KAPOSVÁR UNIVERSITY

FACULTY OF ANIMAL SCIENCES

Department of Poultry - and Companion Animal Husbandry

THESES OF DOCTORAL (PhD) DISSERTATION

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THE EFFECT OF THE DIFFERENT DIETARY SUPPLY OF THE PULLETS ON THE GROWTH AND PRODUCTION TRAITS OF THE DIFFERENT LAYER HYBRIDS KEPT IN CAGE AND ALTERNATIVE HOUSING SYSTEM

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KAPOSVÁR

2008

1. Introduction and objectives of the research

Eggs – due to their exceptional dietary composition – are one of the most ancient food of mankind. The proteins and vitamins which can hardly be found in any other foodstuffs, and minerals which are vital in the different biological processes are present in eggs in significant quantity and a biologically easily available form.

Egg production by the layer species is developing dynamically worldwide. The basis of this quantitative increase is the growing capacity of food industry, as nowadays eggs are undoubtedly one of the healthiest basic foodstuffs.

The quantitative development can be thanked partly to the number increase of laying hens, partly the realized genetic progress, and last but not least to the improvement of the environmental factors. One of the important elements of the environmental factors is feeding, the importance of which has risen in value also because it plays a leading role as a decisive part of the direct costs both during egg production and pullet growing periods.

This is why exceptional emphasis is laid on the feeding technology of the pullet growing period already by the breeding companies, though it is also true that attention has been drawn to the events of the few first weeks for only the past years.

In the field of feeding it has meant a continuosly new challenge to satisfy the nutriton demands of the modern hybrids in every respect, and feeding technology itself will be more and more important.

The growing period is becoming shorter and shorter, the egg production starts earlier and earlier at reaching smaller body weight, thus any ”mistake” made during the first few weeks of growing can be incorrigible in the future.

According to ELLIOT (2002) it is a fact that the modern layer hybrids are more sensitive to the faults of feeding and management than their ancestors, and this sensitivity can be even more serious from the effect of technological stressors.

Taking into consideration also the thoughts above it seems, that nowadays the biological limits of the improvement of egg production capability have to be searched in the controlled growth and evolution of certain organs, organisms during pullet growing.

It is useless to provide sufficient nutrition in every respect during the egg production period, unless at the pullet growing period the maximum of biological effeciency was aimed by the feeding.

The question arises, to what extent it can be possible to interfere in these physiological processes with special, rational dietary supply which is more flexibly suitable for the growth of pullets during the exceptionally critical starting period of growing, and to what extent the future results will justify the correctness of the concept?

According to our decision two concepts will be competed: a detailed comparison test will be executed to examine the effect of a widely used, „classical" starter diet with traditional composition in mashed form, and that of a special pre-starter diet according to the new concept which is different both in nutrient content and form (crumbled) from the other.

During the growing with the examination of the standard characteristics an answer was searched to the question how the body weight, mortality, the measurement of the organs and the proportion of those compared to their body will change as a result of the feeding treatment at the technologically critical dates.

During my scientific investigations an answer was searched to the question how the whole body composition in terms of chemistry of the layer

hybrid which has been breeded for the longest period of time on earth will change during the growing period – when the development of the body and preparation for the egg production is happening – then during the egg production period, when intensive productivity is characteristic to the animal organism.

The description to what extent can these changes be traced by CT (computer tomoghraph examinations and chemical analyses done at laboratories)? Is there any difference and if so to what extent between Leghorn and medium heavy type, due to the selection which has been performed for decades?

During the laying period with the examination of numerous standard characteristics it was to be found out if different feedings are applied during the first few weeks of life will their effect be shown in the future level of production?

Can we observ later how the different genotype layers react on the feeding treatment in different laying systems?

The experimental work on examining the different dietary supply at pullet age was significantly supported by the several decades' experience of the Department of Poultry- and Companion Animal of the Animal Sciences Faculty of Kaposvár University on the central performance tests of layer hybrids, since the layer tests of the Hungarian breeding authorities (OMMI and MGSZH) are regularly executed by them.

The preparation of these theses was also supported by **AGROKOMPLEX** C.S. Feed Producer and Distributor Joint-Stock Company with their international feeding experience with their own technical and scientific background.

2. Materials and methods

The animal experiments were set up at the experimental poultry farm of Kaposvár University, where Leghorn-type (Hy-Line W-98) and medium heavy body (Hy-Line Brown) layers were tested at the same time.

The experiment lasted from the placement of the day-old chickens till the end of the egg production period, until slaughtering which was executed at the age of 92 weeks. At the time of placement it was cut the phalangeal individually with thermo-kauter in order to ensure that during the experiment the feeding treatment of every bird can be unambigously traceable and controllable. The total stock was de-beaked at the age of 7 days.

The experimental stock was brooded from day-old age till transfering to the layer house – that was at the age of 18 weeks– in litter, in the air conditioned growing building of the test farm without windows.

The individual ground space of the pens used during the growing was 9.2 m^2. The stocking happened by genotype (2) and by feeding treatment (2) into separate pens, placing 175 day-old chicks by the group repeated 7 times. The total number of the experimental groups during the growing period was 28, while 2 further pens were operated as reserves. The placement of the certain groups within the stable happened in blocks, within this in pens of randomised position. The total experimental stock consisted of 4900 pullets.

During the egg production period the performance of the layer hybrids was examined in traditional cage system and in alternative system. In the laying period the measurement of the 3 floor Delta type cages was 40x46 cm, the floor angle was 7 degrees. 3 layer hens were placed into the 1840 cm^2 cage, thus the space for one layer hen was 613 cm^2 which fulfills the EU (550 cm^2) requirements.

There were 60 layer hens placed per block into the layer house in cage system, into separate cages by type and by feeding treatment, repeated 18 times. Besides the experimental groups – in order to standardize the number – a reserve stock was formed, out of which died birds were replaced.

In the alternative system there were 53 layer hens placed into the pen of 5.52 m^2 ground space, thus there were 1041 cm^2 for one layer hen. 30 % of the pen was litter, while the rest was battery system. There were 14 laying nests in every pens, thus there were 3.8 layer hens for one nest.

In the alternative system the forming of the experimental setting happened separately by types and by feeding treatment, there were 212 layer hens placed per block repeated 3 times. There the starting number was 636. Using the full capacity of the alternative pens, there was no possibility of replacing died birds.

In line with the aims of the examination there were two feeding treatment sets. The feeding programs were different from each other only in the starter diets fed during the weeks 0-4^{th} (experimental diet of special composition, and traditional, that is control diet). The pre-starter diet of special composition used during the experiment was prepared based on the tried and trusted conception at the broilers. Our aim was to add some extra to the growth of the birds with the dietary supply. The complete diets necessary for the experiment were produced by the Zichyújfalu feed plant of AGROKOMPLEX C.S. CO. (PROVIMI Group).

The preventive immunisation program of pullet growing was defined taking into consideration the offers of the breeding companies and the local animal health situation. During the growing and laying period the artificial lighting program was used offered by the breeding company.

