In this experiment the influence of stocking density on the body conformation of broiler carcasses was investigated. One hundred and twenty broiler chickens were divided into three groups; each group comprised 40 chickens. At the end of the first week of the fattening period 20 chickens in each group were marked by random sampling. The first testing group (P₁) represented the one with a lower stocking density (12 chickens per square meter); the second one (P₂) with a higher stocking density (18 chickens per square meter), while the control group (K) was set in accordance with the technological recommendations (15 chickens per square meter). Breast circumference, drumstick circumference, keel length (crista sterni), breast depth and breast angle were monitored and measured on a weekly basis. Body conformation measures were determined on the carcasses in a horizontal position with their backs placed on the table. The appropriate instruments such as millimetre tape, caliper and ZP-3 protractor were used. In addition, a weekly live weight and feed consumption were measured. Production results (live weight, gain, feed-to-gain ratio and European Production Index (EPI) were calculated. Carcass grades were calculated based on the mass ratio of the cooled carcass and the live body weight before slaughtering. The research findings have confirmed that overcrowding in production facilities is always risky in regard to the expected production results. In contrast, by fully conforming to the production technology requirements, it is possible to achieve better production results.

Key words: broiler, body conformation, stocking density
Stocking density is one of the most important factors in broiler production. It affects the health and well-being of broilers to a large extent in the sense of productivity and behaviour. Definition of the concept of stocking density in poultry production is given on the basis of various criteria. So far, the crucial criteria have been established relating to economic factors, and consequently, the practice has been to place the greatest possible number of chickens per square metre in the final stage of the fattening period. In technical terms it has been expressed as a live weight of chickens per square metre at the end of the fattening period (Broiler Campaign, 2001; Broiler Management Guide Cobb 500, 1998).

Density is an exceptionally important non-genetic factor in regard to successful fattening and it has often been attempted to reconcile the two diametrically opposed views within this determinant. On the one hand, we have productivity goals in terms of the highest possible yield of meat per area unit; while on the other hand, there is a physiological reality and the irrefutable fact that we are dealing with living creatures that cannot be overcrowded in an unacceptable manner. As a result, stocking density is a problem that all producers of commercial hybrids have attempted to resolve for the benefit of animals and the breeding farm as such.

It is a common practice that farmers are trying to maximize the number of chickens per square unit to get the optimal yields. Animal welfare activists have been insisting on humanizing the production process in the fattening period, but also on other segments of poultry breeding with the aim of reducing the stocking density of animals per square unit. According to recommendations of commercial broiler breeders (Cobb, Ross) stocking density depends on many factors, the most important being the manner of breeding and its goals. In open (non-controlled environment) poultry houses the calculation of stocking density is dependent on temperature, especially in the summer season, in addition to the type of production facilities. In controlled environment houses for intensive broiler fattening, the maximal stocking density should be up to 34 kg of live weight per one square metre (Broiler Management Guide Cobb 500, 1998).

The increased demand for chicken meat in markets has imposed a challenge for big selection centres to produce broiler chickens with a wide breast circumference and good body conformation. The term "conformation" is of American origin, but it is nowadays used in many countries around the globe to determine form (shape), type and body build of broilers (Pavlovski and Mašić, 1983). Determining body conformation in carcasses is vital for any qualitative assessment in research or commercial production. It is done by applying subjective and objective assessment methods (Pavlovski and Mašić, 1983; Antonijević et al., 1981; Mašić et al., 1980; Mašić, 1967).

Over the past few years a number of different broiler hybrids have been used in Bosnia and Herzegovina that have remained on the market for a
shorter or longer period. Nevertheless, the dominant breeds used in our country today are Ross and Cobb commercial hybrids. Consequently, we conducted our research to examine the influence of this particular factor stocking density on body conformation of broiler chickens in testing and breeding conditions during the fattening period. In addition we also measured their production results such as live body weight, total gain, feed-to- gain ratio and EPI index, as well as the car-
cass grade.

Materials and methods / Materijal i metode rada

During the six-week fattening period 120 broiler chickens Cobb 500 were divided into three groups; each group comprised 40 chickens. At the end of the first week 20 chickens in each group were marked by random sampling. The chickens in the first testing group (P₁) represented the one with a lower stocking density (12 chickens per square metre); the second one (P₂) with a higher stock-
ing density (18 chickens per square metre), while the control group (K) was set in accordance with the technological recommendations (15 chickens per square metre).

