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Effect of housing conditions and feeding system on slaughter performance parameters of Popielno White rabbits*

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The objective of the study was to determine the production potential (rearing performance, fattening performance and dressing percentage) of rabbits of the native breed Popielno White raised in backyard conditions. The study was conducted on 261 young rabbits housed indoors in single-tier cages and outdoors in wooden multi-tier cages. During the spring and summer season, 20 females with all of their offspring were fed complete diets, while another 20 does and their offspring received on-farm feed *ad libitum.* The offspring kept in open-air cages and those kept indoors were evaluated for rearing performance. Six 90-day-old rabbits (3 males and 3 females) from each experimental group were slaughtered. The Popielno White rabbits fed complete diets and housed indoors had an average body weight of 2,609 g on day 77 and as much as 2,992 g at 90 days of age. The animals reared in outdoor cages weighed 2,067 g and 2,365 g, respectively, at the same ages. Feed consumption was only 3.41 kg for rabbits housed indoors, and slightly higher, at 3.66 kg, for those housed outdoors. The growth of the young Popielno White rabbits fed on-farm feed was much lower than that of the animals receiving complete feeds. The rabbits kept indoors reached a body weight of 2,500 g at 120 days of age while those housed outdoors attained this weight at 130 days. Differences in body weight between sexes were not observed until the age of 120 days. The highest dressing percentage was obtained for the carcasses of rabbits receiving the complete diet, irrespective of the housing system.

KEY WORDS: Popielno White rabbit / feeding system / housing system / performance indicators / slaughter parameters

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The Popielno White rabbit is the only surviving native Polish breed of rabbit. Work on the creation of this breed, conducted by prof. Z. Kaminski, was begun in 1950 at the Experimental Unit of the National Research Institute of Animal Production in Chorzelów. Later, the research was transferred to the Experimental Department of the Polish Academy of Sciences in Popielno, hence the name of the breed. As a result of the work, a herd of rabbits with uniform, albino coat colour was obtained in 1964 in Popielno [3, 12, 21].

Commercial production of rabbits has not yet eliminated traditional breeding in any country in the world. In many European Union countries, such as the Netherlands, Belgium and France, close co-operation with small breeders has led to transformations that have turned small farms into family rabbit farms supporting the entire household. The volume of global production of rabbit meat is difficult to determine precisely because its structure is fragmented and difficult to ascertain, and in many countries no relevant statistics are kept. According to Lebas and Colin [16, 17] who attempted to estimate global production of rabbit meat, it is about 1,250,000 tonnes. Of this, 550,000 tonnes, i.e. 43.7%, is obtained in traditional farming and the rest in commercial production. The increased demand for rabbit meat observed in many countries suggests that there will be family-run commercial farms in the future. A similar situation is also observed in Poland. In countries with an established tradition of eating rabbit meat, since the start of this century there has been a sharp increase in interest in traditional rabbit farming combined with the use of on-farm feed, known as organic farming [15].

Research into the welfare of rabbits has become increasingly important in the 21st century. It focuses on housing conditions and their impact on the rate of growth of animals and the quality of meat obtained. The first works in this field have appeared in the literature, published by Dal Bosco et al. [8], Lambertini et al. [14], Kustos et al. [13], and Maertens and Van Oeckel [18]. Similar studies have been conducted at the National Research Institute of Animal Production [4, 5, 11, 22, 23]. Within the framework of research dedicated to animal welfare, there has been a return to the subject of local breeds of rabbits and their use in organic or small-scale production [7, 15, 19].

The objective of the study was to determine the production potential of rabbits of the native breed Popielno White raised in backyard conditions and fed complete feed or on-farm feed.

Material and methods

The experimental material consisted of Popielno White (PB) rabbits. The animals were kept on a private farm in the village of Załuż (Podkarpackie Voivodeship). The experimental design and numbers of young rabbits in the experimental groups are shown in Table 1.

