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Application of vitreous Maize Endosperm in poultry feeding on the production results, chemical composition of meat and skin and meat colour in meat chicken

Mirjana Delić-Jović[1], M. Domaćinović[1], M. Lukić[3], Marcela Speranda[2], Zdenka Škrbić[3] and V. Petrićević[3]

Summary

Corn starch is the most important food ingredient, but also the main energy source for poultry. In corn grain 98% of starch comes from endosperm. The aim of this study was to determine the impact of vitreous (resistant) maize starch in broilers feeding on: basic product indicators, chemical composition of meat, and skin and meat colour. The study was conducted by a single-factor experiment with a total of four dietary treatments on the Ross 308 heavy hybrid broiler chickens, on 480 chickens overall, divided into four groups, three experimental and one control. The chickens of the control group were fed with 100% corncobs, while the experimental groups had the share of corncobots replaced by fractions of vitreous maize starch in the ratio of 25%, 50% and 75%. In this study, a positive effect on chickens for experimental treatment was related to the following factors: daily intake (at the end of the experiment), increased food consumption over four weeks, food conversion in the first part of the experiment, the value of b* index of skin and white meat.

Keywords: broilers, feeding, maize, resistant starch

Zusammenfassung

Einfluss von glasiertem Maisendosperm im Broilerfutter auf Produktionsergebnisse, chemische Zusammensetzung von Fleisch und Haut sowie Fleischfarbe bei Masthühnern

Maisstärke ist die wichtigste Futtermittelkomponente, aber auch die Hauptenergiequelle für Geflügel. In Maiskörnern stammen 98% der Stärke aus dem Endosperm. Ziel dieser Studie war es, den Einfluss von glasierter (resistenter) Maisstärke bei der Mast von Masthühnern auf das Wachstum, die chemische Zusammensetzung des Fleisches und der Haut sowie die Farbe vom Fleisch zu bestimmen. Die Studie wurde durch ein Einzelfaktorexperiment mit insgesamt vier Fütterunsvarianten mit schweren Hybrid-Mast-

[1] Faculty of Ecology, University of Business Studies, 78000 Banja Luka, the Republic of Srpska, Bosnia and Herzegovina, mdelicjovic@yahoo.com

[2] Faculty of Agrobiotechnical Sciences at the Josip Juraj Strossmayer University of Osijek, 31 000 Osijek, the Republic of Croatia

[3] Institute for Animal Husbandry, 11 080 Belgrade, the Republic of Serbia

hühnern Ross 308 an insgesamt 480 Tieren durchgeführt. Die Tiere waren in drei Versuchs- und eine Kontrollgruppe unterteilt. Die Hühner der Kontrollgruppe wurden mit 100% Mais gefüttert, während in den Versuchsgruppen der Anteil Mais durch Fraktionen von glasierter Maisstärke (resistente Stärke) im Verhältnis von 25%, 50% und 75% ersetzt wurde.

In dieser Studie wurde ein positiver Effekt bei den Hühnern der Versuchsgruppen hinsichtlich Wachstumsleistung, täglicher Futteraufnahme (am Ende des Versuches), erhöhter Futterverzehr über vier Wochen, Futterverwertung im ersten Teil des Versuches und der Werte des b * -Indexes von Haut und weißem Fleisch nachgewiesen.

Schlüsselwörter: Broiler, Fütterung, Mais, resistente Stärke

1 Introduction

Poultry farming has been developing very intensively in recent decades and is considered a very important branch of animal husbandry in the world. In the production of poultry meat in the world, chicken meat is the most represented, while the most important category of meat is considered to be broiler meat. Modern and intensive poultry production is very complex in terms of feeding. Concentrated mixtures should be very precisely balanced in all nutrients and energy (Đorđević et al., 2006). When it comes to broilers, the basic role of feeding is to follow the genetically predisposed growth curve and that the consumption of nutrients is optimal, all with the aim of obtaining quality meat in economically justified production. New poultry hybrids require better and well-balanced feeding for maximum productivity in order to achieve maximum genetic potential (Đorđević et al., 2009). New requirements have been imposed regarding the preparation of animal feed and the transition to mixtures that fully meet the nutritional needs of animals has been gradually introduced (Vukmirović, 2015). The goal of many studies on broiler chickens, on which the recommendations are based, is to determine the optimal amounts of feed that can meet the needs of maximum utilisation of genetic potential, without health disorders (Glamočlija, 2013). The most important goals in food production are safety and quality satisfaction. In intensive livestock production, which is based on the use of modern chemical, biological and physical preparations, the aim is to produce quality and hygienically correct meat, which must not have a negative effect on human health (Savković et al., 2008). Starch plays an important role in the nutrition of all domestic animals, especially monogastric animals (Domaćinović, 2006). Maize starch is the most important food ingredient (50–75%), but also the main source of energy for the body of poultry. In corn grain, 98% of the starch comes from the endosperm. Poultry is thought to make better use of hybrids with a higher proportion of vitreous than floury endosperm. It is also believed that 82% of energy originating from corn comes from starch (Grbeša, 2016). Differences in the structure of starch, as well as differences in the zein-starch matrix, and also the size of granules, cause different nutritional value of corn grains with similar content and digestibility of starch. The structure of starch differs between different maize hybrids, and has a significant effect on the height and speed of starch digestion, i.e. the uniformity of glucose supply to key organs, and thus on animal production and food conversion. Starch structure factors that affect digestibility are the enamel/flour endosperm ratio, amylose/amylopectin ratio, as well as the share of total and individual zeins (proteins), but also the size and shape of granules (Grbeša, 2016). In his research, Grbeša (2016) states that moderate concentrations of about 5% amylose or 20–24% amylopectin have a beneficial effect on growth, conversion and poultry health. Amylose in the colon increases the level of short-chain fatty acids (lactic, acetic and butyric) and reduces the number of pathogenic bacteria, which has a beneficial effect on animal health. Likewise, amylose as an ingredient in resistant starch (as used in our study) reduces the production and thus the emission of ammonia from the colon. Endosperm proteins make up 75% of grain proteins. Most of about 70% of corn protein is zein. The digestibility of maize starch in the whole digestive tract of poultry is 97%, which is almost complete digestibility and there are no major differences between maize hybrids. However, for high milk, meat and egg production, in addition to the amount, simultaneous and uniform digestion of starch and protein is important. Thus, chickens fed the same proportion of separated starch from corn compared to tapioca starch grow more, make better use of food, energy and amino acids, and have more desirable bacteria in the appendix (Grbeša, 2016). Due to all the above, it can be said that similar research is needed and applicable in poultry. In broiler experiments, a total starch degradation of less than 82% was found (Svihus et al., 2005). In this study, the fraction of vitreous maize endosperm in fattening chickens was used and the influences on production indicators, oxidative status and quality of chicken meat were monitored.

2 Material and methods

The practical part of the study of the impact of the use of vitreous endosperm in maize in food for broiler chickens was conducted by a one-factor experiment with a total of four feeding treatments. The experiment was performed in specialised experimental facilities of the Institute of Animal Husbandry on broiler chickens of the heavy line hybrid Ross 308. The experimental facilities in which the chickens were housed meet all zoohygienic and microclimatic conditions.

The study was conducted on a total of 480 chickens distributed in four groups, three experimental and one control. Each group consisted of three sections with 40 chickens, a total of 120 chickens per group. Fattening is organised in the floor mode, on a deep mat. Chickens in all groups had uniform conditions in terms of population density, feeding space, temperature, light and humidity, so that the possible influence of other paragenetic factors was minimised.