Conditions in breeding capacities (such as temperature, humidity and light program) were in accordance with the producer's recommendations relating to floor keeping. Inside the facilities three boxes, differing in size, were set. Each box was adapted to a particular tested group. The manual equipment was in-
stalled in the boxes and all production amenities were in conformity with the selector's instructions. Broiler chickens were fed in accordance with nutritional require-
ments of the Cobb broiler breeds.

During the testing period breast circumference, drumstick circumference, keel length (crista sterni), breast depth and breast angle were monitored and measured on a weekly basis. Body conformation measures were determined on the carcasses in a horizontal position with their backs placed on the table. The appropriate instruments such as millimetre tape, caliper and ZP-3 protractor were used. In addition, a weekly live weight and feed consumption were measured.

Production results (live body weight, total gain, feed-to-gain ratio and European Production Index (EPI) were calculated and presented for the total number (n=40) of the tested broiler chickens. Carcass grades were calculated based on the mass ratio of the cooled carcass and the live body weight before slaughtering. Body conformation measurements were calculated and presented for the marked (n=20) broiler chickens.

The results were analyzed by ANOVA Single factor. If the Fisher's p value proved to be significant (p<0.05), the differences between means were tested by Duncan's multiple range test. The significance was determined at the level of p<0.05.
The means of production results are shown in Table 1. The highest final body weight of 2.36 kg and highest total gain of 2.32 kg were achieved in Group K. The best feed-to-gain ratio (1.78 kg) was also achieved by the chickens from the same group as well as the highest EPI index (317).

### Table 1. Means of production results of fattening chickens from 1 to 42 days

<table>
<thead>
<tr>
<th></th>
<th>P₁</th>
<th>P₂</th>
<th>K</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of chickens Day 1 / Broj пилца 1. дана</td>
<td>40</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>Number of chickens Day 42 / Broj пилца 42. дана</td>
<td>40</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>Body weight day 1 (kg) / Telesna masa 1. dana (kg)</td>
<td>0.04</td>
<td>0.04</td>
<td>0.04</td>
</tr>
<tr>
<td>Body weight day 42 (kg) / Telesna masa 42. dana (kg)</td>
<td>2.34</td>
<td>2.26</td>
<td>2.36</td>
</tr>
<tr>
<td>Total gain (kg) / Ukupni прираст (kg)</td>
<td>2.30</td>
<td>2.21</td>
<td>2.32</td>
</tr>
<tr>
<td>Daily gain (kg) / Dnevni прираст (kg)</td>
<td>0.05</td>
<td>0.05</td>
<td>0.06</td>
</tr>
<tr>
<td>Total feed consumption (kg) / Ukupni unos hrane (kg)</td>
<td>4.12</td>
<td>4.10</td>
<td>4.12</td>
</tr>
<tr>
<td>Daily feed consumption (kg) / Dnevni unos hrane (kg)</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>Feed to gain ratio / Odnos hrane i prirasta</td>
<td>1.79</td>
<td>1.85</td>
<td>1.78</td>
</tr>
<tr>
<td>European Production Index (EPI) / Indeks za evropsku proizvodnju (EPI)</td>
<td>310</td>
<td>290</td>
<td>317</td>
</tr>
</tbody>
</table>

The highest carcass weight and carcass grade was confirmed in Group K, but were not significantly different compared to the other two groups (Table 2).

Means of body conformation measurements of broiler carcasses are presented in Table 3. The highest value of the breast circumference was found in Group K which was significantly higher than in Group P₂, but not in Group P₁. Drumstick circumference and keel length were essentially the same in all tested groups. Breast depth was the highest in Group P₁ and the lowest in Group K, and breast angle was also highest in Group P₁.
### Table 2. Means of broiler carcass weight and carcass grade (% live body weight)

<table>
<thead>
<tr>
<th>Groups / Grupe</th>
<th>S. E. M.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P₁</td>
</tr>
<tr>
<td>Carcass weight (kg) / Težina trupa (kg)</td>
<td>1.66</td>
</tr>
<tr>
<td>Carcass grade (% live body weight) / Ocena trupa (% žive mase)</td>
<td>70.94</td>
</tr>
</tbody>
</table>