During the growing and egg production period the following standard characteristics were examined.

The death of the birds was recorded daily – mortality in percentage of the starting number – until the age of 2, 18, 72 and 92 weeks regarding every experimental group.

Live weight was measured at day-old age and later at the age of 3, 4, 6, 8, 10, 12, 14, 18, 20, 25, 30, 52 and 72 weeks, and using the data the deviation (CV %) was calculated. During the pullet growing period every bird was individually measured at the weighing date and the received data was averaged by group and the deviation was calculated.

The feed intake and consumption per one pullet (until the age of 18 weeks) and per the production of one egg were calculated. During the pullet growing period at 7 dates (at the age of 4, 6, 8, 10, 12, 14, 18 weeks) the quantity of the feed consumed by the certain groups (175 pullets/group) was measured. During the laying period the feed-intake of the chosen groups (by feeding treatment and genotype 60-60 layer hens in cage and 53-53 in alternative pens) was measured every month for a week and this was considered as relevant in the actual month.

The growth of the experimental stock and the development of certain organs were controlled at a previously set date, when at every occasion the computer tomographic (CT) X-ray examination, total body analysis, bone skeleton examination and that of the internal organs was made on 20 (by the treatment and by hybrid 5-5) pullets and layer hens.

The *in vivo* CT examinations were done at the age of 12, 14, 20, 25, 30, 52 and 72 weeks. At every date there were measured 10-10 birds by genotype at the Diagnostical and Onkocardiologic Institute of the Faculty of Animal Sciences in Kaposvár.

The birds were examined by the 3, fixed on their belly without anaesthesia (ROMVÁRI et al., 1994).

After the CT examination the birds were slaughtered and internal organ examination was done by genotype on 10-10 species on each occasion. Always the same two veterinarians made the autopsies according to a previously set autopsy methodology. The weight and volume of the heart, the weight and volume of the liver (with bile), the weight of the ovary, the length and weight of the left thigh bone, the length of the breast bone crest, the weight of the *thymus* and the weight of the Fabricius bursa (*Bursa fabricii*) were measured. The volume of the internal organs was defined by water displacement method in measuring cylinder.

After examining the internal organs, the total body crude protein, crude fat, crude ashes contents were defined from 100 g homogeneous total body on the Chemistry-Biochemistry Department of Kaposvár University.

The 50 % egg production was recorded at both hybrids – as the date of mature – based on the number of live days. The determination was made upon the fact, when the average egg production of the relevant group reached or exceeded the 50 % egg production for 3 subsequent days, the date of the middle day was considered as the day of mature.

Having reached the 50 % production level, on every fourth week all the eggs produced on the same day were weighed individually in order to decide the feeding treatment and the average egg weight characteristic for the hybrid.

The egg production data were recorded during the total period of the examination daily and by the experimental group.

Egg production projected for the average bird number was calculated until the day of mature, later on every fourth week, until the end of the egg production period (at the age of 92 weeks) by keeping method for the two feeding treatments and genotypes.

Sample was taken for studying the quality parameters of the eggs at the age of 30 and 67 weeks and the qualitative characteristics of the food egg were defined, which were the followings. Besides the individual egg weight the dry shell weight, the density of the eggshell and the thickness of this were measured.

The examined sample was the total egg quantity produced by one experimental unit (15 layer hens) at the groups placed in cages, while at the production stocks kept in the alternative system it was 20-20 eggs chosen by chance.

During the total production period this meant the examination of 420 eggs. The examinations were carried out only in the afternoons and only with the fresh eggs of the day.

In order to prove the reliability of the differences measured among the experimental groups a variance analysis was done with several factors at every date separately, regarding the mortality, live weight, feed conversion, egg production, bone skeleton, and the internal organs, during which the SPSS 10.0 FOR WINDOWS (1999) statistical program package was used.

In the case of the CT examinations the construction of the 3D hystograms examining the tissue distribution were made with the method of the negative exponential interpolation (SYSTAT, 1990).

3. Results

The results were valuated first regarding the growing period and then the egg production period.

Considering the change of live weight during the growing period – at the age of 4 and 12 weeks – in the case of both layer hybrids a distinct difference could be observed on the favour of the groups eating the special pre-starter diet (P<0.001), which remained the same in its nature until the age of 18 weeks (Table 1).

Table 1

The change of live weight (*g*) of the examined pullet groups during the growing period, depending on feeding treatment, genotype and age

Age (weeks)		Leghorn type		Medium heavy type		Genotype (G)		Feed (F)		Factors		
		Exp.	Control	Exp.	Control	Leghorn type	Medium heavy type	Exp.	Control	G	F	GxF
4	Av. sd	289 ±21^{a}	243 ±4^{b}	288 ±24^{a}	242 ±18^{b}	266 ±32^{A}	264 ±32^{A}	288 ±1^{A}	243 ±1^{B}	NS	***	NS
12	Av. sd	998 ±56^{c}	958 ±59^{d}	1107 ±73^{a}	1039 ±69^{b}	978 28^{B}	1073 ±48^{A}	1052 ±77^{A}	998 ±57^{B}	***	***	***
18	Av. sd	1394 ±96^{c}	1359 ±100^{d}	1509 ±116^{a}	1462 ±108^{b}	1376 ±24^{B}	1486 ±33^{A}	1452 ±81^{A}	1411 ±72^{B}	***	***	NS

Factors: G=genotype, F=feeding, GxF= interaction. Exp.= experimental
a-b: the group averages indicated with small letters are significantly different from each other at the respective date of taking the sample (P<0.05).
A-B: the feed and genotype averages indicated with capital letters are significantly different from each other.
Levels of significance: *=P<0.05; **=P<0.01; ***=P<0.001; NS=P>0.05.
The data are in the form of average value and ± standard deviation (sd).

At the end of the starter phase – that is at the age of 4 weeks – among the pullet groups eating the experimental and the control diets an equal body weight difference of 46-46 g could be weighed at both genotypes which is equal to a 19 % live weight surplus in relative sense for the advantage of the group eating the experimental diet.

At the age of 12 weeks of growing – though already 2 months passed since the end of the starter phase – the advantage of the groups eating the experimental diet is still considerable, and significant at the same time ($P<0.001$).

Studying the body weight data of the experimental groups at the age of 18 weeks it can be observed that though the difference caused by the two feeding treatments diminished to less and less, it has still remained statistically provable until the end of pullet growing period. This tendency is the same among others as the experimental results of DORAN et al. (1983), KESHAVARZ (1984), HUSSEIN et al. (1996) and that of SUMMERS and LEESON (1994), who experienced the similar phenomenon when at the beginning of the pullet growing period a diet with higher crude protein and higher energy content was fed.

Observing the feed intake of pullets (Table 2) based on the results of the first 4 weeks in the case of both genotypes a significant difference was measured ($P<0.001$) among the feeding treatments.

