INFLUENCE OF BREEDING AND MANAGEMENT ON THE EFFICIENCY OF DUCK PRODUCTION

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Introduction

Production of ducks worldwide increased from 1.2 mill. tons in 1991 to 2.7 mill. tons in 1997. With about 4.5 % of total poultry meat production, ducks play only a minor role. The leading countries of duck production are found in East and South-East Asia, especially China, Thailand, Taiwan and Vietnam, where duck egg production is also important. France has the highest duck production in Europe, based on muscovies and mulards. Table 1 shows the top ten duck meat producing countries.

Table 1: Leading countries in duck meat production (1000 tons, FAO-statistics, 1997)

Country	1991	1997
China	644	1974
France	118	184
Thailand	97	111
Taiwan, Rep. of China	64	75
Vietnam	33	55
USA	42	46
Malaysia	39	37
Egypt	32	37
UK	23	38
Germany	21	28

Other countries with high duck production are Indonesia, Philippines, Brazil, Mexico, Hungary and Madagascar. The highest production of ducks per capita will be found in Taiwan, Reunion and France with 3 to 4 kg. Germany is the main importer of duck meat with more than 40,000 tons.

Table 2: Supply of duck meat in Germany (Jahrbuch für Geflügelwirtschaft, 1999)

	1991	1997
Production (1000 tons)	31	33
Import (1000 tons)	35	41
Consumption (1000 tons)	64	74
Consumption (kg/capita)	0.8	0.93

Selfsufficiency of duck meat amounts to 45 %. The main exporters of duck meat to Germany are France, the Netherlands, Hungary and United Kingdom.

Characteristics of fattening and reproductive performance of ducks

Ducks have a remarkably rapid growth during the first weeks of life. At slaughter age of 7 weeks in Pekin ducks, 10 to 12 weeks in Muscovy ducks and 10 weeks in Mulard ducks (crossbred of Muscovy drake and Pekin duck) they attain 70 to 80 % of adult weight, while chicken broilers have a slaughter weight less than 40 % of adult weight (table 3).

Table 3: Body weight at slaughter age and growth rate calculated on adult weight

	Sex	Broiler	Pekins	Muscovies	Mulards
Age at slaughter (wks)		5	7	12/10	10
Body weight at slaughter age (kg)	male female	2.0 1.6	3.4 3.1	4.5 2.5	4.0 3.6
Body weight in relation to adult weight (%)	male female	40 40	75 75	75 75	70 70

The different duck species differ in growth rates and in the degree to which males grow faster than females. White Pekins typically exhibit early growth with a difference of 10 % in size between sexes. The early growth of muscovies is usually quite slow and they develop a marked difference in weight between sexes. At the age of 12 weeks males are about 40 % heavier than females. Mulards have a difference between the sexes of 10 % at the age of 10 weeks.

Selection limits for growth rate have not yet been reached, but problems have arisen from consumer demand for a smaller carcass and from the low breast meat proportion at young ages (table 4).

Table 4: Composition of duck carcass (ready to grill) at different age in percent (PINGEL, 1986)

	Age wks.	Sex	Muscle total	Breast muscule	Skin + subcut. fat	Bones
Muscovies	6	male	45.5	3.7	29.9	22.6
	11	male	59.3	16.0	20.2	20.5
	6	female	49.9	4.1	29.9	20.2
	9	female	55.6	14.6	23.4	21.0
Pekins, small type	4	male	33.7	4.9	30.7	35.6
	8	male	47.8	19.4	29.9	22.3
	4	female	33.5	5.8	31.1	35.3
	8	female	49.9	19.6	29.5	21.6
Mulards	6	male	48.5	6.9	29.0	22.5
	9	male	54.6	15.3	26.0	19.4
	6	female	45.4	6.3	30.7	23.9
	9	female	54.6	15.3	26.0	19.4

There is a high increase of muscle percentage, especially of breast muscle and a slight decrease of carcass fat content due to decreasing skin proportion. The percentage of breast muscle increases more than the percentage of leg muscle decreases with advancing age.

