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YIELD RESPONSE OF THE LAYING HYBRIDS TO THE MODIFIED COOPS REARING SYSTEM

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Abstract. The management conditions provided to the fowl having not free access to hall floor (Lc, L_1exp and L_2exp) allowed the expression of the used hybrid (Lohmann Brown) potential. Thus, control group yield counted 325.05 eggs, compared to just 311.34 eggs, produced by the L_3exp (hens with free access on hall floor). Mortality has been correlated with the brooding density (7.46÷9.57% in experimental groups and 11.66% in Lc one). Shell was found thicker in L_3exp group (0.369÷0.448 mm), as well as its breaking strength (0.337÷0.348 kg f/cm^2). Microbial load of the shell gradually increased, especially in L_3exp group (148.62÷258.94 germs/cm^2, compared with 106.31÷106.61 germs/cm^2).

INTRODUCTION

Almost 75% of the worldwide laying hens are reared in coop batteries, in some different brooding density conditions, as related to the country or region. The amount of hens, which should populate one single coop, is a quite controversial problem, knowing that selecting fowl for eggs yield improvement led to an increase of their aggressive temperament. Starting from 2012, the egg producers from the European Union will be constrained by law enforcements to use modified coops or other alternative systems in laying hens husbandry, knowing that conventional coops will cease to be used as legal or accepted production facilities. In Romania, the rearing of chicken laying hybrids uses almost exclusively the conventional coops batteries as accommodation manner. The replacement of this system by another one, would lead to the bankruptcy of an economic field that is still profitable.

MATERIAL AND METHODS

The „Lohmann Brown" hens we used as biological material (1731 hens) have been randomly distributed to 4 groups and reared in unmodified coops (Lc), modified coops (L_1exp and L_2exp) and having free access all over the hall (L_3exp), as well (*tab. 1*).

Table 1

Experimental design

Notice	Experimental groups			
	Lc	L_1exp	L_2exp	L_3exp
Husbandry system	superintensive	superintensive	superintensive	intensive
Accommodation density	4 hens/coop of 2000 cm^2	5 hens/coop of 3000 cm^2	6 hens/coop of 6000 cm^2	4 hens/coop of 2000 cm^2
Coop floor surface/hen (cm^2)	500	600	1000	500 cm^2 in laying+resting coop and 500 cm^2 in feeding+watering coop

Initial flock (hens)	432	435	432	432
Coops amount	108*	87**	72**	108***
Coop size (cm)	length=40; wide= 50	length=60; wide= 50	length=120; wide= 50	length=40; wide= 50
Coop floor surface (cm^2)	2000	3000	6000	2000

* standard coops ** modified coops *** feeding+watering coops and laying+resting coops

Several parameters and indexes have been assessed during the study:

Body weight	body weight dynamics
Eggs yield	eggs yield dynamics; laying intensity
Feeding	average feed intake (g/hen/day); feed intake (g feed/egg)
Health status	flock looses dynamics; flock looses casualty
Morphological and physical eggs quality indexes	morphological anomalies (%); eggs weight (g); shell thickness (mm); eggshell breaking strength (kg f/cm^2)
Microbiological eggs quality indexes	microbial load (germs/cm^2 of eggshell)

All groups have been accommodated within the same shelter, divided in four compartments, identical as size and technological conditions.

RESULTS AND DISCUSSIONS

1. Body weight dynamics. The values for this parameter were slightly equal at all 4 groups, during the beginning of our studies (20th week) (1575.31÷1577.82g), whilst the first major differences occurred when fowl reached peak of production (28th week). Thus, hens weight reached 1901.69±40.86g in Lc, de 1870.53±38.07g in L_1exp, 1868.58±45.01g in L_2exp and only 1859.40±45.37g in L_3exp. At the end of our research (80th week), the differences became more pronounced, reaching 2125.13±69.71g at the control group; 2087.83±67.95g at L_1exp group; 2083.03±66.99g at L_2exp group and 2030.29±69.64g at the L_3exp one.

