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Effect of quantitative feed restriction on growth performance, carcass traits and meat quality of male Peking ducks.

Einfluß der restriktiven Fütterung auf die Mastleistung sowie die Schlachtkörper- und Fleischqualität bei den männlichen Pekingenten.

By A.M.A. Osman[1]

1 Introduction

It is well known that, feeding cost represents ca. 60-70% of the total cost of poultry production. Ducks characterize with their greater voluntary feed intake, which is associated with their higher fat content compared to other species of commercial poultry (SIREGAR and FARRELL, 1980). Therefore, limiting feed intake/unit gain might increase the net profit of the producer and produce carcasses with lower fat content which realize healthy nutrition for human. The common methods of feed restriction are lighting control, limiting feeding time, nutrient dilution and quantitative feed restriction. The latter technique is more reliable for experimental purposes, because birds are capable to compensate the retardation in body weight only through the improvement in feed conversion and not by increasing feed intake. CAMPBELL et al. (1985), indicated that, feed conversion of Peking ducks deteriorated as food intake increased progressively from 0.49 ad-lib. to ad-lib. intake. Also, LECLERCO and DE CARVILLE (1978) and DE CRAVILLE and DE CROUTTE (1978), recommended feed restriction for Muscovy ducks during the period from 8 to 12 weeks of age, because feed conversion during this period was deteriorated, but the valuable cuts of the carcass improved with the prolongation of the fattening period.

Therefore, the present experiment was designed to study the effects of feeding different amounts of feed on the productive performance, carcass traits and meat quality of male Peking ducks.

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2 Materials and Methods

Ninety six, one day old, male Peking chicks purchased in summer season from a commercial hatchery were raised in wire cages during the first two weeks of age without using supplemental heat. At the beginning of the third week of age, ducklings were weighed and randomly divided into 3 groups. Each group was subdivided into 4 subgroups with eight chicks each and reared on deep litter pens (1 x 1 m) up to 12 weeks of age. Average initial body weight of chicks was similar amoung groups. Ducklings in the first group were full access to feed(control), while those in the second and third groups were fed 85 and 70% of the full fed control treatment respectively. The amounts of feed given to the restricted groups were calculated on the basis of the mean weekly feed consumption of the ad-lib. group at the previous week.

The actual feed restriction was calculated from feed intake during the experimental period as compared to the control treatment. A starter mash diet containing 170 g protein and 2800 Kcal ME/kg feed was fed ad-lib. during the first two weeks of age, thereafter a grower mash diet containing 155 g protein and 2940 Kcal ME/kg feed was offered up to 12 weeks of age according to DLG (1982). Ducklings in the restricted groups were fed twice daily at 8.0 a.m. and 2.0 p.m., while drinking water was available ad-lib. for all treatments. Environmental temperature and relative humidity during the experimental period were recorded continuously using thermohygrograph and fluctuated between 21-31°C and 39-67% respectively. Ducklings in each replicate were weekly weighed and means of body weight, feed intake, cumulative feed conversion and mortality rate were calculated.

At 10 and 12 weeks of age, eight birds from each treatment were randomly taken, deprived from feed, but not water for about 12 hours and slaughtered. So that a total number of 48 birds were slaughtered (2 birds x 4 rep x 3 treat. x 2 ages = 48 birds). After bleeding out, the birds were scalded, plucked with electrical cyclomatic picker and eviscerated. Heads and shanks were separated and then, the carcasses were soaked in a tap cold water for about 15 minutes. Eviscerated carcasses with giblets and abdominal fat, but without heads were individually weighed and dressing % was calculated (eviscerated carcass + liver + purified gizzard + heart + abdominal fat in relation to pre-slaughtered weight). Eviscerated carcasses were portioned into breast, legs, back, wings and neck according to WPSA (1985).