Contrary to a wide spread opinion, there is no increase of fat content up to the usual slaughtering age of ducks shortly before the first youth moulting. From the beginning ducks have a high percentage of skin with subcutaneous fat for protection against cold water. The late intensive growth of the breast muscle is related to the growth of wings to become able to fly. The high breast muscle percentage in pekins in table 4 depends on the breeding history of this experimental line, which was developed by crossing with dwarf ducks.

The reproductive performance (number of viable ducks) depends on number of settable eggs, mating activity and semen quality, fertilization and hatchability. The reproductive performance of pekins and muscovies is different (table 5). Pekins are used for two laying periods and muscovies, because of the short laying season of 5 month, for 4 laying periods by application of forced moulting. Crossing muscovy drakes with pekin ducks often results in poor fertility and hatchability of eggs. The use of artificial insemination or natural mating with narrow mating ratio (1 to 2) are important. It is necessary to select pekin ducks with the highest biological predisposition for reproduction in hybridisation of both species.

Table 5: Reproduction performance of ducks in the first laying period (calculation)

	Pekins	Mulards (musc.drake x pekin duck)	Muscovies
Age at first egg (wks)	24	24	28
Duration of 1st laying period (wks)	40	40	22
No. of eggs produced	220-230	220-230	80-90
No. of settable eggs	200	200	80
Fertility (%)	90	60	85
Hatchability (%)	85	60	80
Number of offspring	150-160	70-75	55-60
Feed for parents (kg/offspring)	0.75	1.7	1.2

Breeding

The breeding strategy in meat ducks is usually cross line breeding. Taking into account the negative relationship between growth rate and reproduction performance the breeding program works with specialised male and female lines. The male lines are selected for growth rate, feed efficiency and carcass quality. In the female lines egg production and hatchability have to be considered. By crossing of genetically different lines heterosis can be utilized, especially for duckling production with the female parent stocks. But in most duck breeding companies the male parent stock is also produced by crossing of two lines. The usual meat duck is a product of 4-way-crossing. On the other side backcrossing can be an efficient strategy. The crossing of a sire line with a dam line allows to utilize the maternal heterosis in the crossbreds for duckling production. Backcrossing with the sire line provides the utilization of complementary effects with regard to carcass quality and feed efficiency.

The main objective of successful duck breeding is to increase the percentage of muscle and to improve feed efficiency. There are two possible ways of improving the meat proportion of ducks by breeding:

- By crossing commercial breeds with breeds that can fly and have a high percentage of breast muscle like dwarf ducks. The disadvantage of crossing with flyable ducks is the low body weight of the crossbreds.
- By indirect selection for breast muscle thickness measured on living ducks or by direct selection based on yield of breast and thigh muscle of dissected sib groups.

Breeding for higher breast meat yield is possible, when it is evaluated in the live bird by measuring the thickness of breast meat. As shown in table 6 the relationship between breast meat thickness (measured by a needle probe) and the percentage of breast muscle (carcass dissection) is high enough for efficient selection in ducks.

Table 6: Relationship of breast meat thickness (BMT) and body weight (BW) with amount and percentage of breast muscle in ducks (PINGEL, 1986)

	Breast muscle (amount)	Breast muscle (%)
BMT	0.68	0.73
BW	0.48	-0.04
BMT + BW (mult.)	0.81	0.73
BMT - BW (part.)	0.75	0.73

The high accuracy of determining percentage breast muscle in ducks is due to the cylindrical form of the duck body. In a breeding experiment with pekin ducks over 7 generations a synthetic line was selected for body weight and breast meat thickness at the age of 8 weeks and compared with an unselected control (table 7).

Table 7: Body weight, breast meat thickness and percentage breast muscle of carcass after 7 generations (PINGEL and HEIMPOLD, 1983)

	Selected line	Control line	Difference (%)
n	675	689	-
Body weight (g)	3287	2782	+18.2
Breast meat thickness (cm)	1.98	1.69	+17.2
Breast muscle (%)	13.0	11.9	+9.4

The cumulative selection differences for body weight and for breast meat thickness were 1288 g and 0.91 cm, respectively. They were adjusted for the number of offspring. The realized heritabilities for both traits were 0.39 and 0.32, respectively, confirming the estimated values.

