African Journal of Biotechnology Vol. 9 (18), pp. 2584-2594, 3 May, 2010
Available online at http://www.academicjournals.org/AJB
ISSN 1684–5315 © 2010 Academic Journals

Review

Possibilities of more efficient usage of genetic potential of broilers breeders

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Accepted 17 December, 2009

During the last ten years, poultry production in the world and particularly, EU has been specific due to new trends, whereby special attention is focused on regulations and procedures that are adopted by European Union (EU), Food and Agriculture Organization of the United Nations (FAO), International Organization for Standardization (ISO) and the World Trade Organization. Legal regulations in EU (standards, directions) are focused on all species and categories of poultry. Based on this, breeding of broiler (meat-type line strains) and production of hatching eggs and day old chickens (incubation) as well as other issues are the focus of this review. This paper presented results of studies carried out using different technological procedures in the breeding of broiler and production of one day old chickens. These showed a full expression of genetic potential of strains, along with preservation of poultry welfare.

Key words: Broiler breeders, incubation, genetic potential, efficiency of production.

INTRODUCTION

It is well known that the bases of industrial poultry meat production (broiler chickens) involves the breeding of different broiler of meat-type strains. Breeding and exploittation of breeder flock and incubation of hatching eggs are very specific, strictly specialized and involves complex phases in the process of production. It should be noted that the average production of some strains of breeder flock's, the production of hatching eggs and one day old chickens, is a result of combined influence of genetic potential and applied technology during the process of production and incubation. Further more, achieved level of production is explained not just by the genetic potential of flock, but also by the influence of non-genetic factors (breeding technology, duration of exploitation - age of flock, body weight of broiler breeders, sex ratio, weight of eggs and the applied technology of artificial hatching of chicken).

In addition, the reproduction of poultry is a biologically very specific process. In contrast to mammals, birds do not deliver their progeny alive. The new organism develops out of the fertilized egg after it has being laid. Well fertilized egg is the "package" that contains embryo with nutritive substances. These substances are essential for the development of embryo up to moment of hatching and a few days after.

The foundation of successful hatching of poultry offspring ensures appropriate conditions for the development of embryo. These conditions are biologically specific based on the specie of the poultry. However, nutrition and proper breeding of parental stock can affect reproductive process of poultry. Appropriate nutrition and rearing technology of offspring as well as breeding of parental stock, are essential preconditions of maximal hatchability as well as the survival and quality of hatched poultry offspring. With consideration to the above, special attention should be aimed at the standards, regulations and directions of EU.

Therefore, this paper presents results of some researches in this field carried out in the Republic of Serbia. The presentation of the results was done in a systematic and chronological order.

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BROILER BREEDERS PRODUCTIVITY IN THE REPUBLIC OF SERBIA AND IN THE WORLD

In the last few decades in the Republic of Serbia, focus on production of eggs pointed at productivity of breeder flocks and comparative testing of production traits in different meat-type strains of hens while lesser attention was given to the influence of non-genetic factors (egg age, duration of exploitation period, body weight of breeder flock) in the production of high quality hatching eggs and broiler chicken and the correlations in their relationship.

In the last twenty years in the Republic of Serbia, most researches have been on the comparative testing of production and reproduction traits of imported broiler breeders of hens. However, globally, this topic has being intensely researched into as these researchers included a wider range of aspects in their researches, considering influence of different non-genetic factors such as nutrition of broiler breeders, external and internal traits of hatching eggs quality, age of eggs, frequency of egg rotation in hatchery, treatment of hatching eggs before and during the period of incubation, phases of embryonic development of chicken, hatch weight absolute and relative egg weight among others. These were researched into based on the productive and reproductive traits of broiler breeders and in particular on the quality of hatching eggs as well as the efficiency in production of high quality broiler chicken as a final product in the breeding of parental stocks of hens.

Researches in the Republic of Serbia

Some researchers in Serbia studied the production traits and partly, reproduction traits of breeder flocks of meat-type strains. This was because, these were the strains that were mostly breeded for a period of time (Hybro, Arbor Acres, Vedette, Ross, Ross 208, Hubbard, Purel Line, Cobb 500, Ross 308, Hubbard Flex and Hubbard Ultra-Yield) and used for the production of hatching eggs and one day old chickens. Masic and Pavlovski (1988, 1996), Mitrovic et al. (1995, 2009), Masic et al. (1995), Pavlovski et al. (1995), Tolimir et al. (1995, 1996), Supic et al. (1997; 1998), Milosevic et al. (1997, 1998), Radovic et al. (1998), Skoric et al. (2003), Pavlovski and Mitrovic (2004), Savic et al. (2004), Dermanovic et al. (2005; 2008, 2009), Blagojevic et al. (2005), Skoric (2006), Milosevic and Peric (2008) showed the results of these researches.

Data on the production of 15 broiler breeder flocks (10 flocks - Hybro, 3 flocks - Arbor Acres, 1 flock - Vedette and 1 flock - Ross) were obtained from 13 companies in Serbia in 1994 and analyzed by Tolimir et al. (1996). The authors showed that the average laying in all flocks was 54.53%; percentage production of eggs per housed hen was 116.38 while that of one day old chickens was 90.63%. Eggs used for hatching and the hatchability was 78.71%. The average period of flock exploitation production was 32.27 weeks. Among all analyzed flocks, best results were achieved by the Ross strain. In this flock, the age at the end of the exploitation period was 68 weeks, or in other words, this period lasted for 40 weeks. Mortality and culling during the period of breeder flock's exploitation were 34.78 (hens) and 62.03% (roosters). Maximal laying in flock was achieved at the age of 44 weeks (61.25%), while the average intensity of laying was 33.79%. Total production per housed hen was 80.75 eggs and 95.00% of these eggs were used for hatching. Hatchability was 71.17%. Production of one day old chickens was 54.60 per housed hen and the consumption rate of food per produced egg was 503 g.

