Quantitative feed restriction of Pekin breeder ducks from 3 weeks of age and its effect on subsequent productivity

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Six male and 24 female Cherry Valley Pekin ducklings were randomly allocated to each of 12 pens to test the effects of quantitative feed restriction during the rearing period on the subsequent reproductive performance. The three treatments were 50% of *ad lib.* intake from 3 to 20 weeks; 50% of *ad lib.* intake from 8 to 20 weeks; and *ad lib.* intake throughout. There were four replicates for each treatment. During the laying period (20 – 60 weeks) duck breeder pellets were fed *ad lib.* to all groups. Highly significant ($P \leqslant 0,01$) differences in favour of the two restricted groups over the *ad lib.* fed groups were observed in most of the parameters studied. Differences between treatments in respect of the absolute and relative visceral masses were also investigated, giving some idea of the physiological phenomena that accompany feed restriction.

Ses manlike en 24 vroulike Cherry Valley Pekineendjies is ewekansig aan 12 hokke toegeken om die invloed van kwantitatiewe voerbeperking gedurende die groeiperiode op daaropvolgende reproduktiewe prestasie, te bepaal. Die drie behandelings was as volg: 50% van *ad lib.*-inname vanaf 3 tot 20 weke; 50% van *ad lib.* inname vanaf 8 tot 20 weke; en *ad lib.* inname vir die volle periode. Vier herhalings per behandeling is toegepas. 'n Dieet van broeieendkorrels is *ad lib.* gedurende die lêperiode aan alle groepe gevoer. In die meeste parameters wat ondersoek is, is hoogs betekenisvolle ($P \leqslant 0,01$) verskille in die geval van die twee beperkte groepe teenoor die *ad lib.*-gevoerde groepe waargeneem. Die verskille tussen behandelings ten opsigte van ware en relatiewe ingewandsmassa is ook ondersoek en dit gee 'n aanduiding van die fisiologiese verskynsels wat met voerbeperking gepaard gaan.

Keywords: Pekin breeder ducks, quantitative feed restriction, body mass, reproduction, carcass characteristics

Introduction

Quantitative feed restriction has been shown to benefit Pekin breeder ducks when applied from 7 weeks of age (Olver, 1984). However, when the ducks were restricted by more than 50% of *ad lib.* intake, their mass at 22 weeks of age was less than at 7 weeks when the experiment started. As this loss of mass is undesirable, it was decided to investigate whether restricting the intake of ducklings from an earlier age, i.e. 3 weeks, might not allow this loss of mass to be avoided.

Procedure

Pekin breeder ducklings of the Cherry Valley 'Super M' strain were used in this experiment. From day-old to 3 weeks of age, the ducklings were fed a commercial crumbled broiler starter diet. The ducklings were weighed at 3 weeks of age before being wing-banded and randomly allocated to one of 12 open-sided, deep litter pens measuring 7 m × 6 m where they were kept for the duration of the experiment (from 3 to 60 weeks old). Each pen housed six male and 24 female ducks.

Three treatments of four replications each were randomly assigned to the different pens. The feed treatments during the rearing period (3 – 20 weeks) were (i) 50% of *ad lib.* intake from 3 weeks of age (ii) 50% of *ad lib.* intake from 8 weeks of age and (iii) *ad lib.* intake. The amount of feed required for the restricted groups was calculated from the consumption of the ducks given *ad lib.* access to feed during the previous 7-day period. Birds receiving dietary treatments 1 and 2 were fed the calculated amount daily. Feed consumption was measured throughout the experiment. The ducks were fed a commercial pelleted finisher ration from 3 to 8 weeks of age while from 8 to 20 weeks of age a commercial pullet developer ration was fed. At the end of the rearing period, commercial duck breeder pellets with a protein content of 19% were fed *ad lib.* to all groups until the termination of the laying and breeding period at 60 weeks of age.