The combined selection for breast muscle thickness and for yield of breast and leg muscle of sibs has improved the proportion of breast and leg muscle from 26.2 % to 31.7 % after 10 years (KAIN,1988). The crude fat content of the carcass was reduced from 30.5 % to 26.9 %.

The most efficient way to improve feed efficiency and to reduce the carcass fat content of waterfowl seems to be direct selection for feed conversion ratio (feed intake/ weight gain).

Indirect improvement of feed conversion ratio (FCR) by decreasing age at slaughter holds little promise because of the late growth of breast muscle (table 4), resulting in poor carcass quality. Our selection experiment for FCR was based on an initial cross of flyable dwarf ducks and heavy Pekin ducks. From 1979 onwards, selection was conducted in opposite directions, selection for low feed conversion with heavy live weight (LF) and selection for high feed conversion with heavy live weight (HF). The initial population was used as a control population, reproduced by random mating without mating of relatives. Each line consisted of 20 pens of 1 male and 2 females each, which were kept in individual cages in a windowless shed. Mating was by adding drakes to ducks. The offspring were marked after hatching, raised in a temperature controled house until they were 3 or 4 weeks old, and subsequently in individual cages to be able to determine both body weight gain and individual feed consumption between 22 or 29 and 49 days of age. After calculation of FCR the animals were selected as shown in figure 1.

Figure 1: Summary of breeding termination in the experimental duck line 20 (selection on low FCR)

Week	Selection line	Control
Parents	pens 1 2 3 4 ⇒ 18 19 20	pens 1 2 3 4 ⇒ 18 19 20
Offspring 1	rearing in a warm house on deep litter	
5	**Performance test** [individual FCR defined as the quotient of food consumption and body weight gain in a defined test period] **1st Selection** 20 % of males; 40 % of females	random selection with the aim to reproduce one son/drake and one daughter/duck
	keeping on pasture (flock)	
52	**2nd Selection** pens in cages for reproduction 5-15 % of males; 20-30 % of females	
Parents	pens 1 2 3 4 ⇒ 18 19 20	pens 1 2 3 4 ⇒ 18 19 20

In table 8 results of estimation with the “Individual Animal Modell-PROGRAM ´DFUNI´” are given. These variance components were estimated from data of 2189 tested ducks (with pedigree) from the control line over 8 generations (with 2 sexes and 30 hatches as fixed effects). Body weight and FCR have moderately high heritabilities. Body weight gain and live weight at the age of 49 days have a negative relationship to FCR and a positive correlation to feed consumption.

The response of divergent selection for FCR is shown in table 9 after 8 generations. There was a significant differentiation for FCR in both directions with strong effects on skin percentage, crude fat content and grill losses. The percentage of skin with subcutaneous fat was markedly reduced. The reduction of carcass fat is an important reason for differences in FCR.

Table 8: Phenotypic and genetic correlations and heritability of live weight (LW) and FCR of control line (n = 2189) (KLEMM,1995)

Rp rg	BW (start)	BW (49th)	BW-Gain	FConsumpt.	FCR
BW (start)	**0.40**	+ 0.58	+ 0.35	**+ 0.35**	+ 0.29
BW (49th)	+ 0.57	**0.47**	+ 0.83	+ 0.70	- 0.28
BW-Gain	+ 0.03	+ 0.85	**0.50**	+ 0.63	- 0.55
Fconsumpt.	**+ 0.21**	+ 0.65	+ 0.64	**0.58**	**+ 0.25**
FCR	+ 0.34	- 0.27	- 0.54	**+ 0.59**	**0.52**

Table 9: Effect of divergent selection for FCR over 8 generations (KLEMM and PINGEL, 1988)

	LF	HF	Contr.
FCR 4th-7th week (g)	3133	4349	3763
Skin + subcut. fat of breast and leg (%)	11.5	15.0	13.1
muscle of breast and leg (%)	27.0	26.0	25.8
Crude fat content (%)	21.7	30.1	23.5
Grill losses of leg (%)	41.5	50.8	46.3

The significant genetic differentiation for FCR led to the question, which factors apart from carcass composition and fat content are responsible for the differences in FCR. In cooperation with nutritionists ducks with low and high FCR were compared for utilization of protein and energy. Ducks of the LF-line had a better protein utilization, but the energy utilization was poorer (table 10) compared to the birds of the HF-line.