Table 2

The feed intake of pullets characteristic for the growing period depending on feeding treatment, genotype and age (*g/pullet*)

Age (weeks)		Leghorn type		Medium heavy type		Genotype (G)		Feed (F)		Factors		
		Exp.	Control	Exp.	Control	Leghorn type	Középnehéz type	Exp.	Control	G	F	GxF
0-4	Av. sd	610 ±18^{a}	510 ±8^{c}	590 ±12^{b}	480 ±13^{d}	560 ±70^{A}	530 ±77^{B}	600 ±14^{A}	495 ±21^{B}	*	***	NS
0-18	Av. sd	5982 ±8^{a}	5814 ±74^{b}	6022 ±13^{a}	5877 ±3^{b}	5898 ±118^{B}	5950 ±102^{A}	6002 ±28^{A}	5845 ±44^{B}	*	***	NS

At the Leghorn type pullets a 100 g more (16 %), while at the medium heavy weight pullets a 110 g (19 %) more feed intake was observed at the

experimental groups eating crumbled, special pre-starter diet compared to the control group eating mash diet.

Observing the feed consumption during the whole pullet growing period (0-18 weeks) in absolute value compared to the data at the age of 4 weeks, the difference has grown to 168 g at the Leghorn pullets, and to 145 g for the advantage of the groups eating the pre-starter diet, which can be considered significant ($P<0.05$) in both cases in spite of the fact that this difference equals only to 2.5-3 % relative difference. During the pullet growing period due to the feeding treatment the experienced differences in the feed intake are equal to those described by BISH et al. (1984), but show contrary tendency with the results achieved by HUSSEIN et al. (1996).

The evolution of the skeletal system can partly be traced by the regular measurement of the length of the breast bone (*sternum*) (Table 3), and partly by weight of the left side thigh bone (*femur*) (Table 4).

Table 3

The change of the length of the breast bone (*sternum*) depending on age, genotype and feeding treatment *(mm)*

Age (weeks)		Leghorn type		Medium heavy type		Genotype (G)		Feed (F)		Factors		
		Exp.	Control	Exp.	Control	Leghorn type	Medium heavy type	Exp.	Control	G	F	GxF
4	Av.	57.4	54.0	55.8	52.4	55.7	54.1	56.6	53.2	NS	**	NS
	sd	±1.8 ^{a}	±1.7 ^{bc}	±3.3 ^{ab}	±1.5 ^{c}	±2.4 ^{A}	±2.4 ^{A}	±1.1 ^{A}	±1.1 ^{B}			
8	Av.	79.0	74.4	79.2	78.0	76.7	78.6	79.1	76.2	NS	*	NS
	sd	±2.1^{a}	±4.2^{b}	±1.3^{a}	±3.5 ^{ab}	±3.3 ^{A}	±0.8 ^{A}	±0.1 ^{A}	±2.6 ^{B}			
12	Av.	98.8	93.2	102	95.4	96.0	98.7	100.4	94.3	NS	***	NS
	sd	±2.4 ^{ab}	±2.8 ^{c}	±4.3 ^{a}	±2.8 ^{bc}	±3.9 ^{A}	±4.7 ^{A}	±2.3 ^{A}	±1.6 ^{B}			
18	Av.	109	109	116	107	109	111	112	108	NS	*	*
	sd	±6 ^{b}	±3 ^{b}	±3 ^{a}	±2 ^{b}	±1 ^{A}	±6 ^{A}	±5 ^{A}	±1 ^{B}			
30	Av.	101	102	112	108	102	110	107	105	*	NS	NS
	sd	±4 ^{b}	±7 ^{b}	±10 ^{a}	±5 ^{ab}	±1 ^{B}	±3 ^{A}	±8 ^{A}	±4 ^{A}			
52	Av.	111	106	118	117	108	118	115	112	*	NS	NS
	sd	±4 ^{ab}	±4 ^{b}	±11 ^{a}	±7 ^{a}	±3 ^{B}	±1 ^{A}	±5 ^{A}	±8 ^{A}			
72	Av.	112	109	115	115	111	115	113	113	NS	NS	NS
	sd	±6 ^{a}	±2 ^{a}	±5 ^{a}	±4 ^{a}	±1 ^{A}	±1 ^{A}	±2 ^{A}	±4 ^{A}			

Analyzing the data it can be stated that during the growing period – that is between the age of 4 and 18 weeks – the growth of the bone skeleton of the groups eating special pre-starter diet is more intensive, and the breast bone of the pullets fed with this diet is significantly longer ($P<0.05$), apart from the genotype of the bird. The significance levels of the statistical calculations made to prove the reliability of the found differences among the feeding treatments reflect the same (between $P<0.05$ and $P<0.001$). Among the examined genotypes during the growing period an appreciable difference could not be found.

During the egg production period (data of 30-72nd weeks) the differences among the groups have been completely changed. The different feeding at pullet age had no effect from reaching the peak production (30th week), but at the same time the difference between the two genotypes became considerable and significant for the advantage of the medium heavy hybrid, except for the last date of measurement, when because of the decrease of the difference the statistical confirmation did not happen.

The change of the weight of the thigh bone is shown by the data line included in Table 4, depending on the genotype and the feeding. During the pullet growing period at the age of 4, 12 and 18 weeks the thigh bone weight of the groups eating pre-starter diet earlier was significantly bigger ($P<0.01$ and $P<0.05$) than those fed with control diet, apart from the genotype of the birds, which difference reached the 6.7 – 8.7 % relative magnitude in the averages of the feeding treatment. On the 30th week a significant surplus was shown on the advantage of the control diet ($P<0.05$), but after this a real, that is a statistically veryfied difference could not have been proved between the two feeding treatments.

Table 4

The changes of the weight of the thigh bone (*femur*) depending on age, genotype and feeding *(g)*

Age (weeks)		Leghorn type		Medium heavy type		Genotype (G)		Feed (F)		Factors		
		Exp.	Control	Exp.	Control	Leghorn type	Medium heavy type	Exp.	Control	G	F	GxF
4	Av.	4.25	4.06	4.56	4.18	4.15	4.37	4.40	4.12	*	*	NS
	sd	±0.12 ^{ab}	±0.63 ^{b}	±0.29 ^{a}	±0.29 ^{b}	±0.44 ^{B}	±0.34 ^{A}	±0.27 ^{A}	±0.47 ^{B}			
8	Av.	5.48	5.6	6.18	5.86	5.54	6.02	5.83	5.73	*	NS	NS
	sd	±0.17 ^{b}	±0.75 ^{ab}	±0.23 ^{a}	±0.32 ^{ab}	±0.08 ^{B}	±0.23 ^{A}	±0.49 ^{A}	±0.18 ^{A}			
12	Av.	8.64	7.66	9.58	9.10	8.15	9.34	9.11	8.38	***	**	NS
	sd	±0.44 ^{b}	±0.47 ^{c}	±0.64 ^{a}	±0.56 ^{ab}	±0.69 ^{B}	±0.34 ^{A}	±0.66 ^{A}	±1.02 ^{B}			
18	Av.	9.60	9.46	11.46	10.2	9.53	10.83	10.53	9.83	**	*	NS
	sd	±1.19 ^{b}	±0.88 ^{b}	±0.58 ^{a}	±0.18 ^{b}	±0.10 ^{B}	±0.89 ^{A}	±1.32 ^{A}	±0.52 ^{B}			
30	Av.	9.20	9.93	11.43	12.79	9.57	12.11	10.31	11.36	***	*	NS
	sd	±0.52 ^{c}	±0.54 ^{c}	±0.85 ^{b}	±1.67 ^{a}	±0.52 ^{B}	±0.96 ^{A}	±1.58 ^{B}	±2.02 ^{A}			
52	Av.	10.30	9.90	13.88	13.10	10.10	13.49	12.09	11.50	***	NS	NS
	sd	±0.67 ^{b}	±0.65 ^{b}	±0.96 ^{a}	±0.74 ^{a}	±0.28 ^{B}	±0.55 ^{A}	±2.53 ^{A}	±2.26 ^{A}			
72	Av.	10.40	10.40	12.50	12.80	10.40	12.65	11.45	11.60	***	NS	NS
	sd	±0.82 ^{b}	±0.74 ^{b}	±1.22 ^{a}	±0.57 ^{a}	±0.10 ^{B}	±0.21 ^{A}	±1.48 ^{A}	±1.70 ^{A}			

