Estimating the Production Losses Due to Cystic Echinococcosis in Water Buffaloes (Bubalus Bubalis) in Turkey

savaş sarıözkan (ssariozkan@erciyes.edu.tr)
Erciyes University: Erciyes Universitesi https://orcid.org/0000-0003-2491-5152
Mehmet Küçükoflaz
Erciyes University: Erciyes Universitesi

Research Article

Keywords: Cystic echinococcosis, Production losses, Turkey, Water buffalo

Posted Date: May 22nd, 2021

DOI: https://doi.org/10.21203/rs.3.rs-532820/v1

Version of Record: A version of this preprint was published at Veterinary Research Communications on October 14th, 2021. See the published version at https://doi.org/10.1007/s11259-021-09848-6.

Abstract

Cystic echinococcosis (CE), is a neglected zoonotic parasitic disease among livestock diseases, that causes low productivity (meat, milk, fecundity), profitability and significant economic losses in water buffalo farms and serious public health problem all over the world. This study aimed at estimating the direct (condemned offal) and indirect (meat, milk, and fecundity losses) production losses due to cystic echinococcosis (CE) in water buffaloes in Turkey. A spreadsheet loss model was constructed, and the mean prevalence rate of CE was accepted as 16.4% (3.8% in males and 21.7% in females) in water buffaloes in Turkey. The annual financial losses were estimated with official and previously published data under expected (mean value), optimistic (lowered by 10%), and pessimistic (increased by 10%) scenarios with the prices current in 2020. The production losses in an infected male and female water buffalo were estimated at $54.3 and 105.3, respectively. The nation-wide losses due to CE were estimated at $1.7 million (1.4-2.1) for water buffaloes annually. In conclusion, farmers, policymakers, and the public need to be informed about the risks and financial impact of CE, and control/eradication programs should be included in policies of government at the national level after a cost/benefit analysis.

Introduction

Water buffaloes are highly frugal animals that can adapt to various environmental conditions and digest low quality/cheap roughages and pastures (Sarıözkan, 2011). Since buffaloes have 1/10 fewer sweat glands and thicker skin (6–7 mm) than cattle, they need water (such as rivers, streams, marshes, lakes, ponds, and seas) to remain cool in their habitat. For this reason, they are known as semi-aquatic animals. Although the long history of breeding the water buffaloes in Turkey, carcass and lactation milk yield was lower than cattle. Factors such as a decrease in wetlands with global warming and the number of farmers, the increase in urbanization, insufficient breeding level, and particularly livestock diseases (bacterial, viral, parasitic) may be the main causes of this situation. So, the contribution of buffaloes to the total milk (0.3%) and meat production (0.006%) is always decreasing in Turkey (TUIK, 2020).

Cystic echinococcosis (CE), is a neglected zoonotic parasitic disease among livestock diseases, that causes low productivity (meat, milk, fecundity), profitability and significant economic losses in water buffalo farms and serious public health problem all over the world (Budke et al. 2006; Harandi et al. 2012; Singh et al. 2014). CE is caused by the larvae of *Echinococcus granulosus* and infect ruminants (cattle, buffalo, sheep, goat) especially by means of dogs and other carnivores (Kassai, 1999).

Production losses due to CE in water buffaloes could be summarized as follows: 1) condemned edible offal (liver, lung, spleen, heart), 2) losses of productivity (decreased in carcass weight and milk production) and 3) decrease in fecundity (calf birth rate). Further, the first loss item could be defined as direct losses and the last two as indirect losses (Singh et al. 2014).

The disease is spread worldwide, especially in underdeveloped and developing countries (Asia, Mediterranean, and Middle East countries) such as Turkey. Globally, an annual livestock production loss of at least US $141,6 million and possibly up to the $2,2 billion is estimated due to cystic echinococcosis (Budke et al. 2006). Additionally, the human burden of CE is estimated as 285,407 and 1,009,662 disability-adjusted life years (DALY's), excluding and including under-reporting, respectively.

There are lots of studies in different countries about CE related losses in cattle, sheep, and goat (Mantovani, 1980; Kenzhebaev, 1985; Yang, 1992; Houin, 1998; Torgerson et al. 2000; Torgerson et al. 2001; Jimenez et al. 2002; Köroğlu and Şimşek, 2004). However, studies on water buffaloes and CE are rare (Harandi et al. 2012; Singh et al. 2014). On the other hand, as mentioned by Sarıözkan and Yalçın (2009), some previous studies based on economic losses of CE considered only the direct losses (Khaniki et al. 2013; Ghodake et al. 2014). Therefore, CE related losses are reported as less than real values in these studies.