### Table 3. Means of body conformation measurements of broiler carcasses

<table>
<thead>
<tr>
<th>Parameters / Parametri</th>
<th>P₁</th>
<th>P₂</th>
<th>K</th>
<th>S.E.M.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Live weight, g / Živa masa, g</td>
<td>2334</td>
<td>2315</td>
<td>2347</td>
<td>44.58</td>
</tr>
<tr>
<td>Breast circumference, mm / Obim grudi, mm</td>
<td>309.65ab</td>
<td>302.65a</td>
<td>312.95b</td>
<td>2.92</td>
</tr>
<tr>
<td>Drumstick circumference, mm / Obim batka, mm</td>
<td>142.65</td>
<td>144.15</td>
<td>145.60</td>
<td>2.12</td>
</tr>
<tr>
<td>Keel length, mm / Dužina kobilice, mm</td>
<td>110.15</td>
<td>109.55</td>
<td>114.15</td>
<td>1.66</td>
</tr>
<tr>
<td>Breast depth, mm / Dubina grudi, mm</td>
<td>21.18</td>
<td>21.13</td>
<td>20.56</td>
<td>0.44</td>
</tr>
<tr>
<td>Breast angle* / Grudni ugao*</td>
<td>108.75a</td>
<td>104.85ab</td>
<td>96.15b</td>
<td>2.91</td>
</tr>
<tr>
<td></td>
<td>16.36</td>
<td>16.06</td>
<td>16.12</td>
<td>0.31</td>
</tr>
<tr>
<td></td>
<td>21.18</td>
<td>21.13</td>
<td>20.56</td>
<td>0.44</td>
</tr>
<tr>
<td></td>
<td>21.46a</td>
<td>22.08ab</td>
<td>24.41b</td>
<td>0.78</td>
</tr>
<tr>
<td></td>
<td>126.35a</td>
<td>118.05bc</td>
<td>116.05b</td>
<td>1.75</td>
</tr>
</tbody>
</table>

abc – means in the same row with different superscript differ significantly (p<0.05)

S.E.M. – standard error of mean

Discussion / Diskusija

Production results / Proizvodni rezultati

Our production results were in conformity with the highest performance scores of this hybrid (Broiler Growth Cobb 500, 1998; Broiler Performance Cobb 500, 1998). Results have also proved that high stocking density in production capacities is always risky in respect to the expected breeding results. The pa-
rameters such as body weight, total gain and feed-to-gain ratio were below the technological norms, while the asserted EPI index in broiler chickens bred in conditions of a high stocking density has been proven to be economically unprofitable. Hence, these findings are in conformity with the data from literature (Kavazović et al., 2004; Softić et al., 2004; Alibegović-Zečić et al., 2003; Softić et al., 2003; Feddes et al., 2002; McLean et al., 2002; Broiler Growth Cobb 500, 1998; Broiler Performance Cobb 500, 1998; Martrenchar et al., 1997). We observed only three cases of discrepancy in respect to quantity regarding the final results (Alibegović-Zečić et al., 2003; Pavlovski et al., 2003; Pejin et al., 1980), but they are attributable to a different test design and the use of other broiler breeds in it.

We could not confirm any important influence of stocking density on production results, which is absolutely in conformity with the results obtained by Thomas et al. (2004) who report that the stocking density of 10, 15 and 20 chickens per square metre did not significantly influence the achieved production results.

