Performance of Pekin ducks subjected to qualitative feed restriction at various ages during the rearing period

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Different diets low in lysine were fed to ducklings of various ages in three separate trials to investigate the effect of these diets on bodymass and subsequent reproductive performance. The results showed that when ducklings were fed a diet containing less than 0,40% lysine from day-old their bodymass was reduced significantly ($P \leq 0,01$). When these same diets were fed to ducklings from 2 weeks and older no significant differences were noticed in bodymass. Feed intake was also reduced in proportion to the degree of lysine restriction and to age when first fed. Sexual maturity was delayed by lysine restriction but this did not cause an increase in average egg mass. The ducks on the low lysine diets laid fewer extra large and more smaller eggs than those ducks not restricted by lysine levels lower than 0,40%. The greatest disadvantage of feeding the low-lysine diet was the high mortality rate. If this can be overcome the feeding system would be very economical.
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Diëte met sub-optimale lisienvlakke is in drie afsonderlike eksperimente aan eendjies van verskillende ouderdomsgroepe gevoer ten einde vas te stel hoe die liggaamsmassa en daaropvolgende eierproduksie daardeur beïnvloed word. Eendjies wat diëte waarvan die lisieninhoud minder as 0,40% was vanaf dagoud ontvang het se liggaamsmassa was betekenisvol ($P \leq 0,01$) minder. Wanneer dieselfde diëte vanaf 2-weke-ouderdom en later gevoer is, is geen betekenisvolle verskille in liggaamsmassa waargeneem nie. Verlaagde voerinname is waargeneem en het direk verband gehou met die lisienvlak van die rantsoen en die ouderdom waarop behandeling 'n aanvang geneem het. Geslagsrypheid is vertraag as gevolg van lisienbeperking maar dit het nie aanleiding gegee tot 'n toename in gemiddelde eiermassa nie. Eende wat diëte met lisienvlakke laer as 0,40% ontvang het, het proporsioneel minder ekstra groot en meer klein eiers geproduseer. Die grootste nadeel van die lae lisiendiëte het gemanifesteer in hoë mortaliteite. Indien mortaliteite wat met hierdie behandeling verband hou beperk kan word, kan dit ekonomies voordelig wees.
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Introduction

Low lysine diets only reduce bodymass if the quantity of lysine consumed is well below the requirement of the bird for lysine (Lee, Gulliver & Morris, 1971). Olver (1984) found that when ducks were fed a low-lysine (0,35%) diet from 8 weeks of age their large average daily feed intake of 207 g per day was sufficient to give them adequate lysine needed for growth. It was therefore decided to start ducklings on low-lysine diets at various ages to investigate at what age the duckling is susceptible to a diet low in lysine and what effect this has on subsequent reproductive performance.

Procedure

Trial 1

Thirty day-old ducklings consisting of six males and 24 females per treatment were used. The treatments were (a) a low-lysine diet fed from day-old to 20 weeks of age; (b) broiler starter crumbles from 0 to 3 weeks, low lysine from 3 to 20 weeks of age; (c) broiler starter crumbles from 0 to 3 weeks, broiler finisher from 3 to 7 weeks and low lysine from 7 to 20 weeks of age; and (d) broiler starter crumbles from 0 to 3 weeks, broiler finisher from 3 to 7 weeks, pullet developer from 7 to 20 weeks of age. All the diets were fed *ad lib*. At 20 weeks of age until the termination of the experiment all the ducks were fed duck breeding pellets *ad lib*. Bodymass and feed consumption were measured at 0, 3, 7, 20 and 40 weeks of age. The analysis of the commercial diets is given in Table 1. The low-lysine diet (No 1) is shown in Table 2.

Trial 2

Four diets containing different levels of lysine (Table 2) were fed to ducklings from day-old, 1 week and 2 weeks of age until they were 20 weeks old. The ducklings not receiving a low-lysine diet were fed broiler starter crumbles. Only 12 pens were available for this trial and consequently no replication of each treatment was possible. There were 20 ducklings per treatment. At 20 weeks of age the ducks were fed commercial duck breeding pellets *ad lib* until the termination of the experiment at 50 weeks of age. Bodymass and feed consumption were measured at 0, 2, 8, 20 and 50 weeks of age.

Trial 3

Diet 4 (Table 1) was fed to ducklings from day-old and compared to the commercial diets. Each treatment consisted of four male and 16 female ducklings with three replicates of each treatment. Bodymass and feed consumption were measured at 0, 2, 8, 20 and 60 weeks of age.