Abdominal fat was added to back, because most of fat in Peking ducks is deposited in subcutaneous region. The different cuts and giblets were each weighed and related to the carcass weight as a percentage. The right side of large breast and thigh muscles from each carcass were removed, kept in plastig bags, chilled in a refrigerator at +4°C for 24 h, then freezed at -15°C until required to evaluate physical meat quality. For measuring final pH-value (after storage), meat colour and juice holding capacity, the frozen samples were left to thaw in a refrigerator at +4°C for 24 hours without removing them from the plastic bags. The pH-value was measured directly using pHmeter (650-Knicke Company), F.R. Germany. Meat coloured was measured by colourmeter (Gofo-Meter) from E. Schutt Company, F.R. Germany. The value varied from very light at zero to very dark at 100. To determine juice holding capacity a piece of 0.3 gm muscle from each individual meat sample was put on a filter paper (previously held over saturated Kcl solution in a dessicator) and pressed between two glass plates for five minutes according to GRAU and HAMM method (1957). The areas of meat and meat + juice were estimated by the axis method according to HOFMANN (1982). The juice holding capacity was calculated using the following formula:

Juice holding capacity = meat's area/total area x 100. The higher value means higher juice holding capacity and vice versa.

The statistical analysis were carried out according to SAS programme (1989). The main effects were feeding regimes and age. Differences amoung treatments were calculated at 5% level of significance.

3 Results and discussion

3.1 Growth performance

Quantitative feed restriction retarded ($P < 0.01$) body weight from 3 to 10 weeks of age, thereafter (11 to 12 weeks) ducklings were capable to compensate this retardation and had similar body weight to the full fed control treatment (Fig. 1).

