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THE EFFECTS OF A GUMBORO DISEASE CONTROL PROGRAM ON THE REDUCTION OF ECONOMIC LOSSES

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Gumboro disease is an acute infectious disease which causes primary lesions in the Bursa Fabricii. The disease is most commonly seen in broilers between the third and sixth week of growth, and in egg-laying hens up to the 18th week. In susceptible flocks the disease emerges abruptly, with high morbidity (up to 100%) and with an average mortality of 20-30%. The disease causes large economic losses in intensive poultry production.

In this investigation we used the epidemiological data on Gamboro disease spreading and the extent of economic losses in broilers and egg-laying hens on a single epizootiologic region during a six-year period. Closer analysis of economic losses was performed on experimental farms.

A higher prevalence of the diseases in egg-laying hens than in broilers was observed ($p<0.05$), while the incidence was in both groups higher during the summer period (in June and July) than during the rest of the year ($p<0.05$). The extent of economic losses during observed period was 11,654,336 dinars. Broilers participated in total losses with 14.76%, and egg-laying hens with 85.24%. The proposed program of Gumboro disease control in the observed epizootiological region showed economic justification (NPV = 56.277.056,84 dinars; RBC = 2.418, and RTI = 4.71 years).

Key words: Gumboro disease, economic losses, disease control program

INTRODUCTION

Gumboro disease is a highly contagious poultry disease caused by Gumboro disease virus from the Burnaviridae family (Lukert and Saif, 1991), which has a special predilection for the lymphoid tissue. Gumboro disease was first recognized as a special clinical entity in 1962. The disease has an acute and peracute course. It is clinically manifested as enteritis, anorexia and shivering, and pathologically as inflammation of the Bursa Fabricii, intermuscular bleeding and kidney damage (Faragher, 1972; Hiraga, 1984; Weiss and Kufer-Weiss, 1984;

Chettle *et al*., 1989; Bumstead *et al*., 1993). However, the most important effect of Gumboro disease is prolonged immune suppression which is a prerequisite for the development of other poultry diseases, and also reduces the efficiency of vaccination against some poultry diseases, such as Newcastle disease.

The emergence of highly virulent types of Gumboro disease at the end of the '80es became a significant problem for the European poultry industry, and caused great economic losses. Some of these virus types caused flock mortality of over 90%. Today, the disease is widespread all over the word, which gives it a great socio-economic importance. In addition to the direct losses from mortality, the disease also causes indirect losses by immunosupression and subsequent outbursts of other diseases such as coccidiosis, salmonelosis, colibacillosis, Marek's disease, and infectious tracheobronchitis (McIlroy, 1989; Ducatell *et al*., 1995; Van Den Berg *et al*., 2000; Tešić *et al*., 2003).

Maximal flock protection, as well as disease control programs, contribute to the reduction of losses caused by this disease. Therefore, it is of extreme importance to study the emergence and dynamics of the disease, the spreading of the disease among broilers and egg-laying hens, as well as to calculate the extent of economic losses in order to create an appropriate disease control program based on economic parameters (Carpenter, 1993; Van Den Berg, 2000).

MATERIAL AND METHODS

Constant surveillance of the epidemiologic status of Gumboro disease was performed in a number of epizootiological regions for a six-year period. We used data collected by poultry farms, local veterinary stations, and veterinary institutes. Autopsy and histopathological examination of all cases of dead poultry were routinely performed on all farms where Gumboro disease was registered. On the basis of collected data, we calculated the prevalence of the disease, its incidence among broilers and egg-laying hens aged 18 weeks, and also the value of economic losses. Descriptive statistical methods and trend methods were used to present the epidemiologic data. Calculation of economic losses was based on coefficients for standard heads and on Serbian market price for broilers (per kg) and egg-laying hens (per head) in December 2005.

The development of a Gumboro disease control program was based on cost-benefit analysis (CBA). Necessary inputs and outputs were identified on the level of a single farm with a capacity of 10,000 broilers and egg-laying hens in a single production turn. Approximation of nominal costs and benefits on a regional level was calculated by multiplying the value obtained from a sample farm by 77 (number of all farms included in the investigation). The evaluation of the proposed Gumboro disease control program was based on net present value (NPV), benefit/cost ratio (RBC) and investment return time (RTI).