It can be well seen from the data that with slightly changing significance, but very unambigously the weight of the thigh bone of the medium heavy hybrid showed a significant surplus out of the genotypes at all the examined ages compared to the Leghorn hybrid which is the logical consequence of the smaller body weight of the easy body type and of the size-wise difference of the two genotypes.

During the examination of some characteristics of the bone skeleton, like the regular control of the length of the breast bone and the weight of the thigh bone, it was shown that the differences experienced during the measurements are in connection with each other and partly can explain the differences found in live weight. Based on the available data the weight gain of the pullets during the growing period was influenced by feeding the pre-starter diet favourably, and the advantage deriving from this was devoted partly for the more intensive growing of the bone skeleton. Examining the genotypes separately, still a significant difference could be observed in the

length of the breast bone at the age of 12 weeks at the Leghorn type hybrids for the advantage of the experimental diet, though at the age of 18 weeks no difference could be observed between the two feeding treatments neither in the length of the breast bone nor in the weight of the thigh bone. At the same time the favourable effect of this kind of the experimental pre-starter diet was veryfied at the case of the medium heavy type hybrid at the age of 18 weeks by both heavier thigh bone and significantly longer breast bone growing. In accordance with the management guides (HY-LINE VARIETY BROWN COMMERCIAL MANAGEMENT GUIDE, 2002-2004. and HY-LINE VARIETY W-98 COMMERCIAL MANAGEMENT GUIDE, 2002-2003.) the development of the bone skeleton (in the present case the length of the breast bone and the weight of the thigh bone) reached 80-90 % of the final size.

After finising the pullet growing period both in the length of the breast bone and the weight of thigh bone only slight growing could be observed, and significant difference was not measured as the effect of the feeding treatment of the pullet age, only the difference between the genotypes could be observed. This latter is due to the more intensive bone skeleton building of the medium heavy type, which derives from the bigger life weight characteristic to the genotype.

During the growing, then the egg production period no statistically valuable difference could be observed as the effect of the special pre-starter diet on the absolute weight of the heart, difference could be found only between the two examined genotypes. According to this the heart of the brown shell egg hybrid was significantly heavier ($P<0.01$) (4.26 g compared to 3.87 g and 8.75 g compared to 7.58 g) than that of the Leghorn type.

During the growing period the effect of the pre-starter diet on the weight of the liver was provable only until the feeding of the diets with different nutrient value lasted (4^{th} week of life), and this could really be experienced

only at the Leghorn type hybrid, which was also statistically confirmed ($P<0.05$). Any other provable difference which could have been deriving from the different feedings could not be experienced at any other dates of measurement.

At the same time, at the age of 12 and 72 weeks the two genotypes did not react on the feeding treatment in the same way, which resulted in a significant interaction between the type of the layer hen and the feeding. The change of the liver capacity in most of the cases supports the differences found in the weight of the organ and those evaluated above.

Examining the weight of the *thymus* during the growing period it was experienced that the weigth of this so important organ considering the resistance of the poultry was not influenced effectively by young age feeding.

Examining the weight of the Fabricius-bursa (*Bursa fabricii*) during the growing period evaluable differences could be observed at the age of 4 and 8 weeks, but these differences were not due to the feeding, but to the genotype and were shown in the bigger organ weights of the Leghorn type hybrid.

The evolution of the sexual organs which are of determining importance on the later egg production was observed on one hand with the repeated control of the growth of ovary (*ovarium*), on the other hand with the help of the *gonado-somatic index calculation* (%) (=weight of ovary x 100/live weight) which is an especially often used method in fish farming (LEFLER et al., 2003).

The data regarding the weight of the ovary were summarised in Table 5.

It can be seen from the mentioned data that on the weight of the ovary the feeding had an effect at the age of 8, 18 and 72 weeks, while the genotype had a significant effect at the age of 12 and 18 weeks ($P<0.001$ and $P<0.05$).

Table 5

The change of the weight of the ovary during the growing and laying period *(g)*

Age (weeks)		Leghorn type		Medium heavy type		Genotype (G)		Feed (F)		Factors		
		Exp.	Control	Exp.	Control	Leghorn type	Medium heavy type	Exp.	Control	G	F	GxF
8	Av. sd	0.36 ± 0.06 ^{a}	0.26 ± 0.06 ^{bc}	0.32 ± 0.05 ^{ab}	0.24 ± 0.06 ^{c}	0.31 ± 0.07 ^{A}	0.28 ± 0.06 ^{A}	0.34 ± 0.03 ^{A}	0.25 ± 0.02 ^{B}	NS	**	NS
12	Av. sd	0.60 ± 0.07 ^{a}	0.46 ± 0.06 ^{b}	0.44 ± 0.06 ^{b}	0.46 ± 0.09 ^{b}	0.53 ± 0.10 ^{A}	0.45 ± 0.01 ^{B}	0.52 ± 0.11 ^{A}	0.46 ± 0.01 ^{A}	*	NS	NS
18	Av. sd	35.79 ± 7.06 ^{a}	9.93 ± 3.74 ^{b}	1.70 ± 1.13 ^{c}	1.02 ± 0.19 ^{c}	22.87 ± 18.29 ^{A}	1.36 ± 0.48 ^{B}	18.75 ± 24.11 ^{A}	5.48 ± 6.31 ^{B}	***	***	***
30	Av. sd	52.3 ± 8.9 ^{a}	46.2 ± 7.7 ^{a}	51.8 ± 2.1 ^{a}	52.8 ± 6.3 ^{a}	49.2 ± 4.3 ^{A}	52.3 ± 0.7 ^{A}	52.0 ± 0.4 ^{A}	49.5 ± 4.7 ^{A}	NS	NS	NS
52	Av. sd	42.5 ± 3.7 ^{a}	47.1 ± 8.7 ^{a}	43.6 ± 6.3 ^{a}	48.6 ± 5.9 ^{a}	44.8 ± 3.3 ^{A}	46.1 ± 3.5 ^{A}	43.1 ± 0.8 ^{A}	47.9 ± 1.1 ^{A}	NS	NS	NS
72	Av. sd	52.3 ± 8.0 ^{a}	44.3 ± 9.3 ^{ab}	47.9 ± 6.9 ^{ab}	38.9 ± 8.1 ^{b}	48.3 ± 5.7 ^{A}	43.4 ± 6.4 ^{A}	50.1 ± 3.1 ^{A}	41.6 ± 3.8 ^{B}	NS	*	NS