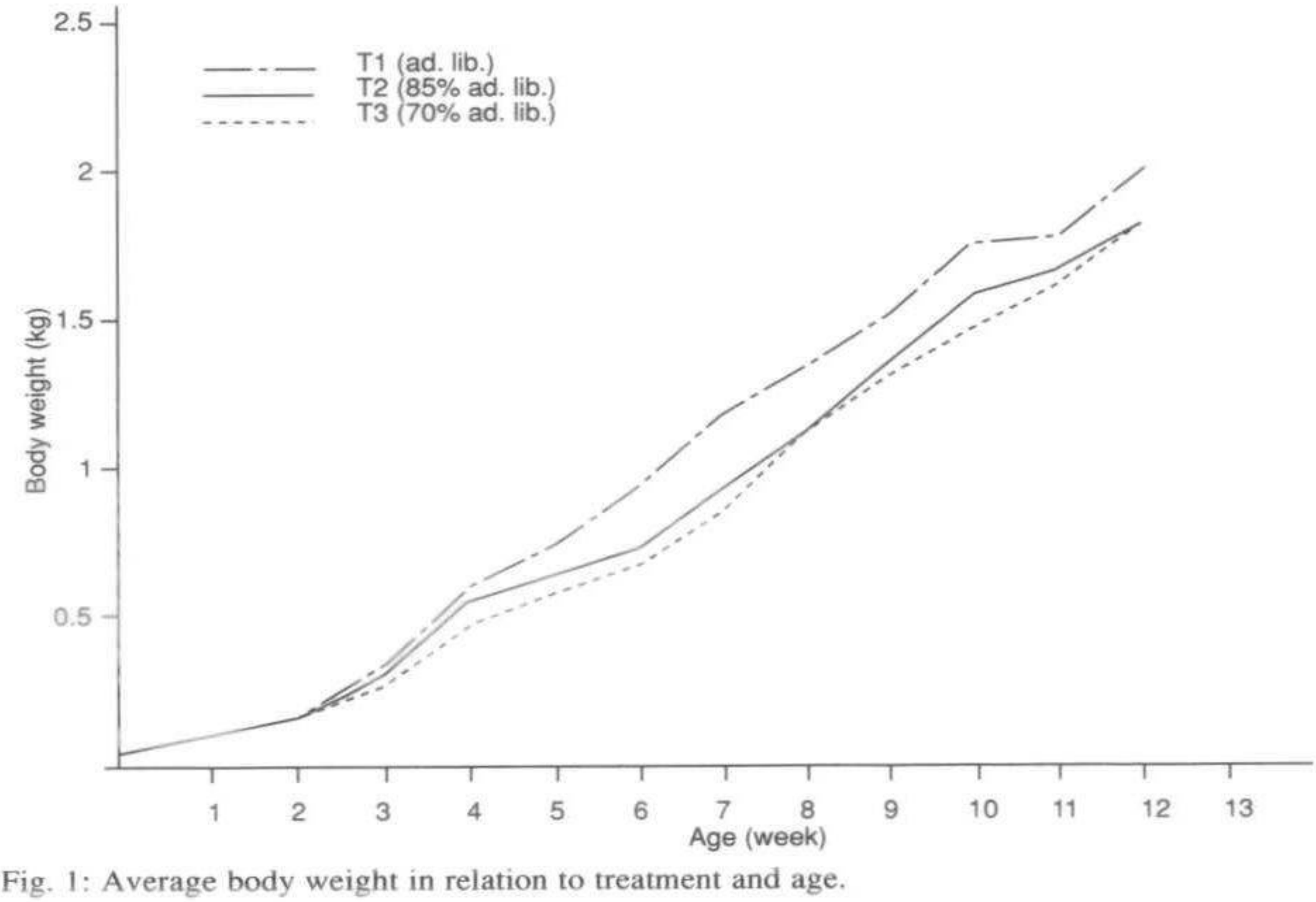

Fig. 1: Average body weight in relation to treatment and age.

The superiority of ducklings fed ad-lib. in body weight over those fed 85 and 70% ad-lib. increased with increasing age and reached its maximum at 6 weeks of age, representing 29% and 42% respectively. Then, it decreased gradually and the difference became insignificant at 11 weeks of age, representing only 6% and 10% over those fed 85% and 70% ad-lib. respectively. The depression in body weight under feed restriction was attributed to the lower feed intake which cannot meet their nutrient requirements for higher growth rate. The slight convergence of the growth curves during the rehabilitation period (from 7 to 10 weeks old) indicated that, ducklings under feed restriction had higher growth rate relative to full fed control treatment. It is well known that, the compensation effect could achieve only by increasing feed intake or better feed conversion relative to full fed control. In this study the compensation effect was achieved by the better feed conversion due to the fact, that birds under feed restriction were not refed ad-lib. throughout the experimental period.

These results are in good agreement with the findings of CAMPBELL et al. (1985), who reported that, Peking ducks fed ad-lib. had significantly ($P < 0.01$) higher body weight at 56 days of age compared to those fed 0.9; 0.8; 0.7 and 0.6 ad-lib. between 14 to 56 days of age.

