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Ethnoveterinary knowledge of farmers in bilingual regions of Switzerland – is there potential to extend veterinary options to reduce antimicrobial use?

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- Ethnoveterinary medicine
- French speaking swiss regions (Fribourg, Jura, Neuchâtel, Jura bernois)
- Medicinal plants
- Antimicrobial
- Livestock diseases

ABSTRACT

Ethnoveterinological relevance: In the pre-antibiotic era, a broad spectrum of medicinal plants was used to treat livestock. This knowledge was neglected in European veterinary medicine for decades but kept alive by farmers. Emergence of multidrug resistant bacterial strains requires a severely restricted use of antibiotics in veterinary medicine. We conducted a survey on the ethnoveterinary knowledge of farmers in the bilingual (French and German speaking) Western region of Switzerland, namely the cantons of Fribourg, Neuchâtel and Jura, and in the French speaking part of the canton of Bern.

Aim of the study: To find out whether differences exist in plants used by farmers in French speaking and bilingual regions of Switzerland as compared to our earlier studies conducted in Switzerland. Additional focus was on plants that are used in diseases which commonly are treated with antimicrobials, on plants used in skin afflictions, and on plants used in animal species such as horses, for which the range of veterinary medicinal products is limited.

Material and methods: We conducted in 2015 semistructured interviews with 62 dialog partners, mainly cattle keeping farmers but also 18 horse keeping farmers. Of these, 41 were native French (FNS) and 21 native German speakers (GNS). Detailed information about homemade herbal remedies (plant species, plant part, manufacturing process) and the corresponding use reports (target animal species, category of use, route of administration, dosage, source of knowledge, frequency of use, last time of use and farmers satisfaction) were collected.

Results: A total of 345 homemade remedies were reported, of which 240 contained only one plant species (Homemade Single Species Herbal Remedy Reports; HSHR). A total of 289 use reports (UR) were mentioned for the 240 HSHR, and they comprised 77 plant species belonging to 41 botanical families. Of these, 35 plant species were solely reported from FNS, 20 from GNS, and 22 from both. Taking into account earlier ethnoveterinary studies conducted in Switzerland only 10 (FNS) and 6 (GNS) plant species connected with 7% of FNS and GNS UR respectively were “unique” to the respective language group.

The majority of the UR (219) was for treatment of cattle, while 38 UR were intended to treat horses. The most used were for treatment of gastrointestinal and skin diseases. The most frequently mentioned plants were Linum usitatissimum L., Coffea L., Matricaria chamomilla L., Camellia sinensis (L.) Kuntze, and Quercus robur L. for gastrointestinal diseases, and Calendula officinalis L., Hypericum perforatum L. and Sanicula europaea L. for skin affections.

Conclusion: No clear differences were found between the medicinal plants used by French native speakers and German native speakers. Several of the reported plants seem to be justified to widen the spectrum of veterinary products.

Abbreviations: CNS, central nervous system; DP, dialog partners; dpe, dry plant equivalent; FNS, French native speaker; GNS, German native speaker; HSHR, Homemade-Single-Species Herbal Remedy Reports; MBW, Metabolic bodyweight; PSES, previous Swiss ethnoveterinary studies; QA, alimentary system and metabolism; QD, dermatologicals; QM, musculo-skeletal system; QQ, genito urinary system and sex hormones; QG, mastitis; QR, respiratory system; QS, sensory organs; UR, Use report; VAS, visual analog scale

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therapeutic options in gastrointestinal and dermatological disorders in cattle and horses, and to reduce, at least to a certain degree, the need for antibiotic treatments. Our findings may help to strengthen the role of medicinal plants in veterinary research and practice, and to consider them as a further measure in official strategies for lowering the use of antibiotics.

1. Introduction

Ethnoveterinary research is defined as “systematic investigation and application of folk veterinary knowledge, theory and practice” (McCorkle, 1986). Therefore, it plays a major role in the conservation of traditional knowledge on medicinal plants, and in the exploration of alternative treatment options in veterinary medicine (Lans et al., 2007; Schäffer, 2010; Lans, 2016; Bullitta et al., 2018). European ethnoveterinary research has been performed mainly in Mediterranean countries (Blanco et al., 1999; Uncini Manganelli et al., 2001; Viegi et al., 2003; Scherrer et al., 2005; Pieroni et al., 2004, 2006; Bonet and Valles, 2007; Akerreta et al., 2010; Benitez et al., 2012; Mayer et al., 2014; Bullitta et al., 2018), in the German speaking parts of the European Alps (Schmid et al., 2012; Disler et al., 2014; Bischoff et al., 2016; Vogl et al., 2016; Mayer et al., 2017; Stucki et al., 2019), and some in eastern European countries (Mayer et al., 2014), notably Romania (Bartha et al., 2015). However, data from French speaking regions, such as western Switzerland, are lacking.

Uses of medicinal plants by farmers could differ not only by geographical territories but also between linguistic groups in a confined area. Such differences have been reported in human ethnomedicine (Menendez-Baceta et al., 2015), but similar comparisons with regard to veterinary use do not exist. Even if (a) earlier studies, comparing ethnoveterinary data from different countries (Viegi and Ghedira, 2014; Bartha et al., 2015; Mayer et al., 2017) suggest that “ethnoveterinary tradition may change with growing geographical distance” (Mayer et al., 2017) and, (b) a within-country comparison of two geographically and linguistically separate regions in Switzerland (Mayer et al., 2017), and a comparison of two populations within the same region of Romania (but without differentiating between different linguistic groups; Bartha et al., 2015) highlighted some differences in ethnoveterinary practises, a comparison of ethnoveterinary data of two linguistic populations within one region is still lacking.

In 2014 the WHO report on antimicrobial resistances (WHO, 2014) disclosed that resistance to antibiotics has meanwhile been detected in all parts of the world. There is evidence that farm animals act as a reservoir of resistance genes, and that transmission of such genes to humans could occur either via direct contact or via food consumption (WHO, 2004; Marshall and Levy, 2011). In addition, pathogenic and non-pathogenic bacteria carrying antimicrobial resistance gene are spread into the environment via the excrements of farm animals (Woolhouse et al., 2015).

Nonetheless, antimicrobials are still widely used to prevent or treat diseases in farm animals, but also for non-therapeutic purposes like growth promotion. On a global scale it is estimated that antimicrobials used in livestock production will increase by 67% from approximately 63’000 tons per year in 2010 to 106’000 tons by 2030 (Van Boeckel et al., 2015). The major classes of antimicrobials used for humans are also used in livestock, including reserve antibiotics (Aarestrup et al., 2008). In Europe the use of antimicrobials is highest with intensive livestock species such as pigs, poultry and young cattle (European Medicines Agency, 2014; Federal Food Savety and Veterinary Office, 2019), mainly for gastrointestinal and respiratory diseases (Bennett et al., 1999). In adult cattle mastitis is one of the most prevalent diseases (Bradley, 2002), and is oftentimes treated with antibiotics.

In Switzerland, the Federal Food Safety and Veterinary Office (FSVO) reported the increase of microbiological resistance in zoonotic...
pathogens and in indicator bacteria (FSVO, 2019). A National Strategy on Antibiotic Resistance (StAR) has been developed to control and combat the development of antimicrobial resistance (StAR, 2015). However, even though the use of medicinal plants in prevention (Ayrle et al., 2019) or first line treatment of mild cases (Ayrle et al., 2016a) could possibly lower the need for antibiotic treatments of farm animals, it is not mentioned in StAR.

