

# **Ph.D. DISSERTATION THESES**

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**CHANGES IN FEATHER DEVELOPMENT AND  
MEAT PRODUCING CAPACITY OF THE PEKIN,  
MULE AND MUSCOVY DUCKS ACCORDING TO  
THE AGE AND SEX**

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## **1. PRELIMINARIES OF THE RESEARCH, OBJECTIVES**

In 1990 I gained a year-long DAAD scholarship to the Hohenheim University.

Using the research opportunities I studied the feather development characteristics of barbary or muscovy (hereinafter referred to as muscovy) ducks. The results obtained there were elaborated in my diploma work in 1992 (SZÁSZ, 1992).

Relying on the experiences gained from these studies I had the opportunity to set up an experiment on mule ducks. In these studies the effect of ad libitum and rationed feeding was tested not only on development of integument of the birds but also on their different carcass characteristics. This study led to the idea that the comparison under equal rearing and feeding conditions of feather development and relevant carcass parameters would be desirable, involving all three presently commercially exploited duck types, namely Pekin, muscovy and mule.

We have predominantly Peking-blooded import hybrids of excellent genetic abilities for broiler duck production, which can be well marketed even in export markets.

The muscovy and mule duck production will also be more and more considerable since now it constitutes more than 50 % of the broiler duck sector production. The recognition that females of both genotypes shall

be used for meat production (they used to be killed in day-old age) had a predominant role in gearing up their production. Drakes constitute the raw product for duck liver production. They are not so fatty as the goose when fattened, and their dark gamy meat – which is even weaved through by adipose tissue in the mule duck – is highly appreciated by up-scale consumers.

The duck meat is a food with a protein content of more than 20 % along with a favorable amino-acid composition. The meat itself is not really fatty, its fat content is app. 2% according to BOGENFÜRST (1999), whereas according to MIKLÓSNÉ (1981) it is 4.7 - 5.8%. However, under the skin of domestic duck a considerable amount of fat is deposited. Although the adiposity is not favorable in nutritional respect, the duck meat consumption shows a rising tendency in the high-quality-demanding markets. This is due, in particular, to the versatility of the products and demand for specialties. The fat content of the body in domestic ducks has been lowered by different breeding procedures; however, the special taste of the meat still remained.

The muscovy is popular due to its red gamy meat, and the attractively marbled meat of the mule duck is a special delicacy. These two genotypes differ from the domestic duck in many respects, especially in the lower fat content of the body and in the meat quality.

Duck feather is not as valuable as goose feather, but it is still a popular product. Similarly to geese, the stripped feather of live animals and the plucked feather of slaughtered ones constitute the stock fund. A full-grown duck yields about 60-80 g feather suitable for bedding filling.

According to the two big areas, my investigations were directed to the feather development and certain aspects of meat producing capacity of the two duck species and their species hybrid.

The feather growth was examined with two reasons in mind. For one, duck feather is a valuable product. For two, genotype differences were presumed in feather development that have an influence on slaughter maturity. Therefore in this topic the following objectives are set for investigation:

- Monitoring feather development on the abdomen and back, and in the 4th primary wing covert from its start till the 12<sup>th</sup> week of life.
- Determination of the down-feather content in the feather sample taken from the abdominal region.
- Correlation analyses between the length of the 4th primary wing covert and live weight.

By meeting these objectives the abdominal plumage value of the three duck genotypes can be clearly assessed, and by investigating the feather development and maturity, the optimal slaughter age as regards plucking can be determined.

The second area of my research looked at how the carcass parameters that substantially determine the carcass quality of the genotypes change with the age. The objectives of the investigation were as follows:

- Investigation of changes in the carcass parameters between the 6-12<sup>th</sup> week of life.
- Finding out the proportion of skin/subcutaneous fat between the 6-12<sup>th</sup> week of life.

I chose these objectives so that I can determine the most optimal slaughter age in respect to killing-out percentage of the valuable body parts in the three genotypes. I also wanted to find evidence for the possibility of rearing the animals for a longer time than usual, keeping special consumer demands in mind, and to monitor changes in the critical adiposity with the age in water birds, especially in domestic ducks.

