

**EFFECT OF FEEDING AND TYPE OF MANAGEMENT  
ON THE PERFORMANCE AND CARCASS CHARACTERISTICS  
OF HUNGARIAN CHICKEN BREEDS DEVELOPED FOR ALTERNATIVE MANAGEMENT**

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## **Abstract**

1600 chickens from two experimental chicken strains (Naked-necked New Hampshire (NH) and Naked-necked Plymouth Rock (NP)) selected by the Institute for Small Animal Research and their reciprocal cross-breeds participated in the experiment. Mix-sexed birds of each strain were kept on deep litter and free-range, too. Two types of four-phase diets were used. The experiment lasted up to 98 days.

At the end of the trial the experimental breeds reached a good slaughtering weight. According to the housing system, it can be stated that the higher activity and bigger space in the free-range keeping did not alter negatively the slaughtering weight of these table birds at the end of a long growing period. The diet did not influence the live weight of 14 weeks old birds.

The experimental chicken strains had genetically bigger thigh yield and smaller breast yield than the conventional broilers. In the experiment neither the housing systems nor the applied diet influenced the killing-out percentage and the proportion of breast and thigh, too.

The carcass composition was highly influenced by the housing system. The birds from the free range produced meat with higher dry matter and protein and less fat content than the chickens kept on deep litter. The used diets did not influence significantly the chemical composition of the breast and that of the thigh.

**Keywords:** meat chicken, free range, weight gain, feed conversion, carcass quality

## **Introduction**

In recent decades, besides industrialised large-scale poultry production systems, alternative production systems meeting special demands have also become widespread. The objective of the latter is to produce commodities in the natural environment, as part of the former. In this way especially delicious and valuable food products can be obtained. In alternative (ecological) management systems, the living space of animals is not restricted to an area of limited size; rather, they have opportunity to ramble over larger areas of free space. As a result, birds living in such systems will acquire better physical condition, their body will not become fatty, the exercise influences muscle growth and characteristic and carcass conformation (Sandusky and Heath, 1988., Gordon and Charles, 2002) too. In such an environment, it is not possible to rear chickens in an intensive manner (so-called "forced rearing"); therefore, only poultry breeds of lower growth rate can be employed. Consequently, the fattening period will become longer (at least 12 weeks) and result in a product of different quality. Touraille et al. (1981) found that the flavour intensity of Label Rouge chickens increased up to 14 weeks of age. Due to the slower growth and the more intensive exercise, the nutrition of birds reared in such systems markedly differs from the feeding used in intensive broiler production.

## **Materials and methods**

Two experimental chicken breeds selected for body weight at the Institute for Small Animal Research (naked-necked New Hampshire, NKS and naked-necked Plymouth, NKF) and their reciprocal crosses were used for the study, which included a total of 1600 birds, each breed represented by 25%, in a sex ratio of 1:1.

During the study, the chickens were fed diets formulated locally at the Institute considering the suggestion of Leeson and Summers (1997) (Table 1). Between 0 and 14 weeks of age, they received the diet in four phases. When formulating the diets, preference was given to readily available, inexpensive and primarily Hungarian feed materials. The entire flock received the same starter diet (weeks 1–3) and grower diet (weeks 4–8). Subsequently, half of the chicken flock received a roaster grower (weeks 9–12) and roaster finisher (weeks 13–14) diet of higher energy and protein content (Diet I) while the other half was given a diet of lower energy and protein content (Diet II).

The production results of the chicken breeds and their crosses fed the two diets of different nutrient content were studied in closed housing system on deep litter and also in free-range management (outdoor keeping).

At 14 weeks of age, test slaughtering was carried out. For that purpose, five birds per breed, type of management, diet and sex were selected at random. After the test slaughter, the weight of eviscerated birds as well as the weight of the bony breast, the thigh and the abdominal fat were determined. From the breast and the thigh muscle samples were taken for the determination of dry matter, fat and protein content according to Hungarian Standard MSZ 6830.