RESULTS

The observed epizootiological region includes 5.66% of the whole territory of Serbia, and participates with 8.92% in total poultry number. Gumboro disease was registered in 92 flocks housed in 76 locations. Broilers participated with 59.78% and 56.57% of the total number of infected flocks and number of locations where the disease emerged, respectively, while egg-laying hens participated with 40.22% and 43.42% (Table 1).

Table 1. Number of outbursts and prevalence of Gumboro disease

Year	Broilers			Egg-laying hens			Total		
	Outburst		Prevalence %	Outburst		Prevalence %	Outburst		Prevalence %
	Farm	Place		Farm	Place		Farm	Place	
1	9	9	9.29	3	3	31.25	12	12	18.34
2	6	6	10.02	5	5	26.21	11	11	17.10
3	9	13	4.61	5	5	24.75	14	18	6.54
4	10	16	4.45	11	11	39.97	21	27	11.89
5	2	2	11.58	3	3	11.76	5	5	11.62
6	7	9	1.19	6	10	43.81	13	19	11.16
Total	43	55	X = 3.65	33	37	X = 37.98*	76	92	X = 11.68

* $p<0.05$

The largest total number of infected poultry, and also the largest numbers of infected broilers and egg-laying hens, was registered in the fourth year of the observation period. The mean prevalence for broilers was 3.65%, for egg-laying hens 37.98%, and 11.68% for both categories. The difference between individual prevalence was statistically significant ($p<0.05$).

Number of disease outbursts showed marked peaks during the summer months throughout the observed period (Table 2).

The number of Gumboro disease outbursts in broilers during the summer period was 30 vs. 25 during the rest of the year ($p<0.05$), and in egg-laying hens was also significantly greater in the summer period than during the rest of the year (56 vs. 36, $p<0.05$).

The trend of increased number of outbursts during the summer months for broilers is defined by $y = 9.49 + 0.157x - 0.058x^2$ and by $y = 12.24 + 3.065x - 0.078x^2$ for egg-laying hens.

The value of direct economic losses was determined on the basis of calculated mass and current market price of lost broilers (80 dinars per kg), and egg-laying hens (320 dinars per head). The highest losses were recorded during

the final year of the observed period, when it reached 5,860,448.00 dinars. The value of direct losses varied throughout the observed period, but on average was 1,942,389.33 dinars (Table 3).

Table 2. Distribution of outbursts by season during the observed period

Year	Broilers		Egg-laying hens		Total	
	Total	Summer	Total	Summer	Total	Summer
1	9	3	3	1	12	4
2	6	5	5	3	11	8
3	13	6	5	4	18	10
4	16	8	11	11	27	19
5	2	1	3	–	5	1
6	9	7	10	7	19	14
Total	55	30*	37	26*	92	56*

* $p<0.05$

Table 3. Direct economic losses during the observed period

Year	Total (din)	Broilers	Egg-laying hens (%)
1	1 858 496	18.90	81.10
2	102 000	21.57	70.43
3	529 984	49.28	50.72
4	2 871 312	18.45	81.55
5	432 096	62.97	47.03
6	5 860 448	4.68	95.32
Mean	1 942 389.33	14.76	85.24*

* $p<0.05$

Average participation in total economic losses was significantly higher in egg-laying hens than in broilers during the whole observed period. Egg-laying hens participated with 85.24% of total direct losses, while broilers participated with only 14.76% ($p<0.05$).

As the basic point for the development of the disease control program on farm level we defined the required elements and activities:

- Farm capacity – 650 m^2 of useful surface for 10,000 chicken,
- Five production turns of broilers per year, and two for egg-laying hens,
- Blood sampling – 20 birds per flock,
- Serologic examination by ELISA method,
- Control of acquired immunity in egg-laying hens must be performed twice,
- Disinfection of objects after each turn,
- Disinsection and deratization of the whole farm at least once per year.

The prices of material and work were calculated according to the current price list of Veterinary Chamber and Institute in December 2005.

On the basis of defined inputs the total costs of one turn of broilers were calculated to 44,734 dinars, and for egg-laying hens to 57,106.30 dinars. Approximately the same level of expenses was maintained throughout the whole observed period. Expected benefit on the account of reduced mortality during program implementation was also calculated.

CBA values for the whole region with 77 farms were calculated by approximation of nominal values from a single farm and by discounting at an interest rate of 7% per year (Table 4).

