

Nutrition/Mortality Interactions in Laying Hens

R.B. Cumming, R.C. Chubb*, J.V. Nolan, W.Ball

*Department of Animal Science, University of New England, Armidale, Australia

Department of Biochemistry, Microbiology & Nutrition, University of New England, Armidale, Australia

Summary

A laying trial compared two Australian egg laying strains with an imported brown egg layer. They were fed a high quality diet recommended for the imported bird or a good Australian layer diet. In addition, these two diets were fed in a free-choice system – whole wheat, protein concentrate and limestone chips. The birds throughout received standard husbandry regarding vaccinations and lighting.

All dead birds were post mortemed and this report details the losses possibly due to nutrition and management. The choice-fed protein concentrate was found to be marginally deficient in phosphorus and this markedly increased the incidence of deaths due to cannibalism in the imported strain. The one Australian strain reacted in a similar but reduced manner, while the second Australian strain was not affected by this phosphorus deficiency.

Introduction

The recent importation of laying strains from the Northern Hemisphere into Australia has presented the Australian poultry farmer with new challenges. The standard housing of laying hens in Australia is in single-deck Californian type laying cages with little or no environmental control and exactly how the imported strains will react to these different environmental situations is not known. Further, Australian poultry diets are usually somewhat different from those utilised in the Northern Hemisphere, being based on wheat and meat meal.

Free-choice feeding (defined as feeding whole grain, plus a protein concentrate (about 40% crude protein) and granular calcium) has been vigorously investigated at the University of New England over the past 20 years. All ten Australian layer strains tested have adapted quite satisfactorily to free-choice feeding, which can offer significant economies to the poultry farmer.

This report details the mortalities possibly related to nutrition and management recorded in a comparative trial involving an imported layer and two Australian layer strains fed on a standard Australian layer diet

and the higher nutrient diet recommended for the imported strain. The two diets were fed as a mash or free-choice.

Methods and Materials

The three layer strains were 1) Hy-Line Tint – White Leghorn x New Hampshire, producing tinted eggs; 2) Siro CB-Black Australorp x New Hampshire, producing brown eggs; and 3) the Isabrown egg layer originating from France which lays intensely brown eggs.

The chickens were hatched on 25 October 1993 with 1500 chickens of each of the three strains being delivered to a commercial egg producer in the Tamworth area, where the birds were reared in groups of 30 in wire-floored brooders.

The chickens received a commercial chicken starter crumble from day-old and water was available from nipple drinkers throughout. The chickens were vaccinated against Marek's Disease (HVT) at the hatcheries, while at three weeks of age the chickens were vaccinated by the in-contact method with the A3 Infectious Bronchitis (IB) virus produced by Phillips-Duphar. At three weeks of age they were beak trimmed

At five weeks of age, the chickens were transported from Tamworth to the University farm, 'Lau-reldale', where they were placed in deep litter pens on fresh litter in groups of approximately 85 chickens of the same breed. They were fed the chicken starter crumble diet for a further two weeks and then changed to a pullet developer. A coccidiostat was incorporated in their diets as soon as they were placed on the ground. At ten weeks of age, half of each breed was introduced to free-choice feeding and then maintained on this regimen. Limestone chips 2-4 mm diameter were available *ad libitum* to all choice fed birds from 16 weeks of age. At 14 weeks of age the birds were vaccinated against Avian Encephalomyelitis virus by the in-contact method and revaccinated with the Vic S strain of IB vaccine by the in-contact method. Body weights were determined at two-weekly intervals to

ensure that the birds met the breeders' recommendations.

At 18 weeks of age the pullets were moved to the laying cage shed when their beaks were again trimmed if necessary. The saw-tooth roofed shed contains 96 replicates of 14 three bird cages (42 birds per replicate) in 12 rows, ten of the rows being back to back and a single row along the north and south walls. The three breeds were randomised across the shed, care being taken to ensure that each strain was housed opposite their sisters in all but ten replicates in the shed. There were thus three breeds and four dietary treatments giving eight replicates of 42 birds (336 birds per treatment).

In the case of the two Australian strains, they were found to be slightly overweight at 18 weeks of age and a time feed-restriction was applied to 23 weeks of age.

The birds were fed one of four diets (see Table 1):

1. a good conventional Australian wheat-based diet
2. the same diet fed free-choice, i.e. whole wheat (10% CP) plus protein concentrate in mash form plus granular calcium.
3. the Isa diet (wheat based) recommended by the breeders in complete form.
4. the Isa diet fed free-choice.

