The use of polygenic designs in the creation of meat breeds of quail

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Abstract. The conserved gene pool of quails (breeds Pharaoh, Texas White) from the collection of “Genofond” LCC (Moscow Province) was used for the development of a new competitive breed of meat-type quails. Complex reproductive crossing with subsequent continuous selection for reproductive and productive performance during 11 generations resulted in new quail breed called “Radonezhskie”. The selection was performed with the use of traditional and innovative methods. The basis of bird selection was based on the selection of complex polygenic structures of quantitative traits in conjunction with their adaptive ability at the stages of growth, development, and productivity. The breed structurally consists of two types specialized on the productivity type. These two types consist of 12 genealogic lines and 117 families. During the process of selection live body weight (LBW) in the new breed was increased by 31.0%, feed conversion ratio (FCR) decreased by 13.4%. Average LBW at 5 weeks of age is 290 g in males and 315 g in females; FCR 2.35; average mortality level 3.0%. At 6 weeks of age, these parameters are 330 g; 360 g; 2.95; 3.5%. The intense body growth in this fast-maturing breed occurs until 5-6 weeks of age, the onset of lay occurs at 7-8 weeks. Up to 5 generations could be obtained and evaluated within a year. The breed can, therefore, serve as a model for the genetic research in quails. The large-scale trials proved that the yield of poults per hen in the new breed is higher by 12.2%, LBW at slaughter age higher by 16.9% in compare to parental Texas White breed. High quality of products and lower production costs (by 13.4-27.2% in comparison to parental breeds Pharaoh and Texas White) determine the competitiveness of the new quail breed “Radonezhskie”.

1. Introduction

Until recently there has been no experience of breeding quails in Russia. The situation changed when Pharaoh and Texas White quails were brought to the country. These are the most widespread meat breeds in the world. [1-3] Initially, genetic material was introduced by amateur poultry farmers. They brought quails without background from abroad by exchanging birds with other amateur poultry farmers of neighbouring countries or other ways. [4,5]

The evaluation of Pharaoh and Texas White quails in “Genofond” LLC showed that these breeds are of particular practical interest. They gain body weight fast and have a sufficient feed conversion per one kilo of product. However, these breeds had low reproductive potential and unstable productivity. [6,7,8].
Thus, to develop meat quail farming it was necessary to create a highly-productive meat breed, suitable for feeding and management conditions common in Russia. The breed should have high meat productivity with biological full-value and its production should be cost-effective.

2. Materials and methods

The conserved gene pool of quails (breeds Pharaoh, Texas White) from the collection of “Genofond” LCC (Moscow Province) was used for the development of a new competitive breed of meat-type quails.

The typical species of these breeds were marked and kept in groups in a specially-equipped cage battery with the ratio of male and female birds of 1: 3.

Based on the 2007 quail assessment the Pharaoh (brown plumage colour) and Texas White (white plumage colour in general) had low egg production equal to 205–210 eggs per 44 weeks of life. The incubation of young stock during a production period varied between 55 and 63% with the body weight of 6-week young quails was 195–256 g for females and 215–287 for males with the preservation of young birds equal to 91–93%. The initial stage activities showed that birds had defects in the exterior (deformation of beaks, lophosteon, toes, etc.) that are characteristic for highly inbred poultry.

To decrease the inbred depression and create birds of a new generation it was decided to carry out direct and back breed crossings with the following scheme:

1 group - 20♂ Pharaoh х 80♀ Texas White
2 group - 20♂ Texas White х 80♀ Pharaoh

Three hundred eggs were incubated from both groups. The groups gave 211 and 194 young quails respectively with 115 (28.4%) chicks having predominately white plumage colour (analogous to Texas White), while others having brown plumage or even another colour (smoke colour, etc.).

During the assessment of meat qualities, the poultry with predominately white plumage had a more attractive appearance. Thus, it was selected for further breeding.

The model of the designed breed was created to produce the poultry of the needed type. The planned parameters were achieved during selection by using polygenic designs consisting of traits belonging to parent species. The choice of a trait and the use of breeding pressure was done based on its influence on a composite index for a paternal form, including live weight, meat-type body build and fertilization of eggs and maternal form, including fertility (egg production, yield and quality of hatchable eggs) with standard indexes of live weight. The selective pressure was determined based on the influence of traits on a resulting product, its inheritance, variability and relationship to other traits.

3. Results

The work resulted in the creation of meat-type species of quails, homogeneous in plumage colour, and exterior development that consistently pass selected traits to descendants.

The breed species is characterised by the common background and long-term internal breeding. There are two types that are different in terms of productivity. In turn, they consist of 12 genealogical lines and 117 families. The data indicating the changes in the live weight of quails during selection is given in table 1.

The variation in live weight (Cv) for male and female species by the years of selection was between 18.9 and 10.1, heritability (h²sd) from 0.42 to 0.28.