**Carcass weight and carcass grade / Težina i ocena trupova**

After slaughtering and processing the weight of the carcasses in broiler chickens from the control group amounted to 1.70 kg with a carcass grade of 72.03%. At the same time, these were by far the best expected results based on the selector's recommendations and breeding conditions as such (Broiler Growth Cobb 500, 1998; Broiler Performance Cobb 500, 1998). The weight of the processed carcasses and the carcass grade appeared to be better, and as such it could elicit some doubts. This outcome was hinted at by the production results of live broiler chickens, and in spite of the fact that chickens from this group had a somewhat larger living space, it did not result in irrational use of food energy for movement and did not influence the gain. On the contrary, the chickens from the group that had a reduced living space, or the least capacity for movement, did not use the feed rationally, and thus, they achieved the poorest pre-slaughter results. In production circumstances these results may have been caused by difficult access to water and feed, which was not a case in our experiment. Therefore, the causes should be looked for in a wide range of factors relating to high stocking density, but generally, they can be summed up under the notion of a disrupted well-being of individual chickens. In this respect, our research results are similar to those of authors who reported etological factors as serious causes of production failures in intensive poultry breeding conditions (Spinu et al., 2003; Tablante et al., 2003; Estevez et al., 2002; Feddes et al., 2002; Sanotra et al., 2001; Martrenchar et al., 2000; Sorensen et al., 2000; Martrenchar et al., 1997; Cherry and Barwick, 1962). Otherwise, the slaughter-related results that we obtained for the control and the first testing group are similar to those of other authors (Kavazović et al., 2004; Alibegović-Zečić et al., 2003; Pavlovski et al., 2003; Feddes et al., 2002; Supić et al., 2000; Alibegović-Zečić, 1999; Mitrović, 1996; Petrović, 1981), but they are even better than the results obtained by others (Čaklovica et al., 1991; Pav-
lovski et al., 1980). The reasons could be related to different broiler strains used in their experiments (Čaklovica et al., 1991), or a different experiment design aimed at establishing the influence of various feed brands on the fattening results (Pavlovski et al., 1980), but not the housing conditions.

**Body conformation of broiler carcase** / Telesna konformacija trupova pilića

Body conformation is a crucial indicator in assessing the quality of chicken carcases. The measures of body conformation of broiler carcases, expressed as the index of body weight before slaughtering and the observed measures on the carcases themselves, aimed at reducing the effect of the body weight and accentuating the importance of the applied treatment, are also considered to be the important indicators of the carcase quality. We could not find data in the available literature for some tested parameters because of the nature of our experiment design. Consequently, in such conditions we tried to compare our results related to body conformation measures with available results from other authors, being fully aware that the results of the latter were most commonly influenced by other factors, namely, by other experiment designs.

The trend of breast circumference increase on carcases of the broiler chickens bred in conditions in conformity with the recommended technical standards proved to be statistically different compared to the carcases of two other testing groups. Nevertheless, the best mean value of breast circumference in our experiment was lower than that reported by Latshaw and Bishop (2001). It must here be mentioned that the authors in their experiment on broiler chickens, which were divided according to sex, used another set of instruments for measuring breast circumference. On the other hand, our values regarding the breast circumference of all the three groups are higher in comparison with the results obtained by Antonijević et al. (1981) who conducted their experiments on broad-breasted broiler chickens of the Hubbard breed.

Drumstick meat, along with white breast meat, is classified as the top-quality part of the chicken carcase. Taking into consideration the fact that drumstick circumference is bigger in broiler chickens with full, rounded drumsticks, our results for all the tested groups are better than those reported by other authors (Lukić, 2001; Hopić, 1996; Pavlovski and Mašić, 1983; Pavlovski et al., 1980).

The lower index value of the drumstick is an indicator of a more favourable body conformation factor (Pavlovski and Mašić, 1983; Mašić, 1973). In accordance with the said criterion the most favourable body conformation was observed in broiler chickens bred in conditions of a higher stocking density, although the total values for all the three groups were very similar. The keel length index can be observed from two points. The longer the keel means the more space is provided for breast musculature, but the breast roundness in this case is smaller, and as a result, the carcase appears less compact. When priority is given to carcase meatiness, it is understood that longer-keel carcases have an advantage. Therefore, a lower index value indicates a more favourable body conforma-
The broiler chickens from the control group achieved the best results although statistically they did not differ from the other two groups. Our results for all the three groups are approximately the same as those of other authors (Hopić, 1996; Pavlovski and Mašić, 1983), but considerably lower than the results reported by Pavlovski et al. (2003). It must be emphasized that the latter authors used several broiler breeds in their study, and chickens were divided according to sex.

Selection, aimed at improving body conformation and slaughter-related parameters of broiler chickens, was focused on the breast part of the carcass. Bearing in mind that a higher index of breast depth indicates a more favourable body conformation, the results we obtained in this respect were also better in comparison with other research results (Pavlovski et al., 1980; Lukić, 2001). Although breast meatiness and roundness need not always be in correlation, our results have also proven that, apart from selection, the limited movement of broiler chickens is an indispensible prerequisite of a better body conformation. However, this does not mean that the factor of limited movement should be used indiscriminately because other research findings in the present study appear to be against a higher stocking density of broiler chickens in the fattening period.