The Isa birds were introduced to the laying diets from 18 weeks of age, while the two Australian strains were introduced to these diets at 20 weeks of age.

The birds were exposed to natural daylength from hatching until 24 weeks of age and, at this time (March), they were under a rapidly decreasing day-length pattern. Additional lighting was then introduced, increasing the day-length 20 minutes per day at weekly intervals until the birds were on 16 hours daylight and this was then maintained for the duration

of the trial.

The feeders were filled three times a week, (Mondays, Wednesdays and Fridays) when feed put out was recorded. Egg production was recorded daily from Mondays to Fridays and weekly egg weight determined. All dead birds were removed as soon as possible from the cages and placed into a deep freeze.

At roughly three weekly intervals, the **carcasses** were thawed out and gross post mortems conducted on every bird.

The deaths were categorised according to the most obvious abnormality or lesion present when examined. Emphasis in this report is on the causes of death, possibly related to nutrition and management - prolapse, vent peck, cannibalism and **salpingitis/peritonitis**, plus fatty liver and haemorrhage.

Briefly, the conditions were:

- a) **prolapse** - where the cloaca was **everted**, usually containing an unlaidd hard-shelled egg, the tissues engorged with blood and sometimes showing signs of pecking of the area.
- b) **vent peck** - where the cloaca was usually damaged and contused, with portions of the reproductive tract **and/or** digestive tract sometimes missing. Such birds were often **anaemic**.
- c) **cannibalism** - where a portion of the body, usually the back and thighs, had been eaten away.

Usually the birds in categories a), b) and c) were in full production, as shown by their comb development and ovarian activity.

- d) **salpingitis and peritonitis** - where there were macroscopic signs of inflammation of the oviduct **and/or** the peritoneal cavity.

This condition varies from acute to chronic and the lesions vary accordingly. In the acute cases the prominent lesion is marked venous congestion of the

Table 1 Specifications of complete layer diets and layer concentrates

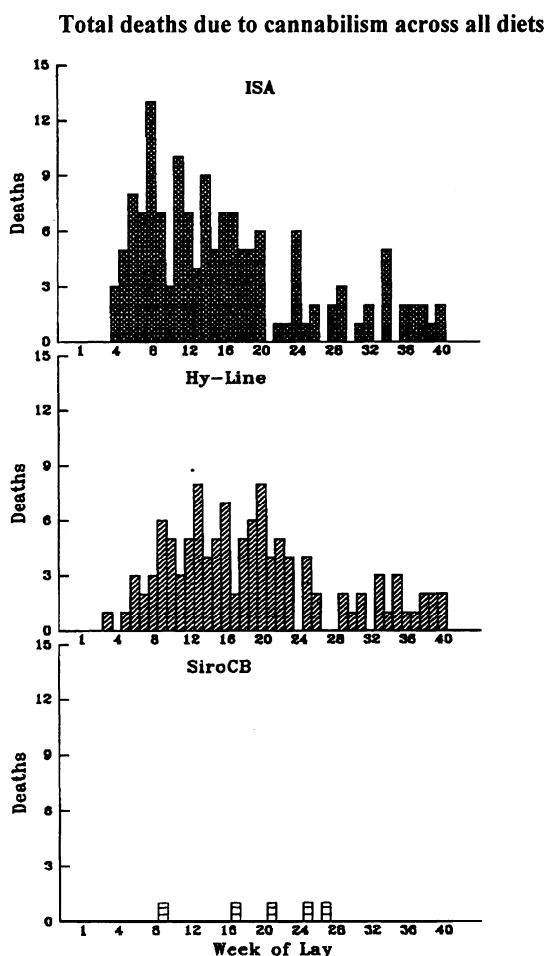
	Aust. Complete Ration	Australian *Concentrate	Isa Complete	Isa Concentrate
Protein	16.3	41.9	16.4	42.8
Energy	11.0	10.7	11.5	11.2
Calcium	3.77	4.53	3.69	2.59
Total Phosphorus	0.77	2.54	0.62	1.79
Avail Phosphorus	0.53	2.67	0.37	1.46
Methionine	0.36	1.25	0.36	1.27
M & C	0.62	1.70	0.63	1.76
Lysine	0.76	2.61	0.77	2.67

* The choice concentrates were supplied alongside whole wheat (C.P. 10%) and limestone chips.

When grouped according to diet (Table 3) the deaths were higher on the two choice-fed diets. These differences were mainly due to increases in mortality from the cannibalism complex on the choice-fed diets and the Isa choice in particular.

