„ION IONESCU DE LA BRAD" UNIVERSITY OF AGRICULTURAL SCIENCES AND VETERINARY MEDICINE IAŞI
FACULTY OF ANIMAL SCIENCE

DOCTORAL FIELD: ANIMAL SCIENCE

SPECIALIZATION: „POULTRY AND FUR ANIMALS EXPLOATATION TECHNOLOGY"

Eng. Adela I. IVAŞCU (married MARCU)

Phd DISSERTATION

Scientific leadership,
Prof. univ. Ioan VACARU-OPRIŞ, Phd

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Eng. Adela I. IVAŞCU (married MARCU)

„Contributions at knowledge of the influence of some technological factors on the growth and slaughter performances of some commercial hybrids of hen for meat"

Dissertation for the achievement of PhD degree in Sciences
Animal Science Field

Scientific leadership,
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PhD DISSERTATION ABSTRACT

Keywords: *biochemical and hematological blood parameters, body mass, bursa of Fabricius, feed conversion index, EBI and EPEF, heterophil/limphocites, hiybrid of hen for meat, original, slaughter yield, meat/bone ratio, thickness muscular fibres, thymus.*

Breeding of chickens for meat saw in the last 20 years a spectacular development. Were obtained broiler chickens with productive performance remarkable, was improved breeding and feeding technology, progress has been made in terms of providing health, well-being, and biosecurity approach.

Among the many commercial hybrids of chicken meat on the market, farmer, endorsed or beginner, is forced to choose one that fits best depending on technical conditions of growth and feeding it has and market demands. Studies related to how behaves a hybrid chickens for meat under conditions of growth and feeding partially modified to that established by the breeder in the growth guide are few, some controversial, others incomplete or anecdotal, requiring further scientifically study.

Performances of broilers are influenced by several factors: characteristics of hybrid exploited, farm management, quality compound feed given and microclimate conditions provided in the operating period. These factors are particularly important for achieving the proposed productive performance and to achieve maximum economic efficiency.

Permanently modification the genetic potential of the hybrids of meat requires continuous review of energy requirements, protein, amino acids, macro-minerals, micro-minerals and vitamins, according to the stage of feeding and the broiler chickens slaughter age. Nutrition at broiler chickens has crucially influence on the bio-productive performance and carcass quality, allowing to express high genetic potential of its.

Therefore, there is various recommendations concerning the energy, protein, amino acids, micro-minerals, macro-minerals, vitamins and additives, respectively the nutrient content of compound feeds which is given according to the age of chicks, so as to obtain good productive performances, in condition of maximum economic efficiency.

Although in the world is a small number of companies producing hybrids of chicken for meat and selection methods are similar, each hybrid has certain features of growth technology. Detailed knowledge, in theory and practice, of the specific features of hybrid chickens for meat ensures a proper choice depending on specific technical features that we have in a farm, objectives and target markets for the sale of products obtained.

Following Romania's EU accession, competition in the market quality of broilers is increasingly visible. Lately, the demand of Romanian consumers for quality carcasses and poultry products increased. Romanian market insurance with local products from poultry with a higher value at a good price is a prerequisite for development of poultry sector in Romania.

Management manuals for broiler chickens are indicative and must be filled with new knowledge. This is valid to industrial farms, and especially for small and medium-sized farms, with limited material and technical possibilities.

The since researchs on improving the growth performance of broiler chickens carried both new and look abroad, especially, quantitative aspects of meat production at this poultry category, by the proposed theme will be pursued, especially issues the qualitative of the carcass and meat.

In this respect, research done to achieve the PhD thesis have followed the influence of some technological factors on growth and slaughter performances at commercial hybrids of hen for meat *„ROSS-308”, „COBB-500”, „ARBOR ACRES□, „LOHMANN MEAT□, „HYBRO PN*$^{+}$*□ and „HUBBARD F15□*, reared under identical conditions of microclimate.