Table 1. Composition of diets for growth

	Starter 0-3 weeks	Grower 4-6 weeks	Roaster grower 7-10 weeks		Roaster finisher 11-(12)14 weeks	
			Diet I.	Diet II.	Diet I.	Diet II.
Crude protein %	21	18	17	15.5	16	15
ME MJ/kg	12.8	12.5	13.1	12.8	13.2	12.8
Lysine %	1.1	0.9	0.9	0.75	0.8	0.72
Methionine %	0.46	0.38	0.38	0.32	0.36	0.30
Met+Cys %	0.79	0.65	0.65	0.56	0.60	0.54
Ca %	0.95	0.92	0.90		0.85	
P available %	0.42	0.40	0.38		0.35	
Na %	0.18	0.18	0.17		0.17	
Mn mg	70	70	70		70	
Vitamin A IU	6500	6000	6000		6000	
Vitamin E IU	30	27	25		25	
Vitamin D3 IU	3000	2700	2700		2700	

## Results and evaluation

### Body weight gain

The breeds and their crosses studied showed very good body weight gain as a result of nutrition specifically developed for them (Table 2). By the age of 12 weeks, the average body weight of cockerels exceeded 2 kg in all the four groups tested. The body weight of birds of all the four experimental flocks had increased substantially by 14 weeks of age.

Table 2. Average live weight of naked-necked New Hampshire (NKS) and naked-necked Plymouth (NKF) and their reciprocal crosses during planned feeding

Average live weight of females (g)							
Date	Day old	3 weeks	6 weeks	8 weeks	10 weeks	12 weeks	14 weeks
NKS (a)	37.4	211.3	635.3	926.2	1278.5	1553.7	1698.6*bcd
NKF (b)	37.8	243.7	694.1	1015.9	1385.9	1628.4	1853.3*a
NKSxNKF(c)	37.3	237.2	682.9	994.5	1372.3	1654.3	1847.0* a
NKFxNKS (d)	37.1	232.3	676.9	993.4	1358.4	1617.4	1836.5* a
Average live weight of males (g)							
Date	Day old	3 weeks	6 weeks	8 weeks	10 weeks	12 weeks	14 weeks
NKS (a)	36.8	224.9	708.9	1102.1	1558.6	2014.2	2336.8*bcd
NKF (b)	38.0	250.5	805.7	1317.7	1797.4	2215.2	2556.9*a
NKSxNKF (c)	37.5	247.9	800.2	1280.0	1768.5	2181.0	2509.4*a
NKFxNKS (d)	38.2	248.1	794.5	1287.6	1754.0	2143.3	2490.2*a

Level of significance: \*:  $P \leq 0,5$

From 9 weeks of age, half of the flock received a roaster-type diet of higher energy and protein content (Diet I) while the other half was given a diet of lower energy and protein level (Diet II). At the end of the rearing period, at 12 and 14 weeks of age, there was no significant difference in live weight between the two groups of

birds fed the two different types of diet (Table 3). This indicates that the diet of lower energy and protein content can be used with good results for obtaining end-product of this type.

Table 3 Effect of the diets on the average live weight of 14 weeks old experimental chicken strains

	Sex	Diet I.	Diet II.
Whole stock	Pullet (g)	1801.9 ±94.5	1815.2 ±85.3
	Cockerels (g)	2471.2 ±131.6	2475.5 ±132.3

The experimental chicken flocks were reared in a closed poultry house on deep litter until six weeks of age, when half of the flock was given access to an outdoor run while the other half remained in the closed house. Studying the entire flock, there was no difference between the two different management systems in terms of the body weight achieved by 14 weeks of age (Table 4). Therefore, the larger space available for movement does not exert an adverse effect on the attainable slaughter weight of broiler chickens produced over a longer fattening period.

Table 4. Average live weight of 14 weeks old experimental chicken strains in free-range and on deep litter

Strain	Sex	Free-range 14 weeks	Closed housing 14 weeks
Whole stock	Pullet (g)	1803.2±94	1818.0±142
	Cockerels (g)	2481.0±89	2458.2±213

#### *Feed conversion rate*

The feed conversion rate of chickens was studied in different phases of the rearing period, taking into account the two different management systems and the two types of diets (Table 5). Neither the management system nor the diets used exerted an unambiguous influence on the feed conversion rate of the breeds and their crosses studied.

However, on the basis of the feed conversion data it can be established that rearing broilers up to more than 12 weeks of age is uneconomical because of the markedly increased feed consumption and decreasing growth rate of the chickens. Namely, in the period between 12 and 14 weeks of age the feed conversion rate exceeded 6 kg in three-quarters of the flock, while in the previous periods only 3 to 3.5 kg of feed had been used up for 1 kg of live weight gain. As a consequence, if broilers are reared up to 14 weeks of age, their feed conversion rate for the entire rearing period will be nearly 300 grams worse than if they were reared up to 12 weeks of age only.

