Toxic - Hazardous Substances Found in Plants in a Natural Pasture Protected from Grazing and Their Effects on Animals

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Abstract

The study was conducted to determine plants possibly toxic-hazardous to animals in the floristic composition of a natural pasture protected from grazing for long years. The study area was a 30 hectares area located in the military garrison of the Tokat province, on which studies were carried out between the years 1993-2012. In the floristic composition of the study area, 211 plant species belonging to 37 families and 132 genera were identified. 53 species, which make up 25.1% of the species identified and which belong to 19 families and 36 genera were recognized as possibly toxic-hazardous to animal health and products due to the chemicals they contain. The weight of toxic-hazardous plants in the total dry herbage yield (12.025 kg ha^{-1}) of the study area was 12% in total (approximately 1.440 kg ha^{-1}), of which 10% came from 13 plants belonging to the legumes family and 2% came from 40 plant species belonging to 18 other families.

Keywords: *Protected pasture, floristic composition, toxic-hazardous plants, alkaloid, glycoside, other chemical substances.*

Otlatmadan Korunan Doğal Bir Meradaki Bitkilerde Bulunan Zehirli - Zararlı Maddeler ve Hayvanlar Üzerindeki Etkileri

Öz

Araştırma, uzun yıllardır otlatmadan korunan doğal bir meranın floristik kompozisyonunda, hayvanlar için zehirli-zararlı olabilecek bitkilerin belirlenmesi amacıyla yürütülmüştür. Araştırma alanı Tokat ili askeri garnizonunda bulunan ve üzerinde 1993-2012 yılları arasında çalışmalar yapılan 30 hektarlık bir alandır. Araştırma alanının floristik kompozisyonunda 37 familya ve 132 cinse ait 211 bitki türü tespit edilmiştir. Bunların sayısal olarak %25.1'ini oluşturan 19 familyaya ve 36 cinse ait 53 türün içerdikleri kimyasallardan dolayı hayvanların sağlığına ve ürünlerine zehirli-zararlı olabileceği belirlenmiştir. Araştırma alanındaki toplam kuru ot verimi (12.025 kg/ha) içindeki zehirli-zararlı bitkilerin ağırlığının %10'unu (yaklaşık 1.440 kg/ha) baklagil familyasının 13, %2'sini ise diğer 18 familyaya ait 40 bitki türü olmak üzere toplam %12'sini oluşturduğu hesaplanmıştır.

Anahtar Kelimeler: Korunan mera, floristik kompozisyon, zehirli-zararlı bitkiler, alkaloid, glikozit, diğer kimyasal maddeler.

1. INTRODUCTION

Ecologically, natural pastures are the most important natural resource of the earth's surface and as organic areas where artificial fertilizer or pesticides aren't used, they are nothing less than the child of the soil to which they hold on and belong. In terms of vegetative and animal production, pastures are the most economic spaces to meet the need for quality roughage for animals. However, due to years of excessive and uncontrolled grazing, their natural structures have deteriorated immensely. As a consequence, plant communities which animals don't eat and which may be toxic-hazardous for them have emerged.

Turkey is one of the most important countries in plant diversity [1]. Pastures possess rich vegetational covers consisting of many different species. In very-well-ranking pastures, weeds; i.e. plants that animals don't eat, don't enjoy eating or are harmful if eaten, are non-existing or are present in very small proportions. In a strongly flourishing pasture where climax plant species exist, weeds cannot grow. However, if the climax vegetation is damaged by cause of different factors such as uncontrolled grazing, ecological factors and unfavorable environmental conditions, then the amount and yield of decreaser plants declines and as a result, invader plants thrive [2]. Invader plants, generally defined as weeds, have no nutritive value; what's more, animals who consume them are poisoned due to the chemicals in their system and are injured due to their thorny structure [3,4,5]. Chemicals which cause this poisoning are located in the root, husk, leaf, fruit and other parts of plants. Many researchers [4-26] have

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conducted research on toxic-hazardous plants in pastures.

In order to be able to diminish the harm caused by toxic-hazardous plants on animal health and animal production, it is necessary that we know what plants are toxic and the effects chemical compounds they contain have on animals. With this study, we aimed to identify the possible toxic-hazardous plants for animals in a natural pasture vegetation protected from grazing, examine their effects on animals and suggest potential precautions.

