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Gastrointestinal nematodes (GIN) infections, commonly called "*worms*", affect both humans and animals. In veterinary medicine, the search for alternatives to control GIN is now considered a priority because of increasing resistances to commercial anthelmintics. The use of bioactive plants and related secondary metabolites is one of these alternatives. This study aimed to collect data on the use of medicinal plants (MPs) for humans and veterinary practices and at listing plant species with potential anthelmintic properties to select some plant species for further studies following three criteria (availability, originality and popularity). A cross sectional survey was conducted with a total of 384 participants, using semi-structured face-to-face interviews and a free list. To evaluate quantitative data of MPs, two ethnobotanical indices were calculated, the Salience index (SI) and the Use Value (UV). The importance and use of MPs in the population of study was high, 98% (372/383) of participants reported use MPs and 86% (321/384) mentioned knowledge of MPs used against GIN. The transmission of knowledge is not limited to the family environment. Sixteen plant species were listed belonging to 10 botanical families. The Asteraceae was the most popular botanical family. Six plants species were indicated for veterinary use. The four MPs selected for furthers studies were, namely: *Kyllinga odorata* Valh. (Cyperaceae), *Cassia occidentalis* L. (Fabaceae), *Artemisia absinthium* L. (Asteraceae), *Verbena litoralis* Kunth. (Verbenaceae). Evaluation of those MPs based on *in vitro* and *in vivo* assays are planned to validate the traditional local knowledge of these 4 plants.

Keywords: Anthelmintic, Alternative control, Ethnoveterinary, Ethnomedicine, Local knowledge, Medicinal plants, Paraguay

IPC Code: Int Cl.[22]: A61K 36/00, A61K 36/28, A61K 36/48, A61K 36/85, A61K 36/89, A61P 33/10

Gastrointestinal nematodes (GIN) infections, commonly called "*worms*", affect both humans and animals. In the tropics, GIN are considered part of neglected diseases in humans, although they affect at least two billion people in the world[1]. In veterinary medicine, FAO considers GIN as main parasitological infections being responsible for major economic losses, clinical signs and even death in a range of livestock species. In small ruminants, the mentioned losses are estimated in millions of dollars per year mainly due to reduced low production[2].

The term medicinal plant (MPs) refers to a variety of plants species that have medicinal properties[3]. MPs have been used for centuries in healthcare worldwide. In the past centuries, humans depended on plant resources to treat infections, parasitic diseases, to heal wounds and injuries. Also, the same plants species were often applied to farm animals[4]. Therefore, the therapeutic uses of plants and their related active metabolites in human and veterinary medicine show a remarkable similarity. Some studies noted that at least 60% of the plants used in traditional veterinary practices are also used in traditional human medicine[5,6].

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After the 1960s, this traditional use of plants was put aside because of the discovery of synthetic drugs which shift the fight against GIN[7]. However, over decades, this control practice relying exclusively on synthetic AH molecules has become insufficient due to the emergence of anthelmintic resistances (AR) and the increasing concerns over chemical residues on the environment and food chain[8]. Therefore, there is a clear need to explore more sustainable approach in order to limit the widespread development and diffusion of AR in worm population. A combination of conventional (i.e., synthetic drugs) and alternative treatments (i.e., new substances with anthelmintic properties) has been suggested, under the concept of "integrated control"[9].

Alternative treatments relying on plants have been identified as a valuable option and have been increasingly explored since the early 2000's. Part of this approach is based on ethnobotanical knowledge and ethnoveterinary practices and could provide information on bioactive plants species of interest for further studies to suggest sustainable treatment of GIN in small ruminants based on local uses and availability of resources. Despite remarkable growth of ethnobiology and ethnopharmacology research in the last decades[10,11], ethnoveterinary studies still are scarce, especially in Paraguay. Additionally, a lack of ethnobotanical studies in urban areas and in non-traditional populations was noted worldwide[12-14].

Therefore, this combined ethnobotanical and ethnoveterinary survey was carried out in 2019 in Paraguay. The first objective was to collect data on the use of medicinal plants (MPs) in humans and veterinary practices and at listing plant species with anthelmintic properties in a predominant urban environment. The data collected was aimedi) to identify the mode of use of these plants and also ii) to characterise the population (by gender and age), who has this traditional knowledge.