Cumming (1972) proposed that the fundamental cause of *salpingitis/peritonitis* in laying hens was the trauma to the lower portions of the reproductive tract due largely to pecking by pen mates. This resulted in an ascending infection that could vary from acute to chronic. As this hypothesis is not widely accepted, and

Figure 1 Total death's due to cannibalism in two imported and one of layer on one of three types of feeding system.



as distinguishing between deaths due to vent peck, prolapse and cannibalism is subjective, it may be most useful to consider these three causes together, termed "total cannibalism". The data are presented in Table 4 and Figures 1, 2 and 3.

The Isa and Hyline Tint birds both suffered high losses (144 and 113 respectively); while only 5 Siro CB birds died. When grouped according to diet, 38 and 42 birds died on the complete Australian and Isa diets, while 69 and 110 died on the Australian choice and Isa choice.

When grouped according to diet and breed, the Isa birds on the two complete diets had essentially the same losses (16 and 14 on the Australian complete and Isa complete diets respectively) with increases to 44 deaths on the Australian choice and 70 on the Isa choice-fed diets. The Hyline Tint had essentially the same deaths on the two complete diets and the Australian choice (21, 27 and 25 respectively) but 40 on the Isa choice. The Siro CB had one death on each of the complete diets and three on the Isa choice.

Losses due solely to *salpingitis/peritonitis* were 31 Isa, eight Hyline Tint and one Siro CB.

The first death from the fatty liver haemorrhage syndrome was recorded in week 24 of production and five more cases occurred to week 34. Four were in the Siro CB group and one in each of the other two breeds. Four were on the Australian choice diet, and one each on the Isa choice and Australian complete diet.

Discussion

Viewed overall, the cases of "total cannibalism" were comparatively "normal" on both the complete diets in all three breeds. Increased mortalities were recorded in all three breeds when given the Isa choice diet, while mortalities were increased, but to a lesser degree in the Isa birds fed the Australian choice diet.

The fact that the deaths from "total cannibalism" declined once the additional phosphorus was added to the free-choice concentrates, increased when it was omitted and then reduced again when it was again added, strongly suggests that the urge to cannibalise was in response to a phosphorus insufficiency in these diets. There appear to be marked breed differences in response to this phosphorus insufficiency. The Isa bird would appear to be the most sensitive, followed by the

Table 4 Losses from "total cannibalism"

BREED	TOTAL	%	DIETS							
			Australian Complete	%	Australian Choice	%	Isa Complete	%	Isa Choice	%
Isa	144	10.7	16	1.1	44	3.3	14	1.0	70	5.2
Hyline Tint	113	8.4	21	1.6	25	1.9	27	2.0	40	3.0
Siro CB	5	0.4	1	-	0	-	1	-	3	0.3

oviduct, which usually contains small (1 to 4 mm) floccules of yellowish pus. There may be similar floccules of pus in the peritoneal cavity as well. The bird is in good condition, with an active ovary. In the chronic form, in which case the hen may be emaciated, the ovary is usually atrophied, and the oviduct distended with concentric layers of inspissated pus.

e) fatty liver and haemorrhage – This condition has been widely reported (Peckham, 1984) and tends to occur more frequently in Australia in certain strains of Australorps. The birds are usually in production, but put on a considerable amount of abdominal fat, increasing the body weight by up to 20%. They die suddenly and the liver is enlarged, pale and friable, with large adherent clot(s) of blood.

Results

The chickens reared well with losses at under 1% for the first five weeks and under 2% to 18 weeks of age. These deaths were due to variety of causes.

Body weights were generally close to the breeders' recommendations, except for the Hy-Line Tint and CSIRO, which were about 7% overweight at 18 weeks of age. The time restriction treatment moved them back to the breeders' recommendations by 23 weeks of age.

Egg production commenced at 18 weeks of age in the Isabrown pullets and at 22 weeks of age in the other two strains. Production appeared to rise quite normally, reaching 90% or over, in all three breeds.

By about week 6 of production it was observed that the Isa birds were tending to lose their brown colour and feather pecking and eating was observed. This became more marked fairly quickly, particularly in the birds in the choice fed groups. Mortality due to vent pecking and cannibalism started to increase markedly by week 5 of production, especially in birds

in the choice fed Isa groups, as well as the Hyline Tint, a bird renowned for prolapse and vent pecking problems (see Tables 2 and 3).

Close examination and chemical analysis of the protein concentrates then revealed that the Isa protein concentrate was marginally low in available phosphorus. When consuming it at about 20% of the total intake, the birds would have been phosphorus deficient. This was corrected by the addition of 3% dicalcium phosphate and 3% mono sodium phosphate to the concentrate. At the same time, 1.5% mono sodium phosphate was added to the Australian concentrate as it was perhaps marginally low in phosphorus.

