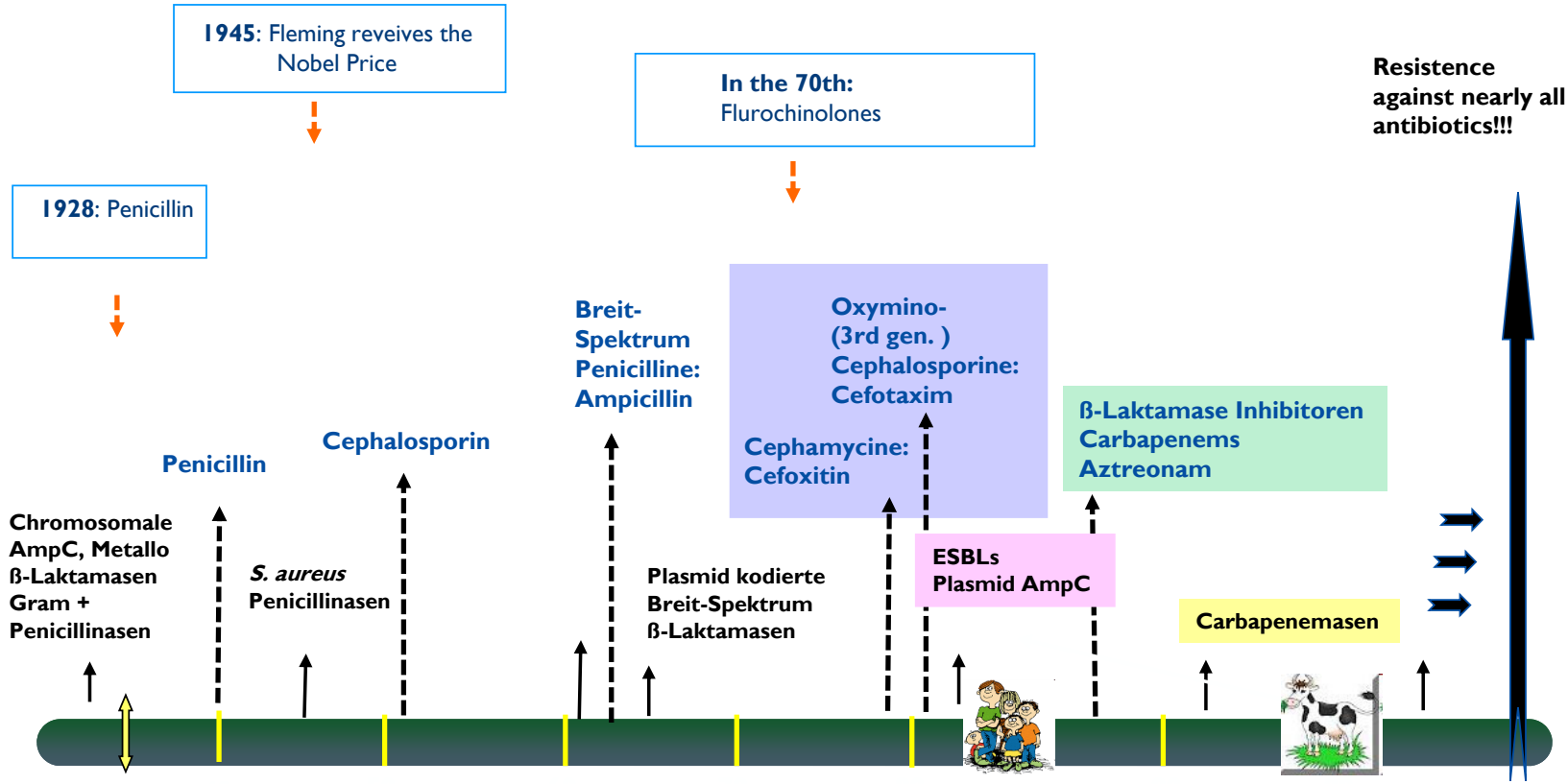
History of antimicrobial resistance



Dr. Norbert Roers, 14. Int. GGTM-Kongress, April 2014

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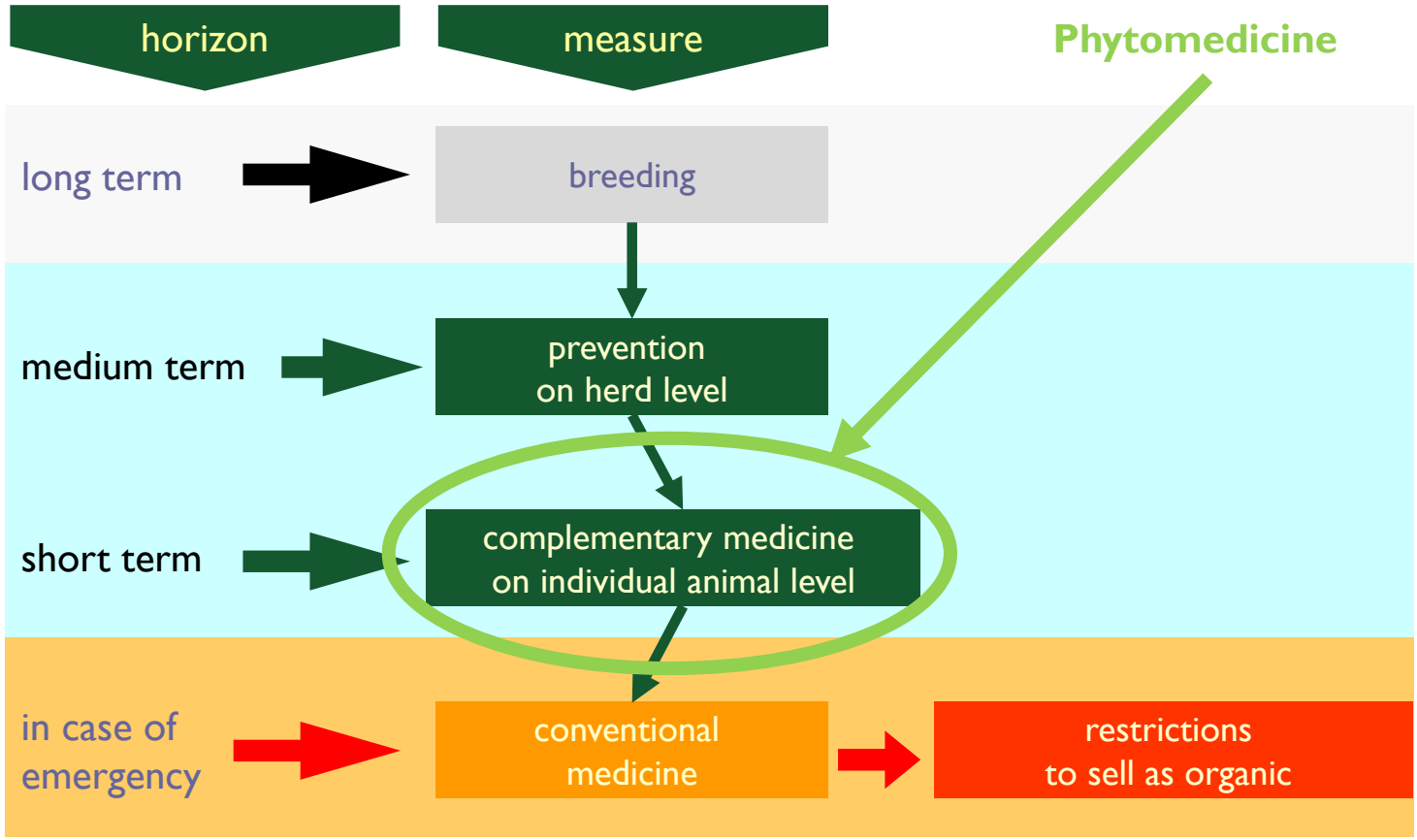
Maintaining animal health in organic agriculture



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Organic livestock production rules

Phytomedicine

1.5.2. Veterinary treatment

1.5.2.1. Where animals become sick or injured despite preventive measures to ensure animal health, they shall be treated immediately.

1.5.2.2. Disease shall be treated immediately to avoid suffering of the animal. Chemically synthesised allopathic veterinary medicinal products, including antibiotics, may be used where necessary, under strict conditions and under the responsibility of a veterinarian, when the use of phytotherapeutic, homeopathic and other products is inappropriate. In particular, restrictions with respect to courses of treatment and withdrawal periods shall be defined.

1.5.2.3. Feed materials of mineral origin authorised pursuant to Article 24 for use in organic production, nutritional additives authorised pursuant to Article 24 for use in organic production, and phytotherapeutic and homeopathic products shall be used in preference to treatment with chemically synthesised allopathic veterinary medicinal products, including antibiotics, provided that their therapeutic effect is effective for the species of animal and for the condition for which the treatment is intended.

1.5.2.4. With the exception of vaccinations, treatments for parasites and compulsory eradication schemes, where an animal or a group of animals receives more than three courses of treatments with chemically synthesised allopathic veterinary medicinal products, including antibiotics, within 12 months, or more than one course of treatment if their productive lifecycle is less than one year, neither the livestock concerned nor produce derived from such livestock shall be sold as organic products, and the livestock shall be subject to the conversion periods referred to in point 1.2.

1.5.2.5. The withdrawal period between the last administration to an animal of a chemically synthesised allopathic veterinary medicinal product, including of an antibiotic, under normal conditions of use, and the production of organically produced foodstuffs from that animal shall be twice the withdrawal period referred to in Article 11 of Directive 2001/82/EC, and shall be at least 48 hours.

1.5.2.6. Treatments related to the protection of human and animal health imposed on the basis of Union legislation shall be allowed.

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Evidence based medicine – Sackett et al., 1996

to create "win-win" relationships. By extension, critics of competition maintain that the NHS should do the same. These developments have been reinforced by concerns about the increase in management costs associated with the introduction of competition.

Estimates suggest that the NHS reforms may have resulted in up to £1bn extra being spent on administration, although changes in definitions make it difficult to be precise. This is because of the need to employ staff to negotiate and monitor contracts and to deal with the large volumes of paperwork involved in the contracting system. Ministers have responded to these concerns by streamlining the organisation of the NHS and introducing tight controls over management costs. They have also encouraged the use of long term contracts in order to reduce the transaction costs of the new arrangements.

Out of the ashes of competition has arisen a different policy agenda. This owes less to a belief in market forces than a desire to use the NHS reforms to achieve other objectives. The current agenda centres on policies to improve the health of the population, give greater priority to primary care, raise standards through the patient's charter, and ensure that medical decisions are evidence based. These policies hinge on effective planning and coordination in the NHS and all have been made more salient by the separation of purchaser and provider roles on which the reforms are based.

In particular, the existence of health authorities able to take an independent view of the population's health needs without being beholden to particular providers has changed the way in which decisions are made. To this extent the organisational changes introduced in 1991 have served to refocus attention on those whom the NHS exists to serve, even though the effects were neither anticipated nor intended when the reforms were designed. Like a potter moulding clay, only in the process of creation has the shape of the product become apparent. The effect of this policy shift has been to open up common ground between Labour and the Conservatives, notwithstanding the differences that remain.

Yet before the obituary of competition is written, the consequences of a return to planning need to be thought through. The NHS was reformed precisely because the old command and control system had failed to deliver acceptable improvements in efficiency and quality, and the limitations of planning must also be acknowledged. While competition as a reforming strategy may have had its day, there are nevertheless elements of this strategy which are worth preserving. Not least, the stimulus to improve performance which arises from the threat that contracts may be moved to an alternative provider should not be lost. The middle way between planning and competition is a path called contestability. This recognises that health care requires cooperation between purchasers and providers and the capacity to plan developments on a long term basis. At the same time, it is based on the premise that performance may stagnate unless there are sufficient incentives to bring about continuous improvements. Some of these incentives may be achieved through management action or professional pressure, and some may derive from political imperatives.

In addition, there is the stimulus to improve performance which exists when providers know that purchasers have alternative options. This continues to be part of the psychology of NHS decision making, even though ministers seem reluctant to use the language of markets. It is, however, a quite different approach than competitive tendering for clinical services, which would expose providers to the rigours of the market on a regular basis.

The essence of contestability is that planning and competition should be used together, with contracts moving only when other means of improving performance have failed. Put another way, in a contestable health service it is the possibility that contracts may move that creates an incentive within the system, rather than the actual movement of contracts. Of course for this to be a real incentive then contracts must shift from time to time, but this is only one element in the process and not necessarily the most important. As politicians prepare their plans for the future it is this path that needs to be explored.

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1 Smith R, Wilkinson Waldegrave: thinking beyond the new NHS. *BMJ* 1995;311:711–4.
2 Bottomley V. *The new NHS: continuity and change*. London: Department of Health, 1995.

Evidence based medicine: what it is and what it isn't

It's about integrating individual clinical expertise and the best external evidence

Evidence based medicine, whose philosophical origins extend back to mid-19th century Paris and earlier, remains a hot topic for clinicians, public health practitioners, purchasers, planners, and the public. There are now frequent workshops in how to practice and teach it (one sponsored by the *BMJ* will be held in London on 24 April); undergraduate[1] and postgraduate[2] training programmes are incorporating it[3] (or pondering how to do so); British centres for evidence based practice have been established or planned in adult medicine, child health, surgery, pathology, pharmacotherapy, nursing, general practice, and dentistry; the Cochrane Collaboration and Britain's Centre for Review and Dissemination in York are providing systematic reviews of the effects of health care; new evidence based practice journals are being launched; and it has become a common topic in the lay media. But enthusiasm has been mixed with some negative reaction.[4–6] Criticism has ranged from evidence based medicine being old hat to it being a dangerous innovation, perpetrated by the arrogant to serve cost cutters and suppress clinical freedom. As evidence based medicine continues to evolve and adapt, now is a useful time to restate the discipline of what it is and what it is not.

Evidence based medicine is the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients. The practice of evidence based medicine means integrating individual clinical expertise with the best available external clinical evidence from systematic research. By individual clinical expertise we mean the proficiency and judgment that individual clinicians acquire through clinical experience and clinical practice. Increased expertise is reflected in many ways, but especially in more effective and efficient diagnosis and in the more thoughtful identification and compassionate use of individual patients' predicaments, rights, and preferences in making clinical decisions about their care. By best available external clinical evidence we mean clinically relevant research, often from the basic sciences of medicine, but especially from patient centred clinical research into the accuracy and precision of diagnostic tests (including the clinical examination), the power of prognostic markers, and the efficacy and safety of therapeutic, rehabilitative, and preventive regimens. External clinical evidence both invalidates previously accepted diagnostic tests and treatments and replaces them with new ones that are more powerful, more accurate, more efficacious, and safer.

Good doctors use both individual clinical expertise and the best available external evidence, and neither alone is enough. Without clinical expertise, practice risks becoming tyrannised by evidence, for even excellent external evidence may be inapplicable to or inappropriate for an individual patient. Without current best evidence, practice risks becoming rapidly out of date, to the detriment of patients.

This description of what evidence based medicine is helps clarify what evidence based medicine is not. Evidence based medicine is neither old hat nor impossible to practice. The argument that "everyone already is doing it" falls before evidence of striking variations in both the integration of patient values into our clinical behaviour[7] and in the rates with which clinicians provide interventions to their patients.[8] The difficulties that clinicians face in keeping abreast of all the medical advances reported in primary journals are obvious from a comparison of the time required for reading (for general medicine, enough to examine 19 articles per day, 365 days per year[9]) with the time available (well under an hour a week by British medical consultants, even on self reports[10]).

The argument that evidence based medicine can be conducted only from ivory towers and armchairs is refuted by audits from the front lines of clinical care where at least some inpatient clinical teams in general medicine,[11] psychiatry (J R Geddes *et al*, Royal College of Psychiatrists winter meeting, January 1996), and surgery (P McCulloch, personal communication) have provided evidence based care to the vast majority of their patients. Such studies show that busy clinicians who devote their scarce reading time to selective, efficient, patient driven searching, appraisal, and incorporation of the best available evidence can practice evidence based medicine.