To the author's knowledge, there is no study about production losses due to CE in water buffaloes in Turkey. This study aimed to estimate the production losses (reduced in carcass weight, milk production, fecundity, and edible offal) due to CE in water buffaloes at the national level under mean-expected, optimistic, and pessimistic scenarios.

Materials And Methods

According to the previous studies conducted in different regions of Turkey (Black Sea, Thrace, and East Anatolia), the mean prevalence values of CE varied between 10.2%-22.3% in water buffaloes and the mean prevalence was accepted as 16.4% for nation-wide estimation (Türkmen, 1992; Umur and Aslantaş, 1993; Beyhan and Umur, 2011). Additionally, as considered in this study the disease prevalence was reported as 3.8% in male and 21.7% in female buffaloes by Beyhan and Umur (2011). The CE related production losses in nation-wide and per infected buffalo were estimated under three scenarios; expected (mean value), optimistic (mean value lowered by 10%), and pessimistic (mean value increased by 10%) scenarios for evaluating the better and worse situation. The official data for total milked and slaughtered buffalo populations were obtained from the Turkish Statistical Institute (TUIK, 2020). Market prices of meat, milk, offal, and calf were considering on estimation. The estimation was conducted per infected animal (male, female) and nation-wide annually (current prices in 2020). Liver and heart were taking into account as edible offal. According to this information, total production losses (TPL) were estimated in four categories (losses of meat, milk, fecundity, and condemned edible offal) by using the constructed spreadsheet model given in Table 1.

Table 1
Spreadsheet loss model for estimation of CE induced losses in water buffalo

Loss components	**Calculation methods**
1. Meat production losses (L_{meat})	[(Mean no. of slaughtered buffalo × CE prevalence) × (reduction in the carcass weight, %) × (meat price)]
2. Milk production losses (L_{milk})	[(Mean no. of milked buffalo × CE prevalence) × (reduction in the milk production, %) × (milk price)]
3. Losses of fecundity ($L_{fecundity}$)	[(Mean no. of milked buffalo × CE prevalence) × (mean no. of calves born per year × reduction in fecundity,%) × (calf price)]
4. Losses of offal (L_{offal})	[(Mean no. of slaughtered buffalo × CE prevalence) × (prices of condemned offal)]
Total production losses (TPL)	TPL = $[(L_{meat}) + (L_{milk}) + (L_{fecundity}) + (L_{offal})]$

The technical and financial parameters used for the estimation of losses in Turkey are presented in Table 2.

Table 2
Technical and financial parameters used in the analysis

Parameters	Values	References
a. Technical parameters		
Mean prevalence of infection (%)	16.4	Türkmen, 1992; Umur and Aslantaş, 1993; Beyhan and Umur, 2011
Mean prevalence in male buffalo (%)	3.8	Beyhan and Umur, 2011
Mean prevalence in female buffalo (%)	21.7	Beyhan and Umur, 2011
Population of buffalo (head)	180,826	TUIK, 2020
No. of slaughtered buffalo (head/year)	1,880	TUIK, 2020
Mean carcass weight (kg/head)	213.8	Calculated from TUIK (2020)
Reduction in carcass weight (kg/head)[a]	8.0[a]	Calculated from Majorowski et al. (2005) and Polydorou (1981)
Mean no. of milked buffalo (head)	75,879	TUIK, 2020
Mean milk production (l/head/lactation)	998	TUIK, 2020
Reduction in milk production (l/head)	62.4[b]	Calculated from Majorowski et al. (2005) and Polydorou (1981)
Mean no. of newborn calf per year (head)	0.8[c]	Çolakoğlu and Özbeyaz, 1999
Reduction in no. of newborn calf (%)	11.0[c]	Majorowski et al. 2005; Budke et al. 2005
Mean liver weight (kg/head)	5.4	Gracey, 1992
Mean heart weight (kg/head)	3.0	Vaidya et al. 2014
b. Financial parameters		
Producer price of meat (US$/kg)	4.2	DMYMB, 2020
Producer price of milk (US$/l)	1.2	DMYMB, 2020
Prices of calf (US$/head)	276.8	DMYMB, 2020

[a] Reduction in carcass weight calculated as 3.75% of mean carcass weight. [b] Reduction in milk production calculated as 6.25% of mean milk production. [c] Data of cattle were used due to lack of reduction in newborn calf's data related to CE infection in water buffaloes.