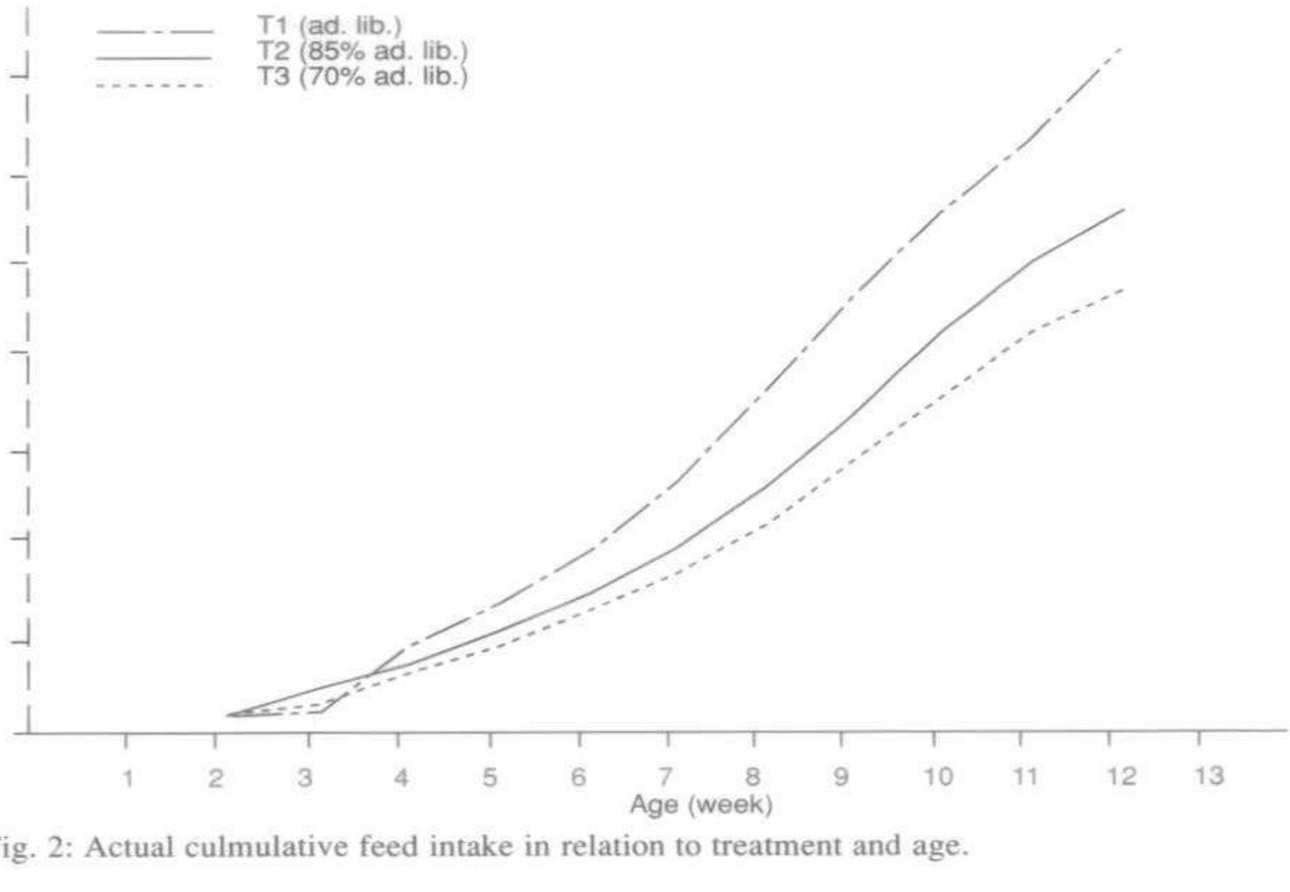

Fig. 2: Actual culmulative feed intake in relation to treatment and age.

Fig. 2 shows the actual cumulative feed intake during the experimental period. Cumulative feed intake in the full fed control treatment was significantly ($P < 0.05$)

higher that those fed 85 and 70% ad-lib. throughout the experimental period. Also ducklings fed 85% ad-lib. consumed higher ($P < 0.05$) feed than those fed 70% ad-lib. from 3 to 12 weeks of age. The actual feed intake under feed restriction was lower than assumed, due to increased feed consumption as birds aged, therefore feed restriction was higher that this indicated, being 76% and 64% ad-lib., respectively during the whole growing period.

Cumulative feed conversion was significantly ($P < 0.05$ or $P < 0.01$) better for ducks under feed restriction compared to those fed ad-lib. at 4,5 and from 8 to 12 weeks of age (Fig. 3). Also from the same figure it is clear that, ducklings fed 70% ad-lib. realized better ($P < 0.05$) cumulative feed conversion than those fed 85% ad-lib. from 8 to 12 weeks old. The improvement in cumulative feed conversion under feed restriction increased with increasing age and the severity of feed restriction, being 11% and 26%, 15% and 23% and 17% and 29% for 85% and 70% ad-lib. treatments at 8, 10 and 12 weeks old respectively. The improvement in cumulative feed conversion under feed restriction could be attributed to the better nutrient utilization and the reduction in body fat deposition.