The doctoral thesis has 280 pages, at which are attached 137 pages with appendices and is structured into two parts. The first part of the thesis, in the 87 pages (31,07%), includes an extensive study on two chapters, respectively national and international stage of knowledge related to the studied features. The second part (Chapters III-VI) extends over 193 pages (68,93%) and refers to the original researches on influence of some technological factors on growth and slaughter performances at comercial hybrids of hen for meat *„ROSS-308”, „COBB-500”, „ARBOR ACRES□, „LOHMANN MEAT□, „HYBRO PN*$^{+}$*□ and „HUBBARD F15□*, reared under identical conditions of microclimate.

The paper is illustrated with a number of 92 figures and 52 tables, and annexes include 125 tables and 38 figures. Substantiating the PhD thesis was based on scientific information provided by the 416 bibliographic references consulted.

In bibliography part, in chapter I is presented the dynamics of poultry flocks for meat, the dynamics of poultry meat production and consumption of poultry meat, and in chapter II is presented some aspects referring at drawn situation from the scientific literature consulted

regarding to forming the commercial hen hybrids for meat and factors that influencing the meat production at hen.

Part of original researches, comprises four chapters in which are presented: characterization of the natural/organizational and institutional framework in which have occurred the researches (Chapter III), researches aim, research material and methods (Chapter IV) results and discussion for the three series of experiences (Chapter V), conclusions and recommendations (Chapter VI).

The research undertaken in this PhD dissertation, regarding the influence of technological factors on growth and slaughter performance at commercial hybrids of broiler chickens reared in Romania, were organized in 3 (three) series of experiences, as follows:

-*in the first series of experiences* were tested hybrids *„ROSS-308"*-L_{C1}, *„ARBOR ACRES"*-L_{1exp} (with experimental variants V_1, V_2, V_3) and *„LOHMANN MEAT"*-L_{2exp} (with experimental variants V_1, V_2, V_3) growth under identical conditions of microclimate, as recommended in *„The Broiler Management Guide ROSS-308, 2009"*. Energy and protein levels at compound feed for chickens were different by according to experimental variant and hybrid. For L_{C1} and experimental variants V_1 were given recipes of compound feed (for starting, growing and finishing), which complied the recommendation in *„The Broiler Management Guide"* for each tested hybrid. In experimental variants V_2, energy and protein levels of compound feed was approx. 10% higher and the experimental variants V_3, with approx. 10% lower than the recommendations in *„The Broiler Management Guide"* for each tested hybrid;

-*in the second series of experiences* were tested hybrids *„COBB-500"*-L_{C2}, *„HYBRO PN$^+$"*-L_{3exp} (with experimental variants V_1, V_2, V_3) and *„HUBBARD F15"*-L_{4exp} (with experimental variants V_1, V_2, V_3) growth under identical conditions of microclimate, as recommended in *„The Broiler Management Guide COBB-500, 2010"*. Energy and protein levels at compound feed for chickens were different by according to experimental variant and hybrid. For L_{C2} and experimental variants V_1 were given recipes of compound feed (for starting, growing and finishing), which complied the recommendation in *„The Broiler Management Guide"* for each tested hybrid. In experimental variants V_2, energy and protein levels of compound feed was approx. 10% higher and the experimental variants V_3, with approx. 10% lower than the recommendations in *„The Broiler Management Guide"* for each tested hybrid;

-*in the third series of experiences* were tested hybrids *„COBB-500"*-L_{C3} and *„ROSS-308"*-L_{5exp} growth under identical conditions of microclimate, as recommended in *„The Broiler Management Guide COBB-500, 2010"*. Energy and protein levels at compound feed has complied the recommendation in *„The Broiler Management Guide"* for each tested hybrid.

Indicators track in the three series of experiments were: *the productive parameters* (the dynamic of weight gain, average daily gain, weekly and cumulative, feed consumption on periods of growth and cumulative, feed conversion index), *the health status of the studied chickens* (flock losses and their causes; dynamics of the major blood constants: biochemical parameters Ca, P, Mg, total protein, albumin, triglycerides, uric acid and hematological parameters erythrocytes, leukocytes, hemoglobin, heterophil, lymphocytes; resistance to stress by cytological examination of the bursa of Fabricius and thymus), *quantitative and qualitative meat production* (weight loss in chickens during transport from farm to slaughterhouse; the quality class of live chickens before slaughter and the quality class of carcasses resulting from slaughter; slaughter yield at fresh and after 24 hours of refrigerated carcasses; the participation of the cutting parts from the whole carcass structure; meat/bone ratio in the whole carcass and the cutting parts from carcass; thickness of myocytes in the superficial pectoral muscle; physical-chemical characteristitics of meat: pH value; chemical composition of meat: water content, dray matter, proteins, lipids and total minerals; carcass and meat microbiology) and *the economical efficiency* (costs with the nutrition segment; the European Production Efficiency Factor-*EPEF*; the European Broiler Index-*EBI)*.