When choosing the objectives, it was important to remember that the three duck genotypes differ substantially in their growth rates and in their valuable body parts, as well as in their adiposity. In summary, by setting the objectives of these two research areas, the three duck genotypes were intended to be assessed from the aspects of the poultry industry and trade, by way of comparing them with each other.

## **2. MATERIAL AND METHODS**

The study involved 200 Pekin type, 200 muscovy and 200 mule ducks originating from the *Palotási Kacsafarm Kft.* They were accommodated

in closed, air-conditioned poultry houses in 6 boxes, separated according to genotype and sex. Each duck was fitted with a wing band.

The floor space of the pens was 14 m<sup>2</sup>. By removing some birds for weekly trial slaughters the initial stock density of 7.1 ducks per m<sup>2</sup> was reduced to a level of 2.8 birds per m<sup>2</sup> by the end of the study. Lighting was provided for a period of 23 hours per day in the first week, 18 hours per day in the second week and 12 hours per day from the third week on. The initial lighting intensity was 18-20 Lux, which was then reduced to 6-7 Lux from the second week. This was important in particular due to the violent temperament of the muscovy ducks. The Pekin type ducks were fed *ad libitum* by *English hybrid duck starter feed*, whereas the muscovy and mule by *muscovy starter feed* in their first two weeks of life. Between the 3<sup>rd</sup> and 12<sup>th</sup> weeks of life each group was fed *ad libitum* by the same *English hybrid duck rearing feed*.

## **2. 1. Feather measuring and sampling methods**

The investigations on feather development were carried out on 28 drakes and 28 females every week. Individual marking allowed me to measure the same individuals every time. In the course of the experimental period the changes in feather length on the abdomen, back, and in length of the 4<sup>th</sup> primary covert were examined.

The length of the feathers was measured by means of a purpose-adapted ruler in such a way that the ruler was placed close behind the feather to be measured, perpendicular to the body surface, after which the length of

the part of the feather protruding from the skin was read off. Feathers to be measured were in each case chosen so as to give a fair representation of the given area of feather growth. All individuals were studied each measuring day.

On each occasion, the measurement of the feather length was accompanied by subjective observations primarily with the objective of monitoring the various phases of feather development and the degree of feather cover attained.

The samples for the examination of the down-feather content were taken in the 6-12<sup>th</sup> week of life by dry plucking method, carried out after the slaughter, and in the 24<sup>th</sup> week of life by live stripping, from the abdomen, directly in front of the thighs (pectosternal region), from eight ducks of each genotype and sex. The samples were individually marked when storing according to MSZ 6997-1989. After drying to a moisture content of 12.5%, the samples were treated according to MSZ EN 1883 and were set apart by hand, observing the recommendations of MSZ EN 12131, the constituents then were weighed to the nearest 0.1 mg. Then the down-feather content was individually calculated. The results gained therefore give information only on the feather content of this body region and not that of the whole body.

## **2.2. The slaughter and sampling conditions**

Eight birds of each genotype and sex were slaughtered every week, at the University Experimental Slaughterhouse, between the ages of 6 and 12 weeks. The animals were selected as follows. After weighing the animals, I calculated the mean weight typical of the genotype and sex. Subsequently 8 individuals were selected from the pool of animals to be slaughtered the next day that fell in the group average  $\pm$  5% standard deviation. The ducks were slaughtered by bleeding method after starving them for 12 hours, were wet plucked by hand and cut into parts by a method known from the literature (JENSEN, 1983).

The oven-ready weight was determined according to SÜTÖ (1990); the plucked, cleaned carcass without head, neck and legs, into which the edible parts such as heart, liver, cleaned gizzard were wrapped.

The parameters measured at the trial slaughters were as follows:

- oven-ready weight,
- Weight of skinned thigh, thigh fillet, skinned breast and breast fillet,
- Weight of whole skin and subcutaneous fat.

### **2.3. The methods and programs applied in the statistical process**

The body weight, feather length and carcass parameters were analyzed by two-factor variance analysis. Correlation and regression calculations were made between the length of the 4<sup>th</sup> primary wing covert and live weight. The calculations were carried out by means of the SPSS 10.0 FOR WINDOWS (1999) statistical program package.

