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Endozoochorous seed dispersal of plant species in semi-steppe rangelands

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Abstract

During last two decades studies on endozoochorous seed dispersal indicated that a large numbers of plant seeds are potentially dispersed and suceefully germinated via animal dung. However, very little is known about the relative importance of endozoochory in germination success of plant species in semi-steppe rangelands. In this paper we examined dung germinating seed content, seed deposition patterns of different domestic animals (Cattle, Sheep and goat), ecological correlate with seed traits (Seed weight, length, width and shape) and the possible correlate of dung seed content characteristics with vegetation in a simulated feeding experiment. 39 native plant species were fed to domestic animals and their germination successes were recorded in a simulated glasshouse experiment.

Keywords: endozoochory, morphological characteristics, germination indices, animal treatments

Introduction

Plant regeneration opportunities and dispersal has become an important issue in plant ecology and restoration management (Cosyns et al. 2005). Large numbers of plant seeds are potentially dispersed and germinated via endozoochory (Welch 1985; Malo & Suarez 1995a ; Pakeman et al. 2002; Cosyns et al. 2005) improving seed disperal and enhancing the diversity of plant species and consequently the stability of plant population and communities, (Couvreur et al. 2005). Endozoochory covers the consumption of fleshy fruits by frugivores and the consumption of seeds of grasses and herbs by herbivorous mammals (Pakeman et al. 1998, Heinken et al. 2001, Cosyns 2004, Cosyns et al. 2005). Since many plant species cannot relied only on soil seed bank, germination success through the endozoochorus seed dispersal has a significant role on their survival of plant species and studies on possible seed dispersal and germination

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mechanisms are of key interest in the understanding of the colonization abilities of plants at the landscape scale (Verhagen et al. 2001; Pywell et al. 2002). During last two decades, an increasing number of attempts have been undertaken to get reliable knowledge of which plants are dispersed zoochorously and which factors and plant traits direct zoochorous dispersal (Cosyns et al. 2005). There are now many studies which have quantified such effects on a wide range of plants and habitats, such studies, are still very limited in semi-steppe rangelands (Jaroszewicz et al 2009). Steppe and semi-steppe rangeland systems are structurally diverse, exhibiting differences in woody plant canopy cover, stature, shrub functional form (evergreen vs. deciduous; broad-leaved vs. needle-leaved vs. succulent-leaved; shallow vs. deeply rooted), grass functional form[annual vs. perennial, C3 vs. C4 photosynthetic pathway] and spatial arrangement [random, regular, or clumped trees, bunch vs. rhizomatous grass] (Archer et al. 2001). The effectiveness of endozoochory and germination success of plant species after passage through the animal gut is a function of quantitative and qualitative traits. The quantity of dispersal depends on the amount of seeds ingested, animal type and livestock digestive system (Herrera and Jordano 1981). This can happen either deliberately due to high palatability or accidentally when a herbivore consumes seeds along with palatable leaves or neighboring palatable plants (Janzen, 1984; Pakeman et al., 2002). While the quality of dispersal depends on the percentage of undamaged seeds that are defecated. Germination may be enhanced by the softening of the coats during the digestive process, but destruction of seeds or inhibition of germination can also occur (Ramos et al. 2006). Some seeds adapted for endozoochory require scarification, the abrasion or chemical degradation of the seed coat that may be required by some species in order for the seeds to germinate (Davise 2007). Deposition of seeds with fecal material may provide nutrients that promote seedling establishment, but seed germination and seedling establishment could also be inhibited due to the toxicity and hydrophobic nature of dung (Ramos et al. 2006). Additionally, Seed germination successes after gut passage are not simply a function of the parent plant. Animal species have different effects on seed germination because of the differences in the oretical mean retention times of digestive products (Wallander et al. 1995; Mueller et al. 1998).

Including different sized herbivore species, with different digestive physiology and morphology and by combing the results of a simulated feeding experiment and in a field study we aimed to :1-assess germination success of 39 native plant species after gut passage; 2- To explore the possible ecological correlates of the dung germinal seed content with seed traits 3- To compare dung seed content characteristics between different animal type.

