Vol. 23(3), pp.95-101, March 2024
DOI: 10.5897/AJB2023.17640
Article Number: 7A6031071967
ISSN: 1684-5315

http://www.academicjournals.org/AJB

ACADEMIC JOURNALS
expand your knowledge

African Journal of Biotechnology

Full Length Research Paper

Systematic studies on tetra SL hybrid hen technology and rearing for chicken welfare

Milena Milojević[1]*, Aleksandra Milošević[2], Goran Stanišić[1], Suzana Knežević[1] and Maja Došenović Marinković[1]

[1]Unit for Agricutural and Business Studies and Tourism, Academy of Applied Studies Šabac, No. 56 Vojvode Putnika Street, 15000 Šabac, Serbia.
[2]Faculty of Law, University of Belgrade, No. 87 Bulevar kralja Aleksandra Street, 11000 Belgrade, Serbia.

Received 16 December, 2023; Accepted 9 February, 2024

In Serbia, there are 4 to 6 genotypes of hens used for producing eggs for consumption, including hybrid Tetra SL. The proper rearing of commercial flocks is critical for timely laying, intensity of laying capacity, number of laid eggs, and period of hen usage. The aim of this paper is to analyze the results of rearing the offspring of hybrid Tetra SL, from one-day-old chickens to eighteen-week-olds, with a review of the conditions to which domestic producers must adjust in order to meet the European Union standards for laying hens breeding systems. At the beginning of rearing period, 9500 heads were put into two objects, totaling 19000 one-day-old chickens. A completely identical rearing technology was applied in these two identical objects. The chickens were of the same age and line hybrid, and the same manufacturer's equipment was used, resulting in equal costs. The chickens were debeaked on the first and tenth day, respectively. The comparative method was used. The breeder adhered to the technological norms recommended by the hybrid selectioner. A special attention was paid to increasing chicken body mass and vitality from the beginning until the end of rearing (18th week).

Key words: Poultry, hybrid Tetra SL, offspring rearing, mortality, 18th week chicken, EU standards.

INTRODUCTION

Rearing poultry, from brooding eggs to final products (meat and eggs for consumption), used to be one single process even in different rearing systems (Živković et al., 1991), while today each stage of this type of production is done separately and as such, is a main industry, that is, a direction in production. In this way, today we have defined norms for the requirements for housing, appropriate feed, micro-climate (ambient) conditions, and health protection (Miljković, 2006). The goal is to achieve as large production and as good product quality as possible, taking into consideration that these are high quality products for human nutrition, but with gradual decrease and complete abolishment of keeping animals in cages (ECI, 2020).

Serbian poultry producers keep laying hens in cages which are very remote from European standards and

*Corresponding author. E-mail: milojevic.milena23@gmail.com.

animal well-being. All the so-called 'commercial' hybrids ensure exceptionally high production (Mitrović, 1996; Bogosavljević-Bošković and Mitrović, 2005; Milošević and Perić, 2011). They are primarily reared in closed premises and fed with ready-made, complete forage mixtures exclusively. EU laws are quite different from domestic legislation when it comes to the housing of laying hens. In 2010, the Rulebook on requirements for animal well-being was passed in Serbia, dealing with space for animals, rooms, and equipment in the objects in which animals are kept, bred and put into circulation for production purposes, way of keeping, breeding and circulation of certain animal species and categories, and the content and way of keeping register on animals ("Sl. glasnik RS" br. 6/2010 i 57/2014). Serbia provided a year and a half period to the producers to adjust to new regulations. Since they have not adjusted, the issue was postponed until December 2020, which is the deadline the producers were not ready to meet once again. In order for all poultry farms to adjust to new requirements, it takes between 50 and 60 million euros investment per year, according to the estimates of Serbian Chamber of Commerce, so the new deadline is 2023.