Table 4. Results of cost/benefit analysis

Year	Benefit (dinars)	Costs (dinars)
1	14,463,000	9,680,196.80
2	18,508,000	9,680,196.80
3	26,560,000	9,680,196.80
4	29,024,000	9,680,196.80
5	31,488,000	9,680,196.80
Total	120,043,360	48,400,984
PV	91,963,926.00	39,686,869.16
NPV	56,277,056.84	
RBC	2.4180	
RPI	4.71	

Nominal costs of Gumboro disease control program for the whole observed region were calculated at 48,400,984 dinars, and the expected benefit was calculated to be 120,043,360 dinars, or by 148.02% higher than costs. Economic justification of the program is seen from NPV which is larger than 1. Investing in Gumboro disease control program was also shown to be high (RBC = 2.4180), and return period of invested assets (RPI = 4.71 years) is shorter than the expected realization period (t_{max} = 5).

The effects of the control program on Gumboro disease incidence in the observed epizootiological region are shown in Table 5.

Table 5. Effects of program implementation on the incidence of Gumboro disease

Run	Variable	Period	
		Before program implementation (1995-2000)	After program implementation (2001-2005)
1	Broilers Sum of incidences	56	17*
2	Egg-laying hens Sum of incidences	36	16*
3	Total Sum of incidences	92	33*

*$p<0.05$

Implementation of Gumboro disease control program led to a significant reduction of disease incidence in both categories. In broilers the incidence of Gumboro disease before and after program implementation was 56 vs 17, respectively ($p<0.05$), and in egg-laying hens was 36 vs 16 ($p<0.05$). The total incidence of Gumboro disease in both categories was significantly reduced after program implementation, from 92 to 33 ($p<0.05$)

DISCUSSION

Gumboro disease is an infectious disease which is on the "B" list of International zoosanitary codex. According to current Serbian legislation it is mandatory to report cases of this disease. Reduction of Gumboro disease emergence risk requires the development of strategies on both national and farm levels. National level implies continuous monitoring based on legislative procedures, adequate equipment and diagnostic laboratories, qualified experts, supervision and control of markets, as well as implementation of current diagnostic procedures and developing investigations of Gumboro disease.

Implementation of certain measures on a farm should bring the farmer to a certain level of biosecurity. Acquisition of biosecurity starts with the initial phase of farm designing and building, and continues with embedding of equipment, observing "all in - all out" principle, implementation of systematic disinfection, disinsection and deratization, control of food and water safety, and health control of birds at introduction.

Economic losses which arise in the poultry industry can be divided into direct and indirect. Direct losses are caused by perishing of broilers and egg-laying hens, and also by spending on increased quantities of medicines needed

for the treatment of the diseased flock. These losses are easy to quantify, and are very often used in cattle breeding and veterinary medicine. However, indirect losses in Gumboro disease arise from reduced immunity of broilers and egg-laying hens and their increased predisposition for other diseases. Thereby, as a consequence, we have delayed growth, reduced wheight gain, greater food conversion, longer fattening, lesser production values, increased mortality and lower quality of products. It is very hard to exactly quantify indirect losses. Therefore, as a screening method for determination of economic losses direct losses caused by death of broilers and egg-laying hens were used. McIlroy, Godal, and McCracken (1989), performed an investigation in Northern Ireland on a large number of broiler flocks to determine and quantify economic losses in sub-clinical Gumboro infection. They found bursal lesions in about 60% of broiler flocks, even without apparent clinical manifestations. Flocks free from Gumboro disease had by 10% larger net income per 1000 birds than the infected ones. Mean food conversion and chicken weight were improved in disease-free flocks. However, there was no significant difference in mortality between infected and disease-free flocks. Authors concluded that losses were caused mainly by reduction of average body weight and increased food consumption (conversion). Ducatelle *et al*. (1995) also indicate indirect economic losses as a consequence of lesser quality of carcasses of slaughtered chicken caused by the presence of sub clinical forms of Gumboro disease in flocks.

Van Der Sluis (1999) and De Wit (2001) indicate indirect losses as a consequence of immune suppression caused by Gumboro disease and additional losses by using antibiotics in the treatment of secondary infections. They also emphasize the existence of antibiotic residues in chicken meat, which makes it useless for human consumption. Chettle et al. (1989), after analysis of the epidemiological situation of Gumboro disease in East England, calculated approximate yearly losses to be about 50 flocks, with a mortality probability within an interval of 10%-15%-30%.