For indications such as topical treatment of skin afflictions, the number of available veterinary medicinal products in Switzerland is small. Only 18 veterinary drugs are registered for the treatment of dermatological disorders in livestock. The majority are either disinfecting agents or topical antibiotics (CPT, 2019). For some animal species the available veterinary medicinal products are even more limited. Over 100 antimicrobial drugs for systemic use in cattle are commercialized, but only 9 for use in horses (CPT, 2019).

There is a need to widen the spectrum of veterinary medicinal products and other therapeutic and preventive options for specific veterinary indications, and to reduce the use of antibiotics. However, even though the interest of veterinarians in herbal medicine has been increasing over the past decade (Kupper et al., 2018), there is still a lack of clinical veterinary research with medicinal plants (Ayrle et al., 2016a). In vitro and in vivo studies (Ayrle et al., 2016a), historical veterinary literature (Stucki et al., 2019) and ethnoveterinary surveys can serve as knowledge base for the veterinary use of medicinal plants.

With a survey conducted in the bilingual regions of the Cantons Fribourg, Jura, Neuchâtel, and the French speaking part of Bern (administration of Bernese Jura) we wanted

(a) to publish the first ethnoveterinary data from French speaking areas of Europe,
(b) to compare the ethnoveterinary knowledge of native French and German speakers in the survey area, and
(c) to evaluate whether medicinal plants discussed in this survey could be an option to enlarge the therapeutic spectrum with a particular emphasis on antimicrobial therapies, skin disorders, and horses.

![Fig. 2. Recruitment of dialog partners for the study via snowball sampling. DP = dialog partner; FNS = French native speaker; GNS German native speaker). Informants are persons without own ethnoveterinary knowledge who acted as intermediaries in recruiting further DP.](image-url)
2. Material and methods

The study was conducted according to previous ethnoveterinary studies from Switzerland (Schmid et al., 2012; Disler et al., 2014; Bischoff et al., 2016; Mayer et al., 2017; Stucki et al., 2019).

2.1. Study area

The survey was conducted in 3 western Swiss cantons, namely Fribourg, Neuchâtel, Jura, and in the French-speaking part of the canton of Bern, namely the administration of Bernese Jura (Fig. 1). The total study area is located between 6°3’ and 7°3’ E and 46°3’ and 47°3’ N. The cantons Jura and Neuchâtel are bordered by France to the west, and the regions of previous Swiss ethnoveterinary studies (PSES, Fig. 1) to the east. The study covered an area of 3853.7 km² and a population of approx. 600’000 persons. The majority of the population in the study area are native French speaking and, depending on the canton, up to one quarter are native German speaking persons (Bundesamt für Statistik, 2019). The altitude is between 373 and 2386 m above sea level. Annual precipitation of the area varies from 947 mm to 1441 mm, and the average temperature at 647 m above sea level is 4.6 °C (Bundesamt für Meteorologie und Klimatologie, 2019). The area had a total of 5431 farms, of which 4365 kept cattle and 1361 kept horses (Bundesamt für Statistik, 2013).

2.2. Farms and dialog partners

Dialog partners (DP) were recruited according to a previously described approach (Disler et al., 2014). In a first step, the Departments of Agriculture of the cantons Fribourg, Jura and Neuchâtel supported the project by informing all farmers via bulletin or newsletters. Second, all organic farmers in the study area were informed via personal letter or e-mail. Additionally, farmers were informed through publications in the regional agricultural press. All farmers of the research area who were known to be member of complementary medicine working groups, or member of the farm research network of the Research Institute of Organic Agriculture (FiBL) were contacted by telephone. Furthermore, the project was presented at two general assemblies of regional associations of organic farmers (Bio Jura, Bio Fribourg, Fig. 2).

A total of 62 dialog partners (DP) participated in the study: 26 DP (42%) in Fribourg, 15 (24%) in Jura, 11 (18%) in Bernese Jura, and 10 (16%) in Neuchâtel (Fig. 2). Thirty-one farmers spontaneously agreed (contacting the research team spontaneously based on the overall information via bulletin, newsletter, or individual letter or confirmed their participation during the telephone calls or personal meetings) to become a DP, while further 31 DP were recruited via snowball sampling (Bernhard, 2006; Disler et al., 2014, Fig. 2). DP who had spontaneously agreed to participate were asked whether they knew of other farmers using medicinal plants for their livestock. Additional DP were recruited with the help of farmers or farm advisors who by themselves were not using ethnoveterinary knowledge. For these intermediary persons the term “informant” was used (e.g. informant 1 established the contact to DP23; Fig. 2).

Thirteen DP were recruited from the complementary medicine working groups, 12 from the organic farm research network of the FiBL, and further 37 farmers were recruited via regional information (Fig. 2). The mother tongue of 41 DP was French (French Native Speakers, FNS), and German for the remaining 21 DP (German Native Speakers, GNS).

Each of the 62 DP was associated to a single farm, of which 25 (40%) were organic and 37 (60%) were non-organic. Forty-four farms kept cattle, 22 farms kept horses, 18 farms goats, 15 sheep, 6 rabbits, 5 pigs, 3 kept donkeys, 3 kept bees, and 1 kept deer. The farms were located between 430 and 1250 m (808 m ± 194 m) above sea level.

Thirty-two interviews were carried out with the DP only. In 27 cases, one or two family members, and in further 3 cases neighbours or farm staff were assisting the DP. All supplementary information from assisting persons were matched to the respective DP. In total, 93 persons aged between 28 and 87 years (54 ± 14) were interviewed. Of these 59 were men (63%) and 34 (37%) were women.

2.3. Data collection

Open, semi-structured interviews with DP were conducted from mid-February to end of April 2015 by the first author (DM) who is a native French speaker with an excellent command of German. The interviews were conducted in the mother tongue of the DP by using questionnaires in either French or German. In some interviews, language was occasionally switched if it helped to clarify specific points between DP and the interviewer. All information from one interview was assigned to the mother tongue of the DP.

The interviews took between 0.5 and 4.0 h and were recorded (WS-818 Digital Voice Recorder, Olympus, Hamburg, Germany) after a written consent of the DP.

With the aid of their local vernacular names, plants were identified during the interviews together with the DP, utilizing the Flora Helvetica (Lauber and Wagner, 2007), by cross-checking (a) illustrations and, (b) distribution areas of the plant species. If plant material was available, further cross-checking was done based on information and material collected in earlier studies (Disler et al., 2014; Mayer et al., 2017; Stucki et al., 2019). Commercial products and herbal drugs or extracts from commercial sources were identified with the aid of the package leaflet, or were considered as correctly delivered by the pharmacy or drug store. In the summer of 2015 nine dialog partners were revisited. A total of 27 herbarium voucher specimen of 16 plant species harvested from the wild were collected together with the dialog partner, dried, labelled, and deposited at the herbarium of the “Basler Botanische Gesellschaft”. All plants for which voucher specimens were available from this and from former Swiss studies (Disler et al., 2014; Mayer et al., 2017; Stucki et al., 2019) are listed in Additional File 1.

2.4. Definition of the applied ethnoveterinary units

The same definitions as in earlier studies were used (Disler et al., 2014; Bischoff et al., 2016; Mayer et al., 2017; Stucki et al., 2019).

Homemade remedy report (HR): [dialog partner] x [plant species or other natural product] x [plant part] x [manufacturing process of the finished product]

Use Report (UR): [homemade remedy report] x [category of use] x [specification of use] x [animal species] x [animal age classification] x [administration procedure]

The specification of use followed mainly the Anatomical Therapeutic Chemical classification system for veterinary medicinal products (ATCvet Code, WHO, 2018).