The rabbits housed indoors were kept in single-tier cages made of galvanized metal mesh and the rabbits housed outdoors were kept in wooden multi-tier cages.

Table 1
Experimental design

Specification	Complete feed pellets	On-farm feed
Indoor housing	55 ♂♀	75 ♂♀
Outdoor cages	63 ♂♀	68 ♂♀

After the rabbits were weaned from their mothers, they were separated by sex, tagged, and vaccinated against haemorrhagic bronchopneumonia and myxomatosis.

All rabbits were fed ad libitum in the spring/summer period. The diet consisted of a complete pelleted compound feed supplemented with Polfamix FK with a coccidiostat, but 14 days before slaughter Polfamix F without a coccidiostat was used instead of Polfamix FK. The complete feed contained 16.1% total protein, 13.1% crude fibre and 3.18% of crude fat, and the calculated metabolic energy was 10.94 MJ/kg (Table 2).

The composition of the on-farm feed is shown in Table 2. The level of crude protein was 16.1% to 16.9%, crude fibre 12.2% to 12.4%, crude fat 3.2%, and metabolic energy calculated from feed composition tables was 9.1 to 9.7 MJ/kg (Table 2). The rabbits had constant access to drinking water.

Evaluation of rearing was based on the following data:

- weight of rabbits at weaning (day 35) and at the age of 56, 70, 77 and 90 days
- daily weight gains from weaning to the age of 56, 70, 77 and 90 days
- feed consumption per kg of body weight gain up to the age of 90 days
- deaths and their causes

Young rabbits randomly selected at random at the age of 90 days from each of the experimental groups (3 males and 3 females) were subjected to experimental slaughter. Carcass analysis was performed, and after the carcasses were cooled for 24 hours they were dissected according to the method described by Niedźwiadek [20].

The carcass was divided between the 7th and 8th thoracic vertebrae along the ribs and thoracic wall and between the 6th and 7th lumbar vertebrae. The carcass and abdominal walls were cut in a transverse line to the spinous processes (photo). Then the forelimbs were separated, excluding the chest muscles and the hind limbs. As a result of this division, the forelimbs were obtained, including the muscles connecting the thorax and the thorax together with the first seven ribs. These parts were treated as the fore part. The loin, including the abdominal wall and ribs after the 7th thoracic rib, was treated as the middle part (saddle). The hind limbs, including the sacrum and the lumbar vertebrae after the 6th lumbar vertebra, comprised the rear part.

Table 2
Composition (%) and nutritional value of complete compound feed and on-farm feed mixture

Specification	Complete compound feed with coccidiostat	Complete compound feed with no coccidiostat	On-farm feed mixture
Dried green plants	25.0	25.0	–
Meadow hay	–	–	25
Green forage	–	–	28
Barley meal	25.0	25.0	11.0
Maize meal	18.0	18.0	–
Soybean meal	8.0	8.0	10.0
Rapeseed „00" meal	–	–	10.0
Wheat bran	18.6	18.6	15.0
Milk replacer for kits	2.0	2.0	–
Feed yeast	1.0	1.0	–
Feed phosphate	1.0	1.0	–
NaCl	0.4	0.4	–
Polfamix FK	1.0	–	1.0
Polfamix F	–	1.0	–
Nutritional value			
total protein	16.08	16.08	15.31
crude fat	3.18	3.18	3.18
crude fibre	13.12	13.12	12.44
Metabolizable energy* (MJ/kg)	10.94	10.94	9.15

*calculated from feed composition tables

Dressing percentage I was calculated according to the formula
hot carcass weight with head (g) x 100/*body weight at slaughter* (g)
and dressing percentage II from the formula
hot carcass weight without head (g) x 100/*body weight at slaughter* (g).

Phot. Division of the rabbit carcass (phot. P. Bielański)

After the carcass was divided in this manner, a detailed dissection was performed, dividing the individual cuts into muscle, bone and fat tissue. Muscle samples were then taken from the left and right haunch and the saddle for chemical analyses.