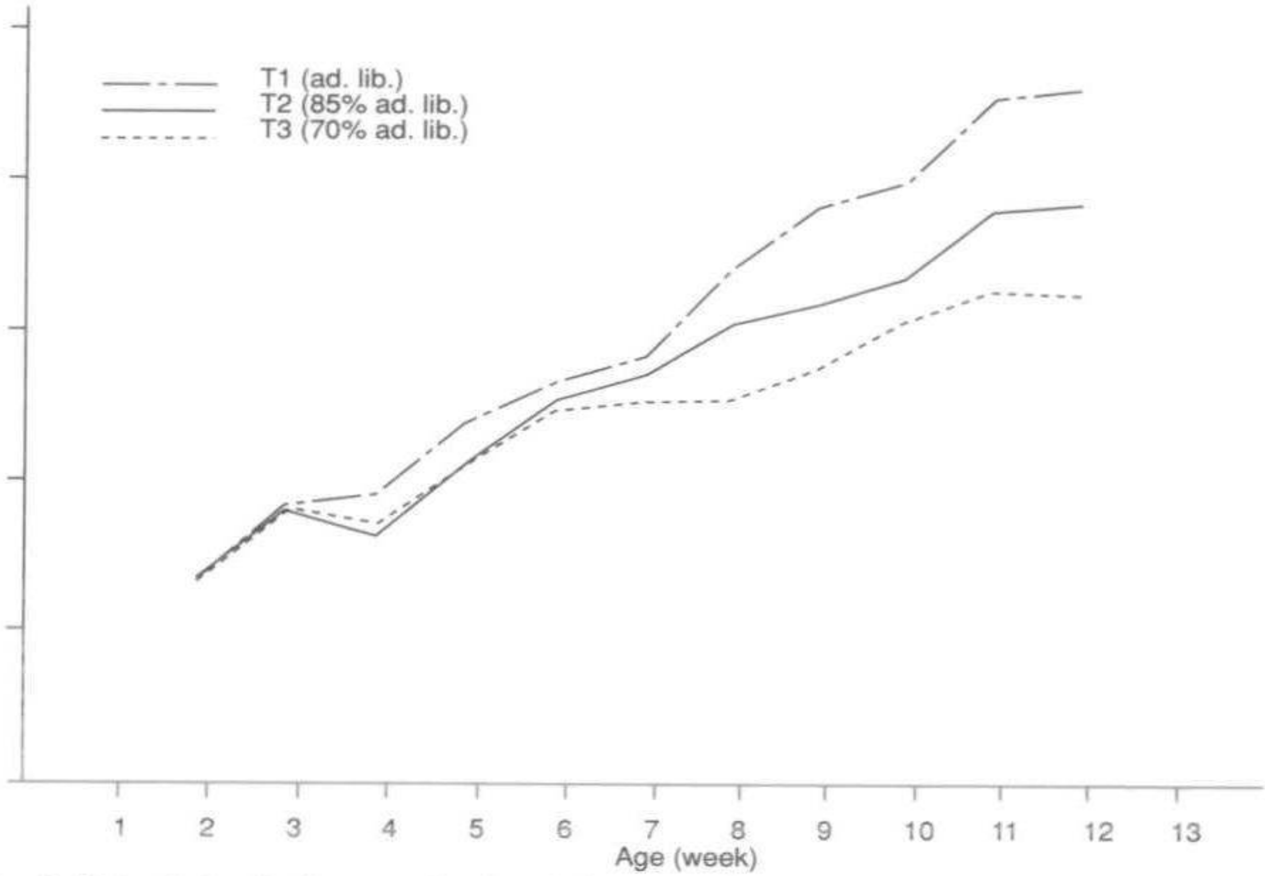

Fig. 3: Culmulative feed conversion in relation to treatment and age.

Similar improvement in feed conversion under feed restriction was observed by SINGH et al. (1981), MOLLISON et al. (1984), CAMPBELL et al. (1985) and PLAVNIK and

HURWITZ (1985). Fig. 3 also shows a sharp rise in cumulative feed conversion at the 8th week of age and this rise was more pronounced under ad-lib. than feed restricted treatments. For instance, cumulative feed conversion for birds fed ad-lib. increased from 4.60 at 7th week of age to 5.53 at 8th week old, whereas cumulative feed conversion for the restricted birds was slightly increased over the whole growing period. These results are in good agreement with CAMPBELL et al. (1985), who reported that feed conversion increased from 4.9 in week seven to 7.2 in week eight, when ducklings were fed ad-lib., whereas feed conversion for birds receiving 0.8, 0.7 and 0.6 ad-lib. remained relatively constant over the whole period. They reported also that, this deterioration in feed conversion with increasing age was attributed to either a marked change in the partition of nutrients between the various components of weight gain or a decline in the metabolizability of dietary energy. From these results, it could be concluded that feed restriction is recommended for ducks from 8 to 12 weeks of age, due to the deterioration in feed conversion during this period.

3.2 Carcass traits

Least squares means ± SE of carcass traits of male Peking ducks are shown in Tab. 1. At 10 weeks old, starved body weight and carcass weight were progressively decreased ($P < 0.05$) with increasing the severity of feed restriction, which coincided nicely with those reported in the growth performance data. The superiority of the full feed control treatment over feed restricted treatments in the previous criteria was not sufficient to produce significant differences in dressing %. Therefore, dressing % remained relatively constant around 68% among different treatments. At 12 weeks of age, ducklings fed ad-lib. had higher ($P < 0.05$) starved body weight, carcass weight and dressing % than those fed 85% or 70% ad-lib. The higher starved body weight of ducklings fed ad-lib. than feed restricted ones showed reversible trend from those obtained in the growth performance. This may be due to the selected ducklings for slaughtering, which were relatively higher than the average of the group fed ad-lib. The superiority of ducklings fed ad-lib. in dressing % over those fed restricted may be due to their higher starved body weight and carcass weight. RIZK (1975) found strong positive relationship between starved body weight and carcass weight of ducks ($r = 0.97$). Also, KRAPOTH (1987) showed similar relationship in broilers between starved body weight from one side and carcass weight ($r = 0.92$) and dressing % ($r = 0.27$) from another side.

