Litter´s Quality and Temperature Changes during Broiler´s Fattening

Štefan Boďo, Roman Gálik, Lenka Staroňová, Hristo Beloev, Jan Marecek

Abstract: *The study was focused to outside temperature, air moisture content and also the microclimate conditions of fattening broilers hall monitoring. Also the litter´s quality and temperature, and stocking density during summer days were monitored. Measurements were done at selected farm in the 10th and 20th day of chickens' age. To evaluate the litter´s quality the three stage system was used. If the litter was dry and hard - value was in stage „1", if it was moist and supple - value was in stage „2" and if it was wet - value was in stage „3". Outside and inside temperature was measured with logger Comet R 3120, litters temperature was measured with noncontact thermometer Raytek Raynger ST. The hall was divided into 33 rectangles parts. To determine the stocking density by images, made with a thermal imager Guide TP8S. If the stocking density was high - value was in stage „1", if there was the median stocking density - value was in stage „2" and if the density was low - value was in stage „3". In that time cause of colder summer was reached into the hall required temperature. During the litter´s quality monitoring, an average value of 1.2 on day 10 and 1.3 on day 20 of fattening were achieved. The litter quality was estimated as dry and hard. The stocking density on day 10 was 1.0 and on day 20 was 1.3. In comparison of P-value and α (0.05) was determined that the P-value (0.000) < alpha (0.05), respectively. P-value (0.04) < alpha (0.05). The litter´s quality and temperature respectively the litter´s temperature and stocking density were statistically significant during monitored days. The litter´s quality in hall in 10th and 20th days was statistically significant (P = 0.000 < α = 0.05). Litter´s temperature in 10th and 20th days was also statistically significant (P = 0.024 < α = 0.05).*

Keywords: *broiler, litter, temperature, humidity*

INTRODUCTION

Litter quality and suitable climatic conditions are the key factors in assessing the costs and profits. In the first fattening broiler chicken period approximately to 14th or 21th day, must be ensured the suitable environment temperature and humidity by hybrid. In the second half fattening, it is important not to exceed a temperature above 25 °C and keep the relative humidity below 70 % with using intensive ventilation for not exceeding the permitted levels of harmful gases (Brouček, 2014).

Stocking density is given either in birds per 1m^2 of floor surface, or the stocking density of holding area in kg of bird liveweights at the end of fattening period. This amendment to Council Directive 2007/43 / EC, which was taken over Slovak Republic for Slovak Government Regulation no. 275/2010 from 9 June 2010. Poultry suffering from the summer heat stress from high temperatures. This causes a reduction in production, worsening health status and increased mortality. Neutral zone temperature in generally for poultry is between 13 to 24 °C. For temperatures from 24 to 29 °C were slightly reduced feed consumption and decreasing at temperatures from 29 to 32 °C. The temperature rise of 35 ° C greatly reduces the feed intake, increasing mortality, especially in broilers. The air in the building is heated by birds as themselves, the heat of litter´s fermentation and the heat primarily from an overheated walls and roof (Brouček, 2014).

On the other hand dry litter has the lower dry matter content and better thermomechanical properties influencing lying comfort. Wet chemically aggressive environment creates hygienic hazards either for animals, human and *reduce* a *building's life* (Reichstädterová et al., 2013). Animals' heat is influenced mainly of liveweights and their activity (Bessei, 2006). If the stocking density of surface is to high, the temperature could be rapidly increased, cause of metabolic heat, when the ventilation system in older hall or reconstructed hall was missing (Pogran, 2011). This is dangerous if ventilation is inadequate or if the existence of non-ventilated places with a fixed layer of warm air. (Karandušovská et al., 2009). In summer, the creation of appropriate microclimate conditions, with high

quality litter and the stocking density are important parameters that determine both the farming economy but also on animal welfare (Pogran, 2011). According Knížatová et al. (2009) therefore do not have an important role as temperature, humidity and pH, as well as the duration of litter usage. On the other hand the measurement of litter quality parameters, resulting enormous animal stress (Weaver, 1991). According Butcher (1995), the optimal moisture content of litter is between 25 % and 35 % of relative humidity. Despite the fact that animals live in a specified area, although for limited period, should not cause animal suffering (Webster, 1999).

