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THE IMPACT OF POPULATION DENSITY AND SEEDS OF CHICKEN ON THE PRODUCTION PARAMETERS OF BROILER CHICKEN

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Abstract

The primary objective of this study was to investigate the influence of population density on production parameters in fattening chickens of Cobb 500 hybrids. Based on theoretical and experimental studies, the influence of population density, floor surface per chicken, chickens mortality, chickens weekly growth, final body chicken weight, food consumption (in kg) per kg of food intake or conversion, and other production parameters.

The study was carried out on 225 day-old chickens - Cobb 500, which were placed in 3-square-foot boxed cubicles with five different population density. The control group (K_0) was populated in a density of 15 chickens / m² which is a technological standard, and the experimental groups K_1 , K_2 , K_3 and K_4 were populated with density of 13 chickens / m², 14 chickens / m², 16 chickens / m² and 17 chickens / m² of floor pads.

When choosing chickens, it was considered that the chickens of the experimental groups were approximately the same mass. Selected chicken specimens of the same gender ratio 50:50 (ten male and ten female) are marked with rings, with the number of records attached to their legs. The rings are made of modified plastic resistant to water and high temperature, avoiding the possibility of damaging numbers and the determination of the number of sample chickens.

Nutrition and environmental conditions were the same for all chickens. For the purpose of the research production parameters after a completed 42-day fattening period, 10 male and 10 female chicks of each sample group were selected by the random sample method. By Individual weighing of chickens the body mass was determined, the weekly increase in body mass per group, and the final body mass at the end of each week. In addition, in all sample groups, mortality of chickens, consumption and food conversion was monitored. The data were analyzed by statistical program SPSS 15.0 (SPSS Inc., Chicago, IL, USA).

Based on the results of the researches it was shown that population density in the sample groups did not affect the mortality of chickens and that the daily and physical growth rates were highest in the K_2 group with population density of 14 individuals / m² and the smallest in group K_1 with density of population of 13 units / m².

Also, the lowest average body mass of chickens was obtained in the K_1 group with a population density of 13 units / m². There was no statistically significant difference ($p > 0.001$) of population density impact on the final body mass of chickens in the sample groups.

Keywords: broilers, population density, the production parameters.

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INTRODUCTION

The production and consumption of poultry meat in most developed countries, as well as in Bosnia and Herzegovina, has been following the trend of growth for the last ten years. The high percentage of poultry meat in general, especially chicken, is based on the nutritional properties of this meat in human nutrition. The fact that chicken meat is high protein content, and that fat content is very low in chicken meat in dietetic products. This explains the growing increase in the consumption of poultry meat in all populations.

The success of chicken meat production is based on the selection of best commercial hybrids, the implementation of appropriate technological solutions for accommodation and nutrition, and the application of non-specific and specific health care measures. In order to improve production results and to preserve good health and welfare of chickens, various modifications in the technological processes of chicken production are used.

The population density has recently been the subject of much research in fattening chickens. Many authors who carried out these studies, in their experiments, made great differences in the density of chickens per m². Imports were made with a density variation of 5, 10, 15 and 20 units per m², and there were statistically significant differences between this range of density on production and slaughter parameters. For this reason, all efforts of researchers in this area are aimed at finding suitable population density i.e. optimum number of chickens per m², so that the welfare of chicks as well as the economy of production are not endangered.

Population density is considered to be one of the most important factors of the environment due to the determined impact on the growth rate of broiler chickens. In addition to this direct impact of population density indirectly influences the formation of microclimates in the building and the formation of other environmental factors. Also, the breadth of the feeding space is in function of population density. A large number of researches were carried out in order to determine the optimum population density both from the point of view of economic results and from the point of view of the market or consumers (Z. Škrbić et al., 2008).

S.Mitrović et al. (2005) obtained the most favorable results with population density of 15-17 chickens per m² in their population density research and found that the density of population has a statistically significant effect on the daily growth and the value of the production index. The same authors found that there was no statistically significant influence on the length of the rat or the weight of one-day chickens on the production parameters.