The crude protein and crude fibre analyses of the feeds were determined by standard procedures (AOAC, 1980). Amino acid composition was determined using the method of de Lange, Smith, le Roux Cilliers & Ireland (1979). True metabolizable energy values were determined by the method of McNab & Fisher (1984). Daily egg production records were kept for each pen, including egg count and mass of each egg. All the eggs were incubated at weekly intervals in a forced-draught Buckeye incubator at dry and wet bulb temperatures of 37,5 and 31°C respectively. The eggs were turned hourly. On day 24 the eggs were transferred to the Buckeye hatcher which was run at dry and wet bulb temperatures of 37 and 33° respectively. The hatch was taken off on day 29. Egg numbers, including infertile and fertile eggs, dead embryos, and number of ducklings hatched were recorded for each of the 12 pens.

At 20 weeks of age, four females were randomly selected from each of the three treatments and killed by dislocation of the cervical vertebrae. They were then dissected to remove the intestines, heart, liver and gizzard for weighing and measuring. Results were expressed on an absolute and relative (to live mass) basis. The ducks were then ground, including feathers, into a smooth paste before determining moisture, fat

Table 1 Determined analysis of the commercial diets used in this experiment

Component	Diet		
	Broiler finisher	Pullet developer	Duck breeding
Crude protein, %	20,0	13,0	19,4
Crude fibre, %	3,60	5,15	4,94
Metabolizable energy, MJ/kg	13,2	11,9	11,8
Lysine, %	0,98	0,60	0,75
Arginine, %	1,22	0,68	0,84
Methionine, %	0,40	0,27	0,32
Tryptophan, %	0,26	0,16	0,19

(ether extract) and protein content using standard laboratory procedures (AOAC, 1980).

Analysis of variance procedures followed that of Rayner (1967).

Results and Discussion

Composition of diet

Composition of the diets used was determined by standard analytical techniques and is shown in Table 1.

Live mass

The average live masses at 3, 8, 20 and 60 weeks of age are shown in Table 2. At 8 weeks of age highly significant ($P \leqslant 0,01$) differences were observed in live mass between the ducklings fed 50% of *ad lib.* intake from 3 weeks of age and the other two groups of ducklings.

Table 2 Mean live mass, feed consumption and carcass composition of ducks during the experiment (± *SD*)

Parameter	Treatment		
	50% of *ad lib.* from 3 weeks	50% of *ad lib.* from 8 weeks	*Ad lib.*
Live mass (g)			
3 Weeks	$705^a \pm 8$	$705^a \pm 8$	$705^a \pm 5$
8 Weeks	$1912^a \pm 29$	$2882^b \pm 110$	$2907^b \pm 57$
20 Weeks	$2155^a \pm 53$	$2457^b \pm 90$	$3152^c \pm 90$
60 Weeks	$3238^a \pm 123$	$3431^b \pm 133$	$3593^b \pm 99$
Feed consumption (kg/duck)			
3 – 8 Weeks	$3{,}79^a \pm 0{,}0$	$7{,}57^b \pm 0{,}2$	$7{,}59^b \pm 0{,}1$
8 – 20 Weeks	$8{,}10^a \pm 0{,}0$	$8{,}10^a \pm 0{,}0$	$16{,}21^b \pm 1{,}1$
20 – 60 Weeks	$58{,}05^a \pm 1{,}1$	$57{,}82^a \pm 0{,}8$	$56{,}31^a \pm 0{,}2$
Carcass composition (g/kg)			
Moisture	$623{,}0^b \pm 32{,}0$	$578{,}0^b \pm 4{,}0$	$521{,}0^a \pm 50{,}0$
Fat	$143{,}0^a \pm 35{,}0$	$162{,}0^a \pm 8{,}0$	$254{,}0^b \pm 55{,}0$
Protein	$222{,}0^b \pm 13{,}0$	$219{,}0^b \pm 5{,}0$	$196{,}0^a \pm 9{,}0$

[a,b,c] Results not bearing same superscripts in rows are significantly different ($P \leqslant 0,01$)

At 20 weeks of age all three treatment groups of ducklings differed highly significantly ($P \leqslant 0,01$) from each other in live mass. Ducklings restricted to 50% of *ad lib.* intake from 8 weeks of age were, on average, 425 g lighter in body mass at 20 weeks than they were at 8 weeks. This was observed in both previous studies on quantitative feed restriction (Olver, Kuyper & Mould, 1978 and Olver, 1984). However, those ducks on a restricted intake programme from 3 weeks of age showed an average gain of 243 g from 8 to 20 weeks of age, even though they were highly significantly ($P \leqslant 0,01$) lower in body mass than those restricted from 8 weeks of age. The aversion of mass loss during this period could have contributed to the improved performance recorded during the laying period.