Raw data obtained from researches conducted in the three series of experiments were processing, using methods of biostatistics with Microsoft Excel spreadsheet. In the first stage of work was calculated arithmetic mean $(\bar{x})$, variance (S^2), standard deviation (s), standard error of the mean $(\pm s_{\bar{x}})$ and coefficient of variation (CV%). To test the statistical significance differences between mean values of the characters studied has been applied analysis of variance using tests ANOVA Single Factor, included in Microsoft Excel software and *MANN WHITNEY* (Wilcoxon) of the program *MINITAB 14*.

Following the completion of those experiences clearly emerges numerous conclusions of major interest in practice, for the industrial farms for growing the broiler chickens, and especially, for small and medium farms, among which we highlight below the most important:

- Hybrids tested *(„ROSS-308", „COBB-500", „ARBOR ACRES□, „LOHMANN MEAT□, „HYBRO PN$^+$□ and „HUBBARD F15□)* had at the end of growth period (42 days), a average ***body mass*** lower than the standard values. Thus, hybrids „ROSS-308□ (L_{C1} and L_{5exp}) and „COBB-500□ (L_{C2} and L_{C3}), had registred a difference of -3.83 ÷ -4.81%, respectively of
- -2.84 ÷ -5.36%, and experimental variants V_1 in the same feeding conditions had with slightly over 90% of hybrids standard performance. Experimental variants V_2, were registred between 94.93 to 97.91% of the performance standard. The largest differences were recorded for experimental variants V_3, which have approx. 80% of standard performance for the hybrids studied.

➢ The chickens ***body weight*** at the age of 6 (six) weeks, was influenced by hybrid tested genotype and the energy-protein level of feeding. The best performance in growth were at hybrids *„ROSS-308"* (L_{C1} and L_{5exp}) and *„COBB-500"* (L_{C2} and L_{C3}), and differences between: L_{C1} with V_1, V_2, V_3 (L_{1exp} and L_{2exp}); L_{C2} with V_1, V_3 (L_{3exp}) and L_{C2} with V_1, V_2, V_3 (L_{4exp}) were statistically at $p \leq 0.001$. At the experimental groups, the best growth performance was obtained at V_2 variants, which in all cases show significant differences from V_1 and V_3 variants.

➢ Efficiency of food capitalization measured by ***feed conversion index (FCI = kg feed./kg gain)***, had different values depending on the hybrid and the energy-protein level of feeding. Thus, feed conversion index was lower to standard values, with 2.03% up to 5.74% at experimental variants V_2, with 3.58 ÷ 4.36%, at *„COBB-500"* hybrid and with 0.85 ÷ 1.01%, in *„ROSS-308"* hybrid. Values close to the standard have been reported at experimental variants V_1 (+0.67 ÷ +4.24), while experimental V_3 variants have the biggest difference (+8.25 ÷ +11.19%).

➢ ***Biochemical and hematological blood parameters*** were within the range considered normal for species, age and production profile from that was worked. The value of these constants was to the lower limit, at experimental variants V_3, which have benefited rations with energy-protein level lower and at the higher limit, at experimental variants V_2, fed with compound feed with a higher level of energy and protein. Heterophil/lymphocytes ratio as objective indicator of the state of stress was maintained within the range considered normal in the scientific literature.

➢ ***Histological examination of sections made on the thymus*** at 42 days old chicks revealed a normal histological appearance of this organ, at all groups and experimental version studied.

➢ ***Histological examination of sections made on the bursa of Fabricius*** in aged 42 days old chickens showed a normal structure of this organ according to species, age and production profile on that were worked.