Also, Z. Škrbić et al.(2009) examined the determination of broiler welfare in different population density by assessing gait score, opiate, appearance and degree of inflammation of the wrist, lesions on the foot pad, and determination of biochemical blood parameters (glucose concentration, concentration of total cholesterol) as indicators of stress. One-day chickens of the

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Hubbard genotype were spread in the box of underfloor heating systems in 3 population density and 5 repetitions of each treatment.

Treatment A was a population density of 10 chickens per square meter; treatment B 13 chickens / m² and treatment C 16 chickens / m². The results of the experiments indicate the inefficiency of the difference between broiler groups' probability of movement, the condition of the skin and the leg, the stress indicator. In general, the welfare of broilers in all experimental groups was satisfactory. However, the established tendencies of deterioration of the quality of the mat, the increase in the frequency of poorer ratings of the ability to move, the inflammation of the wrist and the lesion on the foot pad with the increase in population density, indicate the importance of this breeding factor and the need to define the limiting population density from the aspect of welfare of broilers but also the economy of production.

K. De Baere et al. (2007) examined the cost-effectiveness and the impact of population density and light intensity during fattening chickens. Their research included testing the impact of population density on production parameters and cost efficiency, and research was carried out in six production cycles, with two density populations (13 chickens / m² and 20 chickens / m²). The intensity of light had no effect on the characteristics of the increase in weight of chickens, and there was no interaction between the intensity of the light and the density of the population of chickens.

Lower population density (13 chickens / m²) resulted in better results in the growth of chick body weight, a lesser occurrence of lesions on chicken feet, less mortality and higher food conversion, compared to a population density of 20 chickens / m². On the basis of the obtained results of the density of population density on the economy of fattening poultry, the authors carried out the cost calculation, which showed that the density of the population has a very significant impact on the price of meat and on the total cost effectiveness in fattening chicks.

Significant research was conducted by Ihsan T. Tayebi et al. (2011) who investigated the impact of population density on productivity and some physiological parameters of fattening chickens. In the experiment, the chickens were divided into three groups of different population density, i.e. 8.66 and 10.41 and 13.36 chickens / m². The results obtained are shown as follows: body weight of chickens at the end of the fattening - live weight and food conversion ratio after 7 weeks of fattening, do not show statistically significant differences between groups. The consumption of food was significantly high in the group with a population density of 8.66 chickens / m² while mortality was high statistically significant in the group with a population density of 13.36 chickens / m².

The greatest number of studies carried out so far is related to the influence of population density on production and clonal parameters of fattening chickens (Z. Škrbić et al., 2011, 2009, 2008, A. Sekeroglu, 2011, Z. Pavlovski et al., 2009; S. Bogosavljević- Bošković et al 2005, J. Moriera et

al 2006, D. Nembilwi, 2002, HHM Hassaninen, 2011, W. Molee et al., 2011, MS Barcho et al., 2006, P. Sørensen et al 2000).

MATERIAL AND METHODS OF WORK

The survey was conducted on 225 day-old Cobb 500 chickens, which were placed in 3-square-foot boxed squares with five different population density. The control group (K_0) was populated in a density of 15 chickens / m² which is a technological standard, and the experimental groups K_1 , K_2 , K_3 and K_4 were populated with density of 13 chickens / m², 14 chickens / m², 16 chickens / m² and 17 chickens / m² of floor pads. Nutrition and environmental conditions were the same for all chickens.

For the purpose of questioning the production parameters after the completion of the 42 days fattening period, 10 male and 10 female chickens from each group were selected by the random sample method. Individual weighing of chickens determined the body mass at the end of each week, the weekly increase in body mass per group, and the final body mass. In addition, in all sample groups, mortality of chickens, consumption and food conversion was monitored.

The performance of the mirror is monitored by recording all data on the elements that provide optimal conditions for the chickens. All the data are recorded in the mirror book. Control of the temperature and relative humidity of the air, the ventilation of the object, the health of the chickens, the consumption of food and the control of chickens of chickens every week at the same time and in the same order.

Chicken weighing was done before moving, then after 7, 14, 21, 28, 35 and at the end of the day after the 42nd day at the farm and on arrival at the slaughterhouse to determine the transport fish. Also, carcass measurement was performed after slaughter and cooling to determine the slaughter rate. Weekly results were analyzed by monitoring the increase in the body mass of the chickens by groups depending on the density of the population and gender.

