

### Comparison of chemical composition and content of heavy metals in meat of sea bass (*Dicentrarchus labrax*) and gilt-head sea bream (*Sparus aurata*)

#### Summary

The aim of this research was to compare chemical composition and content of heavy metals in the meat of sea bass and gilt-head sea bream, both in farmed fish and from free fishing. A total of 30 samples of gilt-head sea bream and 30 samples of sea bass of commercial size, out of which half the samples were farmed fish and the other half were from free fishing. Chemical composition analyses have shown that in both kinds of fish there is a statistically significant difference in content of water, protein, fat and collagen between the samples from free fishing and farmed fish. There was determined four times, i.e. eight times higher content of fat in the meat of farmed samples of sea bass and gilt-head sea bream in comparison to samples of farmed fish. Contents of heavy metals, cadmium (Cd) and lead (Pb) with both fish species and regardless of the origin of fish, were lower than the maximum quantities allowed proscribed by Croatian and EU regulations. As opposed to the quantities of Cd and Pb, the quantity of mercury (Hg) determined in certain samples of both fish species from free fishing was higher than maximum quantity allowed, indicating to the fact that some samples were not safe for consumption. Considering the fact that the content of heavy metals in muscle tissue of fish can vary depending on species, sex, age, season, diet and food availability, in the goal of the total assessment of potential dangers due to consumption of the above-mentioned fish species, it is necessary to conduct a more detailed research, taking into account the listed factors.

**Keywords:** chemical composition, heavy metals, sea bass, gilt-head sea bream

### Vergleich der chemischen Zusammensetzung und der Inhaltsmenge der schweren Metalle im Fleisch von Seebarsch (*Dicentrarchus labrax*) und Goldbrasse (*Sparus aurata*) aus der Zucht und aus dem freien Fang

#### Zusammenfassung

Der Zweck dieser Untersuchung war, den Vergleich der chemischen Zusammensetzung und der Inhaltsmenge der schweren Metalle im Fleisch von Seebarsch und Goldbrasse aus der Zucht und aus dem freien Fang zu machen. Insgesamt wurden 30 Muster Seebarsch und 30 Muster Goldbrasse von Konsumgröße analysiert, die Hälfte davon war aus der Zucht und die andere Hälfte aus dem freien Fang. Die Analyse der chemischen Zusammensetzung hat gezeigt, dass bei beiden Fischarten ein statistisch bedeutender Unterschied hinsichtlich Wassergehalt, Eiweißstoffgehalt, Fett und Kollagen bei dem Fisch aus der Zucht und aus dem freien Fang besteht. Es wurde für beide Sorten eine 4 bis 8 Mal größere Fettmenge im Fleisch von Fischen aus der Zucht als im Fleisch von Fischen aus dem freien Fang festgestellt. Die Menge von Schwermetallen Cadmium (Cd) und Blei (Pb) war bei beiden Sorten niedriger als die kroatischen und die EU Vorschriften als Größtmenge vorschreiben, u.zw. ohne Rücksicht darauf, ob die Fische aus der Zucht oder aus dem freien Fang stammten. Zum Unterschied von Cd und Pb Mengen, war die festgestellte Quecksilbermenge (Hg) in manchen Mustern beider Fischarten aus dem Fang größer als NDK, was auf die gesundheitliche Unrichtigkeit einiger Einzelproben hinweist. Da der Inhalt von Schwermetallen im Muskelgewebe der Fische variiert kann, u.zw. in Bezug auf Sorte, Geschlecht, Alter, Jahreszeit, Nahrung und Nahrungszugänglichkeit, ist es nötig bei angeführten Fischarten umfangreiche Untersuchungen durchzuführen. Dies erweist sich als Schlüsselfolgerung wegen der potentiellen Gefahren hinsichtlich des Konsums der angeführten Fischarten.