2.5. Determination of dosages

To estimate the dosing of plants, the weight of the amount of plant material used for a remedy was determined with a precision scale (EMB, 2000-2, Kern, Balingen, Germany). Whenever possible weight was determined using the original plant material of the farmer, or reference drugs of the interviewer on site. If this was not possible, the dosage was estimated by assessing the volume of plant material and measuring it subsequently by the interviewer. For orally administered remedies the oral daily dosage of medicinal plant (dry plant equivalent, dpe), and for externally administered remedies the concentration in g dpe per 100g of final product was determined. Oral daily dosages were calculated in g dpe per kg metabolic bodyweight (kg<sup>0.75</sup>) (Löschler et al., 2014). The metabolic bodyweight was calculated with the average live weight of animal species and age classes described by Disler et al.
Table 1
Metabolic bodyweight (according to Disler et al., 2014, and Sambraus, 1996).

| Species       | Weight | Metabolic bodyweight (MBW) |
|---------------|--------|----------------------------|
| Adult cattle  | 650 kg | 128.7 g·kg⁻⁰·⁷⁵            |
| Adult horse   | 650 kg | 128.7 g·kg⁻⁰·⁷⁵            |
| Calf          | 75 kg  | 25.5 g·kg⁻⁰·⁷⁵             |
| Adult sheep   | 80 kg  | 27.0 g·kg⁻⁰·⁷⁵             |
| Young sheep   | 20 kg  | 9.5 g·kg⁻⁰·⁷⁵              |
| Rabbit        | 3 kg   | 2.3 g·kg⁻⁰·⁷⁵              |
| Hen           | 1 kg   | 1 g·kg⁻⁰·⁷⁵                |
| Human         | 65 kg  | 22.9 g·kg⁻⁰·⁷⁵             |

(2014), or based on additional information (Sambraus, 1996, Table 1).

\[
\text{Oral daily dose (g/kg)} = \frac{\text{drug dose per administration (g) x repetition per day}}{\text{metabolic bodyweight (kg)}}
\]

2.6. Satisfaction with the use reports (UR)

The degree of satisfaction of the DP with the reported use was determined using a visual analog scale of 100 mm, ranging from “no effect” (0 mm) to “very good effect” (100 mm) (Zealley, and Aitken, 1969).

3. Results

A total of 345 homemade remedy reports were recorded during the A total of 240 (70%) homemade remedy reports were collected for the 240 HSHR. Most of them were for cattle (219 UR, 76%), followed by horses (13%), and horses (13%) for other animals, such as sheep, goats, hens and rabbits (Table 3, Additional file 1). The majority of the UR were for treatment (225; 78%), while 64 UR (22%) were for prophylactic use, mainly for prevention of cattle ringworm (Berberis vulgaris L.), or in the peripartum period (Linum usitatissimum L., Achillea millefolium L.).

3.2. Categories of use

Gastrointestinal disorders and metabolic dysfunctions (QA; 111 UR, 38%) were the most often mentioned indication, followed by skin alterations and sores (QD; 92 UR, 34%). Other indications included infertility and diseases of female genitals (QG; 20 UR, 7%), diseases of the respiratory tract (QR; 13 UR, 5%), mastitis (QG52; 6 UR, 2%), muscular skeletal system (QM; 6 UR, 2%), and others, such as general strengthening (38 UR, 12%).

The most frequently reported plants for the treatment of gastrointestinal disorders and metabolic dysfunctions were Linum usitatissimum L. (35 UR), Coffea L. (22 UR), Matricaria chamomilla L. (19 UR), and Camellia sinensis (L.) Kuntze. For the treatment of skin alterations and sores Sanicula europaea L. (21 UR) was most often mentioned, followed by Calendula officinalis L. (16 UR). Phyllitis scolopendrium L. (3 UR) was most often used in afflications of the respiratory tract (Table 3).

3.2.2. Route of administration

Oral administration (168 UR, 58%) was most frequently used (Table 3), mainly for the treatment of gastrointestinal disorders like diarrhoea, colic, constipation or rumination problems. The plants were mainly administered as infusion or decoction. Topical administration was described for 90 UR (31%), mainly for the treatment of altered and sore skin (71 UR), for disinfection of open wounds, or for the promotion of wound healing. Farmers used these HSHR as washes, compresses, or by direct application onto the skin of ointments, oils, tinctures, or fresh plants. Administration on intact skin (19 UR) was mainly described for the treatment of swellings, inflammations of joints, or other subcutaneous afflictions. Treatment of housing
environment was mentioned in 28 UR (10%). To prevent or treat cattle ringworm twigs of *Berberis vulgaris* L., *Ilex aquifolium* L., or *Prunus spinosa* L., hanged up in the stable. Finally, two UR were for intravaginal/intrauterine administration, and one UR with essential oil of lavender (*Lavandula angustifolia* Mill.) was used as an inhalant for calming nervous horses.

### 3.2.3. Comparison of linguistic populations

FNS reported a total of 57 plant species connected to 180 UR, and GNS described 42 plant species and 109 UR. Thirty-five plant species were solely reported from FNS, and 20 solely from GNS, and these species were associated with one quarter of the respective UR each. Twenty-two plant species were reported by both FNS and GNS, and