### 3. RESULTS

#### *8.1.1. Examination of feather development and feather composition*

In the course of the study it was established that the down-feather content of the abdominal region in the genotypes under examination continuously grew. In the 6<sup>th</sup> week of life the muscovy, in the 12<sup>th</sup> week of life the Pekin drakes and the mule females, and in the 24<sup>th</sup> week of life the Pekin drakes and muscovy females had the highest rate of down-feathers. Investigating the abdominal plumage growth it was concluded that feather growth on this region of the body had been concluded earlier (in the 7<sup>th</sup> week of life) in females than in males, which reached maturity 1-2 weeks later.

In the case of drakes, Pekin, mule, muscovy orders can be distinguished when evaluating the abdominal plumage growth, whereas in females only the Pekin type differed distinctly from the two other genotypes by its faster feather growth.

The feather development process on the back has a great influence on poultry carcass quality. This process started earliest in Pekin ducks, in the 4<sup>th</sup> week of life, and was in constant growth till the 11<sup>th</sup> week of life. In the two other genotypes the back feathers began to grow only weeks later and reached their maximal length by the 12<sup>th</sup> week of life.

The 4<sup>th</sup> primary wing covert plays a predominant role among flight feathers, which fact has been established by several earlier studies (GORNWOTRH, 1952; GEHRE, 1975; YONG et al, 1988). They served the basis for my study of growth of this primary wing covert. It was concluded that the growth rate of wing covert in mule ducks was between the values of the two parental genotypes till the 9-10<sup>th</sup> weeks of life. After the 10<sup>th</sup> week of life it exceeded the feather length of both paternal and maternal parents, which was observed to differ distinctly (by the longer feathers of Pekin and shorter ones of muscovy) up until this time.

Based upon the methodology of the above mentioned authors, correlation and regression calculations were made between the length of the 4<sup>th</sup> primary wing covert and live weight, in the course of which only the Peking drakes show significant correlation between the two traits. The highest correlation ( $r=0.8^{**}$ ) was found in the 6<sup>th</sup> week of life.

#### ***8.1.2. Examination in relation with carcass quality traits***

The study of growth of oven-ready weight showed the continuously increase till the 12<sup>th</sup> week of life in all three genotypes. The heaviest weight was recorded in mule ducks both in drakes and females, in the 12<sup>th</sup> week of life. Similar tendency was found in the case of oven-ready weight.

The data recorded on the growth of breast fillet weight verified that the recent lines of Pekin duck retain their growing ability of breast weight up until the 12<sup>th</sup> week of life. Furthermore, this weight growth was due to the increase of the muscle mass and not to fat incorporation. The mule ducks showed an outstandingly heavy breast fillet weight in their 12<sup>th</sup> week of life.

The data lines recorded on thigh weight showed its continuous increase in all three genotypes. The drakes had an outstandingly high, 25-30 % growth rate of thigh fillet between the 9-12<sup>th</sup> week of life.

In contrast to muscular tissue, the proportion of skin + subcutaneous fat decreased in each genotype till the usual slaughter time, and thereafter increased significantly only in Pekin drakes. The Pekin ducks have no more fat till the age of 6-7<sup>th</sup> week than the two other genotypes.

The mule ducks were found to be the least fatty, where there was no significant difference in this trait between the two sexes.

#### **4. CONCLUSIONS AND PROPOSALS**

- The investigations on feather composition carried out in the frame of this dissertation made perfectly clear that the down-feather content in the genotypes under examination continuously grows with the age.

- The abdominal plumage growth in all three genotypes has been concluded earlier with 1-2 weeks (in the 7<sup>th</sup> week of life) in females than in drakes.
- The feather development process on the back started earliest in Pekin ducks, in the 4<sup>th</sup> week of life, and was in constant growth till the 11<sup>th</sup> week of examination. In the two other genotypes the back feathers began to grow only weeks later and reached their maximal length by the 12<sup>th</sup> week of the examination.
- The growth rate of the 4<sup>th</sup> wing covert in mule ducks was between the values of the two parental genotypes till the 9-10<sup>th</sup> week of examination. After the 10<sup>th</sup> week of life it exceeded the feather length of the parental genotypes in both sexes.
- From the examined genotypes and their sexes only the Pekin drakes show correlation between the length of the 4<sup>th</sup> primary wing covert and live weight.
- The oven-ready weight continuously increased in all three genotypes in both sexes till the 12<sup>th</sup> week of life.
- The breast and thigh weight also showed a continuous increase in all three genotypes in both sexes till the 12<sup>th</sup> week of life.  
The Pekin type broiler ducks slaughtered in practice in their 46-52 days of life showed a considerable increase both in the breast and thigh weight even between their 9-12<sup>th</sup> week of life.
- The skin + subcutaneous fat content of the three genotypes changed similarly in the course of the examination. A pronounced matching could be measured in mule ducks.