➢ At the end of experimental period (42 days), ***the chicken's viability*** from the three series of experiments ranged from 98-100%. The mortality cause in the first 14 days of life of the chickens was generated by omfalit, and after that age, losses by mortality were from accidental causes. We believe that this situation was possible by adequate nutrition and optimal microclimate conditions, according to standard recommanded for each studied hybrid.

➢ ***Percentage of weight loss of chickens during transport from farm to slaughterhouse*** showed an ascendent linear trend, in parallel with live body weight of the studied chickens.

➢ For the ***slaughter yield***, have reported superior values, both at *„COBB-500"* hybrid (80.66 to 80.80%, warm carcasses and 79.28 to 79.40%, chilled carcasses), and at *„ROSS-308"* hybrid (79.77 to 80.36%, warm carcasses and 78.28 to 79.01%, chilled carcasses). At the experimental groups the highest values were recorded in variants V_2, while the V_3 variants had the lowest values of yield at slaughter for both moments of measurement (warm and chilled carcass).

➢ ***Liver weight*** has the highest values at the experimental variants V_2 and lowest at V_3 variants. Differences between experimental variants of the groups L_{1exp}, L_{2exp}, L_{3exp} and L_{4exp} were statistics insurance.

➢ ***The most valuable portions obtained by cutting carcasses****,* respectively: breast, thighs and drumsticks had quota of participation in the carcass weight that different according to by genotype and the energy-protein level of feeding. By corroboration of obtained results in the 3 (three) series of experiences, we can say that the best performances were registered at hybrids *„COBB-500",* with 61.51 to 61.70% and *„ROSS-308",* with 58, 99 to 59.44%, followed by hybrids *„ARBOR ACRES"* (56.21 to 58.98%), *„HYBRO PN*$^{+}$*"* (56.36 to 58.60%), *„LOHMANN MEAT"* (55.37 to 58, 40%) and *„HUBBARD F15"* (53.51 to 56.18%). In the experimental groups (L_{1exp}, L_{2exp}, L_{3exp} and L_{4exp}), the highest values were reported at variants V_2 and the lowest at V_3 variants, which registered the highest values for the participation quota of wings and remaining parts (head, neck, back, legs and abdominal fat).

➢ For ***meat/bone ratio*** on the total carcass the highest values were obtained at hybrids *„ROSS-308"* (4.24/1 to 4.28/1) and *„COBB-500"* (4.22/1 to 4.29/1), while at the experimental variants V_1, under the same conditions of feeding, were inferior results (3.76/1 to 4.19/1). In the experimental groups, at the V_2 variants, that have received feed with energy-protein level higher, were recorded the highest values for the ratio meat/bone in total carcass (4.07/1, at $L_{4exp}V_2$; 4.27/1, at $L_{3exp}V_2$, 4.37/1, at $L_{1exp}V_2$ and 4.38/1, at $L_{2exp}V_2$), and at the chickens from V_3 variants, with feed of energy-protein with lower level, were negatively influenced the values for this indicator.

➢ ***Superior quality meat (breast, thighs and drumsticks)*** had registred the participation quota in the whole carcasses between 57.57 to 58.55%, at the *„COBB-500"* hybrid and between 56.20 to 57.03 %, at the *„ROSS-308"* hybrid. For experimental variants V_2, the ration with higher energy-protein level, positively influenced the mean values for fallowed indicators (53.47%, at $L_{4exp}V_2$, 56.22%, at $L_{2exp}V_2$, 56.37%, at $L_{3exp}V_2$ and 57, 19, at $L_{1exp}V_2$), while the experimental variants V_3, which have benefited rations with energy and protein level reduced, the situation was reversed.

➢ ***Average diameter of myocytes of the superficial pectoral muscle*** ranged between 47.21 to 54.85 μm (males) and 47.51 to 57.17 μm (in females), with strong fibers hypertrophied at variants experimental V_2, while at V_3 variants the fibers were thinner. Pectoral muscles with the thickest fibers were harvested from chickens *„ROSS-308□,* while the finest fibers were found in *„COBB-500□* hybrid. Thus, one can say that, the genotype, chickens sex and nutrition influenced the muscle fibers thickness from the superficial pectoralis muscle.