2. MATERIAL AND METHODS

The study was conducted on an area protected from grazing of approximately 30 hectares with a 23% slope, located within the borders of the Tokat Province 48th Infantry Brigade territory (40° 19'34.80" N, 36°33'18.26" E, and 640 m above sea level). The research includes the period between 1993-2012 (19 years).

The total annual amount of precipitation for long years of the survey area is 445.5 mm, average temperature; 12.1 °C and the relative humidity is 62.2% [27].

Soil samples taken from 0-40 cm depths of the research area were analyzed at the Tokat Soil and Water Resources Research Institute. The soils were slightly alkaline (pH: 7.3-7.7), medium saline (0.072-0.084%), medium limey ($CaCO_3$: 87-92 kg ha^{-1}), phosphorus deficient (P_2O_5: 11.1-13.2 kg ha^{-1}), potassium sufficient (K_2O: 580-661 kg ha^{-1}) and at a medium level (16.61-21.61% kg ha^{-1}) in terms of organic substances [28].

The fundamental material of the study was plants found in the floristic composition designated by research carried out the period between the 1993-2012. The research area was monitored weekly particularly in the spring and summer months when flowering and seeding increased. As all plants could not be identified at the pasture, samples taken from plants were carried to the laboratory after being assigned a number and name, their herbariums were made and they were rendered ready for identification. All plants were identified at the Gaziosmanpasa University Agriculture Faculty and Gazi University Sciences Faculty.

3. RESULTS

As a result of the research conducted, 211 plant species belonging to 37 families and 132 genera were identified. By performing a literature research on the identified plants; 53 species possibly toxic-hazardous to animals, belonging to 19 families and 36 genera, were discovered in the floristic composition of pastures in the ecological conditions of Tokat and these were listed in Table 1.

3.1. Plants Harmful to Animal Health

Plants which cause bio-chemical or physiological changes in animals when eaten are scientifically and technically called toxic-hazardous plants. Because these plants poison and kill animals, they are defined as the most important weed encountered in pastures [3].

Classifying plants as toxic-nontoxic is rather difficult. Some plants are toxic on certain periods of the year and during certain developmental stages. Some plants have no negative effects as long as they are not solely used and can be used with other plants in rations [18].

Situations in which animals exhibit;
- Sudden sickness without a known reason
- Acute nervous system disorders in certain animals in the flock,
- Fast and extreme weight loss accompanied by digestive system disorders,
- Fast heartbeat, gastroenterological disorder,
- General stress and tendency to defecate frequently and
- Severe weariness, a state of coma, lying down and difficulty breathing, these are when one must suspect that the animals have been poisoned and take the necessary precautions [3].

3.2. Plants Containing Toxic Substances Poisonous to Animals

Certain chemical substances which plants themselves produce or take in by absorbing plant nutrients lead to poisoning when digested by animals. These chemicals have been summarized below.

3.2.1. Alkaloids

Amine, which is naturally produced by the plant, contains complex compounds like morphine, nicotine, strychnine, ephedrine, codeine and quinine in its structure; has a direct impact on the nervous system and liver upon consumption by humans and animals, and is generally known for its addictive properties. Alkaloids are the most commonly encountered toxic substances in plants and when consumed can affect the brain and spinal cord, cause nervous system disorders and sudden death [20,29] 23 plant species with alkaloids were identified in the research area and were presented in Table 1.

Table 1. Toxic-harmful plants identified in the research area and chemicals they contain