**Schlüsselwörter:** chemische Zusammensetzung, Schwermetalle, Seebarsch (*Dicentrarchus labrax*), Goldbrasse (*Sparus aurata*)

### Confronto tra la composizione chimica e la quantità di metalli pesanti Nella carne di branzino (*Dicentrarchus labrax*) e di orata (*Sparus aurata*) dall'allevamento e dalla pesca libera

#### Sommario

Lo scopo di questa ricerca era paragonare la composizione chimica e la quantità di metalli pesanti nella carne di orata e quella di branzino dall'allevamento e dalla pesca libera. Sono stati analizzati 30 campioni di branzino e 30 campioni di orata, di misura consumo, la metà delle quali proveniva dall'allevamento e l'altra dalla pesca libera. Le analisi del contenuto chimico hanno mostrato che da tutti i due i tipi di pesce c'era una notevole differenza in statistica nella quantità dell'acqua, delle proteine, dei grassi e del collagene tra le entità dalla pesca e quelle dall'allevamento. È stata rivelata da 4 a 8 volte maggiore quantità dei grassi nella carne delle entità d'orata e branzino dall'allevamento rispetto alle entità dalla pesca. Le quantità di metalli pesanti, il cadmio (Cd) e il piombo (Pb), da ambedue i tipi di pesce, e indipendentemente dalla loro provenienza, erano minori dalle quantità massime consentite prescritte nei regolamenti croati e dell'Unione europea. A differenza della quantità del cadmio e del piombo, la quantità del mercurio (Hg) determinata in certi campioni di tutte e due i tipi di pesce dall'allevamento era maggiore della quantità massima consentita, e questo vuol dire che certe entità non erano conformi alla sicurezza sanitaria. Siccome il contenuto di metalli pesanti nel tessuto muscolare può variare rispetto al tipo, sesso, età, stagione, regime alimentare e del cibo accessibile, bisogna fare degli studi più dettagliati che, allo scopo di valutazione del pericolo potenziale del consumo di branzino e orata, prenderanno in considerazione i suddetti indicatori.

**Parole chiave:** composizione chimica, metalli pesanti, branzino, orata

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## Trend analysis of the dead on arrival and condemnation causes of broiler chickens from farm Lieskovec (The Slovak Republic) in the years 2006 – 2010

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scientific paper

#### Summary

The influence of transport distance and temperature on the dead on arrival and condemnation causes of broiler chickens from a small farm Lieskovec (Slovak Republic) in the period 2006-2010 was evaluated. The results showed significant increase in dead on arrival and condemnation percentage in relation to the transport distance and season. The average percentage of the dead on arrival throughout the whole period was 0.209% (0.031 to 0.702%) and the average percentage of condemnation was 0.524% (0.041 to 1.422). The most common causes of condemnation were cyanosis, birds slaughtered in agony, breaking of the legs and wings and cachexy.

**Key words:** slaughter poultry, transport, dead on arrival, condemnation

#### Introduction

The interest in the welfare of food-producing animals throughout the European Union (EU) continues to increase and the perceived 'welfare status' of the animal from which food is produced is now seen as a part of product quality (Haslam, 2008). Numerous farm animal welfare problems can be measured in the slaughter plant where it is easy to observe large numbers of animals or birds. Many problems that are detrimental to animal welfare which occur also during transport and handling can be scored at the plant (Grandin, 2010). The problems can be evaluated according to the body condition score; lameness measure; body lesions caused by poor housing or disease; broken wings and legs on chicken and turkeys; dead animals on arrival at the slaughter plant; dirty soiled livestock and poultry, and scoring of

bruised carcasses (Grandin, 2010).

The Council Regulation No 1/2005 on the protection of animals during transport and related operations will apply to the transport of live vertebrate animals carried out within the Community, including the specific checks to be carried out by officials on consignments entering or leaving the custom territory of the Community.

In the context of the controls performed under the Regulation (EC) No 854/2004, the official veterinarian will evaluate the results of the *post mortem* inspection to identify other possible indications of poor welfare conditions such as abnormal levels of contact dermatitis, parasitism and systemic illness in the holding or the unit of the house of the holding of origin. If the mortality rate or the results of the *post mortem* inspection

are consistent with poor animal welfare conditions, the official veterinarian will communicate the data to the owner or keeper of the animals and to the competent authority. Appropriate actions will be taken by the owner or the keeper of the animals and by the competent authority (Council Directive 2007/43/EC).

The aim of this study was to evaluate the influence of transport distance and season on the dead on arrival of broiler chickens and the results of the *post mortem* inspection.

#### Material and methods

Broiler chickens were fattened on the poultry farm Lieskovec (The Slovak Republic). Poultry farm capacity is 47 000 – 50 000 birds (hybrid Ross 308) per fattening period. Feeding lasted approximately 40 days and cycles were repeated 5 times a year.