2. Eggs yield and laying intensity *(tab. 2)*. Classical rearing version (4 hens/unmodified coop) proven to generate the highest eggs yield meaning 325.05 eggs/hen. It followed the L_1exp (319.09 eggs/hen), then L_2exp, with 316.32 eggs/hen. The production reached only 311.34 eggs/hen within the L_3exp (free access over the whole rearing compartment), probably due to the energy and protein feed expenditures for the supplementary movements. The highest values of the laying intensity have been reached during the 28th week of life, meaning 91.56% in Lc, 89.97% in L_1exp, 89.88% in L_2exp and 88.35% in the L_3exp one.

Table 2

Eggs yield and laying intensity

Week	Lc				L1exp				L2exp				L3exp			
	Flock (hens)	Eggs yield	Laying %	Eggs/ hen (cumul.)	Flock (hens)	Eggs yield	Laying %	Eggs/ hen (cumul.)	Flock (hens)	Eggs yield	Laying %	Eggs/ hen (cumul.)	Flock (hens)	Eggs yield	Laying %	Eggs/ hen (cumul.)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
20	431.5	1154	38.2	2.67	434	1139	37.49	2.62	431.5	1136	37.61	2.63	431	1115	36.96	2.59
21	431	1753	58.10	6.74	433	1730	57.07	6.61	431	1725	57.17	6.63	430	1694	56.28	6.53
22	431	2261	74.91	11.98	432.5	2232	73.72	11.77	431	2225	73.75	11.79	429.5	2184	72.64	11.61
23	430.5	2503	83.06	17.79	431.5	2471	81.81	17.50	431	2463	81.64	17.50	429	2418	80.52	17.25
24	430	2642	87.79	23.93	431	2608	86.44	23.55	431	2600	86.18	23.53	429	2552	84.98	23.20
25	429.5	2689	89.44	30.19	431	2654	87.97	29.71	431	2646	87.70	29.67	429	2598	86.51	29.26
26	429	2729	90.87	36.55	431	2694	89.29	35.96	430.5	2685	89.10	35.91	429	2636	87.78	35.40
27	428.5	2731	91.05	42.92	430.5	2696	89.46	42.22	429.5	2687	89.37	42.17	428.5	2638	87.95	41.56
28	427.5	2740	91.56	49.33	429.5	2705	89.97	48.51	428.5	2696	89.88	48.46	428	2647	88.35	47.74
29	427	2722	91.07	55.70	428.5	2687	89.58	54.78	428	2678	89.38	54.72	428	2629	87.75	53.88
30	426.5	2702	90.50	62.03	428	2667	89.02	61.01	427.5	2659	88.85	60.94	427.5	2610	87.23	59.98
31	426	2688	90.14	68.34	428	2653	88.55	67.20	427	2645	88.49	67.13	427	2696	86.85	66.06
32	426	2683	89.97	74.63	427.5	2648	88.49	73.39	427	2640	88.32	73.31	427	2691	86.68	72.13
33	426	2648	88.80	80.84	426.5	2614	87.59	79.52	426.5	2606	87.29	79.42	426.5	2657	86.65	78.12
34	425.5	2622	88.08	87.00	426	2588	86.78	85.59	426	2580	86.52	85.48	425.5	2631	84.87	84.07
35	425	2617	87.66	93.16	426	2583	86.62	91.65	426	2575	86.35	91.52	424.5	2626	85.01	90.02
36	424	2588	87.63	99.29	425.5	2567	86.18	97.68	425.5	2560	85.95	97.54	423.5	2613	84.77	95.95