2.1 Chicken feeding programme during the experimental period

The fattening lasted for 42 days, and according to the mixtures used, it was divided into three parts. In the first fattening period (days 1 to 10), a starter starting mixture for chickens was used. From the 11th to the 25th day, a mixture for growth – grower was used, while the final finisher mixture was offered to chickens from the 26th to the 42nd day of age (end of fattening).

According to the set goals, the differences between the chickens of individual groups referred to the differences in the recipe in all three mixtures of experimental groups. While the chickens of the control group were fed with a 100% proportion of whole corn grain, the experimental groups had different proportions of corn grain replaced by the fraction of vitreous maize starch. Thus, the chickens of experimental group I were fed with 25%, experimental group II with 50% and experimental group III with 75% of corn starch in relation to the proportion of corn coarse. Throughout whole fattening period food and water were offered to the chickens at thier will, *ad libitum*.

2.2 Methods of chemical food analysis

Chemical and microbiological correctness of all raw materials used was a condition for assembling complete mixtures. The control of the chemical composition and microbiological correctness of the mixtures was performed in the laboratory for the analysis of animal feed of the Institute of Animal Husbandry Zemun.

The usual procedures were used for sampling and preparation of animal feed, and the following methods were used for analysis:
- water content was determined by drying the samples at 105°C to constant weight SRPS ISO 6496 2001
- crude ash is determined by burning and annealing samples at 550 – 600°C SRPS ISO 5984 2002
- SRPS ISO 5983 2001 crude protein was determined by a modified Kjeldahl method based on nitrogen content SRPS ISO 5983 2001
- crude fat was determined by extraction of organic solvents by the Soxlet method SRPS ISO 6492 2001
- crude cellulose was determined by the standard method SRPS ISO 6865 2004
- NET was calculated as the difference: 100 – (% water +% ash +% protein +% fat +% cellulose)
- energy was determined on the basis of chemical composition using the appropriate formula
- calcium content was determined by atomic absorption spectrophotometry (Rowe, 1973) on the atomic absorber Varian AA-175 in food in all raw materials
- the content of total phosphorus in food was determined by the method SRPS ISO 6491 2002
- sodium content in food was determined according to the method described in the Ordinance on sampling methods and methods of physical, chemical and microbiological analyses of animal feed (Official Gazette of the SFRY No. 15, 1987).

The raw material and chemical composition of feed mixtures for broiler feeding during the experiment are given in Table 1.

The composition of the mineral-vitamin premixes used in the broiler chicken mixtures are shown in Table 2, noting that the same premix was used in all four groups.

2.3 Microbiological analysis of feed mixtures

The hygienic correctness of the mixtures was checked by standard methods in the microbiological laboratory of the Institute of Animal Husbandry by determining the total number of bacteria in 1 g of the sample, by the method IS-LDM-21 (SRPS EN ISO 4833–1: 2014); total number of molds in 1 g of sample, method IS-LDM-22 (SRPS ISO 21527–1: 2011); identification of sulfide-reducing clostridia in 50 g of the sample, by the method of IS-LDM-23 (ISO 15213: 2003); by isolation and identification of *Sallmonella spp.*, by the IS-LDM-25 method (SRPS EN ISO 6579: 2008).

2.4 Basic production indicators

Monitoring of basic production indicators referred to body weight movement, daily gain and food consumption. Measurement of body weight was performed at the end of each week by individual measurement of chickens, and with the help of a technical scale with an accuracy of 10^{-3} kg. Based on the differences in body weight of chickens determined by seven-day weighing, the average daily gain for each week of the experiment was calculated. Control of food consumption was also carried out weekly for each group.

2.5 Analysis of the chemical composition of meat

In order to determine the quality of meat, chemical analyses of samples of muscle tissue of the chest and thighs, i.e. breast meat and dark meat, were performed. Chemical

Table 1. Raw componets and chemical composition of feed mixtures in the experiment (%)
Rohbestandteile und chemische Zusammensetzung der Futtermischungen im Versuch (%)

Feed	Starter (1. – 10. day)				Grower (11. – 25. day)				Finisher (26. – 42. day)			
	(C)	(I)	(II)	(III)	(C)	(I)	(II)	(III)	(C)	(I)	(II)	(III)
Corn	46,3	34,7	23,2	11,6	49,1	36,8	24,6	12,3	51,2	38,4	25,6	12,8
Vitrous maize endosperm	–	11,6	23,2	34,7	–	12,3	24,6	36,8	–	12,8	25,6	38,4
Fodder flour	7				5,5				5,5			
Soya cake	19				25				17,5			
Sunflower meal	2l				3,5				4,3			
Fish flour	3,5				2				–			
Soybean semolina	18,5				10				15			
Vegetable oil	–				1,1				2,5			
ICF	1				1,1				1,1			
Livestock chalk	1,3				1,1				1,3			
Mikozel	0,2				0,3				0,3			
Salt	0,2				0,3				0,3			
Premix	1				1				1			
Total	100	100	100	100	100	100	100	100	100	100	100	100
Chemical composition												
ME (MJ/kg)	12,8				13,2				13,4			
Crude protein (%)	22,2	21,9	21,7	21,2	22,1	21,9	21,7	21,5	19,9	19,6	19,5	19,4
Water (%)	10,9	11,1	10,9	11,0	11,6	11,3	11,1	10,9	11,1	10,9	10,8	10,8
Crude fat (%)	8,8	7,9	7,9	7,0	7,5	7,5	7,0	7,3	10,2	9,6	9,0	8,7
Crude cellulose (%)	4,26	3,53	3,39	3,58	4,94	4,84	4,27	4,02	5,55	5,54	5,42	5,44
Raw ash (%)	5,3	4,6	5,3	4,9	5,4	5,3	5,6	5,4	5,1	5,2	5,0	5,5
NET (%)	48,6	51,0	50,8	52,2	48,5	49,1	50,2	50,9	48,2	49,0	50,3	50,04
Calcium (%)	0,95	0,78	0,93	0,85	0,77	0,90	0,91	0,84	0,78	0,75	0,78	0,90
Phosphorus – Total (%)	0,56	0,67	0,57	0,59	0,71	0,61	0,66	0,61	0,58	0,61	0,56	0,62
Sodium (%)	0,20	0,15	0,19	0,16	0,20	0,20	0,18	0,19	0,14	0,16	0,14	0,18

C… control group: 100% proportion of whole corn
I… experimental group I: 25% of corn starch in relation to the proportion of corn coase
II… experimental group II: 50% of corn starch in relation to the proportion of corn coase
III… experimental group III: 75% of corn starch in relation to the proportion of corn coase

analysis of the basic composition of breast meat and dark meat was performed on muscle tissue samples derived from 5 male and 5 female carcasses of broiler chickens in each

Table 2. Content of vitamins, microelements and amino acids in premixes
Gehalt an Vitaminen, Mikroelementen und Aminosäuren in den Vormischungen