The pH of the muscles was measured by the potentiometric method in the haunch (*m. gluteus medius*) 45 minutes after slaughter (pH_{45}) and after 24-hour storage at 4°C (pH_{24}) using a CyberScan pH10PMMU microprocessor pH-meter.

Statistical analysis was performed with the SAS statistical package, using the GLM (General Linear Model) procedure. A t-test (Tables 3 and 4) was used to compare the two groups, while slaughter performance traits were compared by a two-way analysis of variance model:

$x_{ijk} = \mu + a_i + b_j + e_{ijk}$, where: μ – mean, a_i – feed factor; b_j – housing factor; e_{ijk} – sampling error.

The significance of the differences between means was tested by the F test. In the case of differences between pairs of objects, Fisher's LSD multiple comparison test (Table 5 and 6) was used.

Results and discussion

During the growth of young rabbits, the weight of males and females was monitored separately. However, the results of the study, conducted up to the 90th day of life, showed no differences between the sexes. For this reason the results in Tables 3 and 4 are combined rather than broken down by sex. Although some authors claim that there are gender-de-

pendent differences in body weight, most researchers believe that gender differentiation in body weight is revealed only when sexual development is complete, at the age of 4-5 months [6, 9].

During the course of the experiment a total of 4 deaths were recorded (in the first week after weaning). They were caused by diarrhoea. The very small percentage of deaths should be emphasized, as in industrial rabbit farming mortality in this age group can reach up to 20% [2].

Table 3 presents the growth results of the young rabbits fed complete pelleted feed and housed in two systems: indoor and outdoor. Only at the onset of rearing at 35 days of age was the mean body weight of the rabbits at a similar level; from 56 days of age a difference ($P \leq 0.05$) was noted between housing systems, in favour of the animals kept indoors. The Popielno White rabbits housed indoors attained a mean weight of over 2,600 g at 77 days of age and 2,992 g at 90 days. Rabbits kept in cages outdoors weighed 2,067 g and 2,365 g, respectively, at these ages. The differences between means were statistically confirmed ($P \leq 0.01$). Bielański [1] reported a body weight of 2,906 g on day 90 for rabbits of a meat line housed indoors, and 2,693 g for New Zealand White rabbits.

Daily weight gains in the rabbits increased until the age of 77 days, after which the rate of growth slowed. Average daily gains from 35 to 70 days of age did not exceed 40 g, but in the period from 70 to 77 days the animals housed indoors surpassed 50 g, while those kept outdoors reached a weight of 43 g. After 77 days the growth rate dropped below 30 g per day, probably because the rabbits kept indoors had attained a high body weight. In the final growth period of the animals kept outdoors, the significant temperature fluctuations between day and night may have negatively affected weight gain.

Feed consumption per kg of body weight gain was at a good, low level: only 3.41 kg of feed for the rabbits kept indoors and 3.66 kg for those kept outdoors. The difference between mean feed conversion was statistically significant ($P \leq 0.05$). The results obtained are very good in comparison to studies by Zając [22] and Zając et al. [23] conducted on the most common medium-sized rabbit breeds in Poland. Consumption of more than 4.0 and even 5.0 kg of complete feed per kg of rabbit body weight is completely unprofitable and would lead to complete liquidation of a commercial farm. Bielański [1] used complete feeds both indoors and outdoors and obtained very high growth rates for a meat line of New Zealand White rabbits and for crossbred rabbits, not exceeding 3.5 kg of pellets per kg body weight gain.