Materials and methods:

Feeding experiment:

39 native plant species were selected with a range of morphological characteristics within different plant life forms and considering their role in structure and composition of semi- steppe plant communities (Table 1). 50 air-dried seed of each plant species were chosen to measure seed weight, length, width and shape (Grime et al. 1988). Three individuals of each animal species were kept under similar conditions in the stable separated from each other and were fed and freely access to water from 6 days before experiment. In the seventh day, a known amount of seeds was mixed with the previous food and offered to the animals. Then animals were carefully observed to ensure that the seeds were completely consumed. After seed feeding, all dung from each individual animal was collected regularly until 6 days and kept at 2–4 °C for 2 weeks.

Several subsample were extracted from each animal dung and spread out on 0.4 m^2 trays kept for 6 month at greenhouse condition (temperature 20°C, ventilation, humidity 50% , 16 h light and 8 h dark, Watering, twice a day). The same number of seed for each plant species was dried and kept in 2-4°C for 2 weeks and then planted on the bare soil substrate to compare germination success of seed passed gut with control. Then, seedlings were identified and counted removed from trays. Moreover the date of seedling emergences was also recorded for each plant species. This continued for six months since the seedling emergence was abruptly decreased after three months. Six trays without seed addition were used to avoid possible germination from the potting soil substrate and contamination in the greenhouse.

Data Analysis

Greenhouse conditions may not be suitable for germination of some seeds, therefore the seeds did not germinate in any of the treatments (sheep, goat, cattle and control) were removed from the analysis among which seeds of plant species and analyses were performed with the rest of the plant species (21 plant species were excluded from the analysis, and 18 plant species were compiled to analyzed, species starred in Table 1.). Data were analyzed using software **SPSS17** using **Chi-square test** was performed to distinguish between plant species and growth form.

Result

1- Seeds pass through the digestive system of the plant species

Plant species are able to germinate in 3 treatments per animal and control treatment (Table 1). The results showed that the germination percentage equal to 82% of the treated cows *Festuca ovina*, 10/6% in the treated sheep and 14/6% for the treatment of goats. Between cows treated with control, there was no significant difference for any *F. ovina* (p< 0/05) and germination control equal to 34/ 6% (Figure 1).

Table1. Complete list of plant species studied in experiment

					Number of seed germination in each treatment			
Number	**Scientific Name**	**Vegetative Form**	**Family**	**Number of seed in treatment**	**Cow**	**Sheep**	**Goat**	**Control**
1*	*Festuca ovina L.*	perennial grasses	*Gramineae*	75	62	8	11	26
2*	*Festuca arundinacea Schreb*	perennial grasses	*Gramineae*	112	0	0	0	12
3*	*Agropyron elongatum (Host) .Beeauv.*	perennial grasses	*Gramineae*	66	16	2	3	24
4*	*Agropyron tricophorom (Link) Richter.*	perennial grasses	*Gramineae*	70	0	0	0	8