Another way to determine the extent of economic losses caused by Gumboro disease is to create a mathematical model or computer simulation. One of these simulations was created by Christen (1985), who, besides inciting indirect economic losses on farms caused by reduced body weight, longer fattening and poor food conversion, also estimated potential loss from Gumboro disease to be 10 million dollars if the disease emerged in New Zealand.

Most authors in their investigations incite necessary factors and circumstances which should be taken into consideration while developing Gumboro disease control programmes, such as: serologic examination of blood; choice of appropriate type of vaccine and optimal time for vaccination; application of disinfection, disinsection, and deratization; control of bird and meat trafficking; implementation of quarantine and other (Benton *et al*., 1967; Cho *et al*., 1969; Winterfield *et al*., 1972; Alexander *et al*., 1988; McAllister *et al*., 1995; Mandeville *et al*., 2000). Moreover, authors engaged in economics and management of health control and flock or herd productivity indicate that, during the development of a program for control and eradication of the disease on farms, special attention should be paid to necessary inputs and outputs expected during program

implementation. According to these recommendations, in our study we have thoroughly included all necessary inputs and outputs in the calculations made.

However, because Gumboro disease is an infectious disease which has an epidemic character, expected economic benefits for producers, consumers and the state itself has priority importance, as in case of control of infectious diseases in other animal species (Carpenter, 1993; Tešić *et al*., 2003).

In our study, we have thoroughly analyzed the prevalence and number of disease outbursts in the observed epizootiological region (Tables 1 and 2), quantified economic losses in broiler and egg-laying hen production caused by Gumboro disease, and analyzed effects of developed Gumboro disease control program on the reduction of disease incidence, as well as on the reduction of direct and indirect losses in poultry production (Tables 3-5). We have shown that the implementation of this program leads to reduction of economic losses and also to the reduction of disease incidence, which implies that the program has not only an economic value, but also significant impact on animal and human health.

Accomplished economic evaluation and quantification of economic losses, and proposed Gumboro disease control program on the given epizootiological region represents a model for economic evaluation which can also be used for other poultry diseases.

CONCLUSION

During the development of a Gumboro disease control program on the given epizootiological region, we established the net present value of the proposed program to be 559.622 din for broilers, and 1.400.262 din for egg-laying hens. Planned benefit dynamics during a five-year period of program implementation ensures investment return time of 4.33 years in broilers, and 2.43 years in egg-laying hens.

Gumboro disease control program in the observed region has a social and economic justification which is defined by the net present value of 56.277.056 din, benefit/cost ratio of 2.4180 and a total investment return time of 4.71 years for both categories.

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REFERENCES

1. *Alexander DJ, Chetlle NJ,* 1998, Heat inactivation of serotype 1 infectious bursal disease virus, *Avian Pathol*, 27, 1, 97-9.
2. *Benton WJ, Cover MS, Rosenberger JK, Lake RS,* 1967, Physicochemical properties of the infectious bursal agent (IBA), *Avian Dis,* 11, 430-8.
3. *Bumstead N, Reece RL, Cook JKA,* 1993, Genetic differences in susceptibility of chicken lines to infection with infectious bursal disease virus, *Poult Sci*, 72, 3, 647-54.