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Table 1. The percentage of dead on arrival and condemnation of broiler chickens from farm Lieskovec during the years 2006 – 2010

Tablica 1 Postotak uginuća i bolesnih stanja brojlera s farme Lieskovec tijekom 2006-2010

Year Godina	Month Mjesec	Number of deliveries Broj dostava	Average daily temperature (°C) Srednja dnevna temperatura	Transport distance/ duration (km/min.) Prijevoz/ Udaljenost/ trajanje	Number of birds Broj piliča	Dead on arrival (%) Uginuća pri istovaru (%)
2006	I.	2	2.90; 1.35	3/15	46414	0.032
	IV.	2	12.00; 14.85	3/15	45569	0.057
	VI.	2	12.2; 13.3	3/15	48956	0.041
	IX.	2	16.9; 16.4	3/15	45187	0.033
	XI.	2	10.10; 12.30	3/15	44461	0.031
2006-total ukupno	10			208 990	0.039 ± 0.011*	
2007	IV.	2	9.0; 11.7	3/15	40962	0.040
	V.	3	22.65; 23.25;	3/15	44171	0.093
	VII.	3	22.10	3/15	47380	0.078
	IX.	2	26.8; 29.45; 23.70	3/15	43929	0.043
	XI.	2	13.60; 17.35	3/15	47346	0.032
	XII.	1	7.5; 2.15	3/15	21539	0.102
	2007-total ukupno	13	-3.25		245 327	0.065 ± 0.030*
2008	IV.	1	20.25	3/15	22807	0.053
	V.	2	16.15; 16.30	3/15	44801	0.058
	VII.	2	19.5; 21.30	3/15	44955	0.049
	IX.	2	20.25; 22.90	3/15	44140	0.075
	XI.	2	12.40; 13.50	3/15	45739	0.031
2008-total ukupno	9			203 788	0.053 ± 0.016*	
2009	2009-total ukupno	3	18.60; 14.60; 15.85	170/180	44430	0.799 0.799*
2010	IV.	2	11.45; 8.20	243/240	43475	0.145
	V.	2	14.85; 12.30	243/240	43638	0.066
	VIII.	2	21.70; 21.05	243/240	43697	0.060
	IX.	1	13.05	243/240	24657	0.081
	2010-total ukupno	7			155 467	0.088 ± 0.039*
Mean Prosječno					0.209 ± 0.331	

Forty-two deliveries of broiler chickens (858 317 birds) were evaluated (2006 – 208 990 birds, 2007 – 245 327 birds, 2008 – 203 788 birds, 2009 – 44 430 birds, and 2010 – 155 467 birds). Broiler chickens were caught manually by hand and placed into crates. The transport was performed by trucks with passive ventilation during early morning. Capacity of the trucks was 4000 birds and the deliveries were performed in all seasons (spring – 16, summer – 9, autumn – 14, and winter – 3).

The transport distance to the three poultry slaughterhouses was as follows: 3 km to Zvolen, 170 km to Kežmarok, and 243 km to Košice. The minimum and maximum daily temperatures in the transport days were received from the Slovak Hydrometeorological Institute Banská Bystrica (The Slovak Republic). The minimum daily temperatures ranged from -3.7°C (winter) to +18.7°C (summer), maximum daily temperatures from -2.8°C (winter) to +40.21°C (summer), and average daily temperatures in all seasons from -3.25°C to +29.45°C.

The data considering the dead on arrival and condemnation causes were reached from statistical records of the District Veterinary and Food Administration in Zvolen (the Slovak Republic). Inspection of broiler chicken's welfare in the farm Lieskovec was being carried out annually. In breeding of broiler chickens no violation of valid legislation was found. The dead of broiler chickens on arrival at the slaughter plant and percentage of condemned poultry was evaluated according to the official results of the *ante mortem* and *post mortem* inspec-

Table 2. The reasons of broiler chickens condemnation from farm Lieskovec during the years 2006 – 2010

Tablica 2. Uzroci bolesnih stanja brojlera sa farme Lieskovec tijekom 2006.-2010. godine