A selectioner in their leaflets gives performances related to production properties and quality of each hybrid, with certain waranties. In order for the offspring rearing to be successful, certain fixed requirements must be met. Health status, premises temperature, work organisation are just a few of the factors that have a capacity to change genetic potential. Tetra SL hybrid is very adaptable concerning harmonization of egg size and colour, and it should be noted here that maximum performances are, however, only possible in controlled environmental conditions.

Tetra SL is the most popular brown egg layer, which has outstanding resistance against climatic and management conditions, the highest livability on the market and an excellent egg quality. These properties make her a market leader in many European countries. Concerning feed conversion rate, she is competitive with any other brown egg layers on the market (https://www.winmixsoft.com/en/blog/item/tetra).

In our country, this hen hybrid (Tetra SL) is not reared in significant numbers (though the numbers have been rising in recent years), unlike hybrids Isa Brown or Lohmann Brown, which are also light hybrids for the production of eggs of coloured shell. Accordingly, Škorić (2006) and Mitrović et al. (2015) point out that in our country, 4 to 6 different genotypes are reared for the production of eggs for consumption and rearing system has a great influence on them.

It is completely clear that the following things are dependant on the success in this very production stage and proper rearing: timely laying, laying capacity intensity, number of laid eggs, and the period of laying hen, that is, commercial flock and usage (Pavlovski, 2006; Khatibi et al., 2021).

It is for these very reasons that this hybrid was taken for the analysis and monitoring of achieved results in appropriate conditions on the agricultural property of Mr Miodrag Stojanovic in the village of Kosančić.

The aim of this paper is to look at only one producition stage, that is, the analysis of the technology and results of Tetra SL hybrid hen offspring rearing, from one-day-old chicks to eighteen-week-olds.

MATERIALS AND METHODS

On the agricultural property of Mr Miodrag Stojanovic in the village of Kosančić, the offspring of laying hens of light line hybrid Tetra SL was reared from the first day of life until the 18th week. The offspring rearing was conducted in the first half of 2019.

At the beginning of rearing, 9500 one-day-old chickens were moved into two objects, which is a total of 19000 heads. The two objects were identical and a completely identical rearing technology was applied in both of them. The inputs were the same, that is, the chickens were of the same age and same line hybrid and the equipment produced by the same manufacturer was used. Consequently, the cost levels were equal.

One-day-old chickens of light line hybrid Tetra SL were moved into previously prepared objects suitably furnished for this type of production. Appropriately allocated objects, according to the EU standards, have 0.85 m^2 of space for each laying hen, 0.6 m^2 of useful space with a nest with protective curtain where they can freely lay eggs, beds should be made of artificial grass and sand so that they can peck, blunt their beaks, spread wings, so that the most natural conditions for animals well-being are met (Council Directive, 1999/74/EZ; Council Directive 1998/58/EZ). Different minimal standards apply for non-member states (Directive 1988/166/EZ). During the period of rearing, the technology of rearing, feeding, and health protection (immunoprophylaxis) recommended by the selectioner (www.babolnatetra.com) of the hen hybrid was used. The offspring was reared on the floor with deep mat. The population density during offspring rearing was on a suitable level (approximately 12 heads/m^2 of floor surface), which depended on head age, that is, rearing stage. It must be noted that chicken were accommodated in one quarter of the object until the end of third week. From the fourth week onward, the offspring was reared on the whole production surface of the object.

Throughout the rearing process, the offspring was fed at their own will (*ad libitum*). Three full forage mixtures were used, with various participation of individual nutrients and various chemical composition.

In some periods of rearing laying hens, individual control measurings of body mass were conducted. During each measurinig, a minimum of 2% of the total number of heads in the object were measured, selected by the random sample method. The mentioned control measurings were conducted early in the morning before the feed was distributed.

In addition to the body mass, the mortality and removals from production were also monitored during rearing. The deaths of offspring were registered daily and then calculated per week and shown in absolute and relative values.

In each control measuring of heads and for the whole period of offspring rearing, the common variation and statistical indicators were calculated: arithmetic mean – average ($\bar{x}$), arithmetic mean error ($S_{\bar{x}}$), standard deviation (S) and coefficient of variation (CV).

