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Changes in some biochemical parameters of hair goat kids diagnosed with oak poisoning

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ABSTRACT

In this study, some biochemical parameters of hair goat kids which had consumed excessive amounts of oak leaves and acorns in the autumn season and displayed toxicity symptoms during clinical inspections were evaluated. Blood samples were collected from the jugular veins of the goat kids. Glucose, AST, ALT, ALP, GGT, Na, K, Cl, cholesterol, and triglyceride levels of poisoned animals were found to be within the reported reference intervals. Creatinine, total protein, albumin, Ca, Mg and Fe levels, on the other hand, were found to be below the reference intervals. As a result, it was concluded that goats reflect the clinical findings of oak poisoning described in the literature, which courses with lowered amounts of mineral (Fe, Mg, Ca), TP, albumin and creatinine, yet without a significant change in other biochemical parameters. It can also be concluded that excessive consumption of oak by goats was capable of leading to toxicity.

Key words: Biochemical parameters, Hair goat kids, Oak poisoning, Siirt, Turkey.

INTRODUCTION

Poisonous plants are one of the main causes of economic losses in the livestock industry (James *et al.*, 1992; Panter *et al.*, 2011). Oak (acorn) toxicity is a well-known phenomenon for approximately 300 years now and is sporadically encountered in various parts of the world (Bausch and Carson, 1981; Vermeire and Wester, 2001; Pérez *et al.*, 2011; Eröksüz *et al.*, 2013). Oak leaves are often used as feed for the cattle, sheep, and goats, especially in the autumn and winter months during which the feeding grasses are scarce (Silanikove *et al.*, 1996; Hume, 2006; Pérez *et al.*, 2011). Toxicity occurs in the animals when the oak is used as the main feed ingredient for more than a couple days (Patterson, 1966; Guitart *et al.*, 2010; Pérez *et al.*, 2011; Eröksüz *et al.*, 2013), and it specifically causes harm to the liver, kidneys, and the digestive system (Kumar and Singh, 1984; Reed, 1995). Toxicity with this plant is more commonly encountered in the years of drought (Akar and Filazi, 1992).

Oak trees contain tannic acid in their buds, leaves, branches, and acorns (Balıkçı and Gürdoğan, 2003; Cortinovis and Caloni, 2013). Tannins are poly-phenolic compounds produced by the plant in order to protect itself from pathogenic microorganisms and herbivores (Üstün and Aydın, 2012; Ünver *et al.*, 2014). Tannins are categorized into two groups as hydrolyzable and non-hydrolyzable tannins (condensed tannins), based on their molecular structures (Makkar, 2003; Kushwaha *et al.*, 2011; Aydın and Üstün, 2012). Rumen microorganisms can decompose hydrolyzable tannins, yet they are unable to catabolize condensed tannins as these can only be decomposed with strong acids. Decomposition of hydrolyzable tannins by rumen microorganisms results in the formation of the metabolites (Vermeire and Wester, 2001; Makkar, 2003; Aydın and Üstün, 2012; Kushwaha *et al.*, 2012). Tannins hydrolyze into low molecular weight compounds like gallic acid and pyrogallol, which are absorbed by the digestive system and introduced into the bloodstream (Dollahite *et al.*, 1962; Neser *et al.*, 1982; Knight and Walter, 2001; Parton and Bruere, 2002). Even though the toxicity mechanisms of oak have not been completely revealed (Pérez *et al.*, 2011), it is known that gallic acid and pyrogallol react with cell proteins, causing denaturation and cell death. The strongest lesions as a result of oak poisoning are encountered in the kidneys, digestive system, and the liver (Kumar and Singh, 1984; Knight and Walter, 2001; Cortinovis and Caloni, 2013). Oak poisoning is known to occur in cattle, horses, sheep, goats, pigs, rabbits, and guinea pigs, and the cattle are known to be the most sensitive to it (Akar and Filazi, 1992; Guitart *et al.*, 2010; Pérez *et al.*, 2011). Rumen mucosa of the goats naturally contains the tannase enzyme, which makes goats more resistant to oak poisoning. That being said, as the goats may consume a higher amount of oak leaves and acorns during the drought seasons, or when they are introduced higher doses of oak materials in research studies, even the goats can become poisoned (Akar and Filazi, 1992; Silanikove *et al.*, 1996; Smith and Sherman, 2009).

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In this study, some biochemical parameters of hair goat kids which consumed excessive amounts of oak leaves and acorns in the autumn season and displayed toxicity symptoms during clinical inspections were evaluated.