Year Godina	Month Mjesec	Condemnation (%) Bolesna stanja (%)	Causes of condemnation (number of birds/%) Uzroci bolesnih stanja (broj ptica, %)			
			resp. and digest. diseases respiratorne i bolesti probavnog trakta	technological defects tehnoške greške	Cachexy kaheksija	„other“ „ostalo“
2006	I.	0.254	0/0	39/33.05	29/24.58	50/42.37
	IV.	0.211	10/10.42	13/13.54	33/34.38	40/41.67
	VI.	0.249	20/16.39	25/20.49	46/37.70	31/25.41
	IX.	0.128	0/0	17/29.31	14/24.14	27/46.55
	XI.	0.211	8/8.51	39/41.49	24/25.53	23/24.47
	2006-total ukupno	0.211 ± 0.050*	38/7.06 ± 7.07	133/27.58 ± 10.88 <sup>ab</sup>	146/29.27 ± 6.31 <sup>ab</sup>	171/36.09 ± 10.36*
2007	IV.	0.193	0/0	39/49.37	16/20.25	24/30.38
	V.	0.351	16/10.32	64/41.29	35/22.58	40/25.81
	VII.	0.370	27/15.43	40/22.86	56/32.00	52/29.71
	IX.	0.328	4/2.78	56/38.89	39/27.08	45/31.25
	XI.	0.292	4/2.90	63/45.65	40/28.99	31/22.46
	XII.	0.191	2/4.88	11/26.83	13/31.71	15/36.59
2007-total ukupno	0.288 ± 0.078*	53/6.05 ± 5.74	273/37.48 ± 10.51 <sup>ab</sup>	199/27.10 ± 4.82 <sup>ab</sup>	207/29.37 ± 4.84*	
2008	IV.	0.041	0/0	48/58.54	14/17.07	20/24.39
	V.	0.431	16/8.29	68/35.23	42/21.76	67/34.72
	VII.	0.363	0/0	69/42.33	40/24.54	54/33.13
	IX.	0.437	7/3.63	103/53.37	34/17.62	49/25.39
	XI.	0.267	10/8.20	60/49.18	20/16.39	32/26.23
	2008-total ukupno	0.308 ± 0.164*	33/4.02 ± 4.13	348/47.73 ± 9.17 <sup>a</sup>	150/19.48 ± 3.52*	222/28.77 ± 4.78*
2009	2009-total ukupno	0.558 0.558*	30/12.20 30/12.20	37/15.04 37/15.04*	50/20.33 50/20.33*	129/52.44 129/52.44*
2010	IV.	1.253	15/5.30	118/41.70	50/17.68	100/35.34
	V.	1.163	25/9.69	22/8.53	120/46.51	91/35.27
	VIII.	1.422	20/5.80	47/13.62	136/39.42	142/41.16
	IX.	1.178	10/6.41	30/19.23	70/44.87	46/29.49
	2010-total ukupno	1.254 ± 0.119*	70/6.80 ± 1.98	217/20.77 ± 14.62*	376/37.12 ± 13.31*	379/35.32 ± 4.76*
Total/ Mean % Ukupno/ Prosječno %		0.524 ± 0.429	224/7.23 ± 3.02	971/29.72 ± 13.08	921/26.66 ± 7.21	1108/36.40 ± 9.57

tion during the period from January 2006 to September 2010.

Statistical analysis consisted of group means and standard deviations analysed using column statistics, following by one-way ANOVA analysis of variance, Tukey's multiple comparison test (GraphPad Prism 5, 2007); and treatments were considered significantly different when  $p < 0.05$ .

## Results

The results of forty-two deliveries of broiler chickens transported from poultry farm Lieskovec to the poultry slaughterhouses during the years 2006 – 2010 are summarized in Tables 1 and 2. In this period the average percentage of dead on arrival was 0.209% and percentage of condemned birds 0.524%. From 2009 to 2010 the poultry was transported to the more distant poultry slaughterhouses Kežmarok and Košice (170, resp. 240 km). The highest average percentage of dead on arrival (0.702%) was in 2009 when the poultry was transported to the poultry slaughterhouse in Kežmarok (170 km). In all deliveries in 2009 the dead on arrival (0.799%) was the highest ( $p < 0.05$ ) compared with previous years and the next year 2010. In 2010 the dead on arrival was higher compared to 2006 – 2008 when distance to slaughterhouse was short, but not significantly. The highest percentage

of dead on arrival in different years was recorded as follows: 2006 (May, June), 2007 (May, July, and December), 2008 (November), 2009 (October, only one delivery), and 2010 (November) (Table 1). The highest average percentage of dead on arrival was recorded in autumn (0.142%), while the lowest in summer (0.057%).

