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EFFECT OF INULIN-SUPPLEMENTED DIET ON QUAIL PERFORMANCE PARAMETERS AND MEAT QUALITY

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Abstract. This study aimed at evaluation of the effect of inulin-supplemented diet in the rearing period on quail performance parameters and slaughter value. The quails of group 2 and 3 were fed compound feeds containing inulin at a level of 1.5% for 3 and 6 weeks, respectively. The feed for the control group was not supplemented with inulin. The obtained results show that feed supplementation with inulin, regardless of administration time, did not have any effect of quail performance traits, slaughter value and percentage of some organs in body weight. The most favourable percentage of breast with bones and skin was also observed in group 2 (51.35%). Significantly ($P \leq 0.01$) lower content of this carcass element in relation to both experimental groups was a characteristic of the birds of the control group (51.35%). In male quails of this group, a significantly ($P \leq 0.01$) lower percentage of breast muscle was also observed (27.02%); in groups 2 and 3, these values were 29.93 and 28.41%, respectively. A significantly ($P \leq 0.05$) lower cholesterol content per 100 g of the breast meat, in relation to the control group (122.4 mg), was recorded in experimental groups 2 and 3 (116.6 and 114.3 mg, respectively). Feeding with inulin-supplemented feed did not have any effect on the results of physicochemical evaluation and sensory attractiveness of meat and broth.

Key words: prebiotic, quails, performance, meat quality

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INTRODUCTION

An important role in modern poultry nutrition is played by feed additives belonging to the group of prebiotics which can be an alternative solution to antibiotics. The results of studies on the effect of prebiotic application on animal performance are often contradictory and strongly depend on the type of compound being used, level of diet supplementation and duration of administration. In the study by Lipiński et al. [2009], the use of mannan-oligosaccharides in feeds for broiler chickens in the amount of 2 kg $\cdot$ t^{-1} improved their production results expressed in body weight, feed conversion and European Broiler Production Index. The study performed by Yusrizal and Chen [2003] showed that adding inulin and FOS at 10 g $\cdot$ kg^{-1} diet improved body and carcass weights, carcass percentage and FCR in female broiler chickens. Xu et al. [2003] found that supplementation of 4 g $\cdot$ kg^{-1} FOS to the basal diet significantly increased average daily gain (ADG) of broilers. The addition of 2.0 or 8.0 g $\cdot$ kg^{-1} FOS had no effect on ADG. A 1% addition of inulin to feed for hens increased their lying performance by 13.3% compared to the control group and was shown to increase the total weight of eggs being produced during the experiment, as well as improved feed conversion [Chen et al. 2005a].

Some of the studies have shown however a small and less stable effect on animal productivity [Juśkiewicz et al. 2004, Stańczuk et al. 2005]. Alzueta et al. [2010] have shown that inulin supplementation (from 4.0 to 20 g $\cdot$ kg^{-1}) improved the digestibility of protein and fat in a maize-soybean meal based diet, but had no effect on the performance of broiler chickens. In the study on turkeys, Stańczuk et al. [2005] have found no significant effect of inulin administration (1 and 4 g $\cdot$ kg^{-1}) on body weight gain and feed consumption. On the other hand, Józefiak et al. [2008] have reported that certain prebiotics (β-glucan, inulin, lactose) can even significantly ($P \leq 0.05$) decrease the body weight of broilers. Biggs et al. [2007], when feeding broiler chickens with a diet containing inulin in the amount of 8 g $\cdot$ kg^{-1}, have found a decrease in the digestibility of amino acids.

Differences in the final production results being obtained so far do not allow at present to precisely and clearly assess the suitability of prebiotics, including inulin, in animal breeding. Therefore, there is a need to perform further observations on their application, with a particular focus, among other, on their quantitative share in diet, feed composition, or line of production.

In view of the above facts, a study aiming at evaluation of the effect of inulin-supplemented diet in the rearing period on quail performance traits, slaughter value and meat quality was undertaken.