Parameters	Values	References
Price of liver (US$/kg)	3.0	DMYMB, 2020
Price of heart (US$/kg)	1.5	DMYMB, 2020

[a] Reduction in carcass weight calculated as 3.75% of mean carcass weight. [b] Reduction in milk production calculated as 6.25% of mean milk production. [c] Data of cattle were used due to lack of reduction in newborn calf's data related to CE infection in water buffaloes.

Results

The estimated production losses per infected water buffalo due to CE in Turkey under three different scenarios are given in Table 3.

Table 3
Production losses per infected water buffalo due to CE under different scenarios

Loss item	Expected (mean) estimation		Optimistic estimation		Pessimistic estimation	
	Male	Female	Male	Female	Male	Female
L_{meat}	33.6	-	30.2	-	37.0	-
L_{milk}	-	74.9	-	67.4	-	82.4
$L_{fecundity}$	-	30.4	-	27.4	-	33.4
L_{offal}	20.7	-	18.6	-	22.8	-
Total losses	54.3	105.3	48.8	94.8	59.8	115.8

[a] Production losses were given in US$ (1 US$ = 6.86 TL).

The mean production losses in an infected male water buffalo were estimated at $54.3 (optimistic 48.8 and pessimistic 59.8) and in female water buffalo $105.3 (94.8-115.8) in Turkey with current 2020 prices (Table 3).

Nation-wide production losses from CE in water buffaloes in Turkey under different scenarios are given in Table 4.

Table 4

Total production losses[a] from CE in buffaloes in Turkey under different scenarios

Loss item	Expected (mean) estimation	Optimistic estimation	Pessimistic estimation
L_{meat}	2,337.2	1,930.4	2,851.9
L_{milk}	1,233,284.1	997,277.8	1,494,330.1
$L_{fecundity}$	500,558.6	405,421.5	605,711.7
L_{offal}	1,439.9	1,323.1	1,595.5
TPL	1,737,619.8	1,405,952.8	2,104,489 .2

[a] Production losses were given in US$ (1 US$ = 6.9 TL).

The nation-wide annual financial losses due to CE in water buffaloes were estimated at $1.7 million (1.4–2.1) for the year 2020. Milk production and fecundity losses were ranked as the highest loss items as 71% and 28.8% in total production losses (TPL), respectively. The quantity of meat and offal losses were low (Table 4).

Discussion

A continuous increase in the world's population leads to higher demand for livestock products. Water buffaloes are an alternative source of meat and milk production. However, livestock diseases/infections like zoonotic CE disease are limited to this potential production and threaten public health. Current prevalence values and previous studies indicated that CE is an endemic disease in Turkey (Umur, 2003; Altıntaş et al. 2004) similar to neighborhood countries such as Greece, Iraq, and Iran.

The prevalence of CE in water buffaloes in Turkey (10–22%) was higher than in some countries such as Italy (Capuano et al. 2006; Cringoli et al. 2007), Egypt (Haridy et al. 2006; Abbas, 2016), Iraq (Al-Nassir, 2012) and Nepal (Manandhar et al. 2006). However, CE is more prevalent in Greece (Chaligiannis et al. 2015), India (Verma and Swamy, 2009; Borua et al. 2010; Khan et al. 2013), Iran (Khanmohammadi et al. 2008; Samavatian et al. 2009; Dadkhah et al. 2011), Pakistan (Sheikh et al. 1968; Khan et al. 1990) and Bangladesh (Islam, 1982).

The high number of stray/wild dogs, infected and rougher pastures, unofficial slaughtering of domestic animals, traditional slaughtering in Muslim religious observances, insufficient abattoir facilities and easy access of stray dogs to infected organs may be considered as main reasons for the high prevalence of the disease (Sarıözkan and Yalçın, 2009; Umur, 2003; Eslami and Hosseini, 1998). Additionally, in rural areas, the proximity of domestic animals and stray/wild dogs increases the infection risk, and high incidence rate of *E. granulosus* in dogs' intestine leads to severe environmental contamination and also a potential risk for domestic animals and public health (Khan et al. 1990).

Another feature of buffaloes is that they are generally of higher age at the time of slaughtering, and age is reported as an essential factor of high prevalence rates in buffaloes (Islam, 1982; Aarif et al. 2015). The high prevalence rate of CE in female water buffaloes in Turkey is related to their long life as breeding material (15–20 years). Male water buffaloes were generally slaughtered at 2–4 years old, and so prevalence in males was lower than females.