The technology of rearing hen offspring

Rearing poultry hybrids sets the ground for industrial poultry keeping and production. The process of obtaining good quality commercial hybrid is a long and complex one, which is why it inherently requires high expertise. Commercial poultry flocks are specially created for egg production, and heterosis effect is fully expressed in hybrids. Hybrids for egg production compared to pure poultry breeds have stronger average laying capacity, larger egg mass, better feed usage and calmer temperament. When appropriately reared, that is, when basic technological procedures are adequately applied, laying hens of commercial flock lay eggs at the end of 19th and beginning of 20th week already. Since heritability coefficient for the majority of reproductive and production properties in poultry is pretty low (around 30%), production capabilites are more dependant on rearing conditions, nutrition and health protection during production process, especially in the early period. The application of appropriate technology and compliance with it have a direct impact on the commercial effect.

For the production of eggs for consumption in our country, exclusively foreign hybrids are used (there are no domestic ones). All the hybrids are of various origin and name (commercial name), and Isabrown, Tetra SL, Hisex Brown, Harco, Shever, Hisex White, Pure Line and others (Mitrović, 1996; Bogosavljević-Bošković and Mitrović, 2005; Milošević and Perić, 2011) are reared most frequently and in largest numbers.

In light line hybrids, the period of rearing lasts 18 weeks. On the farming household in the village of Kosančić, the rearing of offspring until the 18th week is done in two completely identical objects. During rearing, the following conditions were provided:

(1) appropriate housing conditions - objects;
(2) optimal micro-climatic conditions in the object;
(3) adequate nourishment and hydration;
(4) appropriate health protection;
(5) regular organization of the production cycle.

In order to breed poultry successfully, it is necessary to provide a proper housing for it in the first place (Milošević, 2006; England and Ruhnke, 2020).

A good hennery (object) should:

(1) Protect the poultry against cold, too much heat, moisture and various pests or predators;
(2) Enable an easy maintenance of hygiene, it should be dry, lighted and ventilated;
(3) Enable a proper equipment positioning and rational space usage.

This technology is supported by research done by Milisits et al. (2021).

The spread of both alternative and non-cage laying hen housing systems and the more forceful European refusal of beak trimming generate new problems in commercial egg production. The hybrid layers, which have been genetically selected under cage housing conditions for more decades, have lively temperament, are more susceptible for feather pecking and, in more cases, they are expressly aggressive, which led to permanent conflict situations in the large group keeping systems. Therefore, the omission of beak trimming could lead to an increased risk for feather pecking and consequently to a risk for increased mortality in the hen house by using the current commercial layers. Therefore, changes in the live weight, plumage and body condition, egg production, and mortality of different Tetra pure line non-beak-trimmed laying hens were compared during the egg-production period in the current study, where the plumage condition was considered as an indicator trait for feather pecking.

When Serbia joins the European Union, new problems of keeping and breeding laying hens will appear. The transitional shock could significantly impact the economy of production, so if Serbian poultry keepers do not harmonize their cages with the EU standards, it is questionable whether they will be able to work in this industry in the future. As a consequence of change, it can be expected that farm capacity will drop (Babić et al., 2015). Joining the EU brings the implementation of all its standards for Serbia, which includes regulations that regulate the keeping of laying hens. It is important to point out that within the EU member states, there are a divergence and different approaches to the problem of cage keeping of laying hens (Rodić et al., 2023).

European consumers have adopted a progressive and proactive approach in order to ensure animal well-being and food safety. Regional instructions and the political standards which indisputably affect the public opinion can determine which way of keeping is acceptable and will ensure the desired well-being and production results that meet the arranged requirements (Matković et al., 2007).

