EXPERIMENTAL INFLUENCES OF PROBIOTICS LACTIFERM ON EGG LAYING CHARACTERISTICS IN *GALLUS DOMESTICUS*

K. Koudela[1], M. Burešová[1], D. Vomelová[1], C. C. S. Nyirenda[2], A. Paseka[3], D. Sánchéz[1]

[1] *Czech University of Agriculture, Faculty of Agronomy, Prague, Czech Republic*
[2] *Hochipapa Research Station, Choma, Zambia*
[3] *TEKRO Ltd., Prague, Czech Republic*

Continual experimental application of probiotics Lactiferm changed the laying curve, laying intensity and basic egg technological properties. The heaviest egg weight was recorded from layer hens, fed on feed mixtures supplemented with probiotics Lactiferm during the pullets rearing phase. In experimental hens were observed changes in the weight and share index of the yolk and increased albumen weight of experimental eggs from group E2 of layer hens. All three experimental groups of laying hens conserved higher shell weight and strength in contrast with control eggs.

Gallus domesticus; nutrition; probiotics; Lactiferm; laying period; laying curve; egg; technological properties

INTRODUCTION

The high performance of commercial egg-type chicken is the result of improvements in poultry breeding, nutrition, physiology, disease and environmental control. Despite the improvements in its livability, egg production, feed efficiency, and overall egg quality, two problems of great importance in the commercial egg industry are the decline in interior quality and the decline in shell quality with advanced age of the chicken (G r a n d a m et al., 1973).

Pullets begin to lay eggs with thick shells and high interior quality. As the pullets become older, the interior quality declines (R o b e r t s o n , 1971). In the production cycle, there is always a point at which the decline in interior quality and shell quality make marketing of the eggs difficult because of broken shell and thin egg white (H u g h e s , 1988).

Egg shell quality is an important economic trait that primary breeders of egg laying stocks, incorporate into breeding programme to reduce egg shell breakage (Grunder et al., 1988).

Egg shell quality includes shell weight (SW), percentage shell (%), shell thickness (STh), shell strength (Sst) and continues to be a serious problem to the industry or the farmer for various reasons:

- Additional losses result from breakage in consumer cartons and from downgrading because of poor shell quality.
- A further but frightening problem to the consumer is infection of eggs by Salmonellae, *Pseudomonas fluorescens* and other pathogenic microorganisms because poor shell quality does offer little resistance to penetration by pathogenic agent (Sauter et al., 1974) and which depends upon species and on shell quality of egg challenged. Eggs of excellent shell quality (specific gravity 1.090) were considerably more resistant to penetration by all the Salmonellae studied than were eggs of lower shell quality (Nascimento, 1992).

Age is known to gradually decrease egg shell qualities. Feeding calcium at high levels or feeding antibiotics (Peterson et al., 1973) did not prevent the decline of shell quality with age. Egg shell quality (Wolford et al., 1965; Proudfoot, Hulan, 1987) also depends upon:

- The time which an egg spends in the uterus (shell gland) prior to oviposition. The shorter the time of stay in the uterus, the less satisfactory is the quality of shell deposition.
- Involvement of the nervous system; frightening of chickens has repercution on shell thickness resulting from shunting away of blood from the reproductive system in the course of stress.
- The synchronization of hormones involved in the reproductive process may also influence egg shell quality.

Quoting more than six sources, Wolford and Tanaka (1970) reported that egg shell quality of chickens whether measured by specific gravidity, shell thickness, shell smoothness, breaking strength, percentage of cracks or shell appearance has been reported to be influenced by dietary calcium. High production in hen is related to calcium, protein and energy intake (Davidson, Boyne, 1970).

It is well known that the amount of calcium and phosphorus required by laying hens depend on their stage of production and, therefore, vary not only from day-to-day but also throughout the day (Mongin, Mueller, 1974; Härtel, 1987). Good shell quality is assumed to result from feeding diets high in calcium and low in phosphorus (Härtel, 1987). High quantity of calcium changes the quality of feed and decrease the dietary energy.

Egg weight is a factor that hatching industry has always taken carefully into account. Citing the work of Halbersleben and Mussehl (1922), Shanawany (1987) reported a close correlation between egg weight and chick weight at hatching and that chick weight was about 64% of the unicubated weight.

Hullan and Nikolaiczuk (1971) observed a general increase in egg specific gravity, and highly variable plasma calcium level when several antibiotics and arsenic acid were fed to yearling hens during a July–August period. When a similar study was conducted during September–November, no effect on specific gravity of egg or plasma calcium was noted. Hullan and Nikolaiczuk (1971) reported that feed consumption and egg production were not increased when several feed additives (arsenilic acid, procaine penicillin) were fed to White Leghorn hens.