Active substance	Quantity in 1 kg of food	
	Starter and grower mixture	Finisher mixture
Vitamin A (IJ/kg)	15000	12000
Vitamin D3 (IJ/kg)	3000	3000
Vitamin E (mg/kg)	150	50
Vitamin K3 (mg/kg)	8	6
Vitamin B1 (mg/kg)	4	3
Vitamin B2 (mg/kg)	11,3	9,4
Vitamin B6 (mg/kg)	5	4
Vitamin B12 (mg/kg)	0,015	0,02
Vitamin C (mg/kg)	100	100
Niacin (mg/kg)	60	50
Biotin (mg/kg)	10	10
Kalpan (mg/kg)	20	18
Folic acid (mg/kg)	2	1,5
Choline chloride (mg/kg)	500	400
Ferrum (mg/kg)	50	50
Copper (mg/kg)	6	6
Manganese (mg/kg)	100	100
Zink (mg/kg)	75	75
Iodine (mg/kg)	0,5	0,5
Antioxidant (mg/kg)	100	100
Cobalt (mg/kg)	0,25	0,25
Selenium (mg/kg)	0,15	0,15
Methionine (mg/kg)	1000	1000
Coccidiostatic (mg/kg)	500	–

examined treatment. In order to determine the basic chemical composition, the following tests were performed:

- moisture content is determined according to the standard SRPS ISO 1442/1998
- free fat content according to SRPS ISO 1444/1998
- the content of total ash is determined according to the standard SRPS ISO 936/1999
- nitrogen content was determined according to the standard SRPS ISO 937/1992, and the protein content was determined according to the following calculation: PC (%) = N (%) × 6.25
- The softness of the meat, expressed in terms of the cutting force (kg), was measured after cooking (at 100°C for 10 minutes) and cutting the meat in the direction of mus-

cle fibres (into 1x1 cm pieces), on a Volodkevich consistometer (1938). Higher readings indicated a higher cutting force, i.e. harder meat.

2.6 Skin and meat colour

The method as described was used to determine skin and meat colour. Instrumental skin colour of breast meat samples was measured using a Chroma Meter CR-400 device (Minolta Co. Ltd, Tokyo, Japan), previously calibrated on a standard white plate. Measuring was performed in the CIE L* a* b* method: brightness (L*), red share (a*) and yellow share (b*) (Cie, 1976).

2.7 Statistical processing

The obtained results were processed by the statistical package StatSoft, Inc. (2014) STATISTICA (data analysis software system) version 12. The method of descriptive statistics was used, and the differences between treatments were verified by the GLM model. In case of significant differences, LSD *post hoc* test was used.

3 Results

3.1 Daily gain

A review of the results on the average daily gains of chickens by groups for the entire fattening period (Tab. 3) shows that in the first week the highest daily gain was achieved by chickens of experimental group II (17.11 g), slightly lower value was recorded in control

Table 3. Daily gain of chickens in fattening periods (g) depending on feeding variant
Tägliche Zunahme von Masthühnern in den Mastperioden in Abhängigkeit von der Fütterungsvariante

Week of experiment	Control	Experimental I	Experimental II	Experimental III	SEM	P-value	Standard deviation
	$\bar{x}$	$\bar{x}$	$\bar{x}$	$\bar{x}$			
1. week	16.89	16.63	17.11	16.75	0.09	0.3431	0.178536
2. week	35.10	34.57	34.57	34.17	0.22	0.5319	0.330407
3. week	55.87^{a}	57.31^{a}	56.12^{a}	51.60^{b}	0.34	0.0001	2.162458
4. week	84.42^{a}	79.10^{b}	74.42^{c}	79.04^{b}	0.63	0.0001	3.539926
5. week	80.47	79.59	78.18	78.28	0.57	0.4345	0.952917
6. week	64.23^{a}	63.47^{a}	67.97^{b}	65.01	0.61	0.0472	1.705814

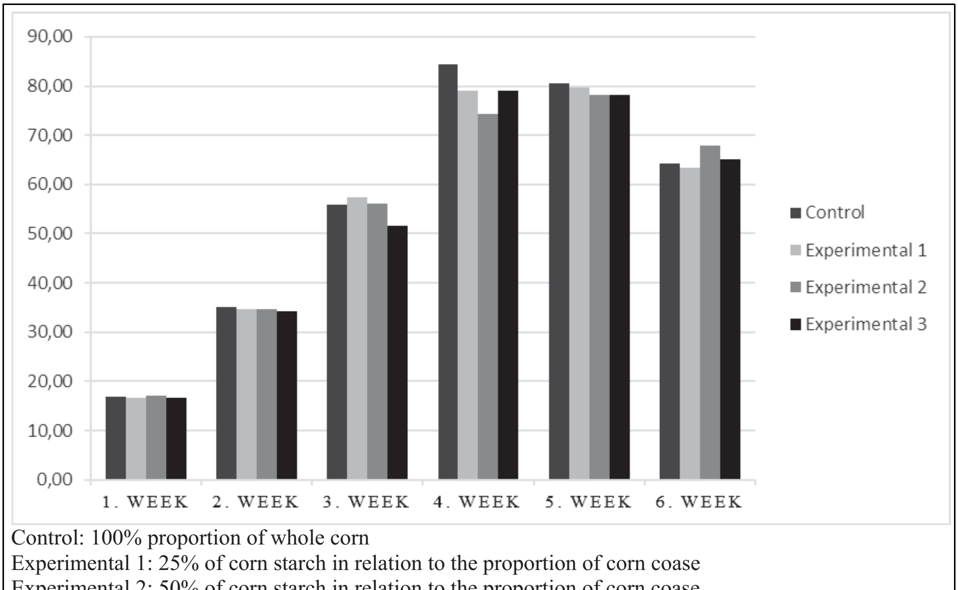
^{a,b} different letters mean significantly different (P < 0,05)
Control group: 100% proportion of whole corn
Experimental group I: 25% of corn starch in relation to the proportion of corn coase
Experimental group II: 50% of corn starch in relation to the proportion of corn coase
Experimental group III: 75% of corn starch in relation to the proportion of corn coase

group chickens (16.89 g) and chickens of experimental group III (16.75 g), and the smallest in chickens of experimental group I (16.63 g). However, the differences found in the first week were not statistically significant among control chickens and experimental groups, nor among experimental groups of chickens (P > 0.05).

In the second week of fattening (Fig. 1), the highest daily gains were recorded in the chickens of the control group (35.10 g), then, almost uniformly, in the chickens of experimental groups I and II (34.57 g), while the lowest daily gain was achieved in the chickens of experimental group III (34.17 g). The differences in the daily gain of chickens between the groups recorded in this week were not statistically significant (P > 0.05).

In the third week, the highest values of daily gain of chickens were recorded in chickens of experimental group I (57.31 g), slightly lower values were achieved in chickens of experimental group II (56.12 g) and control group (55.87 g), while the lowest value was recorded again in chickens of experimental group III (51.60 g). Statistically significantly higher (P < 0.05) values of daily gain were achieved by chickens of experimental groups I and II and control group compared to chickens of experimental group III.

In the fourth week, the highest daily gain of chickens was achieved in the control group (84.42 g). Slightly lower values of daily gain were recorded in chickens of experimental groups I and III (79.10 g; 79.04 g), while the lowest values of daily gain were achieved in chickens of experimental group II (74.42 g). Statistically significantly higher (P < 0.05) values of daily gain were achieved by chickens of the control group compared to chickens of all experimental groups. Statistically significantly higher (P < 0.05) value



Control: 100% proportion of whole corn
Experimental 1: 25% of corn starch in relation to the proportion of corn coase
Experimental 2: 50% of corn starch in relation to the proportion of corn coase
Experimental 3: 75% of corn starch in relation to the proportion of corn coase

Fig. 1. Daily growth of chickens in fattening periods depending on feeding variant
Tägliche Zunahme von Masthühnern in den Mastperioden in Abhängigkeit von der Fütterungsvariante

of daily gain in the fourth week was achieved by chickens of experimental groups I and III compared to chickens of experimental group II.