RESULTS AND DISCUSSION

Each poultry production stage is characterized by its own specificities. In this manner, the production of eggs for consumption is a very complex production process which can be divided into two stages: rearing the offspring of laying hens and using the commercial flock. Bearing in mind that the breeding of commercial flock is the final stage in the production of eggs for consumption, all the producers (breeders) of these flocks must pay a special attention to the period of offspring rearing. Special attention should be paid to offspring debeaking. Debeaking one-day-old chickens using infrared rays (in object I) and ten-day-old chickens (in object II) caused the difference in mortality, that is, of egg mortality, and it is known that flock welfare is judged according to mortality. Debeaking is performed by professional staff at the age of 1 to 10 days (Hester and Shea-Moore, 2003), which was done in this case too, only at different age. It is common to debeak one quarter or one third of beak, leaving approximately 2 mm to the nostrils (Sandilands and Savory, 2002; Singh, 2021). Debeaking is only a partial removal of beak tip and it is a routine method that can be repeated between the 8 and 12th week. It is typically performed using infrared technology (infrared beak trimming) or thermal cauteries (hot blades). Infrared light is used to damage the beak so that the tip falls off (https://poultry.extension.org/articles/poultry-behavior/beak-trimming-of-poultry/). This method directs a strong source of heat into the inner tissues of the beak and within a week or two the tips of the upper and lower beak die and fall off, leaving the bird with a shorter beak and blunt tip. While infra-red beak trimming (IRBT) of day-old chicks was recognised by the Farm Animal Welfare Committee as not causing any pain to birds, successive governments have always indicated they were keen to introduce a ban (https://www.poultryworld.net/poultry/

beak-trimming -the-way-ahead-for-the-uk/).

In addition to preventing feather pecking and canibalism, another reason for applyling debeaking is a reduced food scattering, reduced food intake and poor growth. However, chickens and later hens, must adjust to the new beak shape. The ability to consume food is reduced after debeaking, so authors think that it is necessary to do it as soon as possible in our context (before the 1st day) for the purposes of faster adjustment.

Recently, in 2017, a company Roxell (https://www.roxell.com) in Hanover used ethology and data about the ways poultry feeds to design special feeders using which poultry performs the debeaking themselves. This is when for the first time a high quality and permanent solution for new trends and regulations on poultry welfare was presented, with the concept of Natural Beak Smoothing which has been used in some welfare states but very rarely in Serbia due to economical reasons.

It is exactly this period that is the most important and most sensitive stage of such a complex production process (cycle) because in this period, to put it roughly, a good quality laying hen is formed through proper rearing of offspring. For all the these reasons, a special attention should be paid to the proper growth (development) of heads, ambiental conditions, nutrition, health protection and body mass control, all this to the aim of producing a larger number (lower percent of mortality and removals) of healthy and vital commercial laying hens.

Offspring mortality during rearing

In addition to body mass (growth), mortality and removals were also monitored during the rearing of offspring of the laying hens which produce eggs for consumption. The data are shown in Table 1 in absolute and relative values per week, that is, for the total period of rearing.

The data in Table 1 show that in both objects the same number of one-day-old chickens was put, 9500 heads per object. At the end of the rearing period, there were 9311 pullets in object I (mortality 1.99%) and 9221 laying hens in object II (mortality 2.94%). On top of that, 279 heads died and were removed in object II, which means the mortality was 0.95% higher compared to object I in which 189 pullets died and were removed.

Observed per weeks, mortality and removal were higher in object II, except in 12th week (0.07%), 16th week (0.06%) and 18th week (0.05%) compared to object I. The hypothesis is that the cause of higher mortality in object II is later debeaking (on the 10th day) because the food scattering was probably larger, food consumption was smaller and adjustment to feeding after debeaking lasted longer. Also, it is clearly visible from the data that the highest mortality and removal happened in the first weeks in both objects. However, the mortality of offspring of laying hens in both objects was within the limits of technological norms (www.babolnatetra.com). More recent research (Milisits et al., 2021) shows that laying hens should be of good health and with low mortality rates in order to keep egg production on a high level. The same authors (Milisits et al., 2021) point to the bad impact of debeaking on laying capacity itself and mutual pecking in contemporary housing systems, which is a bad influence on their welfare. Therefore, some of the measures introduced over the last decade should be reconsidered.