Condemnation percentage of slaughtered birds was lower in the years 2006 – 2008 (0.211, 0.288, and 0.308%); with increasing transport distance the higher percentage of condemned birds ( $p < 0.05$ ) in 2009 – 2010 (0.558 and 1.254%) was recorded. The highest average percentage of condemned birds was in 2010 (1.254%) and the lowest in 2007 (0.288%). The highest percentage of condemnation was in August 2010 (1.422%). There were no significant differences in respiratory and digestive diseases comparing all deliveries in evaluated period. Technological defects were more frequent ( $p < 0.05$ ) in 2008 (47.73%) compared to findings in 2009 and 2010. Percentage of cachexy causes was higher ( $p < 0.05$ ) in 2010 (37.12%) in comparison with 2008 and 2009 and other causes were the most frequent ( $p < 0.05$ ) in 2009 (52.44%) compared with all other years. The results showed the highest average percentage (36.40%) of "other causes" as reasons of condemnation during the reporting period. These causes ("other" and cachexy) represented the highest percentage of condemnation (41.16 and 39.42%) in 2010 when the highest percentage of condemnation was recorded (1.263%). The highest percentage of condemned birds was in summer, the lowest in winter (Table 2).

#### Discussion

The catching and loading of birds is a potential source of injury, as prior to transport, broiler houses are depopulated by catching teams working at speeds of 1000 – 1500 birds per man and hour. The handling of poultry

probably always causes some degree of stress and moreover, broilers suffer bruising, discolorations and bone breaks (Metheringham, 1996). Broilers are exposed to a number of interactive stressors during transit, which may vary according to the location of the bird within the vehicle (Mitchell *et al.*, 1994). These include restriction of behaviour; fear; motion, acceleration, vibration and noise; thermal demands, and the withdrawal of feed and water (Mitchell and Keettlewell, 1993). Birds that die before slaughter must be considered unfit for human consumption. The following conditions can indicate poor welfare either on the farm, during transport, or at the slaughterhouse: broken bones, bruising, badly bled carcasses and breast blisters (Popelka *et al.*, 2007).

The average percentage of dead on arrival during the years 2006 – 2010 was 0.209% and the percentage of condemned birds was 0.524%. The transport distance of poultry in 2006 – 2008 was 3 km (slaughterhouse Zvolen) and lasted only 15 minutes compared with the years 2009 – 2010 when the poultry was transported to the more distant poultry slaughterhouses. The highest average percentage of dead on arrival (0.799%) was in 2009 when the poultry was transported to the poultry slaughterhouse in Kežmarok (170 km). During all three deliveries in 2009 the dead on arrival was higher compared with previous years and the next year 2010. The average daily temperatures were 18.60, 14.60, and 15.85°C. The highest average percentage of dead on arrival was recorded in autumn, the lowest in summer. Our results are comparable with study of Ekstrand (1997), who published results of several investigations into the number of broilers that are "dead on arrival" at the slaughterhouse and mentioned that a mortality of between 0.1% and 0.6% is usual. According to Voslařová *et al.* (2007) poor welfare is the cause of high mortality among hens and

roosters transported to poultry processing plants. In the Czech Republic, death rates among hens and roosters in transport to poultry slaughter plants were monitored between 1997 and 2004, and their total mortality rate was  $0.925\% \pm 0.479$ . Based on records of all (59 171 843) broiler chickens slaughtered over three years at one processing plant, the overall mortality of birds in transit was 0.126%. There was a pronounced seasonal effect with increased mortality in the summer months, particularly June, July and August. Mortality increased when the maximum daily temperature rose above about 17°C at the start of the summer. Between 17.0 and 19.9°C, mortality was 30% higher than at lower temperatures. Between 20.0 and 22.9°C it increased 2.6-fold, and at temperatures of above 23°C 6.6-fold. There was no evidence of birds dying from hypothermia at very low ambient temperatures (down to -1°C). The implication from the results is that above a maximum daily temperature of 17°C steps may need to be taken to ameliorate the damaging effects of transport on bird welfare (Warriss *et al.*, 2005). The incidence of dead birds on arrival was surveyed by Petracci *et al.* (2006) in over 33 broiler, 11 turkey, and 19 spent hen abattoirs representing the majority (around 70%) of the Italian poultry slaughter plants. The overall average incidence of dead on arrival was found to be 0.35, 0.38, and 1.22% in broilers, turkeys, and spent hens, respectively. The season significantly ( $p \leq 0.01$ ) influenced the mortality of all considered poultry categories, with higher incidence being observed during the summer (0.47, 0.52, and 1.62% for broilers, turkeys, and spent layers, respectively). The incidence of dead on arrival broilers was found to be lower in small slaughter plants compared with medium and large slaughter plants (0.28 vs. 0.38 and 0.35%,  $P \leq 0.01$ ). The data obtained in this study might be used for establishing limit values of dead