Table 10: Effect of divergent selection for FCR on protein and energy utilization (PAHLE et al., 1989)

	Low FCR	High FCR
Number of ducks tested	16	16
Intake of dry matter (g)	6117	6137
Body weight (g)	1909	1619
Intake of dry matter/gain	3.2	3.8
g protein retention/100 g protein intake	26.0	23.2
MJ energy retention/MJ met. energy intake	0.345	0.361

Improvements in feed efficiency cause differences in metabolism and physiological parameters. MÜLLER (1986) was able to show different enzymatic activities. The activity of alkaline phosphatase and of creatinkinase in plasma was much higher in ducks of the LF-line than in ducks of the HF-line. Studies on behaviour by REITER and PINGEL (1989) resulted in higher locomotor activity in ducks with high FCR.

CAHANER and LEENSTRA (1992) have observed, that broilers selected for low FCR developed better under hot temperature conditions than broilers selected for fast growth.

In our experiments both duck lines and the unselected control were divided into two groups, one group was kept under hot temperature (30 to 32°C) up to 7 weeks of age, the other was kept under moderate temperature (20 to 22° C). In the first experiment each group consisted of 60 ducklings, in the second experiment the HF-line was not available and each group had 30 ducklings.

Table 11 shows the body weights at 7 weeks of age and FCR`s from 4 to 7 weeks of age. Body weight was decreased significantly by hot temperature in all lines. There is a significant genotype-temperature-interaction because the LF-line had a lower growth depression. The FCR was better under hot temperature in all lines.

As can be seen in table 12 high temperature has decreased skin percentage and abdominal fat. There was the same tendency in all lines, but the LF-line had the lowest values for fat content.

Table 11: Effect of temperature on fattening performance of ducks with different FCR

Line	Temp.	Experiment I BW 49d	Experiment I FCR 4-7 wks	Experiment II BW 49d	Experiment II FCR 4-7 wks
HF	H	1774	3.521	-	-
	N	2306	3.710	-	-
LF	H	2214	2.608	2043	2.775
	N	2649	2.847	2184	2.685
Control	H	1846	2.913	1759	3.376
	N	2145	3.305	2078	2.993
Source of var.		F-values		F-values	
Line		132.9 *		48.9 *	
Temperature		353.9 *		69.6 *	
Interaction		9.2 *		3.9 *	

* = significant

Table 12: Effect of temperature on carcass quality of ducks with different FCR

Line	Temp.	Experiment I Skin of breast and leg	Experiment I Abdominal fat	Experiment II Skin of breast and leg	Experiment II Abdominal fat
		Percentage of whole carcass			
HF	H	11.2	1.1	-	-
	N	16.1	2.0	-	-
LF	H	9.0	0.6	9.5	0.6
	N	11.7	0.9	11.4	0.7
Control	H	11.9	1.1	12.6	1.0
	N	14.4	1.7	14.6	1.1
Source of var.		F-values		F-values	
Line		14.4*	26.9*	18.5*	53.9*
Temperature		25.9*	46.1*	29.8*	0.7
Interaction		1.9	3.5*	0.9	0.5

* = significant

Additional investigations were conducted to find out the emission of nitrogen and phosphorus of the HF- and LF-lines. In two replications 8 birds of each line were kept in single cages from day 22 to day 48. The manure was collected daily, dried and analyzed.

Table 13 shows that there was no difference in excrements (dry matter) per kg feed intake. The reduction of emission of N and P in the LF-line is mainly caused by the decreased feed intake. Improvement of FCR by selection results in lower pollution of environment.