The aim of the study is to monitoring microclimatic condition inside the broilers´ fattening hall in selected farm. According to obtained results show how the litter quality, respectively the stocking density are influencing and propose suggestions for the undertaking measures to improve animal welfare.

THE METHODOLOGY OF WORK

The study was focused to outside temperature, air moisture content and also the microclimate conditions of fattening broilers hall monitoring. Also the litter´s quality and temperature, and stocking density during summer days were monitored. Measurements were done at selected farm in the 10^{th} and 20^{th} day of chickens' age. Monitored hall had dimensions of 100 x 10 m, with 17 280 broiler chicken. Hall was put into operation at the end of sixty years of the 20^{th} century. Fresh air holes were made in the side walls of the hall. Ventilation was provided by 5 ceiling fans to the performance of one 13 800 $m^3.h^{-1}$ and of three wall fans with a performance 35 000 $m^3.h^{-1}$ for each. The litter consisted of 3.5 kg cut straw for $1m^2$ of floor space. Feeding and watering systems formed bowl feeders and nipple drinkers. To evaluate the litter quality the subjective three-stages system was used (Weaver, 199). If the litter was dry and hard - value was in stage ,,1", if it was moist and supple - value was in stage ,,2" and if it was wet - value was in stage ,,3". Outside and inside temperature was measured with logger Comet R 3120, litters temperature was measured with noncontact thermometer Raytek Raynger ST. Stocking density of broilers in hall was estimated with using thermal camera Guide TP8S with a spectral sensitivity of 8/14 μm. Data were statistically processed in Excel and Statistica. Themal images of litter´s temperature, litter quality and stocking density maps were processed using the program Surfer.

RESULTS AND DISCUSSION

Table 1 shows averages values of measured parameters. Even though it was summer, noted the high differences of temperatures and humidity in the reference period.

Table 1 Measured values

HALL 2	10^{th} day of chicken´s age	20^{th} day of chicken´s age
Average outside temperature, °C	36.1	16.4
RH % outside	32.5	68.1
Average inside temperature, °C	32.8	24.2
RH % in hall	40.6	55.2
Average litter´s temperature, °C	29.9	27.2
Average litter´s quality, -	1.2	1.3
Average stocking density, -	1.0	1.3
Number of broiler chicken, pcs	16 840	16 664

Table 1 describes, that the average outside air temperature at the 20th day of broilers chicken decreased (from 36.1 °C to 16.4 °C), and relative humidity has increased

(from 32.5 % to 68.1 %). This change was also reflected in the microclimate conditions in the fatting hall. Figure 1 depicts temperatures running on day 10 of broiler chicken age.