5*	*Agropyron cristatum (L.) Gaert.*	perennial grasses	*Gramineae*	55	0	0	0	5
6*	*Dactylis glomerata L.*	perennial grasses	*Gramineae*	112	8	1	0	35
7*	*Secale montanum Guss.*	perennial grasses	*Gramineae*	95	0	0	0	9
8*	*Rumex ponticus E.H.L. Krause*	perennial forbs	*Polygonaceae*	428	86	2	2	0
9*	*Rumex crispus L.*	perennial forbs	*Polygonaceae*	1400	65	14	11	395
10	*Rheum ribes L.*	perennial forbs	*Polygonaceae*	270	0	0	0	0
11*	*Salvia officinalis L.*	perennial forbs	*Labiatae*	350	72	8	6	179
12	*Stachys spectabilis Choisy ex DC.*	perennial forbs	*Labiatae*	1450	0	0	0	0
13	*Ziziphora tenuir L.*	perennial forbs	*Labiatae*	1100	0	0	0	0
14*	*Conium maculatum L.*	perennial forbs	*Umbelliferae*	1800	20	5	4	275
15	*Dorema Aucheri Boiss.*	perennial forbs	*Umbelliferae*	66	0	0	0	0
16	*Ferula gumosa Boiss.*	perennial forbs	*Umbelliferae*	134	0	0	0	0
17	*Ferula Assa-foetida L.*	perennial forbs	*Umbelliferae*	200	0	0	0	0
18	*Ferulago angulata (Schlecht.) Boiss.*	perennial forbs	*Umbelliferae*	120	0	0	0	0
19*	*Cynara Scolymus*	perennial forbs	*Compositae*	200	10	2	2	23
20*	*Silybum marianum (L.) Gaertn.*	perennial forbs	*Compositae*	170	28	4	3	140
21	*Artemisia aucheri Boiss.*	perennial forbs	*Compositae*	90	0	0	0	0
22	*Achillea sp*	perennial forbs	*Compositae*	126	0	0	0	0
23	*Artemisia sieberi Besser*	bush	*Compositae*	360	0	0	0	0
24	*Onopordon leptolepis DC.*	perennial forbs	*Compositae*	2000	0	0	0	0
25	*Eurotia ceratoides(L.) C. A. Mey.*	bush	*Chenopodiaceae*	112	0	0	0	0
26	*Atriplex leucoclada (Boiss.) Aellen*	perennial forbs	*Chenopodiaceae*	83	0	0	0	0
27	*Kochia.prostrata*	perennial forbs	*Chenopodiaceae*	150	0	0	0	0
28*	*Plantago lanceolata L.*	perennial forbs	*Plantaginaceae*	65	26	4	1	21
29*	*Vicia sativa L.*	perennial forbs	*Papilionaceae*	75	5	0	0	11
30	*Asragalus adsendence*	perennial forbs	*Papilionaceae*	120	0	0	0	0
31*	*Trigonella elliptica Boiss.*	perennial forbs	*Papilionaceae*	200	0	0	0	23
32*	*Nigella sativa L.*	perennial forbs	*Ranunculac*	200	0	0	0	6

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33	*Fritillaria persica L.*	perennial forbs	*Ranunculaceae*	285	0	0	0	0
34	*Cerasus Mahaleb(L.) Miller*	shrub	*Rosaceae*	200	0	0	0	0
35*	*Sanguisorba minor*	perennial forbs	*Rosaceae*	63	0	0	0	5
36	*Hypericum scabrum L.*	perennial forbs	*Hypericaceac*	1750	0	0	0	0
37	*Alyssum linifolium Steph. ex Willd.*	annuals forbs	*Cruciferae*	250	0	0	0	0
38	*Allium hirtifolium Boiss.*	perennial forbs	*Liliaceae*	200	0	0	0	0
39	*Ixiolirion tataricum(Pall.) Herb*	perennial forbs	*Amaryllidaceae*	1500	0	0	0	0

Table2 - Chi-square values significant at the 5% level of significance between the treatments of animals. (ns: Not significant at the 5% level,*: Is significant at the 5% level)

Compare of animals treatment	perennial grasses	Chi-Square	perennial forbs	Chi-Square	annuals forbs	Chi-Square
Cow-sheep	0*	65.28	0*	194.68	0*	20.94
Cow-goat	0*	94.68	0*	217.69	0.017*	22.75
Sheep-goat	0.304 ns	0.497	0.126 ns	1.62	0.5	0.145
Cow-control	0.047 *	3.11	0*	373.21	0*	143.36
Sheep-control	0*	47.48	0*	807.06	0*	116.06
Goat-control	0*	71.37	0*	917.28	0*	180.74

For species *Agropyron elongatum*, there a significant difference between the treatment of cattle, sheep and goats, so that germination in treatment cow, are more of sheep and goats treatments, and the percentage of cattle treatment is equal to 24.2%. Comparison between sheep and goats treatments, there was no significant difference, and germination percentage, equal to 3% for sheep and goats with 4.5%. For *Ag.elongatum* species, no was significant difference between cow treatments and control treatment (p> 0/05), also is germination percentage for controls with 36.6%.The results showed that the germination of *Dactylis glometara*, between cattle treatment with sheep and goat treatments, there is a significant difference, so that germination in plants cattle treatment, is higher than the sheep and goats treatments. Germination for these species, respectively, in the treatment of cattle, sheep and goats with 7.1 of 0.89 percent and zero percent. For these species, the percentage of seed germination between treatments sheep with goat, there was no significant difference. For *D.glomerata* species, between treatments with control animals, there were significant differences. The results for *D.glometara* species indicate there are significant differences between animal treatment and control treatments, and germination percentage in control treatment, were higher than of animal treatments and equal to 31.2 percent. The results showed that the species in Table 1, could not germinate after passing through the digestive system.