Table 13: Emission of nitrogen and phosphorus of ducks with high and low FCR from day 22 to 49 of age (n = 8 per line and replication)

	LF	HF	LF	HF
Replication	1	1	2	2
Gain (g)	1542	1329	1357	1284
Feed intake (g)	4520	5349	4203	5069
Kg feed/ kg gain	2.932	4.030	3.097	3.948
Excr. DM (g)	1015	1179	946	1100
Excr. DM/kg feed intake (g)	225	220	225	217
N-intake (g)	133.8	158.4	124.4	150.1
N-emission (g)	64.3	80.6	58.8	73.8
N-emission/kg gain (g)	41.8	60.9	43.7	58.1
P-intake (g)	40.7	48.1	37.8	45.6
P-emission (g)	27.3	34.4	22.5	27.5
P-emission/kg gain (g)	17.8	25.9	16.7	21.5

The emission of N and P via manure related to 1 kg gain of body weight is in the LF-line reduced by 45 and 31 % in replication 1 as well as by 33 and 22 % in replication 2. That means selection for feed efficiency is an important ecological factor.

In dam lines the most important traits are those related to reproduction. Growth rate plays only a secondary role. Pekin ducks usually have a reliable and highly efficient reproductive capability, therefore in most breeding farms with pekin ducks there is little selection for reproductive performance. Nevertheless, egg production and hatchability can be increased by crossing of lines with good combining ability to utilize heterosis. Crossbred ducks are usually used as parent females.

Reproduction rate is very important at crossing of muscovy drakes and pekin ducks for production of interspecific hybrids, the so called mulards or mule ducks. It seems to be necessary to select muscovy drakes and pekin ducks with the highest biological predisposition for fecundity when used for hybridization.

There are differences between pekin lines but also between individual pekin ducks in suitability for crossing with muscovy drakes. Selection programs for improvement of reproduction of muscovy drakes and pekin ducks in case of crossing have been successful in Taiwan, where the annual production of mule ducks amounts to 40 millions (CHENG et al., 1997).

A narrow ratio of 1 drake to 2 ducks for natural mating or frequent insemination (3 times per week) is necessary for high fertility. The duration of fertility (number of days with fertile eggs after the last insemination) is relatively short.

This trait is in good agreement with the number of spermatozoa on the vitelline membrane on successive days after the last insemination (WAGNER, 1998).

With regard to the low hatchability of mule ducks our investigations have shown that there is a relationship between frequency of chromosomal aberrations in embryos and early embryonic mortality (table 14).

Table 14: Frequency of chromosomal aberrations in mule duck embryos from pekin ducks with high and low early embryonic mortality (EEM)

Replication	Group	Total no. embryos	Analysable embryos	Chr. aberrat. n	Chr. aberrat. %
1	High EEM	67	51	21	41.2
1	Low EEM	25	22	4	18.2
2	High EEM	38	31	9	29.0
2	Low EEM	133	112	16	14.3
	Total	263	216	50	23.2

Management

Duck meat belongs to the more expensive kinds of meat. This can have a favourable effect on the image of duck meat but it must be justified by a corresponding quality. In view of increasing concern of consumers about animal welfare, producers will have to deal not only with price and quality of the final product, but also the manner in which ducks are produced. That means that the methods of waterfowl production have to be organized with respect for animal welfare, environment and landscape to get an additional bonus with regard to consumer acceptance.

Generally there are three production systems for meat-type waterfowl:

- Intensive production systems have been developed during the last 40 years. The birds are housed in closed buildings, mainly on deep litter or deep litter combined with slatted floor or wire mash with relatively high stocking density, feed and drinking water supply.
- Semi-intensive systems with restricted range with and without facilities for bathing.
- Extensive systems based on the utilization of cheap natural feed resources of pastures or fish ponds.

The design, construction and maintenance of buildings and equipment must be such that they fulfil the basic behavioural and health needs, maintain good conditions of hygiene and limit the risk of disease, disorders due to behavioural changes, traumatic injuries to the animals, or injuries caused by the animals to each other.

As result of intensive production systems muscovies sometimes develop the problem of feather pecking. Beak trimming is a common method to reduce the rate of injured birds, but is in the conflict with principles of animal welfare. More attention deserve genetic components and selection procedures.