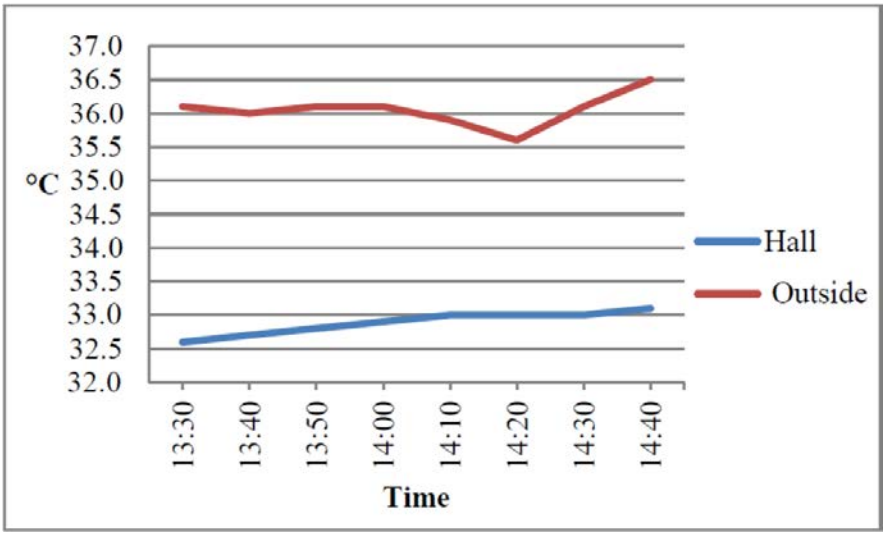

Fig. 1 Air temperature on day 10 of broiler chicken age

Regression between the outside air temperature and the inside air temperature in the hall on the 20th day of broilers chicken age described by equation y = + 0.1607 x 21.549 and is shown in Fig. 2. The regression equation shows, when the outside air temperature increase by 1 °C, the inside hall temperature increase of 0.160 °C. Coefficient of determination R^2 (0.864) indicates that in 86 % of indoor air temperature variability is influenced of the outside temperature.

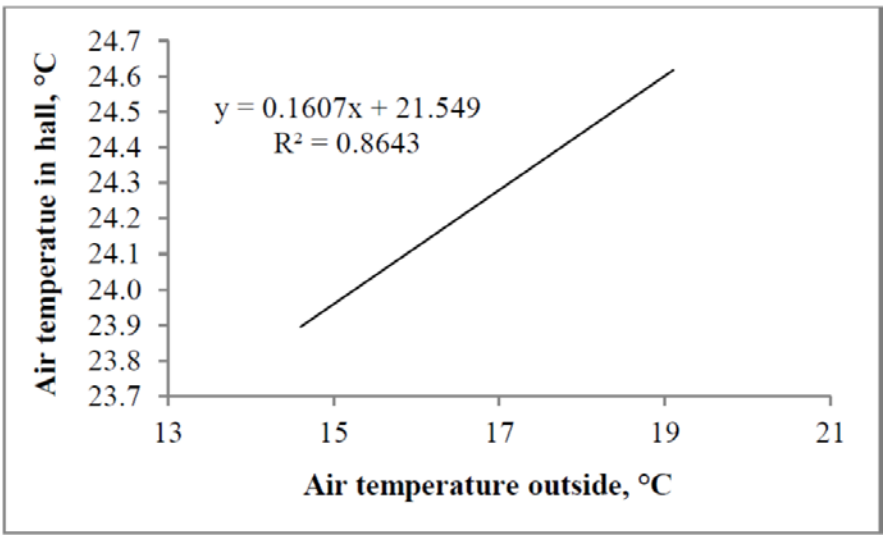

Fig. 2 Regression dependency of inside hall air temperature on day 20 of broiler chicken age

Values of relative humidity (%) during litter´s temperature measuring inside the hall on day 20 of broiler chicken age, depicts Fig. 3. Average outside temperature was reached value 16.4 °C with outside relative humidity 74.6 % and had been increasing during the day up to 86 %. Therefore, was necessary to minimalized ventilation, according to the limits of harmful substances of air in hall. With continuous reduction of light intensity the chicken activity in hall was achieved. After the outside relative humidity decrease, ventilation was again restored.