Body mass of laying hens in the period of rearing

For objective and subjective reasons, the control measurings of offspring (11 measurings in total) in defined periods of rearing, the body mass of heads selected by random sample method was controlled. It included a smaller number of heads (120 heads) out of projected number (2% = 190 heads), but even with that, the conducted measurings were not enough to analyse achieved results. However, with the application of the proper nutrition regime and proper selection, it was the idea for the offspring to have during rearing a body mass that corresponds to this genotype and production direction, which was mostly achieved on the farm (object I).

The trend of average of offspring body mass from day 1 until week 18 of rearing and variabilities are shown in Table 2.

The data from Table 2 show that the average body mass of offspring during rearing was in certain periods in accordance with technological norms. Also, the data show that the flock reared in object I was more homogenous than the flock from object II. This is confirmed by the calculated coefficients of variation, which were higher in heads reared in object II, both in one-day-old chickens just moved in and in pullets during rearing. Besides, at the end of the rearing period, pullets from object I had a higher body mass (1435.69 g) than heads from object II (1371.56 g), which is more favourable, that is, closer, to the values of technological norms (www.babolnatetra.com) of the examined hen hybrid. Also, later debeaking can be the cause of smaller average body mass in hens in object II because, earlier, chickens grew faster and had better food consumption. There are many factors that can have an influence on severe feather pecking behaviour: the feed composition such as reduced content and disproportion of minerals (Ca and P); the climate; the size of the group and the type of light in the house, to name a few. All of these factors can also influence one another. However, since all of them were identical in the present research, it can be concluded that chicken age at the moment of debeaking had an impact on mortality and body mass

Table 1. Mortality and removals of heads during rearing.

Age	Object	At the beginning of week	At the end of week	Mortality	
				Heads	%
1st week	I	9500	9458	42	0.44
	II	9500	9449	51	0.54
2nd week	I	9458	9441	17	0.18
	II	9449	9411	38	0.40
3rd week	I	9441	9422	19	0.20
	II	9411	9380	31	0.33
4th week	I	9422	9412	10	0.11
	II	9380	9360	20	0.21
5th week	I	9412	9400	12	0.13
	II	9360	9343	17	0.18
6th week	I	9400	9389	11	0.12
	II	9343	9325	18	0.19
7th week	I	9389	9379	10	0.11
	II	9325	9313	12	0.13
8th week	I	9379	9371	8	0.08
	II	9313	9302	11	0.12
9th week	I	9371	9363	8	0.08
	II	9302	9290	12	0.13
10th week	I	9363	9357	6	0.06
	II	9290	9281	9	0.10
11th week	I	9357	9350	7	0.07
	II	9281	9272	9	0.10
12th week	I	9350	9343	7	0.07
	II	9272	9265	7	0.07
13th week	I	9343	9337	6	0.06
	II	9265	9257	8	0.09
14th week	I	9337	9332	5	0.05
	II	9257	9248	9	0.10
15th week	I	9332	9327	5	0.05
	II	9248	9241	7	0.08
16th week	I	9327	9321	6	0.06
	II	9241	9235	6	0.06
17th week	I	9321	9316	5	0.05
	II	9235	9226	9	0.10

Table 1. Contd.

18th week	I	9316	9311	5	0.05
	II	9226	9221	5	0.05
Total	I	/	/	189	1.99
	II	/	/	279	2.94

Table 2. Average values and variabilities of offspring body mass (g).