If animals were not beak trimmed, non of the following treatments prevent mutual injuries: various light programs (intensity, colour), enriched environment, offering straw, grass, bathing facilities. Early access to open water as well as mixing Pekin ducks with Muscovy ducks in the same flock reduced the incidence of mutual injuries in some groups as a result of social learning.

Our investigations were conducted in a poultry house with 44 compartments - 1.5 m x 3.2 m - each with 20 ducks. The ducks of 22 groups had access to a limited range - 1.5 m x 6.5 m - with bathing place - 1.5 m long x 0.4 m wide x 0.15 m deep - from the first day of life.

Muscovies and Pekins were mixed in different ratios:

- 20 Muscovies - 0 Pekins
- 18 Muscovies - 2 Pekins
- 15 Muscovies - 5 Pekins
- 10 Muscovies - 10 Pekins
- 0 Muscovies - 20 Pekins.

To determine the level of feather pecking, visible injuries and plumage condition were evaluated. In order to prevent cannibalism the injured ducks with visible blood wounds were handled with beech-wood tar. In addition we measured the body weight and food consumption.

The analysis of table 15 shows a significant influence of housing environment on the criteria “injury” (yes/no) after a fattening period of 55 days. About 50 % of ducks reared “indoor” showed injuries. There is a significant influence of mixing ratio on injuries only by outdoor rearing with bathing area. In groups with a ratio of 3:1 and 1:1 only two ducks (1.3 %) showed injuries. After 55 days, injured ducks reached only 90 % of body weight of ducks without injuries.

Table 15: Percentage of injured ducks at 35 and 55 days of age (KLEMM et al., 1995)

Treatment	Number of groups	Number of ducks	Injured ducks 35^{th} day (%)	Injured ducks 55^{th} day (%)
Housing				
outdoor	18	360	4.4	**12.2**
indoor	18	360	25.0	**49.4**
Mixed ratio				
20:0 outdoor	6	120	10.0	28.3
20:0 indoor	6	120	30.0	56.7
9:1 outdoor	4	80	5.0	10.0
9:1 indoor	4	80	12.5	36.3
3:1 outdoor	4	80	**0.0**	**1.3**
3:1 indoor	4	80	35.0	56.3
1:1 outdoor	4	80	**0.0**	**1.3**
1:1 indoor	4	80	20.0	45.0

Extensive systems like integrated fish cum duck production are applied in East Europe as well as in East Asia. In Germany this production system is limited to avoid water pollution, but there are some results in the complementary benefits to both fish and waterfowl. Manure from waterfowl fertilizes the fish pond and this increases fish yield. Waterfowl will find some additional feed in the water. Good results were found by VARADI (1995) in Hungary. As an effect of duck rearing on fish ponds some 300 to 500 kg additional yield of fish gained per hectar.

Stocking density of ducks per hectar fish pond depends on various factors such as water temperature, depth of the pond, type and intensity of fish production and the composition of the microflora in the water. Overfertilization by manure of ducks can lead to a breakdown of the system and to fish poisoning.

Under moderate climatic conditions with a relatively short fish growing period 400 to 500 ducks may be kept per hectar water surface per year. In tropical areas up to 4000 ducks per hectar fish pond and year are kept. The effect of duck manure and wasted feed allows to save 75 % of the special fish feed for 20,000 tilapia per ha pond (LEE et al., 1997).
VARADI (1995) demonstrates an aquacultural-rotation-system based on 3 production cycles such as: 5 years fish cum duck production, 2 years alfalfa production and 3 years rice production. It allows to bring back N and P accumulated in the sediments into productive use. The sequential integration of duck and fish production offers new perspectives, but it needs further research work.

Traditional and alternative production systems of waterfowl are suitable to utilize grassland especially by geese and muscovies to complement small ruminants (sheep and goats). It can be important in countries, where import of concentrated feed is expensive. Grazing of waterfowl has to be controlled in order to avoid pasture deterioration.

In practice rotational grazing or strip folding by using electric or other fences is applied. Mulards seem to be suitable for extensive production systems with pasture. Mulards from crossing of muscovy drakes with pekin ducks of a light type were kept in two groups from the age of 22 days up to 84 days and 77 days, respectively. In experiment 1 concentrate was given in both groups ad libitum, in experiment 2 the mulards, kept on pasture, received restricted amounts of concentrate (60 % of ad libitum).