37	422.5	2578	87.44	105.41	424.5	2552	85.88	103.69	424.5	2545	85.66	103.53	422.5	2498	84.46	101.86
38	421.5	2562	87.27	111.52	423.5	2542	85.75	109.69	423.5	2534	85.48	109.51	421.5	2488	84.32	107.76
39	420.5	2538	87.04	117.61	422.5	2529	85.51	115.67	422.5	2522	85.27	115.48	420.5	2475	84.08	113.64
40	420	2523	86.33	123.65	421.5	2505	84.99	121.61	422	2498	84.56	121.40	419.5	2452	83.50	119.48
41	420	2492	85.82	129.66	420.5	2490	84.59	127.53	421.5	2483	84.15	127.29	418.5	2437	83.19	125.30
42	420	2492	84.76	135.59	420	2459	83.64	133.38	421	2453	83.24	133.12	418	2407	82.26	131.08
43	419.5	2470	84.11	141.47	420	2437	82.89	139.18	420.5	2431	82.59	138.90	418	2385	81.51	136.76
44	419	2463	83.97	147.35	420	2431	82.68	144.97	420	2424	82.45	144.67	418	2378	81.27	142.45
45	418.5	2424	82.74	153.14	419.5	2393	81.49	150.67	420	2385	81.12	150.35	418	2340	79.97	148.04
46	418	2398	81.95	158.88	419	2366	80.67	156.32	420	2360	80.27	155.97	418	2314	79.08	153.57
47	418	2376	81.20	164.56	419	2344	79.92	161.91	420	2338	79.52	161.53	418	2292	78.33	159.05
48	417.5	2364	80.89	170.22	418.5	2332	79.60	167.48	419.5	2337	79.24	167.08	417.5	2280	76.01	164.51
49	416.5	2346	80.53	175.86	418	2316	79.15	173.02	419	2311	78.79	172.59	417	2268	77.69	169.96
50	416	2322	79.74	181.44	418	2292	78.33	178.50	419	2285	77.90	178.04	417	2242	76.81	175.33
51	415.5	2307	79.32	186.99	417.5	2277	77.91	183.95	419	2271	77.43	183.46	417	2229	76.36	180.67
52	414.5	2288	78.85	192.51	416.5	2259	77.48	189.37	419	2252	76.78	188.83	416.5	2210	75.80	185.98
53	414	2558	77.91	197.96	416	2229	76.54	194.73	418.5	2222	75.85	194.14	416	2181	74.89	191.22
54	414	2339	77.26	203.37	415.5	2210	75.98	200.05	418	2204	75.32	199.41	415.5	2162	74.33	196.42
55	413.5	2218	76.63	208.73	415	2190	75.39	205.33	418	2183	74.61	204.63	415	2141	73.70	201.58
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
56	413	2196	75.96	214.05	415	2168	74.63	210.55	418	2161	73.85	209.60	415	2121	73.01	206.69
57	413	2172	75.13	219.31	414.5	2145	73.93	215.72	417.5	2137	73.12	214.92	415	2098	72.22	211.75
58	413	2156	74.57	224.53	413.5	2129	73.55	220.87	417	2121	72.66	220.00	415	2082	71.67	218.76
59	412.5	2131	73.80	220.70	413	2104	72.78	225.96	417	2097	71.83	225.03	415	2059	70.95	221.76
60	411.5	2097	72.79	234.79	412.5	2070	71.69	230.98	416.5	2064	70.79	229.98	415	2025	69.71	226.64
61	410.5	2072	72.11	239.84	411.5	2045	70.99	235.95	416	2039	70.02	234.88	414.5	2002	68.99	231.47
62	409	2051	71.64	244.85	411	2024	70.35	240.37	416	2018	69.29	239.73	414	1981	68.36	236.25
63	407	2026	71.11	249.83	410.5	2000	69.60	245.74	415.5	1994	68.50	244.52	414	1957	67.53	240.98
64	405.5	2007	70.71	254.78	409.5	1981	69.11	250.58	414.5	1975	68.07	249.28	413.5	1938	66.95	245.67
65	404.5	1967	69.47	259.64	408	1941	67.96	255.34	413.5	1935	66.85	253.96	413	1898	65.65	250.28
66	403.5	1936	68.54	264.43	406.5	1910	67.12	260.03	413	1905	65.89	258.57	413	1868	64.61	254.78
67	403	1912	67.78	269.17	405.5	1886	66.44	264.68	413	1881	65.06	263.12	413	1844	63.78	259.24
68	402.5	1886	66.94	273.85	405	1860	65.61	269.27	412.5	1855	64.24	267.61	412.5	1816	62.89	263.64
69	401	18853	66.01	278.47	404.5	1828	64.56	273.79	411.5	1822	63.25	272.04	412	1790	62.07	267.98
70	399.5	1836	65.72	283.07	403.5	1814	64.22	278.28	411	1807	62.81	276.43	412	1776	61.58	272.29
71	398	1800	64.61	287.59	402.5	1777	63.07	282.69	410.5	1769	61.56	280.74	411.5	1739	60.37	276.52
72	396.5	1756	63.27	292.02	401.5	1733	61.66	287.01	409.5	1728	60.28	284.96	410.5	1696	59.02	280.65
73	395.5	1726	62.34	296.38	400.5	1704	60.76	291.26	409	1698	59.31	289.11	409.5	1667	58.15	284.72
74	394.5	1698	61.49	300.68	399	1676	60.01	296.46	408.5	1671	58.44	293.20	408.5	1640	57.35	288.73
75	393.5	1655	60.08	304.89	398	1634	58.64	299.56	407.5	1629	57.11	297.19	407.5	1599	56.06	292.65
76	392	1638	59.69	309.07	397.5	1617	58.11	303.63	406.5	1612	56.65	301.15	406.5	1582	55.59	296.54
77	390.5	1581	57.84	313.12	396.5	1561	56.24	307.57	405	1556	54.88	304.99	406	1527	53.73	300.30
78	389	1558	57.22	317.13	369	1538	55.48	311.45	403	1533	54.34	308.79	405.5	1502	53.02	304.01
79	387	1541	56.88	321.11	395.5	1522	54.97	315.30	401	1516	54.01	312.57	404	1489	52.62	307.69
80	385	1519	56.38	325.05	395	1500	54.25	319.09	309	1495	53.53	316.32	402	1467	52.13	311.34