The final objective wasto select a few plant species based on three pre – established criteria (availability, originality and popularity) for further *in vitro* and *in vivo* studies to validate their claimed anti-GIN activity.

Materials and Methods

Study area

The study area, namely Central Department region in Paraguay is divided into 19 districts. It is located between the parallels 25º 07 'and 26º 00' and the meridians 57º 45 'and 57º 10'. Central Department comprises two types of area: (a) urban area (82%) and (b) rural area (18%).

Study population and sample

Population data was based on results of the census of population[15]. The total of population was composed of 2.082.023 inhabitants of the Central Department. The target population was calculated based on the main criteria ≥30 years old, this includes 982.399 inhabitants. The age was considered to take into account the economically active population and the average age of population. The sample size was 384 participants, being determined following the formula showed in *Data analysis* [Eq1]. To minimize selection bias and increase precision, interviews were conducted covering a fair quota (ratio) per district.

Survey methodology

The research participants were informed of the subject and verbal consents were requested in accordance with the Declaration of Helsinki[16]. The form did not include personal, recognisable, sensitive and/or confidential data.

The cross-sectional survey was conducted from January to July 2019 with 384 participants, using a semi – structured face to face interviews and free list. Forms were written in Spanish and translated in Guarani (i.e., both official languages in Paraguay).

A combination of snowballing and intentional sampling methods based on main selection criteria (i.e., individuals ≥30 years old) was used to select participants, who were randomly approached in different places (i.e., squares, fields, streets, markets, houses).

In a first stage, a pilot survey form was carried out with 10 inhabitants randomly chosen, respecting the parity of men / women. Afterwards, the final survey form was adjusted and validated in order to know the theoretical and practical knowledge on MPs of the studied population.

Survey form and questions

The survey form included simple questions, multiple choice and free list. The form was divided into four sections: A. Demographic data (i.e., age, gender) to describe the study population; B. Uses of MPs in daily life (i.e., purpose of use, frequency of use, mode of consumption and source) to evaluate use of MPs in the studied population. C. MPs used against GIN (i.e., common names, plant part used as medicine, uses in human or veterinary practices,

internal or external use) to list MPs mentioned with anti-GIN activity. D. Ethnobotanical knowledge (EK): Origin and transmission of knowledge, to evaluate EK the number of participants able to mention name of plants (i.e., theoretical knowledge), preparation and part of plant used in traditional medicine (i.e., practical knowledge) were noted and compared by age and gender. The relation between Practical and The orical knowledge was calculated following the formula showed in *Data analysis* [Eq4]. Additionally, to know the origin and how is the transmission of EK in the study population, the participants were asked: *Where do you learn about MPs*? those answers were analyzed by range of age and gender.

Data collection and MPs quoted against GIN "worms"

The present study focused to identify the MPs used by the local population to treat helminthiasis. Parasitic diseases caused by helminths are grouped under the term "*worms*" and the treatments used are indicated as "*against worms*".

Information obtained from the participants was treated according to the principle of triangulation: a) repetition (at least two people had referred to an identical medicinal use of the same plant in two different interviews);b) direct observation (using the blind test as a criterion: a sample of each cited plant was purchased to verify whether they matched the common name and the plant marketed as such); and c) informal confirmation by random vendors and collectors[17,18].

Afterwards, the MPs cited by the participants were summarized in a list. The common names from each mentioned MPs was associated with the botanical family, English and scientific name, using the Plant List database (http://www.theplantlist.org) and Tropicos database (htpp://www.tropicos.com). All cited MPs were evaluated in Availability, Originality and Popularity and these three variables were considered as criterion for selection of MPs for further studies.

The availability was considered as the main criterion of selection. Since as alternatives to control GIN, these plants species must be easy to find and cultivate by local people. To evaluate availability a number was assigned to each plant on the basis of different characteristics of each plants species (Na). The Na for evaluating the accessibility of MPs ranged from 1 to 3. The number assigned to the most accessible was 3, while 1 for the inaccessible ones. Where note 3 "*accessible*": perennial and easy to find; note 2 "*intermediary*": difficult to find according to season; note 1 is "*inaccessible*": hard to find or cultivate.

The number of scientific publications was considered as Originality criteria. MPs with fewer scientific studies in the area of interest were privileged. The cited plants species were subjected to a bibliographic research using the Web of Science (WSC) all data base from 1980 to 2019. The keywords used were the Latin and the English name of each plant species, in combination with the following keywords: "anthelmintic *"; "gastrointestinal nematode*"; and "small ruminants".