These altered protein concentrates were fed out from about week 12 of production and mortalities from cannibalism and vent peck declined soon afterwards. The feather eating tended to decline as well.

However, more cases of cannibalism, especially injuries to the thigh area, appeared on the post mortem table at about week 32 of production. It was found that, due to logistical problems, the additional phosphorus was no longer being added to the Isa concentrate. This was rectified and these mortalities then subsided again and remained "normal" until the end of the 40 week laying trial.

The three main causes of death during the 40 week laying period were Marek's Disease (MD), lymphoid leucosis (LL) and the cannibalism, prolapse, vent peck, salpingitis complex (see Table 2). The mortality rates and patterns in each of the three breeds varied markedly.

In the Isa birds, of a total mortality of 23.5%, over 9% was due to MD and 13% to the cannibalism complex. The Hyline Tint had a total mortality of 31.3%, of which 4% was due to MD, 16% to LL and 9% to the cannibalism complex. The Siro CB had a low total mortality of only 2.2% for the 40-week period.

Table 2 Main Causes of Mortality According to Breed

Breed	Total deaths	%	Marek's Disease	%	Lymphoid Leucosis	%	Cannibalism Complex*	%
Isa	316	23.5	108	9.0	4	0.3	175	13
Hyline Tint	420	31.3	54	4.0	217	16.2	121	9
Siro CB	30	2.2	11	0.82	4	0.3	6	0.5

*Cannibalism complex = vent peck, plus prolapse, plus cannibalism, plus salpingitis

Table 3 Main Causes of Mortality According to Diet

Diet	Total deaths	%	Marek's Disease	%	Lymphoid Leucosis	%	Cannibalism Complex	%
Australian Complete	166	16.5	45	4.5	60	6.0	46	4.6
Australian Choice	196	19.4	29	2.9	64	6.4	82	8.1
Isa Complete	162	16.1	45	4.5	52	5.1	53	5.3
Isa Choice	242	24.0	54	5.4	49	4.9	121	12.0

Figure 2 Deaths due to cannibalism in Isa Brown hens fed either a recommended diet or a complete standard layer formulation, or choice fed.

Deaths due to cannibalism in Isa hens by diet

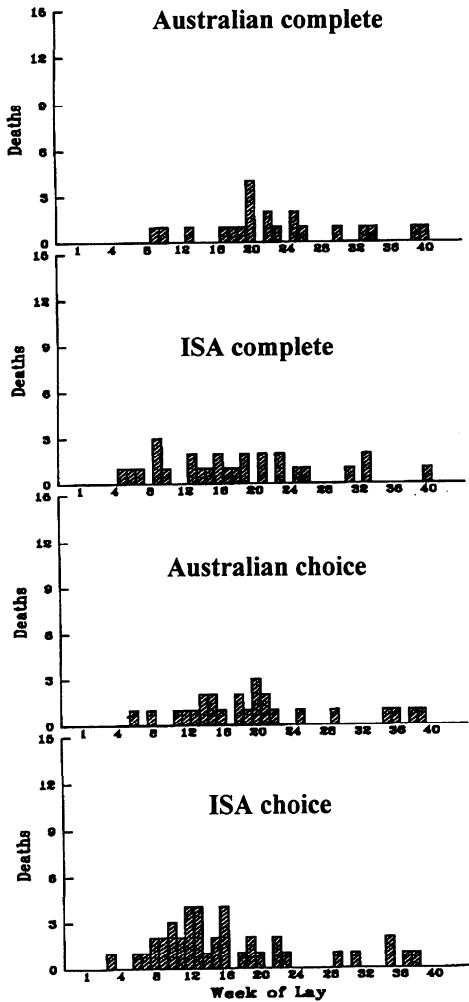
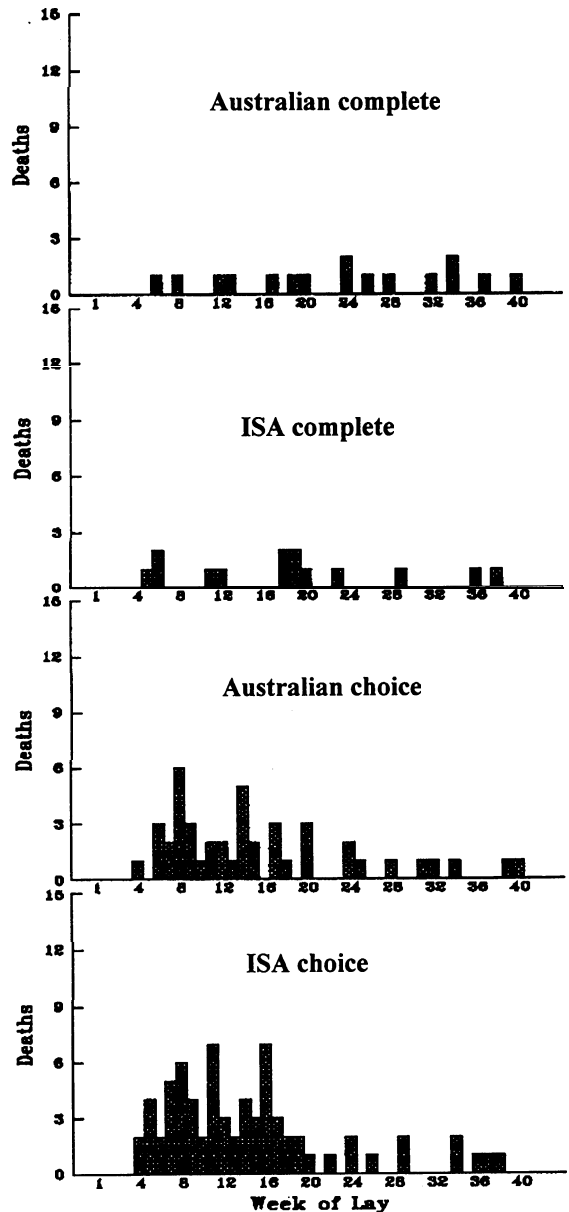