Evidence based medicine is not "cookbook" medicine. Because it requires a bottom up approach that integrates the best external evidence with individual clinical expertise and patients' choice, it cannot result in slavish, cookbook approaches to individual patient care. External clinical evidence can inform, but can never replace, individual clinical expertise, and it is this expertise that decides whether the external evidence applies to the individual patient at all and, if so, how it should be integrated into a clinical decision. Similarly, any external guideline must be integrated with individual clinical expertise in deciding whether and how it matches the patient's clinical state, predicament, and preferences, and thus whether it should be applied. Clinicians who fear top down cookbooks will find the advocates of evidence based medicine joining them at the barricades.

Some fear that evidence based medicine will be hijacked by purchasers and managers to cut the costs of health care. This would not only be a misuse of evidence based medicine but suggests a fundamental misunderstanding of its financial consequences. Doctors practising evidence based medicine will identify and apply the most efficacious interventions to maximise the quality and quantity of life for individual patients; this may raise rather than lower the cost of their care.

Evidence based medicine is not restricted to randomised trials and meta-analyses. It involves tracking down the best external evidence with which to answer our clinical questions. To find out about the accuracy of a diagnostic test, we need to find proper cross sectional studies of patients clinically suspected of harbouring the relevant disorder, not a randomised trial. For a question about prognosis, we need proper follow up studies of patients assembled at a uniform, early point in the clinical course of their disease. And sometimes the evidence we need will come from the basic sciences such as genetics or immunology. It is when asking questions about therapy that we should try to avoid the non-experimental approaches, since these routinely lead to false positive conclusions about efficacy. Because the randomised trial, and especially the systematic review of several randomised trials, is so much more likely to inform us and so much less likely to mislead us, it has become the "gold standard" for judging whether a treatment does more good than harm. However, some questions about therapy do not require randomised trials (successful interventions for otherwise fatal conditions) or cannot wait for the trials to be conducted. And if no randomised trial has been carried out for our patient's predicament, we must follow the trail to the next best external evidence and work from there.

Despite its ancient origins, evidence based medicine remains a relatively young discipline whose positive impacts are just beginning to be validated,[12 13] and it will continue to evolve. This evolution will be enhanced as several undergraduate, postgraduate, and continuing medical education programmes adopt and adapt it to their learners' needs. These programmes, and their evaluation, will provide further information and understanding about what evidence based medicine is and is not.

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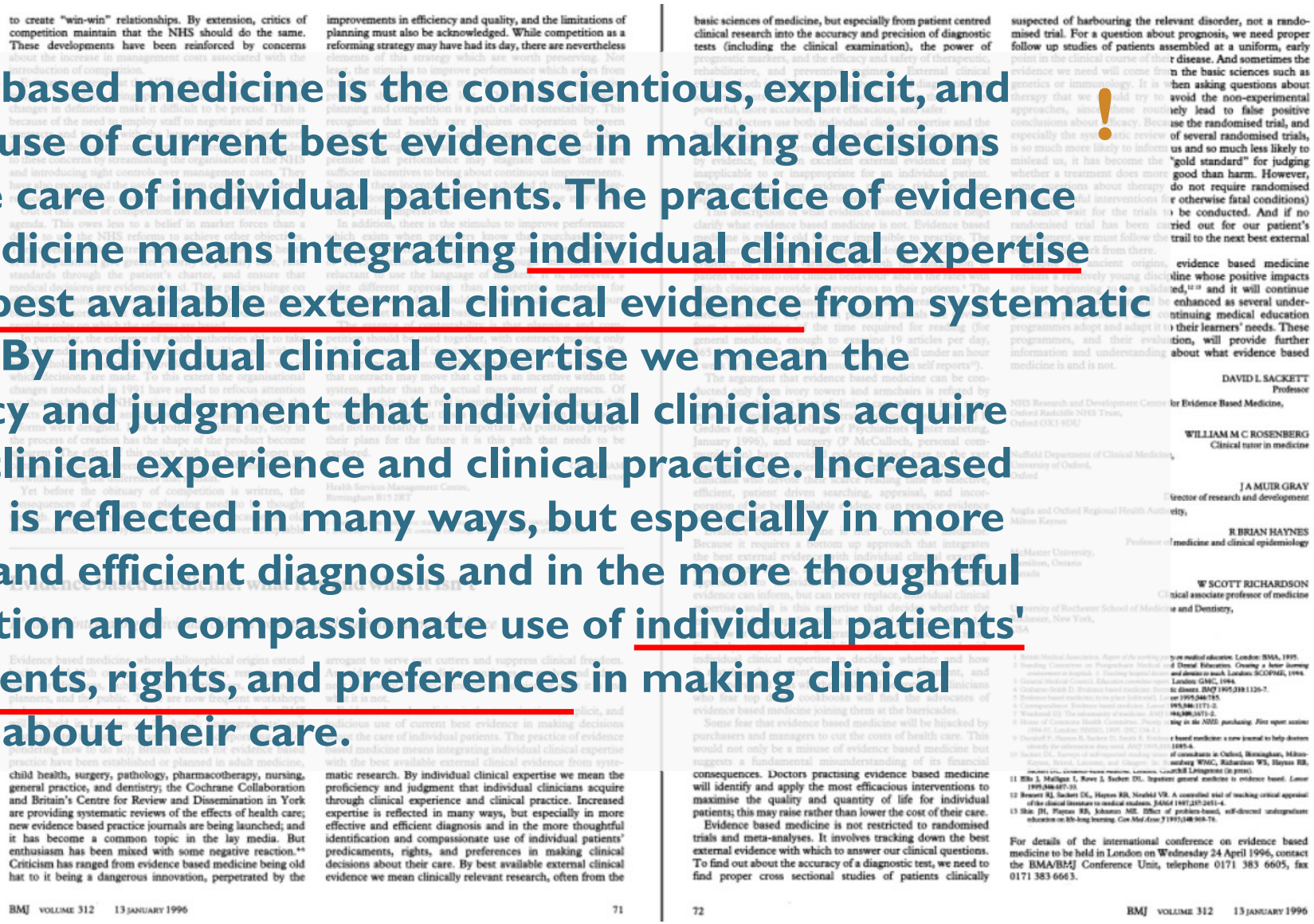
9 Davidoff F, Haynes B, Sackett D, Smith R. Evidence based medicine: a new journal to help doctors identify the information they need. *BMJ* 1995;310:1085–6.
10 Sackett DL. Surveys of self-reported reading times of consultants in Oxford, Birmingham, Milton-Keynes, Bristol, Leicester, and Glasgow. In: Rosenberg WMC, Richardson WS, Haynes RB, Sackett DL. *Evidence-based medicine*. London: Churchill Livingstone (in press).
11 Ellis J, Mulligan I, Rowe J, Sackett DL. Inpatient general medicine is evidence based. *Lancet* 1995;346:407–10.
12 Bennett KJ, Sackett DL, Haynes RB, Neufeld VR. A controlled trial of teaching critical appraisal of the clinical literature to medical students. *JAMA* 1987;257:2451–4.
13 Shin JH, Haynes RB, Johnston ME. Effect of problem-based, self-directed undergraduate education on life-long learning. *Can Med Assoc J* 1993;148:969–76.

For details of the international conference on evidence based medicine to be held in London on Wednesday 24 April 1996, contact the BMA/BMJ Conference Unit, telephone 0171 383 6605, fax 0171 383 6663.

Evidence based medicine – Sackett et al., 1996

Evidence based medicine is the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients. The practice of evidence based medicine means integrating individual clinical expertise with the best available external clinical evidence from systematic research. By individual clinical expertise we mean the proficiency and judgment that individual clinicians acquire through clinical experience and clinical practice. Increased expertise is reflected in many ways, but especially in more effective and efficient diagnosis and in the more thoughtful identification and compassionate use of individual patients' predicaments, rights, and preferences in making clinical decisions about their care.



to create "win-win" relationships. By extension, critics of competition maintain that the NHS should do the same. These developments have been reinforced by concerns

improvements in efficiency and quality, and the limitations of planning must also be acknowledged. While competition as a reforming strategy may have had its day, there are nevertheless

child health, surgery, pathology, pharmacotherapy, nursing, general practice, and dentistry; the Cochrane Collaboration and Britain's Centre for Review and Dissemination in York are providing systematic reviews of the effects of health care; new evidence based practice journals are being launched; and it has become a common topic in the lay media. But enthusiasm has been mixed with some negative reaction.** Criticism has ranged from evidence based medicine being old hat to it being a dangerous innovation, perpetrated by the

matic research. By individual clinical expertise we mean the proficiency and judgment that individual clinicians acquire through clinical experience and clinical practice. Increased expertise is reflected in many ways, but especially in more effective and efficient diagnosis and in the more thoughtful identification and compassionate use of individual patients' predicaments, rights, and preferences in making clinical decisions about their care. By best available external clinical evidence we mean clinically relevant research, often from the

BMJ VOLUME 312 13 JANUARY 1996 71

basic sciences of medicine, but especially from patient centred clinical research into the accuracy and precision of diagnostic tests (including the clinical examination), the power of

consequences. Doctors practising evidence based medicine will identify and apply the most efficacious interventions to maximise the quality and quantity of life for individual patients; this may raise rather than lower the cost of their care.

Evidence based medicine is not restricted to randomised trials and meta-analyses. It involves tracking down the best external evidence with which to answer our clinical questions. To find out about the accuracy of a diagnostic test, we need to find proper cross sectional studies of patients clinically

72

suspected of harbouring the relevant disorder, not a randomised trial. For a question about prognosis, we need proper follow up studies of patients assembled at a uniform, early

DAVID L SACKETT
Professor

WILLIAM M C ROSENBERG
Clinical tutor in medicine

J A MUIR GRAY

R BRIAN HAYNES

W SCOTT RICHARDSON

For details of the international conference on evidence based medicine to be held in London on Wednesday 24 April 1996, contact the BMA/BMJ Conference Unit, telephone 0171 383 6605, fax 0171 383 6663.

BMJ VOLUME 312 13 JANUARY 1996

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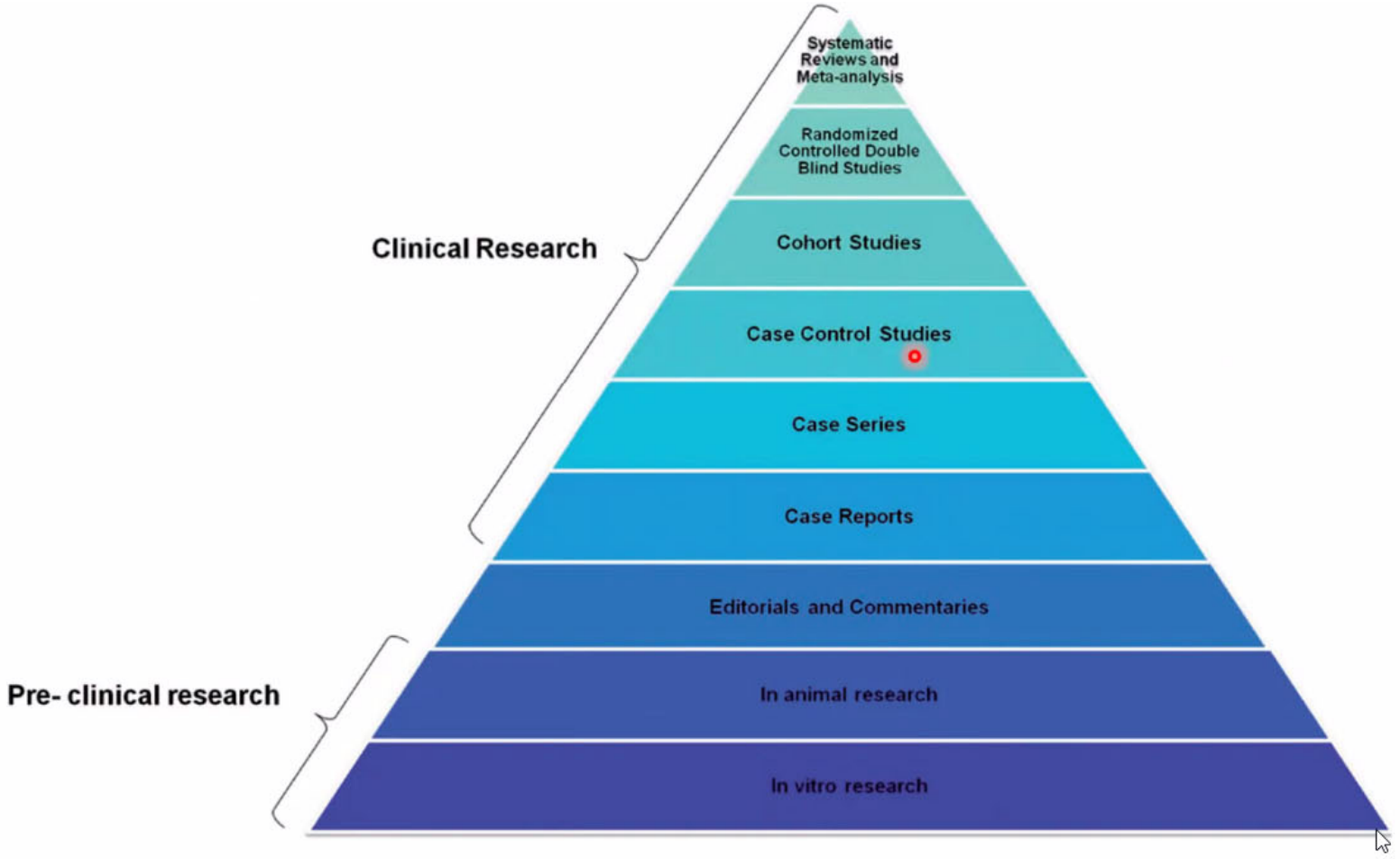
External Evidence based mainly on scientific (peer-reviewt) publications



Hubertus Wald Tumorzentrum
Universitäres Cancer Center Hamburg
Ein Kompetenznetzwerk des UKE

[Varoni EM et al. – Efficacy behind activity – Phytotherapeutics are not different from pharmaceuticals. Pharm Biol 2015;53(3):404-406]

While looking for new phytomedicines…

- ❑ *in vitro / ex vivo* data on biological activities
- ❑ evidence of effectiveness in human
- ❑ animal *in vivo* data – clinical studies

Extrapolation into:

- ❖ target-species
- ❖ *in vivo* condition

- ❑ animal self-medication
- ❑ traditional veterinary medicine / Ethnoveterinary research

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Let’s start interaction - group work

- Form groups of 3
- Define a topic (can be very broad - a plant, a disease complex, an “area of knowledge”)
- Search for literature together (our literature list as a suggestion, but also your own search with the various search engines)
- Present the results to each other
- Over the entire 3 days, repeatedly incorporate what you have heard into the topic you have chosen, at the end of the training, create a 20-minute presentation, which is then presented to everyone in a subsequent online meeting (total - 2 hours).

