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The effect of various methods of additional feed application during the first days of rearing on broiler chickens performance

Abstract. The aim of the study was to determine the impact of various methods of feed administration during the early days of meat-type chickens rearing on their livability and final performance under typical farm conditions. Day-old Ross 308 chicks were allocated to three experimental groups. During the first week of rearing, in group A (the control one) the feed mixture was administered only *via* automatic feeding line (2 cm of feeder edge length per chick). In groups B and C birds were provided with additional access to feed on the litter covered with grey corrugated paper or commercial chick paper (covered with wax layer), respectively. The birds were kept in pens of equal stock density, the area of paper constituted 30% of each pen area. Mortality cases and body weight of birds were registered. After 42 days birds were commercially slaughtered and 20 carcasses from each group were randomly chosen and subjected to simplified dissection. Feed administration on paper strips considerably improved liveability of birds during the first week of life. Mortality in group A mainly resulted from the fact that chicks did not begin ingesting the feed. The additional feeding of birds using cardboard or paper strips on the litter had positive effects on their gastrointestinal tract development and some production results. The grey corrugated cardboard seemed to be more effective in this respect.

Key words: newly-hatched chicks, early feeding, feeding methods, corrugated paper, chick paper

INTRODUCTION

The first week of rearing broiler chickens is crucial for their further development as well as for the achieved production effects [Yerpes et al. 2020]. Lilburn [1998] stated that it affects approximately 17% of body weight. The breeder's priority is to provide chicks with feed and water as soon as possible. Noy et al. [1996] demonstrated that yolk sac absorption is markedly more intensive in early-fed chicks than in birds whose access to the first feed is delayed. It is accelerated as a result of intestinal activity stimulation. Early feed ingest is also conducive to digestive tract development [Cengiz et al. 2012, Qu et al. 2021], which in turn enhances its ability to digest and assimilate feed nutrients and further contributes to birds' productivity [Yang et al. 2008]. The first feed ingest also positively modulates the function of the birds' immune system, among other things, by enhancing disease resistance [Wijnen et al. 2021] and contributing to maximizing their survivability [Dibner et al. 1998, Yassin et al. 2009].

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The term "early feeding" of chicks can be considered in many aspects. In terms of the type and quality of the feed [Toghyani et al. 2012], the time of feed application [Noy and Sklan 1999] and, finally, its accessibility for chicks. Boyner et al. [2021] observed that chicks remain inactive for a considerable amount of time before initiating foraging. Eating activity, defined as birds eating or standing close to the feeder, was observed in 5% (5/100 birds) at an average biological age of 25.4 h, while 50% of birds had full crops at an average age of 30.6 h. Therefore, the use of additional feed sources (paper or cardboard strips, egg cartons, etc.) can, firstly, enrich the environment, stimulating the chicks' curiosity, and secondly, ensure rapid feed intake through natural foraging before the birds learn to use conventional feeders.

Only limited scientific literature addresses methods of feed application for 1-day-old chickens, with most studies focusing on the effects of delayed first feeding [Proszkowiec-Weglarz et al. 2020, 2022, El-Azeem et al. 2024], rather than the method of feeding itself. Currently, some farmers are encouraged to use commercially available chick paper. It is marketed as an indispensable product that increases foraging activity, absorbs droppings and thereby improves house hygiene, is biodegradable, and equalizes the chicks' access to feeders. The use of such paper is expected to improve the survivability and productivity of birds. However, there is currently no scientific evidence confirming these advantages and justifying the additional cost.

The aim of this study was to determine the effect of various feeding methods during the first week of broiler chicken rearing on their survivability and selected final production parameters.

MATERIALS AND METHODS

The experiment was carried out under farm conditions on meat-type chickens during the standard production cycle.

As the birds were kept as a commercial flock and slaughtered at the end of a typical, commercial production cycle, no experimental procedures compromising animal welfare were performed during rearing. According to the legislation in force (Act of 15 January 2015 on the protection of animals used for scientific or educational purposes; Directive 2010/63/EU of the European Parliament and of the Council of 22 September 2010 on the protection of animals used for scientific purposes), ethics committee approval was not required for the study.

Broiler chickens were kept on the experimental farm under the housing conditions indicated in Council Directive 2007/43/EC of 28 June 2007 laying down minimum rules for the protection of chickens kept for meat production. Microclimatic conditions and lighting were kept according to the recommendations of the manufacturer of the Ross 308 commercial hybrids (Aviagen®).

