THE EFFECT OF TEMPERATURE ON RESPONSES OF LAYING HENS TO CHOICE FEEDING AND FEED AND WATER RESTRICTION

by

Yusuf Leonard Henuk

Ir. (Engineer) in Animal Nutrition - Nusa Cendana University, Kupang - N.T.T., 85361 Indonesia (1984).

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Department of Animal Science
University of New England
Armidale, N.S.W. 2351
AUSTRALIA

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"Listen to advice and accept instruction,
that you may gain wisdom for the future".
(Proverbs, 19 : 20).

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SUMMARY

Studies were conducted to attempt to solve three particular nutritional problems of feeding laying hens in the author's home country, West Timor, Indonesia, namely : (1) the high cost of processed (protein) feedstuffs (all of which are currently imported), (2) seasonal shortages of feedstuffs (particularly in the period before a new harvest), and (3) seasonal shortages of drinking water (particularly during the later stages of the annual dry season).

The first five experiments were conducted to obtain information on the practical application of choice feeding to laying hens in a single feeder at 20 °C (Experiments 1 and 4), 32 °C (Experiments 2 and 5) or 16 h/d at 20 °C and 8 h/d at 32 °C (Experiment 3). A total of 68 light hybrid pullets of White Leghorn x Australorp genotype (Tegel Tint, Hy-Line 300) were used in the first three experiments and 76 pullets from the same strain in Experiments 4 and 5. Two feeding treatments (choice feeding and complete diets) and two grains (wheat and maize) were used.

In Experiments 1 and 4, the choice-fed birds not only consumed less feed in total (114.6 vs 126.5; and 120.3 vs 123.8 g/d), but also converted feed more efficiently to eggs (2.0 vs 2.2 and 2.2 vs 2.3 g feed intake/g egg weight) and laid eggs at a similar rate (91.6 vs 91.4; and 93.8 vs 94.2 %) to those fed the complete diet. The overall saving in total feed intake in Experiment 1 (whole wheat) was greater than in Experiment 4 (whole maize; 10.4 vs 2.9 %). Body weights of the choice-fed birds in both experiments were greater than those fed the complete diet (1839 vs 1786; and 1719 vs 1693 g).

Unlike Experiment 1, the protein intake of hens on choice feeding was significantly ($P < 0.01$) reduced by about 3 % compared to those fed a complete diet in Experiment 4. Birds on choice feeding in Experiment 1 consumed a diet which was slightly deficient in Ca and the control birds ate a slight excess of Ca (3.1 vs 5.8 g/hen/d), resulting in the choice-fed birds having a mean egg-shell quality which was highly significantly (1.083 vs 1.084 g/ml; $P < 0.01$) less strong. In Experiment 4, however, the choice-fed birds had similar mean Ca intakes (3.8 vs 3.9 g/hen/d), egg specific gravity (1.083 vs 1.082 g/ml), and they also tended to have slightly greater egg-shell thickness than did the controls (365 vs 358 µm). This indicated that oyster-shell grit was a better Ca source than limestone. Overall, improvements in efficiency of laying hens on choice feeding can be expected under the conditions of Experiments 1 and 4, presumably because the choice-fed birds were able to self-select the appropriate feedstuffs related to their physiological status and level of egg production from a range of feed ingredients mixed together in a single feeder.

The results of Experiments 2 and 5 indicate that at high temperatures, choice feeding can help in solving the problems of decreasing nutrient intake and poor performance that are commonly experienced by laying hens fed a complete diet in the hot tropics. Birds in the current work which had previously been trained in choice feeding were able to do this at both constant high temperature (32 °C; Experiments 2 and 5) and under a cyclical hot-temperature regime (e.g. 16 h/d at 20 °C and 8 h/d at 32 °C; Experiment 3). The total feed intakes of the choice-fed birds in Experiments 2, 5 and 3 were similar to those fed the complete diet (110.7 vs 109.9; 115.8 vs 115.7; and 106.6 vs 105.9 g/hen/d respectively). With the exception of Experiment 5, the current results indicated that choice-fed hens selectively consumed more protein than energy at high environmental temperatures. Thus, their protein intakes were significantly higher ($P < 0.01$) than those fed the compete diet in Experiments 2 and 3 (22.4 vs 18.2; 22.3 vs 17.4 g/hen/d).