➢ For the studied body regions (breast, thighs and drumsticks), ***pH value*** of fresh meat was less or was within the limits mentioned in the literature (6.50 to 6.60 UpH). The lowest pH values were reported in the pectoral muscles, and the highest in the upper thigh muscles. After 24 hours of refrigeration, pH had a normal dynamic for the types of studied muscles, with a stronger decrease in thigh and drumstick muscles, while in the breast muscles decline was slower (characteristic of white fibers).

➢ In all cases, it was found that, in the pectoral muscles, males had a higher quantity of the ***dry matter***, compared to females, situation is reverse, when referring to the muscles of the thighs and the drumsticks.

➢ ***Lipids in meat*** showed the largest variation between analyzed muscles, as follow: in the *pectoral muscles* were recorded minimum values (0.67 to 2.02%, in males and 0.78 to 2.53%, in females), and in the *thighs*, were obtained maximum values (6.86 to 8.97%, in males and 7.54 to 10.38%, in females), while in the *drumsticks* the values were intermediate (4.68 to 7.43%, in males and 5.29 to 8.23%, in females).

➢ The best results for the ***chemical composition*** of meat were recorded in the experimental variants V_2, which in all cases had the highest protein content and lower fat content in the studied muscles, while in the meat from V_3 variants of chickens the situation was reverse higher percentage of fat and lower of protein). Statistical differences between the three variants in the experimental groups support the claim, stating that the content of protein and fat in the examined muscles was influenced by the energy-protein level of the feeding.

➢ In the studied meat has not reported the presence of the germs from ***Salmonella*** genus, which reflects the good health of the slaughtered chickens and hence, low risk of the obtained meat on food safety.

➢ ***Expenditure on nutrition segment*** had different values depending on the hybrid and the energy-protein level of the ration.

Experimental variants V_2, have recorded the highest expenses with *the chickens feed*, worth:

-in the first series of experiences - 2186.88 lei, $L_{1exp}V_2$ and 2185.50 lei, $L_{2exp}V_2$ and obtained live weight was lower as at the hybrid *„ROSS-308"* (L_{C1}) with 2.69 to 3.08%;

-in the second series of experiences - 2197.58 lei, $L_{3exp}V_2$ and 2041.58 lei, $L_{4exp}V_2$, while live weight achieved was lower as at the hybrid *„COBB-500"* (L_{C2}) by 1.54 to 7.10%.

The lower feed costs were recorded in the experimental variants V_3: 1517.22 lei, at $L_{1exp}V_3$, 1540.04 lei, at $L_{2exp}V_3$; 1504.58 lei, at $L_{3exp}V_3$ and 1379.11 lei, at $L_{4exp}V_3$, while live weight per effective had the lowest values (611.88 kg, 614.55 kg, 612.64 kg and 580.44 kg).

Experimental variants V_1, in identical nutritional condition with the control group (the *„ROSS-308"* hybrid, in the first series and the *„COBB-500"* hybrid, in the second series), have required slightly higher expenses for feed segment (2.62 to 2.63 lei/kg live weight vs of 2.51 lei/kg live weight, in the first series and 2.54 to 2.56 lei/kg live weight vs 2.42 lei/kg live weight, in the second series).

In the third series of experiences, in identical nutritional condition, the chickens *„COBB-500"*, had requiring slightly lower costs to nutritional segment compared to the chickens *„ROSS-308"* (2.44 lei/kg live weight vs 2.49 lei/kg live weight).

- ***The economic efficiency of broiler chicken growth***, assessed on the *European Production Efficiency Factor* (EPEF) and *European Broiler Index* (EBI), was positively influenced by the growth performance, the feed conversion index and the recorded viability.

In the first series of experiences, the highest values for the two indices (EPEF and EBI) were recorded at the variants $L_{1exp}V_2$ (3.49 EPEF and 343.64 EBI) and $L_{2exp}V_2$ (3.47 EPEF and 341.42 EBI), followed by the control group (L_{C1}) (3.45 EPEF and 339.24 EBI).

For the second series of experiences, at the control group (L_{C2}) have reported the highest values for the two indices (3.52 EPEF and 346.04 EBI), followed by the variants $L_{3exp}V_2$ (3.48 EPEF and 342.45 EBI) and $L_{4exp}V_2$ (3.31 EPEF and 325.68 EBI).