The growth results of the young Popielno White rabbits receiving on-farm feed are presented in Table 4. The body weight of the rabbits at the start of the growth experiment was significantly lower than that of the rabbits fed complete feed, but it was similar in the two housing systems, at about 400 g. The growth rate of the rabbits fed on-farm feed was much slower; only at the age of 70 days did the average body weight exceed 1 kg, i.e. 1,350 g

Table 3
Body weight, body weight gains, and feed conversion in rabbits fed complete pellets (g)

Specification	Indoor housing		Outdoor cages	
	$\bar{x}$	SEM	$\bar{x}$	SEM
Body weight at 35 days of age	511.2 NS	12.60	474.1 NS	13.37
Body weight at 56 days of age	1348.7[a]	36.66	1237.3[a]	42.58
Body weight at 70 days of age	1878.5[a]	38.72	1764.1[a]	42.77
Body weight at 77 days of age	2608.9[A]	46.46	2067.8[A]	38.12
Body weight at 90 days of age	2992.4[A]	51.64	2365.6[A]	43.32
Body weight gain, 35-56 days	837.5[a]	26.22	763.2[a]	32.09
Body weight gain, 35-70 days	1367.3[a]	48.87	1290.0[a]	38.17
Body weight gain, 35-90 days	2481.2[A]	46.95	1891.5[A]	44.62
Daily weight gains, 35 to 56 days	39.9 NS	2.39	36.3 NS	1.62
Daily weight gains, 35 to 70 days	39.1 NS	2.65	36.9 NS	2.03
Daily weight gains, 35 to 77 days	49.9[A]	2.18	37.9[A]	0.95
Daily weight gains, 35 to 90 days	45.1[a]	1.92	34.4[a]	0.84
Body weight gain, 56 to 70 days	529.8 NS	32.30	526.8 NS	27.27
Body weight gain, 70 to 77 days	365.2 NS	24.16	303.7 NS	18.51
Body weight gain, 77 to 90 days	383.5[a]	26.62	297.8[a]	24.02
Daily weight gains, 56 to 70 days	37.8 NS	2.48	37.6 NS	1.88
Daily weight gains, 70 to 77 days	52.2[A]	3.45	43.4[A]	2.84
Daily weight gains, 77 to 90 days	29.5[a]	2.17	22.9[a]	1.98
Feed conversion (kg feed/kg gain)	3.41[a]	0.22	3.66[a]	0.23

$\bar{x}$ – mean, SEM – standard error of the mean, NS – statistically non-significant
Values with the same capital letters in rows differ highly significantly at P≤0.01, values with the same lower case letters differ significantly at P≤0.05

Table 4
Body weight, body weight gains and feed conversion in rabbits receiving on-farm feeds (g)

Specification	Indoor housing		Outdoor cages	
	$\bar{x}$	SEM	$\bar{x}$	SEM
Body weight at 35 days of age	398.2 NS	13.80	421.2 NS	17.08
Body weight at 56 days of age	944.0 NS	32.6	862.0 NS	42.23
Body weight at 70 days of age	1350.2[a]	49.21	1191.2[a]	43.8
Body weight at 77 days of age	1557.4[a]	42.65	1454.4[a]	39.32
Body weight at 90 days of age	1872.2[a]	53.53	1785.2[a]	44.83
Body weight gain, 35-56 days	545.8 NS	43.12	440.8 NS	37.09
Body weight gain, 35-70 days	952.0[a]	58.85	770.0[a]	39.17
Body weight gain, 35-90 days	1474.0[a]	47.53	1364.0[a]	43.63
Daily weight gains, 35 to 56 days	26.0 NS	1.84	21.0 NS	1.71
Daily weight gains, 35 to 70 days	27.2[a]	1.73	22.0[a]	1.08
Daily weight gains, 35 to 77 days	27.6 NS	1.09	24.6 NS	0.83
Daily weight gains, 35 to 90 days	26.8 NS	0.82	24.8 NS	0.77
Body weight gain, 56 to 70 days	406.2 NS	32.30	329.2 NS	28.18
Body weight gain, 70 to 77 days	207.2 NS	21.16	263.2 NS	19.43
Body weight gain, 77 to 90 days	314.8 NS	25.32	330.8 NS	25.92
Daily weight gains, 56 to 70 days	29.0[a]	1.38	23.5[a]	1.72
Daily weight gains, 70 to 77 days	29.6 NS	2.29	37.6 NS	2.78
Daily weight gains, 77 to 90 days	24.2 NS	2.24	25.4 NS	1.94
Feed conversion (kg feed/kg gain)	5.8 NS	1.81	6.3 NS	1.47