Same authors concluded that broiler breeder flocks in Serbia, during 1994, were not used in the most rational way. This conclusion was reached based on the potentials in production, particularly considering the survival rate, number of eggs and one day old chickens per housed hen as well as the duration of exploitation period. In addition, the authors believed that in the future, with this type of poultry production, much better results can be achieved as it could lead to improved efficiency and profitability of production in the farms of broiler breeders and the improvement of broiler production in general.

A similar research carried out by Milosevic et al. (1998) focused on the duration of exploitation, mortality, culling of hens, number of eggs, and the number of one day old chickens per housed hen. These researches included 16 Hybro and 17 Arbor Acres, broiler breeders flocks in 25 companies in Serbia, in 1996.

The authors claimed that the hybro broiler breeders were used up to an average age of 55.44 weeks, mortality and culling of hens was 23.36%, the average number of produced eggs per housed hen was 125.46 eggs while 80.59 of one day old chickens was gotten. Due to analyses of data obtained, the authors concluded that these flocks were used in production for a somehow shorter period when compared to the preferred time. They also found out that in all analyzed productivity traits, average results were below technological norms.

Radovic et al. (1998) researched on the results of production of broiler breeders of meat-type strain, housed on a floor in different systems (with or without seats). Duration of exploitation period was between age of 22 and 58 weeks. Broiler breeders housed on floor mat were compared to those housed on floor based on grates (1/3 of surface). These achieved higher production of eggs per housed hen (149.2 - 138.2) as well as maximal laying (83.09%) at an earlier age of 32. weeks. The other flock achieved maximal laying (76.82%) at the age of 35 weeks. The average intensity of laying, was more statistically higher in broiler breeders flock housed on floor mat (67.27%) when compared to those housed on grates based floor (62.15%). Further more, the flock housed on floor mat, achieved significantly lower number

of eggs (85.04%) when compared to those breaded on seats (86.29%). However, production of hatching eggs per housed hen was higher in the first case (126.9) when compared to second (119.1). Mortality of broiler breeders, per housed bird was similar in both flocks and it was 19.63 (mat) and 19.43% (seats). The authors highlighted that it is not possible to have a complete answer as to whether the broiler breeders should be housed on floor mat or on floor with a combination of mat and grates. This question requires further and more detailed researches as well as analysis of the data obtained from a wider, non-scientific and commercial production.

In the analyses of production traits of broiler breeders in the region of central Serbia, within the period of 1981 - 1987, Masic and Pavlovski (1988), found out that the average exploitation period of the flock was 30.69 weeks, average culling of hens was 11.08%, average culling of roosters was 21.35%, maximal laying (75.43%) was achieved at the average age of 33.59 weeks, production per housed hen was 115.16 eggs and 90.34% of these eggs were used for hatching. The average hatchability was 78.01%, number of produced one day old chickens per housed hen was 81.45 and the average consumption of food per egg was 318.87 g. A almost similar results in these flocks were achieved during the period between 1981 and 1990 (Masic and Pavlovski, 1996). However, Masic et al. (1995), published results achieved in one smaller farm of broiler breeders, within 1994 and 1995. Accomplished results were much better when compared to the average in Serbia as well as when compared to the widely established technological parameters.

During the period of 1995 and 1996, Milosevic et al. (1997, 1998), Supic et al. (1997) and Tolimir et al. (1995, 1996) researched on the production traits in flocks of different strains of broiler breeders in Serbia. These strains were Arbor Acres, Hybro, Hubbard, Cobb as well as one flock of Ross 208 that achieved slightly better results when compared to other researched strains. The duration of control was 22 weeks or in other words a period between age 25 and 47 weeks. Mortality and culling of hens was 13.89 and 17.12% considering the roosters. The maximal laying was 72.67% and it was achieved at the age of 41 weeks. The average laying was 64.59%. Produced eggs per housed hen was 106.00 and 77.38% of these eggs were capable for hatching. The average hatchability was 75.24%. The consumption of food per produced egg was 413 g. In general, the authors consider that though there were some improvements when compared to the former period, the flocks of broiler breeders in Serbia, during the 1995 and 1996, were still not used in the most rational way.

According to the latest researches, Milosevic and Peric (2008), found out similar statements, which suggest lower rate of usage of genetic potential, considering the strains breaded in Serbia, during the period between 2003 and 2006. The intention of the authors was to present a review of economically most important productive traits of breeder flocks, based on data obtained from Republic Service of Zootechnics. These traits included beginning of laying, duration of exploitation period, mortality and culling of hens and roosters, total number of eggs and number of eggs for hatching, number of chicken per housed hen and consumption of food per produced egg. Calculated parameters were compared to average values of technological parameters of strains included in the analyses.