Figure 3 Deaths due to cannibalism in Hy-line tint hens fed either a recommended diet or a complete standard layer formulation, or choice fed.

Deaths due to cannibalism in Hy-line hens by diet



Hyline Tint which only reacted adversely to the Australian choice diet. The Siro CB appeared most resistant to these nutritional problems.

It is interesting to note that the hens on the Isa choice diet did not appear to increase their intake of protein concentrate, which was their only source of phosphorus. While some researchers have suggested (Holcombe *et al.*, 1976a) that layers can regulate their phosphorus requirements, others (Shannon, Savory and Hughes, cited by Hughes, 1979) found no evidence of regulation of phosphorus intake in laying hens.

The incidence of fatty liver and haemorrhage in

Australian layer strains is around 0.2% over a 52-week laying year (Cumming, unpublished). In addition, cases appear earlier and the incidence may be higher in birds fed free-choice (Cumming, unpublished). The losses recorded in this trial of 40 weeks are in general agreement with these observations. Laying birds affected with this disorder deposit excessive quantities of abdominal fat before dying, and the presentation of whole grain in the free-choice feeding system may assist this procedure. Researchers may find free-choice feeding of assistance in understanding the cause of this problem.

The Isa and Hyline Tint birds both experienced a far greater incidence of trauma to the cloacal area, as evidenced by the losses due to prolapses, vent peck and cannibalism. These strains had significantly more cases of **salpingitis/peritonitis** than the Siro CB birds, in general agreement with the hypothesis that this condition is initiated by trauma inflicted by pen mates.

Finally, these results suggest that routine examination of all dead birds from production trials may help elucidate some of the complex problems of modern layer flocks.

Acknowledgements

The Egg Industry Research and Development Council and the University of New England provided funding and facilities for this study.

Mr Mark Porter is thanked for feeding the birds and technical assistance and the expertise of Mr Evan Thompson with statistical analysis and graphical presentation of data is gratefully acknowledged.

References

- CUMMING, R.B. (1972) The etiology of Salpingitis and Peritonitis. *Proceedings of Australasian Poultry Science Convention*, Hobart, 207.
- HOLCOMBE, D.J., ROLAND, D.A. Sr & HARMS, R.H. (1976a) The ability of hens to adjust calcium intake when given a choice of diets containing different levels of either calcium or phosphorus. *Poultry Science*, 55: 308.
- HUGHES, B.O. (1979) Appetites for specific nutrients. In: K.N. BOORMAN & B.M. FREEMAN (Eds) *Food Intake Regulation in Poultry*, British Poultry Science Ltd., Edinburgh.
- PECKHAM, M.C. (1984) Diseases of caged layers. p.775 In: M.F. HOFSTAD *et al.*, *Diseases of Poultry*, 8th Edition, Iowa State University Press, Ames, Iowa.
-