Latin names	Contains chemical substances
Asteraceae (Compositae)	
Anthemis altissima L.	Alkaloid, Flavonoid
Anthemis tinctoria var. tinctoria L.	Alkaloid, Flavonoid
Artemisia santonicum L.	Taurisin (Glycosid)
Centaurea depressa Bieb.	Santaurin, Sianin, Sikorin (Alkaloid)
Centaurea iberica Trev.&Spren.	Santaurin, Sianin, Sikorin, Pelargonin (Alkaloid)
Centaurea virgata Lam.	Santaurin, Sianin, Sikorin, Pelargonin (Alkaloid)
Cichorium intybus L.	For milk bitter substance
Senecio vernalis Walds&Kit	Pyrrolizidine, Yakobin, Yakonin, Silvasenesin (Alkaloid)
Xeranthemum annuum L.	Xanthostruman (Alkaloid)
Boraginaceae	
Anchusa leptophylla Roem.&Sch.	Saponin
Cerinthe minor L.	Saponin
Brassicaceae (Cruciferae)	
Capsella bursa pastoris (L.) Med.	Bursin (Alkaloid), Kolin, Astilkolin, Hiposin (Glycosid), Saponin
Descurania sophia (L.) Webb&P.	Kumarin, Flavonoid
Fibigia eriocarpa (DC.) Boiss.	Glycosid
Caryophyllaceae	
Dianthus orientalis Adams	Saponin
Convolvulaceae	
Convolvulus lineatus L.	Konvolvulin (Glycosid)
Cuscutaceae	
Cuscuta arvensis Beyrich&Eng.	Konvolvulin (Glycosid)
Euphorbiaceae	
Euphorbia helioscapi L.	Resin, Resinoid, Hemidin, Tanen
Fabaceae (Leguminosae)	
Astragalus brachypterus Fischer	Saponin
Astragalus coodei Chamb	Saponin
Astragalus hamosus L.	Saponin
Astragalus humillinus Frey.&Sin.	Saponin
Astragalus leontinus Wulfen	Saponin
Astragalus lycius Boiss.	Saponin
Astragalus nitens Boiss.&Heldr.	Saponin
Coronilla orientalis Lois	Coronillin (Alkaloid)
Coronilla varia L.	Coronillin (Alkaloid)
Melilotus alba Desr.	Alkaloid, Kumarin
Melilotus officinalis (L.) Desr.	Alkaloid, Kumarin
Psoralea bituminosa L	Alkaloid, Kumarin
Trifolium repens L.	Siyanojenik (Glycosid)
Hypericaceae (Guttiferae)	
Hypericum avioluriifolium J&S.	Hypericine (Light sensitive pigment), Flavon heterozit
Hypericum perforatum L.	Hypericine (Light sensitive pigment), Flavon heterozit
Hypericum sp. L.	Hypericine (Light sensitive pigment), Flavon heterozit
Liliaceae	
Colchicum autumnale L.	Colchicine (Alkaloid), Colchamine (Glycosid), Saponin
Ornithogalum alpigenum Stapf	Colchicine (Alkaloid)
Ornithogalum sp. L.	Colchicine (Alkaloid)
Papaveraceae	
Fumaria officinalis L.	Fumarin, Kriptokavin (Alkaloid), Fumar acit
Fumaria parviflora Lam.	Fumarin, Kriptokavin (Alkaloid), Fumar acit
Papaver dubium L	Antochianin, Rhoadin Rhoesin (Alkaloid), Morfin, Tebain, Isoquiroline
Polygonaceae	
Polygonum aviculare L.	Light sensitive pigment in cows
Rumex acetosella L.	Rumisin, Hırızorobin -root- (Glycosid), Potasyum oksalat acit
Primulaceae	
Anagallis arvensis L.	Cyclamen (Glycosid), Saponinli, bitter substance, Primveraz enzim

Ranunculaceae	
Adonis aestivalis L.	Adonitoksin, Simarin (Alkaloid), Adonin (Glycosid), Saponin
Adonis vernalis L.	Adonitoksin, Simarin (Alkaloid), Adonin (Glycosid), Saponin
Ranunculus arvensis L	Ranunkulin oil, Protoanemonin uçucu oil
Ranunculus isthmicus Boiss	Ranunkulin oil, Protoanemonin uçucu oil
Rubiaceae	
Galium verum L.	Saponin
Scrophyllaceae	
Digitalis lamarckii Ivan	Digitalis, Digitoxin, Digoxin, Gitoksin (Glycosid)
Solanaceae	
Hyoscyamus niger L.	Hyosiyamin, Atropin, Skipolamin (Alkaloid), Solanidine (Glycosid)
Umbelliferae (Ammiaceae)	
Artedia squamata L.	Saponin
Zygophyllaceae	
Peganum harmala L.	Alkaloid, Saponin, Flavonoid
Tribulus terrestris L.	Floeretrin pigment (Glycosid), Resin

[6-26,29-36].

3.2.2. Glycosides

Glycosides are the first substances to be produced as a result of photosynthesis and is the general term used for glycose compounds. They include many pigments that dissolve in water and alcohol. The cyanide ion, which is formed when glycosides are digested in the rumen thanks to bacteria activities, easily enters the blood stream to combine with hemoglobin and forms a cyanohemoglobin complex which cannot carry oxygen. The animal dies due to disruption of respiration [20,30]. The 14 plants containing glycoside in the research area were listed in Table 1.