According to same authors, in 2006, breeder flocks of broiler strains (Arbor Acres, Hybro, Cobb and Ross) recorded: beginning of laying - 23.6 weeks (technological norm - 23 weeks); duration of production period 30.8 weeks (technological norm - 42 weeks); culling of hens - 10.8% (technological norm - 8%); culling of roosters - 18.5% (technological norm - 8%); produced eggs per housed hen - 123 (technological norm - 180); number of eggs for hatching - 109 (technological norm - 170); feed consummated by hens and roosters calculated per egg - 345 g (technological norm - 270 g); number of emerged chickens per housed hen - 93.6 (technological norm - 145 chickens -mail and female).

An interesting research was carried out by Blagojevic et al. (2005) in which they analyzed the productivity and economical results in the production of hatching eggs by Arbor Acres hens. Main subject of this research was the influence of hen's body weight in the period before egg production (age of 22 weeks) on later production of eggs. Considering the analytic calculations, the authors found out 6.30% higher profit per egg, in the first group of hens (initial body weight of 2.70 kg). In a projection of hatching egg production, based on hen's weight at the beginning of exploitation, turning point in production profitability was discovered in the period of 2.38 months of exploitation.

Distinguishable researches, carried out by Mitrovic et al. (1995) focused on the influence of egg weights on parameters of incubation (rate of fertilization, hatchability and hatch weight relative to egg weight), in one breeder flock of heavy hen's type (Hybro) at the age of 36 weeks. Considering the achieved results, the authors found out that the eggs with average weight of 56.69 and 60.94 g (two weight groups) had the highest rate of fertilization (90.32 and 91.35%) while the eggs with weights between 67 and 70 g, had the lowest rate of fertilization (83.87%). Considering the hatchability, the best results (80.65%) were achieved when the weight of eggs was between 55 and 58 g and even better considering the number of fertilized eggs (89.29%.). The lowest values of incubation parameters were achieved in the cases of the biggest eggs. The weight of these eggs was over 67 g. The highest hatch weight relative to egg weight (66.60%) was achieved when the weight of eggs was between 67 and 70 g and the lowest results (62.99%) were achieved when the weight of eggs was between 55 and 58 g. It is necessary to highlight that the authors found these results in a 36 weeks old flock. Probably it would not be the same in older or younger flock of broiler breeders.

The next few years that followed showed a decline in this type of research due to subjective and objective reasons. In the last ten years of the 20th century, due to the crises in the former Yugoslavia, intensive production of poultry meat and eggs in Serbia were rapidly impaired, due to trade embargo and state of war (Pavlovski and Masic, 1995; Supic et al., 1998; Skoric et al., 2003; Pavlovski and Mitrovic, 2004). The import of reproductive material of poultry strains (master flock and breeder flock) was canceled as well as activities of master flock of layer-type strains in the town of Pozarevac. This center was the main provider for reproductive farms. It was the same in the case of meat-type master flock in the town of Backa Topola. Besides, other challenges were faced with the importation of medications and additives for food. All this problems were bases for the upcoming disruptions in a technological hierarchy.

The end of the former century and the beginning of the new was a period particularly specific due to a somewhat slight improvements in poultry production in Serbia. Once again, breading of old and some new meat-type strains started, with the purpose of meat production and the production of broiler chickens. During the period between 1999 and 2005, no more than 4 or 6 strains of broiler breeders were breaded. However, in 2006, according to data published by "Poultry Producer Association", there were five meat-type strains and these were Hubbard, Ross 308, Cobb 500, Hybro and Purel Line (Skoric, 2006). This could be the reason why researcher, during the last few years, mainly focused on the productive and reproductive traits in a various aspects, associated with the mentioned strains of broiler breeders.

Considering the mentioned frames, it should be mentioned that Savic et al. (2004) researched on the productive traits of broiler breeders of Cobb strain. They found out that after a longer period of time in the Republic of Srpska (Bosnia and Herzegovina) and nearby countries, more frequently used meat-type strain for poultry meat production was Cobb as well as broiler breeders of the Ross strain. Research lasted from the age of 23 weeks to the end of breeder flock exploitation period (9 months). The authors found that the results showed that the mortality and culling of roosters and hens were 28.50 and 10.94%, respectively, total production of eggs per housed hen and hatching eggs were 154.87 and 148.45 respectively, the average intensity of laying was 57.29%; hatchability was 85.80% and lastly, during the entire period of 9 months of exploitation of flock, 128.38 of one day old chickens per housed hen was produced. In general, analyzed flock achieved gratifying results. In other words, expression of genetic potential was accomplished in very high rate.

Dermanovic et al. (2005) also researched on productive traits of the other broiler flock of Arbor Acres strain. The main research was on the influence of age of mentioned strain's breeder flock on productive traits. Period of exploitation of breeder flock lasted for 44 weeks, or in the age between 23 and 66 weeks. During this period, the production of 189.45 eggs per housed hen was achieved, and an intensity of laying at a rate of 61.51%. Maximal laying was achieved at age 34 and 35 weeks and it was over 82%, but during the next period, it slowly decreased. During the end of the exploitation period, at the age of 66 weeks or in the other words during the 44th week of the period of exploitation, laying was less than 50%, or exactly 47.66%. Authors claimed that eggs for incubation were used between the 26 and 66 weeks and the number of produced hatching eggs per housed hen was 174.55. Share of eggs used for incubation from the total number of produced eggs, was 92.14%. Furthermore, hatchability was 77.56% and the production of one day old chicken per housed hen was 135.38. Additionally, authors noticed that hatchability, started to decrease significantly, since the parental flock age of 58 weeks, so that at the age of 65 weeks it was not higher than 47.70 or 39.53% at the age of 66 weeks. The average daily consumption of food per housed bird was 163.56 and 290.63 g per produced egg or 315.43 g considering only hatching eggs. In addition, average daily consumption of food per produced one day old chicken was 406.69 g. At the end, the authors claimed that in general, analyzed breeder flock achieved gratifying results, considering the major monitored parameters. Furthermore, they suggested that these results could have being better if the period of exploitation had lasted few weeks more, that is, 10 months, although it is not in accordance with technological norms for respective strain.