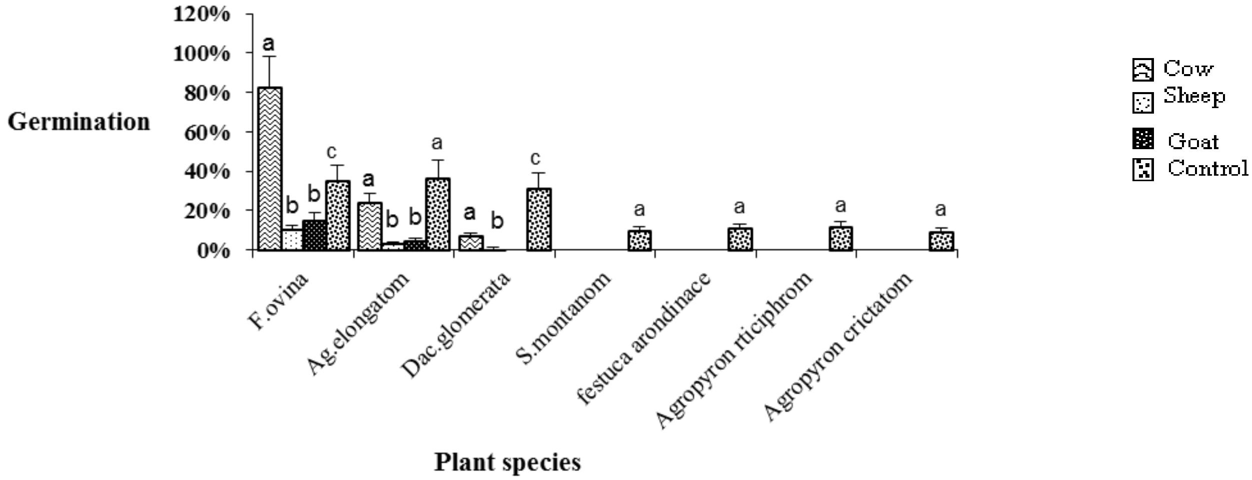

Fig 1- Comparison of germination perennial grasses (cattle, sheep, goats, and control) at 5% significance level based on Chi-square test. Same letters indicate no significant difference.

The result of Chi-square test for *Rumex ponticus* species showed there was significant difference between cattle treatments with sheep and goats treatments, so that germination percentage for cow treated with 20.9%, and for both sheep and goat treatments with 0.46%. For *R. ponticus* species no green shoots in the control treatment (Fig. 2). The results showed for *Rumex crispus* species, there were significant difference between cow treatment with goat and sheep treatment, ($p < 0.05$).

Germination percentage for this species, in cattle treatment equal with 64/4 percent and for sheep and goats respectively 1 and 0.87 percent. The results of the comparison between animals treatment and control treatment for R. crispus species there was shown a significant difference.So that germination percentage in control treatment higher than animal treatments and equal with 1/28 percent. Test results for *Salvia officinalis* species showed, there were significant difference between cattle treatment with sheep and goat treatments, and germination percentage in cow treatment, higher than other animal treatments and with 20.57 percent. Also, there is no significant difference between the treatments sheep fed goats ($p>0.05$), and germination percentage for sheep treatment equal with 2.28% and for goat treatment equal whit 1.71%. The results of the comparison between animal treatments with control treatment, Showed, there was significant differences for *S. officinalis.* So that germination in control treatment is higher than animal treatments and equal with 1/51 percent.

Chi-square test results showed that for *Conium maculatum* species, between cattle treatment with goat and sheep treatments, there is a significant difference. So that germination in cow treatment is higher than two other animal treatment and equal with 1/11 percent, and for sheep and goats treatments, respectively equal with 0.27% and 0.22 percent. The results of the comparison between animal treatments with control treatment show there is significant difference for *Conium maculatum* specie. So that germination percentage in control treatment is higher than animal treatment and is equal with 15 percente. Results for *Cynara Scolymus* species showed, there was significant differences between cattle treatments with sheep and goat treatments. So that germination percent for cow treatment equal with 5 percent and germination percentage for goat and sheep in both the treatment 1 percent. Germination percent in control treatment higher than the animal treatments and equal with 11.5 percent. For species *Plantago lanceolata*, there was significant difference between cattle treatment with sheep and goat treatments. And germination in cow treatment, higher than other animal treatments and is equal to 40 percent. For this species, there was no significant difference between the treated sheep fed goats (Figure 2).