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Inter-species differences

- size & doses
- **anatomy**
- **physiology**

ORAL ROUTE

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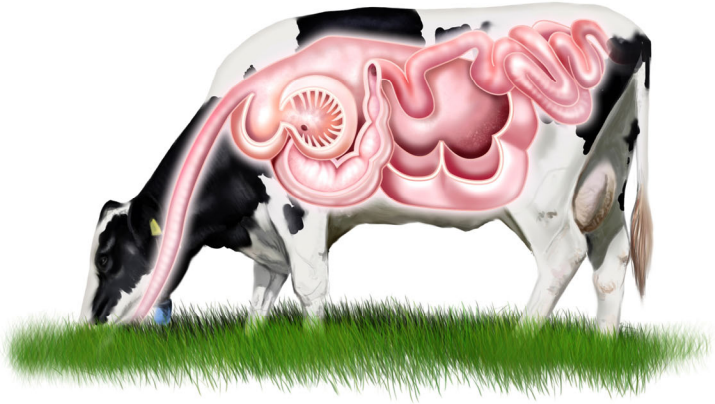
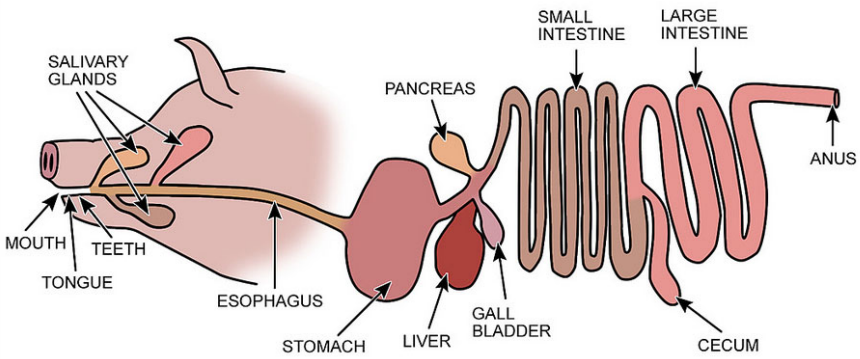
Oral application





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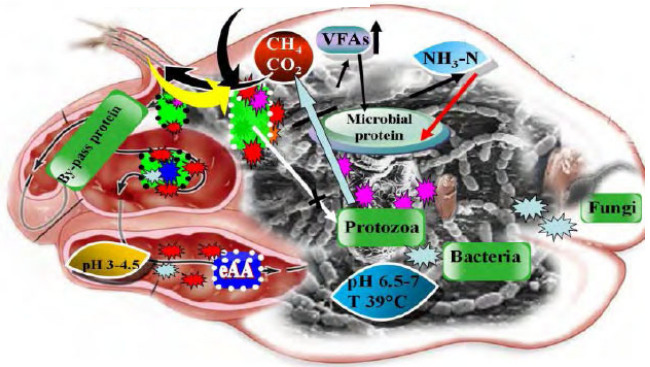
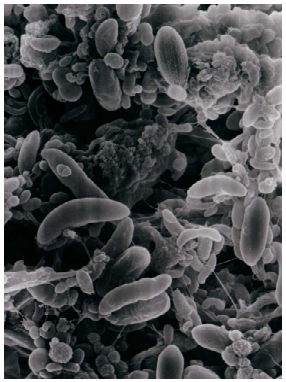
Source: Tree species | European Atlas of Forest Tree Species
Pro Earth Animal Health



Source: Wanapat (2012), modified from Nocek & Russell (1988)



www.intechopen.com

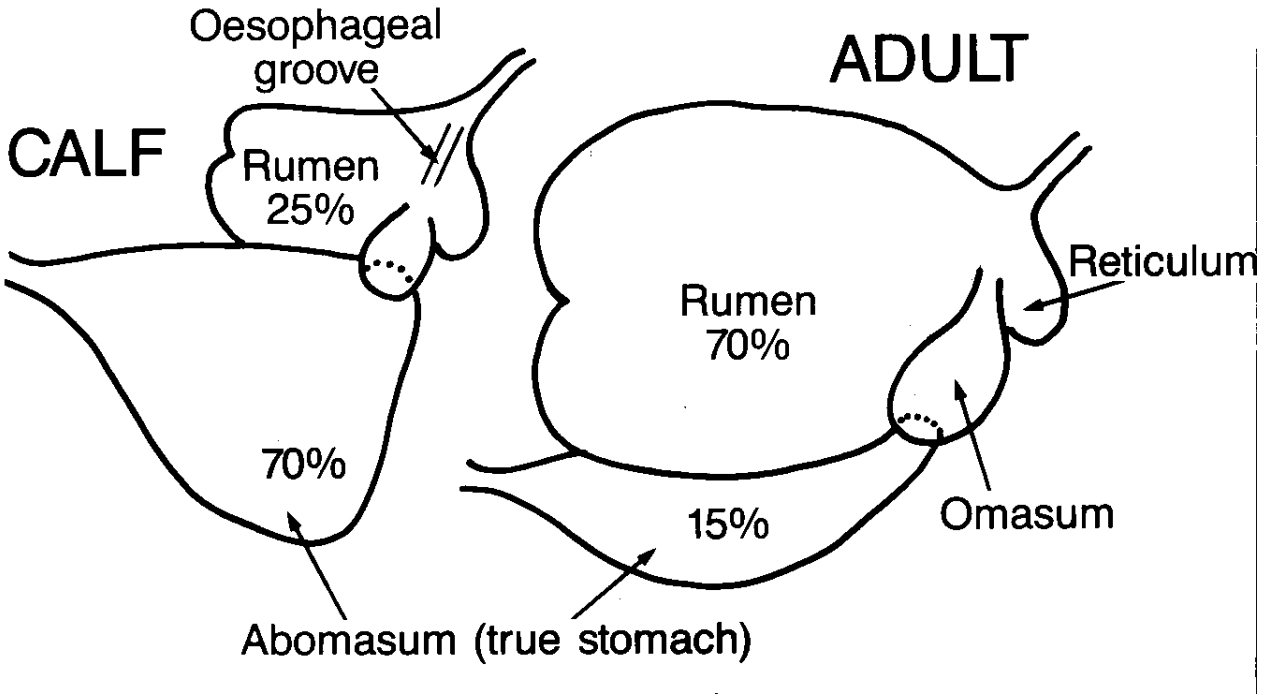
1 mL of rumen fluid:

25 billion bacteria

+10 million protozoa

+ 10 thousand fungi

Oral application - Ruminants



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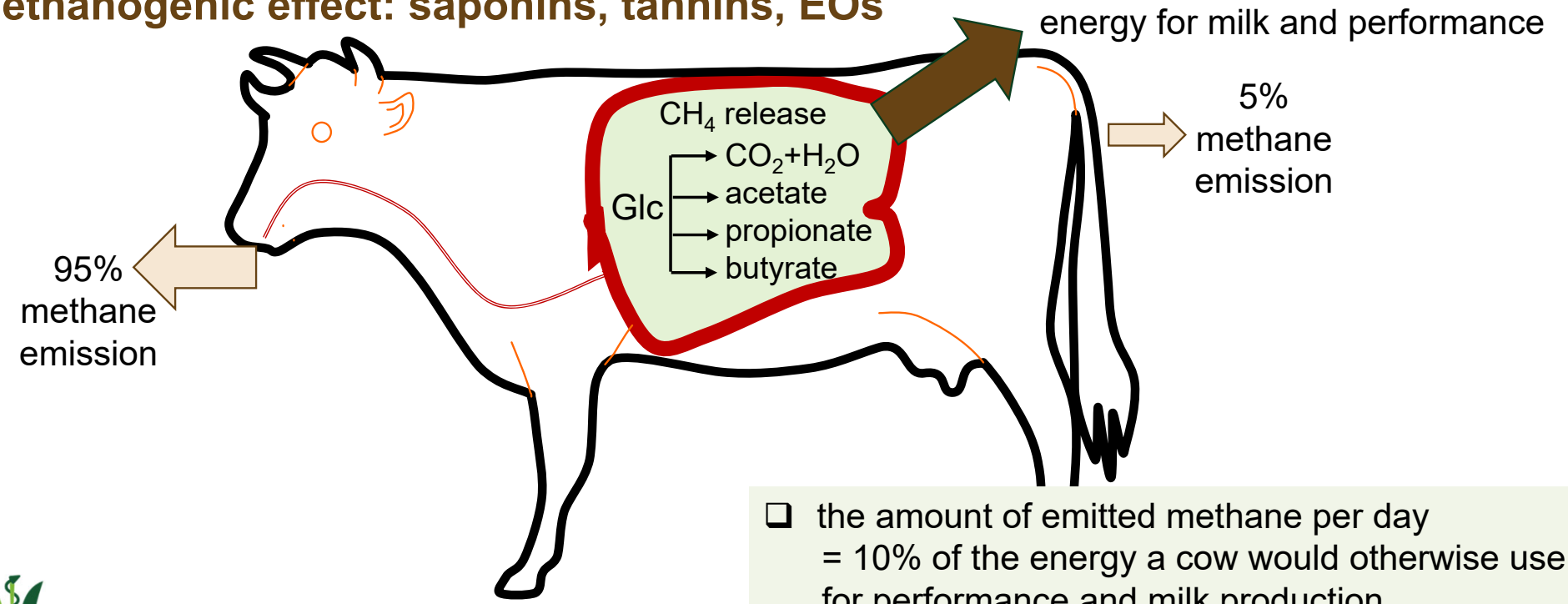
Oral application - Ruminants

The consequences of rumen metabolism:

2. limited usefulness for rumen fermentation control

Antimethanogenic effect: saponins, tannins, EOs



- ❑ the amount of emitted methane per day
  = 10% of the energy a cow would otherwise use for performance and milk production
- ❑ greenhouse gas emission

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Oral application - Ruminants

The consequences of rumen metabolism: limited usefulness for rumen fermentation

Antimethanogenic effect: saponins, tannins, EOs

Control

S.No.	Name of the herb / herbal extract / residue	Percent methane production
1.	*Acacia concinna* pods methanol extract	13.3 ± 1.33
2.	*Acacia concinna* pods methanol residue	13.3 ± 1.34
3.	*Allium sativum* bulbs water residue	15.0 ± 1.00
4.	*Zingiber officinale* rhizomes water residue	15.0 ± 1.08
5.	*Psidium guajava* leaves methanol residue	15.1 ± 1.11
6.	*Allium sativum* bulbs herb	16.7 ± 1.33
13.	*Zingiber officinale* rhizomes herb	20.0 ± 1.73
37.	*Azadirachta indica* seed kernels methanol extract	28.3 ± 1.70
38.	*Azadirachta indica* seed kernels herb	28.3 ± 1.73

Adaptation?

- PROBLEMS: discrepancies between *in-vitro* and *in-vivo* data
  - transient character of the suppression*
  - effectiveness variation dependent on the diet (roughage vs. starch diet)

Bunglavan et al., Livestock Research for Rural Development, 2010, 22

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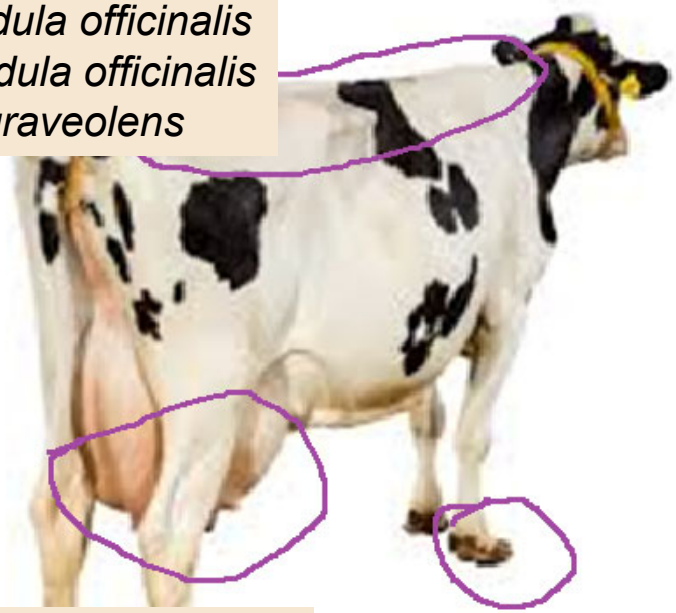
Ruminants

Calendula officinalis
Lavandula officinalis
Ruta graveolens



Fumaria indica
Avena sativa
Garcinia mangostana

primrose oil
Sarsaparrila officinalis
Angelica archangelica

The consequences of rumen metabolism:

※ Dramatic change of toxicity

※ Loss of efficacy due to degradation

※ Limited or no systemic effects after oral administration

TOPIC/LOCAL APPLICATION

ketolution.com

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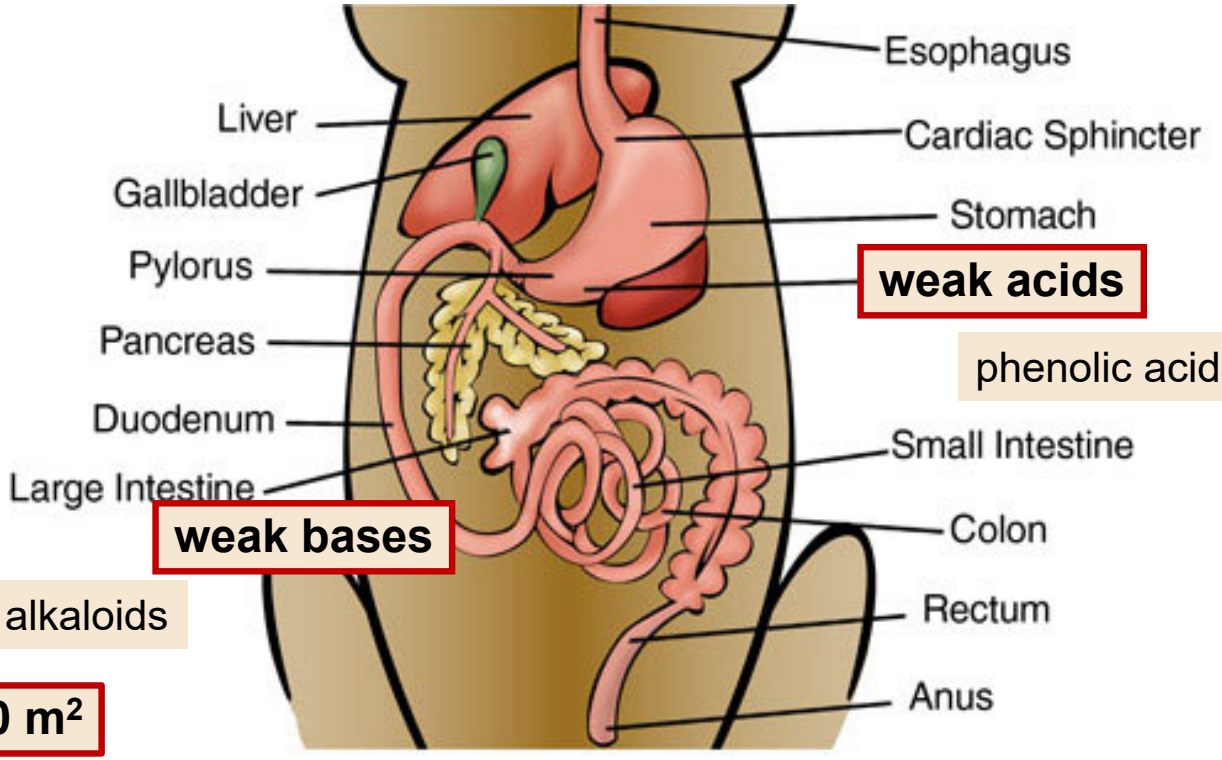
Monogastric animals – Omnivores and Carnivores



weak acids

phenolic acids

weak bases

alkaloids

ca. 200 m²

theorganicdog.wordpress.com/tag/digestive-system/

- **lipophilic substances**
  - sterols, triterpenoids
- all segments of GI tract