Kaminska and Skraba (1991) maintained that with an increase in egg weight, the percentage of yolk decrease from 32% in 50 g egg to 28% in 70 g egg, while the percentage of albumen increases from 58 to 62%. The experiment was conducted on hens reared in cages and fed low protein diet (13–14% crude protein). Every four weeks from 30 to 62 weeks of hen's age, two eggs were collected for analysis. An average egg weight was 50.8 g at 30 weeks and reached maximum weight (59 g) at 58 weeks. The yolk weight beginning with 12.1 g attained 16.5 at week 54 of age and its percentage rose from 23.8 to 28.5 (of egg weight). The highest egg and yolk weight gains were found between 30–34 weeks. Albumen weight increased only by 1.36 g between 38 and 58 week of age reaching the maximum at 36.6 g at 58 week of age. The percentage of albumen was higher at the beginning of laying (65.8%) and the lowest at 54 week of age (61.3%). Albumen: yolk ratio was higher at 30 week – 2.77, and then decreased to 2.22 at 46 week of age being maintained at this level up to 62 week of age.

Nyirenda et al. (1991) fed pullets and hens probiotic Lactiferm during rearing as well as laying period. Experimental group, that received Lactiferm throughout the rearing period, registered significant increase in egg weight, shell strength, yolk and albumen weight. The most striking observation is the early hatching capability of layers receiving Lactiferm (Koudela et al., 1987). The *in vitro* increase in lactic acid production, in function of increasing temperature, has led to the assumption that the high body temperature of domestic fowl could offer a suitable environment for lactic acid production which consequently reduce pH and affect the so-called harmful gut flora. Lactobacillus fermentation products fed in their rations or drinking water have been credited with increasing egg production and feed efficiency by laying hens. These products have been reported to increase the production of large eggs (Goodling 1987; Kumprecht et al., 1990; Koudela et al., 1990).

However, application of probiotics, especially of Lactiferm, on pullets and laying hens Shaver 288 is mentioned nowhere either in local Czech or world's foreign literature.

MATERIAL AND METHODS

Experiments took place at the Common Farm for Eggs Production (SZP) Markovice (Agrokomplex Kutná Hora). Precise specifications about experimental animals, housing, welfare, nutrition, research goals (Koudela, Nyirenda, 1995a, b) were determined.

During laying period, the peak and egg production persistence, the egg qualities, which include, egg weight, egg shape index, yolk and albumen index, shell strength and thickness (Halaj, 1986) were found.

Obtained results were evaluated according to regular variational method of statistics and the basic characteristics of mathematical selective sampling were determined.

RESULTS

Complete absence of exact data on the use of probiotics on layer was the fundamental motive for the experimental verification of probiotics Lactiferm in practical breeding conditions of a big capacity egg production.

In the previous stages of concentrated research on experimental application of lactacidogenic germs *Enterococcus faecium* M-74, it was found that, in meat layer hybrid Hybro, the onset of egg laying was quicker, so was the egg laying peak. An increase in average egg weight and a decrease in daily feed consumption and that for the production of one egg were reported (Koudela et al., 1989). These promising results were, among others, the inspiring force behind the verification of these conclusions on typical laying hybrids.

Experimental application of probiotics Lactiferm was carried out on three experimental groups of layers. Experimental group of layers E1 received probiotics Lactiferm throughout breeding as well as rearing phase. Experimental group of layers E2 was fed on probiotics Lactiferm during the rearing phase only.

From Tab. I, it can be seen that, Lactiferm intake in the three different groups of layers, manifested itself, both through swings from standardized growth curve and the consequences on the laying intensity of experimental layers.

In control layers, the laying intensity was delayed, in contrast with standardized values, by almost 13 days, at 80% of laying intensity. The control layers never reached during the period under studies, 90% of laying intensity.

I. Egg laying curve of experimental and control layers

Laying intensity (%)	Layers age (weeks) Group					
	norm	C	E1	E2	E3	E
10	20	20	18.71	19.00	15.50	19.14
30	21	21	20.28	20.57	21.28	20.71
50	23	23.71	22.00	21.57	22.57	22.42
70	24	25.42	22.57	23.28	24.00	23.28
80	25	27.85	23.53	23.85	25.00	24.14
90	26	not reached	25.85	27.00	28.14	26.86

On the contrary, in all three experimental groups of layers, the laying intensity differed from the control layers or standardized laying values. The egg laying onset appeared slightly earlier. The earliest was registered in E3 group of layers (10% at 16.5 week of age) and in other two experimental groups, about 7 days (E2) and 10 days (E1) in contrast with control layers. Laying intensity in E3 group of layers, which were fed Lactiferm only during the laying period, neared the normalized laying standard. In other two experimental groups E1 + E2, the acceleration of laying intensity was preserved, and that in average about 5 to 8 days when compared with normalized laying standard. Acceleration of egg laying onset was significant in E1 (probiotics Lactiferm fed during both breeding and rearing phase of layers) than in experimental group E2. In experimental group E2, however, with exception of delay in the onset of 90% laying intensity (delayed by about 5 to 7 days), a quick onset of 30, 50, 70 and 80% intensity in comparison with guaranteed laying curve was noted.