After the selection of one-day chickens in the incubator station, individual chicken blood samples (random sample method) were taken, followed by maternal breast immunity and a designated vaccine program for chicken vaccination after 10, 15 and 26 days of age. After each vaccination, vitaminization was performed over a period of three days (AD_3 E vitamin) according to instructions.

Prior to slaughter, the competent veterinarian has found that the chickens are healthy, and accordingly issued a certificate on the health status of the chickens.

The transport of chickens from farm to slaughterhouse was carried out in plastic wrappers with a leak proof bottom, so that the secretions would not fall on the chickens in the lower ranks. Plastic

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casings are arranged in a vehicle so as to allow maximum air access. After transport and unloading, the wreckage and transport equipment are disinfected in a dirty part of the slaughterhouse. The unloading of poultry was done manually.

It is important to note that at 12 o'clock before the slaughter was completed, chicken feeding was stopped. The task of the post is to empty the volcano, the stomach and the intestine to reduce the possibility of contamination of hulls during processing. Longer starvation from the above is also negatively reflected because in that case the chickens begin to consume the stalk and faeces.

During the experimental period no chicks were reported in any of the experimental groups, and an overview of mortality and chickens was given in table 1. Data on body mass of chickens, i.e. chickens with a lower body mass of 1200 g, are given in table 2.

Table 1. *Overview of dead and culled chickens in the experimental groups for the total period of fattening*

Group	Deaths	Rejekt	Total
K_0	0	2	2
K_1	0	3	3
K_2	0	1	1
K_3	0	1	1
K_4	0	0	0
Total	**0**	**7**	**7**

Table 2. *Examination of body mass of chickens in experimental groups, body mass less than 1200 g at the end of the test*

Group	No. of Chickens	Body mass (g)	Total
K_0	2	930 i 1150	2080
K_1	3	1150; 1160 i 1160	3470
K_2	1	1040	1040
K_3	1	890	890
K_4	0	0	0
Total	**7**	**7480**	**7480**

In the experimental phase standard concentrated mixtures for intensive fattening chicks were prepared with three combinations. Each combination of concentrative mixtures consisted of starter, grover and finisher which had exactly the same raw composition and nutritional properties in all components for all five experimental groups.

When programming the nutritive composition of concentrate mixtures, starter, grover and finisher, frames of the raw material composition are in accordance with previously selected raw materials, and the nutritive composition of the concentrated mixtures is shown in Table 3.

Table 3. *Nutritional value of programmed food for fattening chickens*

Components	Units Measures	Starter	Grover	Finisher
Dry matter	%	88,12	87,95	87,89
Metabolic energy	MJ/kg	12,70	12,91	13,01
Digestible protein	%	22,06	20,15	19,70
Usable proteins	%	19,83	17,94	17,70
Crude fat	%	4,30	4,67	5,29
Crude fiber	%	3,44	3,40	2,82
Potassium (K)	%	0,84	0,74	0,82
Natrium (Na)	%	0,14	0,14	0,15
Chlor (Cl)	%	0,17	0,17	0,21
Calcijum (Ca)	%	1,13	1,12	1,03
Phosphor (P)	%	0,60	0,61	0,56
Usable phosphorus	%	0,43	0,44	0,36
Lysine	%	1,34	1,20	1,14
Methionine	%	0,58	0,54	0,48
Methionine + Cystine	%	0,95	0,85	0,82
Arginine	%	1,53	1,35	1,39
Threonine	%	0,90	0,83	0,81
Tryptophan	%	0,29	0,27	0,26
Linoleic acid	%	1,63	1,80	2,27
Vitamin „A“	IJ/g	10,00	10,00	5,00
Vitamin „D_3 “	IJ/g	3,30	3,30	0,75
Vitamin „E“	ppm/kg	30,00	30,00	7,50
Choline chloride	ppm/kg	400,00	400,00	210,00
Virginimicyn	ppm/kg	20,00	20,00	20,00
Maduranicyn	ppm/kg	5,00	5,00	-

RESULTS AND DISCUSSION

In this chapter, the results of researches on the impact of chicken population density on the production parameters are presented. The results and the static analysis of the density of chickweed population density at the end of each week are shown on the table, according to the experimental groups i.e. the different density of the population. Then, the results of daily and weekly increases in body mass gained during the statistical data processing, body weight gains at the end of the experimental groups, chicken fat loss, food consumption and food conversion are presented in table.