MATERIALS AND METHODS

The study material consisted of hair goat kids (Fig 1A) of Çamtaşı Village of Baykan District, located in the Siirt province (38°12'49.95'' N, 41°45'17.12''E) (Fig 1B). The village was visited upon the medical history reports of lack of appetite, diarrhea and death occurrences in goats. During the visit, hair goat kids were found to have been fed only with oak leaves and acorns in the last few days (Fig 2A), which was determined as the reason for the lack of appetite and diarrhea (Fig 2B). After the clinical inspections of the animals, blood samples were collected from the jugular veins of 11 kids into non-anticoagulant tubes. The samples were centrifuged at 3.000 rpm for 10 minutes at 20°C, and the serums were kept in -20 °C till the analyzes were conducted. Using an ADVIA 1800 Chemistry System Auto-analyzer, the samples were inspected in terms of glucose (GLU), creatinine, aspartate aminotransferase (AST), alanine aminotransferase (ALT), alkaline phosphatase (ALP), gamma-glutamyl transferase (GGT), total protein (TP), albumin, calcium (Ca), magnesium (Mg), sodium (Na), potassium (K), chlorine (Cl), cholesterol, triglyceride, and iron (Fe) parameters. Data analyzed with SPSS software for windows. Mean and standard error mean (SEM) were determined by using descriptive statistical method. Parameter values presented as mean and SEM in tables.

RESULTS AND DISCUSSION

Clinical inspections revealed anorexia, depression and mucoid diarrhea in animals (Fig 2B). Furthermore, necropsies revealed high amounts of oak acorns inside the rumens (Fig 2C). The results of biochemical parameter tests are shown in Table 1, and serum mineral levels are shown in Table 2. Glucose, AST, ALT, ALP, GGT, Na, K, Cl, cholesterol and triglyceride levels were found to be within the reported reference intervals, with levels of 51.38 mg/dL, 103.5 U/L, 18.38 U/L, 96 U/L, 46.25 U/L, 145.5 mmol/L, 4.71 mmol/L, 109.13 mmol/L, 55.13 mg/dL, 28 mg/dL, respectively. Creatinine, TP, albumin, Ca, Mg, and Fe levels, on the other hand, were found to be below the reference intervals with 0.6 mg/dL, 5.35 g/dL, 2.71 g/dL, 7.89 mg/dL, 1.75 mg/dL, and 74.25 ug/dL levels, respectively.

Turkey is considered to be one the few oak realms with 18 oak species encountered naturally, and the sub-species, varieties, and natural hybrids of these oaks create wide forest areas in the country (Yaltırık, 1984). Most animal species are sensitive to oak poisoning. There are a limited number of researches conducted on the oak poisoning of animals (Balıkçı and Gürdoğan, 2003; Irak and Yılmaz, 2014), and these rarely report goat poisoning cases (Akar

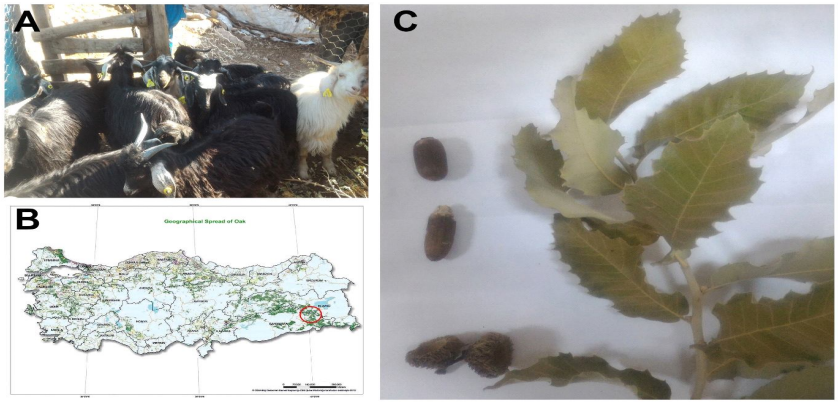

Fig 1: (A) Hair goat kids. (B) Study area (circle) and geographical spread of the oak trees in Turkey. (C) Oak leaves and acorns.

Fig 2: (A) Hair goat kids feeding with oak leaves and acorns. (B) Goat kids with diarrhea. (C) High amounts of oak acorns inside the rumen.

Table 1: Serum enzyme and metabolite levels of goat kids diagnosed with oak poisoning.

Parameters	Mean+SEM	Range in goats
Glucose (mg/dL)	59.38 ± 2.48	50-75[a]
Creatinine (mg/dL)	0.60 ± 0.03	1-1.82 [a]
AST (U\L)	104.38 ± 3.74	100-300[a]
ALT (U\L)	18.38 ± 1.18	6-19[b]
ALP (U\L)	94.88 ± 1.72	93-387 [a]
GGT (U\L)	46.25 ± 4.77	20-56[b]
TP (g/dL)	5.35 ± 0.21	6.2-7.9 [a]
Albumin (g/dL)	2.71 ± 0.09	2.9-4.3 [a]
Cholesterol (mg/dL)	59.88 ± 3.44	55-200 [d]
Triglyceride (mg/dL)	28.00 ± 2.90	27.25-32.15[c]

References [a](Batmaz, 2013), [b](Kaneko *et al.*, 2008), [c](Aşkın, 2013), [d](Altıntaş and Fidancı, 1993).