Photoperiodism of control and experimental layers E1 and E2 was in accordance with technological process for layer hybrid Shaver Starcross 288.

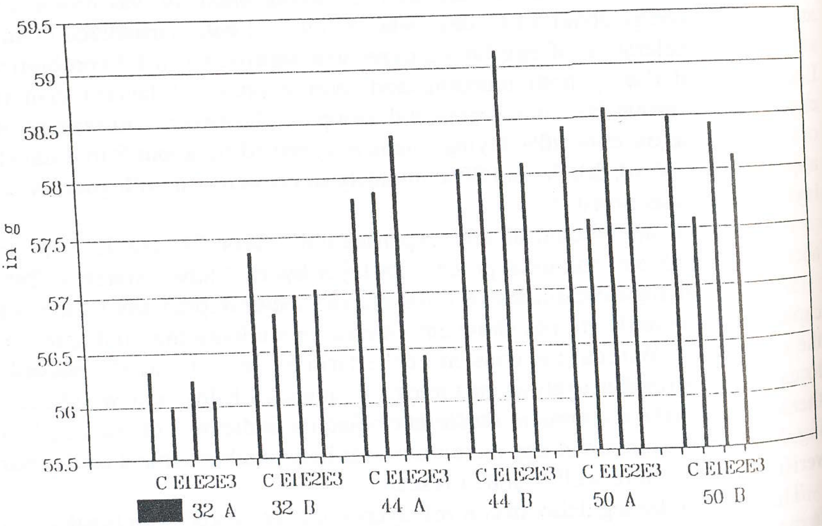
In practical field conditions of birds rearing the entrepreneurs of the big capacity laying halls did not show any interest in studying the production of the egg matter. Without the consent of the farm owners, it was not possible to carry out a regular analysis of the egg frequency of different weight and thereafter to make a comment on further objective indicators of the egg laying. Studied production of egg matter presents here another subject for further verification in future well founded research.

The cause of laying delay in control layers could be linked with breakdown in the organism's internal milieu of the pullets (in the wake of disease, growth depression, etc.). The attractive part of the experimental elucidation of the problem is the reactivation of the layers group E2. Late consequences of intestine colonization resistence evoked already in pullets are very interesting and generally confirm the fact that, advantageous metabolic basis in early postincubation period of domestic hen can influence the formation of layer's useful properties. It concerns here a subject of economical, physiological and zootechnical interest.

In total, during eggs laying phase, three times evaluated the basic egg technological characteristics, and that during the maximal (peak) laying period (32nd week of layer's life and with regard to the analysis of laying persistence, another evaluation was carried out on the 44th and 50th week of layer's life, respectively. From each group of layers, an equal number of egg samples was collected, of which indicators were analyzed, from 9 a.m. immediately after they had been brought to the Czech University of Agriculture in Prague from the poultry farm, in Markovice.

In dependence with the layer's age the egg weight increases (Fig. 1).

One way analysis of variance did not show any significant differences in the egg weight of experimental and control group of layers. A point worth reporting is however a rise in the average egg weight from experimental group E2 which received Lactiferm supplemented feed mixture during rearing period. It offers here a mutual interaction for the creation of an early resis-



1. Average egg weights of experimental and control layer hens

tance colonization already in pullets and late potential consequences of metabolic adaptations.

Egg weight of control layers featured both in the range guaranteed by the technological process SPLP Nitra (1987) and that from the experimental results by H a l a j (1987a, b).

With the increase in layers age, an increase in egg length and a slight one in egg weight are observed (Tabs. II, III).

Analysis of variance has shown no differences between lengths and widths of egg parameters in control and experimental groups of layer. This applies also to the index of the egg shape (Tab. IV). Experimental application of probiotics Lactiferm did not influence the egg shape characteristics.

The yolk is considered one of the most important nutritive components of an egg. In Tab. V are summarized the weight characteristics of the yolk of control and experimental groups of layers. During the period between the 32nd and 50th week of layers' age, a decrease in the yolk weight of control and experimental layers is observed.

During the period under studies, a change in the yolk shape is also noticed from eggs of experimental as well as control layers. The yolk height (Tab. VI) as well as the average yolk width (Tab. VII) slightly increased.