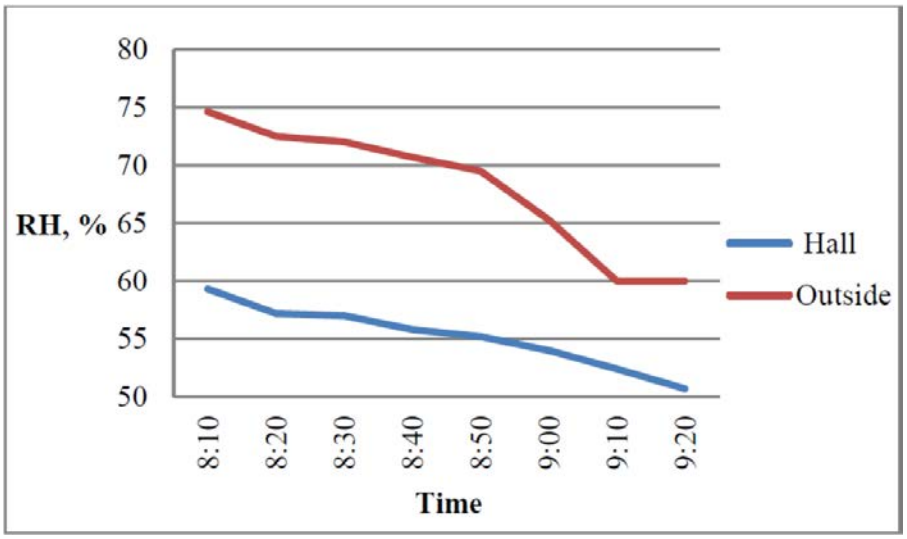

Fig. 3 Air relative humidity in 20th day of broiler chicken age

Regression equation (y = 0.4743x + 22.914) between air relative humidity outside the hall and inside the hall in day 20 of broiler chicken age is shown in Fig. 4. If the outside relative humidity of air is increased of 1 % the relative humidity inside the hall was increased up to 0.474 %. Coefficient of determination R^2 (0.936) indicates, that in 94 % relative humidity inside the hall variability depends of outside air relative humidity.

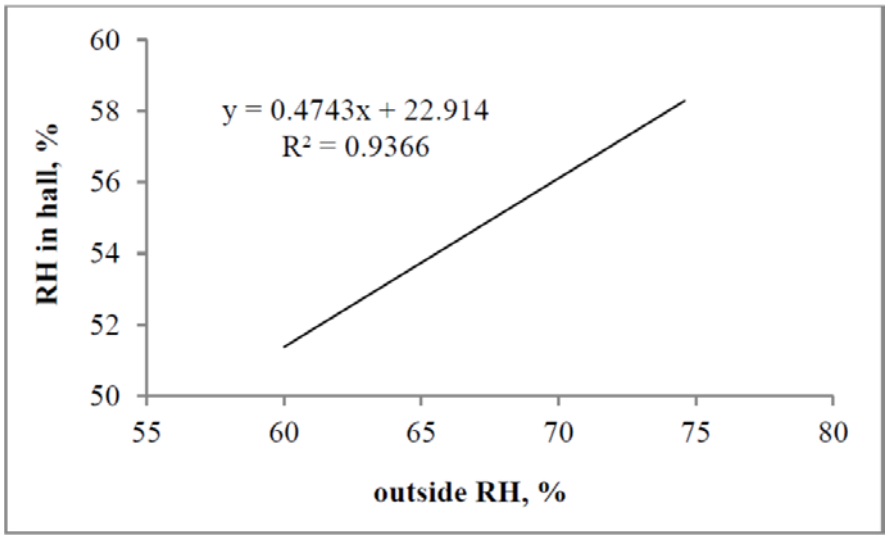

Fig. 4 Dependency of air relative humidity outside the hall and inside the hall on 20th day of broiler chicken

Figure 5 and 6 show thermograms of litter in hall on day 10 and day 20 of broiler chicken age. On day 10 is starting to show in some places lower temperature litter impacts cause of its high humidity. On the 20th day already are clearly distinguished the litter´s cold temperature, caused again of the high humidity, which was higher because of water leakage from a drinker. P-value (0.024) was below alpha (0.05), there were statistically significant. What shows statistical significance between the litter´s temperature on day 10 and day 20 of broilers chicken age.