Under the conditions of ad libitum feeding of concentrates mulards in free range had higher body weights, better FCR and larger gizzards. Restriction of concentrate in experiment 2 had a negative effect on body weight, but FCR was improved.

Table 16: Effect of additional pasture for fattening of mulards (40 ducks per group)

Parameters	Intensive conc. ad lib.	Pasture conc. ad lib.	Intensive conc. restr.	Pasture conc. ad lib.
Body weight at slaughter age (g)	3256 a	3633 b	2835 a	2619 b
FCR 4-12(11) (kg)	3.70	2.87	3.39	2.19
Breast muscle (%)	17.7 a	18.8 a	19.3	19.0
Leg muscle, incl. bones (%)	19.3 a	17.6 b	18.4	19.6
Skin of breast and leg (%)	7.3 b	8.0 a	8.4	8.2
Abdominal fat (%)	0.44 b	1.02 a	1.22 a	0.63 b
Gizzard (%)	3.49 b	4.37 a	4.63 b	5.09 a

The high percentage of linolenic acid with 73 % of total fatty acids in grass (rye grass, fescue and clover) as was found by BAEZA et al. (1998) can increase the content of omega-3-fatty acids in the meat of waterfowl kept on pastures.

Consumer preferences have changed in the direction of meat with low fat content. Marked reductions in the body fat content of waterfowl may not be possible by altering the energy:protein ratio under conditions of ad libitum feeding. Ducks are able to compensate low density diets by increase feed intake up to 30 %. Especially in the last part of the growing period the birds overconsume the diet. Therefore quantitative restriction could be a tool to decrease the fat content. But moderate feed restriction resulted in only slightly leaner and also smaller birds with lower muscle proportion. Feed restriction must be done very carefully. LECLERCQ (1989) observed that restricting feed intake to 82 % of ad libitum consumption during the finishing period significantly reduced the body weight of muscovies at 70 and 84 days of age. Breast and leg weights as well as carcass fat content were also significantly reduced.

Our investigations have shown, that feed restriction is better during the initial weeks of life than during the finishing period. A skip-a-day system during the first two or three weeks of duck fattening has improved the feed efficiency. But the effect on FCR was opposite when the skip-a-day system was applied during the last two or three weeks of the fattening period.

Table 17: Effect of skip-a-day feeding system on body weight (BW), FCR and breast meat percentage of BW (PINGEL and SCHNEIDER, 1978)

Feed restr. wks.	BW g	FCR kg	Breast muscle %	Breast skin %
0 control	2933	3.90	8.3	4.6
0-2	2967	3.78	8.3	5.3*
7-8	2751*	4.12	8.6	5.0*
0-3	2859	3.75	7.9	5.4*
6-8	2733*	3.98	8.5	4.0

* = significant to unrestricted control

There was no reduction of breast muscle percentage but it was not expected that feed restriction during the first weeks increases the percentage of breast skin with subcutaneous fat. Unfortunatedly it was not determined the carcass fat content as was done by HÖG (1984). This author has applied moderate feed restriction during the initial two weeks of life by reducing the amount to 75 % of ad libitum consumption and it was observed a reduction of FCR from 3.1 to 2.9 kg and of carcass fat percentage from 36.3 to 32.0 %. Moderate feed restriction during the first weeks of fattening can help in preventing of leg disorders due to a slower initial growth corresponding with maturity of skeletal system.

Summary

Duck breeding programs are based on crossing of specific sire and dam lines. Direct selection for FCR increases the biological and ecological efficiency (reduction of feed costs and environmental pollution) and improves the adaptability to hot climate. Intensive production of muscovies may lead to the problem of feather pecking and cannibalism, which can be reduced by mixing with pekins and offering range with bathing facili-

ties. For integrated fish and duck production the aquacultural rotation system developed by VARADI (Hungary) can help to reduce environmental pollution. Moderate feed restriction during the first weeks of fattening improves feed efficiency.

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