At 60 weeks of age, the ducks restricted in intake from 3 weeks were still highly significantly ($P \leqslant 0,01$) lighter in body mass than those ducks fed the other two treatments. In previous experiments (Olver, *et al.*, 1978 and Olver, 1984), no significant mass differences were observed at the end of the experiment in those ducks that were restricted quantitatively from 7 or from 8 weeks of age.

Feed consumption

Feed consumption of the ducks on the different treatments is shown in Table 2. From 3 to 20 weeks of age, feed consumption of the ducks in all three treatments differed highly significantly ($P \leqslant 0,01$) from one another, showing that feed restriction may have a beneficial effect on feed cost. From 20 to 60 weeks, no significant differences in feed consumed per duck were observed between treatments, although the restricted groups appeared to consume slightly more feed than the *ad lib.* group, in the period from 20 to 24 weeks. This may be due to an expected compensatory growth. The ducks fed 50% of *ad lib.* intake from 3 weeks of age had an average feed consumption of 10,17 kg less than those ducks fed *ad lib.* for the period from 3 to 60 weeks.

Carcass analyses

The proportions of moisture, fat and protein in the whole carcasses of Pekin ducks on the different treatments are shown in Table 2.

There were highly significant ($P \leqslant 0,01$) differences in carcass moisture content between the restricted and *ad lib.* fed groups of ducks. As expected, the fat content of the carcass of the two groups on a restricted feeding regime was highly significantly ($P \leqslant 0,01$) lower than those given *ad lib.* access to food. This phenomenon was also noticed in the previous experiment (Olver, 1984). The protein level was highly significantly ($P \leqslant 0,01$) higher in the carcasses of the two groups of ducks restricted in intake as compared with those fed *ad lib.*, although the fat-free protein level was the same.

Egg production characteristics

The effects of the different rearing treatments on the egg production characteristics of these ducks are shown in Table 3. Sexual maturity (50% production) was delayed ($P \leq 0{,}01$) by restricting feed intake, the magnitude of the delay increasing with the severity of restriction during rearing. The delay in reaching sexual maturity between the ducks restricted to 50% of *ad lib.* intake from 3 weeks of age and those given free access to feed was 34 days. This protracted delay did not, however, result in larger eggs from the restricted ducks. The average number of eggs laid per duck differed highly significantly ($P \leq 0{,}01$) between the three treatments. The two groups of ducks fed a restricted diet, i.e. 3 – 20 and 8 – 20 weeks, respectively laid 12 and 5 eggs more per duck than the ducks fed *ad lib.* Although the average egg mass showed a stepwise increase with increased restriction of feed intake during the rearing period, the results were not statistically significant. The ducks restricted to 50% of *ad lib.* from 3 weeks of age had a highly significantly ($P \leq 0{,}01$) greater peak (best 7-day period) and terminal (last 7-day period) egg production than those ducks fed *ad lib.* This phenomenon was previously reported by Olver, *et al.* (1978) and Olver (1984).

Fertility and Hatchability

The results obtained from the incubated eggs are shown in Table 3.

The eggs from ducks restricted in feed intake during the rearing period were significantly ($P \leq 0{,}01$) more fertile than those from ducks fed *ad lib.*. These results were similar to the results obtained by Olver, *et al.* (1978) and Olver (1984). The lower fertility of the ducks given *ad lib.* access to food may be due to their higher body fat content (Table 2). Lorenz (1969) observed that excessive body fat depressed reproductive activity in turkeys.