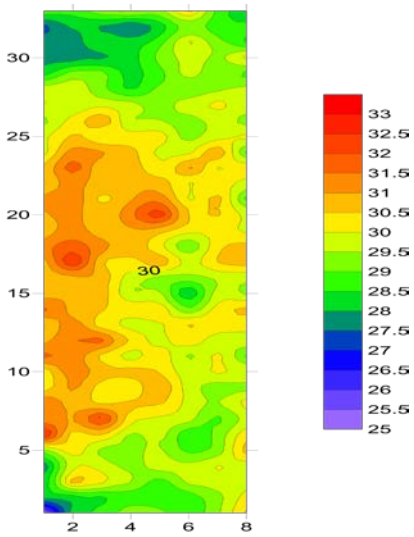

Fig.5 Temperature changes thermorgram on 10th day of broiler chicken age

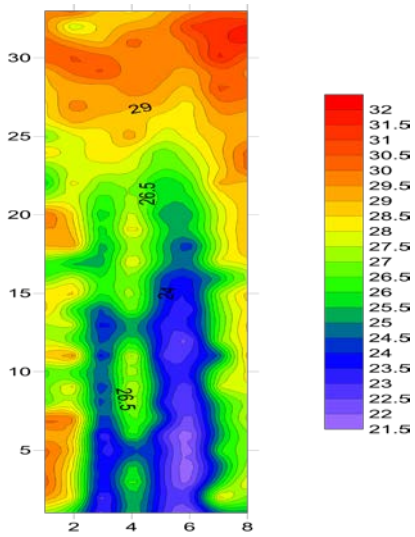

Fig. 6 Temperature changes thermogram on 20th day of broiler chicken age

The litter´s quality is shown in Fig. 7 and 8. The results show that the obtained values of litter´s quality on day 10 was running from value 1 to value 2. On day 20 are not visible parts with lower litter´s quality (higher moisture content), caused of water leak from a drinker, where are already chickens not present. The litter´s quality between 10th and 20th day was statistically significant (P-value 0.018 < α = 0.05).

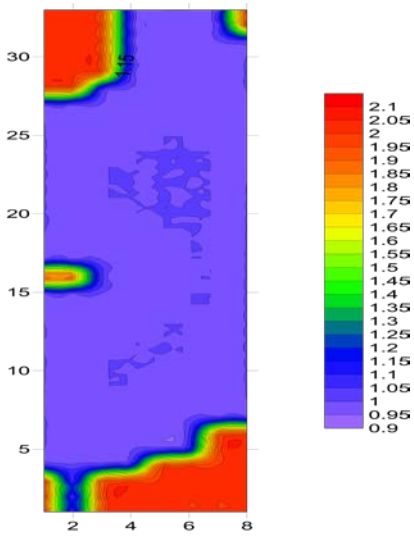

Fig.7 Litter´s quality thermorgram on 10th day of broiler chicken age

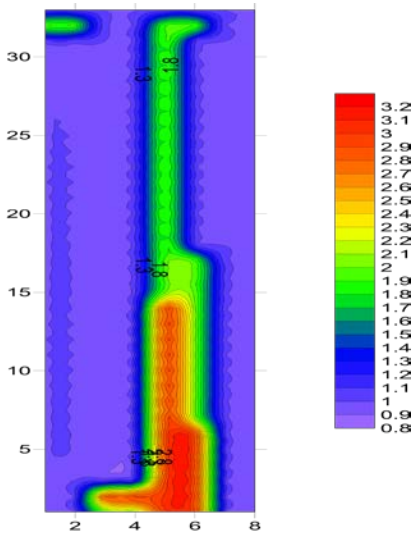

Fig. 8 Litter´s quality thermorgram on 20th day of broiler chicken age

Fig. 9 and 10, show high stocking density of the chickens in hall. When is compared litter´s quality and stocking density on day 20 of broiler chicken age is visible that the chickens use whole area in hall except the places nearby drinkers. However, due to lack of space, broilers stayed on the litter, which was considerably waterlogged. P-values (0.12) was not below α (0.05). There was not statistical significance between the stocking density on 10th day and 20th day of broiler chicken age.