Daily egg production records were kept for each pen,

including a record of the number of eggs in each of four classes graded according to egg mass. As there are no officially specified size categories laid down for duck eggs in this country the following masses were used: extra large > 89 g; large 80 – 89 g; medium 70 – 79 g; and small, < 70 g. Sexual maturity was regarded as the age at which the ducks reached 50% egg production.

Eggs were incubated in a forced draught Mayfair incubator at 37,5°C and 75% RH. The eggs were turned five times a day and on the 24th day the eggs were transferred to the hatching trays in the same incubator. The hatch was taken off on the 29th day. Egg numbers, infertile eggs, fertile eggs, dead embryos and ducklings hatched were recorded for each of the pens.

Where possible each variate was subjected to statistical analysis of variance (Rayner, 1967) and least significant differences at $P \leq 0,05$ and $P \leq 0,01$ were calculated.

Table 1 Analysis of the commercial diets used in the experiment

Component	Diet			
	Broiler starter crumbles	Broiler finisher pellets	Pullet developer pellets	Duck breeding pellets
Protein, (%)	22,5	20,8	13,4	19,4
ME, (MJ/kg)	13,4	13,6	11,9	11,8
Lysine, (%)	1,20	1,10	0,54	0,75
Methionine, (%)	0,45	0,40	0,26	0,32
Arginine, (%)	1,25	1,16	0,55	0,84
Tryptophan, (%)	0,23	0,20	0,16	0,19

Table 2 Composition of the diets containing different levels of lysine used in the experiment

Ingredients, (%)	Diet			
	1	2	3	4
Yellow maize meal	78,0	57,0	60,0	60,0
Maize gluten		6,0	7,6	7,4
Wheaten bran		19,0	24,0	27,0
Pollard	2,0			
Lucerne meal	17,0			
Groundnut oil cake meal		9,0		2,0
Sunflower oil cake meal		6,0		
Fish meal			6,0	0,5
Monocalcium phosphate	2,0	1,4	1,0	1,5
Limestone powder	0,6	1,0	0,9	1,0
Salt	0,2	0,4	0,3	0,4
Vitamin + Mineral premix	0,2	0,2	0,2	0,2
Calculated composition				
Protein, %	10,1	14,4	13,4	11,3
Metabolizable energy, (MJ/kg)	12,3	11,6	11,8	11,5
Lysine, %	0,35	0,47	0,55	0,39
Methionine, %	0,20	0,26	0,30	0,21
Arginine, %	0,49	1,07	0,77	0,68
Tryptophan, %	0,11	0,17	0,16	0,14

Results and discussion

Trial 1

The average bodymass of ducks at 3, 7, 20 and 40 weeks of age are shown in Table 3.

The ducklings fed the low-lysine diet from day-old had bodymasses that were lower ($P \leq 0,01$) than those not fed the restricted diets at 3 weeks of age. The feeding of a lysine-deficient diet to ducklings at day-old was very successful in reducing bodymass as these ducklings had an average mass of only 14% of those fed an adequate lysine diet. At 7 weeks of age the ducklings restricted from day-old were still the lightest ($P \leq 0,01$). The ducklings fed the lysine-deficient diet from 3 weeks showed a reduced bodymass although this was not significant ($P \leq 0,01$). At 20 weeks of age those ducklings restricted from day-old were still lower in bodymass than those fed the other three diets ($P \leq 0,01$). Ducklings fed the lysine-deficient diets from 3 and 7 weeks respectively were heavier than those fed the commercial diet *ad lib*, showing that the ducklings were able to consume enough of the low-lysine diet to meet their lysine requirements. At 40 weeks of age there were no differences ($P \leq 0,01$) in bodymass of the ducks on the different treatments although the ducks receiving the lysine-deficient diet from day-old were still the lightest. The trial therefore underlined the fact that low-lysine diets are only successful in reducing bodymass if applied to the ducklings before 3 weeks of age.

The subsequent performance of these ducks is presented in Table 4.