| Botanical family (Number of named plant species in the family) | Plant species with ≥3 named HSHR (Number indicate the frequency of mentioned 239 HSHR) | On-farm extraction procedure (Number indicate the frequency of HSHR) |
|---------------------------------------------------------------|-----------------------------------------------------------------------------------|---------------------------------------------------------------|
|                                                               |                                                                                   | Commercial products | None | Water | Alcohol | Oil/Fat | Room temperature | Infusion | Decoction | Room temperature | Room temperature | Heated up |
| Linaceae (1)                                                   | *Linum usitatissimum* L. (28)                                                      | Semen (28)          | 5    | 3     | 20      |         |         |           |           |           |           |           |           |
| Rubiaceae (1)                                                 | *Coffea* L. (20)                                                                 | Semen (20)          | 20   |       |         |         |         |           |           |           |           |           |           |
| Asteraceae (7)                                                | *Matricaria chamomilla* L. (16)                                                   | Herba (1)           | 15   | 1     |         |         |         |           |           |           |           |           |           |
|                                                               | *Calendula officinalis* L. (10)                                                   |                    |      | 1     | 2       | 4       | 1       |           |           |           |           |           |           |
| Theaceae (1)                                                  | *Camellia sinensis* (L.) Kuntze. (15)                                             | Folium (15)         | 15   |       |         |         |         |           |           |           |           |           |           |
| Berberidaceae (1)                                             | *Berberis vulgaris* L. (13)                                                       | Herba (13)          | 13   |       |         |         |         |           |           |           |           |           |           |
| Apiaceae (5)                                                  | *Sanicula europaea* L. (13)                                                       | Folium (12)         | 2    | 9     | 1       |         |         |           |           |           |           |           |           |
|                                                             | *Achillea millefolium* L. (3)                                                     | Herba (3)           | 1    | 2     |         |         |         |           |           |           |           |           |           |
|                                                             | *Other Asteraceae* (5)                                                            |                     | 1    | 1     |         |         |         |           |           |           |           |           |           |
| Fagaceae (1)                                                  | *(Cortex) (9)                                                                     | 2                  | 1    | 3     | 3       |         |         |           |           |           |           |           |           |
| Boraginaceae (1)                                              | *Symphytum officinale* L. (6)                                                     | Radix (3)           | 1    | 1     | 1       |         |         |           |           |           |           |           |           |
|                                                             | *(Folium)* (2)                                                                   | 1                  | 1    |       |         |         |         |           |           |           |           |           |           |
| Urticaceae (1)                                                | *Urtica dioica* L. (6)                                                            | Herba (6)           | 5    | 1     |         |         |         |           |           |           |           |           |           |
| Hypericaceae (1)                                              | *Hypericum perforatum* L. (4)                                                     | Flos (3)            | 3    | 1     |         |         |         |           |           |           |           |           |           |
|                                                             | *(Herba) (1)                                                                     | 1                  | 1    |       |         |         |         |           |           |           |           |           |           |
| Pinaceae (2)                                                  | All Pinaceae (7)                                                                 | 5                  | 2    |       |         |         |         |           |           |           |           |           |           |
|                                                             | *(Abies alba)* MILL; (4)                                                           | Herba (4)           | 2    | 2     |         |         |         |           |           |           |           |           |           |
|                                                             | *(Picea abies)* (L.) H. Karst. (3)                                                | Resina (2)          | 2    | 1     |         |         |         |           |           |           |           |           |           |
|                                                             | *(Herba) (1)                                                                     | 1                  | 1*   |       |         |         |         |           |           |           |           |           |           |
| Aquifoliaceae (1)                                             | *Ilex aquifolium* L. (4)                                                          |                     | 4    |       |         |         |         |           |           |           |           |           |           |
| Aspleniaceae (1)                                              | *(Phyllitis scolopendrium)* (L.) Newman (3)                                      | Folium (3)          | 3    |       |         |         |         |           |           |           |           |           |           |
| Malvaceae (2)                                                 | All Malvaceae (5)                                                                | 5                  |       |       |         |         |         |           |           |           |           |           |           |
|                                                             | *(Malva neglecta)* Wallr. (3)                                                     | Folium (1)          | 1    |       |         |         |         |           |           |           |           |           |           |
|                                                             | *(Herba)* (2)                                                                    | 2                  |       |       |         |         |         |           |           |           |           |           |           |
|                                                             | *(Other Malvaceae)* (2)                                                           | 2                  |       |       |         |         |         |           |           |           |           |           |           |
| Lamiaceae (7)                                                 | All Lamiaceae (11)                                                               | 4                  | 4    | 2     | 1       |         |         |           |           |           |           |           |           |
|                                                             | *(Thymus vulgaris)* L. (4)                                                        | Herba (4)           | 2    | 1     | 1       |         |         |           |           |           |           |           |           |
|                                                             | *(Other Lamiaceae)* (7)                                                           | 3                  |       |       |         |         |         |           |           |           |           |           |           |
| Rosaceae (6)                                                  | *(Prunus spinosa)* L. (3)                                                         | Herba (3)           | 3    |       |         |         |         |           |           |           |           |           |           |
|                                                             | *(Other Rosaceae)* (5)                                                            | 5                  |       |       |         |         |         |           |           |           |           |           |           |

(continued on next page)
Table 2 (continued)

| Botanical family (Number of named plant species in the family) | Plant species with ≥ 3 named HSHR (Number indicate the frequency of mentioned 239 HSHR) | On-farm extraction procedure (Number indicate the frequency of HSHR) |
|---------------------------------------------------------------|------------------------------------------------------------------------------------------|---------------------------------------------------------------------|
|                                                               |                                                                                          | Commercial products |
|                                                               |                                                                                          | None | Water | Alcohol | Oil/Fat |
|                                                               |                                                                                          | Room temperature | Infusion | Decoction | Room temperature | Room temperature | Heated up |
| Gentianaceae (1)                                              | Gentiana lutea L. (3)                                                                       | Radix (3) | 1 | 2 |
| Others’ (37)                                                 | 37 other plant species (45)                                                              | 6 | 23 | 1 | 10 | 3 | 2 |
| Total (77)                                                    | Total (240)                                                                               | 12 | 86 | 6 | 92 | 27 | 8 | 2 |

n.a. information not available.

a Arnica montana L. (2), Matricaria discoidea DC.(2), Leontopodium nivale subsp. alpinum (Cass.) Greuter. (1), Bellis perennis L. (1).
b Carum carvi L (2), Daucus carota L(2), Petroselium crispum (Mill.) Fuss (1) Peucedanum ostruthium (L.) W.D.J.Koch (1).
c Malva sylvestris L. (2).
d Salvia officinalis L. (1), Mentha canadensis L. (1) Origanum vulgare L.(1), Mentha longifolia (L.) L. (1), Lavandula × intermedia Emeric ex Loisel. (1), Lavandula angustifolia Mill (2).
e Alchemilla xanthochlora Rothm. (1), Rosa canina L. (1), Malus domestica Borkh.(1), Sorbus aucuparia L. (2), Rubus idaeus L. (1).
f Allium cepa L.(2) (Liliaceae), Allium ursinum L. (1), Allium sativum L. (1), Aristolochia clematitis L. (1) (Aristolochiaceae); Atropa belladonna L. (1) (Solaniaceae), Beta vulgaris L. (subsp. vulgaris) (1) (Amaranthaceae), Brassica oleracea L. (convar. capitata var. sabauda L.) (1) (Brassicaeae), Chelidonium majus L. (1) (Papaveraceae), Cinnamomum camphora (L.) J.Presl (2) (Lauraceae), Cinnamomum verum J.Presl (1) (Lauraceae), Citrus ×aurantium L. (1) (Rutaceae), Citrus limon (L.) Osbeck (2) (Rutaceae), Cucumis sativus L. (1) (Cucurbitaceae), Equisetum arvense L. (2) (Equisetaceae), Fagopyrum esculentum Moench (1) (Polygonaceae), Geranium robertianum L. (1) (Geraniaceae), Horapogophyrum procumbens (Burch.) DC ex Meisn.(1), (Pedaliaceae), Hordeum vulgare L. (1) (Poaceae), Juglans regia L. (2) (Juglandaceae), Juniperus communis L. (2) (Cupressaceae), Melaleuca alternifolia (Maiden & Betche) Cheel (2) (Myrtaceae), Oryza sativa L. (2) (Poaceae), Plantago lanceolata L. (1) (Plantaginaceae), Plantago media L. (1) (Plantaginaceae), Polygonum aviculare L. (1) (Polygonaceae), Raphanus raphanistrum subsp. sativus (L.) Domini (1) (Brassicaceae), Rhannus alpinus L. (1) (Rhamnaceae), Rhannus catharica L. (1) (Rhamnaceae), Rumex conglomeratus Murray (1) (Polygonaceae), Rumex obtusifolius L. (1) (Polygonaceae), Sambucus nigra L. (1) (Caprifoliaceae), Sinapis alba L. (1) (Brassicaceae), Syzygium aromaticum (L.) Merr. & L.M.Ferry (1) (Myrtaceae), Trigonella foenum-graecum L. (1) (Polygonaceae), Triticum aestivum L.(1) (Poaceae), Veratrum album L.(1) (Melanthiaceae), Zingiber officinale Roscoe (1) (Zingiberaceae).
g * Calendula ointment Sanicair (online pharmacy) Bombastus-Werke AG, used in one HSHR.

h Arnica tincture (pharmacy) used in one HSHR.
i Comfrey gel (drugstore) used in one HSHR.
j CNP Liniment(R) Swissgenetics (containing Mentha arvensis L.) used in one HSHR.
k NJP Liniment(R) Swissgenetics (containing Mentha arvensis L.) used in one HSHR.
l Comfrey gel (drugstore) used in one HSHR.
m Lavandula angustifolia oil (pharmacy) used in one HSHR; Lavandula x hybrid oil (internet: aroma-zone.com) with alcohol mixed, used in one use report.

n Plant part: twigs.

5 Plant part: buds in two remedy, twigs in 3 remedies.

6 Plant part: buds; * sugar extraction.

were linked to three quarters of the respective UR. The degree of satisfaction of farmers with the treatments outcomes were evaluated for 247 UR, with an average value of 74 mm and no differences between the language groups (Fig. 3).