MATERIAL AND METHODS

The experiment was carried out on young Pharaoh quails coming from own hatching. One-day old chicks were weighed and separated into three groups, 50 birds with similar body weight each. The quails were fed complete feeds intended for the rearing period – feed I and feed II, to day 28 of life and from day 29 to 42 of live, respectively (Table 1). The nutritive value of feeds being fed to quails during their rearing was adjusted to the recommendations adopted for this poultry species (Poultry Nutrition Standards, 2005). Feeds for the quails of group 2 and 3 were supplemented with a 1.5% addition of inulin (FRUTAFIT® IQ, Sensus, Netherlands). According to the certificate of conformity, the product contained 94.1% inulin (DP2-DP60) and 5.9% mono- and disaccharides. In group 2, the inulin-supplemented feed was fed in first three weeks of life, while in group 3 during the whole rearing period (to day 42 of quail life). The feed had a mash form and was administered *ad libitum*.

Table 1. Composition of compound feeds

Tabela 1. Skład mieszanki paszowej

Item – Wyszczególnienie	Compound feeds Mieszanka paszowa	
	I	II
Feed components, % – Składniki mieszanki, %		
Ground barley – Śruta jęczmienna	10.00	15.00
Ground corn – Śruta kukurydziana	15.00	13.00
Ground wheat – Śruta pszenna	36.39	35.30
Extracted soybean meal (46% c.p in DM) – Poekstrakcyjna śruta sojowa (46% b.o w SM)	31.00	21.00
Fish meal (60% c.p in DM) – Mączka rybna (60% b.o w SM)	4.40	2.70
Wheat bran – Otręby pszenne	–	10.00
Fodder lime – Kreda pastewna	0.67	0.90
Monocalcium phosphate – Fosforan jednowapniowy	0.43	0.50
Soybean oil – Olej sojowy	0.80	0.30
DL-methionine – DL-metionina	0.12	0.08
NaCl	0.19	0.20
Kemzyme Layer[1]	0.10	0.10
$NaHCO_3$	0.10	0.10
Luctamold[2]	0.10	0.10
Natuphos 5% broiler[3]	0.20	0.20
Lutamix[4]	0.50	0.50
Calculated nutritive value – Wyliczona wartość pokarmowa		
Metabolisable energy – Energia metaboliczna, MJ · kg^{-1}	12.00	11.70
Total protein – Białko ogólne, g	24.00	20.00
Crude fibre – Włókno surowe, g	3.80	4.10
Assimilable phosphorus – Fosfor przyswajalny, g	0.40	0.40
Lysine – Lizyna, g	1.20	1.00

[1] Multi-enzyme feed additive – Wieloskładnikowy preparat enzymatyczny.
[2] Anti-mycotoxin solution – Preparat przeciw mikotoksynom.
[3] Enzyme preparation containing phytase – Preparat enzymatyczny z fitazą.
[4] Vitamin-mineral premix – Premix mineralno-witaminowy.

During the experiment, the quails were weighed individually once a week, applying sex separation from the third week; moreover, feed intake and their mortality were recorded.

After the experiment, 10 males were selected from each group and, after a 6-hour fasting, these birds were slaughtered. Female and other male quails were arranged into a breeder flock and further observations were performed. Following exsanguinations, deplumation and evisceration, quail carcasses were left to next day at about 6°C, after which they were weighed and then their partial dissection was performed. The following meat parameters were determined: pH using a pX-processor PM-600 pH-meter with a combined glass electrode ESAgP-307, and water-holding capacity based on the percentage of free water in meat (FW) according to the method of Grau and Hamm [1953], as modified by Pohja and Niinivaara [1957]. Sample preparation for determination of the total content of cholesterol (extraction, separation of unsaponifiable fraction, preparation of trimethylsilyl sterol ethers) and chromatographic analysis with mass spectrometry (GCMS) were carried out according to the Polish Standard PN-EN 12228:2002 (2002), by means of a PerkinElmer CLARUS® 600 CG/MS system.

Colour measurement was made after placing the meat samples in measuring cells and keeping them at 4°C for 20 minutes to allow myoglobin in the surface layer of meat to oxygenate. Meat colour was measured using a HunterLab MiniScan® XE Plus 45/0 apparatus with a measuring port diameter of 31.8 mm, adapted to measure ground meat colour, applying the CIEL*a*b*colour scale according to CIE (CIE, 1976) and a standard illuminant D65 and a 10° standard observer. The apparatus was standardised in relation to reference black and white points with the following co-ordinates: X = 78.5, Y = 83.3, and Z = 87.8.