Saponin Glycosides: These are steroid glycerides which increase surface tension by forming persistent lather when shaken with water and for this reason they are used to hold water insoluble substances in the emulsion or suspension state, and they also cause the breakdown of red blood cells [20,31]. If eaten by animals, they lead to poisoning characterized by vomiting, ache, diarrhea, hypersalivation and suffocation [32]. 18 plants containing saponin were identified in the research area and were presented in Table 1.

Coumarin Glycosides: They cause poisoning which manifests as generalized and heavy interstitial bleeding brought on by suppression of the potassium vitamin synthesis [20,33]. Plants containing coumarin in the research area were: *Descurania sophia, Melilotus alba, Melilotus officinalis* and *Psoralea bituminosa* (Table 1).

3.2.3. Other Chemical Substances

Oxalates: Not many plants contain these substances in hazardous levels. Oxalates show their toxic effect by binding calcium, thereby altering the balance of blood. When taken in great amounts, they cause damage to the kidneys and bone degeneration in monogastric animals [16]. When animals are given calcium supplements these negative effects are eliminated [20]. The only plant containing oxalate in the research area was identified as *Rumex acetosella* and was given in Table 1.

Resins-Resinoids: The best known is andromedotoxin (acetotoxin). It is generally found in English Roseum (*Rhododendron sp*) species together with ericolin and rhododentrin. It is mixed into honey via honey bees especially in the West Black Sea Region [7]. A different plant group rich in resin and Resinoids is the mole plant (*Euphorbia sp.*) species. The milk of animals who eat this plant turns pink and acquires burning, reddening, lapactic and nauseant properties due to the polyhydric diterpene esters it contains. Deaths can also be observed in offspring who drank the milk of an animal feeding on mole plant. *Euphorbia helioscapi* and *Tribulus terrestris* were identified as plants containing resin and Resinoids in the research area and were presented in Table1.

Photosensitizing agents: These substances are pigments which cause toxic reactions towards light. The most important is phylloerythrin, an end-product of chlorophyll metabolism. Liver disorders further enhance the impacts of this substance [16]. Due to the red flower pigment called hypericin found in *Hypericum* species, in a few weeks skin deformations and inflammations together with injuries can be observed in non-pigmented skin fragments exposed to sunlight in animals who eat these plants [9]. *Hypericum* species and *Polygonum aviculare*, plants containing photosensitizing agents in the research area, were listed in Table 1.

Phenolic Compounds: These are secondary metabolites widely distributed in plants. They protect the plant against insects and pests. Phenolic compounds in plants are divided into two groups, which are phenolic acids (phlounoids, isoflounoids,

tocopherols) and flavonoids (anthocyanins being the most important). Phenolic compounds may contribute to the taste and aroma of many plant-based foods. They are the source of bitterness and acerbity in foods. A wide group of flavonoids are also responsible for the color of foods. Anthocyanins, which are in the flavonoids group, are natural color substances and are responsible for the pink, red, blue and purple colors of vegetables, fruits, juices and wines [20,26,34]. These compounds become oxidized and when combined with aminoamides they decrease the usability of certain minerals and nutrients; the end products cause an unwanted dark color in feeds [12,19]. *Anthemis altissima, Anthemis tinctoria var. tinctoria, Descurania sophia* and *Peganum harmala* were identified as plants containing flavonoid in the research area (Table 1).

3.3. Substances Reducing Feed Quality

Certain chemicals which plants themselves produce or take in by absorbing from plant nutrients do not directly cause poisoning when digested by animals but reduce the quality of animal products, thus are undesired. These chemicals have been explained below.

3.3.1. Tannins

Also known as tannic acid. Tannins are polyphenolic compounds and are used to describe formless (amorphous) substances in the shape of pale yellow to light brown powder, flake or spongy mass, which can be found in the seeds of colza, tea and especially legumes [35]. They lessen tastefulness due to their bitter taste and complicate cellulose digestion [13]. *Euphorbia helioscapi* was determined as a tannin-containing plant in the research area (Table 2).