Dermanovic et al. (2008) carried out a similar research on broiler parents of Ross 308 strain. However, in this research, the period of breeder flock exploitation lasted 40 weeks considering all eggs and 38 weeks in case of hatching eggs. With regard to this period, the average production per housed hen was 170.03 of all eggs and 157.70 for hatching eggs. Average ratio of eggs used for hatching in a total number of produced eggs was 92.75%. Achieved intensity of laying and number of produced hatching eggs fitted the technological norms for this strain. However, hatchability was 4.33 chickens lower when compared to technological norms (80.99 - 81.67%). That is, the number of produced hatching eggs per housed hen was 157.70 and the number of produced one day old chickens of both sex was 127.73 in a period that lasted for 38 weeks. The hatchability started to decrease at the age of 59 weeks (36 weeks of exploitation period) so that at the age of 60 and 61 weeks it was 62.38 and 53.22%.

Mitrovic et al. (2009) researched on the productive and reproductive traits of Hubbard Flex strain's broiler breeders. During the period, egg production lasted 37 weeks (between age of 22 and 58 weeks), or 34 weeks (between age of 25 and 58 weeks) in case of eggs used for incubation. Authors claimed that the productivity of analyzed flock was reliable, considering that the period of exploitation did not last as long as it was suggested by

technological norms, so that achieved production per housed hen was 136 of total eggs, 127 of hatching eggs and approximately 99 of emerged one day old chickens. However, the average consumption of food per housed bird (155.63 g), per produced egg (321.82 - 351.50 g) and per hatched bird (493.60 g) was higher compared to technological norms of mentioned strain.

In a wider and more realistic view and according to new researches, Milosevic and Peric (2008), Dermanovic et al. (2008, 2009) and Mitrovic et al. (2009), in general suggested that the genetic potential of strains breaded in Serbia, still did not expressed as much as it could be. The authors believed that despite the hard conditions for production in the farms, all technological processes in poultry production could be significantly improved with better management, higher engaging of labor and increased attention to the entire society as well.

In addition to the above authors, some distinguishable researches were carried out in order to find out the correlations of phenotype, considering relations among some production and reproduction traits (body weight of hens, intensity of laying, dynamics of egg weight loss during the incubation etc.) of various strains of hens. These researches were accomplished by Mitrovic et al. (1987, 1989, 1993, 2005, 2009), Bogosavljevic-Boskovic et al. (1996) and Dermanovic et al. (2008). However, most of the authors included two or three production and reproduction traits, in their researches and they have find out similar as well as contradictory results.

Mitrovic et al. (2005) researched on the correlations of phenotype between age and the production and reproduction traits of hens in breeder flock of meat-type strain. Period of breading in breeder flock of Arbor Acres strain lasted relatively long or exactly 44 weeks (between age of 23 and 66 weeks) and due to this, there were possibilities for the calculation of phenotype correlations between monitored parameters. According to the calculated coefficients of phenotype correlations, the authors found out a positive influence of the age of breeder flock on the intensity of laying through the whole period of flock exploitation. However, calculated coefficients of correlation were statistically approved only up to the age of 59 weeks (37 weeks of production). In addition, the authors found out that the age of breeder flock in the positive phenotype correlated with hatchability, up to the age of 50 weeks (28 weeks of production). Considering the period between the age of 58 weeks and the end of the exploitation period, the negative coefficients of correlations were founded, at the various levels of statistical significance.

Dermanovic et al. (2008) carried out similar researches. In addition to other traits, they researched on the correlations of phenotype between the age of flock and some more important production and reproduction traits of broiler breeders of Ross 308 meat-type strain.

The authors emphasized that due to calculated coefficients of phenotype correlations, it could be claimed that the age of breeder flock do have a positive influence on the intensity of laying up to the age of 56 weeks as well as after and up to the end of exploitation period with a negative influence. In addition, only at the age of 61 weeks was the coefficient of correlation (r_p = - 0.275) concluded as statistically significant, at $P < 0.05$. However, correlations of phenotype were altered considering the relations between the age of breeder flock and the hatchability. The correlation was positive up to the age of 55 weeks but was later negative, till the end of the exploitation period (61st week). Calculated coefficients during the age of 60 and 61 weeks were negative and concluded as statistically significant (60 weeks - r_p = - 0.336* and 61 weeks - r_p = - 0.423**). In addition, obtained results indicated validity of culling of broiler breeders out of the production at the age of 61 weeks, despite the technological norms which required that broiler breeders should be engaged in the production of hatching eggs or the one day old chickens, up to the age of 65 weeks.

Based on calculated correlation coefficients and established level of significance between the age of broiler breeders and the achieved results in production and reproduction, it could be possible to determine the age that limiting economic validity of breeder flock exploited in the production of hatching eggs, as well as considering other important factors. In other words, researches should be expanded in a bid of obtaining a wider range of factors, so that a more concrete evaluation of exploitation period of various broiler breeders could be determined and the economic validity of respective type of production (hatching eggs - one day old broiler chickens) as well.