During the 22-week-studied egg laying period, a slight decrease in the index of the yolk shape is observed (Tabs. VII, VIII).

The dynamics of the yolk percentage over the total egg weight is summarized in Tab. IX.

Swings in the yolk weight and changes in the yolk shape of the control eggs were in line with common characteristics of hen's egg (H a l a j , 1986) and those measured for layer hybrid Shaver Starcross 288 (H a l a j , 1987a, b).

Experimental application of probiotics evidently changed the egg yolk height in experimental group E2 fed on Lactiferm supplemented feed mixtures during rearing phase, in contrast with the other two experimental and the control groups. One way analysis of variance did not show any other significant changes in the yolk characteristics. Experimental application of probiotics did not change the yolk weight. Meanwhile, that of control eggs decreased, during the period between 32 and 50 weeks of layer's life, about 4.66% in contrast with a 2.68% average decrease in all three experimental groups of layers.

Albumen represents biologically high valuable constituent of avian egg. During the 22-week-long laying period, the egg albumen weight (Tab. X) of experimental as well as control layers increased. This increase was remarkable (nearly 8%) for experimental group E2, which was fed on probiotics Lactiferm exclusively during the rearing period. We suspect here further immediate as well as possibly prolonged, Lactiferm.

During the period under studies changed equally the albumen shape, and that be it in length (Tab. XI) or width (Tab. XII) and so changed the height of hard albumen (Tab. XIII).

Changes in egg shape considerably influenced the index of the albumen shape (Tab. XIV).

Changes in albumen weight, during the period under studies, influenced as well its percentage over the total egg weight (Tab. XV).

The egg albumen characteristics of the control layers were in line with generally approved particulars for hen's egg as well as for egg from layer hybrid Shaver Starcross 288 in particular (H a l a j , 1986, 1987a).

Variation analysis has shown the only significant difference in albumen width (E2 x E1, E3), albumen height of eggs from experimental group E2 shrank in contrast with control group as revealed by eggs evaluation on the 25th of May 1990, at the 50th week of layers age.

Experimental application of probiotics Lactiferm was manifested in the changes of albumen characteristics. These changes were significant especially for eggs from experimental layers, which were fed on Lactiferm, as pullets, during rearing period only.

An unambiguous explanation of the cause needs some special immunologically oriented studies, which could elucidate thus far neglected characters of physiologic polyfactorial actions of egg albumen lysozyme. In Czechoslovakia, promising research work on these actions initiated K o u d e l a et al. (1987).

For handling with eggs, be it at the poultry farm (eggs grading, transportation, brooding) or in shops, has shell strength got the maximal practical importance.

During evaluation of egg shell characteristics, shell weight of eggs from experimental and control layers was analyzed (Tab. XVI).

The experimental group E3 was the exception in registering a slight decline in egg shell weight during the 18-month-week interval. Remarkable changes in egg shell weight were, during the period under studies, registered from layers group E2 which received Lactiferm during pullets rearing period. These changes reached the level of statistical importance. Egg weight of the control birds reached the lowest level of the variation span (H a l a j , 1987a).

In Tab. XVII, it is apparent, the shell percentage over the total egg weight did not differ between experimental and control groups.

For an objective measurement of egg shell strength, M a r c i n k a and G a ž o (1964) developed a special instrument. It measures the pressure force needed to break through the shell. The egg shell can stand a pressure of between 8 and 56 $N.cm^{-2}$ (H a l a j , 1986).

Tab. XVIII summarizes obtained results on the egg shell strength of control and experimental layers. Egg shell strength of control and experimental layers did not show any conclusive statistical difference. Very interesting is that, during the period under studies, eggs from experimental group E2 reached the highest values in shell strength (40.50 more or less 3.65 $N.cm^{-2}$). The control eggs registered a 40.13 more or less 3.73 $N.cm^{-2}$. In control group, a decline of 4.08% in average shell strength was observed between the 32nd and 50th week of bird's life. All experimental groups registered a 3.44%. Very significantly was reduced the egg shell strength in experimental group E1 (about 6.69%), experimental group E2 (3.32%) with E3 showing almost no decline (0.16%).

In a limited extent, we can here notice that, the use of Lactiferm, during the rearing period, enhanced a slight increase in average egg shell strength. Furthermore, the use of probiotics Lactiferm maintained a high egg shell strength, during the period under studies, in contrast with egg shell from the control group.

Obtained results were achieved from big capacity egg production system, in which we were requested for scientific collaboration. It was not possible to intervene into organization and zootechnical conditions. However, it is possible to achieve interesting results under limited conditions.