The popularity was considered a criterion to validate local knowledge. Each cited plant species was assessed on the basis of the number of times it was cited by the participants.

Additionally, to evaluate uses and cultural importance of MPs in the study population, two ethnobotanical indexes, namely: Use Value (UV) and Smith Salience Index (SI) were calculated for each plant species, using formula showed in *Data analysis* [Eq2] and [Eq3], respectively.

Procedures of selection of MPs for furthers studies

Among the list of MPs cited by the population and the relation between those three pre-established criteria, four MPs were selected for further studies to evaluate and validate their claimed anti GIN – activity in *in vitro* and *in vivo* studies.

Plant collection and identification

Following the recommendations on ethnopharmacological surveys, only those species of interest were collected[19]. The international, national and institutional rules concerning the biodiversity rights were followed.

The selected plants species were collected and taxonomically identified by Faculty of Chemical Sciences (FCQ) and Faculty of Exact and Natural Sciences (FACEN). Botanical specimens were deposited at the Herbarium of the National University of Asunción (UNA), San Lorenzo – Paraguay. A voucher number was assigned for the selected plants species *Kyllinga odorata* Valh (Cyperaceae) (FACEN4719); *Cassia occidentalis* L (Fabaceae) G01 (FCQ); *Artemisia absinthium* L (Asteraceae) (FACEN4720); *Verbena litoralis* Kunth (Verbenaceae) G02 (FCQ).

Data analyses

Descriptive methods were used to summarize data using Tables and Figures with Microsoft EXCEL®

The sample size formula was determined by the Equation1 (Eq1)

$$\textbf{(Eq1)}\ n = \frac{N \times Z\alpha^2 \times p \times q}{d2 \times (N-1) + Z\alpha^2 \times p \times q}$$

Where, n = sample size, N = population size; Z = confidence level (95% = 1.96); ρ = expected frequency (50%); q = (1 - p), d = maximum accepted error (5%)[2021].

The Use Value (UV)was calculated using formula in Equation 2 (Eq2). UV determine the relative importance (i.e., preference) of a particular species with respect to others species.

$$\textbf{(Eq2)}\mathrm{UV} = \frac{\Sigma U}{N}$$

Where, U=number of use reports for a given species, N=total number of informants

High values of UV indicates that the plant is very important, while the low values approaching zero suggest a relatively less importance with respect to other species[22,23].

The Smith Salience Index (SI) was calculated using formula of Equation 3 (Eq3). SI determined the importance of a particular species in a free list. The aim is to combine the average position and citation frequency of each item to determine the relative importance of the mentioned plants for the study population.

$$\textbf{(Eq3)}\mathrm{SI} = \frac{((L - R + 1)/L)}{N}$$

Where L is the size list of the species, R is the range of occurrence of the ethno species and N is the total number of informants[24]. The SI was normalized to vary between 1 and 0. The SI of the most prominent ideal term has the number 1 and when the term is not mentioned at all, the value is 0. Negative items were also noted.

The relation between practical and theoretical knowledge was calculated by comparing the number of answers of those participants who could are able to explain the parts and the mode of use (i.e., practical knowledge) between whose are able to cite the plants names (i.e., theoretical knowledge) and. Those answers were presented by percentage (%) **(Eq4)**.

$$\textbf{(Eq4)}\ Relation\ (\%) = \frac{PK}{PT}\ X\ 100$$

Where, PK represents the number of participants with practical knowledge and PT represent the number of participants with theoretical knowledge.

Results

Demographic data - the studied population (N= 384)

A total of 384 participants (127 men and 257 women) were interviewed and grouped into four age ranges: 1) 30 and 40 years old, with 45.8% of participants; 2) 41-50 years old, with 22.1% participants; 3) 51-60 years old, with 20.8% participants; 4)>61-year-old, with 11.2% participants. Demographic data by gender were summarized in (Fig. 1).

Use of medicinal plants in daily life (N= 372)

Ninety-six percent (372/384) of the participants recognized using MPs in daily life. The results were summarized in (Table 1).

The most cited purposes of use were refreshing 77% (e.g., taste, flavors, habits) and preventive 42% (e.g., for health maintenance or illness preventions).