$\bar{x}$ – mean, SEM – standard error of the mean, NS – statistically non-significant
Values with the same lower case letters in rows differ significantly at $P \leq 0.05$

Table 5
Slaughter performance indicators of rabbits

Specification	Feeding with complete pellets				Feeding with on-farm feeds			
	indoor housing		outdoor cages		indoor housing		outdoor cages	
	$\bar{x}$	SEM	$\bar{x}$	SEM	$\bar{x}$	SEM	$\bar{x}$	SEM
Body weight at slaughter (g)	2656^{ABC}	213.2	2350^{Aab}	196.4	2200^{Ba}	184.3	2100^{Cb}	126.1
Hot carcass weight with head (g)	1446^{ABC}	158.4	1278.6^{Aab}	138.3	1126.4^{Ba}	131.6	1068.9^{Cb}	118.8
Hot carcass weight without head (g)	1260.8^{ABC}	132.8	1109.7^{Aa}	125.2	1032.0^{B}	97.5	983.4^{Ca}	98.9
Dressing percentage I (%)	54.43	–	54.38	–	51.2	–	50.9	–
Dressing percentage II (%)	47.47	–	47.22	–	46.91	–	46.83	–

$\bar{x}$ – mean, SEM – standard error of the mean, NS – statistically non-significant
Values with the same capital letters in rows differ highly significantly at $P \leq 0.01$, values with the same lower case letters differ significantly at $P \leq 0.05$

Table 6
Carcass dissection results

Specification	Feeding with complete pellets				Feeding with on-farm feeds			
	indoor housing		outdoor cages		indoor housing		outdoor cages	
	$\bar{x}$	SEM	$\bar{x}$	SEM	$\bar{x}$	SEM	$\bar{x}$	SEM
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Cold carcass weight (g)	1134.28^{AB}	118.3	1089.6^{C}	123.6	1000.2^{A}	98.6	968.3^{BC}	97.7
Weight of fore part (g)	446.67^{ab}	26.3	436.9^{c}	24.8	401.1^{a}	19.4	394.1^{bc}	18.3
Tissue composition of fore part: weight of muscles (g)	303.7^{a}	17.5	296.1	18.9	265.5	16.3	261.3^{a}	15.7
proportion of muscles (%)	68	–	67.7	–	66.2	–	66.3	–
weight of bones (g)	105.2	12.4	102.4	13.2	103.1	12.8	94.2	14.3
proportion of bones (%)	23.56	–	23.43	–	25.7	–	23.9	–
weight of fat (g)	37.8	12.3	40.5	9.4	32.5	8.9	38.6	5.6
proportion of fat (%)	8.5	–	9.27	–	8.1	–	9.8	–
Weight of saddle (g)	346.66^{a}	19.7	337.8^{b}	15.2	324.1	14.6	309.9^{ab}	16.3
Tissue composition of saddle: weight of muscles (g)	266.66	18.4	257.7	14.7	243.7	15.2	231.2	16.4
proportion of muscles (%)	76.9	–	76.3	–	75.2	–	74.6	–
weight of bones (g)	56.67	3.5	54.0	2.8	50.9	2.6	48.0	2.4