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Food Consumption Data per Chicken and One Kg Growth (Food Conversion) for Group 1 to 41 days are given in Table 4.

Table 4. *Average and total consumption of food per chicken and one kg of body weight of chickens (conversions) in the period from 1st to 42th day*

Sample group	Applied chickens	Dead chickens	Remaining chickens	Average consumption of food (g)	Average body mass gain (g)	Average consumption of food per kg increase (conversion in kg)
K_0	45	0	45	4491,78	2059,89	2,18
K_1	39	0	39	4784,62	1821,23	2,63
K_2	42	0	42	4304,77	2140,89	2,01
K_3	48	0	48	3981,25	2002,53	1,99
K_4	51	0	51	3728,63	1937,12	1,92

Comparative relations of the realized feed and food conversion rates in fattening chicks are shown in Table 4. The highest food consumption was recorded with the group K_1 (4784.62 g) and the smallest group K_4 (3728.63 g). The best conversion of food, which means the lowest food consumption per kilogram of growth, were K_4 (1.92) and K_3 (1.99). The worst conversion was K_1 (2.63), followed by the control group K_0 (2.18) and the K_2 group (2.01).

Body weight of chicks and body weight gain in experimental groups were checked for all experimental groups, in all biologically and economically interesting stages of fattening. The achieved average weight of chickens per week of fattening, separated by experimental groups i.e. with different chickens' density in fattening, is shown in Tables 5. - 9. The results of daily and weekly increment of chicken weight per week of fattening and population density are shown in Table 10.

Table 5. *Average weight of chickens per week of fattening for the control group K_0 with a population density of 15 individuals / m²*

STATISTICAL PARAMETERS	Fattening period						
	1 day	7 days	14 days	21 day	28 days	35 days	42 days
Arithmetic mean	45,89	152,31	393,09	713,33	1.177,11	1.676,67	2.105,78
Median	46,00	151,00	392,00	730,00	1.190,00	1.730,00	2.140,00
Variance	7,83	416,04	3.409,90	15.313,64	50.866,46	122.568,18	117.929,49
Standard variation	2,80	20,40	58,39	123,75	225,54	350,10	343,41

Xmin	38,00	92,00	153,00	200,00	280,00	520,00	930,00
Xmax	53,00	190,00	497,00	910,00	1.560,00	2.230,00	2.820,00
Variation range	15,00	98,00	344,00	710,00	1.280,00	1.710,00	1.890,00
P25	44,00	142,00	365,00	675,00	1120,00	1585,00	1945,00
P50	46,00	151,00	392,00	730,00	1190,00	1730,00	2140,00
P75	48,00	166,00	431,00	790,00	1310,00	1920,00	2330,00
Interquartile space	4,00	24,00	66,00	115,00	190,00	335,00	385,00

The average body mass weight analysis of the examined groups of fattening chicks separated by population density as well as other descriptive-statistical parameters (Table 5.) showed that the average body weight of chickens in the control group of 15 chickens / m², at the start of the experiment was 45.89 g with an average deviation of 2.80 g, while the average final body mass at the end of 42 days was 2.105,78 g with an average deviation of 343.41 g.

The lowest body weight at the beginning of the hair was 38 g, while the highest body weight at the beginning of the hair was 53 g. The lowest body weight at the end of the hair was 930 g and the highest was 2,820.00 g. Taking into account at least the highest body mass at the beginning and end of the brain, the variation range in which the body mass was moving initially was 15 g, while the mentioned range at the end of the Fattening was 1,890.00 g.