Regarding mode of consumption, Tereré (i.e., maceration of herbs in cold water) was mentioned by 72% of participants and Mate by 20% (i.e., decoction of herbs).

Concerning the frequency of use 46% of participants admitted using a least one MPs every day.

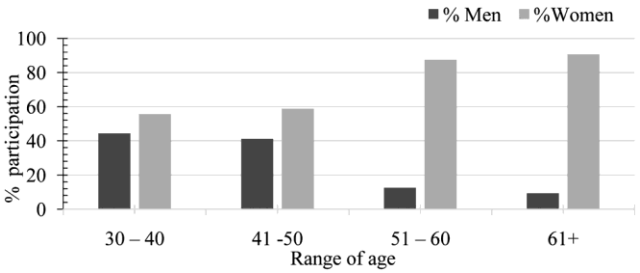

Fig. 1 — Demographic data of total participants by range of ageandgender (N=384).

Table 1 — Use of medicinal plants in daily life (N= 372)

	Category	%	n
Purpose of use	Refreshing recreational	77.41	288
	Medicinal curative	42.20	157
	Medicinal preventive	49.73	185
Mode of consumption	Tereré	71.8	267
	Mate	20.1	74
	Herbal infusion/teas	17.0	65
Frequency of use	Every day/daily	46.8	174
	≥ 2 times a week	17.5	65
	≤2 times a week	35.8	133
Source of MPs for consumption	Market	79.8	297
	Natural environment	16.0	60
	Cultivate	4.0	15

PS: variables were multiple choice with more than one answer considered into data.

About the source of MPs for consumption, 79% mentioned the market as the main source.

Medicinal plants used against GIN (N= 321)

Eighty-six percent of participants mentioned know the MPs used against GIN (321/372) among them, 68.54% were women and 31.46% men (Fig. 2).

The list of plants cited by participants was summarized in (Table 2) and include botanical name, English and common name of each species. Sixteen plant species were listed belonging to 10 botanical families. The most mentioned botanical family was Asteraceae. Fourteen plants species were reported for

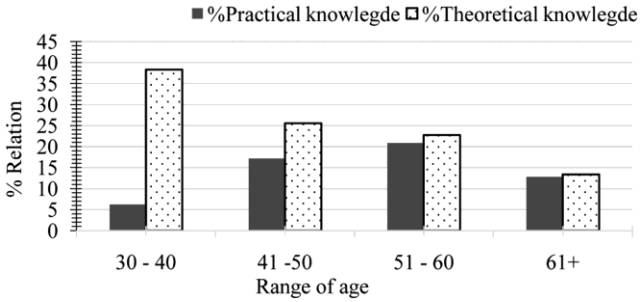

Fig. 2 — Relation into Practical and theoretical knowledge according to the range of age by gender (N= 321)

Table 2 — Medicinal plant species used against GIN in Central Department, Paraguay (N= 321)

Scientific name and Botanical family	English name	Common name	Part (s) of plant used	Mode of use	Use	Na	N° publications	Citation (n)
Amaranthaceae								
Chenopodium ambrosioides L.	Wormseed	Ka´are	Leaves, stems	Infusion	H, A, I	3	1337	238
Apiaceae								
Foeniculum vulgare Mill.	Fennel	Hinojo	Seeds	Infusion	H, I	2	484	48
Apocynaceae								
Aspidosperma quebracho Schltd.	White Quebracho	Quebracho blanco	Bark	Decoction	H, I	1	143	10
Asteraceae								
Acanthospermum australe Loefl. Kuntze	Paraguayan starbur	Tapekue	Whole plant	Poultrice, bath, infusion	H, A, E, I	2	33	80
Artemisia absinthium L.	Wormwood	Ajenjo	Leaves, stems	Infusion	H, A, I	3	1634	71
Baccharis trimera Less. DC.	Carqueja	Yagua rete ka´a	Leaves, stems	Infusion	H, I	2	206	35
Tagetes minuta L.	Mexican marigold	Suico	Leaves, stems	Infusion	H, I	1	332	218
*Tanacetum partheniu*mL. Sch. Bip	Feverfew	Altamisa	Leaves	Infusion	H, A, I	2	682	16
Commelinaceae								
Commelina nudiflora L.	Creeping Dayflower	Santa Lucia	Whole plant	Infusion	H, I	1	24	6
Cyperaceae								
Kyllinga odorata Vahl.	Fragrant spike sedge	Kapi' i Kati	Roots	Decoction	H, I	3	0	154
Fabaceae								
Cassia occidentalis L.	Coffee senna	Taperyva hû	Roots	Decoction	H, I	3	487	170
Lamiaceae								
Mentha piperita L.	Pepper mint	Menta´i	Leaves	Infusion	H, I	3	4452	83
Mentha spicata L.	Spear mint	Yerba buena	Leaves	Infusion	H, A, I	2	1201	77
Meliaceae								
Azadirachta indica A. Juss.	Neem	Hoja de Paraíso	Leaves, stems	Bath, infusion	H, A, E	3	5935	270
Verbenaceae								
Verbena litoralis Kunth.	Vervain	Verbena´i	Leaves, flowers, stems	Infusion	H, I	3	16	42
Aloysia polystachya Griseb.Moldenke	Oysterleaf	Burrito	Leaves	Infusion	H, I	3	39	3