Age	Object	$\overline{x}$	S_x	SD	VC
1st day	I	42.00	0.32	3.46	8.24
	II	40.00	0.34	3.77	9.42
29th day	I	266.10	1.96	21.51	8.08
	II	202.18	2.47	27.10	13.40
36th day	I	364.20	2.34	25.65	7.04
	II	305.58	2.45	26.82	8.78
43rd day	I	484.50	2.84	31.11	6.42
	II	407.67	3.50	38.34	9.40
58th day	I	642.70	2.96	32.43	5.05
	II	611.80	3.14	34.41	5.62
66th day	I	723.00	3.52	38.55	5.33
	II	655.10	3.71	40.65	6.20
75th day	I	796.07	3.37	36.93	4.64
	II	747.70	3.52	38.52	8.11
92nd day	I	1236.90	4.68	51.28	4.15
	II	1160.94	5.88	64.41	5.55
109th day	I	1307.60	5.72	62.67	4.80
	II	1241.65	5.95	65.14	5.25
119th day	I	1388.70	4.15	45.46	3.27
	II	1314.33	5.55	60.74	4.62
126th day	I	1435.69	5.29	57.88	4.03
	II	1371.56	6.09	66.72	4.86

during rearing.

Conclusion

Over the last decade, 4 to 6 different genotypes, including the hybrid Tetra SL, have been bred in our country in order to obtain eggs for consumption. Bearing in mind the fact that the success in this production stage and the proper breeding of commercial flocks are critical for timely laying, laying capacity intensity, number of laid eggs, period of laying hens and commercial flock usage, the main goal of the paper was to analyse the technology and results of this hybrid offspring rearing from day 1 until

week 18, using comparative method.

Viewed as a whole, it can be concluded that the analyzed flock at the farm of Mr Miodrag Stojanović in the village of Kosančić produced significant results. However, regardless of the achieved results during offspring rearing, it is necessary to pay more attention to regular (weekly) growth/body mass control and keep a precise and neat register of food consumption (Kabir and Islam, 2021). The implementation of alternative systems of production can bring into question the economy of production, taking into consideration the mutual independence of fixed costs on the number of animals. It can be argued that it would be useful to direct a 'general recommendation' to producers, which would be based on the experiences of states which were last to join the European Union and to make a deal on the relation, producers - state - EU - producers, with necessary consideration of interests of all interested parties.

It is particularly important to highlight the fact that the behavioural problems of feather pecking and cannibalism seem to occur both in intensive farming systems and in organic and hobby poultry farms. Scientists are looking into ways to improve chicken welfare by finding alternative measures to combat injurious pecking behaviour. Because egg laying strains of chicken can be kept in smaller group sizes in caged systems, cannibalism is reduced, leading to a lowered trend in mortality as compared to non-cage systems. Good breeding programme could reduce the problem. The scientists also indicated that selecting for social behaviour would lead to a reduction in feather pecking. If stress and anxiety could also be removed then the likelihood of the birds engaging in this excessive behaviour would also be reduced.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

REFERENCES

Babić V, Milošević B, Maksimović G (2015) Management of health, safety and wellbeing of employees in the business system. Economics of Agriculture 3/2015UDC:336.56:631 Review article.

Bogosavljević–Bošković S, Mitrović S (2005). Gajenje različitih vrsta živine. Univerzitet u Kragujevcu, Agronomski fakultet, Čačak.

Council Directive 88/166/EEC (1988). Complying with the judgment of the Court of Justice in Case 131/86 (annulment of Council Directive 86/113/EEC of 25 March 1986 laying down minimum standards for the protection of laying hens kept in battery cages) OJL 74, 19.3.1988, p. 83-87.

Council Directive 98/58/EC (1998). Concerning the protection of animals kept for farming purposes OJL 221, pp. 23-27.

Council Directive 1999/74/EC (1999). Laying down minimum standards for the protection of laying hens OJ L 203, 3.8 pp. 53-57.

England A, Ruhnke I (2020). The influence of light of different wavelengths on laying hen production and egg quality. World's Poultry Science Journal 76(3):443-458.

European Citizen Initiative (ECI) (2020). End the Cage Age, submitted 02.10.2020.