Table 6. *Average body weight of chickens per week for control group K_1 with density of population of 13 units / m²*

STATISTICAL PARAMETERS	**Fattening period**						
	1 day	**7 days**	**14 days**	**21 day**	**28 days**	**35 days**	**42 days**
Arithmetic mean	45,69	161,82	374,87	694,36	1.140,26	1.651,03	1.866,92
Median	46,00	160,00	383,00	710,00	1.170,00	1.670,00	2.030,00
Variance	11,59	241,94	2.723,38	10.483,13	28.334,14	36.198,92	174.890,28
Standard variation	3,40	15,55	52,19	102,39	168,33	190,26	418,20
Xmin	38,00	137,00	197,00	390,00	550,00	1.050,00	1.150,00
Xmax	52,00	190,00	467,00	910,00	1.360,00	1.990,00	2.500,00
Variation range	14,00	53,00	270,00	520,00	810,00	940,00	1.350,00
P25	43,00	151,00	343,00	640,00	1070,00	1570,00	1550,00
P50	46,00	160,00	383,00	710,00	1170,00	1670,00	2030,00
P75	48,00	180,00	406,00	760,00	1250,00	1800,00	2200,00
Interquartile space	5,00	29,00	63,00	120,00	180,00	230,00	650,00

The average body weight of chickens in the K_1 group, distributed at a density of 13 chickens per square meter (Table 6), at the beginning of the pot is 45.69 g with an average deviation of 3.40 g,

while the average body mass at the end for 42 days, was 1,866.92 g with an average deviation of 418.20 g. The lowest body weight at the beginning of the herd was 38 g, while the highest body weight at the beginning of the herd was 52 g. The lowest body weight at the end of the herd was 1.150,00 and the highest was 2,500.00 g.

Considering the minimum and maximum body mass at the beginning and at the end, the variation range in the body mass ranged at the beginning with 14 g, while the range at the end of the test was 1.350, 00 g.

Table 7. *Average body weight of chickens per week for control group K_2 with population density of 14 units / m²*

STATISTICAL PARAMETERS	Fattening period						
	1 day	7 days	14 days	21 day	28 days	35 days	42 days
Arithmetic mean	44,60	177,33	429,02	815,24	1.266,67	1.764,52	2.185,48
Median	45,00	176,00	432,00	805,00	1.265,00	1.765,00	2.235,00
Variance	10,59	253,79	2.460,46	9.884,09	19.500,81	33.625,38	108.835,13
Standard variation	3,25	15,93	49,60	99,42	139,65	183,37	329,90
Xmin	35,00	149,00	307,00	540,00	800,00	1.200,00	1.040,00
Xmax	52,00	217,00	579,00	1.040,00	1.530,00	2.100,00	2.650,00
Variation range	17,00	68,00	272,00	500,00	730,00	900,00	1.610,00
P25	42,75	165,75	397,75	767,50	1180,00	1647,50	2035,00
P50	45,00	176,00	432,00	805,00	1265,00	1765,00	2235,00
P75	47,00	188,50	458,25	890,00	1390,00	1912,50	2452,50
Interquartile space	4,25	22,75	60,50	122,50	210,00	265,00	417,50

The average body weight of chickens in the K_2 test group, distributed at a density of 14 chickens per square meter (Table 7), at the start of the experiment was 44.60 g with an average deviation of 3.25 g, while the average body mass at the end of 42 was day, was 2,185.48 g with an average deviation of 329.90 g. The lowest body weight at the start of the game was 35 g, while the highest body weight at the start of the game was 52 g.

The lowest body weight at the end of the hook was 1,040.00 and the highest was 2,650.00 g. Taking into account at least the highest body mass at the beginning and at the end of the fattening, the variation range in which the body mass was moving at the beginning was 17 g , while the mentioned range at the end of the game was 1,610.00 g.