This allows the conclusion that during the pullet growing period the advantage of feeding the special pre-starter diet in the egg production can be seen in the earlier ”set up” and its more persistent, steady nature. Observing the data it is clear that until the age of 18 weeks, the group eating the experimental diet of the Leghorn type had at almost all dates a significantly bigger ($P<0.05$) ovary weight than the other groups. Attention has to be paid to the changes which happened in the last third of the growing period, since we can experience tremendous changes in the evolution of the ovary between the age of 12 and 18 weeks. In the case of the Leghorn type eating experimental diet, the ovary weight at the age of 18 weeks is with 35.19 g (59 times), in the case of the control group with 9.47 g (21 times), while in the case of the group of medium heavy type eating experimental diet only with 1.26 g (4 times), in the case of the control group with 0.56 g (2.2 times) became bigger, than at the age of 12 weeks. Within the laying period at reaching the peak production – practically by the age of 30th week – the differences in the ovary weight which were experienced earlier have

disappeared. Approaching the end of the laying period – by the age of 72nd week – the group of Leghorn type eating the experimental diet had again a significantly bigger ovary weight ($P<0.05$) than the control group of the medium heavy type.

As a matter of the calculated *gonado-somatic index* (Table 6) very similar changes could be experienced, as in the case of the ovary weight.

Table 6

Change of the gonado-somatic index during the growing and laying period

Age (weeks)		Leghorn type		Medium heavy type		Genotype (G)		Feed (F)		Factors		
		Exp.	Control	Exp.	Control	Leghorn type	Medium heavy type	Exp.	Control	G	F	GxF
8	Av.	0.055 ± 0.009 ^{a}	0.040 ± 0.008 ^{b}	0.047 ± 0.007 ^{ab}	0.039 ± 0.009 ^{b}	0.048 ± 0.010 ^{A}	0.043 ± 0.005 ^{A}	0.051 ± 0.006 ^{A}	0.040 ± 0.001 ^{B}	NS	**	NS
	sd											
12	Av.	0.059 ± 0.005 ^{a}	0.047 ± 0.006 ^{b}	0.040 ± 0.005 ^{b}	0.044 ± 0.008 ^{b}	0.053 ± 0.008 ^{A}	0.042 ± 0.004 ^{B}	0.049 ± 0.014 ^{A}	0.046 ± 0.002 ^{A}	***	NS	**
	sd											
18	Av.	2.56 ± 0.56 ^{a}	1.05 ± 0.48 ^{b}	0.39 ± 0.63 ^{c}	0.06 ± 0.02 ^{c}	1.81 ± 1.06 ^{A}	0.23 ± 0.23 ^{B}	1.48 ± 1.54 ^{A}	0.56 ± 0.70 ^{B}	***	***	*
	sd											
30	Av.	3.21 ± 0.52 ^{a}	2.87 ± 0.49 ^{ab}	2.63 ± 0.10 ^{b}	2.75 ± 0.31 ^{ab}	3.04 ± 0.24 ^{A}	2.69 ± 0.08 ^{A}	2.92 ± 0.41 ^{A}	2.81 ± 0.08 ^{A}	NS	NS	NS
	sd											
52	Av.	2.26 ± 0.19 ^{ab}	2.55 ± 0.45 ^{a}	2.04 ± 0.32 ^{b}	2.30 ± 0.31 ^{ab}	2.40 ± 0.21 ^{A}	2.17 ± 0.18 ^{A}	2.15 ± 0.16 ^{A}	2.42 ± 0.18 ^{A}	NS	NS	NS
	sd											
72	Av.	2.65 ± 0.38 ^{a}	2.25 ± 0.51 ^{ab}	2.21 ± 0.30 ^{ab}	1.79 ± 0.35 ^{b}	2.45 ± 0.28 ^{A}	2.00 ± 0.30 ^{B}	2.43 ± 0.31 ^{A}	2.02 ± 0.33 ^{B}	*	*	NS
	sd											

The main averages of the examined factors clearly show that the feeding at young age had a significant effect on the magnitude of the calculated index at the age of 8, 18 and 72 weeks, while the genotype, as the other main factor had effect at the age of 12, 18 and 72 ($P<0.05$ and $P<0.001$). The phenomenon strengthens the earlier conclusion, according to which in the case of breeding layer hybrid pullets, feeding the special pre-starter diet can somehow accelerate the start of the production even at Leghorn type pullets which become sexually mature earlier, but at the last phase of the egg

production it also enables both layer hybrid genotypes for more persistent egg production.

Summarizing the facts, considering the ovary weight and the magnitude of the gonado-somatic index at the age of 18 weeks a statistically also verified difference could be found to the advantage of the pullets eating special pre-starter diet ($P<0.001$) compared to the control group, apart from the genotype of the bird. At the same time in spite of the totally equal environmental system of conditions in every respect, the Leghorn type hybrid is still able to prepare to start the egg production much earlier, which is verified by both features of examination, and further on the earlier sexual maturity unambigously verifies it, too. It is interesting, that at the end of the egg production period a significant difference can be observed again ($P<0.05$) in the ovary weight and the magnitude of the gomado-somatic index to the advantage of the layer hens eating the experimental pre-starter diet, which can be the long-term effect of the early dietary supply as well.

Neither at the birds in cage, nor at those kept alternatively can be economically significant and at the same time no statistically evaluable difference can be observed at the time of maturity of the groups fed differently at pullet age.

It is important to mention though, that at the age of maturity the two layer hybrid types still a determined and stronly significant ($P<0.001$) difference to the advantage of the Leghorn hybrid which matures 4-6 days earlier, which means much more modest advantage for the genotype, than a few decades ago, but it can still be felt to be real biological difference.

During the egg production period it is not surprising that **in the traditional cage system**, the body weight of the Leghorn and medium heavy types between the age of 20 and 72 weeks, apart from the feeding during the growing period and the significant weight increase during the laying period, was significantly different from each other at every examined age. The effect of the experimental pre-starter diet is already not significant at the age of 20 weeks, and during the egg production both in absolute and in relative value loses more of its effect.

During the laying period the tendency of the earlier recorded feed intake suggests that the difference was basically changed. Apart from one exception in cage system the daily feed intake of the layer hen groups bred on experimental diet was less at every phase of the laying period, than the control stock, emphasizing at the same time, that the measured differences could not be regarded statistically as the result of any kind of treatment.