3. Feed consumption (*tab. 3*). Several mixed feed recipes have been used to feed the fowl, depending on the energy and proteins requirements, as related to the laying intensity. Lowest values for daily feed intake (106.32÷115.18 g/hen) and for FCR (126.29÷141.65 g/egg) have been observed during the first feeding period (20-45 weeks), then increased, during the 46-65 weeks period (111.99÷115.66 g/hen and 146.48÷158.38 g/egg) and mostly across the last feeding stage (66-80 weeks), when daily average intakes reached 119.74÷135.60 g/hen and FCR was calculated values were found within the 191.29÷231.75 g/egg interval. All over the studied period the best values for feed intake have been noticed at the control group (112.63g/hen-average daily intake and 145.34g/egg-FCR), while the poorest results were achieved by the hens belonging to the L_3exp (120.51g/hen and 164.38g/egg).

Table 3

Feed intake and Feed Conversion Rate

Flock age	Parameters	Group			
		Lc	L1exp.	L2exp.	L3exp.
20-45 weeks (182 days)	Group average size (hens)	425	427	426	425
	Feed intake (kg/group/period)	8224	8508	8611	8909
	Average feed intake (g/hen/day)	106.32	109.48	111.07	115.18
	Eggs yield (hens/group/period)	65118	64274	64081	62895
	Feed Conversion Rate (g feed/egg)	126.29	132.37	134.38	141.65
46-65 weeks (140 days)	Group average size (hens)	411	413	416.5	415.5
	Feed intake (kg/group/period)	6444	6546	6637	6728
	Average feed intake (g/hen/day)	111.99	113.21	113.82	115.66
	Eggs yield (hens/group/period)	43993	43422	43294	42480
	Feed Conversion Rate (g feed/egg)	146.48	150.75	153.30	158.38