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Table 8. *Average body weight of chickens per week for control group K_3 with population density of 16 units / m²*

STATISTICAL PARAMETERS	Fattening period						
	1 day	7 days	14 days	21 day	28 days	35 days	42 days
Arithmetic mean	45,40	169,73	417,50	789,79	1.281,46	1.801,67	2.047,92
Median	45,00	172,00	426,50	805,00	1.290,00	1.815,00	2.070,00
Variance	11,86	326,75	3.265,79	17.138,25	47.940,38	74.095,04	130.178,55
Standard variation	3,44	18,08	57,15	130,91	218,95	272,20	360,80
Xmin	39,00	128,00	225,00	300,00	470,00	740,00	890,00
Xmax	55,00	202,00	531,00	1.010,00	1.700,00	2.240,00	2.770,00
Variation range	16,00	74,00	306,00	710,00	1.230,00	1.500,00	1.880,00
P25	42,00	158,75	390,00	750,00	1212,50	1670,00	1802,50
P50	45,00	172,00	426,50	805,00	1290,00	1815,00	2070,00
P75	48,00	182,00	448,75	847,50	1390,00	1985,00	2312,50
Interquartile space	6,00	23,25	58,75	97,50	177,50	315,00	510,00

The average body weight of chickens in the K_3 group of 16 chickens per square meter was 45.40 g at the beginning of the rat with an average deviation of 3.44 g, while the average body mass at the end of 42 days was 2.047.92 g with average with a 360.80 g difference (Table 8).

The lowest body weight at the start of the game was 39 g, while the highest body weight at the beginning of the game was 55 g. The lowest body weight at the end of the game was 890.00 g and the highest was 2.770,00 g. Taking into account at least the largest body weight at the beginning and at the end of fattening, the variation range in which the moving body weight at the start of the addition of 16 g, while the said range at the and was 1880.00 g.

Table 9. *Average body weight of chickens per week for control group K_4 with density of population of 17 units / m²*

STATISTICAL PARAMETERS	Fattening period						
	1 day	7 days	14 days	21 day	28 days	35 days	42 days
Arithmetic mean	45,88	139,84	363,33	745,10	1.141,96	1.598,82	1.983,53
Median	46,00	147,00	368,00	770,00	1.170,00	1.610,00	2.020,00
Variance	7,47	535,13	3.015,79	14.497,49	28.292,08	54.546,59	72.211,29
Standard variation	2,73	23,13	54,92	120,41	168,20	233,55	268,72

Xmin	40,00	82,00	210,00	390,00	650,00	940,00	1.200,00
Xmax	51,00	175,00	464,00	970,00	1.540,00	2.140,00	2.610,00
Variation range	11,00	93,00	254,00	580,00	890,00	1.200,00	1.410,00
P25	44,00	127,00	325,00	670,00	1060,00	1490,00	1770,00
P50	46,00	147,00	368,00	770,00	1170,00	1610,00	2020,00
P75	48,00	159,00	408,00	840,00	1260,00	1750,00	2130,00
Interquartile space	4,00	32,00	83,00	170,00	200,00	260,00	360,00

The average body weight of chickens in the K_4 group of 17 chickens per square meter was 45.88 g at the beginning of the rat with an average deviation of 2.73 g, while the average body mass at the end of 42 days was 1.983.53 g with average with the difference of 268.72 g. The lowest body weight at the start of the fattening was 40 g, while the highest body weight at the start of the fattening was 51 g. The lowest body weight at the end of the fattening was 1,200.00 the highest it was 2,610.00 g 9).Taking into account the minimum and maximum body mass at the beginning and end of the fattening, the variation range in which the body mass was moving initially was 11 g, while the mentioned range at the end of the fattening was 1.410,00 g.

Table 10. *Results of mean daily and sedentary bodyweight gains of chickens are presented as growth rates for experimental groups*

POPULATION DENSITY	**Duration of fattening (days)**							**Daily rate of increase (%)**	**Weekly growth rate (%)**
	1 day	**7 days**	**14 days**	**21 day**	**28 days**	**35 days**	**42 days**		
13 units/ m²	45,69	161,82	374,87	694,36	1140,26	1651,03	1866,92	8,83	61,84
17 units / m²	45,88	139,84	363,33	745,10	1141,96	1598,82	1983,53	8,97	62,78
16 units / m²	45,40	169,73	417,50	789,79	1281,46	1801,67	2047,92	9,07	63,49
15 units / m² (Control)	45,89	152,31	393,09	713,33	1177,11	1676,67	2105,78	9,11	63,77
14 units / m²	44,60	177,33	429,02	815,24	1266,67	1764,52	2185,48	9,27	64,87

According to the results of average daily and weekly growth rates (Table 10) it follows that the lowest daily and weekly growth rate was recorded in the sample group K_1 with a population density of 13 units / m², while the highest daily and weekly growth rates were recorded in the sample group K_2 with a population density of 14 units / m². It should be emphasized that in the case analyzed it is a continuous increase, which is common for natural processes.