The 1-day-old unsexed Ross 308 chickens were allocated to three experimental groups. Control group (A) consisted of 6500 chickens, while experimental groups B and C comprised 3250 birds each. Throughout the fattening period, all groups were kept in the same henhouse, in pens separated by mobile fences (approx. 1 m high). Each group sector was divided into 5 replication subgroups. Chickens were fed with standard balanced mixtures according to their age and requirements. The birds were provided with *ad libitum* access to balanced feed and water. The composition and nutritive value of feed mixtures, based on the manufacturer's declaration, is shown in tables 1 and 2.

The groups of chickens were differentiated according to the additional source of feed. The control group (A) was fed traditionally using only automatic feeders, providing approximately 2 cm of the feeder edge length per bird. The experimental groups were provided with additional access to the feed placed on chick paper stripes on the litter. In group B the litter was covered with grey corrugated cardboard (0.65 m^2/10 m^2), whereas in group C, the paper was smooth, green and unilaterally coated with wax (0.65 m^2/10 m^2). In both experimental groups, the paper-covered area accounted for 30% of total area available to the birds. Paper stripes were placed along the feeding lines, 30 cm from the watering line. Groups B and C were given 500 kg (100 kg per replication subgroup) of prestarter feed in the crumble form, spread uniformly on paper each day during the first rearing week. The same amount of feed was also received by control group A.

Table 1. The composition of feed mixtures used during the experiment

Ingredients (%)	Prestarter	Starter	Grower 1	Grower 2	Finisher
Wheat 11%	60.00	60.22	60.39	62.01	64.47
Rapeseed meal	1.50	3.00	3.00	5.00	7.00
Soybean meal 46%	30.00	28.50	28.25	24.70	20.44
Fish meal	0.50	0.50	0.01	0.01	0.01
Soybean oil	3.50	4.33	5.38	5.82	5.89
Calcium phosphate	1.50	0.64	0.49	0.28	0.35
Limestone	1.50	1.51	1.18	0.89	0.82
NaCl	0.50	0.30	0.27	0.25	
Rapeseed oil			0.01	0.01	
Premix	1.00	1.00	1.00	1.00	1.00
Lard			0.01	0.01	0.01
Rape-cake			0.01	0.01	
Blood meal				0.01	0.01
Total	100.00	100.00	100.00	100.00	100.00

Table 2. Nutritive value of feed mixtures used during the experiment

Item	Prestarter	Starter	Grower 1	Grower 2	Finisher
Total protein (%)	22.30	21.37	21.13	20.37	19.31
Metabolic energy (kcal)	2860	2825	2900	2950	2975
Ether extract (%)	6.882	6.508	7.561	8.004	8.064
Crude ash (%)	5.727	5.791	5.441	4.874	4.585
Crude fiber (%)	3.302	2.728	2.711	2.844	2.971
Lysine (%)	1.326	1.224	1.186	1.130	1.035
Methionine (%)	0.586	0.541	0.510	0.503	0.464
Methionine + cysteine (%)	0.962	0.897	0.863	0.854	0.809
Ca (%)	0.902	0.881	0.789	0.650	0.589
P (%)	0.617	0.549	0.512	0.468	0.485
Na (%)	0.150	0.150	0.138	0.130	0.133
NaCl (%)	0.424	0.453	0.409	0.391	0.410
Vitamin A (IU)	12563	12500	10000	10000	2000
Vitamin D_3 (IU)	3518	3500	2500	2500	2000
Vitamin E (mg)	75.38	75.00	25.00	25.00	20.00

At the beginning of the experiment, 50 birds were randomly chosen from each replication group and marked with wing marks. They were used for body weight recording at 7-day intervals. Mortality and culling were also recorded. In the first week, the causes of death were determined by post-mortem examination.

The production cycle was completed on the 42nd day of the birds' lives. The chickens were slaughtered in commercial poultry slaughterhouse by decapitation (EU Regulation No. 1099/2009 of 24 Sep-

tember 2009 on the protection of animals at the time of killing), then plucked and eviscerated. The carcasses were then chilled to an internal temperature of 4 °C inside. 20 carcasses from each group were randomly chosen and subjected to simplified dissection [Hahn and Spindler 2002]. Carcass yield and the proportions of its elements were determined.