Table 3 Bodymass of ducks (mean ± SD) during Trial 1 (g)

Treatment	Average bodymass (g) at following ages:			
	3 Weeks	7 Weeks	20 Weeks	40 Weeks
Low lysine from day-old	148 ± 12[a]	384 ± 89[a]	2930 ± 288[a]	2592 ± 146[a]
Low lysine from 3 weeks	1055 ± 39[b]	2775 ± 80[b]	3714 ± 196[b]	3089 ± 169[a]
Low lysine from 7 weeks	1015 ± 14[b]	2907 ± 87[b]	3771 ± 256[b]	2993 ± 236[a]
No restriction	1033 ± 41[b]	2933 ± 124[b]	3686 ± 212[b]	2994 ± 222[a]

[a,b]Means within columns with different superscripts are significantly different ($P \leq 0,01$)

Table 4 Production characteristics, food consumption and mortality of ducks on the four treatments in Trial 1

Treatment	Days to 50% prod	Eggs laid per duck	Average egg mass	Egg sizes (%)				Food consumed per duck (kg)	Mortality 0 – 40 weeks (%)
				XL	L	M	S		
Low lysine from day-old	168	92	72,9	1	14	56	29	45,1	27
Low lysine from 3 weeks	156	102	79,1	5	42	45	8	50,1	7
Low lysine from 7 weeks	157	94	79,3	6	38	42	14	52,1	7
No restriction	156	96	79,7	9	40	42	9	54,0	7

The ducks fed the lysine-deficient diet from day-old took an average of 12 days longer to come into production than those ducks on the other three treatments. However, this delay did not account for larger egg masses that normally occurs with such a delay. The average egg mass of ducks fed the lysine-deficient diet from day-old was almost 7 g less than those on the other three treatments. The majority of the eggs laid by the day-old lysine-restricted ducks fell into the medium and small classes whereas the ducks on the other three treatments had the majority of their eggs in the large and medium classes. The number of eggs laid per duck showed no definite pattern on the different treatments but it was interesting to note that those ducks restricted from day-old laid an average of only four eggs less than those ducks that were not restricted.

The food consumed per duck showed a progressive reduction of food intake as the age of applying the restriction was reduced. This would reduce feed costs.

The biggest disadvantage of applying the lysine restriction to ducklings from day-old was the 20% higher mortality of these ducks compared to those on the other three treatments.

Table 5 Bodymass (mean ± SD) of the ducklings at 2, 8, 20 and 50 weeks of age on the four different diets in Trial 2 (g)

	Average bodymass (g) at following ages			
	2 Weeks	8 Weeks	20 Weeks	50 Weeks
Diet 1				
Day-old	$89^{a} \pm 5$	$576^{a} \pm 100$	$2458^{a} \pm 187$	$2518^{a} \pm 34$
1 Week	$352^{d} \pm 12$	$1895^{c} \pm 137$	$3029^{b} \pm 9$	$2789^{abc} \pm 105$
2 Weeks	$593^{g} \pm 2$	$2319^{d} \pm 96$	$3126^{b} \pm 198$	$3063^{bcde} \pm 96$
Diet 2				
Day-old	$170^{b} \pm 19$	$1885^{c} \pm 114$	$2957^{b} \pm 113$	$2871^{bcd} \pm 166$
1 Week	$422^{e} \pm 18$	$2581^{ef} \pm 5$	$3051^{b} \pm 92$	$2977^{bcde} \pm 136$
2 Weeks	$593^{g} \pm 11$	$2599^{f} \pm 20$	$2946^{b} \pm 88$	$2960^{bcde} \pm 178$
Diet 3				
Day-old	$245^{c} \pm 19$	$2324^{de} \pm 140$	$3000^{b} \pm 175$	$3203^{e} \pm 186$
1 Week	$452^{f} \pm 6$	$2600^{f} \pm 129$	$3127^{b} \pm 180$	$3096^{cde} \pm 119$
2 Weeks	$612^{g} \pm 14$	$2724^{f} \pm 44$	$3176^{b} \pm 143$	$3066^{cde} \pm 58$
Diet 4				
Day-old	$149^{b} \pm 6$	$1299^{b} \pm 70$	$2874^{b} \pm 120$	$2753^{ab} \pm 32$
1 Week	$354^{d} \pm 26$	$2052^{c} \pm 101$	$3079^{b} \pm 100$	$3091^{cde} \pm 196$
2 Weeks	$610^{g} \pm 20$	$2636^{f} \pm 42$	$3112^{b} \pm 82$	$3142^{de} \pm 183$

Means within rows with different superscripts (a, b, c, d, e, f, g) are significantly different ($P \leq 0,01$)

Most of these deaths occurred after 7 weeks of age and no specific cause was observed.