- Based on the results of this study, it would be worthwhile for the poultry industry to consider rearing Pekin ducks for a longer time before slaughtering as opposed to adhering to recent practices, because by doing so we could gain both better quality and higher killing-out percentage of valuable meat parts in bigger quantities.
- Thanks to the excellent carcass quality of mule ducks, their proportion in broiler production is advisable to be increased.

## **5. NEW SCIENTIFIC RESULTS**

1. This study is the first to look at feather growth of the Pekin type, muscovy and mule duck under equal environmental conditions. As a result of this study we can conclude that the down-feather content of the abdominal region of the Pekin type, muscovy and mule ducks continuously grow till the 24<sup>th</sup> week of life.
2. Among the different duck species and their species hybrid, the Pekin ducks started and concluded the earliest the abdominal and back plumage growth, as well as the growth of the 4<sup>th</sup> primary wing covert. In the mule ducks, the feather growth started later than in the maternal parents but earlier than in the parental parents and till the 12<sup>th</sup> week of life its rate was between the values of the two parental genotypes, but was closer to that of the muscovy ducks.
3. By investigating the carcass parameters it was concluded that in both sexes of Pekin ducks the dressing percentage of the valuable meat parts related to the oven-ready weight can be increased by 4-5 % till

the 12<sup>th</sup> week of life by rearing them beyond the nowadays usual slaughter time.

4. The proportion of skin + subcutaneous fat did not differ in the three genotypes till the 8<sup>th</sup> week of life. However, after the 9<sup>th</sup> week of life the proportion of skin + subcutaneous fat in Pekin ducks exceeded significantly the values of the two other genotypes. The ratio of skin and subcutaneous fat was not effected by sex in any genotype.

## **6. LIST OF PUBLICATIONS ISSUED TO THE TOPIC OF THE DISSERTATION**

### **Scientific publications in foreign language**

Bogenfürst, F. – Szász, S. – Szécsényi, R. (1993): Evaluation of growth rate and carcass characteristics of mule ducks according to sex and feeding. *Zbornik*. **22**. p. 241-245.

Szász, S. – Bogenfüst, F. – Varjú, M. – Hancz, Cs.: (1997) Federzusammensetzung bei verschiedenen Hausenten. *Agriculturae Conspectus Scientificus*. **1-2**. p. 129-132.

Szász, S.- Bogenfürst, F. (1998) Study on body fat content in Pekin, Muscovy and Mule ducks. *Zbornik*. **30**. p. 131-134.

Szász, S.-Bogenfürst, F.- Varju, M. (1999): Development of the fourth primary wing feathers in three types of duck. *Acta Agraria Kaposvariensis*, **3**. p. 239-245.

Szász, S.- Bogenfürst, F.- Kós, L. (2000): Untersuchungen über einige Schlachtverluste bei den Entenrassen Peking Ente, Flug Ente und deren Hybrid Mularde. *Agriculture*, **1**. p. 68-70.

### **Publications in foreign language published in proceedings in full**

Bogenfürst, F. – Szász, S. – Szécsényi, R. (1995): Evaluation of growth rate and carcass characteristics of mule ducks according to the sex and feeding. *Proc. of the 11<sup>th</sup> European Symposium on the Quality of Poultry Meat, Tours, France.* p. 240-245.

Szász, S. – Bogenfürst, F.- Kobulej, I. (1996): Untersuchungen zur Fleischbildung bei den Entenrassen: Cherry Valley, Flugente und deren Hybrid, Mularde. *Proc. 4. Int. Symposium "Animal Science Days", Kaposvár.* p. 115-124.

Szász, S. – Bogenfürst, F. – Kobulej, I. (1997): Study on thigh-fat content in Pekin, Muscovy and Mule ducks. *11<sup>th</sup> European Symposium on Waterfowl. Nantes.* p. 655-660.