4. Discussion

With a survey covering bilingual regions of Switzerland we here published the first ethnoveterinary data from French speaking areas of Europe. A total of 62 DP were interviewed, and 289 UR based on 240 HSHR were documented, comprising 77 different plant species from 41 botanical families. Compared to previous ethnoveterinary surveys (PSES; Schmid et al., 2012; Disler et al., 2014; Bischoff et al., 2016; Mayer et al., 2017; Stucki et al., 2019), 18 plant species were for the first time described for an ethnovegetarian use in Switzerland.

The methodology of the study was in accord with PSES. Most of the methodological recommendations for ethnopharmacological field studies were adhered to (Heinrich et al., 2018; Weckerle et al., 2018). The short duration of the survey (3 months in early spring) was due to the heavy workload of DP during the rest of the year (Stucki et al., 2019). Given that the survey had to be conducted outside of the vegetation period it was not possible to collect voucher specimen at the moment of the interviews. However, we collected some voucher specimen on some of the farms during the following summer (Additional file 1).

The cantons of Jura and Neuchâtel are officially French speaking, while Fribourg and Berne are officially bilingual (German and French). However, we considered only the French speaking Bernese Jura in our survey. Nevertheless, 41 DP were FNS, and 21 GNS. With one third of all DP, native German speakers appeared overrepresented if one considers the language distribution of the entire population of the study area (Bundesamt für Statistik, 2019). This may be due to the fact that German speaking Mennonites immigrating in the 18th century to the Jura region (cantons of Berne and Jura) were predominantly farmers (Gerber, 1969).

In general, farmers were satisfied with their treatment outcomes, and the mean value of 74 mm on the analog scale is comparable with values of PSES (70–80 mm).

4.1. Compliance and differences between the knowledge of French (FNS) and German native speakers (GNS)

We conducted the first comparative ethnoveterinary study with two populations of different mother tongues within the same geographic region of Europe. An earlier within-country comparison of two different linguistic regions of Switzerland (German and Italian) was characterized by topographical differences (lowland regions vs. southern mountain area; Mayer et al., 2017), while a study in Romania compared ethnoveterinary data from a Hungarian speaking minority in a region of Transylvania with data from Transylvania that had been gathered earlier, but without differentiation of the mother tongue of DP (Bartha et al., 2015). To our knowledge, the only other study comparing traditional uses of two linguistic groups within the same geographic area was an ethnomedical survey conducted recently in north-eastern Spain (Menendez-Bacetta et al., 2015).
Table 3
List of 289 use reports (UR) for 240 homemade herbal remedies reports containing a single herb (HSHR): route of administration, categories of use, and target animal species.

| Botanical family | Plant species with ≥3 named HSHR (Number indicate the frequency of use reports) | Routes of administration | Categories of use | Target animal species Total different use reports |
|------------------|----------------------------------------------------------------------------------|-------------------------|------------------|-----------------------------------------------|
|                  |                                                                                  | External | Internal | Treatment of housing | QD | QA | QG 52 | QM | QR | Others | Cattle | Horse | Others |
|                  |                                                                                  | I       | A       | OR        | IH | IU | others | g   | h  | Others |         |        |        |
| Lineaceae (1)    | Linum usitatissimum L. (35)                                                        |          |          |           |    |    |         | 5   | 35 |
|                  | Semen (35)                                                                        | 50      | 4        | 24        | 3  | 1  | 3           | 29  | 5  | 1  | 35     |
| Rubiaceae (1)    | Coffea L. (28)                                                                    |          |          |           |    |    |         | 28  | 28 |
|                  | Semen (28)                                                                        |          |          |           |    |    |         | 21  | 1  | 6  | 26  | 1  | 1  | 28     |
| Asteraceae (11)  | All Asteraceae (45)                                                               |          |          |           |    |    |         | 45  | 45 |
|                  | Matricaria chamomilla L. (19)                                                      |          |          |           |    |    |         | 19  | 19 |
|                  | Flos (17)                                                                         | 3        | 14       | 3          | 12 | 2  | 1       | 16  | 1  | 17 | 45     |
|                  | Herba (2)                                                                         |          |          |           |    |    |         | 2   | 2  | 2  | 2     |
|                  | Calendula officinalis L. (16)                                                      |          |          |           |    |    |         | 10  | 11 |
|                  | Flos and flos sinea calice (11)                                                   |          |          |           |    |    |         | 11  | 8  | 1  | 2  | 11     |
|                  | Herba (5)                                                                         | 4        |          |           |    |    |         | 4   | 1  | 4  | 1  | 5      |
|                  | Achillea millefolium L. (4)                                                        |          |          |           |    |    |         | 4   | 1  | 3  | 4  | 4      |
| Theaceae (1)     | Camellia sinensis (L.) Kuntze. (16)                                               |          |          |           |    |    |         | 16  | 16 |
|                  | Folium (16)                                                                        |          |          |           |    |    |         | 15  | 15 |
|                  | Berberis vulgaris L. (14)                                                          |          |          |           |    |    |         | 15  | 15 |
|                  | Herba (14)                                                                         |          |          |           |    |    |         | 14  | 14 |
| Apiaceae (4)     | All Apiaceae (27)                                                                  |          |          |           |    |    |         | 27  | 27 |
|                  | Sanicula europaea L. (21)                                                          |          |          |           |    |    |         | 21  | 21 |
|                  | Folium (18)                                                                        | 17       | 1        | 17        | 1  | 1  | 1       | 10  | 7  | 1  | 18     |
|                  | Flos (3)                                                                          | 3        |          |           |    |    |         | 2   | 1  | 2  | 3     |
|                  | Others Apiaceae (6)                                                                |          |          |           |    |    |         | 1   | 3  | 2  | 3     |
| Fagaceae (1)     | Quercus robur L. (9)                                                               |          |          |           |    |    |         | 9   | 9  |
|                  | Cortex (9)                                                                         | 8        | 1        | 8          | 1  | 1  | 1       | 9   | 9  |
| Boraginaceae (1) | Symphytum officinale L. (6)                                                         |          |          |           |    |    |         | 6   | 6  |
|                  | Radix (3)                                                                          | 1        | 2        | 1          | 1  | 1  | 1       | 1   | 1  | 3  | 3      |
|                  | Folium (2)                                                                         | 1        |          |           |    |    |         | 1   | 1  | 1  | 1  | 2      |
|                  | n.a                                                                               |          |          |           |    |    |         | 1   | 1  | 1  | 1  | 1      |
| Urticaceae (1)   | Urtica dioica L. (6)                                                               |          |          |           |    |    |         | 6   | 6  |
|                  | Herba (6)                                                                          | 1        | 5        | 1          | 1  | 1  | 1       | 4   | 3  | 3  | 6      |
| Hypericaceae (1) | Hypericum perforatum L. (9)                                                         |          |          |           |    |    |         | 9   | 9  |
|                  | Flos (8)                                                                           | 1        | 7        | 7          | 1  | 1  | 3       | 3   | 2  | 3  | 8      |
|                  | Herba (1)                                                                          |          |          |           |    |    |         | 1   | 1  | 1  | 1     |
| Pinaceae (2)     | All Pinaceae (9)                                                                   |          |          |           |    |    |         | 9   | 9  |
|                  | Abies alba MILL. (5)                                                               |          |          |           |    |    |         | 5   | 5  |
|                  | Herba (5)                                                                          | 5        |          |           |    |    |         | 3   | 1  | 1  | 1  | 5      |
|                  | Picea abies (L.) H. Karst. (4)                                                      |          |          |           |    |    |         | 4   | 4  | 2  | 2     |
| Aquifoliaceae (1) | Ilex aquifolium L. (4)                                                             |          |          |           |    |    |         | 4   | 4  |
|                  | Herba (4)                                                                          |          |          |           |    |    |         | 4   | 4  |
| Aspleniaceae (1) | Phyllitis scolopendrium (L.) Newman (3)                                             |          |          |           |    |    |         | 3   | 3  |
|                  | Folium (3)                                                                         | 3        |          |           |    |    |         | 3   | 3  |
| Malvaceae (2)    | All Malvaceae (6)                                                                  |          |          |           |    |    |         | 6   | 6  |
|                  | Malva neglecta Wall. (4)                                                           |          |          |           |    |    |         | 4   | 4  | 2  | 6     |
|                  | Folium (1)                                                                         | 1        |          |           |    |    |         | 1   | 1  | 1  | 1     |
|                  | Herba (3)                                                                          | 2        |          |           |    |    |         | 2   | 2  | 1  | 3     |
|                  | Others Malvaceae (2)                                                               |          |          |           |    |    |         | 1   | 1  | 1  | 1     |