The data were analysed using the SPSS 24.0 software package [IBM 2017]. The normality of the data was assessed using the Shapiro-Wilk test. One-way analysis of variance with Tukey's post-hoc test was carried out. Non-parametric data were analysed using the χ^2 (Chi square) and/or Kruskall-Wallis test with pairwise comparisons. Differences were considered significant at $p \leq 0.05$ or $p \leq 0.01$.

RESULTS

Table 3 shows the number and causes of chicks losses during the first week of rearing. The highest mortality was observed in the control group (A), primarily due to starvation caused by the chicks' failure to ingest feed. In this group, 103 dead chicks were found, which accounted for 0.79% of the total number of chicks and 35.3% of chicks that died during the first week. In the experimental groups (B and C), mortality due to failure to initiate foraging was significantly lower and amounted to 21 and 20 chicks respectively, which together accounted for 0.32% of the total stock and 14.04% of the total number of dead birds during the first seven days of rearing. The proportions of birds that died due to failure to initiate feed ingest and post-hatched infection in the experimental groups (B and C) were the reverse of those in the control group (A). The number of deaths caused by infection remained at a similar level in all groups relative to their size. Out of 292 dead chicks from all three groups, only 13 chicks were culled. The number of deaths in the first week of rearing constituted 48% of the total number during entire production cycle, and almost 60% of dead chickens were found in the control group (A).

Table 3. The number and causes of chicks' mortality during the first week of rearing

Cause of dead	Group			χ^2 (p-value)
	A	B	C	
Chick which did not ingest feed	103 (58.8%)	21 (34.4%)	20 (35.7%)	<0.001
Yolk sac or hatchery infection	66 (37.7%)	37 (60.7%)	32 (57.1%)	<0.001
Culled and others	6 (3.4%)	3 (4.9%)	4 (7.1%)	<0.001
Total	175	61	56	<0.001

The number of birds that died in experimental groups during the particular weeks of rearing is shown in Table 4. The highest mortality rate was recorded in the first week of the experiment, which could have resulted from improper incubation conditions or post-hatch selection procedures. The number of deaths in groups B and C was more than 33% lower than in group A. In the second week, the value of this indicator in experimental groups exceeded the number of deaths found in the group fed only by automatic feeders by 28%. A decrease in mortality (by 36%) was observed in the group reared on green paper compared to the group reared on grey paper. At third week of rearing, mortality was equal in all groups, and in the subsequent weeks more birds died in the experimental groups (B and C) than in the control one (A), however, no infectious causes were identified. Finally, the proportion of mortality was similar across all groups; however, the total number of deaths in the experimental groups was higher than in the control group. Moreover, considerably more birds died during the final stage of the fattening period, which negatively affected the economic results. In group A, the highest number of deaths was recorded at the beginning of the rearing period, when production costs were relatively low, while in the last week only isolated mortality cases occurred, accounting for 0.09%.

The average body weight of birds at the end of consecutive rearing weeks is shown in table 5. The body weight at the day of hatching was equal in all groups and ranged from 41 to 42 g. After applying varied methods of feed application (in the 1st week of rearing) chickens from the control group (A) were heavier by 7.6 g (4.8%) and 5.2 g (over 2%) than the group kept on grey and green paper, respectively. On 14th and 21st day, the relationship was reversed and both experimental groups grew faster than the control group. The differences amounted to 6.1 and 7.4%, respectively, in favour of groups B and C, and they were statistically significant. From 28th day of fattening the body weight of birds was similar regardless of group. Finally, at the end of rearing period, the value of this trait ranged from 2442.3 to 2501.9 g and the differences were not statistically confirmed.

Table 4. Mortality of chicks in consecutive weeks of the experiment

Time (wks)	Group						Mortality (%)	χ^2 (*p*-value)
	A		B		C			
	No.	%	No.	%	No.	%		
1	175	60.76	61	38.13	56	35.22	2.25	<0.001
2	46	15.97	36	22.50	23	14.47	0.81	<0.001
3	32	11.11	31	19.38	42	26.42	0.81	<0.001
4	21	7.29	9	5.63	12	7.55	0.32	<0.001
5	8	2.78	13	8.13	14	8.81	0.27	<0.001
6	6	2.08	10	6.25	12	7.55	0.22	<0.001
Total	288	4.43	160	4.92	159	4.89	4.67	0.468