Future research should link with the first Czech experimental results in the breeding as well as layers rearing. In the follow up research phases already ought to be, on representative scale and in the own experiment, elucidated a range of problems, which remain interesting and useful.

Technological characters of egg could not be analyzed morphologically, and that be it optically, or far more useful by electron microscopic analysis of egg shell. During analysis of chemical compositions, it was not possible, due to technical reasons, to analyse cholesterol concentrations in the yolk and lysozyme concentrations in the albumen of the experimental eggs. Remarkable is the implication of slight reduction in yolk weight of the eggs from experimental group E2.

Obtained results from layers of experimental group E2 are very interesting. Special attention is paid to the increase in the weight and strength of the shell. In general, this finding serves as a base for further perspective research work on late consequences of the experimental application of probiotics Lactiferm only during the period of pullets rearing.

In exact model experiments, these results ought to be experimentally explained by scientific hypothesis: In which way does Lactiferm stimulate the egg laying process? Can this process be influenced by synergism between Lactiferm and the fortification of feed mixtures by amino acids pool and

II. Egg length (mm) of experimental and control layers

Layers age (weeks)	Group C			E1			E2			E3		
	$\bar{x}$	s	v%	$\bar{x}$	s	v%	$\bar{x}$	s	v%	$\bar{x}$	s	v%
32	56.32	1.25	2	55.98	1.25	2	56.24	1.66	3	56.05	1.64	3
	57.37	7.79	3	56.84	1.92	3	57.00	1.69	3	57.05	1.17	2
44	57.81	1.53	3	57.86	1.47	3	58.37	1.60	3	56.43	4.00	7
	58.05	2.08	4	58.01	1.19	2	59.15	1.69	3	58.09	3.23	6
50	58.41	1.41	2	57.58	1.24	2	58.57	1.41	2	58.00	1.70	3
	58.48	1.29	2	58.01	1.48	3	58.41	1.92	3	58.11	2.03	4

III. Egg weight (g) of control and experimental layers

Layers age (weeks)	Group C			E1			E2			E3		
	$\bar{x}$	s	v%	$\bar{x}$	s	v%	$\bar{x}$	s	v%	$\bar{x}$	s	v%
32	42.60	0.88	2	42.18	0.89	2	42.94	1.87	4	42.48	1.07	3
	42.56	1.13	3	42.62	0.94	2	43.03	0.93	2	42.80	0.67	2
44	43.76	0.91	2	43.78	1.02	2	44.71	1.34	3	43.25	1.14	3
	43.95	1.29	3	43.40	0.80	2	44.27	1.34	3	43.25	1.14	3
50	38.27	1.91	5	43.60	0.84	2	44.16	0.89	2	43.61	1.35	3
	43.36	1.15	3	43.74	0.99	2	43.79	1.03	2	43.42	0.81	2

IV. Index of egg shape (%) of control and experimental layers

Layers age (weeks)	Group C			E1			E2			E3		
	$\bar{x}$	s	v%	$\bar{x}$	s	v%	$\bar{x}$	s	v%	$\bar{x}$	s	v%
32	75	2	3	75	2	3	76	4	5	75	2	3
	74	2	3	74	2	3	75	3	4	75	2	3
44	75	2	3	75	2	3	76	2	3	77	6	8
	75	2	3	74	2	2	74	2	3	75	4	5
50	75	2	3	76	3	4	75	2	3	76	3	4
	75	2	3	76	2	3	75	2	3	75	3	4

V. Dynamics of the egg yolk weight (g) of control and experimental layers

Layers age (weeks)	Group C			E1			E2			E3		
	$\bar{x}$	s	v%	$\bar{x}$	s	v%	$\bar{x}$	s	v%	$\bar{x}$	s	v%
32	18.92	1.23	6	18.18	1.27	7	18.44	1.23	7	18.14	1.12	6
	18.84	0.79	4	18.08	1.20	7	18.19	0.92	5	18.92	0.75	4
44	18.03	0.73	4	17.64	0.76	4	18.18	0.67	4	18.64	0.79	4
	19.14	0.96	5	17.89	0.44	2	19.00	0.77	4	18.84	1.20	6
50	17.67	1.15	7	16.97	0.96	6	17.76	1.18	7	17.73	0.89	5
	18.42	1.25	7	18.07	0.94	–	18.64	1.00	5	17.83	0.85	5