In order to investigate the impact of chickens population density (number of animals / m²) and chicken gender on the average body mass of chick at the end of fattening, i.e. the final body weight, in table 11 the statistically processed final body mass of chickens according to the

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sample groups and gender was shown. The results of the statistical analysis are presented for female chickens (cockles) and male (chicken) chickens, especially for each experimental group, depending on the number of individuals / m2 - population density. For all observed values, a statistical assessment of 5% significance ($p < 0.05$) was performed. The calculation of the dependent variables made to assist the F-test (homogeneity test of variance) is shown in Table 12.

Table 11. *Results of the impact of population density and gender of chickens on the weight of chickens at the end of fattening, by gender and population density*

Population density	**Chicken Gender**	**μ ± σ**
Control group (15 units /m²)	Male sex	2.270,83 ± 236,68
	Female sex	1.917,14 ± 353,51
	Total	2.105,78 ± 343,41
13 units /m²	Male sex	1.998,13 ± 392,48
	Female sex	1.775,65 ± 419,32
	Total	1.866,92 ± 418,20
14 units /m²	Male sex	2.295,42 ± 363,09
	Female sex	2.038,89 ± 210,49
	Total	2.185,48 ± 329,90
16 units /m²	Male sex	2.276,30 ± 279,92
	Female sex	1.801,90 ± 336,61
	Total	2.068,75 ± 384,87
17 units /m²	Male sex	2.097,14 ± 281,18
	Female sex	1.904,00 ± 232,57
	Total	1.983,53 ± 268,72
Total	**Male sex**	**2.205,89 ± 323,50**
	Female sex	**1.882,83 ± 325,05**
	Total	**2.043,64 ± 361,79**

* μ (gained value) ± σ (standard deviation)

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Considering the experimental group of chickens formed according to the population density, it is noteworthy that the intentions average body weight of chickens at the end of chicken, cockroach, and whole was recorded in a group of chicks disposed at a density of 13 units / m².

Table 12. *Dependent variable: Body weight at the end of the experiment (final body weight) level of significance of 0.05 / F-test (homogeneity of variance)*

F	df1	df2	P -value
2,805	9,000	215,000	**0,004**

In Table 12, we can see from the results of the variance analysis that p <0.05, indicating that the variables of the dependent variable are not equal in all chicken groups.

Table 13. *Dependent variables: Body mass at end of gesture (final body mass,) significance level 0.01*

Source of variability	Sum of squares deviations	Freedom levels	Center of the square deviations	F	p- value	Partial Eta Squared
Corrected Model	8.115.315,06	9	901.701,67	9,14	0,000	0,277
Intercept	906.269.106,03	1	906.269.106,03	9.188,73	0,000	0,977
Population density of chickens	1.757.386,24	4	439.346,56	4,45	**0,002**	0,077
Sex chickens	4.913.125,27	1	4.913.125,27	49,81	**0,000**	0,188
Density * Sex	608.256,01	4	152.064,00	1,54	**0,191**	0,028
Error	21.205.096,49	215	98.628,36	-	-	-
Total	969.029.000,00	225	-	-	-	-
Corrected Total	29.320.411,56	224	-	-	-	-

Since the value p is obtained statistically in Table 12 below 0.05 ie p <0.05, Table 13 shows the calculation of the same values, but with a stricter criteria i.e. at the statistical significance level of 0.01.