Examining the feed conversion ratio for the total laying period between the groups, significant ($P<0.05$) diffenence was found between the Leghorn group eating the experimental diet and the control group of the medium heavy hybrid, while there was no significant different between the feeding treatments within the genotypes (Figure 1).

In the first third of the laying period (between the 19^{th} and 42^{nd} weeks) effective difference between the treatments could not be observed. It can be well seen on the chart that in the second third (between the 43^{th} and 66^{th} weeks) due to the different capabilities of the two genotypes the feed was better consumed after the peak period by the Leghorn type by an average of 10 %. The measured difference is also veryfied statistically ($P<0.05$). The explanation of the phenomenon can be found in the significantly smaller body weight of the Leghorn type, with the little bit less daily feed intake and compared to this in the favourable proportion of productivity.

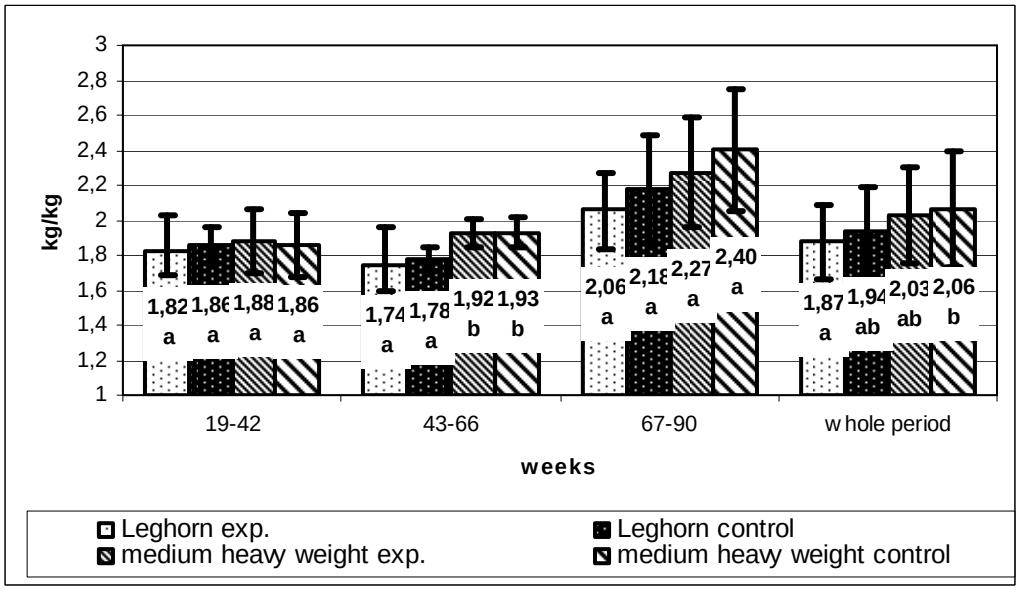

Figure 1

Change of the feed conversion ratio during laying period in cage system, depending on genotype and feeding treatment at pullet age
(feed kg /egg kg)

The different feeding at pullet age had neither any positive nor any negative effects on the egg production of the layers in cage system during the total egg production period.

In the first third of the egg production period, considering the performance of the genotypes, the Leghorn hybrid produced 1.8 eggs less (1.2 %) than its medium heavy companion, which is in spite of its seemingly modest economic effect, still significant ($P<0.01$). The order remained the same in the middle section of the egg production period – between the 45th and 68th weeks –, but the difference between the two types grew a little bit and reached per layer the 2.7 eggs (2.1 %). The egg production did not show any real change in the last third of the egg production period (between 69th and 92th weeks) either. Summarizing the results of the total egg production

period it can be ascertained that the Leghorn groups layed 5.3 eggs less as an average (1.3 %), than the medium heavy hybrids ($P<0.05$).

At cage system examining the change of egg weight the following could be observed. In the first third of the laying period (bet ween the 20^{th} and 44^{th} weeks) the groups of the medium heavy hybrid eating the experimental diet produced eggs with significantly bigger weight, than those of the Leghorn hybrid, at the same time the performance of the control groups of the two genotypes statistically did not show difference. In the medium third of the egg production period feeding had no effect on the weight of the eggs. The order of the genotypes exchanged at the same time. The change is the same as experienced at the alternative system, as the eggs of the Leghorn groups were significantly heavier than those of the medium heavy hybrid. In the last third of the egg production period the orders formed earlier did not change. Considering the averages of the genotypes the Leghorn produced heavier eggs further on, than the medium heavy hybrid, and the difference was significant this time as well.

Examining results of egg quality parameters, it can be stated that the different feeding of pullets did not have an effect on it. Comparing results of two testing times it can be stated that the Leghorn type showed better results regarding to the sketched egg quality parameters during the peak period (in the 30^{th} week), while in the 67^{th} week the medium heavy weight type did it.

From the data it can be proved, that the egg quality parameters of the medium heavy weight type can be regarded stable and permanent as the age of the stock goes forward, but the Leghorn type's results were getting worse significantly during the same period.

In closed, alternative system the effect of the experimental diet on layer hybrids' live weight did not prove to be significant in the egg production period.

Examining the daily feed intake until the age of 42 weeks of the egg production period, experiences were the same as in the cage system. The group fed by experimental diet at the pullet age consumed less amount of feed than the control group, but the difference was not significant in this case either. This tendency was experienced in the middle of laying period with the Leghorn type hybrids – in contrast with the medium heavy weight type – but the tested differences were not enough to reach the values needed for statistical reinforcement. In an economic point of view it can not be neglected that layer hens with the same genotype bred in alternative system consume nearly 1.5 times as much feed as in cage system.

There was not any statistically proved difference among the tested groups in feed conversion ratio.

Regardless to their genotype pullet groups consuming pre-starter diet in alternative system started eggs production earlier and 3 more eggs were laid by them until reaching the age of maturity ($P<0.05$). There could not be found any difference between the average performance of the tested genotypes, but the effect of the special pre-starter was obvious and significant ($P<0.001$) (Chart 7).

The tendency prevailed even in the first four weeks after maturity as well (weeks 20-24th), which means that the effect of the pre-starter diet proved to be strong. As a consequence no significant difference could be found between the treated stocks ($P<0.05$).

Birds fed by pre-starter diet laid 1-1.5 eggs more on average in this period than the control group, while the tested two genotypes did not perform statistically proved differences.