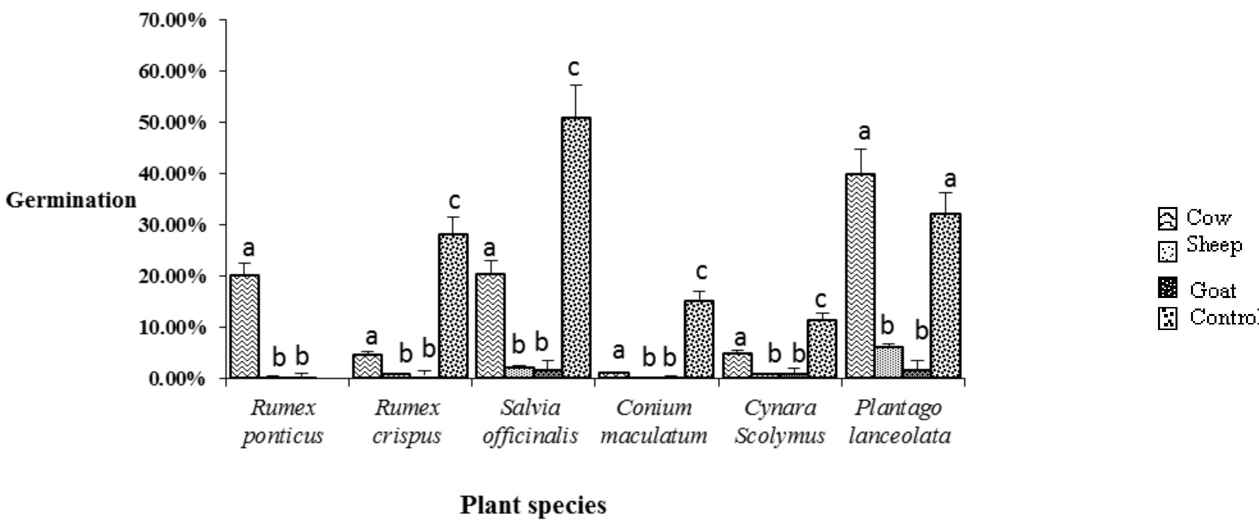

Fig 2- Comparison of germination perennial forbs (cattle, sheep, goats, and control) at 5% significance level based on Chi-square test. Same letters indicate no significant difference.

the Results showed for *Vicia sativa* species, there was significant differences between cow treatment and control treatment for germination. Germination in cow treatment equal with 6.61% and control treatment equal with 14.6 percent. The results showed for *Silybum marianum* species, there was a significant difference between the cattle treatment with sheep and goats treatments. Germination percent in cattle treatment higher than other animal treatments and equal with 4/16 percent. For these species, there was no significant difference between the sheep and goats treatments (Table 2 and Figure 3).

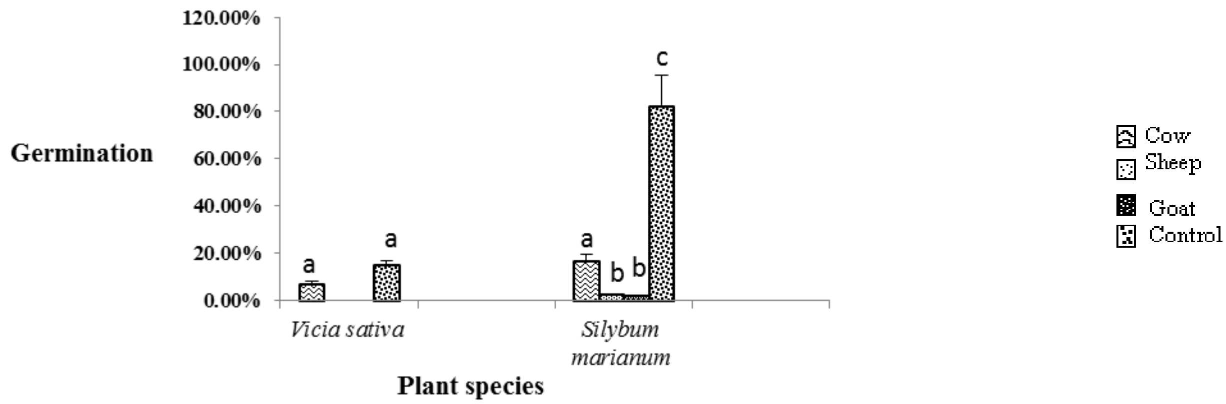

Fig 3- Comparison of germination annuals forbs (cattle, sheep, goats, and control) at 5% significance level based on Chi-square test. Same letters indicate no significant difference.