66-80 weeks (105 days)	Group average size (hens)	394	401	405.5	407
	Feed intake (kg/group/period)	4954	5342	5391	5795
	Average feed intake (g/hen/day)	119.74	126.87	126.61	135.60
	Eggs yield (hens/group/period)	25897	25560	25477	25005
	Feed Conversion Rate (g feed/egg)	191.29	208.99	211.59	231.75
20-80 weeks (427 days)	Group average size (hens)	408	415	415	416.5
	Feed intake (kg/group/period)	19622	20396	20639	21432
	Average feed intake (g/hen/day)	112.63	115.10	116.47	120.51
	Eggs yield (hens/group/period)	135008	133256	132852	130380
	Feed Conversion Rate (g feed/egg)	145.34	153.06	155.35	164.38

4. Flock looses. This parameter reached 0.23% at Lc and L_2exp and 0.46% at L_1exp and L_3exp, at the end of the 20th week of life, being caused by transportation and acclimatization stress and also by the hierarchic social fights. Then, looses significantly decreased, even leading to the lack of mortality, excepting during the cold season (36-41 weeks), when mortality reached 0.23÷0.47%/week or during the warm one (July-August), when mortality reached 0.24÷0.49%/week, because the outer environment temperature influenced the microclimate of the hall which was not endorsed with climate control system. Over the whole period flock looses values were found different between groups, depending on the applied technology. Thus, the lowest value (7.46%) was observed in L_3exp group, whose hens beneficiated of movement freedom all over the compartment. Then, next ascending values were calculated for L_2exp group (1000cm^2 coop floor/hen)-8.22% mortality, for L_1exp group (600cm^2 coop floor/hen)-9.57% mortality and for the control one-11.66%.

5. Proportion of eggs presenting morphologic anomalies. Broken eggshells highly occurred during laying beginning (0.60÷0.99%), followed then by other anomalies, such as: shell less eggs (0.15÷0.22%), malformed shells (0.16÷0.18%), twin yolks eggs (0.06÷0.08%) and also the eggs without yolk (0.02÷0.04%). During laying peak the proportion of broken shell eggs decreased (0.31÷0.72%), but also increased the malformed shells proportion (0.33÷0.35%), the same situation occurring also during the plateau stage (0.50÷0.81% eggs with broken shell and 0.39÷0.41% eggs with malformed shell). When hens approached the end of the laying period, most of the eggs with anomalies presented broken shells (1.18÷1.59%), then malformed shells (0.62÷0.65%) and shell less eggs (0.27÷0.28%).

6. Eggs weight (*tab. 4*). The weight of the eggs issued from all four groups was slightly similar during laying onset (46.78÷47.01 g), during peak (59.96÷60.17 g), plateau (62.91÷63.04 g) and even when laying period ended (68.24÷68.51 g).

Table 4

Eggs weight (n=30)

Control period	Statistical estimators	Experimental group			
		L_c	L_1exp	L_2exp	L_3exp
Laying onset (20th week)	$\bar{X} \pm s_{\bar{x}}$ (g)	46.98±1.30	46.83±1.26	47.01±1.45	46.78±1.28
	s	7.15	6.92	7.95	7.05
	V%	15.21	14.78	16.92	15.03
	Differences significance	Lc vs L1: F=0.87<F5%=4.006 NS Lc vs L2: F=0.56<F5%=4.006 NS Lc vs L3: F=1.14<F5%=4.006 NS		L1 vs L2: F=1.15<F5%=4.006 NS L1 vs L3: F=0.92<F5%=4.006 NS L2 vs L3: F=1.57<F5%=4.006 NS	
Laying peak (28th week)	$\bar{X} \pm s_{\bar{x}}$ (g)	60.17±1.07	60.09±1.05	59.96±0.93	60.12±1.00
	s	5.88	5.76	5.07	5.50
	V%	9.77	9.56	8.45	9.15
	Differences significance	Lc vs L1: F=0.46<F5%=4.006 NS Lc vs L2: F=1.12<F5%=4.006 NS Lc vs L3: F=0.31<F5%=4.006 NS		L1 vs L2: F=0.98<F5%=4.006 NS L1 vs L3: F=0.14<F5%=4.006 NS L2 vs L3: F=0.37<F5%=4.006 NS	
Laying plateau (37th week)	$\bar{X} \pm s_{\bar{x}}$ (g)	62.99±0.94	63.04±0.99	62.91±0.94	63.03±0.86
	s	5.13	5.42	5.15	4.73