Cut-up yields were slightly affected with feed restriction at both 10 and 12 weeks of age (Tab. 1). At 10 weeks of age, ducklings fed ad-lib. had lower ($P < 0.05$) legs %, but higher ($P < 0.05$) wings % than those fed 70% ad-lib. This could be attributed to the differences in starved body weight and growth rate of body organs, in which some of them may reach their maturity earlier than others.

At 12 weeks of age, ducklings fed 70% ad-lib. had higher ($P < 0.05$) giblets % than those fed 85% ad-lib.. Valuable cuts (breast and legs %) and less valuable cuts (back

Tab. 1:Least squares means ± S.E. of carcass traits of male Peking ducks as influenced by quantative feed restriction and age

Items		10 weeks old			12 weeks old		
		T_1 (ad-lib.)	T_2 (85% ad-lib.)	T_3 (70% ad-lib.)	T_1 (ad-lib.)	T_2 (85% ad-lib.)	T_3 (70% ad-lib.)
Starved body wt.	kg	1.665 ± 0.042^{a}	1.550 ± 0.042^{ab}	1.481 ± 0.042*^{b}	2.074 ± 0.050^{a}	1.828 ± 0.050^{b}	1.736 ± 0.050**^{b}
Carcass wt.	kg	1.138 ± 0.032^{a}	1.032 ± 0.032^{b}	1.009 ± 0.032*^{b}	1.447 ± 0.45^{a}	1.228 ± 0.45^{b}	1.165 ± 0.045**^{b}
Dressing	%	68.38 ± 0.85	66.65 ± 0.85	68.68 ± 0.85 NS	69.69 ± 0.78^{a}	67.10 ± 0.78^{b}	67.00 ± 0.78*^{b}
Breast	%	16.92 ± 0.52	17.42 ± 0.52	15.55 ± 0.52 NS	21.28 ± 0.72	20.62 ± 0.72	19.37 ± 0.72 NS
Legs	%	19.50 ± 0.43^{b}	20.21 ± 0.43^{ab}	21.31 ± 0.43*^{a}	17.77 ± 0.58	18.38 ± 0.58	17.63 ± 0.58 NS
Breast + legs	%	36.42 ± 0.50	37.62 ± 0.50	36.86 ± 0.50 NS	39.05 ± 0.63	39.00 ± 0.63	37.00 ± 0.63 NS
Back	%	27.38 ± 0.55	25.87 ± 0.55	27.42 ± 0.55 NS	25.43 ± 0.72	25.97 ± 0.72	25.15 ± 0.72 NS
Wings	%	13.68 ± 0.31^{a}	13.36 ± 0.31^{ab}	12.49 ± 0.31*^{b}	12.72 ± 0.40	13.84 ± 0.40	14.04 ± 0.40 NS
Neck	%	13.18 ± 0.29	12.69 ± 0.29	12.89 ± 0.29 NS	12.93 ± 0.47	11.86 ± 0.47	13.13 ± 0.47 NS
Giblets	%	9.33 ± 0.46	10.45 ± 0.46	10.33 ± 046 NS	9.90 ± 0.35^{ab}	9.32 ± 0.35^{b}	10.69 ± 0.35*^{a}
(Back, wings, neck, giblets)	%	63.57 ± 0.50	62.37 ± 0.50	63.13 ± 0.50 NS	60.97 ± 0.63	60.99 ± 0.63	63.01 ± 0.63 NS

Means within each raw having different letter(s) are significantly different ($P < 0.05$).

and wings and neck and giblets %) were not affected with feed restriction at both 10 and 12 weeks of age. DE CRAVILLE and DE CROUTTE (1978) indicated that, breast and legs weight of Muscovy ducks at marketing age were not affected when fed 95% ad-lib.