(continued on next page)
When comparing the data from the present study with findings from PSES (Fig. 4, Additional file 2), no difference between FNS and GNS regarding the degree of satisfaction with their newly reported plant species, whereas three quarters of plant species (FNS) and 10% (GNS) of the respective UR were connected to the 18 ethnoveterinary use in Switzerland) was found. Furthermore, only 8% of the reported plant species are new for ethnoveterinary use in speaking populations within the same geographic area. However, these differences were associated with political and cultural separatism. If separatist tendencies are missing as in our study area (Fig. 2), different mother tongues of DP alone did not lead to significant differences in ethnoveterinary traditions.

### 4.2. Extending the spectrum of veterinary therapeutic options

There is increased interest of veterinarians in herbal medicine (Walkenhorst, 2017; Stucki et al., 2019), and an undeniable need for possible therapeutic alternatives, in particular to reduce the use of antibiotics. Ethnoveterinary research may be an important source of knowledge on promising plant species and on dosage of administered remedies. As in earlier studies, we determined the quantity of administered plant material and compared with the dosage documented in PSES or in literature (Reichling et al., 2016; Wichit, 2009; ESCOP, 2003; ESCOP, 2009, Tables 4 and 5). We calculated oral daily doses for ministered plant material and compared with the dosage documented in PSES (Fig. 4, Additional file 2), no difference between GNS (19%) and 8% (FNS) of the respective UR were connected to the 18 ethnoveterinary use in Switzerland) was found. Furthermore, only 8% of the reported plant species are new for ethnoveterinary use in speaking populations within the same geographic area. However, these differences were associated with political and cultural separatism. If separatist tendencies are missing as in our study area (Fig. 2), different mother tongues of DP alone did not lead to significant differences in ethnoveterinary traditions.

### Table 3 (continued)

| Botanical family (Number of named plant species in the family) | Plant species with ≥3 named HSHR (Number indicate the frequency of use reports) | Routes of administration | Categories of use | Target animal species | Total different use reports |
|---|---|---|---|---|---|
| Lamiaceae (7) | All Lamiaceae (11) | | | | |
| | Thymus vulgaris L. (4) | | | | |
| | Herba (4) | | | | |
| | Others species (7) | | | | |
| Rosaceae (6) | All Rosaceae (9) | | | | |
| | Prunus spinosa L. (3) | | | | |
| | Herba (3) | | | | |
| | Others Rosaceae (6) | | | | |
| Gentianaceae (1) | Gentiana lutea L. (5) | | | | |
| | Radix (5) | | | | |
| | Others (37) | | | | |
| Total (77) | Total (289) | | | | |

| Botanical family (Number of named plant species in the family) | Plant species with ≥3 named HSHR (Number indicate the frequency of use reports) | Routes of administration | Categories of use | Target animal species | Total different use reports |
|---|---|---|---|---|---|
| Lamiaceae (7) | All Lamiaceae (11) | | | | |
| | Thymus vulgaris L. (4) | | | | |
| | Herba (4) | | | | |
| | Others species (7) | | | | |
| Rosaceae (6) | All Rosaceae (9) | | | | |
| | Prunus spinosa L. (3) | | | | |
| | Herba (3) | | | | |
| | Others Rosaceae (6) | | | | |
| Gentianaceae (1) | Gentiana lutea L. (5) | | | | |
| | Radix (5) | | | | |
| | Others (37) | | | | |
| Total (77) | Total (289) | | | | |
4.2.1. Black tea (Camellia sinensis (L.) Kuntze, Theae nigrae folium). Farmers used infusions of black tea mainly to treat diarrhoea in calves. Black tea reportedly showed activity against bovine coronavirus and rotavirus (Friedman, 2007) which are among the main causes for diarrhoea and gastroenteritis in calves and cattle. Besides, anti diarrheal properties of black tea has been demonstrated in rodents (Besra et al., 2003; Hiller and Melzig, 2010). The additional CNS stimulant properties of black tea (Einother and Martens, 2013) might be beneficial for lethargic calves. The antibacterial, antiadhesive, anti diarrheal and spasmolytic properties of black tea may be beneficial in gastrointestinal diseases.

4.2.1.2. Coffee (Coffea L., Coffeae semen). As in PSES coffee was widely used, mainly to treat gastrointestinal disorders (QA) like constipation, colic, or rumination problems. Purine alkaloids reduce mental and physical fatigue, and chlorogenic acid stimulates gastric secretion (Hiller and Melzig, 2010). There is some previous evidence that coffee may be helpful to treat and prevent polyfactorial infectious diseases in calves (Ponepal et al., 1996).

4.2.1.3. Chamomile flowers (Matricaria chamomilla L., Matricariae flos). Preparations with chamomile were used as an infusion mainly to treat diarrhoea in calves. Chamomile flavonoids showed spasmolytic effects on bovine intestinal smooth muscles (Mendel et al., 2016). Chamomile also exhibited in vitro antibacterial properties against pathogens relevant in gastrointestinal disorders of youngstock (Ayrle et al., 2016a). In vivo studies also show protective effects in gastric ulcers in mouse and rats (ESCAP, 2003; Cemek et al., 2010), and anti diarrheal properties in rats (Sebai et al., 2014).

4.2.1.4. Linseeds (Linum usitatissimum L., Lini semen). A decoction of whole linseeds was orally administered to treat diarrhoea in calves. Farmers also used linseed to treat constipation and ruminating troubles, and a poultice was administered in ruminitis. Anti-inflammatory, anti diarrheal, and spasmolytic properties of linseeds are well known (ESCAP, 2003; Ayrle et al., 2016a), and linked to the content in mucilaginous polysaccharides. Linseeds are recommended to treat gastrointestinal inflammation and obstipation (ESCAP, 2003; Reichling et al., 2016).

4.2.1.5. Oak bark (Quercus robur L., Quercus cortex). Farmers treated diarrhoea in calves with infusions or decoctions of oak bark, or fed oak bark powder directly. The high content in tannins is responsible for the content in anti inflammatory and anti diarrheal properties (Ayrle et al., 2008). Oak bark extracts furthermore possess antibacterial and anti-quorum sensing activities (Deryabin and Tolmacheva, 2015).

4.2.2. Plants used in skin diseases

Marigold (Calendula officinalis L.), St. John’s Wort (Hypericum perforatum L.) and wood sanicle (Sanicula europaea L.) were the most frequently used plants for the treatment of skin disorders. While the therapeutic potential of marigold and St. John’s Wort in veterinary medicine is recognized (Tresch et al., 2019), wood sanicle is poorly studied and merits further investigation.