Szász, S. – Bogenfürst, F. – Kobulej, I. (1997): Study of meat production ability of Cherry Valley, Barbarie and Mule Duck. *Proceedings of 1997 Australian Poultry Science Symposium, Sydney, Australia.* p. 187-190.

Szász, S. – Bogenfürst, F. (1998) Study on body fat content in Pekin, Muscovy and Mule ducks. *Proceedings of the 10<sup>th</sup> European Poultry Conference, Jerusalem.* p. 719-722.

Szasz, S. – Bogenfurst, F.- Varju, M. (1999): Development of the abdominal and back plumage and the 4<sup>th</sup> primary wing feathers in three types of duck. *Proceedings of the 1<sup>st</sup> World Waterfowl Conference Taichung, Taiwan,* p. 483-489.

### **Publications in Hungarian language published in proceedings in full**

Szász, S. – Bogenfürst, F.- Kobulej, I. (1996): A Cherry Valley és a mulard hústermelő képességének összehasonlító vizsgálata. *Proc. I. Nemzetközi Baromfitenyésztési Szimpózium.* p. 51-63.

### **Abstracts published in proceedings**

Szász, S. (1995): A mulard kacsza tollasodásának vizsgálata. **I. Országos Agrár PhD. Konferencia és Találkozó, Debrecen.** p. 294-296.p.

### **Theses, dissertations**

Szász, S. (1992): A tollasodás vizsgálata azonos genotípusú, eltérő ivarú barbari állományokban. **Diplomadolgozat.** Pannon Agrártudományi Egyetem, Mezőgazdaságtudományi Kar, Mosonmagyaróvár

### **Scientific presentations in foreign language**

Bogenfürst, F. – Szász, S. – Szécsényi, R. (1995): Evaluation of growth rate and carcass characteristics of mule ducks according to the sex and feeding. **3. Int. Symposium "Animal Science Days", Bled. Slovenia**

Szász, S. – Bogenfürst, F.- Kobulej, I. (1996): Untersuchungen zur Fleischbildung bei den Entenrassen: Cherry Valley, Flugente und deren Hybrid, Mularde. **4. Int. Symposium "Animal Science Days", Kaposvár.**

Szász, S. – Bogenfürst, F. – Kobulej, I. (1997): Study on thigh-fat content in Pekin, Muscovy and Mule ducks. **11<sup>th</sup> European Symposium on Waterfowl. Nantes.**

Szász, S. – Bogenfürst, F. – Varjú, M. – Hancz, Cs.: (1997) Federzusammensetzung bei verschiedenen Hausenten. **5. Int. Symposium "Animal Science Days", Opatija. Croatia**

Szász, S. – Bogenfürst, F. – Kobulej, I. (1997): Study of meat production ability of Cherry Valley, Barbarie and Mule Duck. **1997 Australian Poultry Science Symposium, Sydney, Australia.**

Szász, S. – Bogenfürst, F. (1998) Study on body fat content in Pekin, Muscovy and Mule ducks. **10<sup>th</sup> European Poultry Conference, Jerusalem.**

Szász, S.- Bogenfürst, F. (1998) Study on body fat content in Pekin, Muscovy and Mule ducks. **6. Int. Symposium "Animal Science Days", Portoroz, Slovenia**

Szasz, S. – Bogenfurst, F.- Varju, M. (1999): Development of the abdominal and back plumage and the 4<sup>th</sup> primary wing feathers in three types of duck. **1<sup>st</sup> World Waterfowl Conference Taichung, Taiwan**

Szász S.-Bogenfürst F.- Varju Mónika (1999): Development of the fourth primary wing feathers in three types of duck. **7. Int. Symposium "Animal Science Days", Balatonföldvár, Hungary**

Szász, S.- Bogenfürst, F.- Kós, L. (2000): Untersuchungen über einige Schlachtverluste bei den Entenrassen Peking Ente, Flug Ente und deren Hybrid Mularde. **8. Int. Symposium "Animal Science Days", Osijek, Croatia**

#### **Scientific presentation in Hungarian language**

Szász S. - Bogenfürst F.- Kobulej I. (1996): A Cherry Valley és a mulard hústermelő képességének összehasonlító vizsgálata. **I. Nemzetközi Baromfitenyésztési Szimpózium. Kaposvár**