CE is also more prevalent in sheep (40–50%) in Turkey (Sarıözkan and Yalçın, 2009; Altıntaş et al. 2004). Accordingly, it is known that the sheep-dog-buffalo cycle has an essential responsibility for the spread of the disease. Similar to Egypt (Abbas, 2016) the extensive use of dogs with sheep flocks for protection in a rural area may increase the prevalence of CE in Turkey. For this reason, potentially infected sheep flocks around the buffalo farms might increase the prevalence rates of buffaloes indirectly. A buffer zone (of at least 5 km) near buffalo farms is suggested to new farms for preventing the spread of the infections (Cringoli et al. 2007). Also, small scale and mixed production structure (the breeding of sheep, cattle, and buffaloes together) and insufficient specialization in livestock enables the spread of the infections. Dog-ruminant-human interaction should be controlled in terms of contamination. Additionally, the amelioration of pastures and public education should be provided.

There are limited studies based on loss estimation of CE in water buffaloes, and some of them take into account only condemned organs (Khaniki et al. 2013; Ghodake et al. 2014; Borji et al. 2012), similar with this study detailed and systematic studies are rare (Harandi et al. 2012; Singh et al. 2012).

In Iran, total production losses ($918,418) and losses for condemned offal ($1.2–1.3) per infected buffalo was lower than Turkey (Harandi et al. 2012; Khaniki et al. 2013; Borji et al. 2012). In India, total production losses in buffaloes ($85 million) were higher than Turkey however, losses per infected buffalo ($18.5) were lower (Singh et al. 2012). Different values between the countries might be related to livestock population, prevalence of infection, estimating methodologies (loss items included in analyses), and prices of livestock products.

Approximately, the estimated CE related production losses in an infected male buffalo ($54.3) in Turkey accounted for 6% of the market value of a male buffalo. Milk production losses due to CE per infected female buffalo ($105.3) nearly equal to 88 liters of milk and 9% of a buffalo’s lactation milk production. TPL in water buffaloes ($1.7 million) is nearly equivalent 2% of the previous reported total production losses from other ruminants (cattle, sheep, and goat) in Turkey (Sarıözkan and Yalçın, 2009). According to previous published and current study results CE is responsible, for considerable production losses in ruminants in Turkey.

The present study is the first attempt to estimate the production losses of CE in water buffaloes in Turkey. Therefore, the present study may encourage other researchers in different countries to estimate the economic impact of CE in water buffaloes.

In conclusion, the results of this study may be used as decision support in the allocation of monetary funds in Turkey. In the short-term, eradication of CE may be complicated; however, farmers, policymakers, and the public needed to be informed about the risks and financial impact of CE. In the middle and long-term, control and eradication programs should be included in policies of the government at the national level after a cost/benefit analysis.

Declarations

Author contribution: SS and MK conceived and designed the research together; MK collected the data and SS analyzed the data; The authors wrote the manuscript together and contributed equally in the preparation and revision of the manuscript. All authors read and approved the final manuscript.

Funding: Not applicable

Conflict of interest: The authors have declared that no competing interests exist.

Availability of data and material: Yes

Code availability: Not applicable

Ethics approval: Not applicable

Consent to participate: Yes

Consent for publication: Yes

References

1. Aarif K, Suhani B, Mathur KN, Sharma R.L., Makhdoomi DM, Nazir A Mehraj-UD (2015) Retrospective study of hydatidosis in buffaloes slaughtered in mirha exports private limited in Punjab, India. Buffalo Bull 34(2): 231-240.
2. Abbas I (2016) Molecular and epidemiological updates on cystic echinococcosis infecting water buffaloes from Egypt Vet World 9(12): 1355-1363.
3. Al-Nassir HS (2012) Epidemiological study on the prevalence of hydatidosis in slaughtered ruminants in Kerbala Governorate. J Kerbala Univ 10(4): 326-333.
4. Altıntaş N, Tınar R, Çoker A, Yazar S (2013) Cystic Echinococcosisde Immun Tanı. Echinococcosis. Türkiye Parazitol Derg 37: 28-31.
5. Beyhan YE, Umur Ş (2011) Molecular characterization and prevalence of cystic echinococcosis in slaughtered water buffaloes in Turkey. Vet Parasitol 181(2-4): 174-179.
6. Borji H, Azizzadeh M, Kamelli M (2012) A retrospective study of abattoir condemnation due to parasitic infections: economic importance in Ahwaz, southwestern Iran J Parasitol 98(5): 954-957.
7. Borua AG, Pal SS, Doimari S, Begum S, Barua CC (2010) Prevalence of cystic echinococcosis in domestic animals. Indian Vet J 87(9): 932-933.