It should be noted that quails of the first three selection generations had a 5.4% excess in the live weight of young quails with a simultaneous decrease in the reproductive qualities of birds. For example, the number of young quails produced by one layer decreased by 6.5 birds or 5.8% (table 2). Because of this, the following selection programme was changed starting from the 4th generation. The families that provided a high (not less than 10%) number of noun quails became the basis for creating a group of poultry that supported the reproductive traits at a sufficient level. The selection data shows that the number of young quails produced by one layer has increased by 8.3% with an increase in live weight of quails (table 2). At the same time, the preservation of adult poultry was 94.2–95.1%. The data indicate the efficiency of the work both in terms of increasing meat productivity and the reproductive qualities of birds. During the selection work egg production varied between h'sD – 17.7–19.8, variation Cv –
23.2–33.8%, the number of young quails $h^2sD = 12.8–19.1$, $Cv = 17.4–21.9$%; composite evaluation indicator (the number of quails produced by one layer), $h^2sD = 17.7–24.9$, variation $Cv = 25.1–34.7$%.

**Table 1.** The characteristic of the live weight for 6-week quails.

| Generation | Paternal form | Maternal form | An average of a breed |
|------------|---------------|---------------|-----------------------|
|            | male quail    | female quail  | male quail            | female quail |
| F1         | 242.4         | 273.5         | —                     | —           |
| F2         | 251.6         | 283.4         | —                     | —           |
| F3         | 264.5         | 287.9         | —                     | —           |
| F4         | 271.4         | 292.1         | 235.7                 | 269.2       |
| F6         | 282.2         | 309.3         | 238.1                 | 285.3       |
| F8         | 294.7         | 331.7         | 242.2                 | 296.4       |
| F9         | 308.9         | 346.2         | 259.7                 | 322.7       |
| F10        | 326.8         | 368.6         | 267.9                 | 330.4       |
| F11        | 338.6         | 376.4         | 287.7                 | 348.8       |

**Table 2.** The productivity of F1–F11 quails with group housing for the period of selection (breed average)

| Trait | Generation | Egg production for 44 weeks, eggs | The mass of an egg, g | The number of fertilized eggs, % | The number of incubated eggs, % | The number of young quails, % | The number of young quails produced from one layer, % | The live weight after 38 weeks, g | The preservation of grown quails, % |
|-------|------------|-----------------------------------|----------------------|---------------------------------|-------------------------------|-------------------------------|---------------------------------|---------------------------------|-------------------------------|
| F1    | 206.5      | 13.7                              | 83.5                 | 75.7                            | 63.2                          | 110.9                         | 367.1                           | 421.3                           | 92.7                          |
| F11   | 215.1      | 13.9                              | 86.2                 | 76.2                            | 65.7                          | 120.1                         | 371.8                           | 437.3                           | 95.1                          |
| +/-   | +9.1       | +0.2                              | +2.7                 | +0.5                            | +2.5                          | +9.2                          | +4.7                            | +16.0                           | +2.4                          |

In general, the designed breed has compact body build, developed muscles and a high yield of pectoral and leg muscles. The increase in live weight growth of young quails with a simultaneous rise in reproductive qualities of birds can be explained by the intensive selection of quails based on the leading traits, using traditional and new methods of selection as well as stabilization of live weight achieved by the directional rearing of young quails.

The resulting breed is quite early-mature with intensive growth of body weight finishing after 5–6 weeks and the generation of eggs possible after 7–8 weeks. It is possible to get and evaluate 5 generations of quails a year, while other species of poultry (chickens, turkeys, ducks, and geese) give not more than one generation [9–11]. The obtained species of quails can become a model for genetic research in meat poultry farming.

The tests showed that raising the breed can be cost-efficient. The quails, which were named “Radonezhskie”, surpass Pharaoh and Texas White breeds in the speed of body weight increase in the
slaughter age by 17.0–25.1% and feed conversion by 12.0–26.1%. At the same time, the net cost of meat production in this case is lower than for Texas White and Pharaoh breeds by 13.4–27.2% respectively.

4. Conclusion
The complex reproductive crossing of Pharaoh and White Texas breeds with subsequent continuous selection to increase both reproductive and productive performance during 11 generations resulted in a new quail breed called “Radonezhskie” (patent № 9996, 23.01.2019). The selection was carried out based on new and traditional methods. The main basis of bird selection was the choice of complex polygenic structures of quantitative traits in conjunction with their adaptive ability at the stages of growth, development, and productivity.

During the selection, the live weight of quails increased by 31% and the feed conversion increased by 13.4%. Average live weights of 5-week male and female quails are 290 g and 315 g respectively; the feed conversion is 2.35 kg per one kilo of body weight gain; young quails survival rate is 97.0%, while the survival rate at the 6-week age is 330; 360; 2.95; 96.5% respectively.

The resulting breed has a compact body build with predominately white plumage.

The large-scale trials proved that the yield of young quails per layer in the new breed is higher by 12.2% than in the case of Texas White. The live weight at slaughter age is also higher by 17.0% and the net cost is lower by 13.4%.

“Radonezhskie” quails are recommended for meat production on factory and subsistent farms.

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