Experimental variants V_1, in the same nutritional conditions with the hybrid *„ROSS-308"* (L_{C1}), at the first series and *„COBB-500"* (L_{C2}), at the second series had lower performance, with 10 48 ÷ 11.53% vs L_{C1}, respectively 17.61% ÷ 13.55 vs L_{C2}.

Experimental variants V_3 were achieved the lowest values for EPEF (2.44 to 2.50) and EBI (237.59 to 245.42).

In the third series of experiences, under identical conditions of feeding and microclimate, the hybrid *„COBB-500"* (L_{C3}) had registred slightly higher values for the two indices (+0.91%, for EPEF and +0.95%, for EBI) compared to the hybrid *„ROSS-308"* (L_{5exp}).

Companies producing industrial or commercial chicken hybrids, in management manuals elaborated for these, presents guidance data on the performance of those hybrids, in

terms of body mass, the weight gain growth, feed conversion index or the flock viability. At the same time, are shown some conditions to be fulfilled on the chickens growth spaces (environment temperature, air relative humidity, ventilation, light programes); also are included nutritional requirements, on the growth phases (kcal EM/kg feed, PB%, energy/protein ratio).

In the last 15-20 years, our country has imported many commercial hybrids of birds, that were directly introduced in production farm, without no period of quarantine or testing for knowing the morpho-productive and economic performances, in condition of growth offered by these farms.

Besides those mentioned, in this paper was tested the growth and slaughter performances of six commercial broilers chicken hybrids, imported in Romania, from different large poultry companies in the world, respectively: *„ROSS-308”*; *„COBB-500”*; *„ARBOR ACRES”*; *LOHMANN MEAT”*; *„HYBRO PN^{+}”* şi *„HUBBARD F 15”*.

✓ Feeding of these hybrids was performed with mixed fodder recipes, made based on local raw materials and with different levels of energy and protein.

✓ Of the made research, included in three series of experiments on several batches and experimental variants, was found that best results were obtained at *„COBB-500”* hybrid, followed closely by the *„ROSS-308”* hybrid.

✓ At *„COBB-500”* hybrid as compared to the *„ROSS-308”* hybrid, the *feed conversion index*, determined for total chickens growth period (1-42 days) was more reduced by 3.58% as compared with standard values and with 2.32% as compared with the references hybris (*„ROSS-308”*). Also, the *breast participation quota in the whole carcass* reached a higher level than at *„ROSS-308”*, with 8.37%. Moreover, *thickness of the striated muscle fibers* was lower, indicating a finer texture and a tenderness more pronounced of its.

✓ The economic efficiency of growth, evaluated by the *European Production Efficiency Factor* (EPEF) and *European Broiler Index* (EBI), had higher values with 0.91%, for EPEF and with 0.95%, for EBI.

✓ We consider that ***this paper has a pronounced original character***, given that have been tested, scientifically, the morpho-productive and economic performances of the most widespread commercial hybrids of hen for meat , currently imported in our country, and their growth was made after the technologies adapted to local conditions.

✓ From research undertaken also was revealed clear that hybrids, *„ROSS-308”* and *„COBB-500”* have most interest for Romanian farmers, profiled on the production of chicken meat.

✓ The paper is original, because, are brought new elements on the meat quality of poultry produced in Romania.

✓ The hematological indices (total number of erythrocytes and leukocytes, hemoglobin, heterophil, lymphocytes), as the blood biochemical parameters (calcium, magnesium, phosphorus, total protein, albumin, triglycerides, uric acid) were within the normal parameters, in this case resulting strong arguments to characterize the very good quality of poultry meat studied. The same strong arguments provided histological examination of the thymus and bursa of Fabricius, taken from chickens belonging to the two hybrids: *„ROSS-308”*and *„COBB-500”*, at the age of slaughter (42 days).

✓ In related context, can make the ***recommendation that producing meat chicken farms in our country to rise especially hybrids „COBB-500” and „ROSS-308”***, leaving to their discretion to choose the preferred hybrid, according to their interests and the requirements of local consumers of poultry meat.