Table 5 Feed conversion ratio of the experimental strains fed with different diets on free range and closed housing systems

Age	Feed conversion ratio (kg feed/kg weight gain)			
	Closed housing		Free range	
	Diet I.	Diet II.	Diet I.	Diet II.
0-21 days	4.19	2.76	3.86	2.93
22-42 days	3.32	2.00	3.12	2.94
43-56 days	3.43	3.79	3.41	4.13
57-71 days	3.60	3.46	3.99	2.98
72-84 days	3.77	4.60	3.39	4.18
85-98 days	6.69	6.10	6.05	4.79
0-85 days	3.72	3.16	3.40	3.31
0-98 days	3.82	3.56	3.68	3.65

### Carcass evaluation

Another objective of the study was to determine how much the dressing percentage of the breeds studied and the ratio of valuable meat parts depended on the type of management and on the nutrient content of the diet fed.

The experimental chicken strains had genetically determined higher thigh ratio (by 26-29 %) and lower breast yield (by 18-23) than the intensively reared broilers, in which the ratio of thigh is 25-26 % and that of the breast is 26-28 % (Broadbent et al, 1981., Körösi-Molnár et al, 2003) as compared to the total eviscerated body weight (Table 6).

Table 6 The ratio of the valuable body parts of the experimental chickens as compared to the carcass at the age of 14 weeks.

Ratio of breast with bones to the carcass (%)		
	Pullets (a)	Cocks (b)
NKS	20.7 ±1.88*b	18.7 ±1.78*a
NKF	21.7 ±1.80*b	20.3 ±0.80*a
NKSxNKF	20.8 ±1.40*b	19.1 ±1.70*a
NKFxNKS	20.9 ±2.20	19.8 ±2.0
Ratio of thigh to the carcass (%)		
	Pullets (a)	Cocks (b)
NKS	26.3 ±1.61**b	28.5 ±1.44**a
NKF	27.0 ±1.10**b	29.0 ±1.20**a
NKSxNKF	26.6 ±1.10***b	29.5 ±1.60***a
NKFxNKS	26.9 ±1.40***b	29.3 ±0.90***a

NKS: naked necked new hampshire, NKF: naked necked plymouth

Level of significance: \*:  $P \leq 0,5$

Chickens reared in free-range management and those reared in closed housing system had similar dressing percentage and thigh and bony breast ratios (Table 7). There were differences in muscle growth and development between the sexes. Statistically significant differences could be demonstrated between the two sexes: cockerels had a higher proportion of thigh and a lower proportion of bony breast than did pullets.

Table 7 Effect of housing system on the dressing percentage of studied chicken strains in 14 weeks old of age

Sex	Housing system	Carcass % <sup>1</sup>	Breast % <sup>2</sup>	Thigh % <sup>2</sup>	Abdominal fat % <sup>2</sup>
Male	Closed housing (a)	80.0 ±2.8	19.53 ±1.4 **cd	28.85 ±1.2 **cd	1.28 ±1.7
	Free range (b)	79.7 ±1.7	19.44 ±1.1 **cd	29.24 ±2.3 **cd	0.80 ±1.3
Female	Closed housing (c)	79.0 ±1.7	21.25 ±1.5 **ab	26.53 ±1.3 **a, ***b	1.95 ±1.5
	Free range (d)	79.0 ±1.7	20.79 ±1.1 *ab	26.84 ±1.4 **a, ***b	1.56 ±1.5

NKS: naked necked new hampshire, NKF: naked necked plymouth

Level of significance: \*\*:  $P \leq 0,1$ , \*\*\*:  $P \leq 0,01$

1: comparing to live weight, 2: comparing to carcass weight

In the proportion of valuable meat parts no substantial difference could be demonstrated between chickens fed the two types of diet (Table 8). These data also confirm our opinion that a diet of lower energy and protein content is suitable for purposes of broiler fattening of this type.

### Chemical composition of meat

During the study it was also evaluated how the dry matter, fat and protein content of the valuable meat parts was influenced by the type of management and the composition of the diet series fed.

The dry matter content of the thigh and breast muscle of chickens reared in free-range management was 1-2% higher than that of birds reared in closed housing system (Table 9).

In all groups, cockerels produced drier meat of higher protein and lower fat content than pullets (Table 9).