From the review of results in the fifth week of the experiment, it is noticeable that the highest daily gain was achieved by chickens of the control group (80.47 g), slightly smaller by chickens of the experimental group I (79.59 g), and the smallest and very approximate values of daily growth were recorded in experimental groups II and III (78.18 g; 78.28 g). The differences found in the fifth week were not statistically significant between chicken of the control and experimental group, nor between chickens of experimental groups ($P > 0.05$).

In the sixth week, the highest daily gain of chickens was achieved in experimental group II (67.97 g), slightly lower values were achieved in chickens of experimental group III (65.01 g), then even less in chickens of control group (64.23), while the lowest recorded values were in chickens of experimental group I (63.47 g). Statistically significantly higher ($P < 0.05$) values of daily gain were achieved by chickens of experimental group II compared to chickens of control and experimental group I.

An overview of the results on the average daily gain by periods (Tab. 4) shows that in the period from 1st to 3rd week the highest average daily gain was achieved by chickens of the control group (35.95 g), the approximate average daily gain was achieved by chickens of experimental groups I and II (35.90 g; 35.93 g), while the lowest values in the observed period were recorded in chickens of experimental group III (34.17 g).

In the period from week 3 to week 6 (Tab. 4), the highest average daily gain was achieved, again, by chickens of the control group (76.37 g), slightly lower values were recorded in chickens of experimental groups I and III (74.11 g; 74.15 g), and the lowest values in chickens of experimental group II (73.52 g).

From the review of the average daily gain for the entire fattening period (1st to 6th week) it can be concluded that the highest average daily gain was achieved in chickens of the control group (56.16 g), followed by chickens of experimental group I (55.00 g), slightly lower in experimental group II chickens (54.72 g), while the lowest average daily gain was recorded in experimental group III chickens (54.16 g).

Table 4. Average daily gain of chicken by fattening periods (g) depending on feeding variant
Tägliche Zunahme von Masthühner in den Mastperioden in Abhängigkeit von der Fütterungsvariante

Period of experiment	Groups				SEM	P-value	Standard deviation
	Control $\bar{x}$	Experimental I $\bar{x}$	Experimental II $\bar{x}$	Experimental III $\bar{x}$			
1.–3. week	35.95	35.90	35.93	34.17	0.404	0.3447	0.760867
3.–6. week	76.37	74.11	73.52	74.15	0.390	0.0506	1.087000
1.–6. week	56.16	55.00	54.72	54.16	0.454	0.3447	0.729589

Control group: 100% proportion of whole corn
Experimental group I: 25% of corn starch in relation to the proportion of corn coase
Experimental group II: 50% of corn starch in relation to the proportion of corn coase
Experimental group III: 75% of corn starch in relation to the proportion of corn coase

Observing the analysed fattening periods (Tab. 4), it is noticeable that the chickens of the control group achieved the highest average daily increments. The differences found, however, were not statistically significant among the chickens of the control and experimental groups, nor between the experimental groups (P > 0.05). It is also evident that the highest average daily gains of chickens were in the period from week 3 to week 6, which is a period of intensive fattening.

3.2 Food consumption

An overview of the results on the average daily food consumption by weeks (Tab. 5) shows that in the first week the best food consumption was by chickens of experimental group II (22.37 g), followed by chickens of experimental groups I and II (21.90g; 21.61 g), while the lowest average daily food consumption was in the chickens of the control group (21.51 g). The differences found in the first week were not statistically significant among the chickens of the control and experimental groups, or among the experimental groups (P > 0.05).

In the second week of fattening (Tab. 5), the highest daily food consumption was recorded in chickens of experimental group II (50.66 g), then slightly lower in chickens of control and experimental group I (50.55 g; 49.95 g), while the lowest value of food consumption was recorded in experimental group III chickens (49.28 g). The differences in the average daily food consumption between the groups recorded in this week were not statistically significant (P > 0.05).

In the third week, the best values of the average daily consumption of chicken feed were recorded in chickens of experimental group I (85.47 g), slightly lower values were achieved in experimental group II and control group (84.81 g; 84.14 g), while the lowest value recorded in experimental group III chickens (75.09 g). Statistically significantly

Table 5. Average daily food consumption of chickens in fattening periods (g) depending on feeding variant
Tägliche Futteraufnahme von Masthühnern in den Mastperioden in Abhängigkeit von der Fütterungsvariante

Weeks of experiment	Control	Experimental I	Experimental II	Experimental III	SEM	P-value	Standard deviation
1. week	21.51	21.9	22.37	21.61	0.189	0.419	0.333944
2. week	50.55	49.95	50.66	49.28	0.118	0.703	0.550136
3. week	84.14^{a}	85.47^{a}	84.81^{a}	75.09^{b}	0.406	0.005	4.233635
4. week	139.61^{a}	137.44^{a}	127.76^{b}	131.41	0.493	0.046	4.715382
5. week	169.3	164.52	181.28	175.74	0.982	0.427	6.350787
6. week	170.08	160.19	205.14	163.49	0.949	0.289	17.91745

^{a,b} different letters mean significantly different (P < 0,05)
Control group, 100% proportion of whole corn
Experimental group I, 25% of corn starch in relation to the proportion of corn coase
Experimental group II, 50% of corn starch in relation to the proportion of corn coase
Experimental group III, 75% of corn starch in relation to the proportion of corn coase

higher ($P < 0.05$) values of average daily food consumption were achieved by chickens of experimental groups I and II and control group compared to chickens of experimental group III.

In the fourth week, the most food was consumed on average by chickens of the control group (139.61 g), followed by slightly less by chickens of experimental group I (137.44 g), and by chickens of experimental group III the average daily consumption was 131.41 g, while the lowest results in this week were achieved by the chickens of experimental group II (127.76 g). Statistically significantly higher ($P < 0.05$) values of average daily food consumption were achieved by chickens of control and experimental group I compared to chickens of experimental group II.

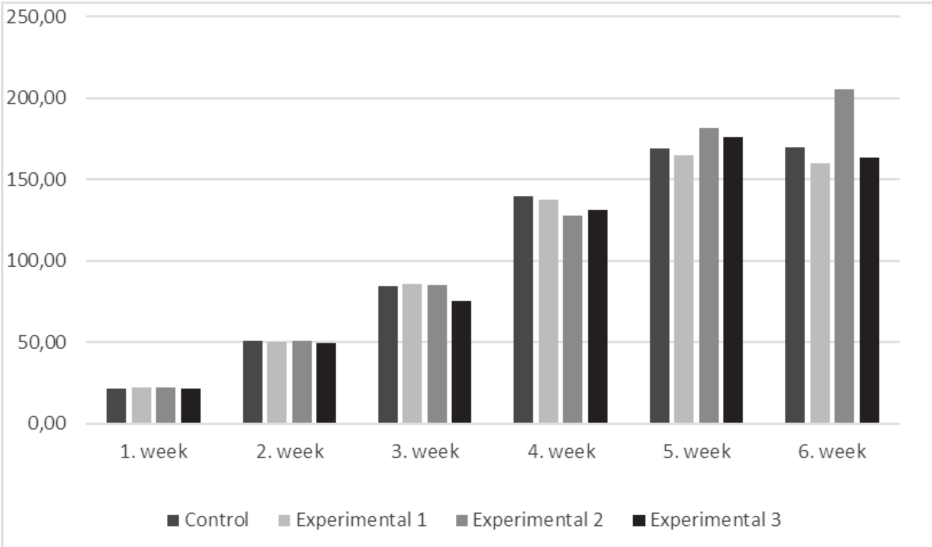
A review of the results in the fifth week of the experiment shows that the highest values of the average daily food consumption of chickens were recorded in chickens of experimental group II (181.28 g), slightly lower value was recorded in chickens of experimental group III (175.74 g), then chickens of the control group (169.30 g), while the lowest values of the average daily food consumption of chickens were achieved in the experimental group I (164.52 g). The differences found in the fifth week were not statistically significant among the chickens of the control and experimental groups, or among the experimental groups ($P > 0.05$).