Wood sanicle (Sanicula europaea L., Saniculae folium et flos). Wood sanicle was already reported in PSES, but only with few UR. However, in an earlier ethnobotanical study on human use of medicinal plants in the canton of Jura, wood sanicle was one of the most often reported species. Use of wood sanicle thus appears to be a distinct particularity of the study area (Broquet, 2006). In the

based on information from at least three UR (Table 3). The medians of the determined dosages per kg metabolic body weight (kg\(^0.75\)) were similar to PSES, and to human and veterinary literature. However, as in PSES minimum and maximum values often differed by one to two orders of magnitude. Despite such big dosage ranges, placebo controlled studies in animals showed positive outcomes in the treatment groups, as was the case in studies with coneflower and garlic (Ayrle et al., 2016b, 2017). We calculated concentrations of five medicinal plants in finished products for external use, and the first dosage for Linum usitatissimum L. (median 6.25g/100g finished product). Again, the medians were similar to PSES, albeit slightly lower than recommended in human and veterinary literature (Table 5).

Corresponding with the outcomes of PSES and former European ethnoveterinary data (Mayer et al., 2014) the categories QA and QD were the most often mentioned indications with 72% of all UR.

### 4.2.1. Plants in diseases for which antimicrobial treatments are often used

In Europe, antimicrobials are most widely used to treat gastrointestinal and respiratory diseases of pigs, poultry, and for fattening cattle, in particular calves (European Medicines Agency, 2014; Schnyder et al., 2019). Mastitis and endometritis are major problems of youngstock (Ayrle et al., 2016). Chamomile also exhibited in vitro antibacterial properties against pathogens relevant in gastrointestinal disorders of youngstock (Ayrle et al., 2016a). In vivo studies also show protective effects in gastric ulcers in mouse and rats (ESCAP, 2003; Cemek et al., 2010), and anti diarrheal properties in rats (Sebai et al., 2014).
present survey, farmers used infusions of leaves or flowers to treat wounds or scars. Washing the injured skin or a direct application on the skin with a bandage were mentioned. Wood sanicle contains saponins as major phytochemicals, and is has also been used in human folk medicine (Hiller and Melzig, 2010). Anti-inflammatory activity of wood sanicle has been reported (Jacker and Hiller, 1976; Vogl et al., 2013).

4.2.3. Plants used in equine diseases

Compared to PSES, UR related to horses as target species were much higher in the present survey area (39 UR, 13%). This was likely due to the importance of horse breeding in this region (about 1400 farms kept horses). Apart from a study from the canton of Berne (Ryhner et al., 2018) referring to 27 plant species, recent European ethnoveterinary data in horses are scarce (Mayer et al., 2014).

In category QA, Coffea L. and Linum usitatissimum L. were documented for the same indication as for cattle. In category QD, farmers used Sanicula europaea L. (7 UR), Calendula officinalis L., and Hypericum perforatum L.. In category QM, Arnica montana L., Harpagophytum procumbens (Burch.) DC ex Meisn., Equisetum arvense L., and Zingiber officinale Roscoe were used to treat sprains and degenerative joint diseases. In category QR, Phyllitis scolopendrium (L.) Newman was used to treat cough, whereby the dried plant was directly administered orally. In vitro antimicrobial activity of Phyllitis scolopendrium (L.) Newman against pathogenic bacteria has been reported (Ferrazzano et al., 2013). Additional plants species mentioned in category QR were Abies alba Mill. and Citrus limon (L.) Osbeck.

Lavandula angustifolia Mill. was administered to calm nervous horses. Interestingly, this traditional use was recently corroborated in a clinical study with foals (Poutaraud et al., 2018).

4.2.4. General aspects

The plants most frequently reported by farmers in our current survey are inexpensive, easily available, and well known for human and veterinary medicinal purpose (Leonti and Verpoorte, 2017; Stucki et al., 2019). The phytochemistry, pharmacological properties, and therapeutic effectiveness is documented with numerous research publications and reviews (Ayrle et al., 2016a; Tresch et al., 2019). The use of complementary medicine and homemade remedies by farmers may help to lower the use of antibiotics (Maeschli et al., 2019). However, medicinal plants cannot replace antibiotics and other modern veterinary medicinal products, not the least for reasons of animal welfare. Nevertheless, a meaningful use of medicinal plants by veterinarians may limit the use of antibiotics and other modern veterinary medicinal products, not the least for reasons of animal welfare. Nevertheless, a meaningful use of medicinal plants by veterinarians may limit the use of antibiotics and other modern veterinary medicinal products, not the least for reasons of animal welfare. Nevertheless, a meaningful use of medicinal plants by veterinarians may limit the use of antibiotics and other modern veterinary medicinal products, not the least for reasons of animal welfare. Nevertheless, a meaningful use of medicinal plants by veterinarians may limit the use of antibiotics and other modern veterinary medicinal products, not the least for reasons of animal welfare. Nevertheless, a meaningful use of medicinal plants by veterinarians may limit the use of antibiotics and other modern veterinary medicinal products, not the least for reasons of animal welfare. Nevertheless, a meaningful use of medicinal plants by veterinarians may limit the use of antibiotics and other modern veterinary medicinal products, not the least for reasons of animal welfare. 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Nevertheless, a meaningful use of medicinal plants by veterinarians may limit the use of antibiotics and other modern veterinary medicinal products, not the least for reasons of animal welfare. Nevertheless, a meaningful use of medicinal plants by veterinarians may limit the use of antibiotics and other modern veterinary medicinal products, not the least for reasons of animal welfare. Nevertheless, a meaningful use of medicinal plants by veterinarians may limit the use of antibiotics and other modern veterinary medicinal products, not the least for reasons of animal welfare. Nevertheless, a meaningful use of medicinal plants by veterinarians may limit the use of antibiotics and other modern veterinary medicinal products, not the least for reasons of animal welfare. Nevertheless, a meaningful use of medicinal plants by veterinarians may limit the use of antibiotics and other modern veterinary medicinal products, not the least for reasons of animal welfare. Nevertheless, a meaningful use of medicinal plants by veterinarians may limit the use of antibiotics and other modern veterinary medicinal products, not the least for reasons of animal welfare. Nevertheless, a meaningful use of medicinal plants by veterinarians may limit the use of antibiotics and other modern veterinary medicinal products, not the least for reasons of animal welfare.

5. Conclusion

Farmers of mainly French speaking regions of Switzerland reported a total of 77 medicinal plants to treat and prevent livestock diseases. Of
### Table 4
Daily dosage in dry plant equivalent per kg metabolic body weight (g/kg^{0.75}) with homemade single species herbal remedy reports (HSHR) for orally administered use reports (UR).