4. *Carpenter ET,* 1993, Animal Health and Production Economics, California, USA.
5. *Chettle NJ, Stuart JC, Wyeth PJ,* 1989, Outbreaks of virulent infectious bursal disease in East Anglia, *Vet Rec*, 125, 271-2.
6. *Cho Y, Edgar SA*, 1969, Characterization of the infectious bursal agent, *Poult Sci,* 48, 2102-9.
7. *Christen NH,* 1985, The cost to the meat chicken industry of the introduction of infectious bursal disease to New Zeland, *N Z Vet J*, 33, 191-3.
8. *De Wit JJ*, 2001, Counting the cost of IBDV, World Poultry, Magazine on Production, Processing & Marketing, October 2001, 6-7.
9. *Ducatelle RVA, Uyttebroek E, De Ruyne L, Mast J, Goddeeris B,* 1995, Infectious bursal disease in Europe, consequences of changing epidemiological conditions. In: International Poultry Symposium Summit on Infectious Bursal Diseases, Proceedings, April 3-4, 10-14.
10. *Faragher JT,* 1972, Infectious bursal disease in chicken, *Vet Bull*, 42, 361-9.
11. *Hiraga M, Nunoya T, Otaki Y, Tajima M, Saito T, Nakamura T*, 1984, Pathogenesis of highly-virulent infectious bursal virus infection in intact and bursectomized chicken, *J Vet Med Sci*, 56, 1057-63.
12. *Lukert PD, Saif YM*, 1991, Infectious bursal disease. In: *Diseases of Poultry,* Eds. B. W. Calnek, *et al*., 9th Edition, Wolfe Publishing Ltd., London, 648-63.
13. *Mandeville WF, Cook FK, Jackwood DJ,* 2000, Heat lability of five strains of infectious bursal disease virus, *Poult Sci,* 79, 6, 838-42.
14. *McAllister JC, Steelman CD, Newberry LA, Skeeles JK*, 1995, Isolation of infectious bursal disease virus from the lesser mealworm, *Alphitobius disperinus (panzer)*, *Poult Sci*, 74, 45-9.
15. *McIlroy SG, Goodall EA, McCraken RM,* 1989, Economic effects of subclinical infectious bursal disease on broiler production, *Avian Pathol*, 18, 3, 465-80.
16. *McIlroy SG, Goodall EA, McCracken RM*, 1989, Economic effects of subclinical infectious bursal disease on broiler production, *Avian pathol*, 18 3, 465-80.
17. *Tešić M, Kljajić R, Uśćebrka G, Tajdić N, Mirilović M,* 2003, Ekonomski i društveni značaj kontrole zdravlja životinja na nacionalnom nivou. *Savremena poljoprivreda,* 52, 3-4, 491-4.
18. *Van Den Berg TP,* 2000, Acute infectious bursal disease in poultry, A review, *Avian Pathol*, 29, 175-93.
19. *Van Der Sluis W,* 1999, 1999 world poultry diseases update, *World Poult*, 15, 30-32.
20. *Weiss E, Kufer-Weiss I*, 1994, Pathology and pathogenesis of infectious bursal disease. In: International symposium on infectious bursal disease and chicken infectious anemia, Rauischolchausen, Germany, June 24, 1994, 116-8.
21. *Winterfield RW, Adly AM, Bickford A,* 1972, Infectivity and distribution of infectious bursal disease virus in the chicken Persistence of the virus and lesions, *Avian Dis*, 16, 622-32.

EFEKTI PROGRAMA ZA KONTROLU BOLESTI NA SMANJENJE EKONOMSKIH GUBITAKA UZROKOVANIH GUMBORO BOLEŠĆU

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SADRŽAJ

Gumboro bolest je akutno infektivno oboljenje koje primarno zahvata burzu Fabricii. Oboljenje se najčešće javlja kod brojlera u starosti između 3 i 6 nedelja i kod kokica nosilja starosti do 18 nedelja. U osetljivih jata oboljenje nastaje naglo,

sa visokim morbiditetom (čak do 100%) i sa prosečnim mortalitetom od 20-30%. Oboljenje izaziva značajne ekonomske gubitke u intenzivnom uzgoju živine.

U ovom istraživanju koristili smo epidemiološke podatke o širenju Gumboro bolesti i veličini ekonomskih gubitaka kod brojlera i kokica nosilja u datom epizootiološkom području tokom šestogodišnjeg perioda. Bliža analiza ekonomskih gubitaka je sprovedena na eksperimentalnoj farmi brojlera i kokica nosilja.

Nađena je statistički značajno veća prevalenca Gumboro bolesti kod brojlera nego kod kokica nosilja ($p<0,05$). U obe kategorije, nađena je statistički značajno veća učestalost epidemija ove bolesti u letnjem periodu nego u ostatku godine tokom celog posmatranog perioda ($p<0,05$). Ukupni iznos ekonomskih gubitaka tokom posmatranog perioda iznosio je 11654336,00 dinara. Učestalost gubitaka kod kokica nosilja u ukupnim gubicima bila je značajno veća nego kod brojlera (85,24% prema 14, 76%, $p<0,05$).

Primena programa za kontrolu bolesti dovela je do značajnog sniženja incidence Gumboro bolesti u obe kategorije ($p<0,05$). Predloženi program kontrole bolesti u posmatranom epizootiološkom području pokazao je ekonomsku opravdanost (NPV = 56277056,84 dinara, RBC = 2,418, RTI = 4,71 godina).