In the sixth week of the experiment, the best values of the average daily food consumption of chickens were recorded in chickens of experimental group II (205.14), then in chickens of control group (170.08 g), in chickens of experimental group III the average daily food consumption was 163.49 g, while the worst was observed in chickens of experimental group I (160.19 g). The recorded differences in the sixth week were not statistically significant among the chickens of the control and experimental groups, as well as among the experimental groups ($P > 0.05$).

From the review of Figure 2 it can be concluded that there is an evident trend of growth of the average daily food consumption from the beginning to the end of the experiment. It is also evident that in the first two weeks of the experiment, the average daily food consumption by groups is quite uniform, while from the third week there are more pronounced differences. In the sixth week, there was a significantly higher daily food consumption of experimental group II, however, there was no statistically significant difference compared to other groups ($P > 0.05$).

3.3 Chemical composition of thigh and breast meat and skin and chicken meat colour

The chemical composition of broiler meat depends on a number of factors: age, sex, nutrition and nutritional status, hybrid, manner of keeping, anatomical region observed, etc. Chicken meat contains high-value proteins and essential amino acids and is a good source of polyunsaturated fatty acids (omega-3 and omega-6), which it contains more than other types of meat (Tab. 6). The total fat content in meat increases with the age of the chickens. A characteristic of chicken breast meat is its low cholesterol content compared to other types of meat. According to some authors, the amount of protein, water and ash in broiler meat is relatively constant, while the amount of fat is variable. The ability of meat to retain water during processing, storage, and cooking is measured by its water binding capacity (WBC). It is one of the important characteristics of meat that determines its quality (softness, juiciness and appearance). The quality of meat is also determined by the color of the meat as a technological property because consumers (users) in the first place choose meat based on its color. A review of the results on the Values of chemical analysis of thigh meat and breast meat and skin colour and colour of breast meat of chickens are given in Tab. 6.



Control: 100% proportion of whole corn
Experimental 1: 25% of corn starch in relation to the proportion of corn coase
Experimental 2: 50% of corn starch in relation to the proportion of corn coase
Experimental 3: 75% of corn starch in relation to the proportion of corn coase

Fig. 2. Average daily food consumption in chickens in fattening periods depending on feeding variant
Mittlere tägliche Futteraufnahme von Masthühnern in den Mastperioden in Abhängigkeit von der Fütterungsvariante

3.4 Chemical composition of thigh meat

From the review of the results of the chemical composition of thigh meat (Fig. 3a), it is noticeable that the percentage of water was the highest in the meat of experimental group II chickens (75.0%), then a slightly lower, almost completely uniform water content was recorded in the meat of chickens of experimental groups III and I (74, 88, 74.8 7%), while the lowest percentage of water was in the thigh meat of chickens of the control group (74.41%). The recorded differences in water content in the thigh meat between the groups were not statistically significant ($P > 0.05$).

The fat content in the thigh meat was the highest in chickens of the control group (9.90%), significantly lower values were in the meat of chickens of experimental groups I and III (4.99%; 4.46%), and the lowest fat content was recorded in meat of experimental group II chickens (3.89%). Differences in fat content in thigh meat between groups were also not statistically significant ($P > 0.05$).

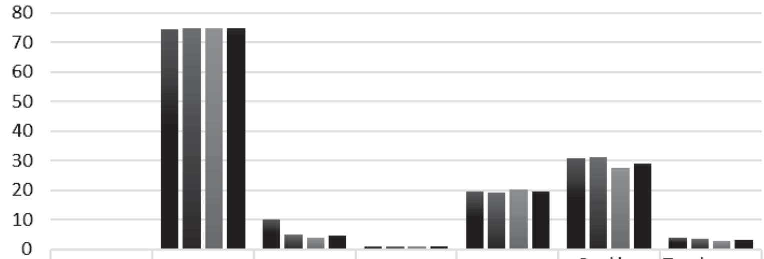
The thigh meat of chickens (Fig. 3a) of experimental group I had the highest ash content in its composition (1.04%), then a slightly lower value of ash content was recorded in the meat of chickens of experimental groups II and III (1.02%), while the lowest per-

Table 6. Values of chemical analysis of thigh meat and breast meat and skin colour and colour of breast meat of chickens depending on feeding variant
Werte der chemischen Analyse von Schenkel- und Brustfleisch sowie Haut- und Brustfleischfarbe von Masthühnern in Abhängigkeit von der Fütterungsvariante

Indicator	Control	Experi-mental I	Experi-mental II	Experi-mental III	SEM	P-value	Standard deviation
	$\bar{x}$	$\bar{x}$	$\bar{x}$	$\bar{x}$			
				Chemical composition of thigh meat			
Water (%)	74.41	74.87	75	74.88	0.138	0.4769	0.2601282
Fat (%)	9.9	4.99	3.89	4.46	0.23	0.3272	2.7634158
Ash (%)	1	1.04	1.02	1.02	0.006	0.5176	0.0163299
Protein (%)	19.66	19.08	20.06	19.62	0.185	0.3259	0.4024508
Cooking loss (%)	30.91[a]	31.07[b]	27.41[c]	28.96	0.518	0.025	1.7399306
Tenderness (kg)	3.69	3.51	2.91	3.25	0.129	0.155	0.3388215
				Chemical composition of breast meat			
Water (%)	73.93	74.1	74.06	74.45	0.153	0.6885	0.1924188
Fat (%)	1.07	1.12	0.97	0.96	0.068	0.8249	0.0674537
Ash (%)	1.12	1.13	1.14	1.13	0.008	0.8326	0.0070711
Protein (%)	23.85	23.61	23.81	31.11	1.902	0.4464	3.1853846
Cooking loss (%)	22.13	21.27	20.15	27.78	1.834	0.4882	2.9414484
Tenderness	3.02[a]	3.10[a]	3.08[a]	2.59[b]	0.074	0.0368	0.2084916
					Skin colour		
L*, skin	68.29	67.92	70.63	68.38	0.395	0.0586	1.0676727
a*, skin	3.64	3.9	3.29	3.42	0.148	0.499	0.2315572
b*, skin	4.26[a]	6.37[b]	6.51[b]	6.46[b]	0.319	0.0271	0.9481825
					Breast meat colour		
L*, b breast meat	54.24	53.92	56.07	53.88	0.456	0.2795	1.040877
a*, breast meat	4.79	1.93	1.36	1.45	0.112	0.7587	1.6243845
b*, breast meat	2.09	4.15	4.29	4.26	0.222	0.0535	1.0733553

[a,b] different letters mean significantly different (P < 0,05)
Control group, 100% proportion of whole corn
Experimental group I, 25% of corn starch in relation to the proportion of corn coase
Experimental group II, 50% of corn starch in relation to the proportion of corn coase
Experimental group III, 75% of corn starch in relation to the proportion of corn coase

centage was recorded in control group chickens (1.0%). The observed differences between the groups were not statistically significant (P > 0.05).