1	2	3	4	5	6	7	8	9
proportion of bones (%)	16.3	–	16.0	–	15.7	–	15.5	–
weight of fat (g)	23.33	1.6	26.3	1.9	29.5	1.7	30.7	1.3
proportion of fat (%)	6.72	–	7.8	–	9.1	–	9.9	–
Weight of rear part (g)	340.9^{ab}	21.7	314.9^{c}	23.7	275.0^{a}	22.5	264.3^{bc}	19.5
Tissue composition of rear part: weight of muscles (g)	282.6	12.4	256.9	13.2	222.2	12.7	211.7	11.8
proportion of muscles (%)	82.9	–	81.6	–	80.8	–	80.1	–
weight of bones (g)	54.5	9.5	49.8	7.6	42.9	6.6	41.5	7.4
proportion of bones (%)	16.02	–	15.8	–	15.6	–	15.7	–
weight of fat (g)	3.7^{ABC}	0.4	8.2^{Aa}	0.9	9.9^{B}	0.8	11.1^{Ca}	1.1
proportion of fat (%)	1.1	–	2.6	–	3.6	–	4.2	–
Weight of muscles in carcass (g)	852.96^{AB}	17.4	810.7^{a}	16.8	731.4^{A}	15.7	704.2^{Ba}	14.2
Proportion of muscles in carcass (%)	75.2	–	74.3	–	73.1	–	72.7	–
Weight of bones in carcass (g)	216.37	13.6	206.2	14.2	196.9	13.2	183.7	12.4
Proportion of bones in carcass (%)	19.08	–	18.9	–	19.7	–	19.0	–
Weight of fat in carcass (g)	64.83^{a}	1.2	75.0	0.9	71.9	0.8	80.4^{a}	10.2
Proportion of fat in carcass (%)	5.72	–	6.8	–	7.2	–	8.3	–

$\bar{x}$ – mean, SEM – standard error of the mean, NS – statistically non-significant
Values with the same capital letters in rows differ highly significantly at P≤0.01, values with the same lower case letters differ significantly at P≤0.05

in the rabbits housed indoors and 1,190 g in those kept outdoors. The differences between means were statistically confirmed (P≤0.05). The average body weight at 90 days of age was also low: 1,872 g indoors and 1,785 g outdoors. The differences between mean body weights were statistically confirmed (P≤0.05). Daily weight gains did not exceed 30 g in any of the growth periods.

The experiment was continued in order to test when the rabbits receiving on-farm feed would attain a weight acceptable to processing plants purchasing livestock. The rabbits housed indoors reached a body weight of 2,500 g at the age of 120 days and those kept outdoors attained this weight at the age of 130 days. There were no differences in body weight between sexes until the age of 120 days.

Concentrate feed conversion during the period from 35 to 90 days of age was relatively high, amounting to 6.0 kg per kg body weight gain. These results are comparable to those obtained by Bielański [1] and Lazzaroni and Biagini [15]. According to Bielański [1], in the case of feeding with on-farm feed, feed conversion in rabbits of medium-sized breeds was more than 6.0 kg of concentrate feed. Lazzaroni and Biagini [15], raising rabbits of the native Italian breed Carmagnola Gray, reported feed conversion of over 7.0 kg per kg body weight gain.

An important indicator of the slaughter performance of rabbits is their dressing percentage. This is another indicator, alongside growth rate and feed conversion, which determines the choice of rabbit breed for the production of slaughter material. Table 5 shows the carcass weight and two types of dressing percentage. Various dressing percentages are reported in scientific studies. The highest values are obtained by including the weight of the head and edible organs (liver, lungs, heart and kidneys) in the carcass weight, and this system appears to be the most accurate. Lower values are obtained by calculating this indicator without the weight of the edible organs, but including the weight of the head. The lowest dressing percentage is obtained by calculating the ratio of the weight of the carcass alone to the body weight at slaughter. Some authors distinguish hot and cold carcass weight.

In the present study two types of dressing percentage were calculated: for hot carcass weight with the head (higher values – dressing percentage I) and for hot carcass weight without the head (lower values – dressing percentage II). Dressing percentages are used in Poland by export slaughterhouses, in part to determine payments for suppliers of live rabbits. At slaughter, the weight of animals from different housing and feeding systems was varied. The highest dressing percentages, both I and II, were obtained for the carcasses of rabbits fed complete feed, irrespective of the housing system. The values obtained for the carcasses of rabbits fed on-farm feed were about 3 percentage points lower for dressing percentage I, while in the case of dressing percentage II the differences between feeding systems amounted to less than 2 points.