As expected, age at slaughter had significant ($P < 0.01$) effect on both starved body weight and carcass weight infavour of the older ducklings, while dressing % was unchanged with increasing age from 10 to 12 weeks. Breast % increased ($P < 0.01$) from 20.34% to 17.92% with increasing age from 10 to 12 weeks. Increasing breast % with greater rate than the reduction in legs % with advancing age from 10 to 12 weeks resulted in an increase ($P < 0.05$) in the valuable cuts (breast and legs %) by about 1.38% at 12 weeks old. Back % and wings %, neck % and giblets % remained relatively constant in connection with age, while the total of less valuable cuts (back and wings and neck and giblets %) decreased ($P < 0.05$) with increasing slaughter age from 10 to 12 weeks. This could be attributed to the slightly reduction of back %, neck % and giblets % with advancing age. These results are in good agreement with RIZK (1975), TORGES and WEGNER (1979), ZIEGLER (1983) and TORGES (1985). They reported that breast % was increased while legs % was decreased with increasing age of ducks. Also, ZIEGLER (1983) found negative relationship ($r = 0.94$) between valuable and less valuable cuts in Muscovy ducks. Moreover, POWELL (1980) reported that, the percentage of breast and legs increased, while the percentage of the remainder of the carcass decreased in males Cherry Valley L_3 ducks with the increase of age from 39 to 56 days.

3.4 Meat quality

Least squares means of physical meat quality of male Peking ducks as affected by feed restriction are shown in Tab. 2. It could be observed that, feed restriction had a little effect on physical meat quality at both 10 and 12 weeks of age. PH-value of thigh meat decreased ($P < 0.05$) progressively with increasing the severity of feed restriction at 10 weeks of age, but the difference at 12 weeks of age was insignificant pH-value of breast both 10 and 12 weeks of age remained relatively constant within 6.0 to 6.21 among treatments. Also meat colour of breast and thigh was not adversely affected by feed restriction. Ducklings under feed restriction had insignificant better juice holding capacity in breast and thigh at 10 weeks of age, but the reverse trend was observed at 12 weeks of age.

These results agree partially with GIULIOTTI and ROMBOLI (1988), who reported that, the chemical composition of breast muscle or meat quality at slaughter age of Muscovy ducks fed to appetite or restricted to 92 and 84% of free intake during the first 30 days after hatching were similar among treatments.

PH-value of breast meat decreased ($P < 0.01$) 0.18 point with increasing age from 10 to 12 weeks, while pH-value of thigh meat remained relatively constant in relation to

Tab 2: Least squares means ± S.E. of physical meat quality of male Peking ducks as affected by quantative feed restriction and age

		10 weeks of			12 weeks old		
	Items	T_1 (ad-lib.)	T_2 (85% ad-lib.)	T_3 (70% ad-lib.)	T_1 (ad-lib.)	T_2 (85% ad-lib.)	T_3 (70% ad-lib.)
pH-value							
	Breast	6.21 ± 0.05	6.15 ± 0.05	6.17 ± 0.05 NS	6.00 ± 0.05	6.00 ± 0.05	6.01 ± 0.05 NS
	Thigh	6.52 ± 0.04 ^{a}	6.41 ± 0.04 ^{ab}	6.34 ± 0.04* ^{b}	6.34 ± 0.06	6.38 ± 0.06	6.40 ± 0.06 NS
Meat colour (Gofo)							
	Breast	83.88 ± 0.97	81.75 ± 0.97	82.63 ± 0.97 NS	84.64 ± 1.00	84.75 ± 1.00	82.25 ± 1.00 NS
	Thigh	88.38 ± 0.72	88.25 ± 0.72	89.00 ± 0.72 NS	89.50 ± 0.57	89.25 ± 0.57	89.63 ± 0.57 NS
Juice holding capacity							
	Breast	17.45 ± 1.05	17.54 ± 1.05	20.00 ± 1.05 NS	27.13 ± 2.27	20.39 ± 2.27	20.83 ± 2.27 NS
	Thigh	20.90 ± 2-46	26.59 ± 2.46	22.12 ± 2.46 NS	27.48 ± 1.95	25.93 ± 1.95	26.56 ± 1.95 NS

Means within each raw having different letter(s) are signigicantly different ($P < 0.05$).

age (Tab. 2). Ducklings aged 12 weeks had insignificant darker meat in breast and thigh than those aged 10 weeks. Juice holding capacity of breast increased ($P < 0.05$) with increasing slaughter age from 10 to 12 weeks. Similar trend was also observed in thigh meat, but the difference was insignificant.