As in Experiments 1 and 4, the body weights of the choice-fed hens in Experiments 2, 3 and 5 were greater than in complete-fed birds (1969 vs 1912; 2033 vs 1910; and 1711 vs 1685 g respectively). The increased protein intake and/or body weights of the choice-fed hens in these experiments were of economic importance because they supported a slightly improved level of egg production (88.1 vs 85.7; 84.1 vs 81.3; and 82.1 vs 81.9 %) and even egg weight in Experiment 5 (56.8 vs 56.3 g). Although mean Ca intakes of the choice-fed hens in Experiment 3 were higher than in Experiments 1 and 2 (3.3 > 3.1 and 3.1 g Ca/hen/d), the mean value of their egg-shell quality was lower (1.074 < 1.077 < 1.083 g/ml), and this presumably resulted from the direct effects of heat stress on hens. As in Experiment 1, the specific gravity of eggs in Experiment 2 declined progressively with time, and this suggests that further studies are required on techniques to increase Ca intake and thus improve the shell quality of eggs produced by hens fed oyster-shell grit as a Ca source in the choice-feeding system.

While the cost savings and improved feed efficiency of choice-fed hens at 'normal' temperature, and their maintenance of adequate performance at high temperatures, could be of considerable importance in modern layer operations where all-mash diets are normally fed *ad libitum*, choice feeding can offer even more to small-holder farmers in many developing countries in the tropics, to whom the high cost of processed (protein) diets is a considerable burden. Choice feeding allows birds to choose their own nutrient mix, and thus obviates the need for chemical analysis, and indeed there is no longer any need for mechanical feed grinding and mixing. Capital costs can thus be considerably reduced. An additional practical outcome is in a more assured supply of feedstuffs, since home-produced ingredients can readily be utilised.

In West Timor, Indonesia, the author's home country where feed, transport and feed-milling facilities are scarce and the need to contain costs is great, choice feeding is thus considered to have an immediate and widespread application as an alternative to the use of complete diets for laying hens. Moreover, oyster-shell grit, which proved to be a better Ca source than limestone in the current work, is readily available in West Timor at a lower cost than limestone, and its use could thus further benefit small-holding poultry farmers in this area.

The last two experiments in the series were conducted to study the effects of short-term feed and water restriction programs on water requirements, egg production and body weight and on the utilisation of feed in light-weight White Leghorn cross hens. Three weeks were chosen as the experimental period as this approximated the period during which seasonal deficits of feed and water affect hens in small-holder operations in West Timor. Other production traits (i.e. egg weight and egg specific gravity) and the relationships between water and feed intakes were also examined.

A total of 30 White Leghorn hens of the Leach 'Reds' strain (New Hampshire x Single Comb WL) were used in the experiments. Four feeding and watering levels were utilised in each experiment. In Experiment 6, the hens in treatment 1 served as an *ad libitum*-fed control group; those in treatments 2, 3 and 4 were restricted to 80, 60 and 40 % respectively of each individual hen's mean feed intake during the last week of the preliminary period. In Experiment 7, the birds in treatment 1 served as an *ad libitum*-watered control group and those in the other three groups (treatments 2, 3 and 4) were restricted to 85, 70 and 65 % of their respective mean *ad libitum* water intakes recorded in the week immediately before the experiment began.

Restricting the feed intake of hens to 80 or 60 % for three weeks in Experiment 6 resulted in no loss in egg production, but there were significant reductions in body weight (of from 6 to 17 %; $P < 0.001$). Similarly, water restriction in Experiment 7 had no significant effect on egg production, but in this case there were only small (from 4.7 to 10.9 %) and non-significant reductions in body weight. In most cases, feed restriction was more effective in reducing the live weight of the hens used in these experiments than water restriction, and consequently, the feed restriction practice was most effective in controlling the body weights of hens and thus in protecting them from any adverse effects of excessive fat deposition, which is especially a problem in light-bodied White Leghorn cross hens.