In order to perform sensory evaluation, quail breast muscles were placed in 300 ml glass jars and 100 ml water was poured over them. The jars with samples were closed, placed in water bath until a temperature of 85°C was reached inside the breast muscles, according to the method given by Baryłko-Pikielna [1964]. When evaluating the sensory traits of meat and broth, a 5-point scale was applied, with a score of 1 being the worst and a score of 5 the best. This evaluation was conducted by a 5-person team according to the Polish Standard PN-ISO 4121:1998 (1998).

The results were processed statistically with one-factor analysis of variance, while significance of differences was determined with Duncan's test using the procedures of Statistica 7.0 software package.

RESULTS

Quail chicks on the first day of life were characterised by good uniformity in respect of their body weight (Table 2). During rearing, the control of their gains did not show significant differences in body weight. It was similar in all feeding groups in the analysed weeks of experiment but on week 42 of life both males and females of group 2 were the heaviest.

Table 2. Body weight of quails (mean ±SD)

Tabela 2. Masa ciała przepiórek (średnia ±SD)

Quails age, days Wiek przepiórek, dni	Group – Grupa 1	 2	 3
1 ♂ + ♀	7.9 ±0.7	8.1 ±0.8	7.9 ±0.7
7 ♂ + ♀	28.9 ±3.4	29.2 ±2.9	27.7 ±3.3
14 ♂ + ♀	62.0 ±4.2	59.9 ±4.6	59.0 ±5.1
21 ♂	100.7 ±9.4	96.6 ±11.1	96.0 ±6.8
21 ♀	101.7 ±6.7	102.2 ±10.7	100.2 ±9.2
28 ♂	136.5 ±9.2	134.5 ±9.2	131.5 ±10.4
28 ♀	143.6 ±8.4	139.3 ±11.2	138.3 ±11.9
35 ♂	159.9 ±10.0	156.1 ±9.3	160.7 ±11.8
35 ♀	178.4 ±11.6	175.8 ±17.9	170.2 ±16.5
42 ♂	173.2 ±10.7	178.4 ±13.3	176.5 ±14.4
42 ♀	209.9 ±15.3	210.3 ±17.5	199.4 ±16.9

Feed conversion per 1 kg gain in all quail groups amounted on average to 3.35 kg (Table 3). No significant changes in the growth rate between groups in the analysed stages of quail life were observed either. In experimental groups 2 and 3, no rearing losses were observed, whereas in the control group (group 1) the losses were at the level of 2% of the initial flock number.

Table 3. Feed conversion and mortality of quails (mean ±SD)

Tabela 3. Spożycie paszy i upadki przepiórek (średnia ±SD)

Item – Wyszczególnienie	Group Grupa 1	 2	 3
Feed intake, g/bird – Spożycie paszy, g/osobnika	630.4 ±0.39	643.2 ±0.42	625.4 ±0.37
Feed intake, g/bird/day – Dzienne spożycie paszy, g/osobnika	15.0	15.3	14.9
Feed conversion, kg · kg^{-1} – Zużycie paszy, kg · kg^{-1}	3.4 ±0.41	3.3 ±0.38	3.4 ±0.49
Mortality, % – Upadki, %	2.0	0.0	0.0

The quail development, expressed by the percentage of selected internal organs (heart, liver, spleen, testicles), was similar in all groups. The differences occurring in their weights and percentages in body weight between the control group and the experimental ones being fed with inulin-supplemented diet, regardless of its administration time, were statistically non-significant (Table 4).

Table. 4. Some internal organ weights and their percentage in the body weight of male quails (mean ±SD)

Tabela 4. Masa wybranych narządów wewnętrznych i ich udział w masie ciała samców przepiórek (średnia ±SD)

Item – Wyszczególnienie		Group Grupa		
		1	2	3
Body weight – Masa ciała	g	171.0 ±4.50	169.0 ±4.50	168.0 ±6.90
Right testicle – Jądro prawe	g	2.2 ±0.86	1.9 ±0.50	2.0 ±0.47
	%	1.3 ±0.50	1.1 ±0.30	1.1 ±0.27
Left testicle – Jądro lewe	g	1.9 ±0.54	1.8 ±0.53	2.0 ±0.46
	%	1.1 ±0.33	1.1 ±0.32	1.2 ±0.26
Liver – Wątroba	g	3.1 ±0.47	3.3 ±0.53	3.5 ±0.77
	%	1.8 ±0.29	1.9 ±0.32	2.0 ±0.42
Heart – Serce	g	1.6 ±0.08	1.5 ±0.13	1.5 ±0.12
	%	0.9 ±0.05	0.9 ±0.07	0.9 ±0.05
Spleen – Śledziona	g	0.09 ±0.01	0.07 ±0.01	0.06 ±0.01
	%	0.05 ±0.02	0.04 ±0.01	0.04 ±0.01