VI. Dynamics of egg yolk height (mm) of experimental and control layers

Layers age (weeks)	Group C			E1			E2			E3		
	$\bar{x}$	s	v%	$\bar{x}$	s	v%	$\bar{x}$	s	v%	$\bar{x}$	s	v%
32	15.26	1.33	9	14.75	1.03	7	14.92	1.13	8	15.58	1.29	8
	15.73	1.11	7	15.63	1.04	7	16.31	0.73	4	15.67	1.03	7
44	17.08	1.12	7	17.24	1.00	6	17.63	0.91	5	16.37	1.33	8
	17.64	0.94	5	17.74	1.25	7	18.43	1.24	7	17.17	1.19	7
50	17.88	1.20	7	17.36	0.79	5	17.99	1.05	6	17.76	1.11	6
	17.70	1.39	8	17.51	0.58	3	17.85	0.95	5	17.74	1.14	6

VII. Dynamics of average yolk width (mm) of experimental and control eggs

Layers age (weeks)	Group C			E1			E2			E3		
	$\bar{x}$	s	v%	$\bar{x}$	s	v%	$\bar{x}$	s	v%	$\bar{x}$	s	v%
32	38.57	1.87	5	38.64	1.70	4	39.21	1.34	3	39.75	1.19	3
	40.00	1.22	3	40.71	1.23	3	41.53	1.71	4	39.97	1.26	3
44	41.33	1.73	4	40.71	1.13	3	41.86	1.23	3	40.36	1.70	4
	40.54	1.89	5	40.97	1.46	4	41.27	1.85	4	39.87	1.57	4
50	42.47	1.35	3	42.57	1.49	4	44.23	1.09	2	43.18	1.53	4
	40.30	1.93	5	38.35	1.80	5	42.09	1.87	4	38.88	2.15	6

VIII. Dynamics of the index of the yolk shape

Layers age (weeks)	Group											
	C			E1			E2			E3		
	$\bar{x}$	s	$v\%$	$\bar{x}$	s	$v\%$	$\bar{x}$	s	$v\%$	$\bar{x}$	s	$v\%$
32	48	3	7	47	3	7	47	3	7	45	3	6
	46	3	6	44	3	7	43	2	5	47	2	5
44	43	3	6	43	2	4	43	2	4	46	2	5
	47	3	7	43	2	4	46	2	5	47	3	6
50	41	3	7	40	3	7	40	3	7	41	2	6
	45	3	7	47	3	7	44	3	7	45	3	7

IX. Percent yolk

Layers age (weeks)	Group											
	C			E1			E2			E3		
	$\bar{x}$	s	$v\%$	$\bar{x}$	s	$v\%$	$\bar{x}$	s	$v\%$	$\bar{x}$	s	$v\%$
32	26	2	7	26	2	6	26	2	6	27	1	5
	26	1	5	26	1	5	27	2	6	26	2	7
44	27	3	10	28	2	7	27	1	5	27	3	11
	27	2	6	28	2	7	28	2	7	27	2	7
50	28	2	7	28	2	7	28	2	6	28	2	6
	28	2	7	28	1	5	28	1	5	29	2	7

X. Dynamics of egg albumen weight (g) of experimental and control layers

Layers age (weeks)	Group											
	C			E1			E2			E3		
	$\bar{x}$	s	$v\%$	$\bar{x}$	s	$v\%$	$\bar{x}$	s	$v\%$	$\bar{x}$	s	$v\%$
32	34.90	2.36	7	34.18	3.01	9	35.06	2.84	8	35.04	2.22	6
	35.81	2.35	7	35.57	2.55	7	35.69	3.33	9	35.98	2.21	6
44	37.23	3.61	10	35.31	2.97	8	38.62	3.23	8	35.13	4.19	12
	38.37	3.27	9	36.31	2.26	6	38.87	4.05	1	37.38	3.72	10
50	37.72	1.86	5	36.21	1.41	4	38.67	2.40	6	36.50	2.96	8
	37.60	2.77	7	37.33	2.70	7	38.23	3.32	9	36.46	3.72	10

XI. Dynamics of egg albumen length (mm) of experimental and control layers

Layers age (weeks)	Group											
	C			E1			E2			E3		
	$\bar{x}$	s	$v\%$	$\bar{x}$	s	$v\%$	$\bar{x}$	s	$v\%$	$\bar{x}$	s	$v\%$
32	88.24	5.98	7	85.80	8.05	9	87.99	5.08	6	89.46	6.41	7
	82.95	6.08	7	86.22	4.97	6	90.81	6.01	7	82.59	5.25	6
44	92.05	4.93	5	99.70	4.88	5	89.12	4.49	5	90.56	4.84	5
	87.72	5.76	7	87.59	6.75	8	87.15	5.97	7	84.41	6.86	8
50	97.92	6.33	6	95.40	5.50	6	99.69	6.04	6	94.82	5.40	6
	85.73	6.60	8	88.57	5.35	6	89.51	9.04	10	85.80	4.14	5