	V%	8.15	8.59	8.31	7.62
	Differences significance	Lc vs L1: F=0.81<F5%=4.006 NS Lc vs L2: F=0.89<F5%=4.006 NS Lc vs L3: F=0.80<F5%=4.006 NS		L1 vs L2: F=1.17<F5%=4.006 NS L1 vs L3: F=0.14<F5%=4.006 NS L2 vs L3: F=1.11<F5%=4.006 NS	
Laying end (80th week)	$\overline{X} \pm s_{\bar{x}}$ (g)	68.51±1.56	68.24±1.63	68.37±1.61	68.50±1.76
	s	8.57	8.95	8.83	9.66
	V%	12.51	13.08	12.89	14.11
	Differences significance	Lc vs L1: F=1.11<F5%=4.006 NS Lc vs L2: F=0.57<F5%=4.006 NS Lc vs L3: F=0.05<F5%=4.006 NS		L1 vs L2: F=1.08<F5%=4.006 NS L1 vs L3: F=1.12<F5%=4.006 NS L2 vs L3: F=0.77<F5%=4.006 NS	

7. Shell thickness. The lowest values of the eggshell thickness were observed at the eggs provided by those hens having the best laying intensity (Lc) (0.354÷0.440 mm), while those birds with the lowest eggs yield (L_3exp), presented the thickest shell (0.369÷0.448mm).

8. Egg breaking strength (*tab. 5*). The data we acquired suggest that the best strength of the eggshell was observed during laying onset with different values for each group: 0.340 kg f/cm^3-Lc; 0.342 kgf/cm^3-L_1exp; 0.343 kgf/cm^3-L_2exp and 0.348 kgf/cm^3-L_3exp. During laying peak, shell stiffness varied between 0.330 kgf/cm^3 (Lc) and 0.339 kgf/cm^3 (L_3exp), while during plateau stage, it reached values between 0.329 kgf/cm^3 (Lc) and 0.337 kgf/cm^3 (L_3exp). The worst results for the eggshell breaking strength were noticed when laying ceased, reaching thus: 0.325 kgf/cm^3 in Lc; 0.326 kgf in L_1exp; 0.327 kgf in L_2exp and L_3exp.

Table 5

Eggshell breaking strength (n=30)