Highly significant ($P \leq 0{,}01$) differences with regard to hatchability of fertile eggs were observed between the ducks restricted to 50% of *ad lib.* intake at 3 weeks and those ducks fed *ad lib.* The hatchability of eggs set followed the same pattern as fertility, with both groups on restricted feeding being highly significantly ($P \leq 0{,}01$) better than the ducks fed *ad lib.*

Mortality

Although there were no mortalities during the rearing period, several ducks died during the laying period, as shown in Table 3. All the ducks that died during the laying period were females.

The mortality rate of the ducks fed *ad lib.* was highly significantly ($P \leq 0{,}01$) greater than that of the two groups on restricted intake. Lee, Gulliver & Morris (1971a) found that mortality during the laying period of pullets restricted in feed intake during rearing is usually lower than that of pullets fed *ad lib.* during rearing. Furthermore, they reported that 64 out of 92 other studies confirmed this observation. Olver, *et al.* (1978) and Olver (1984) reported that mortality decreased in the laying period as the rate of restriction increased during the rearing period.

Visceral masses

Absolute and relative visceral masses of ducks on the different rearing treatments are shown in Table 4.

There were no significant differences between treatments with regard to the length of the intestine, confirming previous work by Olver (1984). There were,

Table 3 Mean reproductive performance and mortality of ducks from 20 to 60 weeks of age (± *SD*)

Production parameter	Treatment		
	50% of *ad lib.* from 3 weeks	50% of *ad lib.* from 8 weeks	*Ad lib.*
Age at 50% production (d)	$191^{c} \pm 3{,}1$	$175^{b} \pm 4{,}3$	$157^{a} \pm 2{,}5$
Production (eggs/duck)	$157^{c} \pm 1{,}7$	$150^{b} \pm 2{,}1$	$145^{a} \pm 1{,}3$
Peak production (%)*	$87{,}0^{b} \pm 1{,}8$	$82{,}0^{b} \pm 2{,}8$	$80{,}3^{a} \pm 3{,}6$
Terminal production (%)**	$41{,}0^{b} \pm 3{,}8$	$23{,}0^{a} \pm 2{,}3$	$16{,}0^{a} \pm 3{,}8$
Egg mass (g)			
First month	$73{,}2^{a} \pm 1{,}4$	$74{,}2^{a} \pm 2{,}2$	$69{,}6^{a} \pm 4{,}3$
Last month	$91{,}3^{a} \pm 3{,}1$	$90{,}5^{a} \pm 1{,}8$	$87{,}2^{a} \pm 2{,}7$
Average for experiment	$86{,}3^{b} \pm 1{,}4$	$85{,}7^{a} \pm 1{,}8$	$84{,}1^{a} \pm 0{,}8$
Fertility (%)	$82{,}0^{b} \pm 4{,}9$	$80{,}5^{b} \pm 2{,}1$	$71{,}7^{a} \pm 5{,}6$
Hatchability of fertile eggs (%)	$69{,}3^{b} \pm 0{,}7$	$65{,}2^{a} \pm 1{,}0$	$64{,}0^{a} \pm 0{,}8$
Hatchability of eggs set (%)	$56{,}8^{b} \pm 3{,}6$	$52{,}5^{b} \pm 1{,}5$	$46{,}4^{a} \pm 3{,}0$
Mortality (%)	$4{,}95^{a} \pm 1{,}9$	$8{,}30^{a} \pm 2{,}0$	$16{,}63^{b} \pm 5{,}4$

[a,b,c] Results not bearing same superscripts in rows are significantly different ($P \leq 0{,}01$)

* Rate of lay in best 7-day period

** Rate of lay in last 7 days

Table 4 Mean absolute and relative masses of viscera at 20 weeks of age (± *SD*)