Other researches worldwide

The age of the broiler breeders at the beginning of laying is one of the most important factors that had a direct influence on the success of production of hatching eggs and one day old broiler chickens. In addition, it is well known that the intensity of laying of fertilized eggs and hatchability, increased with the age of the flock, till it reached the maximum and then started decreasing. The moment at which it reached maximum is determined by the genotype of the actual strain and by various non-genetic parameters. Among the mentioned non-genetic parameters, the most suitable for exploiting the technology of breeder flock, adequate for storing mode and time for incubation of eggs and appliance of optimal technological procedures during the artificial hatching of poultry progeny as well should be applied.

Elibol and Brake (2003, 2004), Tona et al. (2004) and Abiola et al. (2008), found out that in their researches, the hatchability of fertilized eggs depended on various factors which included the age of flock, duration of period of storing and the frequency of egg turning during the incubation period.

The authors believed that higher frequency of egg's turning in hatchery, more than a 24 times per day, led to decreased embryonic mortality as well as increased hatchability of broiler chickens (Hybrid Ross 308). In addition, as a results of two researches, carried out by Elibol and Brake (2003, 2004), conclusions were drawn about higher hatchability of broiler breeders (hatching eggs) at the age of 37 and 41 weeks, when compared to older flock (59 and 63 weeks), as well as a data about a higher value of broiler breeders eggs in incubation during the age of 29 weeks, when compared to breeders at the age of 68 weeks. Tona et al. (2004) researched on the influence of Cobb strain broiler breeders (35 and 45 weeks) and the age of hatching eggs (fresh and 7 days) on hatchability. Eggs that were 7 days old, produced by the 35 weeks old flock, tends to have a higher hatchability of 4% (88.36 - 84.65%), when compared to eggs of 45 weeks old broilers breeders. In both age groups of broiler breeders, there was a significantly lower hatchability of fresh incubated eggs.

Decuypere et al. (2001) and Fasenko et al. (2001) claimed that the hatchability is under the significant influence of age of eggs and duration of storage as well as the genotype of broiler breeders. The above mentioned authors researched on the influence of age (storing period) on the hatchability of fertilized eggs. The eggs obtained from broiler breeders of Ross and Cobb strains, were incubated at the age of 3, 8 13 and 18 days. The highest hatchability, considering both strains, was accomplished when the eggs were 3 days old. The worst hatchability was accomplished when the eggs were stored during the 18 days period. When the eggs were incubated at the 8th day, hatchability was 97.14% (Ross) and 95.38% (Cobb). In all four cases of eggs age, there was a slightly higher hatchability of Ross strain broiler breeders hatching, compared to Cobb strain. Fasenko et al. (2001) found out that storing eggs for a period that lasted up to 4 days, when compared to a period of 14 days, led to higher hatchability of incubated eggs as well as of fertilized eggs of meat-type hens. Petek and Dikmen (2006), found out that in the case of meat-type hens at the age of 37 weeks and after the 5 days lasted period of egg storage, there was satisfactorily high hatchability of incubated (88.66%) and fertilized eggs (97.78%). There was a substantially lower value of eggs for incubation when eggs were 15 days old. Schmidt et al. (2009) carried out similar researches. They incubated eggs that were 2, 4, 6, 8, 10, 12 and 24 days old. The highest rate of hatching was achieved when the eggs were 4 days old (94.30%), while the lowest rate was accomplished when the eggs were 24 days old (74.13%).

In addition to the mentioned authors, there were others that found out that the hatchability is under the influence of flock age. Cooper and Rowell (1958), McDaniel et al. (1981), Eslick and McDaniel (1992), Elibol et al. (2002), concluded that the younger broiler breeders flock, compared to the older, achieved significantly higher hatchability of fertilized eggs. In cases where broiler breeders were 31, 37 and 41 weeks old, the hatchability of fertilized eggs were 89.30, 91.08 and 90.32%, but in cases where the flocks were 52, 59 and 63 weeks old, hatchability was approximately 5% decreased and it was 84.30, 86.77 and 86.31%.

Similar to annotated trials, Joseph and Moran (2005), researched on two younger flocks (32 and 41 weeks) of Ross 308 strain and they found out the same fertilization of eggs at a rate of 98%. The hatchability of incubated eggs was 82 (age of 32 weeks) and 83% (age of 41 weeks).

A somewhat better value of eggs for incubation was established in researching on Peterson strain, carried out by Reis et al. (1995). Mentioned authors researched on the fertilization and hatchability of eggs produced by broiler breeders at the age of 46, 56 and 64 weeks. They found out the following on fertilization and hatchability, respectively: 97.17 and 87.08% (46 weeks), 96.92 and 79.43% (56 weeks) and 94.16 and 76.56% (64 weeks). Yildirim and Yetisir (2004) researched on the broiler breeders of Ross 308 strain during the 52 weeks of the entire period of exploitation. They found out that the hatchability of incubated eggs was 80.70%.

Broiler breeders of different genotypes started laying of eggs at the age between 22 and 24 weeks and optimal average body weight was achieved. The body weight and age of hens when they started laying of eggs were mostly determined by the nutrition and system of lightning (photoperiod and intensity of light), during the period of broiler breeders rearing.