Comprehensive research by Bielański [1] on the growth of rabbits of six medium breeds and a crossbred line found both dressing percentages at a level of 47-52%, irrespective of

the diet and housing system. Studies on the quality of Popielno White rabbit meat carried out by Bielański et al. [3] and Kowalska and Bielański [10], show that it has high nutritional value, similar to that of the meat of other rabbits of medium breeds. This, together with the high growth rate, indicates that rabbits of the native Popielno White breed can compete with recognized and widespread medium breeds and crossbred lines of rabbits as raw material for processing plants.

In order to determine tissue composition, the chilled rabbit carcasses were dissected. The weight of the chilled carcasses was varied (Table 6). The heaviest carcasses came from rabbits fed complete pelleted feed. This resulted in the highest proportion of meat in the carcasses of these rabbits. The highest fat content was noted in the carcasses of the animals fed on-farm feed and kept outdoors. The differences in mean weight of muscle and fat were statistically confirmed ($P \leq 0.01$).

The dissection results showed that the diet and housing systems had a significant effect on the meat and fat content of the carcasses, and at the same time that the Popielno White rabbits can be competitive with other early maturing medium-sized breeds. Results obtained by Bielański [1] in comparable conditions have indicated the significant potential of this breed in comparison with crossbred rabbits or synthetic lines.

The results of the research and comparison with the findings of other researchers showed that the rabbits fed complete pelleted feed had the highest growth rate and at the same time the lowest feed conversion. The study indicated great potential for using native Popielno White rabbits in backyard and commercial farming to produce high-quality slaughter material.

REFERENCES

1. BIELAŃSKI P., 2004 – Wpływ rasy i systemów utrzymania na cechy produkcyjne brojlerów króliczych. ***Roczniki Naukowe Zootechniki, Rozprawy Habilitacyjne*** 18, 5-86.
2. BIELAŃSKI P., KOWALSKA D., 2007 – Króliki. Oficyna wydawnicza Hoża, Warszawa.
3. BIELAŃSKI P., KOWALSKA D., PANKOWSKI P., 2008 – Possibility of using the native breed of Popielno White rabbits for meat production. 9th World Rabbit Congress, June 10-13, Verona, Italy, 1515-1518.
4. BIELAŃSKI P., NIEDŹWIADEK S., ZAJĄC J., 1997 – Effect of genetic and environmental factors on fattening performance of rabbits. Proceedings from the 10th Symposium on Housing and Diseases of Rabbits, Furbearing Animals and Pet Animals. Celle, Germany, 276-280.
5. BIELAŃSKI P., ZAJĄC J., KOWALSKA D., 1999 – Effect of rabbit genotype on meat quality. Proceedings from the 11th Symposium on Housing and Diseases of Rabbits, Furbearing Animals and Pet Animals. Celle, Germany, 176-181.
6. CARABANO R., BADIOLA I., CHAMORRO S., GARCIA J., GARCIA-RUIZ A.I., GARCIA-REBOLLAR P., GOMEZ-CONDE M.S., GUTIERREZ I., NICODEMUS N., VILLA-