Trial 2

The average bodymass figures of the ducks at 2, 8, 20 and 50 weeks of age on the four different lysine diets are shown in Table 5. The ducks were weighed individually.

At 2 weeks of age the ducklings showed highly significant differences between treatments and also within treatments. Within treatments the day-old restricted ducklings were always lower in mass than those restricted from 1-week old. The duckling masses increased as the level of lysine in the diet increased. At 8 weeks of age the bodymass of ducklings that had received the lysine diets from day-old differed significantly ($P \leq 0,01$) within treatments from one another. When the lysine diets were fed from 1 week of age only diet 1 and diet 4 were able to restrict growth sufficiently and when the diets were fed from 2 weeks of age only diet 1 was able to limit the growth rate somewhat. With the exception of diet 1 it appears that a low-lysine diet must be fed to ducklings from day-old or at the latest 1-week old in order to reduce growth rate. At 20 weeks of age only the ducklings fed diet 1 from day-old were lower ($P \leq 0,01$) in bodymass than those fed the other treatments. Although the ducklings fed the low-lysine diets at day-old were still the lightest in each of the four lysine diets fed they were no longer significantly so. This means that during this period (8 – 20 weeks) all the ducklings (with the exception of diet 1 fed from day-old) were able to obtain sufficient lysine needed for growth. It appears that one would need to introduce a quantitative feed restriction on these diets during this period to limit the growth rate of the ducklings.

At 50 weeks of age no definite pattern was evident although the ducks fed diet 1 from day-old were still the lightest.

The subsequent productivity, consumption and percentage mortality figures are shown in Table 6.

From Table 6 it can be seen that the ducks which performed the worst were those fed diet 1 from day-old. These ducks laid the fewest eggs, the smallest eggs, took the longest time to lay their first egg, recorded the lowest fertility and hatchability figures and had the highest mortality. They also ate the least amount of feed per duck (0 – 50 weeks). However, when this same ration was fed to ducklings from 1-week old a marked improvement was shown by the ducks as they recorded the second largest average number of eggs laid. They

Table 6 Productivity characteristics, food consumption, percentage fertility, hatchability and mortality of ducklings fed four diets containing different levels of lysine in Trial 2

Diet	Fed from	Eggs per duck (n)	Average egg mass (g)	Days to 50% prod	Egg sizes (%)				Food consumed per duck (kg)			Fertility (%)	Hatchability (%)	Mortality (%)
					XL	L	M	S	0 – 20	20 – 50	0 – 50			
1	Day-old	88	75	208	3	29	44	24	17,4	28,7	46,1	42	48	20
	1 Week	117	76	152	6	28	47	19	22,5	34,9	56,4	62	49	10
	2 Weeks	102	79	149	18	46	26	10	22,7	35,7	58,4	77	55	5
2	Day-old	103	77	138	9	35	37	19	24,2	37,9	62,1	85	53	0
	1 Week	105	79	142	9	34	45	12	24,4	39,4	63,8	73	60	0
	2 Weeks	102	78	142	7	36	42	15	25,2	39,6	64,8	65	48	0
3	Day-old	115	78	136	7	44	42	7	24,0	40,3	64,3	77	56	0
	1 Week	114	79	131	11	37	39	13	25,2	40,5	65,7	67	56	0
	2 Weeks	120	77	138	6	32	46	16	25,8	41,5	66,3	91	63	0
4	Day-old	106	77	141	7	34	40	19	19,8	32,4	52,2	74	54	10
	1 Week	107	79	146	13	36	37	14	23,1	36,8	58,9	85	50	5
	2 Weeks	112	79	139	12	40	34	14	23,8	37,1	60,9	80	51	0

Table 8 Production characteristics, food consumed, percentage fertility, hatchability and mortality (mean ± SD) of ducks fed a low lysine and normal diet during the rearing period in Trial 3