XII. Dynamics of egg albumen width (mm) of experimental and control layers

Layers age (weeks)	Group											
	C			E1			E2			E3		
	$\bar{x}$	s	$v\%$	$\bar{x}$	s	$v\%$	$\bar{x}$	s	$v\%$	$\bar{x}$	s	$v\%$
32	62.40	4.81	8	61.97	5.57	9	65.10	3.34	5	64.21	4.20	7
	64.27	3.41	5	64.91	3.25	5	68.01	4.40	6	64.13	4.28	7
44	67.77	5.33	8	65.72	3.66	6	66.56	3.47	5	66.97	4.93	7
	70.60	3.89	6	69.10	4.12	6	68.41	5.67	8	67.94	2.29	3
50	73.94	4.08	6	74.16	5.34	7	77.17	6.87	9	75.31	7.21	10
	64.01	5.43	8	61.27	5.61	9	68.46	7.30	11	62.85	5.38	9

XIII. Dynamics of egg albumen height (mm) of control and experimental layers

Layers age (weeks)	Group											
	C			E1			E2			E3		
	$\bar{x}$	s	$v\%$	$\bar{x}$	s	$v\%$	$\bar{x}$	s	$v\%$	$\bar{x}$	s	$v\%$
32	7.16	0.98	14	6.61	1.63	25	6.50	1.31	20	6.66	1.25	19
	7.80	1.34	17	7.14	1.29	18	6.96	1.00	14	8.05	1.58	20
44	5.92	1.06	18	5.71	1.22	21	6.58	1.21	18	6.06	1.25	21
	6.81	1.16	17	6.55	1.38	21	7.10	1.12	16	6.87	1.20	18
50	6.90	1.12	16	6.97	1.18	17	7.06	1.37	19	7.12	1.19	17
	6.63	1.47	22	6.11	2.03	33	5.64	1.00	18	5.11	1.05	21

XIV. Dynamics of shape index of egg albumen (%) of control and experimental layers

Layers age (weeks)	Group											
	C			E1			E2			E3		
	$\bar{x}$	s	$v\%$	$\bar{x}$	s	$v\%$	$\bar{x}$	s	$v\%$	$\bar{x}$	s	$v\%$
32	0.09	0.02	28	0.09	0.03	31	0.08	0.02	19	0.08	0.02	29
	0.10	0.02	21	0.09	0.02	20	0.09	0.01	15	0.11	0.03	25
44	0.07	0.02	23	0.07	0.02	24	0.08	0.02	19	0.07	0.02	25
	0.08	0.02	21	0.08	0.02	26	0.09	0.02	21	0.09	0.02	19
50	0.08	0.01	19	0.08	0.01	18	0.08	0.02	26	0.08	0.02	21
	0.09	0.02	26	0.07	0.03	35	0.07	0.01	17	0.06	0.02	24

XV. Percent albumen

Layers age (weeks)	Group											
	C			E1			E2			E3		
	$\bar{x}$	s	$v\%$	$\bar{x}$	s	$v\%$	$\bar{x}$	s	$v\%$	$\bar{x}$	s	$v\%$
32	60	2	3	60	2	3	61	2	3	60	2	3
	60	2	3	60	2	3	60	2	4	61	2	4
44	60	3	2	58	2	4	59	2	3	59	4	6
	60	2	3	58	2	3	59	3	5	59	2	4
50	60	2	3	60	2	3	60	2	3	59	2	3
	59	2	4	59	2	3	60	2	3	59	2	3

XVI. Dynamics of egg shell weight (g) of experimental and control layers

Layers age (weeks)	Group											
	C			E1			E2			E3		
	$\bar{x}$	s	$v\%$	$\bar{x}$	s	$v\%$	$\bar{x}$	s	$v\%$	$\bar{x}$	s	$v\%$
32	7.72	0.63	8	7.53	0.56	7	7.52	0.56	8	7.12	0.65	9
	7.75	0.44	6	7.72	0.66	9	7.85	0.62	8	7.52	0.56	7
44	7.72	0.59	8	8.06	0.53	7	8.46	0.52	6	7.94	0.61	8
	7.81	0.63	8	8.24	0.63	8	8.63	0.56	6	7.78	0.59	8
50	7.51	0.47	6	7.11	0.60	8	7.68	0.47	6	7.60	0.64	8
	7.64	0.53	7	7.75	0.57	7	7.17	0.64	9	7.47	0.62	8

XVII. Percent shell over total egg weight

Layers age (weeks)	Group											
	C			E1			E2			E3		
	$\bar{x}$	s	$v\%$	$\bar{x}$	s	$v\%$	$\bar{x}$	s	$v\%$	$\bar{x}$	s	$v\%$
32	13	1	7	13	1	9	13	1	6	12	1	9
	13	1	7	14	2	14	13	1	9	13	1	9
44	12	1	7	13	1	8	13	1	9	12	1	7
	12	1	7	13	1	8	13	1	9	12	1	7
50	12	1	5	12	1	8	12	1	5	12	1	7
	12	1	8	12	1	9	11	1	7	12	1	8