Usturoi et al. (2007) applied two different systems of lightning during the rearing as well as the exploitation of broiler breeders of Ross 308 strain. In the first group of broiler breeders, up to the age of 20 weeks, the light was turned on for 8 h per day, during the 20^{th} week it was turned on for 11 h, during the 21^{st} week it was 12 h and during the 27^{th} week and after then, the light was turned on for 15 h per day. Up to the 20^{th} week, intensity of light was 50 lux/m^2 of floor surface. In the second group, similar systems of lightning was applied but the program of photoperiod was moved to one week earlier and the intensity of light up to 21^{st} week was 60 lux/m^2 of floor surface.

The above mentioned authors found out that the average body weight of hens was 2189.98 (first group) and 2190.17 g (second group) at the age of 20 weeks while it was 3988.95 (first group) and 3990.44 g (second group) at the age of 60 weeks. Mortality and culling in the first group, during the period between age of 20 and 60 weeks were 9.09 and 9.36% in the second group. Production of eggs per housed hen, during the period between age of 26 and 60 weeks, was 174.59 (first group) and 178.82 (second group). In general, the authors suggested that usage of second systems of lightning is more suitable for rearing and exploitation of broiler breeders of Ross 308 strain, mainly because there

was production of more 4.23 eggs when compared to the first group. However, in the first group, the coefficient of variability for body weight was slightly decreased, or in other words, the flock was more uniform at measurement. Intervals between successive measuring lasted for two weeks. For example, at the age of 60 weeks (the end of the exploitation period), coefficient of variability was 10.29 (first group) and 11.90% (second group). Due to the application of different systems of lightning, the average consumption of food was between 150.35 and 149.75 g daily per hen as well as it was 281.49 and 271.26 g, calculated per produced egg.

Similar research on broiler breeders of Cobb 500 strain was carried out by the Ciacciariello and Gous (2005), Lewis et al. (2005) and Lewis and Gous (2006). Their intention was to achieve earlier production of eggs and the suitable (optimal) body weight of hens by usage of photo stimulation. The hens that started to lay eggs earlier (at the age of 20 weeks) when compared to those that started to lay eggs later, showed higher production of eggs per housed hen, during the period of breading that lasted for 60 weeks, particularly in the first phase of exploitation. However, the weight of eggs and that of the chickens decreased in the group of hens that started laying eggs earlier. Depending on the applied photo stimulation, production of eggs in experimental groups was between 146 and 160, up to the age of 60 weeks and the weight of eggs was between 65.00 and 65.40 g in the last week of exploitation period. The average body weight of hens was between 4.21 and 4.25 kg. Mortality of hens during the period between age of 23 and 60 weeks was between 8.30 and 8.70%. The consumption of food calculated per produced egg was approximately 358 g in both experimental groups.

Lewis and Gous (2007) found out that at the 59th week, the average body weight of hens was 4.34 (Ross 308) and 4.56 kg (Cobb 500) and the total mortality of hens, up to the age of 60 weeks, was 12.00 (Ross 308) and 11.30% (Cobb 500). During the mentioned period of breading, the average weights of eggs was 67.15 (Ross) and 66.20 g (Cobb) and the average consumption of food per produced egg was 369.50 and 398.00 g.

It is a well known fact that the weight of eggs as well as the weight of hatched chickens were increased due to age of breeder flock of hens, so that in most cases, the maximal values were achieved at the end of the exploitation period (Weatherup and Foster, 1980; Wilson, 1991; Novo et al., 1997; Adams and Bell, 1998; Vieira and Moran, 1998, 1999; Maiorka et al., 2004; Luquetti et al., 2004; Vieira et al., 2005; Hamidu et al., 2007; Schmidt et al., 2009).

Novo et al. (1997) researched on the influence of age as well as the influence of additional calcium on the production and reproduction traits or more precisely on weight of eggs and their value for incubation, during the flock age of 46 and 65 weeks in Cobb 500 strain hens. The authors found out that during the age of 46 weeks, there was a slightly higher weight of eggs (64.96 g) when calcium was not added to the diet of hens (first group), compared to eggs produced by the hens that were received additional calcium (second group - 64.83 g). Moreover, the authors suggested that the capability of eggs for hatching in the first group was 91.98 and 92.51% in the second group. Likewise mentioned, in the flock age of 65 weeks, the average weight of eggs was 67.34 (first group) and 68.46 g (second group). Capability for incubation was 72.11 (first group) and 80.30% (second group).

Wilson (1991) emphasize that the weight of eggs and the weight of chickens, were under the influence of the age of broiler breeders. He also found out that at the flock age of 29 weeks, the average weight of eggs was 54.50 g while the average weight of chickens was 34.75 g. These values were 65.50 and 40.50 g at the age of 58 weeks.

Vieira and Moran (1999) carried out some similar trials. They researched on the influence of age of broiler breeders as well as the influence of weight of eggs, on the weight of hatched chicken. Smaller eggs (57.10 g) were produced in the younger flock, at the age of 27 weeks, but the older flock produced bigger eggs (65.30 g), at the age of 56 weeks. Bigger chickens were hatched from the smaller eggs and their average body weight was 39.60 g, while their average hatch weight relative to egg weight was 69.35%. The average weight of chickens hatched from the bigger eggs was 44.50 g, even as their average hatch weight relative to egg was 68.15%. Aforementioned results were similar to those obtained from research carried out by same author (1998), but in this research, trial was carried out on the broiler breeders of Ross 208 strain.