- **hydrophilic substances**
- absorption depends on pH value

Urine EXCRETION – analogue situation

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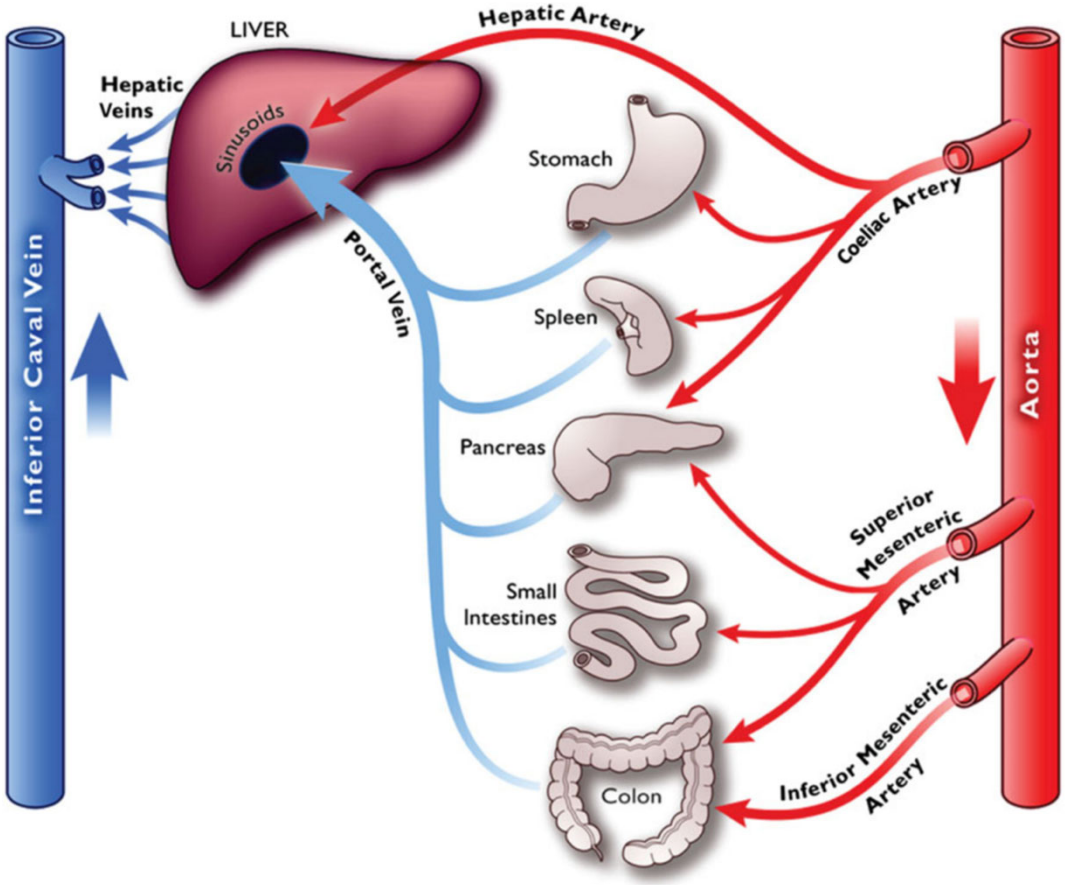
FIRST PASS EFFECT: Distribution/Metabolism vs. Efficacy and Safety



※ **Generation of inactive metabolites**

※ **Generation of toxic metabolites**

- biotransformation (Phase I) ≠ detoxification
- induction of metabolic enzymes
- inhibition of metabolic enzymes
- interactions!

Harper and Chandler,
BJA Education, 16 : 66–71 (2016)

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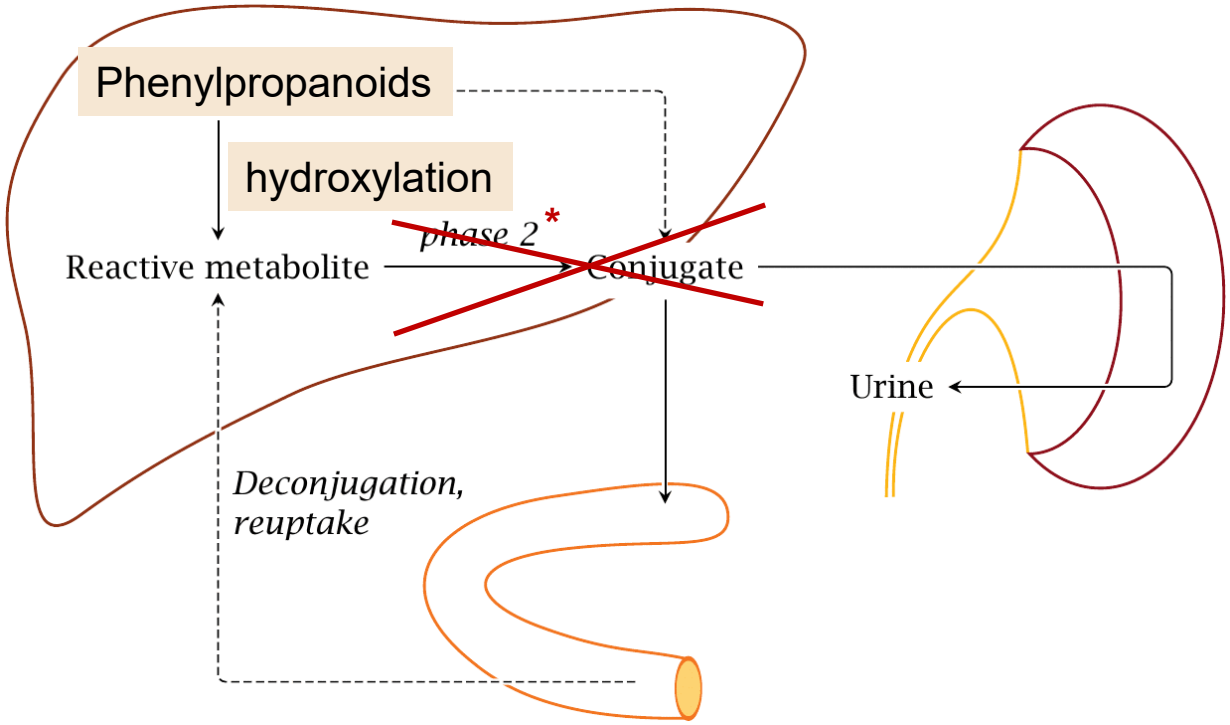
FIRST PASS EFFECT: Distribution/Metabolism vs. Efficacy and Safety

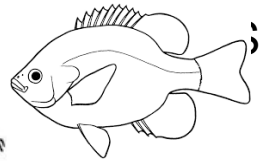


※ **Conjugation**

- active endogenous substances
- **UDPGA**, PAPS, SAM, GSH, ….

-

GLU UR SE



- very insufficient elimination

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http://watcut.uwaterloo.ca/webnotes/Pharmacology/metabolismOverview.html

Ruminants vs monogastics

Animals	urine pH
Cattle	7,4 – 8,4
Canine	5,5 – 7,5
Feline	6,0 – 7,0
Equide	7,0 – 8,0
Sheep & goats	7,0 – 8,0
Pigs	5,5 – 8,5
Human	4,8 – 7,5

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Food-producing animals

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Food-producing animals

Food of animal origin – food safety for consumers

Animals	Milk pH
Cows	6,5 – 6,7
Goats	6,5 – 6,7
Sheep	6,4 – 6,8
Buffalo	6,6 – 6,8
Camels	6,5 – 6,7
Dogs	7,4 – 7,9
Human	7,0 – 7,5

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Food-producing animals

Food of animal origin – food safety for consumers

7,6 – 7,9

9,2 – 9,7

+ lipophilicity

time

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Pharmacodynamic differences vs. Intensity of biological effects

- inter-species susceptibility of receptors, enzymes, intracellular pathways….
- oubain – positive inotropic effect

	oubain concentration
dog, cat	10^{-7} mol/L
guinea-pig	10^{-6} mol/L
rat	10^{-5} mol/L
mole	10^{-3} mol/L

- polymorphism of functional proteins

vet.uga.edu

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Doping in Equine Sport

For Equine Athlete

- the system of regulations that governs equine doping and medication control is the Equine Anti-Doping and Controlled Medication Regulations (EADCMR)

- the list of banned substances and methods for equine athletes is not that clear and precise as for human athletes
- not all prohibited substances are listed
- in animals, all what is not allowed, is prohibited

Doping in Equine Sport

2024 Equine Prohibited Substances List

- Prohibited Substan
  structure or similar
- Prohibited Substan
  below should not ir
  than other Prohibit
  are more likely to h
  enhancement of sp
  substance.

2024 Equine Prohibited Substances List

- Prohibited Substances include any other substance with a similar chemical structure or similar biological effect(s).
- Prohibited Substances that are identified as Specified Substances in the List below should not in any way be considered less important or less dangerous than other Prohibited Substances. Rather, they are simply substances which are more likely to have been ingested by Horses for a purpose other than the enhancement of sport performance, for example, through a contaminated food substance.

LISTED AS	SUBSTANCE	ACTIVITY
BANNED	1-androsterone	Anabolic
BANNED	1,3-Dimethylamylamine (methylhexanamine; DMAA)	Sympathomimetic
BANNED	3β-Hydroxy-5α-androstan-17-one	Anabolic
BANNED	4-chlorometatandienone	Anabolic
BANNED	5α-Androst-2-ene-17one	Anabolic
BANNED	5α-Androstane-3α, 17α-diol	Anabolic
BANNED	5α-Androstane-3α, 17β-diol	Anabolic
BANNED	5α-Androstane-3β, 17α-diol	Anabolic
BANNED	5α-Androstane-3β, 17β-diol	Anabolic
BANNED	5β-Androstane-3α, 17β-diol	Anabolic
BANNED	7α-Hydroxy-DHEA	Anabolic
BANNED	7β-Hydroxy-DHEA	Anabolic
BANNED	7-Keto-DHEA	Anabolic
CONTROLLED	17-Alpha-Hydroxy Progesterone FEMALES	Hormone
BANNED	17-Alpha-Hydroxy Progesterone MALES	Anabolic
CONTROLLED	17-hydroxyprogesterone hexanoate FEMALES	Hormone

On the List:

Caffeine

Hordenine

Hyoscyamine

Ibogaine

Salicylic acid

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A breeze of hope

Herbal bioenhancers

- ❑ active phytomolecules that increase the bioavailability, bioefficacy and biological activity of various drugs when co-administered at low concentration
- ❑ phytosomes: herbal drug formulations which facilitate bioenhancing phytomolecules
- ❑ Milk thistle *(Silybum marianum)*

aanmc.org

silybin, silydianin and silchristin → poorly absorbed from the gut

phytosomal silybin (silybin-phospholipid complex) → more rapidly absorbed, improved hepatoprotective effect

Yurdakok-Dikmen et al., Front Vet Sci, 2018
doi: 10.3389/fvets.2018.00249

How do animals become aware of the medicinal properties of plants?

Animal self-medication

Table 1. Studies showing evidence of self-selection of plant secondary compounds (PSC) aimed at improving health

Animal	PSC	Effect	Reference
Primates			
Chimpanzee (*Pan troglodytes schweinfurthii*)	Sesquiterpene lactones and steroid glucosides	Antiparasitic, antiamoebic, antibacterial, antifungal, antitumour	Huffman & Seifu[54]; Ohigashi *et al.*[55]
Insects			
Monarch butterflies (*Danaus plexippus*)	Cardenolides	Antiparasitic	Lefèvre *et al.*[89]
Woolly bear caterpillars (*Grammia incorrupta*)	Pyrrolizidine alkaloids	Antiparasitic	Singer *et al.*[30]
Tiger moths caterpillars (*Grammia geneura*)	Pyrrolizidine alkaloids	Antiparasitic	Bernays & Singer[90]
Birds			
Blackcaps (*Sylvia atricapilla*)	Flavonoids	Antioxidant, antiinflammatory, immunomodulatory	Catoni *et al.*[9]; Beaulieu *et al.*[63]
Gouldian finch (*Erythrura gouldiae*)	Polyphenols	Antioxidant	Catoni *et al.*[62]
Ruminants			
Sheep (*Ovis aries*)	Condensed tannins	Antiparasitic	Villalba *et al.*[32]; Juhnke *et al.*[33]; Copani *et al.*[59]
Goats (*Capra hircus*)	Condensed tannins	Antiparasitic	Amit *et al.*[34]

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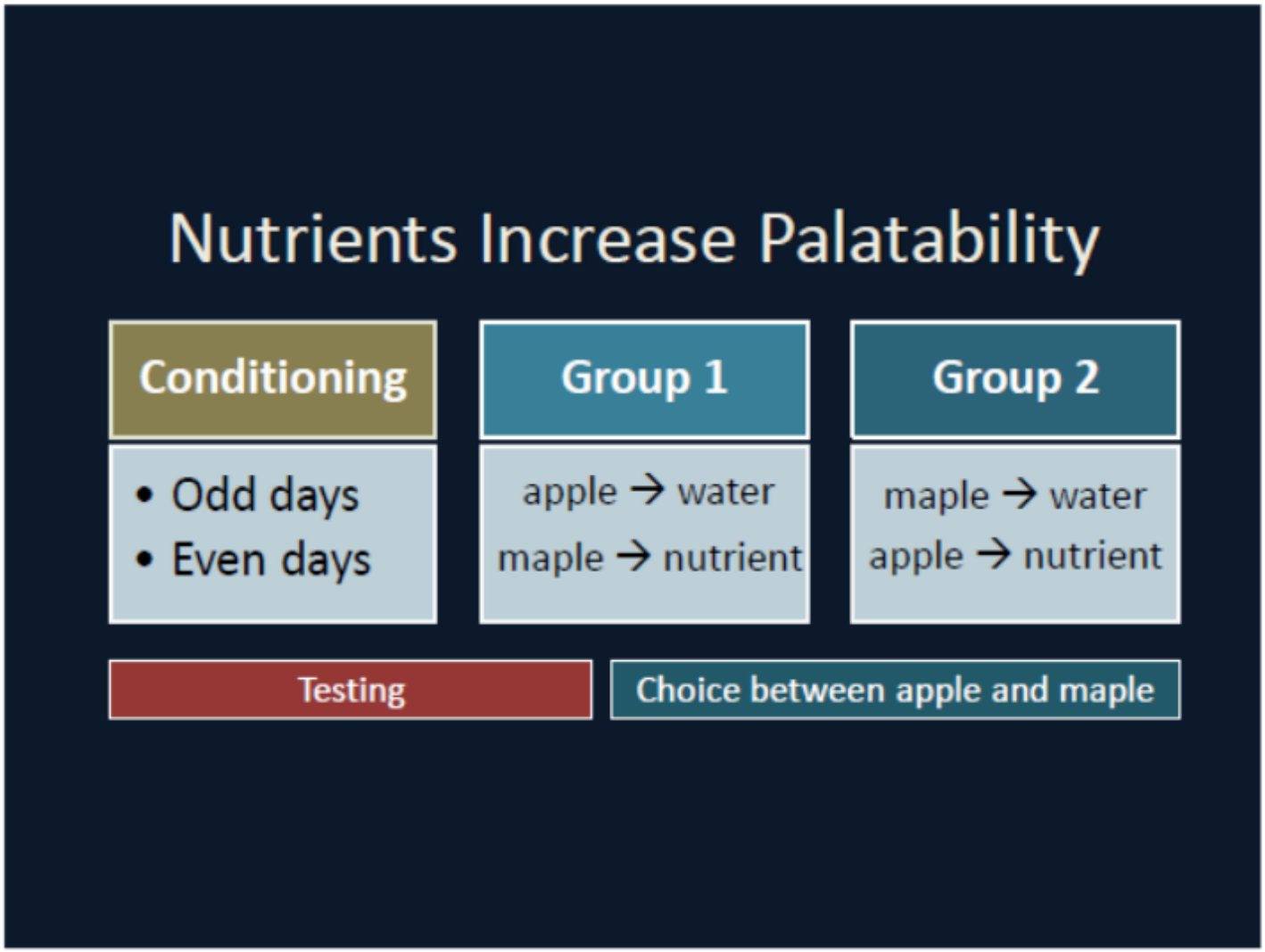

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Sheep learn to avoid foods that cause rumen distention…

…and they learn to prefer foods eaten during relief from rumen distention

MedPlants 4Vet

Fred D. Provenza, Innsbruck, 2019

Secundary plant metabolites

- How get animals aware of medicinal properties of plants?