on arrival as a welfare indicator during the pre-slaughter time of birds, including catching, loading, transportation, and lairage. An estimated 40% of dead on arrivals are attributable to stress or suffocation in transit (Bayliss and Hinton, 1990), which may be influenced by the catching team, the time of day, transport duration, waiting time and stocking density. Control of the thermal environment is very important within the vehicle, as birds are affected by both temperature and humidity.

In the poultry production industry, disease and pathological changes represent a serious problem. Apart from economic losses, disease in poultry might constitute an epidemiologic and zoonotic threat problems concerning meat hygiene and possible health risk to the consumer should be deliberated. In this context, meat inspection data are a potential source of information and have an important role to play in epidemiology and preventive veterinary medicine (Gracey *et al.*, 1999). Key principles of poultry *post mortem* inspection are to take into account *ante mortem* inspection results, the carcasses and accompanying offal must be subjected without delay after slaughter to *post mortem* inspection, all external surfaces must be viewed, and minimal handling of the carcass and offal should take place (Popelka *et al.*, 2007).

Condemnation percentage of slaughtered birds was increased with increasing transport distance. Percentage of condemned birds in 2010 (1.254%) compared with the year 2006 (0.211%) was more than four times higher. The highest percentage of condemnation was in August 2010 when the average daily temperature was 21.7°C. The causes of the birds' condemnation according to the official statistic of the State veterinary and food administration were divided into four groups: respiratory

and digestive diseases, technological defects, cachexy, and "other causes". The "other causes" caused the highest average percentage (36.40%) of condemnation reasons and includes mainly cyanosis, birds slaughtered in agony, breaking of the legs and wings, the lowest average percentage represented respiratory and digestive diseases (7.23%). The "other causes" of the poultry carcasses condemnation are caused mainly by transport load. Ansari-Lari and Rezagholi (2007) investigated the character and prevalence of poultry loss caused by disease and pathological changes in Fars province in southern Iran. As the result of inspections, 0.73% birds were condemned. Cachexy and septicemia were the most common reasons for rejection of carcasses. They were responsible for 0.62% of the total condemnations. The principal causes of poultry carcasses condemnation according to Santana *et al.* (2008) were in the southeastern region of State Goiás (Brazil) cellulite, contusion/fractures and bruises, as well as contamination due to gut severance at evisceration.

Nagy *et al.* (2011) evaluated the incidence of dead poultry on arrival and analyzed the reasons of broiler chickens condemnation in poultry slaughterhouses in the Slovak Republic in 2000 – 2010. Average percentage of mortality throughout the whole period was 0.34% (0.07 to 0.64%). The lowest dead on arrival percentage (0.07%) were recorded in 2001. On the contrary the highest percentage was (0.64%) in 2009. The results obtained showed significant increase in the percentage of broiler chickens mortality during the transport to the slaughterhouse. From 577 921 509 broiler chickens, slaughtered and inspected in the Slovak Republic, 5 635 767 (0.98%) were declared unfit for human consumption. The highest percentage of unfit broiler chickens was in 2009 (1.27%). The causes of broiler chick-

ens consideration as unfit for human consumption were mainly growth retardation (21.81%), cachexy (20.25%), other non-infectious diseases and defects (20.49%); and oedema disease (14.35%). In the period 2006 – 2010 gradual increase in the incidence of oedema disease was recorded. Oedema disease of broiler chickens caused 0.25% of broiler chickens condemnation in 2010.