Dietary treatment	Eggs per duck (n)	Days to 50% prod	Average egg mass (g)	Egg sizes (%)				Food per duck (kg)			Fertility (%)	Hatchability (%)	Mortality (%)
				XL	L	M	S	0–20	20–60	0–60			
Low lysine	$151^a \pm 8$	$136^b \pm 4$	$77,3^a \pm 0,8$	$8,0^a \pm 2$	$34,3^a \pm 6$	$36,0^a \pm 6$	$21,7^a \pm 5$	$20,9^a \pm 0,9$	$39,3^a \pm 1,3$	$60,2^a \pm 3,2$	$74,0^a \pm 7$	$52,6^a \pm 6$	$13,3^a \pm 8$
Normal	$158^a \pm 7$	$127^a \pm 3$	$78,6^a \pm 0,5$	$10,3^a \pm 1$	$36,3^a \pm 5$	$36,0^a \pm 4$	$17,3^a \pm 3$	$24,5^b \pm 0,2$	$71,5^b \pm 0,2$	$72,5^b \pm 0,2$	$72,3^a \pm 13$	$52,0^a \pm 3$	$8,3^a \pm 3$

Means within columns with different superscripts (a, b) are significantly different ($P \leq 0,05$)

Table 7 Bodymass (g) of ducks (mean ± SD) during Trial 3

Dietary treatment	Average bodymass at following ages:			
	2 Weeks	8 Weeks	20 Weeks	60 Weeks
Low lysine	$113^a \pm 4$	$971^a \pm 135$	$2858^a \pm 82$	$2802^a \pm 35$
Normal	$573^b \pm 26$	$2669^b \pm 88$	$3267^b \pm 89$	$3264^b \pm 65$

Means within columns with different superscripts (a, b) are significantly different ($P \leq 0,01$)

also had an average egg mass of 2 g more, took 56 days less to lay their first egg, had 20% better fertility and 10% less mortality than those ducks fed the same ration from day-old. When this diet was fed to ducklings from 2 weeks of age the performance of these ducks was comparable to those ducks receiving the diet with the highest lysine level (diet 3) during the rearing period. The only other ducks to produce sub-optimal performance were those fed diet 4 from day-old. These ducks had higher mortality than the ducks on the other treatments. However, they consumed the second least amount of food per duck and overall could have been the most profitable.

The ducks fed diet 1 from day-old laid the largest number of small eggs and this was similar to the results obtained in Trial 1. They also had the highest mortality (20%) and this was also the case in Trial 1 where it was even higher, being 27%. A good indication of the severity of these lysine diets could be obtained from the mortality figures. No ducklings died on diets 2 and 3 which showed that these levels, although low, did not cause death.

Trial 3

The average bodymass figures at 2, 8, 20 and 60 weeks of age are shown in Table 7.

At 2, 8, 20 and 60 weeks of age the ducklings fed the low-lysine diet (diet 4) from day-old were highly significantly lower in bodymass than those ducklings fed the normal commercial diet. At 8 weeks of age the low-lysine ducklings only weighed 36% of those fed the normal diet and this increased to 87% by the time the ducks were 20 weeks old. To reduce the bodymass further the low-lysine diet would have to be fed quantitatively from 8 weeks of age.

The production characteristics, food consumption, percentage fertility, hatchability and mortality are shown in Table 8.

The ducks fed the low-lysine diet from day-old laid an average of seven eggs less during the 40-week laying period than those ducks fed the normal diet but this was not significant ($P \leq 0,05$). The ducks on the low-lysine diet took longer ($P \leq 0,05$) to lay their first egg (9 days) than those ducks fed the normal diet. In an earlier experiment by Olver (1984) a similar trend was noticed as the low-lysine restricted ducks also took longer to reach maturity than the ducks fed the normal diet. The average egg mass was slightly lower for the ducks fed the low-lysine diet but this was not significant. With regard to the percentage egg sizes, there was very little difference between the treatments. The ducks fed the low-lysine diet laid fewer extra large eggs and more small eggs than did the ducks fed the normal diet.

The greatest advantage of the low-lysine diet was the reduced feed consumption of the ducks fed these diets. These ducks consumed an average of 11,3 kg less feed per duck over the 60-week experimental period and when one considers that the performance of the ducks was similar, the low-lysine fed ducks would be more economical than those ducks fed the normal ration.

The percentage fertility, hatchability and mortality showed no significant differences between treatments although the low-lysine fed ducks had slightly higher values for all three parameters.

In conclusion, qualitative feed restriction is only beneficial if fed to ducklings at day-old and when fed to ducklings older than 2 weeks of age no beneficial reductions in bodymass will be achieved unless fed on a quantitative basis. This would make the operation time consuming. The major drawback of feeding the low-lysine diet to day-old ducklings is the high mortality rate. If one could reduce this high mortality by the addition of extra vitamins and minerals to the diet then this method of feeding would be very effective.

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