MIDE M.J.,DE BLAS J.C., 2008 – New trends in rabbit feeding: Influence of nutrition on intestinal health. ***Spanish Journal of Agricultural Research*** 6, 15-25.
7. COMBES S., JEH N., JUIN H., CAUQUIL L., LEBAS F., 2002 – Comparison between Standard and Label rabbits: chemical, rheological and sensory. Proceedings 2nd Meeting of the COST Working Group 5 in „Meat and Meat Safety". Athens, Greece.
8. DAL BOSCO A., MASOERO G., CASTELLINI C., MUGNAI C., BERGOGLIO G., 2002 – Effect of rearing system and strain on rabbit behaviour, performance, carcass and meat quality and NIRS related traits. Proceedings 2nd Meeting of the COST Working Group 5 in „Meat and Meat Safety". Athens, Greece.
9. KOWALSKA D., BIELAŃSKI P., 2011 – Zastosowanie pasz rzepakowych w żywieniu królików i ich wpływ na jakość mięsa. ***Roczniki Naukowe Polskiego Towarzystwa Zootechnicznego*** 7 (2), 53-63.
10. KOWALSKA D., BIELAŃSKI P., 2011 – Study on the possibility of using the native Popielno White rabbit breed in commercial farming. ***Annals of Animal Science*** 11 (2), 307-320.
11. KOWALSKA D., BIELAŃSKI P., ZAJĄC J., 1998 – Wybrane czynniki wpływające na tempo wzrostu młodych królików. Materiały Międzynarodowej Konferencji Naukowej „Aktualne tendencje w nowych technologiach chowu zwierząt ze szczególnym uwzględnieniem zagadnień ekologicznych i komfortu utrzymania". Balice, 24-25.11.1998. Wyd. własne IZ, Kraków, s. 114.
12. KRUPIŃSKI J. (red.), 2006 – Polskie rasy zachowawcze. Atlas zwierząt gospodarskich objętych programem ochrony w Polsce. Wydawnictwo własne Instytutu Zootechniki.
13. KUSTOS K., SZABO A., EIBEN C., SZENDRO Z., METZGER S., 2002 – Effects of rearing conditions (cage or pen) on meat quality and quantity traits. Proceedings 2nd Meeting of the COST Working Group 5 in „Meat and Meat Safety". Athens, Greece.
14. LAMBERTINI L., VIGNOLA G., ZAGHINI G., 2001 – Alternative pen housing system for fattening rabbits: effect of group density and litter. ***World Rabbit Sci*****ence** 9, 141-147.
15. LAZZARONI C., BIAGINI D., 2002 – Meat production in the Carmagnola Grey Rabbit: different housing systems and sex effect. 2d Meeting of the Working Group 5 COST Action 848, Agricultural University of Athens, Greece.
16. LEBAS F., COLIN M., l992 – World rabbit production and research. ***Journal Applied Rabbit Research*** 15, 29-54.
17. LEBAS F., COLIN M., 2001 – Monde: 1,84 millions de tones de viande de lapin. ***Cuniculture*** 158, 28 (2), 83-84.
18. MAERTENS L., VAN OECKEL M.J., 2002 – Effect of housing (cage or commercial pens) and pen enrichment on the performances, meat colour and water holding capacity of fattening rabbits. Proceedings 2nd Meeting of the COST Working Group 5 in „Meat and Meat Safety". Athens, Greece.
19. MARGARIT R., MOTRERA G., KUZMINSKY G., 1999 – Qualite de la viande de lapins engraisses cages mobiles sur prairie. ***Cuniculture*** 148, 26, 181-182.
20. NIEDŹWIADEK S., 1996 – Ujednolicone kryteria badań nad mięsnym użytkowaniem królików. ***Biuletyn Informacyjny Instytutu Zootechniki*** 34 (1), 37-47.
21. PIOTROWICZ Z., GUBRYNOWICZ A., 1961 – Królik biały popielniański. ***Hodowca Drobnego Inwentarza*** nr VIII i IX.

22. ZAJĄC J., 2003 – Analiza użytkowości rzeźnej królików trzech ras z uwzględnieniem ich różnej masy ubojowej. ***Roczniki Naukowe Zootechniki*** 29 (2), 49-60.
23. ZAJĄC J., NIEDŹWIADEK S., BIELAŃSKI P., 1994 – Wykorzystanie systemu chowu na głębokiej ściółce do produkcji mięsa króliczego. ***Biuletyn Informacyjny Instytutu Zootechniki*** 32 (4), 41-54.