"**biochemically mediated flavor-feedback"**

- ... curiosity and trial and error is the selection advantage of vertebrates

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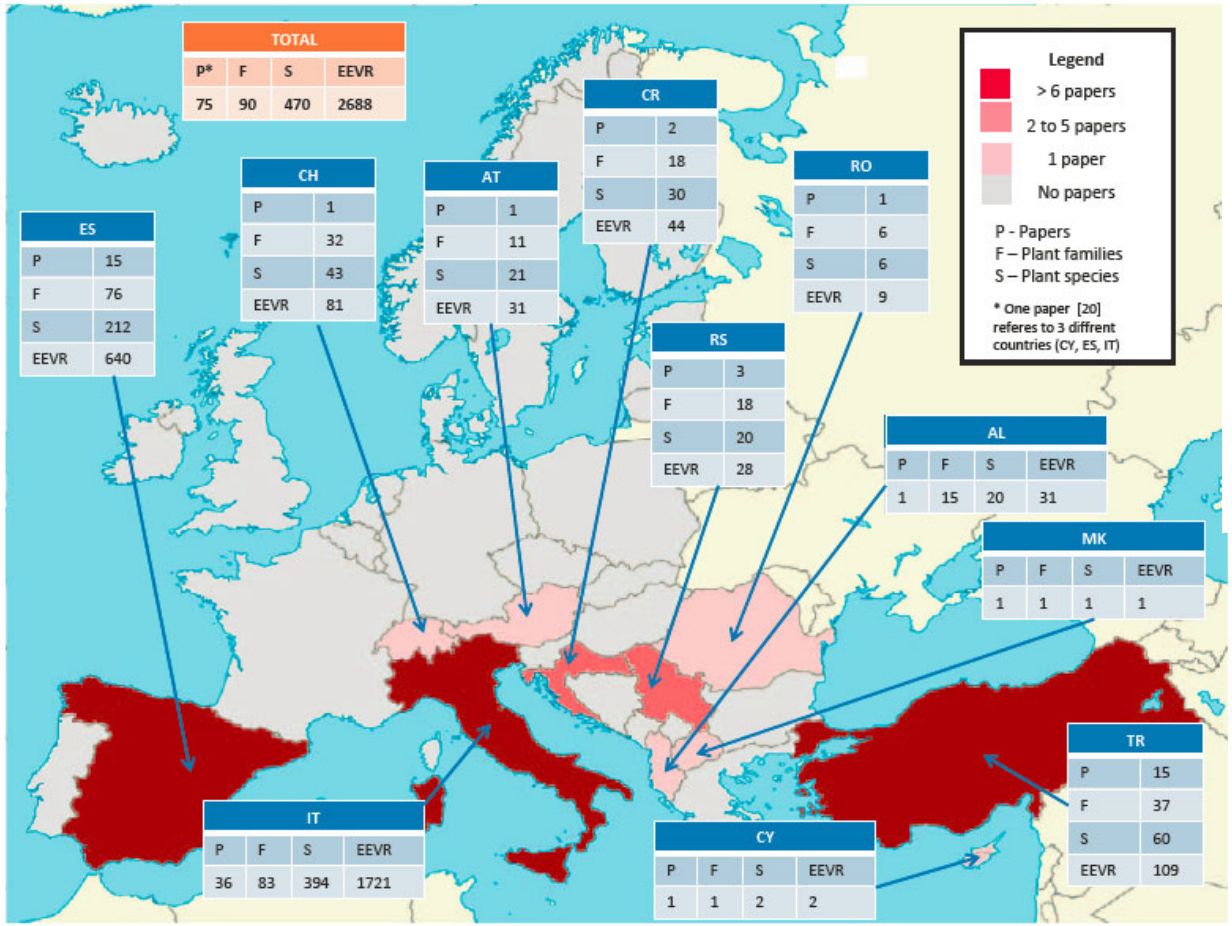
European ethnoveterinary research 1994 - 2014



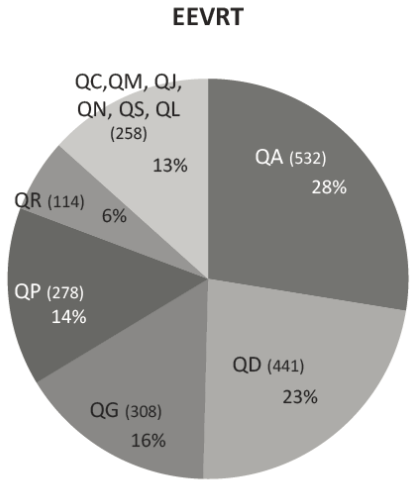
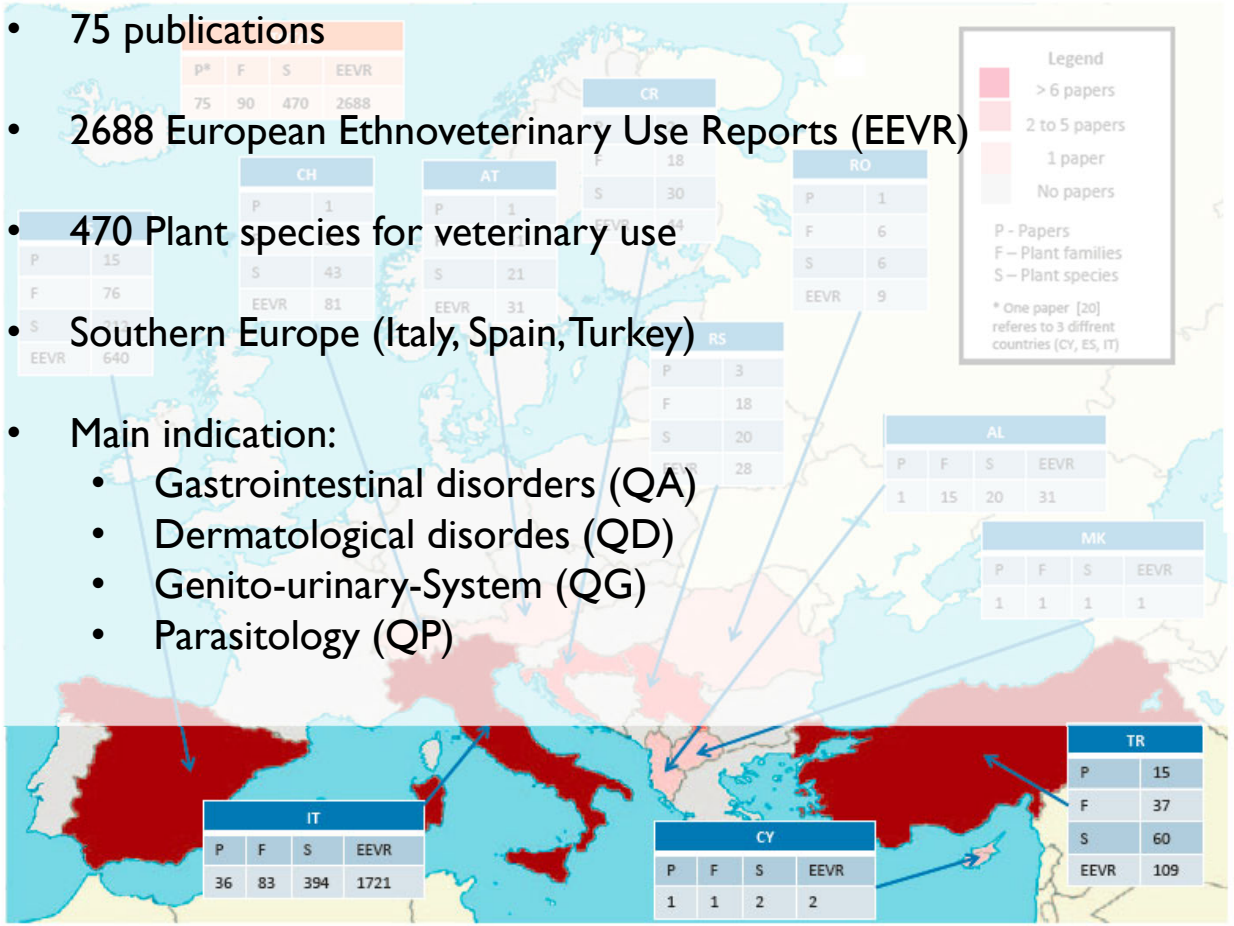


Fig. 2. European map of ethnoveterinary research. AL = Albania; AT = Austria; CH = Switzerland; CR = Croatia; CY = Cyprus; RO = Romania; IT = Italy; MK = Macedonia; RS = Serbia; TR = Turkey.

Mayer et al., 2014

European ethnoveterinary research 1994 - 2014

- 75 publications
- 2688 European Ethnoveterinary Use Reports (EEVR)
- 470 Plant species for veterinary use
- Southern Europe (Italy, Spain, Turkey)
- Main indication:
  - Gastrointestinal disorders (QA)
  - Dermatological disordes (QD)
  - Genito-urinary-System (QG)
  - Parasitology (QP)



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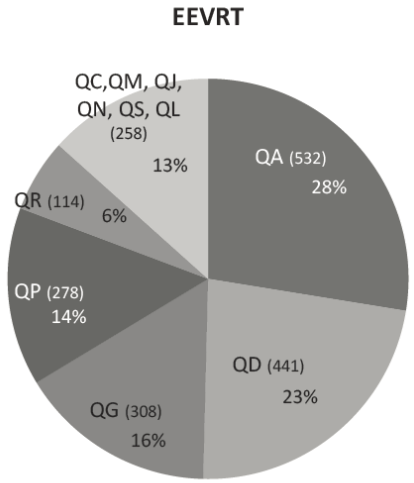
Mayer et al., 2014

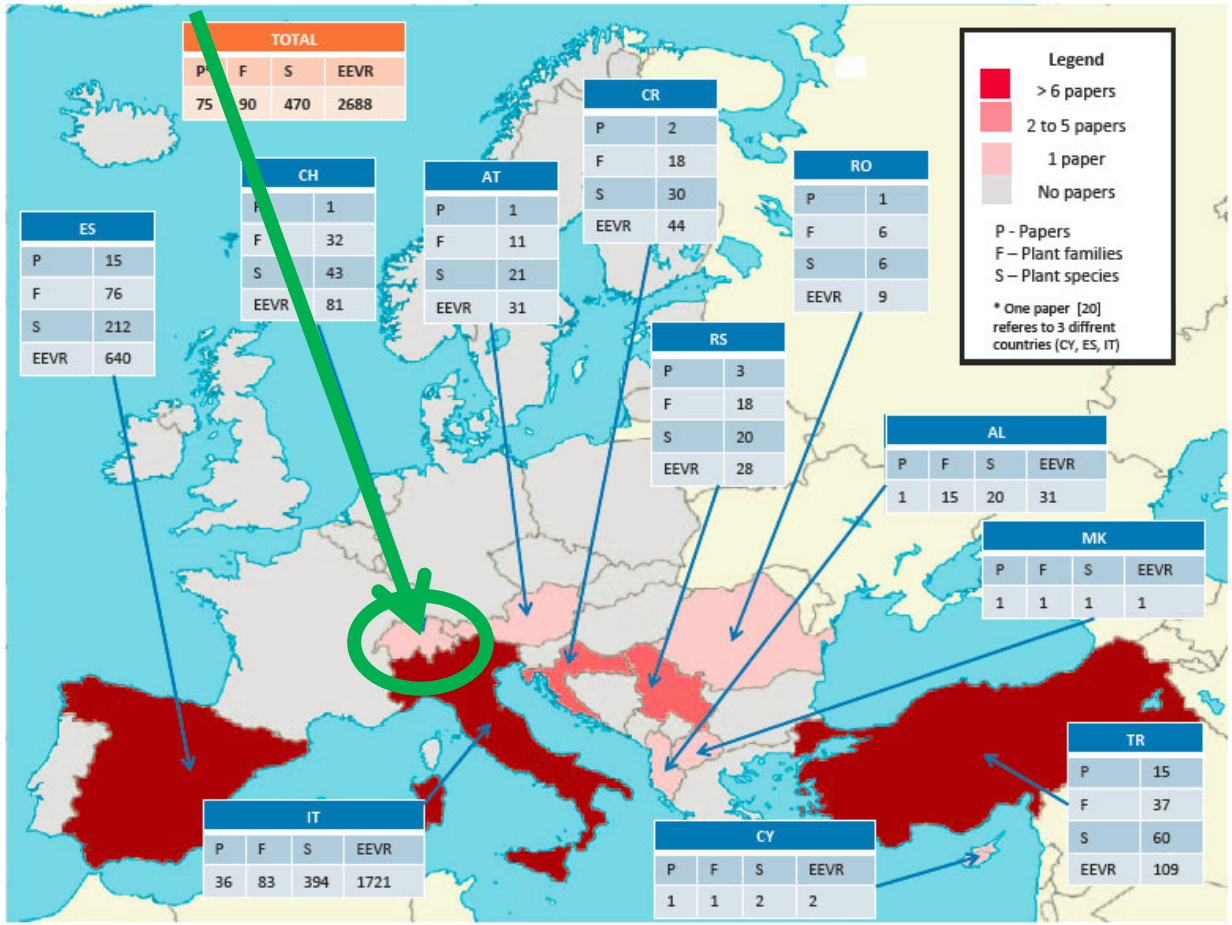


Top 10 plant list:

Malva sylvestris L.
Vitis vinifera L.
Urtica dioica L.
Allium sativum L.
Olea europeae L.
Sambucus nigra L.
Matricaria recutita L.
Hypericum perforatum L.
Fraxinus ornus L.
Scrophularia canina L.

MedPla 4Vet

Swiss ethnoveterinary research since 2011 (ongoing)



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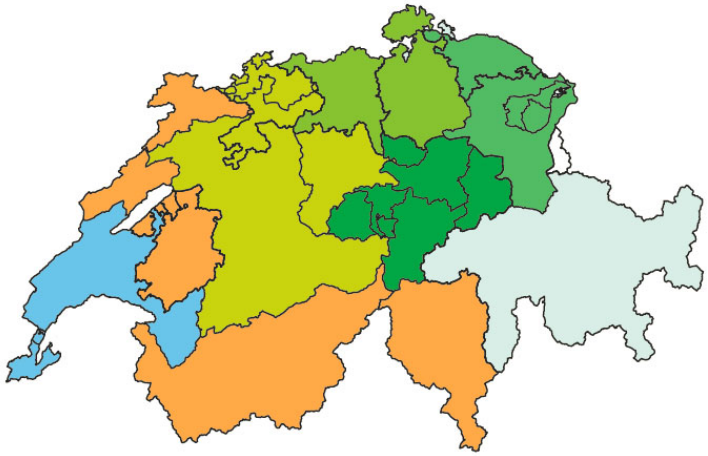
Swiss ethnoveterinary research

- Since 2011 a total of 10 ethnoveterinary studies have been conducted in all Swiss cantons; 9 with the same methodology:
- 334 Interviews (445 persons)
- Single plant preparations:
  - 1770 recepy-reports
  - 2323 use reports



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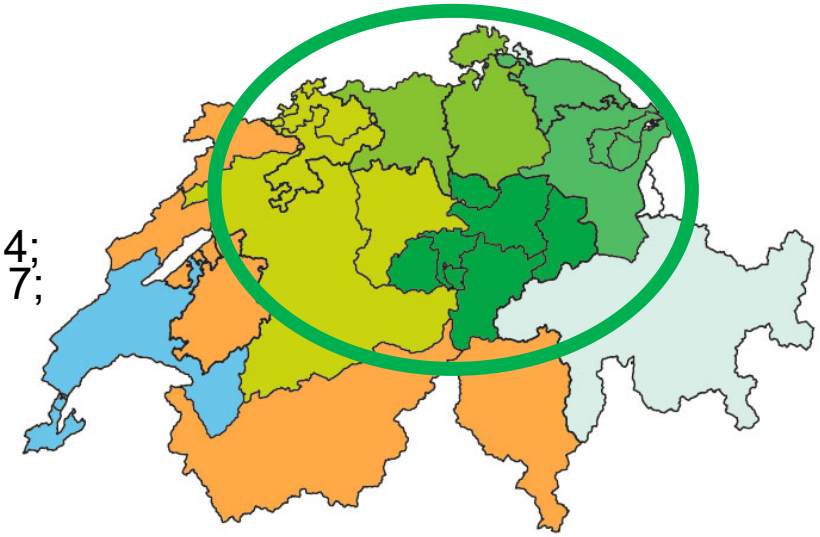
Swiss ethnoveterinary research