These results are in good agreement with RIZK (1975) who reported that, pH-value of breast decreased with increasing age of Peking ducks from 7 to 8 weeks, while juice holding capacity increased in both breast and thigh in relation to age. Also KRAPOTH (1987) indicated that, pH-value of breast decreased, while juice holding capacity and meat colour increased with advancing of age of broiler from 29 to 49 days. WILSON (1981) showed that meat tended to be darker in older animals due to the deposition of brown pigment in muscle and also to the greater amounts of myoglobin. Increasing juice holding of breast and thigh with increasing slaughter age may be due to the lower moisture/protein ratio in relation to age. FRONING and NORMAN (1966) found that, the lower moisture/protein ratio is associated with the higher ability of muscle in question to retain water.

From these results it could be concluded that, feed restriction improved feed conversion and had negliable effect on both carcass traits and meat quality. The improvement of the two latter criteria demands a prolongation of the fattening period, but this is limited by the increase of feed conversion when ducklings were fed ad-lib. and by the beginning of moulting. Therefore feed restriction of male Peking ducks at 8th week to marketing age is recommended to increase the net profit of the breeder and to meet the demands of the consumers by improving the meat quality.

4 Summary

The effect of quantitative feed restriction on growth performance, carcass traits and physical meat quality of male Peking ducks were studied from 2 to 12 weeks of age. Quantitative feed restriction of 85% and 70% retarded ($P < 0.01$) body weight up to 10 weeks old thereafter ducklings were capable to compensate this retardation and realized comparable body weight of the fullfed treatment. Cumulative feed conversion deteriorated of feed intake increased from 70% to ad-lib. intake. Quantitative feed restriction had no influence on mortality rate.

Ducklings fed ad-lib. had higher starved body weight and carcass weight than feed restricted treatments. At 10 weeks of age, dressing % remained relatively constant around 68% for all treatments, but at 12 weeks old, the full fed control treatment realized the best figure. Ducklings fed 70% had higher ($P < 0.05$) legs %, but lower wings % than those fed ad-lib. at 10 weeks of age. Neither valuable nor less valuable cuts % were affected by quantitative feed restriction.

Breast % and the total breast and legs % increased, while legs % and the total of less valuable cuts decreased with increasing slaughter age from 10 to 12 weeks.

Quantitative feed restriction had no adverse effect on physical meat quality. PH-value of breast decreased, while juice holding capacity increased with increasing age. Physical characters of thigh meat were not affected in relation to age. Thigh meat was darker and had higher pH-value and juice holdings capacity than breast meat.

The actual feed intake under feed restriction was lower than assumed. Therefore feed restriction was higher than this indicated, being 76% and 64% during the whole growing period.

From these results, it could be concluded that, quantitative feed restriction of 64% is recommended for male Peking ducks from 8 to 12 weeks of age, because cumulative feed conversion during this period is deteriorated, but the valuable cuts and meat quality improved with prolongation the growing period.

Zusammenfassung

Der Einfluß der Restriktion der Fütterung von 100% auf 85% bzw. 70% auf das Wachstum sowie die Schlachtkörper- und Fleischqualität wurde bei männlichen Pekingenten im Alter von 2 bis 12 Wochen untersucht. Sowohl bei Einschränkung der Futtermenge auf 85% als auch auf 70% wurde niedrigere Mastleistung bis zum Alter von 10 Wochen festgestellt. Durch das kompensatorische Wachstum haben diese Tiere im Alter von 12 Wochen vergleichbare Körpergewichte mit der Kontrollgruppe, die Futter zur freien Verfügung hatten, erreicht.

In der Mortilitätsrate war kein Unterschied zwischen den Gruppen vorhanden.

Die Einschränkung der Futtermenge übte negativen Einfluß auf das Schlachtgewicht und die prozentuale Schlachtausbeute aus. Die Gruppe mit der 70% Futtermenge zeigte höhere Schenkel- und niedrigeren Flügelanteil als die anderen Gruppen. Im allgemeinen aber waren keine Unterschiede zwischen den Behandlungen weder in den wertvollen noch in den weniger wertvollen Teilstücken festzustellen. Das gleiche gilt für die Merkmale der Fleischqualität.

Die Verlängerung der Mast von der 10. auf die 12. Woche hatte positiven Einfluß auf den Brustanteil und verursachte geringere Anteile der anderen Schlachtkörperanteile. Die älteren Tiere hatten im Brustfleisch niedrigere pH-Werte und besseres Safthaltevermögen.

Das Schenkelfleisch war dunkler und zeigte höhere pH-Werte und höheres Safthaltevermögen im Vergleich zum Brustfleisch.

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