2- The results of the germination for vegetative form

2-1: Perennial grasses

The results of Chi-square for the perennial grasses vegetative forms showed, between treatments of cattle, sheep, goats, and control treatments, there was a significant difference ($p< 0.05$). So that percentage of germination in control treatment, higher than the sheep and goats treatments and equal with 27%. This is while, germination in control treatment, began one month later animal treatments. The results showed there was no significant difference between sheep treatment with goat treatment, and sheep treatment germination is equal with 1/3% and for goat treatment equal with 4%. For Grass several, between cow treatment with control treatment there were significant difference, and germination percentage for cow treatment is equal with 24.7 percent (Figure 4 and Table 2).

2-2: Perennial forbs

Results of Chi-square for perennial forbs showed there was significant difference between cattle treatment with sheep and goat treatments, so that germination percentage in cow treatment higher than two other treatments and is equal to 7 percent. Between sheep and goats treatments for perennial forbs, there was no significant difference, and germination percentage is for sheep treatment equal to 0.88 % and for goat treatment equal to 0.66%. The results showed that the germination percentage in control treatment for perennial forbs, there was significant difference with the animal treatments. In control treatment, germination percentage higher than animal treatments and equal with 21.04% germination in control treatment, but the start date germination in control treatment is later than the animal treatments.

2-3: Annuals forbs

Results of Chi-square for annuals forbs showed there was significant difference between cattle treatment with sheep and goat treatments, so that germination percentage in cow treatment higher than two other treatments and is equal to 13.4 percent, so that for sheep treatment germination percentage is equal with 1.65% and for goat treatment equal to 1.25%. The results showed that the germination percentage in control treatment for annuals forbs, there was significant difference with the animal treatments. In control treatment, germination percentage higher than animal treatments and equal with 61% germination in control treatment.

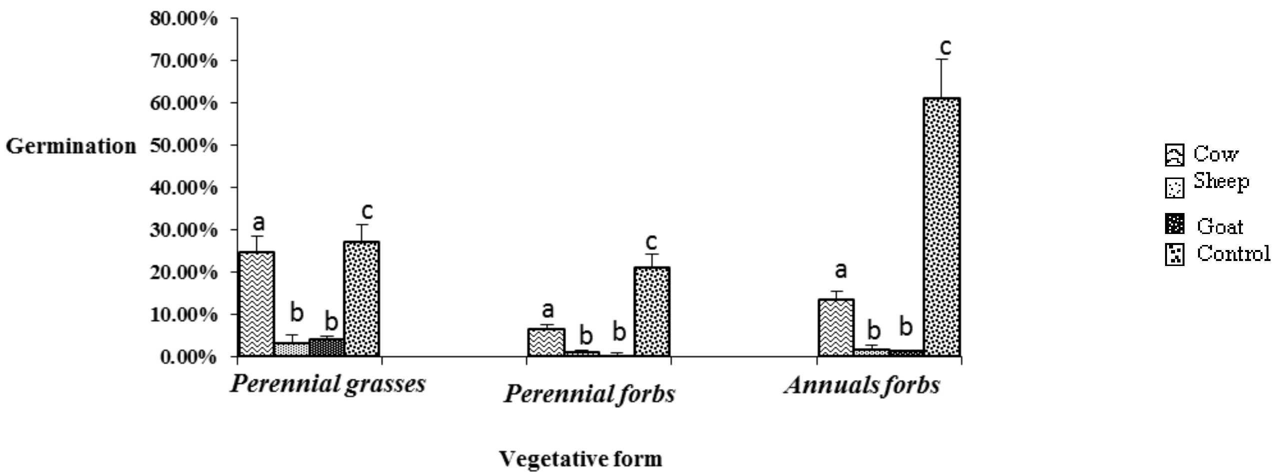

Fig 4- Comparison of germination vegetative form (cattle, sheep, goats, and control) at 5% significance level based on Chi-square test. Same letters indicate no significant difference.