8. Budke CM, Jiamin Q, Qian W, Torgerson PR (2005) Economic effects of echinococcosis in a disease-endemic region of the Tibetan Plateau. Am J Trop Med Hyg 73: 2-10.
9. Budke CM, Deplazes P, Torgerson PR (2006) Global socioeconomic impact of cystic echinococcosis. Emerg Infect Dis 12: 296-303.
10. Capuano F, Rinaldi L, Maurelli MP, Perugini AG, Veneziano V, Garippa G, Cringoli G (2006) Cystic echinococcosis in water buffaloes: epidemiological survey and molecular evidence of ovine (G1) and buffalo (G3) strains. Vet Parasitol 137(3-4): 262-268.
11. Chaligiannis I, Maillard S, Boubaker G, Spiliotis M, Saratsis A, Gottstein B, Sotiraki S (2015) Echinococcus granulosus infection dynamics in livestock of Greece. Acta Trop 150: 64-70.
12. Cringoli G, Rinaldi L, Musella V, Veneziano V, Maurelli MP, Di Pietro F, Di Pietro S (2007) Geo-referencing livestock farms as tool for studying cystic echinococcosis epidemiology in cattle and water buffaloes from southern Italy Geospat Health 2(1): 105-111.
13. Çolakoğlu N, Özbeyaz C (1999) Comparison of some production traits in Malya and Akkaraman sheep. Turk J Vet Anim Sci 23: 351-360.
14. Dadkhah MA, Yeganehzad M, Nadery B (2011) Survey on Hydatid Cyst infestation in Sarab city (Northwest of Iran) using epidemiological and seroepidemiological criteria. JAVA, 10(16): 2099-2101.
15. Eslami A, Hosseini SH (1998) Echinococcus granulosus infection of farm dogs of Iran J Parasitol Res 84(3): 205-207.
16. Ghodake PS, Paturkar AM, Zende RJ, Vaidya VM (2014) Studies on prevalence, antigenic characterization of hydatidosis and its economic impact on cattle and buffalo meat production. J Food Borne Zoon Dis 2(4): 68-71.
17. Gracey JF, Collins DS (1992) *Meat Hygiene*, Ninth ed Bailliere Tindall, England.
18. Harandi MF, Budke CM, Rostami S (2012) The monetary burden of cystic echinococcosis in Iran. PLOS Negl Trop Dis 6(11): e1915.
19. Haridy FM, Ibrahim BB, Elshazly AM, Awad SE, Sultan DM, El-Sherbini GT, Morsy TA (2006) Hydatidosis granulosus in Egyptian slaughtered animals in the years 2000-2005. J Egypt Soc Parasitol 36(3): 1087-1100.
20. Houin R (1998) Current situation of echinococcosis in Europe. In Symposium on Environmental Adaptation of Echinococcosis. Hakkaido University Sapparo, Japan. PP: 18-20.
21. Islam AWMS (1982) The prevalence of hydatid disease in buffaloes in Bangladesh. Ann Trop Med Parasitol 76(6): 623-626.
22. Jimenez S, Perez A, Gil H, Schantz PM, Ramalle E, Juste RA (2002): Progress in control of cystic echinococcosis in La Rioja, Spain: decline in infection prevalences in human and animal hosts and economic costs and benefits. Acta Trop 83: 213-221.
23. Kassai T (1999) *Veterinary Helminthology*. Butterworth-Heinemann, Linarce House, Jordon Hill Oxford. PP. 45-48.