Control period	Statistical estimators	Experimental group			
		L_c	L_1exp	L_2exp	L_3exp
Laying onset (20th week)	$\overline{X} \pm s_{\bar{x}}$ (kg f/cm^2)	0.340±0.008	0.342±0.010	0.343±0.009	0.348±0.009
	s	0.042	0.057	0.047	0.051
	V%	12.51	16.59	13.80	14.79
	Differences significance	Lc vs L1: F=0.31<F5%=4.006 NS Lc vs L2: F=0.45<F5%=4.006 NS Lc vs L3: F=1.21<F5%=4.006 NS		L1 vs L2: F=0.16<F5%=4.006 NS L1 vs L3: F=0.82<F5%=4.006 NS L2 vs L3: F=0.74<F5%=4.006 NS	
Laying peak (28th week)	$\overline{X} \pm s_{\bar{x}}$ (kg f/cm^2)	0.330±0.007	0.331±0.008	0.332±0.007	0.339±0.006
	s	0.036	0.042	0.037	0.035
	V%	11.49	12.78	11.06	10.52
	Differences significance	Lc vs L1: F=0.16<F5%=4.006 NS Lc vs L2: F=0.32<F5%=4.006 NS Lc vs L3: F=1.35<F5%=4.006 NS		L1 vs L2: F=0.15<F5%=4.006 NS L1 vs L3: F=1.28<F5%=4.006 NS L2 vs L3: F=1.12<F5%=4.006 NS	
Laying plateau (37th week)	$\overline{X} \pm s_{\bar{x}}$ (kg f/cm^2)	0.329±0.008	0.330±0.006	0.331±0.007	0.337±0.006
	s	0.042	0.035	0.038	0.036
	V%	12.89	10.62	11.41	10.89
	Differences significance	Lc vs L1: F=0.14<F5%=4.006 NS Lc vs L2: F=0.29<F5%=4.006 NS Lc vs L3: F=1.12<F5%=4.006 NS		L1 vs L2: F=0.15<F5%=4.006 NS L1 vs L3: F=1.05<F5%=4.006 NS L2 vs L3: F=0.84<F5%=4.006 NS	
Laying end (80th week)	$\overline{X} \pm s_{\bar{x}}$ (kg f/cm^2)	0.325±0.008	0.326±0.009	0.327±0.009	0.337±0.008
	s	0.045	0.052	0.048	0.045
	V%	13.98	15.89	14.73	13.74
	Differences significance	Lc vs L1: F=0.15<F5%=4.006 NS Lc vs L2: F=0.31<F5%=4.006 NS Lc vs L3: F=1.95<F5%=4.006 NS		L1 vs L2: F=0.15<F5%=4.006 NS L1 vs L3: F=1.65<F5%=4.006 NS L2 vs L3: F=1.50<F5%=4.006 NS	

9. Microbial shell load *(tab. 6)***.** During the laying beginning (20th week), microbial shell load reached 112.78±3.906 germs/cm^2 at the Lc, 110.4±3.671 germs/cm^2 at L_1exp, 106.31±3.418 germs/cm^2 at L_2exp and also 148.62±6.097 germs/cm^2 at the L_3exp. Statistically speaking, significant differences occurred between L_2exp and Lc and L_1exp, while between L_3exp and the other groups (Lc, L_1exp and L_2exp), the differences proved to be high significant.

Table 6

Germs load on the eggshell (n=30)

Control period	Statistical estimators	Experimental group			
		L_c	L_1exp	L_2exp	L_3exp
Laying onset (20th week)	$\bar{X} \pm s_{\bar{x}}$ (germs/cm^2)	112.78±3.906	110.49±3.671	106.31±3.418	148.62±6.097
	s	21.40	20.12	18.73	33.41
	V%	18.98	18.21	17.62	22.48
	Differences significance	Lc vs L1: F=2.15<F5%=4.006 NS Lc vs L2: F=6.42<F5%=4.006 * Lc vs L3: F=27.7<F0.1%=12.12 ***		L1 vs L2: F=4.28<F5%=4.006 * L1 vs L3: F=29.31<F0.1%=12.12 *** L2 vs L3: F=33.49<F0.1%=12.12 ***	
Laying peak (28th week)	$\bar{X} \pm s_{\bar{x}}$ (germs/cm^2)	125.96±3.721	124.31±3.471	120.14±3.372	187.56±8.663
	S	20.39	19.02	18.48	47.47
	V%	16.19	15.30	15.38	25.31
	Differences significance	Lc vs L1: F=1.08<F5%=4.006 NS Lc vs L2: F=5.40<F5%=4.006 * Lc vs L3: F=56.34<F0.1%=12.12 ***		L1 vs L2: F=4.28<F5%=4.006 * L1 vs L3: F=57.41<F0.1%=12.12 *** L2 vs L3: F=61.69<F0.1%=12.12 ***	
Laying plateau (37th week)	$\bar{X} \pm s_{\bar{x}}$ (germs/cm^2)	139.23±4.662	138.07±4.439	134.98±4.441	221.17±10.836
	S	25.55	24.33	24.34	59.38
	V%	18.35	17.62	18.03	26.85
	Differences significance	Lc vs L1: F=1.07<F5%=4.006 NS Lc vs L2: F=5.35<F5%=4.006 * Lc vs L3: F=77.74<F0.1%=12.12 ***		L1 vs L2: F=4.29<F5%=4.006 * L1 vs L3: F=78.81<F0.1%=12.12 *** L2 vs L3: F=83.05<F0.1%=12.12 ***	
Laying end (80th week)	$\bar{X} \pm s_{\bar{x}}$ (germs/cm^2)	152.61±4.957	150.11±5.317	146.61±4.981	258.94±13.991
	S	27.16	29.14	27.29	76.67
	V%	17.80	19.41	18.62	29.61
	Differences significance	Lc vs L1: F=2.16<F5%=4.006 NS Lc vs L2: F=6.48<F5%=4.006 * Lc vs L3: F=104.48<F0.1%=12.12 ***		L1 vs L2: F=4.32<F5%=4.006 * L1 vs L3: F=106.64<F0.1%=12.12 *** L2 vs L3: F=110.96<F0.1%=12.12 ***	