3- Seeds properties and pass of the digestive system

According to studies, many features of the seed through the digestive system are affected. Scattering by endozoochory include: capture and eat plant seeds and being under the influence of digestive fluids during the passage through the digestive system. Endozoochory assessment, need to assess the viability of seeds in the digestive tract of livestock and other properties, Such as: hard shell, size, length, shape and seed width (cosynse et al, 2005). The results showed that in this experiment, 491 seeds, sprouted animal treatments. Plants sprouted are from different plant families such as: *Gramineae*, *Polygonaceae*, *Labiatae*, *Compositae*, *Plantaginaceae* and the *Papilionaceae*. Also, the number 68 seed, only able to germinate were in control treatment. Between the seeds of grasses family, Most of the species *Festuca ovina* seeds pass through the animal's digestive tract. *F.ovina* seed compared to *Ag. Cristatum* species and *D. glomerata* weight, length and width are less. Also in the family *Gramineae*, species *Festuca arundinaceae*, *Agropyron tricophorom*, *Agropyron cristatum* and *Secale montanom*, germination was successful only in control treatment, and for these species in animal treatments, the buds did not grow, that probably due to the large size, is (Length, width and weight than other seeds of the same family). About two plant species *Rumex ponticus* and *Rumex crispus*, germination percentage between animal treatments, in cattle treatment is higher than, sheep and goats treatments. Also, the species Rumex ponticus compared with species *Rumex crispus*, weight, length and width is greater and the highest percentage of germination for this species, in cattle treatment and is equal with 20 percent. About two plant species *Rumex ponticus* and *Rumex crispus*, there was no clear relationship between seed characteristics and pass through the digestive system. Species S*alvia officinalis*, *Conium maculatom*, *Cynara scolymus*, *Silybum marianum* and *Plantago lanceolata*, germinated in all four treatments (3 animal treatments and one control treatment), that the percentage of germination for this species, in cattle treatment more than two other animals treatments, and germination percentage in control treatment is more than germination of each animal treatments. Species of *Trigonella elliptica*, *Nigella sativa* and *Sanguisorba minor* germination just for control treatment were able to germinate, that there was no clear relationship between seed characteristics and pass through the digestive system (Table 3).

Table 3- Characteristics of size, length and width of seed germination in animal and control treatments

Plant family and species	Seed shape	Number of seeds in each treatment	Weight seed (gr)	Length* width(mm)	Cattle	Sheep	Goat	control
Gramineae								
Festuca ovina	Not Round	75	0.0007	3.2*0.74	*	*	*	*
Festuca arundinacea	Not Round	112	0.0017	7.1*1.9				*
Agropyron elongatum	Not Round	66	0.0016	4.1*0.92	*	*	*	*
Agropyron tricophorom	Not Round	70	0.004	9.2*1.8				*
Agropyron cristatum	Not Round	55	0.0013	5.3*1.01				*
Dactylis glomerata	Not Round	112	0.0012	3.02*0.86	*	*		*
Secale montanum	Not Round	95	0.013	7.5*1.7				*
Polygonaceae								
Rumex ponticus	gabled	428	0.034	5.1*4	*	*	*	
Rumex crispus	gabled	1400	0.002	2.4*1	*	*	*	*
Labiatae								
Salvia officinalis	Not Round	350	0.0055	2.6*2.2	*	*	*	*

Umbelliferae								
Conium maculatum	Round	1800	0.0046	3.7*1.5	*	*	*	*
Compositae								
Cynara Scolymus	Linear	200	0.034	7.1*0.1	*	*	*	*
Silybum marianum	Linear	170	0.015	6.3*3.05	*	*	*	*
Plantaginaceae								
Plantago lanceolata	Not Round	65	0.00013	1.4*0.71	*	*	*	*
Papilionaceae								
Trigonella elliptica	Not Round	200	0.01	3.7*2.7				*
Vicia sativa	Round	75	0.062	4.8*4.2	*			*
Plant family and species	**Seed shape**	**Number of seeds in each treatment**	**Weight seed (gr)**	**Length* width(mm)**	**Cattle**	**Sheep**	**Goat**	**control**
Ranunculaceae								
Nigella sativa	Not Round	200	0.0017	3.02*1.5				*
Rosaceae								
Sanguisorba minor	Not Round	63	0.0043	3.6*2.4				*