- Finally analysed – 19 German speaking Cantons
- 183 Interviews (242 persons)
- Single plant preparations:
  - 1128 recepy-reports
  - 1466 use reports (UR)
- Main indications
  - Dermatological disorders (516 UR)
  - Alimentary tract (412 UR)
- Main administration
  - Externally (660 UR)
  - Orally (705 UR)
- Main animal species treated
  - Cattle
  - (Schmid et al., 2012; Disler et al., 2014; Bischoff et al., 2016; Mayer et al., 2017; Stucki et al., 2019)



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The top 15 ethnoveterinay used plant species of German speaking Swiss cantons

Matricaria recutital L. - 160 UR

Calendula officinalis L. - 110 UR

Urtica dioica L. - 71 UR

Symphytum officinale L. - 71 UR

Coffea ssp. L. - 60 UR

Rumex obtusifolius L. - 52 UR

Hypericum perfotatum L. - 48 UR

Arnica montana L. - 46 UR

Linum usitatissimum L. - 46 UR

*Picea abies (*L.) H. Karst - 44 UR

Thymus vulgaris L. - 41 UR

Malva neglecta Wallr. - 40 UR

Quercus robur L. - 37 UR

*Camelia sinensis (*L.) Kuntze - 33 UR

Rhamnus cartaticus L. - 24 UR

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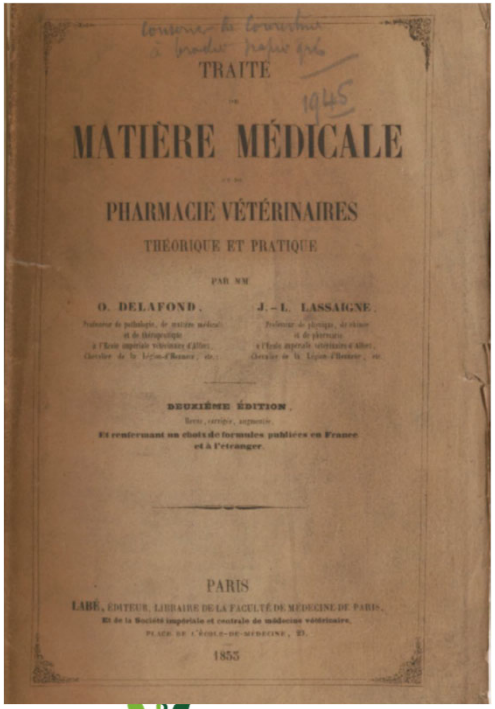
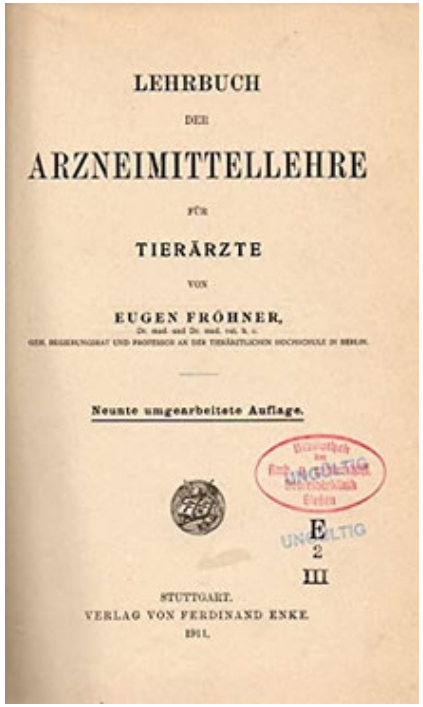
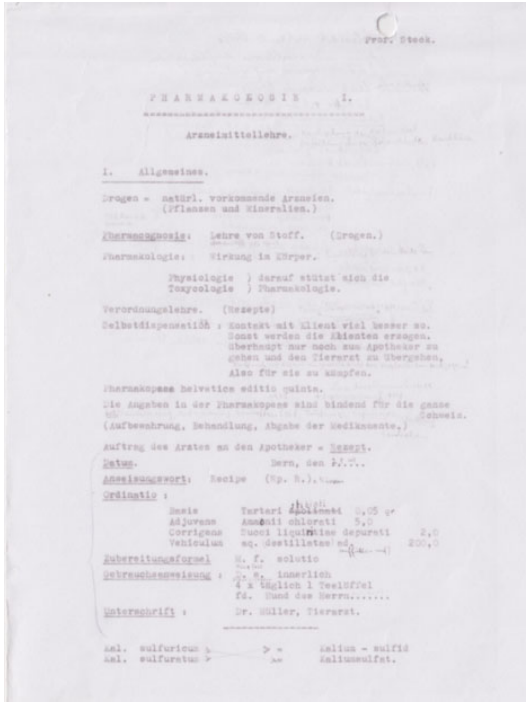
Medicinal plants in veterinary pharmacology

- Medicinal plants were an important basis of veterinary pharmacotherapy well into the 20th century, both in teaching and standard literature


TRAITE
DE
MATIÈRE MÉDICALE
ET DE
PHARMACIE VÉTÉRINAIRES
THÉORIQUE ET PRATIQUE
PAR MM
O. DELAFOND, J.-L. LASSAIGNE,
DEUXIÈME ÉDITION,
PARIS
1855


LEHRBUCH
DER
ARZNEIMITTELLEHRE
FÜR
TIERÄRZTE
VON
EUGEN FRÖHNER,
Neunte umgearbeitete Auflage.
STUTTGART.
VERLAG VON FERDINAND ENKE.
1911.

Delafond, 1855
Fröhner, 1900


Arzneimittellehre.
I. Allgemeines.

Steck, 1944

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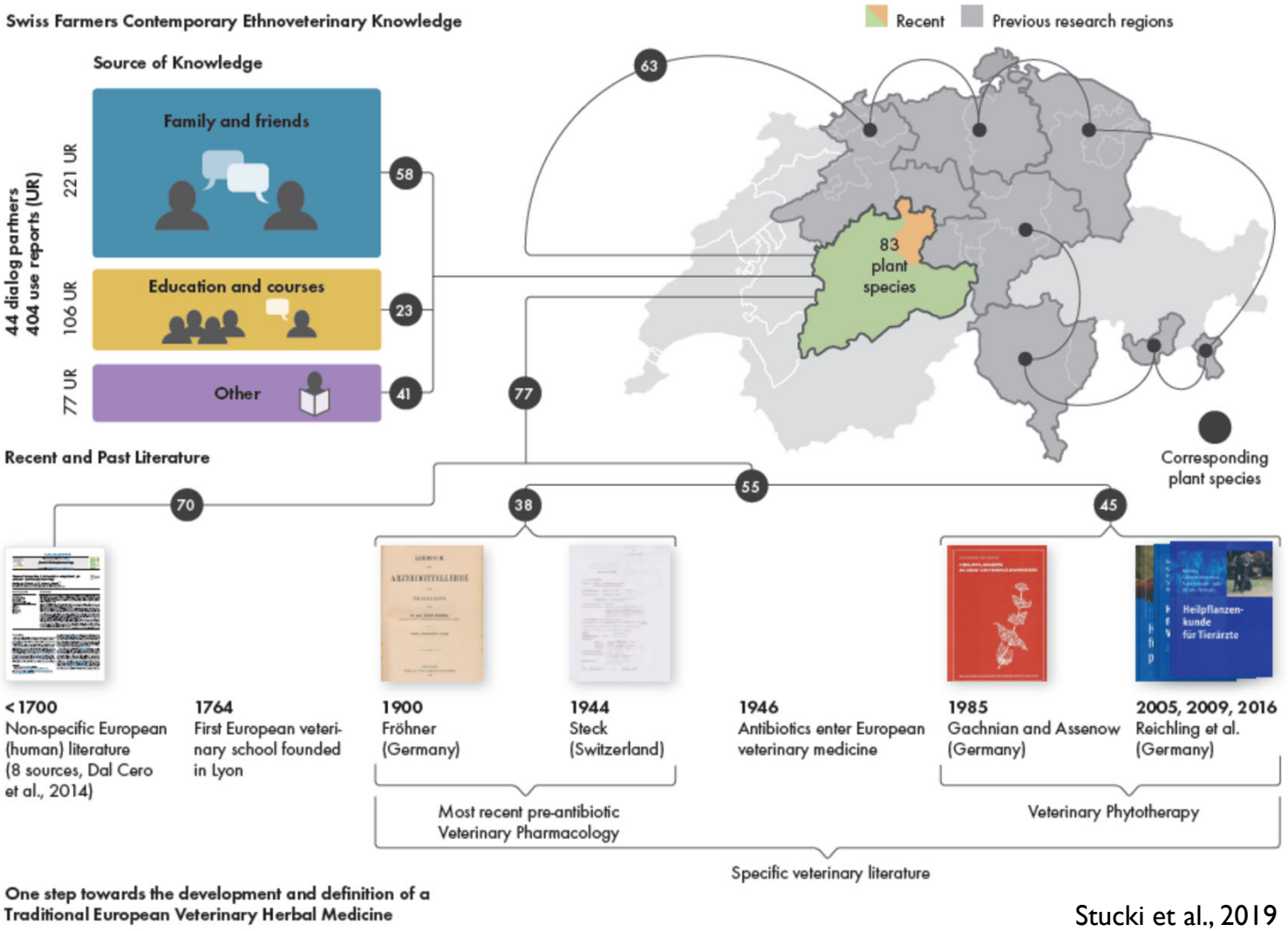
Plant use for animal health – is there a tradition?



Stucki et al., 2019

Example Chamomille – Dosage comparison

Table 4
Daily dosage in dry plant equivalent per kg metabolic body weight ($g/kg^{0.75}$) of homemade single species herbal remedies (HSHR) used in orally administered preparations, and dosage recommendations from literature.

Plant species with ≥ 3 HSHR and documented	Daily dosage [$g/kg^{0.75}$]			Converted animal daily dose [$g/kg^{0.75}$]					Converted human daily dose
	Arithmetic mean (median; min value-maximum value)	Determined mean daily dose [g] (Mayer it; M e; Bischoff; Schmid)		Fröhner (1900)	Steck (1944)	G and w (1985)	Reichling et al., (2005, 2008, 2016)		Converted human da se [$g/kg^{0.75}$]
***Matricaria recutita* L.**									
Flos (22)	0.006, 0.012, 0.013, 0.078, 0.094, 0.113, 0.118, 0.157, 0.177, 0.236, 0.236, 0.324		0.003, 0.128, 0.234	**0.255** (0.167; 0.003–0.864)	0.63; 0.27; 0.35; 1.12; 0.22	0.194–0.389 (cattle), 0.266–0.532 (goat)	0.194–0.389 (cattle)	0.194–0.389 (cattle), 0.266–0.532 (goat)	0.194–0.389 (cattle), 0.266–0.532 (goat)	0.39–0.52[a]
0.25 7; 0.0 64)	0.6 0.35; 1.12; 0			0.194–0.389 (cattle), 0.266–0.532 (goat)	0.194–0.38 (cattle)	0.194–0.389 (cattle), 0.266–0.532 (goat)	0.194–0.389 (cattle), 0.266–0.532 (goat)		0.52[a]
Kuntze.									
Folium (10)	0.02, 0.047, 0.078, 0.141, 0.157, 0.424, 0.761, 0.847, 0.872, 1.694			**0.504** (0.291; 0.02–1.694)	-; 0.38; 0.45; 0.64; -			0.3[c]	0.04[d]	0.22–0.33[b]
***Linum usitatissimum* L.**									
Semen (7)	1.099, 1.166, 4.170, 4.901, 5.490		0.093, 0.124	**2.435** (1.166; 0.093–5.490)	5.79; -; 6.89; 5.16; 2.92	0.389–0.777 (cattle), 1.064–2.660 (goat)	0.622–0.932 (cattle), 1.596–2.660 (goat)	0.39–0.777 (cattle), 1.064–2.660 (goat)	0.39–0.777 (cattle), 1.064–2.660 (goat)	0.66[a] (obstipation), 0.22–0.44[a] (gastritis/ enteritis)
***Alchemilla vulgaris* L.**									
Herba (7)		0.014, 0.078, 0.078, 0.149, 0.155, 0.389	0.106	**0.138** (0.106; 0.014–0.389)	-; -; -; -; -					0.22–0.44[a]
***Coffea* L.**									
Semen (9)	0.078, 0.327, 0.594, 7.843	0.078, 0.104, 0.353, 0.466, 1.345		**1.243** (0.353; 0.078–7.843)	1.67; 1.19; 0.34; 0.35; 0.37			0.05[c]		
***Urtica dioica* L.**										
Folium (6)	0.129	0.070, 0.140, 0.389, 0.648	0.887	**0.377** (0.265; 0.070–0.887)	-; -; -; -; -			0.19–0.39 (cattle), 0.532–0.798 (goat)	0.19–0.39 (cattle), 0.532–0.798 (goat)	0.35–0.52[a]

(continued on next page)

0.4-110g / Kuh

30-150g / Kuh

25-50g / Kuh

50-65g / Kuh

K. Stucki, et al.
Journal of Ethnopharmacology 234 (2019) 225–244

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Chamomille – the dosage, e.g. a daily oral bovine dose (for a cow of 650 kg b.w.)

While looking for new phytomedicines…

Clinical trials, experimental treatments

Effectiveness:	Safety:
❖ sufficient bioavailability	❖ metabolism, incl. interaction
❖ concentration at the site of action	❖ excretion

Various challenges: lack of beneficial effect, adverse-effects …

resulting mainly from inter-species differences!