The results showed the dependence of dead on arrival and condemnation percentage on the transport distance. During the years 2006 – 2008 the average percentage of dead on arrival was 0.052% in comparison with period 2009 – 2010 (0.42%). Similarly, significant increase in average number of condemned birds (0.269 and 0.906%) was observed.

#### Conclusions

The results showed significant increase in dead on arrival of broiler chickens from poultry farm in Lieskovec (The Slovak republic) and their condemnations during the years 2006 – 2010. After the accession of the Slovak Republic to the EU, there was significant change in agricultural production and food industry, which was also reflected in poultry meat production. Despite the implementation of the European legislation on animal protection, the results are not satisfactory. The cause must be sought mainly in the smaller number of poultry slaughterhouses, longer distances from poultry farms, the use of passively ventilated trucks, and in the training of personnel.

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- Council Directive 2007/43/EC of 28 June

### Analiza uzroka uginuća tovnih pilića u klaoničkom objektu iz farme Lieskovec (Republika Slovačka) u razdoblju od 2006. – 2010.

#### Sažetak

Istraživan je utjecaj trajanja transporta i temperature u transportu na uzroke uginuća i procjenu bolesnih stanja tovnih pilića s male farme Lieskovec (Republika Slovačka) u razdoblju od 2006. do 2010. godine. Rezultati su pokazali značajan porast uginuća i postotak bolesti ovisno o vremenu transporta i godišnjem dobu. Prosječan postotak uginulih pilića pri istovaru u klaoničkom objektu tijekom istraživanja perioda je iznosio 0,209% (0,031 do 0,702%) a znakovi bolesnih stanja uočeni su u 0,524% slučajeva (0,041 do 1,422). Uzroci su bili cijanoza, lom nogu i krila, kaheksija, te je zamiječeno iskrvarenje pilića u agoniji.

**Ključne riječi:** klanje peradi, transport, smrt pri dolasku, procjena

### Trendanalyse des Verendens beim Ankommen und Verseuchung von Masthühnern auf der Farm Lieskovec (Republik Slowakei) in der Zeitspanne vom 2006 – 2010

#### Zusammenfassung

Es wurde der Einfluss von Transportentfernung und Temperatur auf die Kadaver beim Ankommen und Verseuchungsursache von Masthühnern auf der kleinen Farm Lieskovec (Republik Slowakei) in der Zeitspanne vom 2006 – 2010 untersucht. Die Resultate zeigen einen bedeutenden Aufstieg des Verendens beim Ankommen und Erhöhung des Verseuchungsprozentes in Bezug auf die Transportentfernung und Jahreszeit. Der durchschnittliche Prozent des Verendens beim Ankommen betrug während der ganzen Periode 0,209% (0,031 bis 0,702%) und der durchschnittliche Verseuchungsprozent betrug 0,524% (0,041 bis 1,422). Die häufigsten Ursachen dafür waren: Zyanose, Hühner geschlachtet in Agonie, Bruch der Beine und der Flügel, allgemeine Schwäche.

**Schlüsselwörter:** Schlachten von Hühnern, Transport, Verenden beim Ankommen, Verseuchung

### Analisi del trend di mortalità durante la venuta e la causa di contagio di pollame in allevamento sull'azienda agricola Lieskovec (Repubblica Slovaca) dal 2006 al 2010

#### Sommario

In quest'articolo è stato ricercato l'infusso della distanza di trasporto e della temperatura agli addomi nel momento di venuta, e la causa di contagio di pollame in allevamento dalla piccola azienda di allevamento Lieskovec (nella Repubblica Slovaca) tra gli anni 2006 e 2010. I risultati hanno dimostrato una notevole crescita di mortalità fino al momento di venuta e la crescita della percentuale di contagio rispetto alla distanza del trasporto e della stagione. La percentuale in media di polli morti fino all'arrivo durante tutto il periodo faceva lo 0,209% (dallo 0,031 allo 0,702%) e la percentuale in media di contagio faceva lo 0,524% (dallo 0,041 allo 1,422). I motivi che più spesso si ripetevano erano: la cianosi, i polli macellati nell'agonia, le fratture delle gambe e delle ali di polli e la loro debolezza in generale.