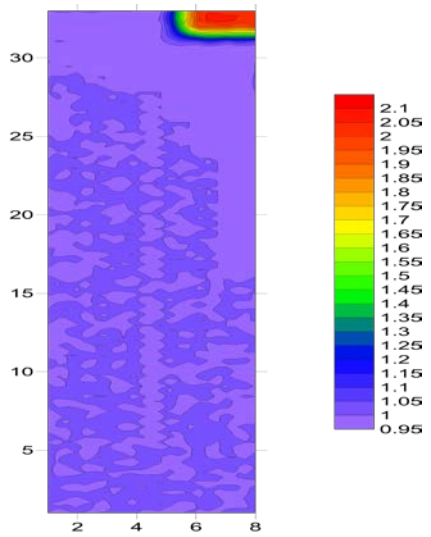

Fig.9 Thermogram of stocking density on 10th day of broiler chicken age

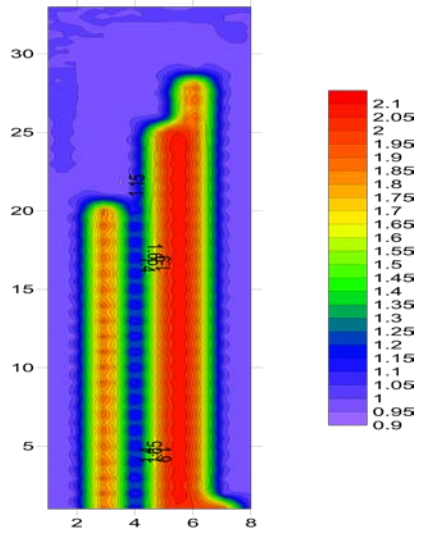

Fig. 10 Thermogram of stocking density on 20th day of broiler chicken age

Unless the dropper drinker do not work properly water is waterlogged into the litter then the litter´s quality is deteriorates rapidly and broiler chickens look for place which is more suitable for them. Despite the fact that it was the summer period, the measured data according to Broučka (2014), not to exceed the reference temperatures. In case of high humidity it requires knowledge of the regulation of the ventilation system. It is important to constantly monitor the air quality in the hall so as not to exceed the levels of harmful substances in the air and minimize the birds' activity in hall. Recommended litter´s humidity by Butcher (2014) in some places exceeded the allowable limit. At the beginning the broiler chickens use to avoid of the waterlogged litter, but just before the end of fattening period they were located in whole hall because of lack of space at appropriate litter. Here it is necessary to pay special attention to proper operation of dropper drinker.

CONCLUSION

The study was focused to outside temperature, air moisture content and also the microclimate conditions of fattening broilers hall monitoring. Also the litter´s quality and temperature, and stocking density during summer days were monitored at selected farm. Summer in Slovakia was rainy with fluctuating temperatures. In this case at the first half of the fattening period was with high temperatures and the second half was with low temperatures with high relative humidity. The obtained results show:

- statistical significance between the litter´s temperature on day 10 and day 20 of broilers chicken age. P-value (0.024) was below alpha (0.05),
- the stocking density on 10th day and 20th day of broiler chicken age was not statistical significance (P-values = 0.12 was not below $\alpha = 0.05$),

In terms of improving the living conditions of broiler chickens recommend focusing more confidence to: dropper drinker during the fattening cycle, the entry of water through the storage place with poorly chosen inclination of access roads, respectively leaks through cracks in a hall peripheral wall.

This paper was supported under the project „Development of international cooperation for transfer and implementation of results into research and development of educational programs“ (TRIVE) ITMS project no: 26110230085.

This paper was supported by the agency KEGA, solution of project no. 011SPU-4/2014 entitled: Transfer of innovative technologies into the educational process in the dimensions of the current needs of agriculture through university textbook.