Discussion

The aims of this study passed a few several sample of pasture plants seed and its effect on seed germination by treatment animals (cattle, sheep, goat), was performed. According to App. 1, of the 39 plant species studied that in this experiment, only 11 plants species including: perennial grasses, perennial forbs and annuals forbs (Table 1), were able to germinate.

Seeds pass through the digestive system, causing poor germination of many plant species studied that is in agreement with results of other experiments by feeding different animal species such as: cattle, sheep, goats, rabbits, horses and donkey (Özer, 1979). Research results showed that all the plant species cannot germinate after passing through the digestive system due to seed characteristics such as: Seed size and its characteristics animals such as chewing and Jaw system and but small seeds, most are able to pass through the digestive system of livestock (Bruun and

Poschlod 2006). Also, the results showed that endozoochory, there has no effected to eliminate dormancy of Plants such as: *Dorema Aucheri*، *Ferula gumosa*، *Ferula Assa-foetida, Ferulago angulata, Artemisia aucheri, Artemisia sieberi, Achillea, Artemisia aucheri, Artemisia sieberi, Eurotia ceratoides* and *Kochia prostrata*.

The results of these experiments for different vegetative forms showed that germination percentage in cow treatment (between all animal treatments), is highest percentage of germination. So, in goat and sheep Treatments, is very low germination percentage. However, germination date in all animal treatments, were recorded faster than in control treatment, because there is food in the stool. This result is may be the result of complex interactions of plant and animal species characterized. For example, the intensity of chewing and digestion food, both of which are different in animal treatments and can be different acts (Simao Neto et al. 1987; Staniforth and Cavers 1977).

Similar findings by researchers in this field, confirm the results of this experiment, So that the seeds in the intestines of sheep, less likely to are germinate than other animal species such as: cattle, horses and donkeys (Simao Neto *et al*. 1987; Shayo and Udén 1998). The researchers showed that, chewing less and swallowing too by cattle and large herbivores, cause is less damage to the seed, but in the case of sheep and goats, is high chewing and damage to seeds and finally, there is an inverse relationship between the animal size and biting animal severity (Lutman *et al*. 2003), that the researchers results in this study, is correct for the plant species: *Festuca ovina, Agropyron elongatum, Dactylis glomerata, Rumex ponticus, Rumex ponticus, Salvia officinalis, Conium maculatum, Cynara Scolymus, Plantago lanceolata* and *Vicia sativa*.

There are many factors in the success of seed to pass through the digestive tract of animal. For example, (Bruun and Poschlod, 2006), features that are associated with endozoochory related to seed traits, characteristics, and characteristics of seed-producing plants, native plants seeds of division. Also (Bruun and Fritzbøger 2002; Heinken *et al*. 2002), believe there was the negative relationship between seed size with endozoochory and positive relationship between seed number with endozoochory. (Leishman 2001) is realized the positive relationship between abundance and population density of plant endozoochory. In a study by (Bakker and Olff 2003), in the nutrient rich plains between cattle and rabbits, in order to examine different effects of herbivores on scattered plant seeds were in their feces, large herbivores, due to heavy use of plants and seeds, germination density in feces, is higher than the rabbit feces, Also, the researchers also found that despite high germination density in feces of cattle, large herbivores cannot travel great distances, however, small herbivores, because of the traverse greater distance seeds in their stools the seeds are broadcast at a great distance. The scientists also examined in order to investigate density of Germination in feces of herbivores (rabbits and cattle), examples of pasture seeds plants without passing through the digestive system in the stool of these herbivores were cultured. They found that the start of sprouting in the feces of cattle and rabbits than starts the germination of seeds that were planted in the soil is much higher. Also, begin to germinate seeds in the feces of cattle is higher than of rabbit feces that due to the high material such as phosphorus and potassium in cow feces. This scientist stated that small ruminants like rabbit, through the Burrow in soil and relocation the seeds beneath the soil, improves seed germination.

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