Eviscerated carcass weight was similar in all groups (Table 5). The slaughter value of male quails ranged from 71.3% (group 1) to 73.1% (group 2). In the groups being fed inulin-supplemented diet, it showed an upward trend, although not proved statistically. In group 2, with inulin-supplemented diet being applied for three weeks of rearing, the slaughter value was higher by 1.8%, while in group 3, being fed inulin-supplemented feed to the end of rearing, by 0.7% in relation to the control group (Table 5). The most favourable percentage of breast with bones and skin was also observed in group 2 (63.40%). Significantly lower ($P \leq 0.01$) content of this carcass element in relation to both experimental groups was a characteristic of the birds of the control group (group 1). In male quails of this group, a significantly lower ($P \leq 0.01$) percentage of breast muscle was also observed (27.02%); in groups 2 and 3, these values were 29.93 and 28.41%, respectively. In the control group, the percentage of breast bones in quail carcass weight was lower, although these differences were non-significant. No effect of different inulin dietary administration time on the percentage of subcutaneous breast fat was observed; on the other hand, a significantly higher ($P \leq 0.01$) percentage of breast skin was observed in groups 2 and 3, by 4.1 and 3.67%, respectively (Table 5).

A significantly lower ($P \leq 0.05$) cholesterol content per 100 g of the breast meat, in relation to the control group, was recorded in experimental groups 2 and 3 (116.6 and 114.3 mg, respectively). The content of cholesterol in the breast muscle decreased with prolongation of the feeding time with inulin-supplemented feed (Table 6).

Table 5. Dressing percentage and partial male quail carcass dissection (mean ±SD)

Tabela 5. Wydajność rzeźna oraz częściowa dysekcja tuszek samców przepiórek (średnia ±SD)

Item – Wyszczególnienie		Group Grupa		
		1	2	3
Dressing percentage – Wydajnośc rzeźna	%	71.30 ±1.28	73.10 ±1.34	72.00 ±1.63
Weight – Masa:				
carcass – tuszki patroszonej	g	122.00 ±4.4	123.5 ±3.9	121.0 ±4.3
breast with bones and skin – piersi z kością i skórą	g	53.27Aa ±4.24	63.40B ±4.05	60.20Bb ±5.80
	%	43.70Aa ±2.42	51.35B ±1.72	49.71Bb ±2.43
breast meet – mięso z piersi	g	33.00a ±3.05	37.01b ±2.34	34.36a ±3.44
	%	27.02Aa ±2.85	29.93Bb ±2.00	28.41b ±2.94
breast bones – kości z piersi	g	10.07a ±1.43	11.20b ±1.49	11.24b ±2.19
	%	8.35 ±1.22	9.08 ±1.22	9.29 ±1.49
breast fat – tłuszcz okołopiersiowy	g	2.71 ±1.43	2.60 ±1.23	2.64 ±1.41
	%	2.23 ±1.18	2.11 ±0.95	2.20 ±1.07
breast skin – skóra z piersi	g	7.49A ±2.61	12.61B ±3.81	11.87B ±3.95
	%	6.11A ±1.84	10.21B ±2.54	9.78B ±2.26

Means in the rows marked different letters differ significantly (A, B – $P \leq 0.01$; a, b – $P \leq 0.05$).
Średnie w wierszach oznaczone różnymi literami różnią się istotnie (A, B – $P \leq 0{,}01$; a, b – $P \leq 0{,}05$).

Inulin administration as a feed additive in the quail rearing did not have a significant effect on meat physicochemical traits (Table 6). No statistically significant effect of inulin on the quality of breast meat with respect to the traits under evaluation was observed.