**Parole chiave:** macellazione di polli, morte all'arrivo, contagio

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## Utjecaj hranidbe na sadržaj elemenata u tragovima u janjećem mesu

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pregledni rad

#### Sažetak

Janjeće meso ima visoku hranjivost i posebno je dobar izvor lako apsorbirajućeg cinka i željeza. Cilj ovog rada bio je prikupiti i analizirati različita istraživanja o mogućnostima obogaćivanja janjećeg mesa elementima u tragovima dodavanjem različitih izvora elemenata u tragovima u obroku janjadi. Hranidbom janjadi ili njihovih majki tijekom gravidnosti i prije odjeka može se utjecati na koncentraciju elemenata u tragovima u tkivima janjadi. Dodatkom elemenata u tragovima u obrok janjadi došlo je do povećanja njihovih količina u tkivima. Osobito su značajna povećanja elemenata u tragovima utvrđena pri dodatku organskih oblika elemenata u tragovima. Janjad ovaca koje su konzumirale obroke s dodatkom organskog selenata u hrani imala su gotovo 30% višu ukupnu koncentraciju selenata u krvi nego janjad ovaca koja je konzumirala obroke s dodatkom anorganskog selenata. Očeno se smatra da su organski izvori dostupniji od anorganskih izvora elemenata u tragovima. Rezultati različitih znanstvenih istraživanja podržavaju koncept da se organski izvori elemenata u tragovima značajno bolje apsorbiraju od anorganskih izvora.

**Ključne riječi:** elementi u tragovima, janjeće meso, hranidba janjadi

#### Uvod

Janjeće meso ima visoku hranjivost i posebno je dobar izvor lako apsorbirajućeg cinka (bitan za rast, tkiva i zdrav imunološki sustav) i željeza (potrebno za formiranje crvenih krvnih stanica). Janjetina je bogata vitaminima B kompleksa, posebno B<sub>12</sub>, koji je ključan za tjelesne metaboličke reakcije. Također je janjeće meso prirodno najbolji izvor karnitina, koji je potreban za generiranje energije iz masnih kiselina. Janjeće meso je bogat izvor visoko kvalitetnih bjelanjčevina. Janjetina ima nizak udio masti, a odličan je izvor vitamina i minerala. Minerali potrebni u vrlo malim količinama nazivaju se mikroelementima ili minerali u tragovima. Potrebe životinja za ovim mineralima izražavaju se u mg po životinji dnevno. Željezo (Fe) je često dodavani mineral (kao željezo oksid), čak i kada se nalazi u dovoljnim količinama u obroku. Međutim, željezo može

ometati apsorpciju drugih minerala kojih nema u velikim količinama, kao što je cink. Cink, bakar i selen su važni u mnogim fiziološkim funkcijama, uključujući imunološki odgovor i sposobnost borbe protiv bolesti. Bakar može biti toksičan za ovce. Višak se bakra deponira u jetri umjesto da se izluči. Tijekom vremena, višak Cu može uništiti stanice jetre, što će dovesti do uginuća životinje.

U nekim dijelovima svijeta postoje područja ili tla koja su jako bogata ili siromašna elementima u tragovima. Nužno je obratiti pozornost na ta područja zato što biljke koje rastu na tim tlima imaju veće ili manje količine elemenata u tragovima. Neka tla često imaju manjak selenata, pa su krmiva koja se uzgajaju na takvim tlima također deficitarna selenom. Neka tla će nakupljati teške metale kao kadmij, olovo, arsen i živu, koji su štetni za zdravlje.

Cilj je istraživanja bio dati pregled uloga različitih elemenata u tragovima, čimbenika koji utječu na njihovu dostupnost te pokazati utjecaj hranidbe na sadržaj elemenata u tragovima u janjećem mesu.

#### Elementi u tragovima

Svi živi organizmi trebaju anorganske elemente (minerale), za životne procese. Sva hrana i životinjska tkiva sadrže minerale u različitim količinama i kemijskim oblicima. Minerali se klasificiraju na nekoliko načina. Minerali koji su potrebni u relativno velikim količinama nazivaju se makrominerali dok se minerali koji su potrebni u malim količinama nazivaju mikrominerali ili elementi u tragovima. Minerali u hrani su prije kom potrebni za sve vrste i kategorije životinja i utječu na produktivnost stočarske proizvodnje. Približno 5% od ukupne tjelesne mase životinja čine mineralne tvari. Element je de-

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