Vieira and Moran (1998) extended their researches. Along the influence of age of broiler breeders on weight of eggs and one day old chickens, they researched on the influence of the mentioned parameters on fattening of broiler chickens up to the age of 49 days. There were four age groups of broiler breeders in this trial, at the age of 36, 40, 42 and 45 weeks. The biggest average final body weight (2890 g) was achieved by the broiler chicken that originated from the 42 weeks old breeder flock, or from the eggs that were averagely weight 61.80 g and from the one day old chickens that were averagely weight 42.00 g. Influence of flock age on weight of eggs, weight of hatched chickens and on average daily gain as well as on final body weight of broiler chicken, were determined by Sengor et al. (2008). During the fattening up to the age of 42 days, the biggest final body weight achieved was from the broiler chickens of Ross 308 strain that originated from the 32 weeks old breeder flock (2159 g). Broiler chickens that originated from the older flocks (45 and 46 weeks) achieved lower body weights at the end of the fattening (2139 and 2131 g).

Somewhat redundant researches in this field were carried out by Luquetti et al. (2004). Among other topics, the authors researched on the influence of flock age (30,

45 and 60 weeks) on weight of eggs, weight of hatched chickens and hatch weight relative to egg weight. Considering the weight of eggs achieved by the meat-type Cobb 500 strain, the authors found out that the differences between flocks at the age of 30 and 45 weeks and the differences between flocks at the age of 30 and 60 weeks were more significant when compared to the differences between flocks at the age of 45 and 60 weeks. Same results were obtained considering the weight of chickens and hatch weight relative to egg weight.

There were some similar researches of broiler breeders of different strains such as the Ross 308 in the researches carried out by Vieira et al. (2005) or the Cobb 500 in trials performed by Almeida et al. (2006). In the flocks of Ross 308 strain, at the age of 27 weeks, the average weight of eggs was 54.00 g, the weight of chicken was 40.30 g while the hatch weight relative to egg weight was 74.63%. When the broiler breeders were at the age of 40 weeks, the average weight of eggs was 58.00 and 69.00 g in the case of 59 weeks old flock. The weight of the chicken in these cases were 41.00 and 51.00 g. Compared to the flock at the age of 27 weeks, hatch weight relative to egg weight decreased in a mode that resulted in a value of 73.91% at the flock age of 40 weeks as well as 70.69% at the age of 59 weeks. In addition, the authors emphasize that the hatch weight relative to egg weight was lowest during the highest flock production and the hatchability of incubated eggs was highest during the age of 27 weeks (88.30%) but lowest during the age of 59 weeks (73.50%). In the research of broiler breeders of Cobb 500 strain, at the age of 32 weeks, the average weight of eggs was 62.76 g and the average weight of chicken was 42.21 g. These values were 67.05 and 44.84 g in the flock at the age of 43 weeks. The highest weight of eggs and chickens were achieved at the flock age of 60 weeks (71.38 and 46.81 g). Hatch weight relative to egg weight was lowest at the flock age of 32 weeks (67.26%) but was highest at the flock age of 60 weeks (65.58%).

In researches of different broiler breeders at the different ages, obtained data on the hatch weight relative to egg weight studied by Wolanski et al. (2007) was between the values obtained by Vieira et al. (2005) and Almeida et al. (2006). Eggs laid during the age of 46 weeks, achieved the average weight of 63.60 and 63.80 g at the age of 57 weeks. However, the weight of chickens was not under the influence of flock age and it was 44.30 g. Hatch weight relative to egg weight was 69.70% at the flock age of 46 weeks and 69.40% at the flock age of 57 weeks.

The influence of flock age on increasing weight of eggs and hatched chicken was also determined in researches of broiler breeders of Cobb 500 strain carried out by Enting et al. (2007). The lowest weight of eggs and chickens were achieved at the flock age of 29 weeks and the best results of these parameters were achieved at the age of 60 weeks. However, hatch weight relative to egg decreased due to the aging of flock. Thus based on this mode, it was 64.39% at the age of 29 weeks, 63.67% at the age of 41 weeks and 62.34% at the age of 60 weeks.

Barnett et al. (2004) researched on the meat-type of hens at the age between 48 and 56 weeks and they found out that the average weight of hatching eggs was 64.04 g, the average weight of hatched and dried chicken was 44.97 g. and the hatch weight relative to egg was 69.90%.

Likewise in the aforementioned researches, trials carried out by Hesna Sahin et al. (2009) after the incubation of eggs of different weights (57.95, 62.76 and 67.15 g), different weights of chicken were achieved (38.00, 41.20 and 43.79 g). The highest hatch weight relative to egg (65.65%) as well as the lowest egg weight loss during the period of incubation was achieved when the eggs of intermediate weight were incubated. The differences between weight groups of eggs as well as differences between the weights of hatched and dried one day old broiler chickens were significant ($P < 0.01$ and $P < 0.001$). Similar results were obtained in researches carried out by Asusquo and Okon (1993) and Smith (2000), although they did not find any statistically significant differences among the mentioned parameters. During the second part of exploitation period of broiler breeders, Schmidt et al. (2009) found out that the average weight of eggs was 66.90 g while the average weight of chicken was 47.04 g. At the end of the incubation period (21 days), hatch weight relative to egg was 70.85%.