The plants summarized in Table 2, included Botanical families; English and Local common names, plant part used, if use in human or animal medicine, internal or external use, (H: Human, A: AnimalI: Internal use, E: External use), Na: note accessibility, Number of PublicationinWeb of science (WSC)*scientific name***OR***english name***AND** "*keywords"*, citation.

internal use. The parts of plants most used in traditional medicine were leaves (62.5%). Only six plants species were pointed out for veterinary use, namely *Acanthospermum australe* Loefl. (Asteraceae), *Chenopodium ambrosioides* L. (Amaranthaceae), *Artemisia absinthium* L. (Asteraceae), *Tanacetum parthenium* L. Sch. Bip. (Asteraceae), *Mentha spicata* L. (Lamiaceae**)** and *Azadirachta indica* A. Juss. **(**Meliaceae).

According to number availability (Na), eight plants species were considered "accessible", six "intermediate". The "inaccessible" plants species were two: *Aspidosperma quebracho* Schltd. (Apocynaceae) and *Commelina nudiflora* L. (Commelinaceae)**.**

From the data base analysis on Webofscience®, the number of studies in some plants exceeds 1000 publications. However, others plants species were considered relatively innovative such as *A. australe* Loefl, *C. nudiflora* L., *Verbena litoralis* Kunth. (Verbenaceae), *Aloysia polystachya* Griseb. Moldenke. (Verbenaceae), with less than 40 scientific publications that report on their anthelmintic activity. The plant species mentioned with anthelmintic properties by the study population and that does not have studies on this claimed activity was *Kyllinga odorata* Valh, (Cyperaceae).

Taking into account the number of citations (n) and the two ethnobotanical indices (SI and UV), the most popular plants species considered with high cultural importance were, namely: *A. indica* A. Juss (270, SI 0.838; UV 0.88), *C. ambrosioides* L. (238, SI 0.735; UV 0.74), *Tagetes minuta* L. (Asteraceae) (218, SI 0.67; UV 0.68) and *Cassia occidentalis* L. (Fabaceae) (170, SI 0.517; UV 0.58). The lowest indexes were for *A. polystachya* Griseb Moldenke. (3, SI -0.039 UV 0.01), *C. nudiflora* L. (6, SI -0.028 UV 0.02) and *A. quebracho* Schltd. (10, SI -0.012; UV 0.3) (Table 3).

Ethnobotanical knowledge- Origin and transmission-(N= 321)

A total of 321 people were able to cite the names of plants used against GIN (the orical knowledge), among them, 183 were able to explain the mode of preparation and parts of plants used in traditional medicine (practical knowledge). The difference between practical and theoretical knowledge decreases as the age range increases (Fig. 2).

Concerning the transmission of ethnobotanical knowledge by range of age at least 70% of participants > 50-year-old reported to have learned about MPs in the familiar environment, while 72% of participants between 30- to 40-year-old mentioned obtained information about MPs through daily life and not in familiar environment (Fig. 3).