Hester PY, Shea-Moore M (2003). Beak trimming egg-laying strains of chickens. World's Poultry Science Journal 59(4):458-474.

https://poultry.extension.org/articles/poultry-behavior/beak-trimming-of-poultry/

https://www.poultryworld.net/poultry/beak-trimming-the-way-ahead-for-the-uk/

https://www.roxell.com

https://www.winmixsoft.com/en/blog/item/tetra

https:// www.babolnatetra.com

Kabir SL, Islam SS (2021). Biotechnological Applications in Poultry Farming. Sustainable Agriculture Reviews 54:233-271.

Khatibi SMR, Zarghi H, Golian A (2021). Effect of diet nutrients density on performance and egg quality of laying hens during the post-peak production phase of the first laying cycle under subtropical climate. Italian Journal of Animal Science 20(1):559-570.

Milisits G, Szász S, Donkó T, Budai Z, Almási A, Pőcze O, Ujvári J, Péter Farkas T, Garamvölgyi E, Horn P, Sütő Z (2021). Comparison of Changes in the Plumage and Body Condition, Egg Production, and Mortality of Different Non-Beak-Trimmed Pure Line Laying Hens during the Egg-Laying Period. Animals 11(2):500.

Milošević N (2006). Objekti i oprema u živinarstvu. Primena savremenih tehnologija u živinarstvu. Institut za primenu nauke u poljoprivredi pp. 49-60.

Milošević N, Perić L (2011). Tehnologija živinarske proizvodnje." Univerzitet u Novom Sadu, Poljoprivredni fakultet. Novi Sad pp. 63-64.

Miljković B (2006). Zdravstvena zaštita živine u industrijskoj proizvodnji. Primena savremenih tehnologija u živinarstvu. Institut za primenu nauke u poljoprivredi pp. 61-70.

Mitrović S (1996). Vrste, rase i hibridi živine. Univerzitet u Beogradu, Poljoprivredni fakultet, Beograd.

Mitrović S, Đermanović V, Đekić V, Zemcov D, Vojinović B, Pandurević T (2015). Influence of cage system on laying hen poroductivity and on economy aspects of egg production. 4th International Congress-New Perspectives and Challenges of Sustainable Livestock Production.

Pavlovski Z (2006). Tehnologija gajenja i trendovi u proizvodnji konzumnih jaja. Primena savremenih tehnologija u živinarstvu. Institut za Primenu Nauke u Poljoprivredi pp. 32-40.

Rodić V, Perić I, Despotović J, Rezar V, Relić R and Đukić Stojčić M (2023). Enhancement of laying hen welfare regulation in Serbia: a lesson to be learned from the EU experience to reduce the prevalence of keel bone damage, Europian Poultry Science 87 p. ISSN 1612-9199, © Verlag Eugen Ulmer, Stuttgart.

Sl. glasnik RS" br. 6/2010 i 57/2014. Pravilnik o uslovima za dobrobit životinja u pogledu prostora za životinje, prostorija i opreme u objektima u kojima se drže, uzgajaju i stavljaju u promet životinje u proizvodne svrhe, načinu držanja, uzgajanja i prometa pojedinih vrsta i kategorija životinja, kao i sadržini i načinu vođenja evidencije o životinjama ("Sl. glasnik RS", br. 6/2010, 57/2014 i 152/2020).

Singh R (2021). Beak-Trimming In Poultry, https://www.pashudhanpraharee.com/

Sandilands V, Savory CJ (2002). Ontogeny of behaviour in intact and beak trimmed layer pullets, with special reference to preening. British Poultry Science 43(2):182-189.

Škorić R (2006). Aktuelno stanje i kapaciteti u živinarstvu. Primena savremenih tehnologija u živinarstvu. Institut Za Primenu Nauke U Poljoprivredi pp. 71-81.

Živković D, Drudarski D, Mitrović S, Todorović S (1991). Uticaj načina gajenja na ispoljavanje proizvodnih osobina 18-to nedeljnih kokica Isabrown hibrida kokoši. Zbornik radova "Živinarski dani" pp. 78-84 Ohrid.