3.3.2. Mineral Material Irregularities

For animals to develop healthily and be profitable, mineral substances in the feed they consume should be sufficient. As many different species can be found within pasture and forage crops, the vegetation generally has a wide mineral substance composition. However, health problems which can arise from mineral substance sufficiency may also be caused by their overabundance. For this reason, mineral substances within plants in the vegetation must be adequate and balanced [5]. Among mineral substances; sodium, cobalt, fluorine and selenium stand out concerning the pastures of our country. Sodium is an important element for the development of halophytes. The sodium ratio of pasture plants depends on the proximity of the cultivation site to the sea, irrigation water and soil properties and the ability of plant species to absorb this element. In cases where pasture plants fail to meet sodium requirements, this need may be fulfilled by adding sodium salts to the ration [11]. Excessive cobalt in pastures is poisonous for plants; whereas, if plants do not have sufficient cobalt in their system this can lead to inappetence and eventually death in ruminants. Cobalt deficiency can be compensated with 250-500 g cobalt sulfate applications to each hectare [2]. An overabundance of the fluorine element causes abnormal bone growth and teeth loss in animals. High levels of selenium have diverse negative effects on animal metabolism and organism, and cause nail malformations, fleece and hair loss as well as tooth diseases. On the other hand, deficiency of selenium in the ration leads to sterility and white muscle disease in animals [11]. Furthermore, low magnesium absorption in ruminants as a result of excessive consumption of green herbage or low magnesium absorption from feeds give rise to the sickness called grass tetany characterized by severe muscle contractions, cramps and hemiplegia. As a precaution, animals are generally given MgO of 50 grams [36].

4. DISCUSSION

When compared to many other countries, Turkey is home to important plant diversity. Turkey contains more than 9000 taxa of plants, including approximately 500 plants used in health, cosmetics and for other purposes [1]. In addition to their medical usage, some can also cause toxic reactions. Particularly people living in rural areas who do not have knowledge of plants can be subjected to these reactions. Moreover, these incidences generally occur in pasture areas. Excessive and uncontrolled grazing causes especially the plant covers of pastures to divert from their original composition, besides giving rise to plant communities containing toxic chemicals which animals don't want, have difficulty eating and which could also harm humans if consumed or contacted. A wide range of poisoning types can be observed in animals who consume these plants [14]. Additionally, these chemicals negatively affect the quality of the milk, and the fleece and wool yield of livestock.

It is possible to say that the research area is rich in terms of plant diversity. However, plants listed in Table 1 relatively reduce herbage quality of the pasture area. In numbers, 53 of the 211 species, i.e. 25% included negativity for animals and their weight in the total herbage yield (1.443/12.025 kg ha^{-1}) was approximately 12%. Plants posing a risk to animals are the ones that animals eat unconsciously while grazing. These plants can both cause poisoning due to the chemicals they contain and can also lead to a decrease in plant diversity by turning into invader plants in the pasture in time. What's more, in order to reduce the harm caused by toxic plants on animal health and production to the lowest degree, it is

necessary that plants be known thoroughly. That is why identification of plants in pasture areas, guidelines aimed at recognition and raising the awareness of people who utilize these areas is of utmost importance in terms of human and animal health and good quality animal production.

5. CONCLUSION AND SUGGESTION

The ratio of toxic plants in our pastures containing substances harmful to animal health must be kept under control. Precautions for this cause, alongside those mentioned by Tongel and Ayan [4] and Balabanli et al. [5], are as follows;

- Pasture management regulations should be followed in order to increase pasture quality.
- The major toxic-hazardous plants should at least be recognized by shepherds and their whereabouts well known.
- Behaviors and physiological reactions displayed by animals towards poison should be well known and necessary interventions should be performed timely.
- Hazardous plants in the vegetation start growing earlier than appetizing plants, both for this reason and in terms of management regulations animals should not be taken to the pasture in early spring.
- Even though animals firstly eat appetizing plants, when hungry they also eat certain poisonous plants or plants harmful at least to their products. Therefore, especially when hungry, animals should not be taken to areas where poisonous plants grow.
- If plants in the vegetation weaken due to drought or similar reasons and green grass cover decreases, animals should be given feed supplements.
- So that animals do not graze on roadside plants poisoned by poisonous gasses emitted by vehicle exhausts while on the road, they should quickly be taken to the pasture area.
- If animals display signs of poisoning, the area containing toxic plants should immediately be abandoned.
- When poisoning has conclusively been determined in animals; they should, without fail, be taken to a veterinarian for examination and treatment.

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