Table 3 — Ethnobotanical indices: Smith Salience (SI) and Use Value (UV)

Rank	Scientific name	SI	UV
1	*Azadirachta indica* A. Juss.	0.838	0.84
2	*Chenopodium ambrosioides* L.	0.735	0.74
3	*Tagetes minuta* L.	0.670	0.68
4	*Cassia occidentalis* L.	0.517	0.53
5	*Kyllinga odorata* Vahl.	0.464	0.48
6	*Mentha piperita* L.	0.240	0.26
7	*Acanthospermum australe* Loefl Kuntze	0.227	0.25
8	*Mentha spicata* L.	0.215	0.24
9	*Artemisia absinthium* L.	0.193	0.22
10	*Foeniculum vulgare* Mill.	0.118	0.15
11	*Verbena litoralis* Kunth.	0.097	0.13
12	*Baccharis trimera*Less. DC.	0.072	0.11
13	*Tanacetum parthenium* L Sch. Bip	0.010	0.05
14	*Aspidosperma quebracho* Schltd.	0.012	0.03
15	*Commelina nudiflora* L.	-0.028	0.02
16	*Aloysia polystachya* Griseb. Moldenke	-0.039	0.01

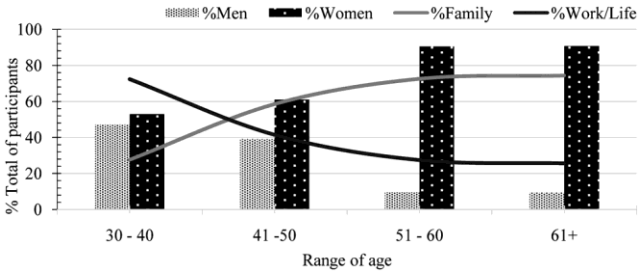

Fig. 3 — Ethnobotanical knowledge and transmission of knowledge byrange of age by gender (N=321)

Selection of four plants species for furthers studies

Based on the three criteria mentioned of selection the four selected plants were *Kyllinga odorata* Valh. (Cyperaceae), *Cassia occidentalis* L. (Fabaceae), *Artemisia absinthium* L. (Asteraceae) and *Verbena litoralis* Kunth. (Verbenaceae).

Discussion

This survey aimed at providing answers to the following questions: 1. What is the percentage of people who use MPs and their habits in daily life (e.g., purpose, mode de consumption, frequency)? 2. What is the percentage of people who know the properties of used MPs against GIN? 3. Which are the MPs used against GIN in both humans and veterinary practices? 4. How is ethnobotanical knowledge transmitted?

The studied population was comprised by 68% of participants ≤50 years old. The participation of female was predominant. However, when the age range increased, a net difference was observed. These distributions of data reflect the general distribution in the population. According to FAO, Paraguay has the youngest population in countries of Latin America and also with the highest percentage of female. In the urban area, the female population has maintained its supremacy steadily since 1950[25].

The results of (Table 1) showed a high percentage of people using MPs. The use as preventive and refreshing were the most mentioned purposes and the daily use concerned nearly 50% of participants. Tereré and Mate were cited for more than 80% of total of responses. Due to the use of Yerba mate (i.e., *Ilex paraguariensis*) in Tereré and Mate their potential interactions with MPs should be evaluated. There is a folks belief that natural products has no consequences, but some studies worldwide warned on the possible consequences for health due to short, medium and long term consumption of MPs in daily life[26,27].

Information such as where do people get or buy MPs for consumption, were significantly useful to know the source of information about its properties, uses and for the conservation of plant species. Since the main source to obtain MPs is the local market, this information perhaps explained why the information between the knowledge on plant species and their uses did not vary much between the participants.

The collection from spontaneous plants species from the natural environment was mentioned by 60 participants of 372. This practice is quite common, but has serious consequences, such as the danger of species disappearance due to it' soveruse and not sustainable management. This situation is especially danger in so-called "trendy" plants.

Results of Figure 2 showed that more than 68% of participants who cited MPs used as treatment against GIN were women. The relationships between knowledge and gender have been largely studied. In fact, several studies reported women have a deeply knowledge about MPs than men, probably due to cultural aspects (e.g., household responsibilities, food preparation, childcare)[28,29].

The results of Table 2 showed those MPs used against GIN cited by the studied population. The Asteraceae was the most popular botanical family, which include 1600 genera and more than 23.000 species. The majority of MPs belonging to this family have potential therapeutic applications[30-32].

The mode of preparation most mentioned was infusion. The most used parts in traditional medicine were the leaves. The use of leaves is a eco - friendly approach since allows to avoid the destruction of plants species, reducing the danger of extinction[33]. *A. indica* and *A. australe* were cited for both internal and external use, the rest of plants species in the list were mentioned for internal use.