Treatment	Length of intestine (mm)	Mass of intestine Absolute (g)	Mass of intestine Relative (%)	Mass of heart Absolute (g)	Mass of heart Relative (%)	Mass of gizzard Absolute (g)	Mass of gizzard Relative (%)	Mass of liver Absolute (g)	Mass of liver Relative (%)
50% of *ad lib.* from 3 weeks	$179,8^a \pm 1,7$	$68,3^a \pm 3,3$	$3,6^b \pm 1,3$	$13,8^a \pm 1,3$	$0,72^a \pm 0,03$	$57,5^a \pm 3,9$	$3,0^b \pm 0,2$	$28,3^a \pm 3,8$	$1,47^b \pm 0,1$
50% of *ad lib.* from 8 weeks	$178,3^a \pm 2,6$	$68,8^a \pm 0,5$	$3,3^{ab} \pm 0,3$	$16,5^a \pm 0,3$	$0,79^a \pm 0,04$	$61,0^a \pm 5,6$	$2,9^b \pm 0,2$	$28,3^a \pm 2,9$	$1,35^b \pm 0,1$
Ad lib.	$177,5^a \pm 2,4$	$86,0^b \pm 8,9$	$2,9^a \pm 0,1$	$21,75^b \pm 1,7$	$0,75^a \pm 0,04$	$60,8^a \pm 4,5$	$2,1^a \pm 0,2$	$34,8^a \pm 6,6$	$1,18^a \pm 0,1$

[a,b] Results not bearing the same superscript in columns are significantly different ($P \leq 0,01$)

however, significant differences with regard to intestinal mass. The intestines of ducks fed *ad lib.* were found to be highly significantly ($P \leq 0,01$) heavier than those fed a restricted diet. Conversely, the relative intestinal mass was higher in the restricted group than in the *ad lib.* group. This relatively heavier intestinal mass would result in an increased absorption of nutrients necessary for the survival of those ducks on a restricted intake. Lee, Gulliver & Morris (1971b) found that the relative increase in intestinal mass of broiler breeder pullets increased with the degree of restriction during the rearing period.

The relative heart mass did not differ between the groups, this being in agreement with earlier work by Olver (1984).

Relative gizzard masses were highly significantly ($P \leq 0,01$) heavier in the two groups fed on a restricted intake programme, but absolute masses showed no significant differences. The gizzard is a muscular organ and its large relative size at the end of the restricted period could indicate that it is unaffected by the magnitude of feed intake.

The absolute liver mass of the *ad lib.* fed ducks was heavier than that of the groups on restricted intake although this difference was not statistically significant. The relative liver masses were highly significantly ($P \leq 0,01$) greater in the two groups restricted in intake than the ducks fed *ad lib*. Since the liver is a vital organ, it appears that liver development has priority over muscle and fat development and that this would account for the relative increase in liver mass.

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References

ASSOCIATION OF OFFICIAL ANALYTICAL CHEMISTS, 1980. Official methods of Analysis. 13th ed. Assoc. Offic. and Chem. Washington, D.C.

DE LANGE, D.J. SMIT, A.J., LE ROUX CILLIERS, J.J. & IRELAND, J.P., 1979. The amino acid composition of the protein of commercial defatted milk powder in comparison with the protein of fresh milk, casein and whey. *S. Afr. J. Dairy Technol.* 11, 2.

LEE, P.J.W., GULLIVER, A.L. & MORRIS, T.R., 1971a. A quantitative analysis of the literature concerning the restricted feeding of growing pullets. *Br. Poult. Sci.*, 12, 413.

LEE, P.J.W., GULLIVER, A.L. & MORRIS, T.R., 1971b. Restricted feeding of broiler breeder pullets during the rearing period and its effect on productivity and breeding. *Br. Poult. Sci.* 12, 499.

LORENZ, F.W., 1969. Reproduction in domestic fowl. In: Reproduction in Domestic Animals. 2nd Edition. Eds. Cole, H.H. & Cupps, P.T. New York and London Academic Press.

McNAB, J.M. & FISHER, C., 1984. An assay for true and apparent metabolizable energy. *Proc. XVIII World Poult. Sci. Cong.* Helsinki, 374.

OLVER, M.D., 1984. Quantitative feed restriction of Pekin breeder ducks during the rearing period and its effect on subsequent productivity. *S. Afr. J. Anim. Sci.* 14, 136.

OLVER, M.D., KUYPER, Margaret A. & MOULD, Diana J., 1978. Restricted feeding of Pekin breeder ducks during the rearing period and its effect on subsequent productivity. *Agroanamalia* 10, 7.

RAYNER, A.A., 1967. Biometry for agriculture students. University of Natal Press, Pietermaritzburg.