XVIII. Egg shell strength ($N.cm^{-2}$) of control and experimenal layers

Layers age (weeks)	Group											
	C			E1			E2			E3		
	$\bar{x}$	s	$v\%$	$\bar{x}$	s	$v\%$	$\bar{x}$	s	$v\%$	$\bar{x}$	s	$v\%$
32	42.85	2.71	6	41.14	3.13	8	41.94	3.82	9	40.79	2.35	6
	40.07	3.75	9	44.45	3.92	9	40.62	4.52	11	38.57	5.02	13
44	39.66	2.45	6	39.17	3.54	9	49.20	3.20	8	39.13	3.39	9
	38.66	4.19	11	40.27	3.84	10	40.42	2.52	6	39.97	3.13	8
50	39.52	4.69	12	37.66	3.45	9	40.38	3.78	9	39.34	3.58	9
	40.03	3.39	8	39.41	4.42	11	39.45	3.48	9	39.90	4.06	10

subsequently the improvement of the technological characters as well as biological values of the egg?

Not to be forgotten, from the general view point, is the fact that a significant sum of money was saved by Czech University of Agriculture in Prague, which offered, through the entire duration of the field experiment, negligible financial support.

CONCLUSIONS

Experimental application of probiotics changed the laying curve and egg laying intensity. The laying onset was slightly quicker. In experimental group E2, a simultaneous increase in the total egg weight as well as long laying persistence were observed. In the period of maximal laying (32nd week of layer's age) and twice during egg laying persistence phase (44th and 50th week) were basic technological properties of the eggs, from experimental and control layers, evaluated. The heaviest egg weight was recorded from E2, fed on feed mixtures supplemented with probiotics Lactiferm during the pullets rearing phase. The egg length and width as well as the egg shape index of experimental and control eggs did not significantly change. During the period under studies, changes were observed in the weight and shape index of the yolk. It was not found some conclusive differences in yolk characteristics of control and experimental layers. Application of probiotics Lactiferm has enhanced an increase in albumen weight of experimental eggs from group E2 of layers, which received Lactiferm during pullets rearing phase. The shell weight and strength of the control and experimental eggs were slightly different. The most significant changes of these two parameters were registered from eggs of E2 group of layers. The all three experimental groups of layers conserved higher shell weight and strength in contrast with control eggs.

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KOUDELA, K. – BUREŠOVÁ, M. – VOMELOVÁ, D. – NYIRENDA, C. C. S. – PASEKA, A. – SANCHÉZ, D. (Česká zemědělská univerzita, Agronomická fakulta, Praha, Česká republika; Hochipapa Research Station, Choma, Zambia; TEKRO, Praha, Česká Republika):

Experimentální vlivy probiotika Lactiferm na snášku kura domácího.

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Kontrolním a pokusným kuřicím a nosnicím se v komerčních krmných směsích kontinuálně podávalo probiotikum Lactiferm L-50. První pokusná skupina (E1) dostávala probiotikum v období odchovu i snášky, v pokusné skupině E2 se Lactiferm podával kuřicím pouze v období odchovu, třetí pokusné skupině (E3) se probiotikum aplikovalo pouze v období snášky.

Experimentální aplikací Lactifermu se u pokusných nosnic urychlil nástup snášky ve srovnání s kontrolními nosnicemi. Celkem třikrát (32., 44. a 50. týden snášky) se analyzovaly technologické vlastnosti vajec. Nejpříznivější hmotnostní ukazatele vajec byly zjištěny u pokusné skupiny E2.

Při experimentální aplikaci probiotika Lactiferm se neprokázaly statisticky významné rozdíly v tvarových vlastnostech vajec a v charakteristice žloutku vajec. Nejvýrazněji se změnila hmotnost a výška bílku u vajec nosnic skupiny E2.

Nejvyšší hmotnost měla vaječná skořápka u nosnic E2. V pokusném období byla zjištěna nejvyšší pevnost skořápky u vajec pokusné skupiny E2 (3,65 $N.cm^{-2}$).

Gallus domesticus; kuřice; nosnice; výživa; probiotikum; Lactiferm; snáška; snášková křivka; vejce; technologické vlastnosti

Contact Adress:

Prof. MVDr. Karel K o u d e l a , DrSc., Česká zemědělská univerzita, Agronomická fakulta, Kamýcká 129, 165 21 Praha 6-Suchdol, Česká republika, tel.: 02/24 38 27 99, fax: 02/20 92 03 12