Six of mentioned MPs are used for both animals and humans in traditional medicine. In particular, their anthelmintic activity was reported for different animal species, such pets and farm animals. However, the use of those mentioned plants species in small ruminants was not reported by the studied population.

The Na of MPs was considered as a main criterion. As mentioned before, the plants species must to being easy to find and cultivate. Among the MPs accessible eight were mentioned, namely: *C. ambrosioides* L., *A. absinthium* L., *K. odorata* Valh, *C. occidentalis* L., *Mentha piperita* L., *A. indica* A. Juss, *V. litoralis* Kunth and *A. polystachya* Griseb. Moldenke.

The popularity could be due to its effectiveness, to the information on the plant species, or to its availability by locals. We expect a trend between the number of times that the plants were cited in the survey and the number of scientific publications available. However, this relation was not always confirmed, such is the case of *K. odorata* Valh that despite being very popular is not mentioned by any scientific studies as a plant with anthelmintic properties.

The cultural importance of the plants was evaluated with the ethnobotanical indices: Salience index (SI) and Use Value (UV) in (Table 3). Those indexes are important quantitative indicators for evaluated the pharmacological potential of plants species[34]. The significantly higher SI values show the importance that the interviewees attribute to each plant[35]. The first plant species that was mentioned by the interviewed person was considered the most important for him, as preferred in comparison with others.

The plant species with lower indices may be due to the fact that these plants are not cultivated in the area and information on their uses and properties are not well known by the non-specialized population. This situation may be due, to the urban environment, the ease access to veterinary services for the study population and the lack of information on uses of plants on veterinary practices.

The popularity and ethnobotanicals indices are considered pointers of cultural and social importance for plants species with pharmacological interest.

The relation between the age of participants and they practical and theoretical knowledge show a remarkable difference between ranges of age (Fig. 2). Young people are able to cite plants species but, the ability to describe parts of use and mode of preparation was lower if compared to the one of older categories. Some previous studies on the transmission of ethnobotanical knowledge, suggested that most of the ethnobotanical nomenclature (i.e., theoretical knowledge) is acquired in adolescence, but practical skills (i.e., practical knowledge) are acquired mainly in adulthood[36].

Concerning the transmission of knowledge in urban environment context, the comparison between transmission by range of age, showed contrasting results, probably due to the fact of generation gap (Fig. 3). The transmission of knowledge on plants in the past (i.e., older generations) probably came from family members and traditions (i.e., information passed through generations) but nowadays, comes also from experienced in daily life, school or media (i.e., younger participants). According to Hurrell, urban knowledge is influenced by the media, educational programs. Moreover, it co-existing in different groups of people (i.e., urban and rural), leading to a more dynamic and complex cycle of transmission of knowledge[37].

Four plants were selected taking into account the three criteria of selection. In particular, the note of availability of plants for the local population, the hypothesis was "*if the plants are easy to find, cultivate and are known to the local population, their incorporation into an alternative control system is more feasible*".

As previously mentioned, those four plant species are abundant in the study area, easy to grow and low maintenance. As results, *K. odorata* Valh and *V. litoralis* Kunth were selected because of low number of scientific publications, *A. absinthium* L. was the only plant species cited in veterinary practices and *C. occidentalis* L. was retained because of popularity indexes.

Conclusion

The results presented in this study correspond to the survey directed to the general public with a participatory approach. The use of MPs inhuman medicine in the population of study is high. The use of MPs in veterinary medicine was very scarce. The risk of losing ethnobotanical knowledge for the new generations is high.

To build credibility for the use of plants in conventional medicine, the empirical arguments should be converted into evidence-based arguments. The selected plants were cited for their potential anti – GIN activity, evaluation of those activities planned to validate the traditional local knowledge.

The perspectives for the future are to verify the AH properties of those four selected plant species to examine whether those plants species can represent an alternative control to reduce the use of AH synthetic in veterinary medicine by using local resources

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Conflict of Interest

The authors declare no conflicts of interest associated with this study or its results.

Authors' Çontributions

GMO: design the study, writing, data collection, statistics, analysis and references, HH: design the study, writing, critical reading, data analysis, article format and references, MTÑ: design the study, survey process, form, pilot validation, data collection, critical reading, NA: validation, critical reading, CPS and GD: botanical identification of plant species, prepared herbarium samples and critical reading.

All authors have read and approved the final version of the manuscript.

Data availability

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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