During laying peak, (28^{th} week), germs amount on each cm^2 of shell increased, the values varying between 120.14±3.372 (L_2exp group) and 187.56±8.663 (L_3exp group). Statistical analysis revealed the same situation (significant differences between L_2exp and Lc, L_1exp groups, respectively high significant between L_3exp and the other groups). The eggs harvested during the plateau stage (37^{th} week) had higher germs amounts that varied within the 134.98±4.441/cm^2 (L_2exp) and 221.17±10.836/cm^2 (L_3exp) limits. Statistically, the differences were found similar to those recorded during the previously control periods. The highest levels of microbial contamination have been noticed when laying almost ceased (80^{th} week), meaning: 152.61±4.957 germs/cm^2 shell at the control group, 152.61±4.957 germs/cm^2 shell at the L_2exp group and 258.94±13.991 germs/cm^2 shell at the L_3exp group. Significant differences occurred between L_2exp and Lc, L_1exp groups and also high significant ones between L_3exp and Lc, L_1exp, L_2exp groups.

CONCLUSIONS

Several conclusions issued from the researches:

Body weight dynamics was found in accordance with the „Lohmann Brown" standard weight curve. However, there were some differences between groups, given by the presence/absence of the movement freedom. The optimized management applied to the groups without free access in the hall (L_1exp, L_2exp and Lc) provides to the fowl the opportunity to express the yielding potential, ***average yields*** of 316.32÷325.05 eggs/hen being achieved, as compared to the average value noticed for the L_3exp group (311.34 eggs/hen). Egg production values influenced ***feed intake***, the best FCR value being calculated for the Lc (134.34g/egg) while the less competitive (164.38g/egg) was observed in the L_3exp. ***Mortality***

rate was 0.76-4.20% lower at the L_3exp (free access in rearing compartment), as compared to the other groups, which provided different rearing floor surface in the coops.

Eggs weight was ascending from the laying beginning toward its end, without the occurrence of statistic significance between groups. **Shell thickens** was reversal correlated to the laying intensity, being higher (0.369÷0.448mm) at the eggs issued from the group with the poorest yield (L_3exp); consequently, the best values for the ***shell breaking strength*** (0.337÷0.348 kg f/cm^2) were measured within the same group. Meanwhile, higher germs load was noticed in the same group (L_3exp), respectively 39.9-69.7% more than the other groups, because the hens spend more time on the layer between battery lines or laid straight on it.

Basing on those previously specified aspects, we still recommend the maintenance of the superintensive rearing system in Romania, at least for a few years ahead, using BP-3 batteries with modified coops, in order to allow the accommodation of 5 hens/each coop of 3000cm^2 (600cm^2/hen).

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