Table 5. The body weight of birds in consecutive weeks of experiment

Time (days)	Group						*p*-value
	A		B		C		
	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	
0	42.1	0.37	41.8	0.53	41.7	0.52	0.970
7	177.4^{a}	1.07	169.8^{b}	1.77	172.2^{b}	0.93	0.003
14	397.0^{a}	8.37	411.0^{ab}	19.49	417.0^{b}	11.51	0.038
21	751.1^{a}	28.39	800.0^{b}	27.30	811.1^{b}	30.79	<0.001
28	1299.0	97.80	1283.0	58.89	1242.0	73.91	0.197
35	1892.3	134.29	1900.0	76.21	1877.9	65.18	0.825
42	2501.9	103.56	2457.7	96.76	2442.3	95.13	0.236

$^{a, b}$ – values in rows marked with different letters differ at $p \leq 0.05$

Table 6 presents the results of simplified dissection analysis of chickens according to experimental groups. The highest carcass yield was found in birds from group B. However, this value was only 0.2% higher than that obtained in the control group (A) and 2.46% higher than in group C. The proportion of breast muscles in carcasses of birds from the control group was similar to that of group B and considerably higher than in the experimental group C. In the experimental group maintained on green paper (C), a significantly larger proportion of trunk was recorded (19.26%), whereas a considerably larger proportion of wings was found in the carcasses of birds from group B. No differences were observed in the proportion of legs between groups. The impact of the additional feed source (grey corrugated cardboard/green waxed paper strips) for chickens on the proportion of edible giblets in their body weight was also confirmed. A significantly larger proportion of gizzard in body weight was observed in group B. Similar numerical relationships between groups were also found for the proportions of liver and heart.

Table 6. Results of simplified dissection in particular groups

Parameter		Group						*p*-value
		A		B		C		
		$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	
Carcass yield (%)		73.68^{b}	0.970	73.83^{b}	1.340	72.01^{a}	0.775	<0.001
Carass parts (%)	breast muscle	29.59^{b}	1.487	29.08^{ab}	1.630	27.72^{a}	1.690	0.001
	legs	41.06	1.531	41.34	1.452	41.87	1.445	0.477
	wings	11.07^{a}	0.675	11.46^{b}	0.426	11.23^{ab}	0.399	0.042
	trunk	18.28^{ab}	1.207	18.11^{a}	0.823	19.26^{b}	0.856	<0.001
Giblets (% bw)	gizzard	1.095^{a}	0.122	1.213^{b}	0.146	1.112^{ab}	0.134	0.014
	liver	1.951	0.308	2.046	0.230	2.043	0.193	0.372
	heart	0.451	0.047	0.469	0.052	0.439	0.052	0.191

$^{a, b}$ – values in rows marked with different letters differ at $p \leq 0.05$; bw – body weight

DISCUSSION

Based on our results it seems that the use of paper in groups B and C played a role in increasing the accessibility of feed for chicks, as well as shortening the time to first feed ingest. However, the available literature in the field of alternative methods of feed application during the first week of broiler production is still limited. Ross 308 broilers are one of the most popular hybrids in the world and are often used as research material, including in nutritional studies. Comparing the results obtained in this study to others [Hristakieva et al. 2014, Al-Shammari et al. 2019, Ahmadzadeh et al. 2025], it should be noted that they are consistent with previous reports, regardless of the group.

Most authors focus on the consequences of delayed access to feed in newly hatched chicks. Pisarski et al. [1998] showed that a 24-hour delay reduces weight gain, which birds cannot compensate for by up to 21 days of rearing. Our experiment confirms these observations, since the average body weight of birds kept without additional feed application was lower at 21 days than that obtained in the experimental groups, by 6.1% and 7.4% relative to groups B and C, respectively. El-Husseiny et al. [2008] also indicated that delaying access to feed for 1 or 2 days significantly accelerates yolk sac absorption and reduces body weight gain of chickens in the first week of rearing. It is recommended to place feeders already in the hatcher to allow chicks to ingest feed immediately after hatching, as this period can often be considerably extended over time. It may happen that the difference in chicks hatching time may amount to 19 hours and thus expose chicks to starvation [Vieira et al. 2005]. In the studies of Obun and Osaguon [2013], the length of time to feed ingest was also negatively correlated with the production results of birds obtained during 28 days of rearing but did not affect chickens survivability. In our experiment, up to day 21, better liveability was observed in groups B and C.