Table 6. Evaluation results for physicochemical traits of quail breast muscles (mean ±SD)

Tabela 6. Cechy fizykochemiczne mięśni piersiowych przepiórek (średnia ±SD)

Item – Wyszczególnienie	Group Grupa		
	1	2	3
Cholesterol, mg · 100 g^{-1}	122.4a ±9.63	116.6b ±7.09	114.3b ±7.67
pH	5.3 ±0.10	5.87 ±0.07	5.84 ±0.12
Free water, % – Woda wolna, %	2.29 ±0.81	2.23 ±0.87	2.12 ±0.90
Lightness L* – Jasność barwy L*	36.15 ±2.31	37.18 ±2.57	37.24 ±2.86
Redness a* – Udział barwy czerwonej a*	12.79 ±0.82	12.68 ±0.62	12.50 ±1.25
Yellowness b* – Udział barwy żółtej b*	9.93 ±1.28	9.60 ±1.13	9.66 ±0.92

Means in the rows marked different letters differ significantly (a, b – $P \leq 0.05$).
Średnie w wierszach oznaczone różnymi literami różnią się istotnie (a, b – $P \leq 0{,}05$).

On the other hand, the sensory evaluation of cooked breast meat and broth followed a similar pattern, regardless of the time of experimental factor administration, being assessed as good and slightly higher. No differences in the sensory evaluation of meat and broth were recorded between the control group and the groups of experimental birds (Table 7).

DISCUSSION

In the own study, the use of inulin during the rearing period has not had any significant effect on the final body weight of quails, regardless of its feeding time, but an upward trend has been recorded in experimental groups. By contrast, an opposite trend has been observed by Juśkiewicz et al. [2004] in the study involving young turkeys for fattening. A beneficial effect of dietary inulin administration on the growth of broiler chickens has not been observed by Ortiz et al. [2009] or Alzueta et al. [2010]. Rebolé et al. [2010], when feeding broiler chickens with inulin-supplemented diet, have obtained higher final body weight in experimental groups. A positive effect of fructants on performance parameters may be in part, according to some authors, the result of increased activity of small intestinal mucosa enzymes as influenced by the stimulating effects of prebiotics, as well as by increased digestibility and better utilisation of feed components.

Table 7. Sensory evaluation results (in points) for cooked breast muscles and breast muscle broth (mean ±SD)

Tabela 7. Ocena sensoryczna (punkty) mięsa gotowanego i bulionu (średnia ±SD)

Item – Wyszczególnienie	Group Grupa		
	1	2	3
Breast muscles – Mięśnie piersiowe			
Flavour – Zapach	4.91 ±0.20	4.77 ±0.26	4.82 ±0.25
Tenderness – Kruchość	4.68 ±0.34	4.73 ±0.26	4.45 ±0.42
Juiciness – Soczystość	4.68 ±0.40	4.59 ±0.44	4.64 ±0.50
Palatability – Smak	4.77 ±0.41	0.40 ±3.73	3.64 ±0.81
Breast muscle broth – Bulion z mięśni piersiowych			
Colour – Kolor	4.18 ±0.60	4.27 ±0.56	4.36 ±0.60
Clarity – Klarowność	5.00 ±0,00	5.00 ±0.00	5.00 ±0.00
Flavour – Zapach	4.64 ±0.81	4.50 ±0.63	4.64 ±0.50
Palatability – Smak	4.36 ±0.39	4.23 ±0.41	4.27 ±0.47

In the own study, a significant effect of inulin-supplemented diet on feed conversion per 1 kg gain has not demonstrated. Similar results have been obtained by Stańczuk et al. [2005] in the study with the use of a preparation with inulin in the feeding of turkeys for fattening. Alzueta et al. [2010] have not observed any effect of inulin supplementation on feed conversion (on weight gain) in broiler chickens either. They have shown however an improvement in apparent ileal digestibility (AID) and total protein and fat, as well as a significantly higher digestibility of some amino acids and fatty acids – oleic acid and linolenic acid. By contrast, an improvement in FCR in broiler chickens has been demonstrated by Lipiński et al. [2009].

In available literature, no publications have been found referring to the effect of prebiotics, including inulin, on the dressing percentage and meat and broth physicochemical and sensory traits. Lipiński et al. [2009], when evaluating the

quality of meat of the broiler chickens fed with prebiotics, have not observed significant differences in the content of dry matter, total protein, raw fat and ash.