Overall FCR (g feed intake/g egg weight) and water : feed intake ratio (ml water drunk/g feed intake) were more affected by restricted feeding than by restricted water intake. In Experiment 6, the efficiency of feed utilisation was higher in the birds on the most pronounced feed restriction. Experiment 7 showed an overall reduction in water : feed intake ratios when water intake was restricted, and restricted watering thus offers an added advantage in that it is likely to limit the so-called 'wet-droppings' problem. Difficulties with odours, flies, disease and removal of faeces from the poultry house could thus be reduced in restrictedly watered birds, which could be expected to produce drier faeces.

Traits such as egg weight and egg specific gravity were not significantly (P > 0.05) affected by feeding treatment in Experiment 6. In contrast, the two parameters were significantly (P < 0.05) affected by watering treatment, but only during the 1st week of treatment in Experiment 7. The birds in Experiments 6 and 7 produced eggs with specific gravities (range 1.029-1.042 g/ml) which were lower than the accepted "standard" of > 1.080 g/ml, a fact which is attributed to their advanced age (> 62 weeks). The regressions of water intake (dependent variable) on feed intake (independent variable) of hens in both Experiments 6 and 7 were compared with the available literature in which water and feed intakes of hens were provided *ad libitum*. The current results clearly indicated that the two parameters were most closely correlated when the water, rather than the feed, intake of birds was restricted (r = 0.74-0.91 vs 0.04-0.39).

The results of Experiments 6 and 7 indicate that the restricted feeding and watering of laying hens are likely to have some beneficial effects of economic significance to small-holder egg producers in areas such as the author's home region, West Timor, Indonesia. However, the small number of birds used, and the short period of time of these experiments, suggest that the effects of feed and water restriction in laying hens require further investigation. Future experiments should indeed be of at least several month's duration, particularly in the "recovery" phase, should include groups of larger size, and if possible should be conducted under practical, field conditions so that feeding, watering, housing and climatic conditions are those actually used by the industry.

PREFACE

The investigations described in this thesis are original, and were conducted at the John Hammond Climate Laboratory and the New Animal House complex, during the period July 1991 - November 1995 when the author was a Post-graduate Master in Rural Science candidate in the Department of Animal Science, School of Rural Science, Faculty of the Sciences, The University of New England.

I certify that the results reported in this thesis have not already been submitted in substance for any other degree and are not being currently submitted for any other degree or award at any other University.

I certify that, to the best of my knowledge, any help received in the preparation of this thesis, and all information derived from the published work of other authors is specifically acknowledged in the text and an alphabetically arranged list of such publications s included in the references.

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Yusuf L. Henuk.
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ABBREVIATIONS COMMONLY USED IN THIS THESIS

et al.	et alia, and others
e.g.	exempli gratia, for example, for instance
i.e.	id est, that is (to say), in other words
etc.	et cetera, and so on
vs	versus
%	per cent
ad libitum	free access or according to pleasure
per se	per (by), se (self): by (or in) itself considered, intrinsically
min	minute(s)
h	hour(s)
d	day(s)
a.m.	ante meridian, before noon
p.m.	post meridian, after noon
CP	crude protein
ME	metabolisable energy
MJ	megajoules
kJ	kilo joule
Kcal	kilo calorie
Ca	calcium
P	phosphorus
FCR	feed conversion ratio
g	gram
kg	kilogram
m	metre
cm	centimetre
mm	millimetre
ml	millilitre
kW h	kilowatts per hour
°C	degrees Centigrade
:	ratio sign, divided by, is to
=	equals
±	plus or minus
LSD	least significant differences
SEM	standard error of the mean
<	less than
>	greater than
/	per
WL	White Leghorn
RH	relative humidity
Hg	mercury
w.v.p	water vapour pressure

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