	Water (%)	Fat (%)	Ash (%)	Protein (%)	Cooking loss (%)	Tenderness (kg)
Control	74.41	9.9	1	19.66	30.91	3.69
Experimental 1	74.87	4.99	1.04	19.08	31.07	3.51
Experimental 2	75	3.89	1.02	20.06	27.41	2.91
Experimental 3	74.88	4.46	1.02	19.62	28.96	3.25

Control: 100% proportion of whole corn
Experimental 1: 25% of corn starch in relation to the proportion of corn coase
Experimental 2: 50% of corn starch in relation to the proportion of corn coase
Experimental 3: 75% of corn starch in relation to the proportion of corn coase

Fig. 3a. Chemical composition of thigh meat in chickens depending on feeding variant
Chemische Zusammensetzung von Schenkelfleisch bei Masthühner in Abhängigkeit von der Fütterungsvariante

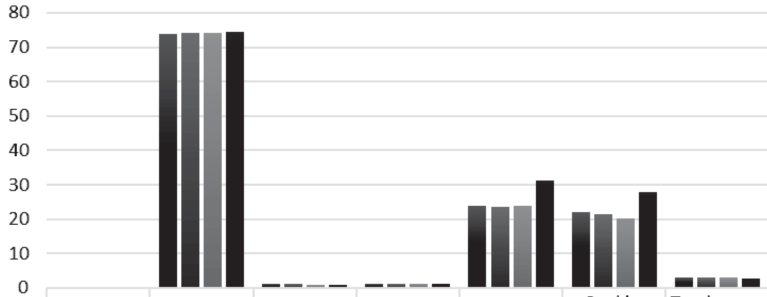
The highest protein content in thigh meat was found in chickens of experimental group II (20.06%), then a slightly lower value of protein was found in the meat of chickens of control and experimental group III (19.66; 19.62%), and the lowest was content recorded in the meat of experimental group I chickens (19.08%). The observed differences in protein content between the groups were not statistically significant also ($P > 0.05$).

The highest cooking loss was recorded in the meat of experimental group I chickens (31.07%), followed by the control group chicken meat (30.91%), the experimental group III chicken meat had a cooking loss of 28.96%, while the smallest loss was recorded in the meat of experimental group II chickens (27.41%). The meat of chickens of experimental group I had statistically significantly higher ($P < 0.05$) values of cooking loss in relation to the meat of chickens of control and experimental group II, and the meat of chickens of control group in relation to chicken meat of experimental group II.

In the meat of chickens of the control group, the highest values of tenderness of meat were found (3.69), then in the meat of chickens of experimental group I (3.51), in chickens of experimental group III the tenderness of meat was 3.25, while the lowest was recorded in chicken meat of experimental group II (2.91). The recorded differences in meat tenderness between the groups were not statistically significant ($P > 0.05$).

3.5 Chemical composition of breast meat

From the review of the chemical composition of breast meat (Fig. 3b), it is noticeable that the percentage of water was the highest in the meat of experimental group III chickens



	Water (%)	Fat (%)	Ash (%)	Protein (%)	Cooking loss (%)	Tenderness (kg)
■ Control	73.93	1.07	1.12	23.85	22.13	3.02
■ Experimental 1	74.1	1.12	1.13	23.61	21.27	3.1
■ Experimental 2	74.06	0.97	1.14	23.81	20.15	3.08
■ Experimental 3	74.45	0.96	1.13	31.11	27.78	2.59

Control: 100% proportion of whole corn
Experimental 1: 25% of corn starch in relation to the proportion of corn coase
Experimental 2: 50% of corn starch in relation to the proportion of corn coase
Experimental 3: 75% of corn starch in relation to the proportion of corn coase

Fig. 3b. Chemical composition of breast meat in chickens depending in feeding variant
Chemische Zusammensetzung von Brustfleisch bei Masthühnern in Abhängigkeit von der Fütterungsvariante

(74.45%), then a slightly lower water content was recorded in the meat of chickens of experimental groups I and II (74.10; 74.06%), while the smallest percentage of water in its composition had the meat of chickens of the control group (73.93%). The recorded differences in water content in breast meat between the groups were not statistically significant ($P > 0.05$).

The fat content in the meat of the breast was highest in the chickens of experimental group I (1.12%), followed by the meat of the chickens of the control group (1.07%), while the lowest and approximately the same values were recorded in the breast meat of the chickens of experimental groups II and III (0.97; 0.96%), Differences in breast meat fat content between groups were also not statistically significant ($P > 0.05$).

The breast meat of experimental group II chickens had the highest ash content in its composition (1.14%), followed by the breast meat of experimental group I and III chickens (1.13%), while the lowest percentage was recorded in control chicken groups (1.12%). The observed differences between the groups were not statistically significant ($P > 0.05$).

The highest protein content (Fig. 3b) was found in the breast meat of experimental group III chickens (31.11%), followed by the breast meat of control and experimental group II chickens (23.85; 23.81%), and the lowest was recorded in experimental group I chicken meat (23.61%). The observed differences between the groups were not statistically significant ($P > 0.05$).

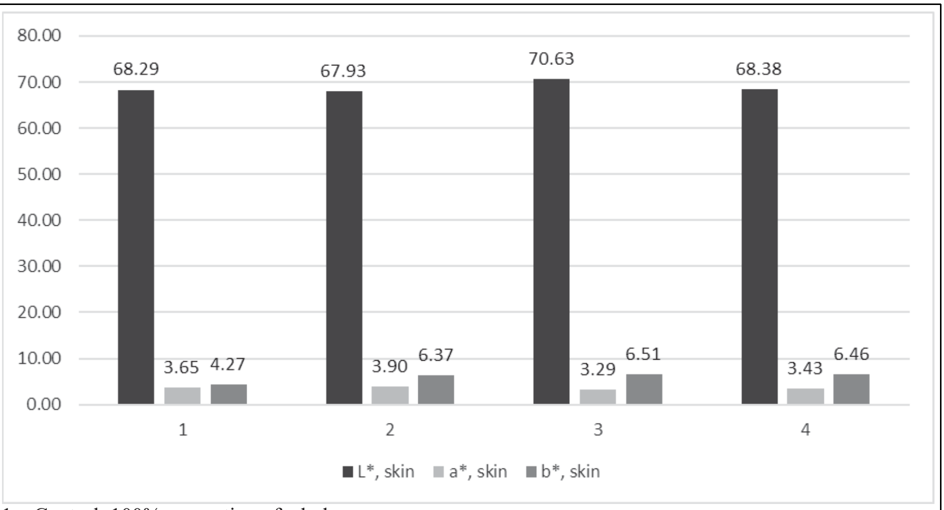
The highest cooking loss of breast meat was recorded in the meat of chickens of experimental group III (27.78%), followed by the breast meat of control group chickens (22.13%), the meat of experimental group I chickens had cooking loss of 21.27%, while the smallest loss was recorded in the breast meat of chickens of experimental group II (20.15%). The recorded differences between the groups were not statistically significant (P > 0.05).

The highest values of tenderness of meat (3.10) were found in the breast meat of chickens of experimental group I, and then in the meat of chickens of experimental group II (3.08). In the chickens of the control group, the breast meat had a tenderness value of 3.02, while the lowest was in the meat of chickens of experimental group III (2.59). The breast meat of chickens of control and experimental groups I and II had a statistically significantly higher (P < 0.05) value of cooking loss compared to the breast meat of chickens of experimental group III.