In the own study, an inulin addition to compound feeds for young quails significantly decreased the content of cholesterol in meat. Few studies have shown that fructans may affect the systemic metabolism of lipides, decreasing the liver levels of lipides and cholesterol and reducing the cholesterol content in blood serum and egg yolk. In the study by Chen et al. [2005b], chicken eggs of the control group contained, on average, 199 mg of cholesterol, whereas those of the hens being fed an inulin-supplemented feed only 153 mg of cholesterol.

A decrease in the cholesterol concentration in blood serum and reduction of fat deposition in the abdominal cavity have been shown by Yusrizal and Chen [2003] in the study on broiler chickens with the use of inulin-supplemented diet. On the other hand, the findings of Velasco et al. [2010] show no effect of inulin on deposition of abdominal fat. Grela et al. [2013] in the experiment being conducted on pigs have also observed a decrease in the content of cholesterol in blood and the longissimus muscle and an increase in the amount of essential omega-3 and omega-6 fatty acids in the examined meat as a result of feeding with inulin-supplemented feed. It seems that efficiency of the prebiotic effect of fructants depends on a number of factors, among others on the type of applied prebiotic, its supplementation level and time, compound feed composition, animal age, and environmental conditions.

CONCLUSIONS

1. The application of 1.5% inulin addition in quail nutrition in the rearing period did not have any effect on body weight, feed conversion, carcass dressing percentage, and the weight and percentage of analysed internal organs in body weight.
2. In the quails of experimental groups being fed inulin-supplemented diet, a significantly higher percentage of breast muscle with bones and skin in the carcass weight was observed, as well as that of breast meat and breast skin.
3. Inulin-supplemented diet significantly decreased the cholesterol content in the breast muscle; on the other hand, it did not have any effect on the results of meat physicochemical evaluation and meat and broth sensory attractiveness.

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WPŁYW DIETY Z INULINĄ NA WSKAŹNIKI PRODUKCYJNE ORAZ JAKOŚĆ MIĘSA PRZEPIÓREK

Streszczenie. Celem pracy była ocena wpływu diety z inuliną w okresie wychowu na produkcyjne parametry oraz wartość rzeźną przepiórek. Przepiórki w grupach 2 i 3 żywiono mieszankami zawierającymi inulinę na poziomie 1,5% odpowiednio przez 3 i 6 tygodni. Pasza dla grupy kontrolnej nie zawierała tego suplementu. W trakcie doświadczenia rejestrowano masę ciała, spożycie paszy oraz upadki. Po zakończonym doświadczeniu wybrano z każdej grupy po 10 samców i poddano ubojowi. Po skrwawieniu, oskubaniu i wypatroszeniu tuszki zważono a następnie przeprowadzono skróconą dysekcję. W wydzielonych mięśniach piersiowych określono cechy fizyko-chemiczne oraz przeprowadzono ich ocenę sensoryczną. Uzyskane wyniki wskazują, że suplementacja paszy inuliną, niezależnie od czasu podawania, nie miała wpływu na cechy użytkowe przepiórek, wydajność rzeźną i udział wybranych narządów w masie ciała. Najkorzystniejszy udział piersi z kością i skórą odnotowano w grupie 2 (63.4%). Istotnie ($P \leq 0,01$) niższą zawartością tego elementu w tuszce w odniesieniu do obu grup doświadczalnych charakteryzowały się osobniki z grupy kontrolnej (51,35%). U samców z tej grupy stwierdzono również istotnie ($P \leq 0,01$) mniejszy udział mięśni piersiowych (27,02%); w grupach 2 i 3 wartości te były na poziomie odpowiednio 29,93 i 28,41%. Istotnie ($P \leq 0,05$) niższą ilość cholesterolu w przeliczeniu na 100 g mięsa z piersi, w odniesieniu do grupy kontrolnej (122,4 mg), odnotowano w grupach doświadczalnych 2 i 3 (116,6 i 114,3 mg). Żywienie paszą z dodatkiem inuliny nie miało wpływu na wyniki oceny fizyko-chemicznej oraz atrakcyjność sensoryczną mięsa i bulionu.

Słowa kluczowe: prebiotyk, przepiórki, użytkowość, jakość mięsa

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