REFERENCES

[1] Bessei, W. 2006. Welfare of broilers: a review. In *World's Poultry Science Journal*, vol. 62, September 2006.
[2] Brouček, J. *Chov hospodárskych zvierat v marginálnych oblastiach* [online], **[**cit. 14. 8. 2014]. Dostupné na internete: <http://chzvmos.sk/chov-hydiny/articles/hrabava-hydina.html>.
[3] Butcher, G. D., Miles, R. D., *Causes and Prevention of Wet Litter in Broiler Houses* [online], **[**cit. 14. 8. 2014], Dostupné na internete: <https://edis.ifas.ufl.edu/pdffiles/VM/VM02000.pdf>.
[4] Čo je to welfare [online], **[**cit. 26. 5. 2014]. Dostupné na internete: <http://www.slobodazvierat.sk/Co-je-to-welfare.98.0.html>.
[5] Karandušovská, I. et al. 2009. *Posudzovanie produkcie škodlivín v objektoch pre chov dojníc a hydiny*. Nitra: SPU, 2009, 170 s. ISBN 978-80-552-0302-7.
[6] Klimatizačné zariadenie systému „Pad" [online], **[**cit. 22. 8. 2014]. Dostupné na internete: <http://www.usgr.com/cooling-pads/cooling-pads.php>.
[7] Knížatová, M. Et Al. 2009. Koncentrácie a emisie amoniaku a skleníkových plynov v chove brojlerových kurčiat v letnom období a ich závislosť od vybraných vlastností podstielky. In *Acta technologica agriculturae*, roč. 12, č. 1, s. 1 - 5. ISSN 1335-2555.
[8] Oznámenie komisie európskemu parlamentu, rade a hospodárskemu a sociálnemu výboru o stratégii Európskej únie v oblasti ochrany a dobrých životných podmienok zvierat na obdobie rokov 2012 – 2015[online], [cit. 26.7.2014]. Dostupné na internete:<http://ec.europa.eu/food/animal/welfare/actionplan/docs/aw_strategy_19012012_sk.pdf>.
[9] Pogran, Š. Et Al. 2011. *Kvalita vnútorného prostredia ustajňovacích objektov.* Nitra: SPU v Nitre, 2011. 242 s. ISBN 978-80-552-0557-1.
[10] Reichstadterová, T. Et al. 2013. Assessment of hygienic criteria of building envelope in poultry housing. In *Trends in agricultural engineering 2013*. 1st ed. 725 s. ISBN 978-80-123-2388-9. Trends in agricultural engineering. Prague : Czech University of Life Sciences Prague, 2013, s. 542-546.
[11] Ross broiler management manual, 2009 [online], [cit. 20. 8. 2014]. Dostupné na internete:<http://en.aviagen.com/assets/Tech_Center/Ross_Broiler/Ross_Broiler_Manual_09.pdf>.
[12] Weaver, W. D. Jr, Meijerhof, R.,The effect of different levels of relative humidity and air movement on litter conditions, ammonia levels, growth, and carcass quality for broiler chickens [online], [cit. 5. 7. 2015]. Dostupné na internete: <http://ps.oxfordjournals.org/content/70/4/746.long>.
[13] Webster, J. 1994. Animal welfare. A cool eye towards eden. In *Blackwell science ltd,* 1994. 259 s. ISBN 80-238-4086-X.

CONTACTS

Štefan Boďo, Department of Production Engineering, Faculty of Engineering, Slovak University of Agriculture in Nitra, Tr. A. Hlinku 2, 949 76 Nitra, Slovak Republic, E-mail: Stefan.Bodo@uniag.sk

Roman Gálik, Department of Production Engineering, Faculty of Engineering, Slovak University of Agriculture in Nitra, Tr. A. Hlinku 2, 949 76 Nitra, Slovak Republic, E-mail: Roman.Galik@uniag.sk

Lenka Staroňová, Department of Production Engineering, Faculty of Engineering, Slovak University of Agriculture in Nitra, Tr. A. Hlinku 2, 949 76 Nitra, Slovak Republic, E-mail: Lenka.Staronova@uniag.sk

Hristo Beloev, Department of Agricultural Machinery, Agrarian and Industrial Faculty, University of Ruse "Angel Kanchev", 8 Studentska str., Bulgaria, e-mail: hbeloev@uni-ruse.bg

Jan Mareček, Department of Agricultural, Food and Environmental Engineering (FA), Mendel University in Brno, Zemědělská 1, 61300 Brno, Czech Republic, e-mail: jan.marecek@mendelu.cz