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cost EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY

Funded by the European Union

PAPER

Veterinary Record: first published as 10.1136/vr.105131 on 18 February 2019. D

Placebo-controlled study on the effects of oral administration of *Allium sativum* L in postweaning piglets

Hannah Ayrle,[1,2] Heiko Nathues,[3] Anna Bieber,[1] Manuela Durrer,[1] Nele Quander,[1] Meike Mevissen,[2] Michael Walkenhorst[1]

Postweaning diarrhoea (PWD) due to *Escherichia coli* is an economically important disease in pig production. In this placebo-controlled study performed in Switzerland, the effects of oral supplementation of *Allium sativum* L. (garlic, AS) on performance (bodyweight (BW) and daily weight gain (DWG)) and health (body condition and clinical score) were investigated in postweaning piglets. Piglets (n=600) were randomly assigned to the treatment groups (placebo, AS or colistin) and observed from birth until three weeks postweaning. The treatments were administered for the first two weeks postweaning. Faecal dry matter (FDM) and coliform bacteria on pen level

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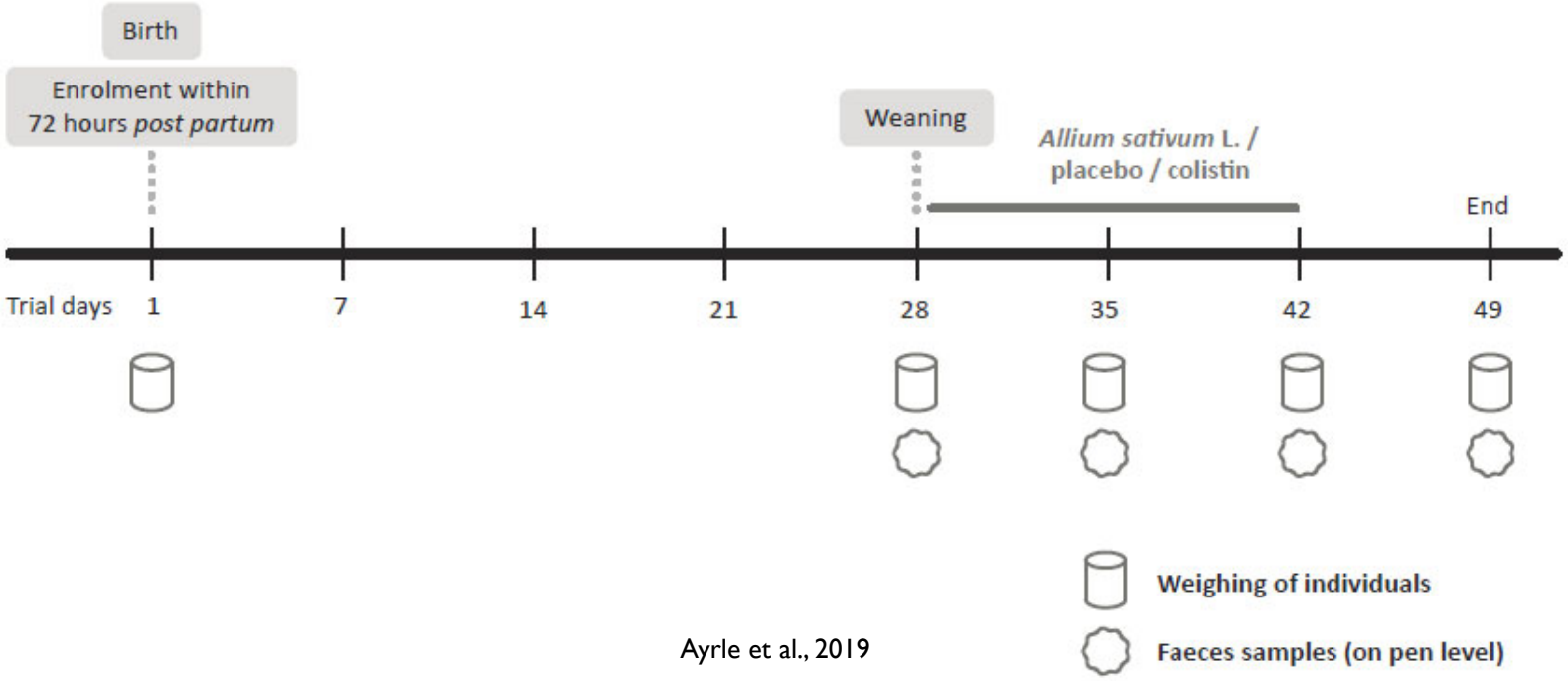
Clinical trial “KnobiPorc” (*Allium sativum* L. for postweaning piglets)

Methods

- randomized (at enrollment)
- placebo-controlled
- monocentric on-farm
- not blinded

Placebo	Equivalent amount of lactose and dextrose	N=200	Ø 21 pigs/pen; 9 repetitions per treatment
Garlic	0.3 g dried powder/kg BW/day	N=200	
Colistin	6 mg/kg BW/day	N=200	



Ayrle et al., 2019

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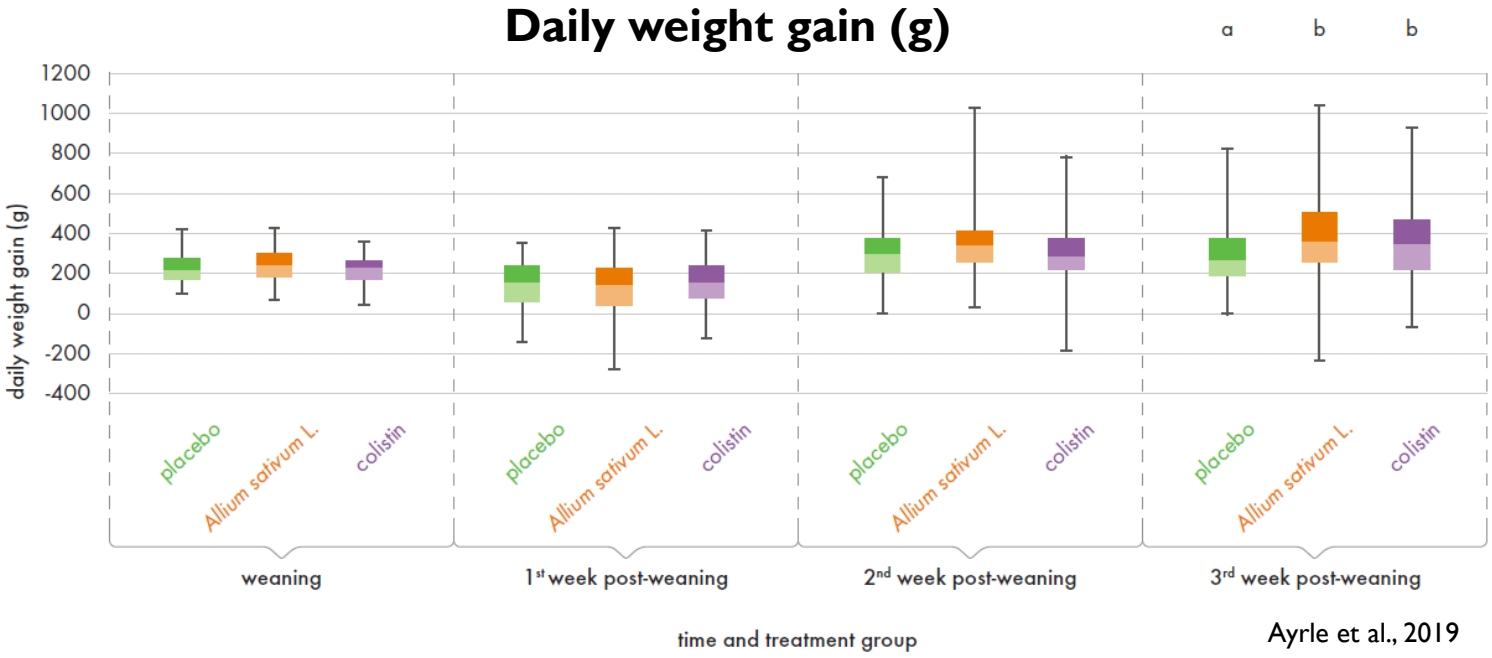
Clinical trial “KnobiPorc” (Allium sativum L. for postweaning piglets)

Results

- antibiotic group treatments due to severe diarrhoea:
  - Placebo: **3** of **9** pens (33.3 %)
  - Garlic: **3** of **9** pens (33.3 %)
  - (Colistin: **all** pens received permanent antibiotic group treatment)

- The clinical score of garlic treated piglets was significantly better than that of the colistin group

- Significantly higher **body weight** (+1 kg; 7.5%) in 3. week p.w. in garlic group (14.1 kg) compared to placebo (13.1 kg)
- Significantly increased **gains** (+61g/day; 21%) in 3. week p.w. in garlic and colistin groups (both 340 g/day) compared to placebo (280 g/day)
  - In accordance with previous studies (+64-78 g/day)



Ayrle et al., 2019

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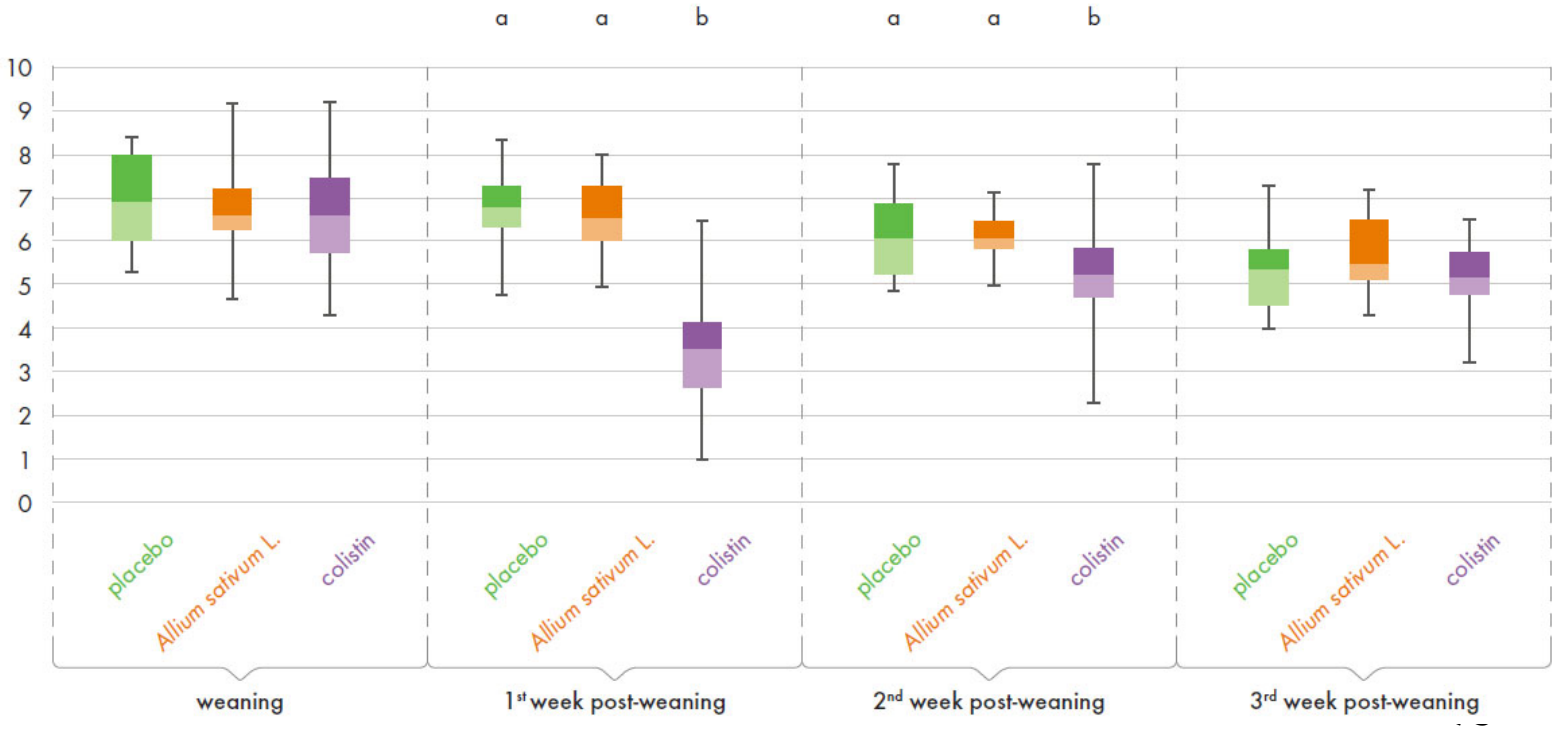
Clinical trial “KnobiPorc” (Allium sativum L. for postweaning piglets)

«side result»

Colony forming units/g feces (logarithmic values)



Ayrle et al., 2019

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Conclusion

- the prophylactic oral administration of garlic leads to an increased body weight and daily weight gain in newly weaned piglets under European on-farm conditions.

- the incidence of severe post weaning diarrhea was not reduced by garlic compared to placebo.

- garlic shows at least a certain potential to reduce the use of antibiotics in newly weaned piglets.

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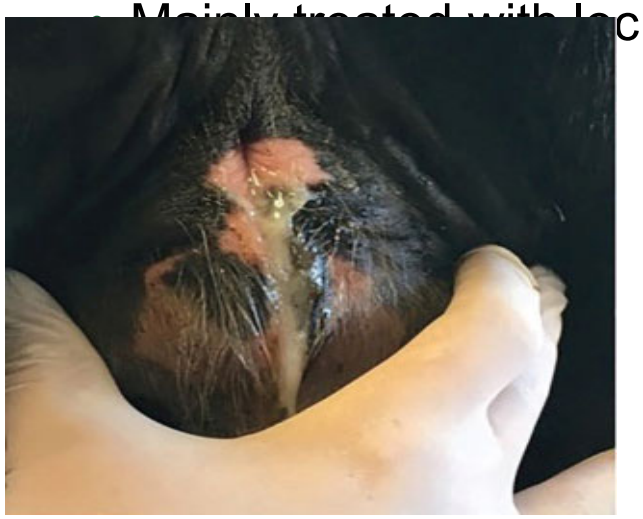
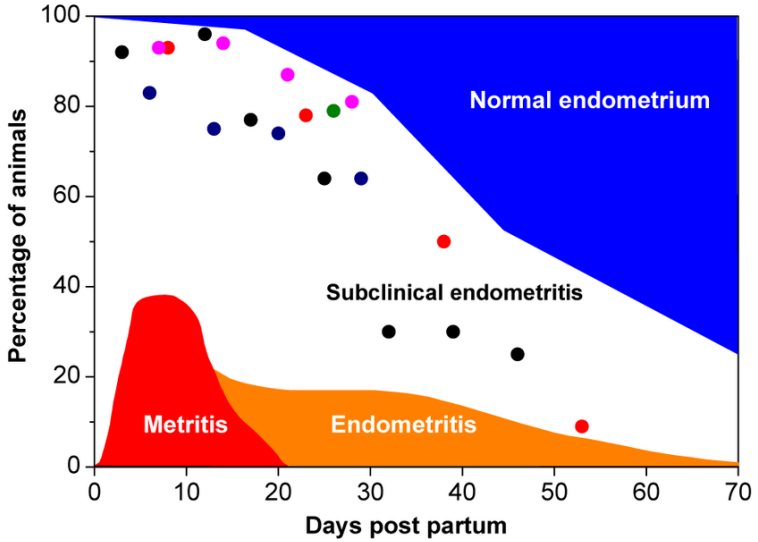
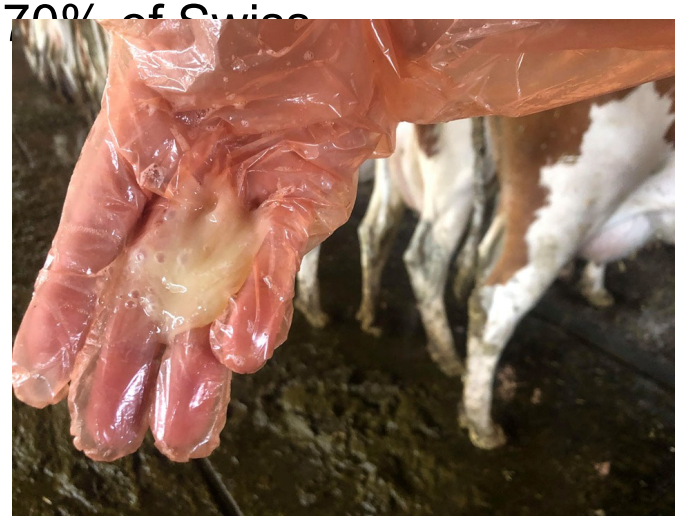
Ayrle et al., 2019

Comparison between intrauterine application of an antibiotic and an herbal product to treat clinical endometritis in dairy cattle – A randomized multicentre field study

- Reproductive disorders are a challanging problem of the dairy cow sector
- Clinical endometritis (purulent vaginal discharge between day 21 and 35 post partum)
- Prevalence in western dairy herds 17% - 54%
- Mainly treated with local antibiotics (standard therapy of 70% of Swiss







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Schlegl et al., 2020; Tison et al., 2017; Makki et al., 2017; Barański et al., 2022; LeBlanc et al., 2002; Sheldon et al., 2009; Hehenberger et al., 2015

Material and Methods – used veterinary medicinal products

- **CEPH -** Metricure®: cephapirin benzathin 500 mg (MSD Animal Health GmbH; Cephalosporin 1. generation)
  - several studies show better cure rates than untreated controll
  - significant differences in one case (Mari et al., 2012)

- **EUC -** EucaComp® PlantaVet: alcoholic extracts of *Calendula officinalis* L., *Origanum majorana* L. and *Melissa officinalis* L. and the essential oil of *Eucalyptus globulus* Labill. (in total 25 ml; SaluVet GmbH)