Table 8. Effect of different diets on the dressing percentage and valuable body parts of the experimental chicken strains in 14 weeks old of age

Sex	Diet	Carcass <sup>1</sup> %	Breast <sup>2</sup> %	Thigh <sup>2</sup> %	Abdominal fat <sup>2</sup> %
Cockerels	I.	79.4 ±2.5	19.40 ±1.2	29.00 ±1.2	0.83 ±1.8
	II.	80.2 ±1.6	19.58 ±1.1	29.27 ±1.0	1.10 ±1.7
Pullets	I.	78.6 ±1.7	20.90 ±1.3	26.51 ±1.0	1.44 ±1.6
	II.	79.4 ±1.7	20.98 ±1.2	26.96 ±1.0	1.93 ±1.7

1: comparing to live weight, 2: comparing to carcass weight

Table 9. Chemical composition of the breast and thigh meat of 14 weeks old chickens kept in free-range and closed housing systems

Sex	Housing	Thigh meat			Breast meat		
		Dry matter %	Fat	Protein	Dry matter %	Fat	Protein
		in dry matter %					
Male	Closed (a)	27.09±1.33 *b, *c	5.24±1.26 *b, *c	22.04±1.45 **b, **c	29.52±1.31*b , *c	4.22±1.33 **b, *c	23.70±1.28 **b, *c
	Free range (b)	28.95±1.91 *a, *d	4.07±1.81 *a, *d	24.62±1.69 **a, ***d	31.40±2.18 *a, *d	2.90±0.92 **a, *d	26.72±1.93 **a, **d
Female	Closed (c)	25.65±1.36 *d, *a	6.65±1.59 *d, *a	19.40±1.17 ***d, **a	27.82±1.00 **d, *a	5.58±1.98 *d, *a	21.32±1.42 **d, *a
	Free range(d)	27.1±1.56 *c, *b	5.15±1.87 *c, *b	21.85±1.62 ***c, ***b	29.5± 0.82 **c, *b	4.02±2.35 *c, *b	24.00±1.72 **c, *b

Statistical comparisons were carried out between the housing systems (a-b and c-d), and between the sexes in the same housing system (a-c and b-d).

Level of significance: \* : P ≤ 0.5, \*\* : P ≤ 0.1,

In addition to its lower water content, the meat of chickens reared in free-range management had higher protein and lower fat content due to the more intensive movement. The meat of chickens reared in free-range management had higher dry matter content and higher crude protein content expressed on dry matter basis. So the meat of these birds contains a substantially higher amount of protein in absolute terms than does the meat of broilers reared in the closed housing system (Table 10). There was no marked difference between the management systems in the absolute fat content of the meat (Table 10).

Table 10. The absolute fat and protein content of the meat of 14 weeks old chickens fattened in free range and closed housing systems

Sex	Housing	Thigh meat		Breast meat	
		Fat g/100g	Protein g/100g	Fat g/100g	Protein g/100g
Male	Closed	1.42	5.97	1.25	6.99
	Free range	1.17	7.13	0.91	8.34
Female	Closed	1.67	4.98	1.55	5.93
	Free rang	1.39	5.92	1.19	7.09

The meat of chickens fed the diet series of lower energy and protein content (Table 1, Diet II) contained less fat and more protein than that of the chickens reared on the other diet series, although the difference was not

statistically significant (Table 11). This comparison also supports the above conclusion that the feeding of Diet II can be recommended for the fattening of the flocks studied.

Table 11. Effect of different diets on meat composition of 14 weeks old slow-growing chickens

Sex	Diet*	Thigh meat			Breast meat		
		Dry matter %	Fat	Protein	Dry matter %	Fat	Protein
			in dry matter %			in dry matter %	
Male	I.	28.10±0.92	4.55±1.71	23.72±1.64	30.31±1.71	3.48±1.69	25.52±1.72
	II.	28.56±1.92	4.36±1.72	23.80±2.12	31.23±2.14	3.20±2.4	25.90±2.36
Female	I.	26.63±0.70	5.93±2.41	21.27±1.83	28.70±0.93	4.84±1.98	23.06±1.72
	II.	26.63±1.28	5.37±2.17	21.30±1.16	29.22±1.48	4.24±1.22	23.16±1.69

\*: see in Table 1.

From the results it can be stated that by adequate feeding a live weight meeting the market demands can be reached with Hungarian-bred broiler flocks under the conditions of alternative (free-range) management. The type of management and the composition of the diet fed did not exert a statistically significant influence on the dressing percentage and the ratio of the valuable meat parts. At the same time, the type of management markedly affected the composition of meat (breast and thigh), which was also slightly influenced by the composition of the diet fed.

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