24. Kenzhebaev SA (1985) Indices of economic losses associated with Echinococcosis in Karakul sheep. Trudy Vsesoyuznogo Instituta Gel’mintologii-im. K. I. Skryabina, 28: 62-66.
25. Khan AM, Gazi M, Bashir S (2013) Seasonal prevalence of hydatidosis in buffaloes-A retrospective study. Vet World 6(9): 647-650.
26. Khan MQ, Afzal M, Ali S (1990) Prevalence and serology of hydatidosis in large ruminants of Pakistan Vet Parasitol 37(2): 163-168.
27. Khaniki GRJ, Kia EB, Raei M (2013) Liver condemnation and economic losses due to parasitic infections in slaughtered animals in Iran J Parasit Dis 37(2): 240-244.
28. Khanmohammadi M, Maghami SG, Zakariazadeh M (2008) The prevalence of hydatidosis by sex, season and location in slaughtered buffaloes at the Tabriz abattoir in 2006-2007. Int J Vet Med, 4(2): 1-3.
29. Köroğlu E, Şimşek S (2004) Hidatidosisin Neden Olduğu Ekonomik Kayıplar. Echinococcosis. Hidatidoloji Dern (1): 333-353.
30. Majorowski MM, Carabin H, Kilani M, Bensalah A (2005) Echinococcosis in Tunisia: a cost analysis. Trans R Soc Trop Med Hyg, 99: 268-278.
31. Manandhar S, Horchner F, Morakote N, Kyule MN, Baumann MP (2006) Occurrence of hydatidosis in slaughter buffaloes (Bos bubalis) and helminths in stray dogs in Kathmandu Valley, Nepal. Nepal Berl Münch Tierärztl Wochenschr 119(7-8): 308-311.
32. Mantovani A (1980) Information on echinococcosis/hydatidosis in Italy. Working paper for the WHO. European Meeting on Hydatidosis Control (Mediterranean Countries). Document ICP/BVM 009.
33. Polydorou K (1981) Animal health and economics. Case study: echinococcosis with reference to Cyprus. Bull Off Int Epizot: 93: 981-992.
34. Samavatian A, Valilou MR, Lotfi A, Khani MY, Mirzaei H (2009) Study of the incidence rate of liver and lung hydatidosis in slaughtered cattle and buffaloes, at Ahar abattoir (Arasbaran region-Northwestern iran) during 2007–2008. Buffalo Bull 28(4): 218-222.
35. Sarıözkan S. 2011. Türkiye'de manda yetiştiriciliğinin önemi. Kafkas Univ Vet Fak Derg 17(1): 163-166.
36. Sarıözkan S, Yalçın C (2009) Estimating the production losses due to cystic echinococcosis in ruminants in Turkey. Vet Parasitol 163(4): 330-334.
37. Sheikh SA, Hussain MZ (1968) Incidence of hydatidosis in livestock in Lahore. Pak J Sci 19: 239-242.
38. Singh BB, Dhand NK, Ghatak S, Gill JP (2014) Economic losses due to cystic echinococcosis in India: need for urgent action to control the disease. Prev Vet Med 113(1): 1-12.
39. Torgerson PR, Carmona C, Bonifacino R (2000) Estimating the economic effects of cystic echinococcosis: Uruguay, a developing country with upper-middle income. Ann Trop Med Parasitol 94: 703-713.

40. Torgerson PR, Dowling PM, Abo-Shehada MN (2001) Estimating the economic effects of cystic echinococcosis. Part 3. Jordan, a developing country with lower-middle income. Ann Trop Med Parasitol 95: 595-603.
41. Turkey Statistical Institute (TUIK). 2020. Hayvancılık İstatistikleri. Available from: http://www.tuik.gov.tr/VeriBilgi.do%3Ftb_id=46%26ust_id=13. Accessed 08.04.2020.
42. Türkiye Damızlık Manda Yetiştiricileri Merkez Birliği (DMYMB) 2020. Fiyatlar. Available from: https://www.dmymb.org/ Accessed 28.04.2020.
43. Türkmen H (1992) Mandalarda (Bubalus bubalis Linnaeus, 1758) hydatidosis. Türkiye Parazitol Derg 16: 31-45.
44. Umur S, Aslantaş Ö (1993) Kars belediye mezbahasında kesilen ruminantlarda hidatidozun yayılısı ve ekonomik önemi. Türkiye Parazitol Derg 17: 27-34.
45. Umur Ş (2003) Prevalence and economic importance of cystic echinococcosis in slaughtered ruminants in Burdur, Turkey. J Vet Med B Infect Dis Vet Public Health 50: 247-252.
46. Vaidya VM, Zende RJ, Paturkar AM, Kumar A, Raut CK (2014) Economic impact of hydatidosis and cysticercosis in food animals slaughtered at different abattoirs of Maharashtra. J Vet Med B Infect Dis Vet Public Health 12(2): 65-70.
47. Verma Y, Swamy M (2009) Prevalence and pathology of hydatidosis in buffalo liver. Buffalo Bull 28(4): 207-211.
48. Yang FC (1992) A study of domestic animals with Echinococcus infection in Qinghai Province and suggestions for control. Qinghai Xumu Shouyi Zazhi 22: 22-25.