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Table 14. *Results of the two-factor analysis (Tukey HSD), Dependent variables - total chicken weight*

(I)Population density	(J) Population density	Mid difference (I-J)	Standard error	P-value	95 % Reliability interval	
					Lower limit	Upper limit
Control group (15 units / m²)	13 units / m²	238.85*	68,707	0,006	49,84	427,87
	14 units / m²	-79,70	67,380	0,761	-265,06	105,67
	16 units / m²	37,03	65,165	0,980	-142,25	216,30
	17 units / m²	122,25	64,231	0,319	-54,46	298,95
13 units / m²	Control group (15 units / m²)	-238.85*	68,707	0,006	-427,87	-49,84
	14 units / m²	-318.55*	69,837	0,000	-510,68	-126,43
	16 units / m²	-201.83*	67,703	0,026	-388,08	-15,57
	17 units / m²	-116,61	66,804	0,408	-300,39	67,18
14 units / m²	Control group (15 units / m²)	79,70	67,380	0,761	-105,67	265,06
	13 units / m²	318.55*	69,837	0,000	126,43	510,68
	16 units / m²	116,73	66,355	0,400	-65,82	299,27
	17 units / m²	201.95*	65,438	0,019	21,92	381,97
16 units / m²	Control group (15 units / m²)	-37,03	65,165	0,980	-216,30	142,25
	13 units / m²	201.83*	67,703	0,026	15,57	388,08
	14 units / m²	-116,73	66,355	0,400	-299,27	65,82
	17 jedinki / m²	85,22	63,156	0,661	-88,53	258,97
17 units / m²	Control group (15 units / m²)	-122,25	64,231	0,319	-298,95	54,46
	13 units / m²	116,61	66,804	0,408	-67,18	300,39
	14 units / m²	-201.95*	65,438	0,019	-381,97	-21,92
	16 units / m²	-85,22	63,156	0,661	-258,97	88,53

* First factor (I) - Population density, second factor (I) - sex of chickens, and difference of these factors (I-J) represents the value of the final weight of chickens

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Table 14 shows the results of the two-factor analysis (Tukey HSD), where the first factor (I) is the population density, the second factor (J), the gender of chickens, and the difference of these factors (I-J) is the value of the final chicken weight. Since p <0.01 in the factor "Chicken population density" and "Chicken gender" factor mean that both of these factors have a statistically significant effect on the final body weight of the chickens. However at interaction "Density * Gender", the p-value is greater than 0.01 but we can say that the effect of interaction was not statistically significant, i.e., population density does not affect the final body weight of chickens males and females. It is important to note that although there is no significant effect on the interaction of two factors, there is a statistically significant separate impact on them.

For this reason, the results of the two-factor analysis (Table 14) have determined the results of statistically significant differences between the sample groups. In other words, among the sample groups formed by the density of population, there is a statistically significant difference in the average finite weight. According to the obtained results, the value of p <0.05 was calculated between the following groups of chickens distributed by population density:

• Control groups K0 (15 units / m²) and K1 (13 units / m²)

• Model groups K1 (13 units / m²) and K2 (14 units / m²)

• Model groups K1 (13 units / m²) and K3 (16 units / m²)

• Model K2 (14 units / m²) and K3 (16 units / m²)

• Model K2 (14 units / m²) and K4 (17 units / m²)

CONCLUSIONS

The following conclusions can be drawn from the work carried out in this paper:

- A total of 225 pieces of one-day chickens were divided into 5 groups (K0, K1, K2, K3 and K4) in the experiment.

- There was no mortality of chickens during the experiment.

- The highest consumption of food was group K1 (4784.62 g), and the smallest group K4 (3728.63 g).

- The best food conversion, which is the smallest consumption of food per kilogram of growth, had K4 (1.92) and K3 (1.99).

- The worst conversion of food had group K1 (2.63) and then control group K0 (2.18) and group K2 (2.01).

- The smallest average body weight of chickens at the end of fattening, cockerel, and of popcorn, recorded for the treated K_1 i.e., arranged in chickens at a density of 13 individuals / m².

- A statistically significant difference ($p < 0.05$) in the average body mass balance exists between the following experimental groups:

• Control groups K0 (15 units / m²) and K1 (13 units / m²)

• Model groups K1 (13 units / m²) and K2 (14 units / m²)

• Model groups K1 (13 units / m²) and K3 (16 units / m²)

• Model K2 (14 units / m²) and K3 (16 units / m²)

• Model K2 (14 units / m²) and K4 (17 units / m²)

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