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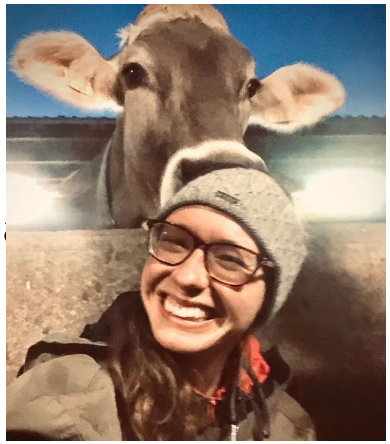
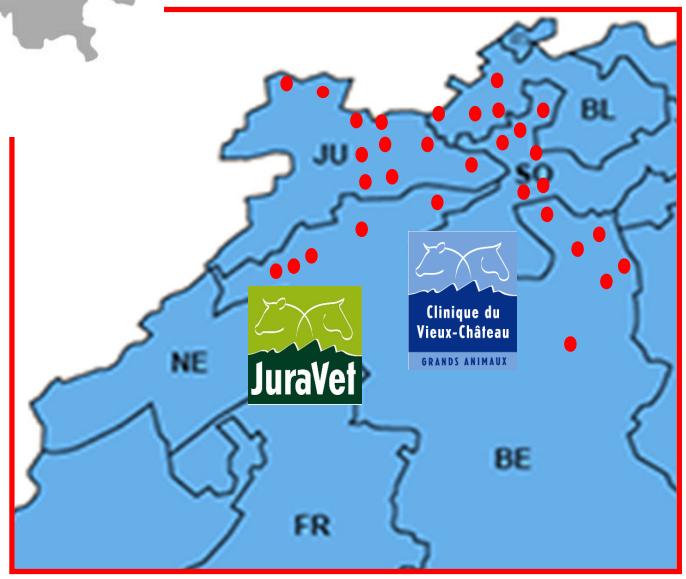
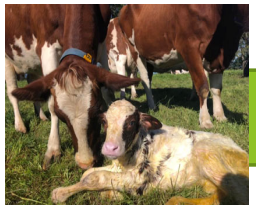
Material and Methods

- Study within a running Swiss herd health programm
- Post partum (pp) routine diagnosis every second week (all cows 21-35 d
- 31 dairy farms in north western Switzerland (herd size 20-120 cows)
- Study period: September 2019 to February 2022





Material and Methods



calving

21d pp

35d pp

+ 14d (± 2d)

+ 14d (± 2d)

First pp controll
- Anamnesis
- Vaginal and rectal clinical examination
- Body temperatur

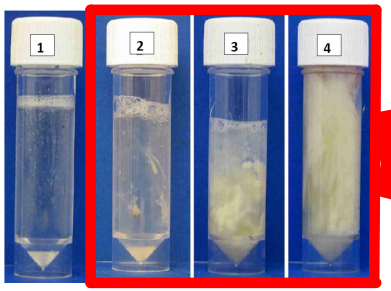
In case of clin. Endometris: First treatment

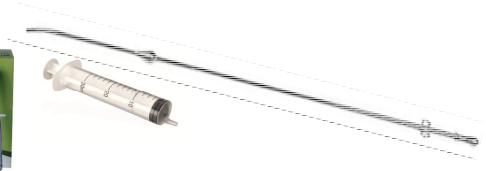
Second pp controll
- Vaginal examination
- rectal examination (incl. ultrasonographie)
- Body temperatur

If still uncured – same therapy again

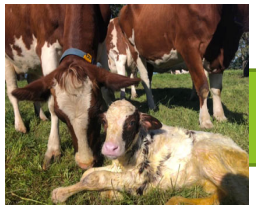
Third pp controll
- Vaginal examination
- rectal examination (incl. ultrasonographie)
- Body temperatur

If still uncured – therapy failure





Material and Methods



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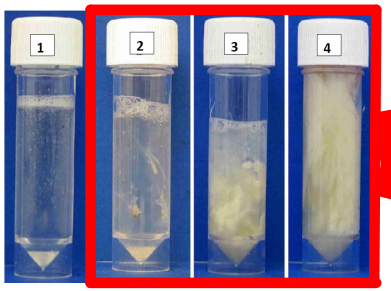
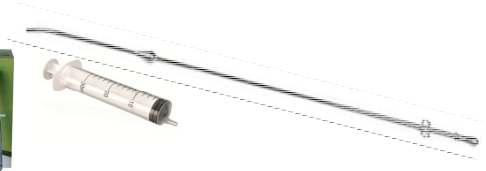
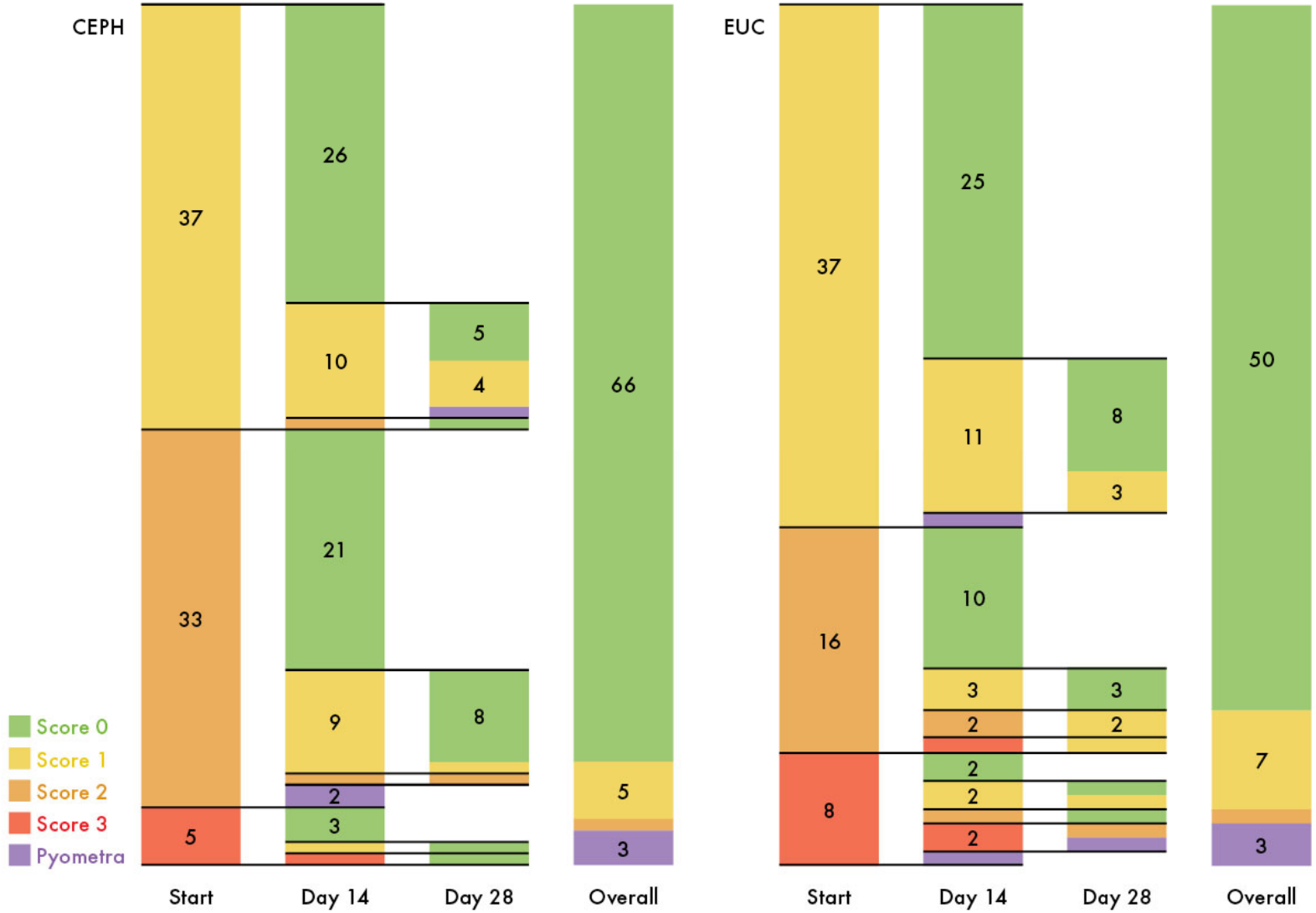


even

odd



Results – clinical cure of the endometritis cases



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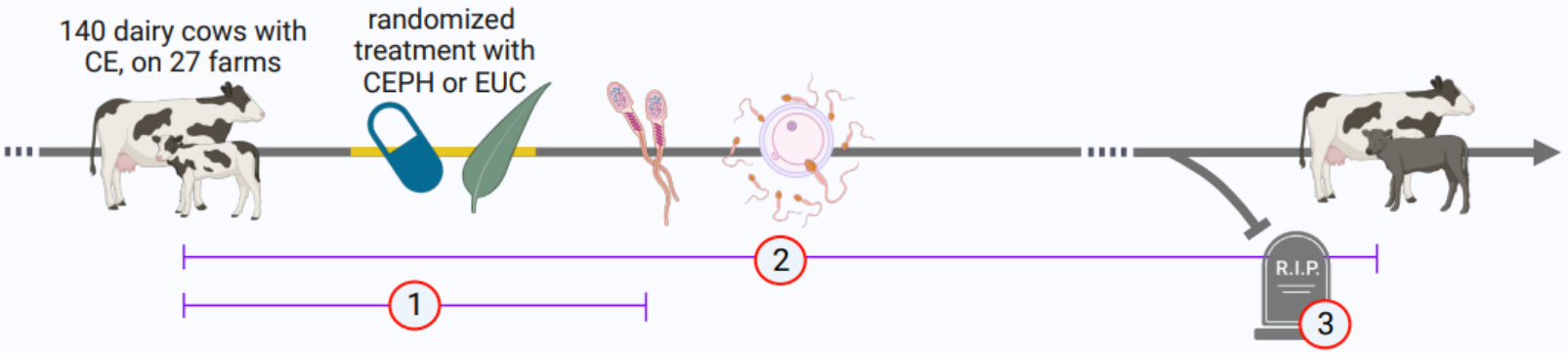
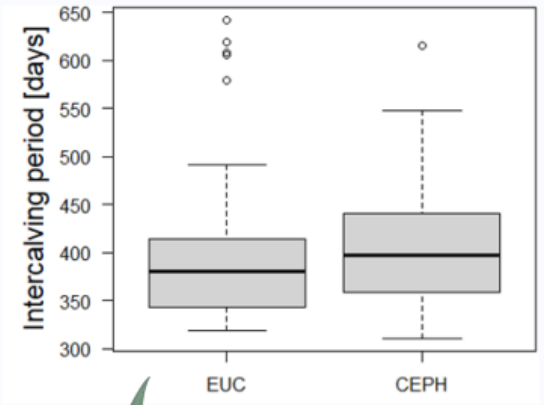
Comparison of an herbal and an antibiotic intrauterine treatment of clinical endometritis on fertility and other long-term parameters in dairy cows

Victoria Scheuber, Michael Walkenhorst, Gaby Hirsbrunner, Mirjam Holinger, Ariane Maeschli, Luc Gerber



1	2	3
First service period *	Intercalving period *	Culling due to fertility *
80d 74d	411d 405d	10% 12%

*no significant difference between treatment groups



= EucaComp®, EUC

= Cephapirin benzathine, CEPH

CE = Clinical endometritis

Conclusion: No significant difference was found between CEPH and EUC for any of the fertility parameters examined. EUC may be non-inferior to CEPH as a CE treatment in terms of fertility performance in dairy cows.

Graphical abstract created by Victoria Scheuber, 15th of October 2023

Published veterinary experience

Phytotherapy in zoo animals

S. Hoby[1], C. Wenker[1], M. Walkenhorst[2]

[1]Zoologischer Garten Basel, Basel, [2]Departement für Nutztierwissenschaften, Forschungsinstitut für biologischen Landbau (FIBL), Frick

Introduction

Phytotherapy is one of the oldest medical disciplines and was traditionally based on empiricism (Reichling et al., 2008). Nowadays, its use as an additional integral component of evidence based medicine is well accepted in human medicine (Finkelmann, 2009). Herbal remedies are generally characterised by a broad therapeutic index. They consist of multicomponent mixtures and act as multi-target drugs with pleiotropic effects. In Switzerland, veterinary phytotherapy has been relaunched in 2006 as a subunit of the Swiss Medical Society for Phytotherapy (SMCP-vet). Since 2012, the certificate of qualification in veterinary phytotherapy has been approved by the Swiss Veterinary Association (GST/SVS). Historically, one of the common approaches to gain insights into the medical effects of plants was self-medication. In non-human animals, self-medication remains a controversial subject, because evidence is mostly anecdotal. A few experimentally verified cases of self-medication support the theoretical expectation that animals can and do make specific foraging decisions that function specifically to remediate illness (Huffman and Caton, 2001; Villalba et al., 2006; Singer et al., 2009). In zoological medicine, this concept has first been implemented by primate keeping institutions. Permanent access to selected medicinal plants suggested self-medication and helped maintain the health of certain primate species (Cousins, 2006).

Zoological medicine is a veterinary discipline that deals with a very broad spectrum of taxa and diseases. Often, treatment protocols have to be extrapolated from farm and companion animals or humans. Clinical daily routine is limited and treatment decisions are based on limited scientific findings and the practitioner's experience. Zoo animals are generally highly susceptible to capture stress and handling for medical treatments may be counterproductive. Hence, the prevention of disease has to be emphasised (Hosey et al., 2009). The aim of this study was to give a summary on the practical experience with herbal remedies at Zoo Basel from 2010 to 2014 as a means to expand the disease prevention and therapy spectrum.

Results and Discussion

In the five-year investigation period, Zoo Basel kept an average number of 616 animal species, approximately two thirds of which belong to invertebrates and fishes. Overall, 31 applications in 20 animal species were evaluated. A total of 48 medicinal plants was used, either in a single (n = 21), or a mixed formulation (n = 10). For the classification of indication, the anatomical therapeutic chemical classification system for veterinary medicine products (ATCvet) was applied (WHO, 2015). Most frequently, herbal remedies were used for gastrointestinal and metabolic disorders (ATCvet code QA, n = 9), followed by dermatological (QD, n = 5), nervous (QN, n = 5) and cardiovascular (QB, n = 3) treatments. The highest number of treatments was received by the order of primates (n = 11), followed by perissodactyla (n = 7) and artiodactyla (n = 5).

Thirteen applications were further characterised as established standard therapeutics. The criteria for the inclusion in this group were on the one hand the proof of a repeatable positive effect to treat or prevent diseases, and on the other hand good patient compliance, simple administration and a lack of adverse effects. Details of indication, animal species, plant species and plant parts used as well as treatment regimens are listed in Table 1. We rated the effectiveness of these established standard applications subjectively as good (n = 9; treatment led to resolution ad integrum or prevented disease), moderate (n = 1; treatment led to an improvement of a medical condition) or variable (n = 3; treatment led to an improvement of a medical condition in several but not all of the patients). For a comparison between different species including humans, daily dosages were converted to dosage per kilogram metabolic body weight (MBW = body weight$^{0.75}$). Live weight from animals was either taken from medical or pathological records established at Zoo Basel.

One example of an established application is the prophylaxis of gastrointestinal colic symptoms and diarrhea in African elephants (*Loxodonta africana*) with *Triticum aestivum* L. soaked in water for 30 minutes prior to feed-

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Let’s start interaction - group work

- Form groups of 3
- Define a topic (can be very broad - a plant, a disease complex, an “area of knowledge”)
- Search for literature together (our literature list as a suggestion, but also your own search with the various search engines)
- Present the results to each other
- Over the entire 3 days, repeatedly incorporate what you have heard into the topic you have chosen, at the end of the training, create a 20-minute presentation, which is then presented to everyone in a subsequent online meeting (total - 2 hours).

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Thanks for
your attention!