3.6 Skin and colour of the breast meat

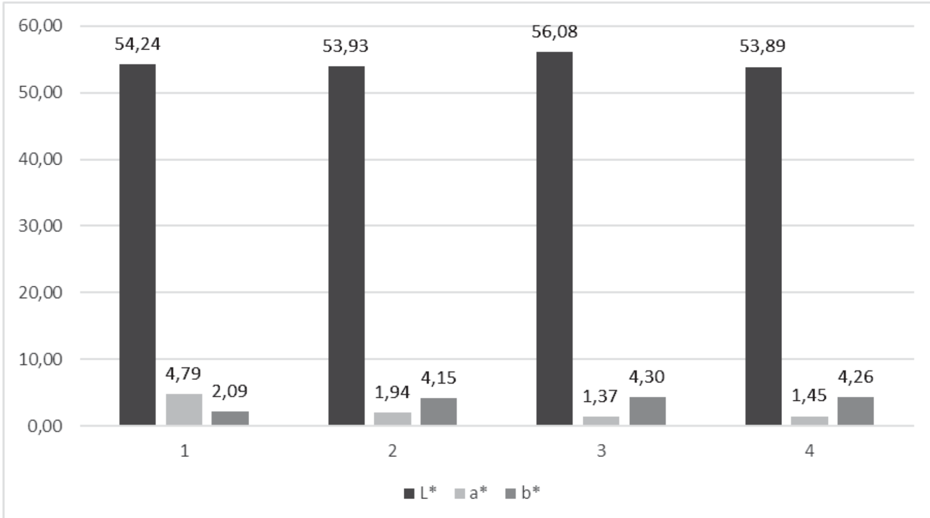
The skin colour results in chickens (Fig. 4a) show that the chickens of experimental group II had the highest L * value (70.63), lower values were in chickens of experimental group III and control group (68.38; 68.29), while the lowest L* was observed in chickens of experimental group I (67.92). The observed differences between the groups were not statistically significant (P > 0.05).

Values of a * (degree of redness) were highest in chickens of experimental group I (3.90), followed by chickens in control group (3.64). The chickens of experimental group III had a value of a * 3.42, while the lowest was recorded in the chickens of experimental group II (3.29). The recorded differences between the groups were not statistically significant (P > 0.05).



1 ...Control: 100% proportion of whole corn
2 ...Experimental 1: 25% of corn starch in relation to the proportion of corn coase
3 ...Experimental 2: 50% of corn starch in relation to the proportion of corn coase
4 …Experimental 3: 75% of corn starch in relation to the proportion of corn coase

Fig. 4a. Skin colour in chickens depending on feeding variant
Hautfarbe bei Masthühnern in Abhängigkeit von der Fütterungsvariante



Control: 100% proportion of whole corn
Experimental 1: 25% of corn starch in relation to the proportion of corn coase
Experimental 2: 50% of corn starch in relation to the proportion of corn coase
Experimental 3: 75% of corn starch in relation to the proportion of corn coase

Fig. 4b. Breast meat colour in chickens depending on feeding variant
Farbe des Brustfleisches von Masthühnern in Abhängigkeit von der Fütterungsvariante

The highest b * value (degree of yellow colour) was in experimental group II chickens (6.51), followed by experimental group III chickens (6.46), in chickens of experimental group I the b * value was 6.37, while the lowest values were recorded in control group chickens (4.26). Chickens of experimental groups I, II and III had statistically significantly higher ($P < 0.05$) values of b* skin colour indicators compared to chickens of the control group. There were no statistically significant differences between the experimental groups ($P > 0.05$).

From the review of breast meat colour results (Fig. 4b), it can be seen that the highest L * value (degree of brightness) had chickens of experimental group II (56.07), slightly lower chickens of control group (54.24), followed by chickens of experimental group I (53.92), while the lowest L* color value was measured in the breast meat of experimental group III chickens (53.88). Differences between groups were not statistically significant ($P > 0.05$). It was found that the a * index was the highest in the chickens of the control group (4.79), then in the chickens of experimental group I (1.93), in the chickens of experimental group III it had a value of 1.45, while the lowest color value of the indicator a* was on breast meat measured in chickens of experimental group II (1.36). The recorded differences between the groups were not statistically significant ($P > 0.05$).

The highest b * value of breast meat colour was measured in chickens of experimental group II (4.29), slightly lower was in chickens of experimental group III (4.26), then in chickens of experimental group I (4.15), and the lowest b* value of breast meat was measured in chickens of the control group (2.09). Differences between groups were not statistically significant ($P > 0.05$).

4 Discussion

4.1 Daily gain

The daily gain of the control group chickens achieved in the fourth week of the experiment is also the best growth gained for the entire duration of the experiment. Analysing the movement of the average daily gain of chickens throughout the experimental period, it is noticeable that the highest values of growth in the second, fourth and fifth week of the experiment were in control group chickens, while in the first, third and sixth weeks were highest in experimental chickens (experimental groups I, II and III). While these differences in the first week were not statistically significant, in the third and sixth weeks they were statistically significant.

Thus, in the sixth week of the experiment, concentrations of 50% and 75% of vitreous maize starch had a positive effect on daily gain compared to chickens fed with 25% vitreous maize starch as well as on control chickens. Given that the daily gains in the chickens of the experimental groups were better only in the first, third and sixth weeks of the experiment and that they did not have continuity, it cannot be reliably claimed that the increased proportion of vitreous corn starch increases the daily gain of chickens in a certain fattening period. Referring to the same results of daily gains and differences between experimental groups, it is not possible to reliably claim which feeding treatment, given the different proportion of vitreous starch, should be preferred in the feeding of broilers.

Milošević et al. (2007) analysing the influence of the application of non-extruded and extruded corn fodder in the feed of broiler chickens as a substitute for corn with a share of 50% (experimental group with extruded and experimental group with non-extruded corn fodder flour) and 100% (experimental group with extruded and experimental group with non-extruded corn fodder flour), concluded that there were no significant differences between the groups in the achieved daily gain. In the chickens of the control group, the achieved daily gain, viewed throughout the experiment, was 50.13 g, while in the experimental group with a content of 100% extruded and non-extruded corn fodder flour was 50.08 g; 53.66 g, and in the experimental group with a content of 50% of extruded and non-extruded corn fodder flour was 50.29 g; 51.73 g.

Picoli et al. (2014) examined the effect of cassava starch on the average daily gain of chickens. The experiment was performed on 510 fattening chickens, and cassava starch was added to the experimental groups of chickens in amounts of 2, 4, 6, 8 and 10%. Their results show that there was no positive effect on the average daily gain of chickens.

Batal and Parsons (2004) researched the effects of different carbohydrate sources on the production indicators of broilers and found a higher daily gain of chickens when fed with unprocessed corn starch compared to heat-treated corn starch.

4.2 Food consumption

From our results on the average daily food consumption by weeks, it can be seen that in the first, second, fifth and sixth week, the best food consumption was in chickens of experimental group II. However, differences in food consumption between chickens of experimental group II and other groups were not statistically significant ($P > 0.05$).

Rude (2008) in his study of the effect of gelatinised starch formed during the process of pelleting corn on broiler production indicators concludes that a higher percentage of gelatinised starch in food gives positive results. Namely, in experimental groups of broilers with a gelatinised starch content of 35% in the mixtures lower food consumption was recorded, while in groups with a gelatinised starch content of 21%, food consumption was significantly higher.

In their study, MORITZ et al. (2005) analysed the influence of different maize processing processes (pelleting and extrusion) on the production characteristics of broilers up to the third week of feeding. Pelletised and extruded corn was replaced in unprocessed mixtures with a proportion of 1/3, 2/3 and 3/3 in the total mixtures. It was concluded that the groups with pelleted corn had lower food consumption. In relation to the ratio of one or the other corn in the mixtures, there was no significant difference between the experimental groups, but in relation to the control group, differences occurred, so the broiler chickens of all experimental groups had higher food consumption and higher body weight. The authors also concluded that gelatinised starch has a positive effect on broiler production results.