Share of yolk, albumen and eggshell in total weight of egg as well as the specific gravity of egg, were under the influence of various factors and among them significant role was assigned to the age of flock (Fletcher et al., 1981; Akbar et al., 1983; Butcher et al., 1991; Danilov, 2000). Results of researches suggested that due to aging of broiler breeders, specific gravity of egg and share of eggshell, total weight of egg decreased due to a faster increase in egg size, compared to the increase in eggshell weight (Butcher et al., 1991) as well as due to a slower storing of calcium in eggshell when compared to increased of egg volume (Curtis et al., 1985).

It is necessary to highlight that the bases of industrial mode of poultry breading and production are not the pure breeds, but the strains, obtained as a result of crossbreeding of different lines through several generations. However, this fact do not lead to decreased importance of breeds, as they represent a base for certain pure (eventually synthetic) lines, important and suitable as a crossbreeding material for creating of strains of different species and types of poultry. Therefore, it is reasonable to mention results of scientific activities carried out by Witt and Schwalbach (2004), wherein they researched on some production and reproduction traits of pure breeds, used in a certain frequency during the process of creation of master and breeder flocks of different types of poultry.

These researches included two pure breeds: New Hampshire and Rhode Island. New Hampshire achieved the average weight of eggs of 53.50 g, but considering the Rhode Island the value of this parameter was slightly lower and it was 52.85 g. Unlike the weight of eggs, New Hampshire achieved lower hatchability (78.88%) when compared to Rhode Island (87.05%).

Results of all aforementioned researches suggested that there were some phenotype correlations among the traits such as age of the breeder flock of hens, poultry species (Turkey), intensity of laying, weight of hatching eggs and weight of emerged offspring.

Considering this field of research, it is important to highlight results published by Suarez et al. (1997), about the full and complete correlation between the age of broiler breeders of Arbor Acres strain and the weight of hatching eggs, during the age between 29 and 57 weeks. In this research, they found out a middling correlation of phenotype, between the age of broiler breeders and the weight of chickens (r_p = 0.489). Established coefficient of correlation was statistically very significant at $P < 0.001$.

Results of detailed analyses of productive traits, of one strain line of turkey (Strain 2200) were published by Algasem (1989). This research was particularly focused on influence of parental stock age on the traits of incubation, fattening and turkey meat after slaughter. Considering data obtained in the research, the authors suggested that the intensity of laying, fertilization and hatchability of eggs, were under the significant influence of the layer age.

Perenyi and Suto (1980) researched on one English meat-type strain of turkey (British United Turkey - B.U.T.) and they found out that there is a very strong correlation (r_p = 0.82) between the initial weight of eggs and the weight of hatched and dried one day old poults.

In addition to the mentioned authors, there were more researches of production and reproduction traits of turkey, carried out by Christensen and McCorkle (1982), Meir et al. (1984), Moran and Reinhart (1979), Ranh et al. (1981), Tullett (1981), Reinhart and Moran (1979).

In the researches of the mentioned authors on the fertilization of eggs (78 - 88%) and the hatchability of incubated (57 - 82%) as well as fertilized eggs (62 - 92%), there was a very high variability of obtained results. It was the same in the case of hatch weight relative to egg weight (62 - 64%) and the egg weight loss up to the 25th day of incubation (10.00 - 14.00%). It is quite intelligible because the result of egg incubation of various poultry species is under the influence of numerous of genetic as well as non-genetic factors.

Based on the review of literature, it can be noted that numerous authors in their scientific activities, more or less, researched on the influence of genetic as well as non-genetic factors, on the intensity of laying of hatching eggs during the period of exploitation and particularly on the fertilization and hatchability of eggs for incubation as well as the conditions of incubation during the period of embryonic development. It is quite intelligible, because success in the production of poultry offspring is under the direct influence of the mentioned factors. Most authors published results about the researches of the influence of some factors on fertilization, hatchability, dynamics of egg weight loss as well as dependence between weight of eggs and growth of embryo during the period of incubation of different strains of hens and turkey. The factors considered were the age and weight of layers, season, conditions of incubation, egg weight, permeability of eggshell, weight of chickens and poults and the interactions between these factors.

CONCLUSION

Some of Serbian authors researched on the production and partly reproduction traits of breeder flocks of meat-type strains of hens (Hybro, Arbor Acres, Ross, Avian, Hubbard, Prelux Bro, Lohmann, Jata, Cobb etc.), mostly breaded for production of hatching eggs and for production of one day old broiler chickens during some periods. Most of the authors suggested that exploited breeder flocks of mentioned strains were not used in a way as rationally as it is possible, considering their genetic potentials for production as well as considering the length of the exploitation period. Essentially, during the last decades, the production of hatching eggs was specific due to focus on the productivity of breeder flocks (parallel testing of production traits of different meat-type strains of hens), and the minor attention on the influence of some non-genetic factors such as the age and weight of breeder flock as well as the influence of applied technology, in all phases of breeding, on the production of high quality hatching eggs and broiler chickens and the interactions between them.

In contrast to Serbian researches, by reviewing international papers, it can be noticed that there were numerous researchers engaged that included non-genetic and genetic factors. These factors do have direct or indirect effect on success of production of high quality one day old broiler chickens. Particularly, important attention is pointed at the flock age, nutrition of broiler breeders, exterior and interior traits of hatching eggs quality (weight and specific gravity of eggs, eggshell thickness and stoutness as well as the absolute and relative share of eggshell, yolk and albumen among others), egg age, frequency of turning of eggs in hatchery, treatment of hatching eggs during the incubation period as well as during the period before the incubation and during the phases of embryonic development of chicken, hatch weight absolute and relative egg weight.

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