Cengiz et al. [2012] evaluated production and physiological and developmental parameters of the Ross 308 chicken gastrointestinal tract following delayed first feed ingest. This manipulation significantly reduced the body weight of birds, relative gizzard weight and intestinal crypt depth. However, these changes were only visible at an early stage of rearing (up to about 10 days) and disappeared later. There were no differences in the proportion of particular carcass cuts. In our research, the highest carcass yield in 42-day-old chicks was found in group B, while in group C the lowest proportion of the breast muscle was found. Furthermore, it appears that an additional source of feed (paper) may contribute to an increase in gizzard weight. Wall et al. [2025] suggested that chickens are capable of compensating for 48 hours of feed and water deprivation post-hatch. It was stated

that 48-hour delay in first feed access resulted in smaller internal organs weights in 5-day-old birds, however, similarly to our observations, none of the differences persisted at the end of the study on day 43. Similarly, Boyner et al. [2025] found a considerably larger gizzard proportion in body weight in birds that were provided with access to feed and water immediately after hatching, However, by day 11 of life, no such difference was observed, whereas in our studies, the effect of additional feed administration persisted until day 42 of the broilers' life.

Another group of researchers assessed the possibility of periodic quantitative or qualitative restriction of broiler feed. Lippens et al. [2009] showed that a 4-day 20% reduction in feed supply (between day 3 and 7 after hatching) does not affect the final body weight of Ross 308 chickens. Additionally, higher body weight was observed in birds fed pelleted rather than mash feed. This confirms the justification for using pelleted feed for meat-type birds. However, feed restriction did not alter the results of carcass traits or their carcass yield in any of the groups. Jahanpour et al. [2015] even reported improvements in both body weight and slaughter parameters as a result of periodic (during the second or third week of rearing) dietary restrictions for broilers of up to 50 and 75% of their recommended daily intake. They recommended reduced diet programs as a useful strategy for broiler chicken management without reducing their slaughter value. In another study, Mohammad and Masoud [2015] indicated that when feed restriction (by 10, 20 or 30%) occurs at an early stage of development, the compensatory gain and, at the same time, the improvement in final productivity results are observed. In addition, feed restriction significantly contributes to the reduction of carcass fatness as indicated by abdominal fat pad size.

Nielsen et al. [2010] pointed to the possibility of differences in feed supply method depending on the meat-type chicken genotype and also suggested that the early transition from paper to feeders may be important for the smallest chicks. In their study, Ross 308, fast-growing chickens were compared to slow-growing birds. The percentage of birds engaged in feeding activity was similar, but slow-growing chicks began to eat from the paper later and were observed eating from the feeder less than fast-growing birds, which were less active, did not forage as actively and preferred a conventional feeder. Feed placed on paper was more easily accessible to chicks than feed provided by standard feeders which required movement to reach them. Access to feed dispensed on paper may also, to some extent, help to adjust the body weight of chicks that vary at the hatching stage, particularly when the hatching window is extended, as the earliest-hatched birds spend the longest time in the high-temperature conditions of the hatcher, lose the most water (body weight), and therefore have the lowest body weight [Lamot et al. 2014]. This highlights the importance of an additional feeding source due to Ross 308 chickens productivity depending on their initial body weight. Michalczuk et al. [2011] found that the smallest chicks, characterised at the same time by the highest growth rate, are not able to reach a similar final weight to heavier birds while maintaining the same rearing and feeding conditions.

CONCLUSIONS

Additional feed provisions on paper strips influenced chick survivability during the production cycle. However, in the first week of life, the main cause of mortality in experimental groups was yolk sac infection (resulted from incubation), while in the control group it was failure to initiate foraging. Total mortality did not differ between groups.

The use of grey corrugated cardboard/green waxed paper strips increased the body weight of broiler chickens, with the effect being particularly evident in the first three weeks of rearing. In group B (grey corrugated cardboard), birds exhibited the highest carcass yield and a significantly larger breast muscle proportion than those in the group provided with green paper. Furthermore, even in 6-week-old birds, improved gastrointestinal development, reflected by greater gizzard proportion was observed, which may have been associated with the additional feed source.

Thus, additional feeding of birds using cardboard or paper strips on litter has positive effects on their physiological development and final production results, with grey corrugated cardboard proving to be more effective in this respect.

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