If food consumption is considered as a production indicator that provides information on the composition of feeds and nutrients in food and therefore their acceptability by the animal, then higher food consumption in chickens of experimental groups (II and I) during most of the fattening can be interpreted as the impact of nutritional treatment. Although without statistical significance, the trend of higher food consumption over four weeks was evident in chickens of experimental group II and in this case shows that at 50% replacement of vitreous starch with coarse whole grain corn chickens react by increasing food consumption.

4.3 Chemical composition of thigh and breast meat, skin color and chicken meat

4.3.1 Chemical composition of thigh meat

In the case of thigh meat, the percentage of water was the highest in the meat of chickens of experimental group II (75.0%), while the lowest percentage of water was in the meat of chickens of the control group (74.4%). The fat content in the thigh meat was the highest in the chickens of the control group (9.90%), and the lowest fat content was recorded in the meat of the chickens of the experimental group II (3.89%). Although the values of fat in thigh meat were not statistically significant ($P > 0.05$) among individual groups, the values of all three experimental groups were lower than in chickens of the control group and it can be argued that vitreous endosperm of maize in food has a reduction effect on fat in the meat of the thigh.

The highest ash content in the meat of the thigh had the meat of chickens of experimental group I (1.04%), while the lowest percentage was recorded in chickens of the control group (1.00%).

The highest protein content in the thigh meat was found in chickens of experimental group II (20.06%), and the lowest was recorded in the meat of chickens of experimental group I (19.08%).

The highest cooking loss was recorded in the meat of chickens of experimental group I (31.07%), while the smallest loss was recorded in the experimental group II chicken meat (27.41%). The meat of chickens of experimental group I had a statistically significantly higher ($P < 0.05$) value of cooking loss in relation to the meat of chickens of control and experimental group II, and the meat of control group chickens in relation to the meat of experimental group II chickens.

The highest values of meat tenderness (3.69) were found in the meat of chickens of the control group, while the lowest value was recorded in the meat of experimental group II chickens (2.91).

In his study conducted on 3000 chickens of hybrid Ross 308 with the use of extruded corn in experimental groups of chickens OKANOVIĆ et al. (2012) found a higher content of water (75.93%) and protein (17.26%) in the thigh meat of broilers which in food had extruded corn relative to water content (73.03%) and protein (16.76%) in the meat of the thigh meat of the control group. In the same study, the author states that the fat content in the thigh meat of the control group (9.24%) was higher than in the experimental groups (5.87%), and the total ash content was approximately the same in all groups, which is in accordance with our results.

4.3.2 Chemical composition of breast meat

From the results of the chemical composition of chicken breast meat, it is noticeable that the percentage of water was the highest in the meat of experimental group III chickens (74.45%), while the lowest percentage of water was recorded in the meat of control group chickens (73.93%).

The fat content in breast meat was the highest in chickens of experimental group I (1.12%), while slightly lower, and almost the same values were recorded in the breast meat of chickens of experimental groups II and III (0.97; 0.96%).

The breast meat of chickens of experimental group II had the highest ash content in its composition (1.14%), while the lowest percentage was recorded in chickens of the control group (1.12%), however, the values were quite similar among individual groups.

The highest protein content was in the breast meat of experimental group III chickens (31.11%), and the lowest was recorded in the meat of experimental group I chickens (23.61%).

In this study, the highest cooking loss in breast meat was recorded in experimental group III chickens (27.78%), while the smallest loss was recorded in breast meat of experimental group II chickens (20.15%).

The highest values of meat tenderness (3,10) were found in the breast meat of experimental group I chickens, while the lowest recorded value was found in the meat of experimental group III chickens (2,59). This value of tenderness of chicken breast meat in chickens of experimental group III was also statistically significant in relation to chickens of control and experimental groups I and II. Statistically significantly higher ($P < 0.05$) values of cooking loss were breast meat of chickens of experimental group I in relation to meat of chickens of control and experimental group II, and meat of chickens of control group in relation to chicken meat of experimental group II.

The results of the research conducted by Okanović et al. (2012) are in agreement with the results of this research. When examining the impact of the use of extruded corn on the yield and quality of meat in broiler feed, Okanović et al. (2012) found a lower content of water (73.66%) and protein (22.58%) in the breast meat of chickens in the control group. Also, the results of free fat content in breast meat and total ash are similar, with the content of free fat in breast meat of the control group (2.42%) higher than in the experimental group (1.40%), and the content of total ash it is approximately the same in all groups.

The results of this research are in line with the data provided by Ristić (2007), who concluded that breast meat compared to thigh meat contains more protein (23.6%: 19.6%) and less fat (0.33%: 1.33%). However, the fat content of chicken breast in this experiment was significantly higher in the control, but also in the experimental groups compared to the reference results of this author.

Baltić et al. (2003) state that poultry meat contains on average about 21% of total protein, 1.85 – 9.85% fat, 70.6 – 78.2% water and about 1% minerals, and the average energy value of poultry meat is 700 kJ per 100 g of meat. A review of the literature shows that the meat of the thighs with the drumstick always contains more fat than the meat of the breast (Ristić et al., 2008; Krischek et al., 2011).

Marcu et al. (2009) analysed the effect of different levels of crude protein and energy in chicken meals on the chemical composition of breast, thigh and drumstick meat. The water and protein content in the meat of the breast, thighs and drumsticks did not differ between the groups, but differences in fat content occurred.

4.4 Skin and flesh color of the breast meat

Based on the average values of three indicators of skin colour and breast meat of chickens (breast), it can be argued that the increased value of b * skin colour index and breast meat in all experimental groups is a consequence of nutritional treatments, especially when measuring skin color where the differences were statistically significant. The values of L* index measured on skin and meat showed the trend of the highest values in the experimental groups, but since the values were not statistically significant, it cannot be said with certainty that this colour indicator was influenced by nutritional treatment. According to the reference bibliography, chicken breast meat with an L* index value > 53 belongs to the category of lighter meat (BMW meat category), and in this experiment the L* values are 53.88 – 56.07.

5 Conclusion

Based on the study of the influence of vitreous (resistant) endosperm of corn in broiler chicken feed on daily gain of chickens, food consumption, chemical composition of drumstick meat, white meat and skin and meat colour of chicken, we found a positive effect on the following indicators:

- Daily gain, at the end of the experiment when fed with a share of vitreous endosperm of maize of 50%;
- The trend of higher food consumption over four weeks in chickens that also had a 50% share of vitreous maize endosperm in mixtures;
- The fat values in the meat of the thighs of all three experimental groups were lower than in the chickens of the control group and it can be argued that the vitreous endosperm of maize in food has an effect on reducing the fat content in the meat of the thighs. It is also possible to conclude that the influence was on the ash content in the meat of the thigh, the protein content in the meat of the thigh, as well as the protein content in the meat of the chicken breast;
- Increased value of b* index of skin and breast meat. Based on the average values of the three indicators, it can be argued that the increased value of the b* index of skin and breast meat in all experimental groups is a consequence of nutritional treatments, especially when measuring skin colour.

Certain analysed parameters in broiler chickens were better when fed with increased proportions of vitreous starch in corn, so it can be argued that at other concentrations and different times of application of this component in fattening chickens would have a positive effect on other parameters, which certainly requires further research of the maize fraction used.

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