Conclusion / Zaključak

The best results were achieved by the broiler chickens from the control group that were fattened in conformity with the recommended stocking density of 15 individual broilers per one square metre. The research findings have confirmed that overcrowding in production facilities is always risky in regard to the expected production results. Fully conforming to the production technology requirements is needed for the achievement of the best production results.

Literatura / References

5. Broiler Management Guide Cobb 500


UTJECAJ GUSTOĆE NASELJENOSTI NA TJELESNU KONFORMACIJU KOD PILIĆA U TOVU

Almira Softić, A. Gagić, Aida Kavazović, Ć. Crnkić, V. Katica, V. Šakić

U radu je istraživan utjecaj gustoće naseljenosti na tjelesnu konformaciju trupova kod pilića u tovu. U tov je bilo uključeno ukupno 120 pilića podijeljenih u tri grupe po 40 jedinki. Na kraju prve sedmice tova metodom slučajnog uzorka uzeto je i obilježeno po 20 pilića. Pilići prve pokusne grupe (P1) predstavljali su grupu sa manjom gustoćom naseljenosti (12 pilića/m²), pilići druge pokusne grupe (P2) predstavljali su grupu pilića sa većom gustoćom naseljenosti (18 pilića/m²), dok je naseljenost kontrolne grupe (K) pilića bila u skladu sa tehničkim preporukama (15 pilića/m²). Tokom pokusa kod obilježenih pilića sedmično su prati i mjereni obim grudi, obim batka, dužina koblice (crista sterni), dužina grudi i grudni ugao. Mjere tjelesne konformacije su utvrđene na trupovima u horizontalnom položaju, sa ledima na stolu uz korištenje odgovarajućih instrumenata: milimetarska mjerna traka, šubler, uglomjer ZP-3. Osim toga kod svih pilića sedmično je mjerena tje-
lesna masa kao i utrošak hrane. Randmani su izračunati iz odnosa mase ohlađenog trupa i tjelesne mase prije klanja. Dobiveni rezultati pokazali su da je prenaseljavanje proizvodnih objekata s aspekta očekivanih efekata tova uvijek rizično, te da je uz potpuno poštivanje proizvodne tehnologije moguće ostvariti bolje proizvodne pokazatelje.

Ključne reči: pilici, telesna konformacija, gustoća naseljenosti

ВЛИЯНИЕ ГУСТОТЫ НАСЕЛЕННОСТИ НА КОНФОРМАЦИЮ ТЕЛА У ЦЫПЛЯТ В ОТКОРМЕ

Алмира Софтич, А. Гагич, Аида Кавазович, Ч. Црнкич, В. Катица, В. Шакич

В работе исследовано влияние густоты населённости на конформацию тела туловищей у цыплят в откорме. В откорм было включено совокупно 120 цыплят, разделённых в три группы по 40 отдельных животных. На конец первой недели откорма методом случайного образца взято и обозначено по 20 цыплят. Цыплята первой опытной группы (C1) представляли собой группу с более маленькой густотой населённости (12 цыплят/м²), цыплята второй опытной группы (C2) представляли собой группу цыплят с большей густотой населённости (18 цыплят/м²), пока населённость контрольной группы (K) цыплята была в соответствии с технологическими рекомендациями (15 цыплят/м²). В течение опыта у обозначенных цыплят недельно слежены и мерены объём груди, объём ножки, длина грудной кости (crista sterna), глубина груди и грудной угол. Меры конформации тела утверждены на туловищах в горизонтальном положении, со спиной на столе при использовании соответствующих инструментов: миллиметровая измерительная лента, угломер-циркуль, угломер ЗП-З. Кроме того у всех цыплят недельно мерена масса тела словно и затрата корма. Выходы вычислены из отношения массы охлаждённого туловища и массы тела до убоя. Полученные результаты показали, что перенаселение производственных объектов в аспекте ожидаемых эффектов откорма всегда рисковано, и что при полном уважении производственной технологии возможно осуществить более хорошие производственные показатели.

Ключевые слова: откорм цыплят, населённость, конформация тела