| Plant species with ≥3 named HSHR and documented dosage | Daily dosage [g/kg^{0.75}] | Converted animal daily dose [g/kg^{0.75}]<sup>a</sup> | Converted human daily dose [g/kg^{0.75}]<sup>b</sup> | Determined median daily dosage [g/kg^{0.75}]<sup>c</sup> |
|--------------------------------------------------------|-----------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|
|                                                        | Calf (75 kg)                | (MWB = 25.5 g/kg^{0.75})                       | (MWB = 128.7 g/kg^{0.75})                       | (MWB = 128.7 g/kg^{0.75})                       |
| Linum usitatissimum L. Semen (29)                      | 39.22, 6.28, 1.57, 2.09, 9.80 | 0.43, 0.97, 0.97, 0.97, 0.78, 0.97, 0.70, 0.83, 0.65, 11.66, 2.05, 0.62, 0.33, 0.24, 1.55, 1.94, 0.77, 1.24, 2.80, 0.80, 0.88, 0.88 | 0.971, 0.194 | 3.21 (0.97; 0.19–39.22) |
|                                                        | Cattle (650 kg)             | (MWB = 128.7 g/kg^{0.75})                       | (MWB = 128.7 g/kg^{0.75})                       | (MWB = 128.7 g/kg^{0.75})                       |
|                                                        | Horse (650 kg)              |                                                               |                                                               |                                                               |
|                                                        | Others<sup>c</sup>          |                                                              |                                                              |                                                               |
|                                                        | Arithmetic mean             |                                                              |                                                              |                                                               |
|                                                        | (median; minimum value-maximum value) |                                                              |                                                              |                                                               |
|                                                        | Calf (75 kg)                | (MWB = 25.5 g/kg^{0.75})                       | (MWB = 128.7 g/kg^{0.75})                       | (MWB = 128.7 g/kg^{0.75})                       |
| Coffea L. Semen (27)                                   | 1.01, 2.05, 1.49            | 0.34, 0.62, 1.02, 0.59, 0.68, 0.42, 0.42, 0.37, 0.45, 0.45, 0.45, 2.03, 1.17, 1.17, 0.55, 0.28, 3.89, 1.94, 0.59, 0.39, 0.34, 0.51 | 0.09 | 1.78 | 0.83 (0.59; 0.09–3.89) |
| Matricaria chamomilla L. Flos (14)                     | 0.56, 0.09, 0.43, 0.16, 0.19, 0.08, 0.12, 0.17, 1.18, 0.19, 0.55 | 0.02, 0.06 | 0.22 | 0.29 (0.18; 0.02–1.18) |
|                                                        | Others<sup>c</sup>          |                                                              |                                                              |                                                               |
|                                                        | Arithmetic mean             |                                                              |                                                              |                                                               |
|                                                        | (median; minimum value-maximum value) |                                                              |                                                              |                                                               |
|                                                        | Calf (75 kg)                | (MWB = 25.5 g/kg^{0.75})                       | (MWB = 128.7 g/kg^{0.75})                       | (MWB = 128.7 g/kg^{0.75})                       |
| Achillea millefolium L. Herba (4)                      | 0.16 | 0.03, 0.22, 0.31 | 0.18 (0.19; 0.03–0.31) | 0.26 | 0.63 | 0.27 | 0.35; 0.19–0.39 (cattle), 0.27–0.53 (goat) |
| Camellia sinensis (L.) Kuntze. Folium (15)             | 0.70, 1.27, 0.27, 0.35, 0.80, 1.33, 0.51, 0.21, 0.22, 0.28, 0.64, 0.28, 1.41, 0.85 | 0.60 | 0.65 (0.60; 0.21–1.41) | 0.29 | 0.38 | 0.45 | 0.64 - 0.39–0.62 (cattle), 0.20–0.31 (calf) |
| Quercus robur L. Cortex (7)                            | 0.78, 1.45, 0.08, 6.42, 1.33 | 0.12, 0.02 | 1.43 (0.78; 0.02–6.42) | 0.47 | 1.17 | 0.87: 0.19–0.39 (cattle), 0.27–0.53 (goat) |
| Gentiana lutea L. Radix (3)                            | 0.59, 0.26 | 0.44, 0.23, 0.01 | 0.31 (0.26; 0.01–0.59) | 0.08–0.39 (cattle) |

<sup>a</sup> Sheeps
<sup>b</sup> ESCOP monographs (ES COP, 2003).
<sup>c</sup> Wichtl, Teedrogen und Phytopharmaka, Ein Handbuch für die Praxis auf wissenschaftlicher Grundlage (Wichtl, 2009).
Table 5
Concentration of medicinal plants for homemade single species herbal remedy reports (HSHR) in preparations for topical use.

| Plant species with ≥3 named HSHR and documented dosage | Extraction with water | Extraction with alcohol | Extraction with oil/fat | Arithmetic mean (median; minimum value-maximum value) | Median concentration other parts of Switzerland (Stucki; Mayer &; Mayer de; Bischoff; Didier) | Recommended concentration g dry plant equivalent in 100g finished product (ESCOP, 2003) | Recommended concentration g dry plant equivalent in 100g finished product (Reichling) |
|---------------------------------------------------------|-----------------------|------------------------|-------------------------|--------------------------------------------------------|---------------------------------------------------------------------------------|---------------------------------------------------------------------------------|---------------------------------------------------------------------------------|
| *Linum usitatissimum* L. semen (5)                      | 6.25, 6.25, 12.01, 4.81, 4.81 | 6.83 (6.25; 4.81-12.01) | 0.28 (0.17; 0.17-0.50) | 0.53; 0.50; 0.50; 0.38; 0.40 | 0.50 | 10.00 |
| *Matricaria chamomilla* L. Flos (3)                      | 0.17, 0.17, 0.50 | 0.28 (0.17; 0.17-0.50) | 0.53; 0.50; 0.50; 0.38; 0.40 | 0.50 | 10.00 |
| *Calendula officinalis* L. Flos and flos sine calice (6) | 2.27, 2.27, 2.27 | 0.70, 1.16, 4.81 | 1.42; 2.00; 0.83; 1.32; 0.91 | 0.67-1.33 | 20.00a | 1.00-5.00 | 11.11 |
| Herba (4)                                               | 2.41, 2.41, 2.41, 90.09 | 0.70, 1.16, 4.81 | 1.42; 2.00; 0.83; 1.32; 0.91 | 0.67-1.33 | 20.00a | 1.00-5.00 | 11.11 |
| *Sanicula europaea* L. Foliun (14)                      | 0.67, 0.09, 0.10, 0.33, 0.40, 0.40, 0.97, 0.60, 0.60, 0.20, 0.40, 0.97 | 3.00, 3.00 | 0.84 (0.50; 0.09-3.00) | 0.13; | | |
| Flos (3)                                                | 0.42, 0.42, 0.42 | 3.00, 3.00 | 0.84 (0.50; 0.09-3.00) | 0.13; | | |
| *Hypericum perforatum* L. Flos (7)                     | 0.51, 7.28, 2.66, 2.66, 2.66, 2.66 | 3.02 (2.66; 0.51-7.28) | 1.56; 2.50; 1.69 | 5.00-10.00 | 5.00 | 5.00-10.00 |

a 40% ethanol.
these, 18 were mentioned for the first time in a Swiss ethnoveterinary context. We found no obvious difference in ethnoveterinary knowledge between French and German native speakers. The most widely used plants are easily available and well known for human and veterinary purposes. Taking into account the current phytochemical knowledge, and in vitro and in vivo studies, several plants reported by farmers could be considered as promising treatment options for gastrointestinal and dermatological disorders in cattle and horses. The use of such plants and finished products could help to reduce, at least to a certain degree, the use of antibiotics. Thus, our findings may contribute to interna-
tional strategies for limiting the use of antibiotics.

Conflicts of interest

The authors declare that they have no competing interests.

CRediT authorship contribution statement

Doréane Mertenat: Data curation, Formal analysis, Writing - origi-
nal draft. Maja Dal Cero: Conceptualization, Writing - review & editing. Christian R. Vogl: Conceptualization, Methodology, Writing - review & editing. Silvia Ivemeyer: Software, Writing - review & editing. Beat Meier: Conceptualization, Methodology, Writing - review & editing. Ariane Maeschli: Software, Writing - review & editing. Matthias Hamburger: Conceptualization, Methodology, Writing - review & editing. Michael Walkenhorst: Writing - original draft, Conceptualization, Methodology, Writing - review & editing.

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Appendix A. Supplementary data

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