Table 2: Serum mineral levels of goat kids diagnosed with oak poisoning.

Parameters	Mean+SEM	Range in goats
Ca (mg/dL)	7.89 ± 0.24	8.9-11.7 [a]
Mg (mg/dL)	1.75 ± 0.07	2.8-3.6 [d]
Na (mmol/L)	145.50 ± 1.02	142-155 [a]
K (mmol/L)	4.71 ± 0.15	3.5-6.7 [a]
Cl (mmol/L)	109.13 ± 1.33	98-110 [a]
Fe (ug/dL)	66.00 ± 6.55	116.91-120.29[c]

References [a](Batmaz, 2013), [b](Kaneko *et al.*, 2008), [c](Aşkın, 2013), [d](Altıntaş and Fidancı, 1993).

and Filazi, 1992). Some oak poisoning cases were reported in researches conducted in Europe (Guitart *et al.*, 2010).

The study of Akar and Filazi (1992) was based on the poisoning case of the goats where 8 of the animals died for grazing in an oak-rich area, and the study aimed to reveal if the deaths were caused by the oak plant or by some other factor. The study reports tannic acid levels of 15 mg/100 ml, 16 mg/100 ml, 20 mg/100 ml, and 21 mg/100 ml in the analysis of rumen content analysis for 4 goats, respectively. A study in India reports that the goats display hemorrhagic gastroenteritis characterized by bloody diarrhea as a result of consuming oak leaves and acorns (*Quercus floribunda*), and also reports that goats do not have absolute immunity to oak toxicity (Katiyar, 1981). These findings mirror the findings of the present study.

The clinical findings of our study, like the anorexia, depression and mucoid feces found in the kids, were also similar to the findings and reports of various researches conducted on oak acorn poisoning (Bausch and Carson, 1981; Eröksüz *et al.*, 2013).

Biochemical analyses of the blood play an important role in consolidating clinical inspection results and health status of animals. In the study conducted by Eröksüz *et al.* (2013) where acute poisoning with oak leaves and acorns (*Quercus infectoria)* was researched, the levels of glucose, creatinine, AST, ALT, ALP, GGT, TP were reported to be in the reference intervals. Another study was conducted on goats where they were fed with tannin-rich leaves (Silanikove *et al.*, 1996), and this study also reports that TP, albumin, cholesterol, GGT, ALP, AST, K, Na, Cl, P, and Ca levels were all within the reference intervals reported for goats. In our study, even though the glucose, ALT, ALP, GGT, Na, K, Cl, cholesterol and triglyceride levels were found to be in accordance with the studies in the literature, the creatinine, TP, albumin, Ca, and Mg levels were found to be lower compared to the reference values, as opposed to the literature findings.

Some researchers (Spier *et al.*, 1987; Yeruham *et al.*, 1998) reported increased levels of BUN and creatinine levels due to oak poisoning, along with hyperphosphatemia, hypocalcemia, hyponatremia, hyperkalemia, and hypoalbuminemia. The findings of our study were similar to the earlier studies in terms of hypocalcemia and hypoalbuminemia. The reason of lowered Ca is attributed to the compounds found in the oak feeds binding the Ca and preventing its absorption through digestive canal. Lowered serum mineral (Ca, Mg) concentrations are usually explained by changes in intestinal absorption mechanisms.

The fact that no increase in creatinine level was observed in our study indicated that kidney damages had not occurred in the studied animals as of the study date. Spier *et al.* (1987)'s study on 60 naturally poisoned calves of 3-8 months of age reported a decrease in serum creatinine level within 7 days, which coincides with the creatinine levels reported in our study.

Literature survey revealed only a handful of studies where Fe levels of goats were inspected. In a study where hematological and biochemical parameters of healthy Ankara Goats were evaluated (Aşkın, 2013), Fe levels were reported as 116,91±3,03 ug/dl for young females and 120,29±3,88 ug/dl for young males. Hemolytic anemia symptoms are reported in the experimental poisoning of goats with oak tannins (Begovic *et al.*, 1978). Tannins prevent absorption of metal cations through the digestive system, especially that of iron and zinc (Brune *et al.*, 1989; Hurrell *et al.*, 1999). In our study, our conclusion was also that the lowered amount of Fe might be attributed to the anemia caused by the malfunctioning absorption system.

CONCLUSION

As a conclusion to our study, we report that goats can indeed be poisoned due to consumption of unusual amounts of oak leaves and acorns, and the clinical course of the poisoning reflects the findings of anorexia, depression, and mucoid diarrhea as expected. Blood mineral (Fe, Mg, Ca) levels of the poisoned animals were lowered, along with albumin, total protein, and creatinine levels, which in turn have led to anemia, hypomagnesemia, hypocalcemia, and hypoalbuminemia. It can be surmised that goats are able to tolerate consumption of oak leaves and acorns for short periods of time, but they can still become poisoned if they consume unusual amounts.

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