Chart 7

Egg production of the experimental stocks in closed alternative system

(egg/laying hen)

Ager		Leghorn type		Medium heavy type		Genotype (G)		Feed (F)		Factors		
		Exp.	Control	Exp.	Control	Leghorn type	Exp.	Control	Exp.	G	F	GxF
Before maturity	Av.	5.45 ± 1.05 ^{a}	1.81 ± 0.70 ^{b}	4.74 ± 0.39 ^{a}	1.98 ± 0.31 ^{b}	3.63 ± 2.57 ^{A}	3.36 ± 1.95 ^{A}	5.10 ± 0.45 ^{A}	1.90 ± 0.12^{B}	NS	***	NS
	sd											
20-24 weeks	Av.	23.3 ± 0.4 ^{a}	22.1 ± 0.5 ^{b}	23.1 ± 0.2 ^{a}	21.6 ± 0.4 ^{b}	22.7 ± 0.9 ^{A}	22.4 ± 1.1 ^{A}	23.2 ± 0.2 ^{A}	21.9 ± 0.4 ^{B}	NS	***	NS
	sd											
20-44 weeks	Av.	141 ± 3 ^{a}	137 ± 2 ^{b}	140 ± 1 ^{ab}	136 ± 3 ^{b}	139 ± 3 ^{A}	138 ± 3 ^{A}	141 ± 1 ^{A}	137 ± 1 ^{B}	NS	*	NS
	sd											
45-68 weeks	Av.	111 ± 1 ^{a}	111 ± 1 ^{a}	112 ± 1 ^{a}	112 ± 2 ^{a}	111 ± 1 ^{A}	112 ± 1 ^{A}	111 ± 1 ^{A}	111 ± 1 ^{A}	NS	NS	NS
	sd											
Whole period	Av.	338 ± 4 ^{a}	332 ± 3 ^{a}	336 ± 1.3 ^{a}	333 ± 5 ^{a}	335 ± 4 ^{A}	335 ± 2 ^{A}	337 ± 1 ^{A}	333 ± 1 ^{A}	NS	NS	NS
	sd											

Examining the first third of the egg production period (between the 20th and 44th weeks) output surplus was found on behalf of the Leghorn type group consuming pre-starter diet ($P<0.05$). It produced even more eggs compared to both control groups. The effect of the special pre-starter diet was four eggs plus, which proved to be significant, supposing 5 % probability of error. Difference could not be proved between the two layer hybrid genotypes.

Examining the weight of eggs in the first third of the laying period, medium heavy weight hybrid groups consuming experimental diet, produced significantly bigger eggs ($P<0.05$), than the Leghorn hybrid groups consuming control diet, while the results of the other groups did not show any difference. According to the average performance of the genotypes, the medium heavy weight hybrid produced heavier eggs than Leghorn ($P<0.05$), the average weight of the eggs was not influenced by the different pullet age feeding.

The same effect, more exactly ineffectiveness was experienced in the middle or last third of the egg production period. The average weight of the

eggs typical to the genotypes turned – even if not in a spectacular way – similarly to the cage system compared to the previous period.

It is true, but not in a significant way, that Leghorn groups produced a bit bigger eggs in absolute value in the middle third of the laying period, than their medium heavy weight counterparts.

According to the egg quality parameters, difference was found ($P<0.05$) only in respect of the shell thickness between the groups treated in different ways with the measurements carried out in the 30th week. Leghorn hybrid control group had the thinnest shell. Reaching the end of the egg production period, in the 67th week, examining the average performance of the groups can be stated, that the dry egg shell weight of the Leghorn type hybrid consuming control diet was smaller, than all of the other groups' ($P<0.05$).

Similar changes were experienced in respect of the shell density just like in the case of the shell weight. The shell density of Leghorn hens' eggs was the smallest, among the examined groups consuming control diet.

The *in vivo* CT examination proved to be appropriate for describing the process of body tissue changing in the case of different types of layer hybrids, for following the muscle development, for describing the fat content of the body or for presenting the development of fat deposition in time. In the last two decades of the 20th century breeder companies consciously and succesfully approached the medium heavy type layers – inclined to gain extra weight – towards the Leghorn type in respect of more qualities that are typical (live weight, feed consumption, feed conversion ratio). According to the examination of changing of the body composition, the relatively bigger weight of the hybrids at the age of 25-30 weeks parallel with a bigger body fat content, seem to mean a bigger security in a physiological point of view, for the peak production, occuring this time. On the contrary, the Leghorn

type uses the energy put in with the diet for producing eggs, which may mean a bigger production risk with the lack of appropriate reservs.

Summarising the experiences, the results allow us to take a consequence according to which at the beginning of breeding the excess body weight can be used for developing the bone skeleton, heart and blood wessels, sexual organs in a more intensive way, with the medium heavy type hybrid stocks, while the Leghorn type hybrid confirmed it only with the bigger weight and development of sexual organs.

Use of special pre-starter diet, due to the input of excess nutrients, is able to accelerate the development of sexual organs in a spectacular way and to cause a burst in the starting of egg production in the feeding programme of layer hybrids that are more and more sensitive to the environment of production.

Although the use of pre-starter diet in the whole process of egg production does not give significant output surplus in cage system, but the four eggs/hen surplus in the first third of the egg producing period in the alternative system is not a negligible difference in the stronger and stronger competition of production.

From a practical point of view, planting pre-starter diet in up to date feeding technology of modern layer hybrids is highly recommended due to the beneficial effect on the starter period and because of the higher security of production. It must be emphasized, that pre-starter diet should be regarded as a later recovering investment and not as a factor increasing feed costs at the beginning of growing period.

4. Discussion and recommendations

After evaluating the results of experiments a question arises: Is the use of pre-starter diet worth recommending in the case of layer type pullet stocks' feeding programme?

The answer can be found after summarising the effects of new feeding programme on the particular standards of value.

- The different early age nutrition supply has a strong effect in respect of the body weight during the growing period, so it can be an appropriate method to gain a bigger body weight with a low cost of feeding.
- According to the results it is obvious, that in the case of medium heavy hybrid, only the group consuming experimental diet reached the standard body weight (1500 g) desirable at the end of the pullet growing period. In the case of hybrids producing brown shelled eggs – that are common in Hungary – special pre-starter diet can be one of the means of reaching the pullet age body weight, which is the aim of the technology, that's why use of the pre-starter diet is highly recommended for the companies growing pullets.
- It is not surprising that in the changing of live weight in the traditional cage system, the average body weight of Leghorn type and the medium heavy hybrid between the ages of 20^{th} and 72^{th} weeks, was significantly different at all the examined ages – regardless to feeding during growing period and the significant growing of body weight during the laying period. In respect of the body weight an important difference exists between the two hybrids in spite of the continuous genetical changes.

- During the one year long egg production period in the cage system, the body weight of Leghorn type layer hybrids grew by 524 g in average, while it was 494 g in the case of the medium heavy hybrids. The biggest difference between the two hybrids was in the 30th week (more than 300 g), which fell below 200 g by the end of the egg production period. The higher live weight of the pullets consuming experimental diet reoccured in all of the ages as a tendency. So applying pre-starter diet can be highly recommended because of this fact as well. In addition, a kind of security is given to the production through the higher body weight.
- During the one year long egg production period in the closed, alternative system the body weight of the Leghorn hybrids grew only by 373 g in average, while it was 485 g in the case of the medium heavy hybrids. The difference from the 30th week – between the two hybrids can be stated constant – 360 g. The higher live weight of pullets consuming experimental diet can be seen again in the live weight of medium heavy hybrids, at all ages again, while this system has modified the pace of the body weight gain of laying hens during the egg production period in a significant way, by giving a better opportunity to move. It caused spectacular differences comparing with the results in the case of the birds kept in cage system.
- As a result of different feed treatments among different genotypes there was not experienced any difference either in the homogenity of live weight or in the mortality.
- Examinig the feed consumption during the whole period of pullet growing (18 weeks), the difference has grown in absolute value according to the four weeks data in the case of both the Leghorn type pullets and the medium heavy type consuming pre-starter diet as well, which proved to be significant in both cases.

- A significant difference was found between the treatments of Leghorn type and medium heavy control groups consuming experimental diet during the whole egg production period, in respect of feed conversion ratio counted on one kg of eggs with the different groups of layer hens in cages, while the genotypes did not show any important different because of the feed treatment. The effect of early feeding can be seen as a tendency, but not statistically proved, especially in the middle and last third of the laying period. The phenomenon can be another argument in the economical point of view, in favour of introducing use of pre-starter diet in the case of cage system too.
- Pullet groups consuming special pre-starter diet in the alternative system started to produce eggs earlier regardless the genotype, and 3 more eggs were laid on average until reaching maturity. The tendency continued after maturity as well. As a consequence can be seen that applying of pullet age pre-starter diet is suitable for increasing egg production in the beginning of laying period in the alternative system.
- The egg weight is not influenced by the pre-starter diet, neither in cage system nor in alternative system, so according to the shown results it can not be any means of increasing egg weight in practice.
- Examining the results of two testing times, in respect of quality parameters of eggs in cage system, can be stated that Lenghorn type produced better results in the peak (30^{th} week), while in the 67^{th} week medium heavy type did it. Egg quality parametrs of medium heavy type proved to be almost identical as the age went forward, but the parameters of Leghorn type significantly declined during the same period.
- According to the data using of pre-starter diet in cage system did not influence the egg quality parameters significantly either in a positive or in a negative way.

- Significant differences were found to the advantage of different early feeding in respect of several shell quality parameters in alternative system. A significant advantage was found in egg shell thickness in the 30th week, while the same was experienced in the egg shell weight and density in the 67th week, but in the latter case only among the genotypes. So in the alternative system the improvement of egg shell quality is experienced as a result of applying pre-starter diet.
- Indicators of bone skeleton development, such as length of the breast bone and the weight of the thigh bone showed that differences observed during measuring were in connection and the differences observed in the live weight of the birds can partly be explained by them. Feeding of pre-starter diet during growing had a beneficial effect on the live weight gain of the pullets and – according to the data – it was used for a more intensive development of bone skeleton. Examining genotypes separately – in the case of Leghorn type hybrid, at the age of 12 weeks – a significant difference was found to the advantage of experimental diet in the lenght of breast bone. But at the age of 18 weeks there was not found any difference between the two feed treatments, either in the length of breast bone or in the weight of the thigh bone. At the same time the medium heavy hybrid even at the age of 18 weeks confirmed the beneficial effect of the pre-starter diet by producing a significantly longer breast bone and heavier thigh bone in the case of both observed qualities.

- During the egg production period only a little growth was experienced in the length of the breast bone and in the weight of the thigh bone and there could not be measured any significant different as an effect of the pullet age feed treatment. The sharp difference occuring between genotypes is a consequence of a stronger bone skeleton building with the medium heavy type, which can be attributed to bigger live weight, characteristic for the genotype.
- Observing the inner organs – heart, liver – during the growing and laying period, there was not measured any statistically provable difference in respect of the absolute weight of the heart as the effect of the pre-starter diet; while differences between the observed two genotypes were sharp and notable.
- The effect of the pre-starter diet on the liver weight could be proved only while different diets were fed (first 4 weeks) and it could be traced only in the case of Leghorn hybrid. No traceable difference was experienced in the other measuring times. Changing of the liver's capacity in the majority of the cases supports the changes found and evaluated previously in the weight of the organ. There was not any evaluable different among the observed groups in the egg production period.
- Observing the development of sex organs determining for the later egg production, it can be deducted from the data, that during growing pullets, advantage of using special pre-starter diet on the earlier *"set up"* to produce eggs manifests in its more persistent character. Until the age of 18 weeks the group of Leghorn type consuming experimental diet had a significantly bigger ovary weight, than the other groups. There were enormous changes in the development of the ovary between the 12^{th} and 18^{th} weeks. While the previously experienced differences in the weight of the ovary absolutely disappeared by the 30^{th} week reaching the peak

production. By the age of 72nd week – approaching end of the egg production period – the group of the Leghorn type fed by experimental diet had an ovary with a significantly bigger weight, than the medium heavy control group, indicating a much persistent, steady ability of egg production.

- Very similar changes were observed in the respect of gonado-somatic index just like in the case of the ovary weight. Young age feeding had a significant effect at the age of 8, 18 and 72 weeks, while in the case of the other main factor the genotype, it was obvious at the age of 12, 18 and 72 weeks. The earlier deduction – according to which use of the special pre-starter diet during breeding pullets can accelerate productivity of earlier maturing Leghorn type – is largely confirmed, but it enables both of the two genotypes to a more persistent egg production, even in the last phase.
- Examining the weight of the *thymus* and the Fabricius bursa during the growing period it was observed, that the young age feeding did not influence the weight of these important organs in the point of view of the health status of the poultry. Examining the weight of the Fabricius bursa during growing period, evaluable differences could be observed at the age of 4 and 8 weeks among the genotypes. The differences were due to the bigger organ weights of the Leghorn type hybrid. According to the data, use of pre-starter diet did not influence the immune system of the pullets.

5. New scientific results

1. Among contemporary, commercially distributed modern layer hybrids representing both Leghorn and medium heavy type react sensitively to the different nutrition supply at the early pullet age (0-4th weeks), in respect of the body weight (+46 g; 19 %).

2. During pullet growing the effect of special pre-starter diet in the first four weeks remains until the end of the growing period, with difference of 41 g, in respect of the live weight, and 157 g in the case of feed consumption. At the same time the special pre-starter diet does not influence either the mortality or homogenity of live weight, neither in the growing nor in the egg production period.

3. At the end of the growing period different type layer hybrids react to the pullet age pre-starter diet in different ways in respect of the bone skeleton development. As an effect of the different feed treating medium heavy hybrid had a significantly longer breast bone (*sternum*, +9 mm) and a bigger thigh bone (*fermur*, +1.25 g) than the control stock.

4. The special pre-starter diet influences preparation of pullets to produce eggs in an advantegous way regardless their genotype. The weight of their ovary was bigger by 13.3 g and their gonado-somatic index was higher by 0.9 than in the case of their control groups.

5. Leghorn end medium heavy type layer hens producing in alternative system reacted on feeding the pullet age pre-starter diet with a higher egg production (+4 eggs) in the first third of the egg production period (between the 20^{th} and 44^{th} weeks). No similar benefit was observed in the case of cage system.

6. Using pre-starter diet with layer hens producing in closed alternative system, had a positive effect on the quality parameters of the egg shell (thickness, weight and density), while they were not influenced in the case of the stocks kept in cages.

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