Reactions of Ross chickens to sequential feeding

I. BOUVAREL[1*], A.M. CHAGNEAU[2], M. VILARIÑO[3], H. JUIN[4], P. LESCOAT[2], J.P. METAYER[3], M. LESSIRE[2], K. CREPON[5], G. ETAVE[6], S. TESSERAUD[2] and C. LETERRIER[8]

[1]ITAVI, 37380 Nouzilly, [2]INRA,UR 83 37380 Nouzilly, [3]Arvalis- Institut du végétal, 41100 Villerable, [4]INRA, UE Le Magneraud, 17700 Surgères, [5]Unip-Onidol, 75008 Paris, [6]INZO°, 02402 Château-Thierry, [7]UMR PRC 37380 Nouzilly

*** Corresponding author: bouvarel.itavi@tours.inra.fr**

Sequential feeding is a 48h-cycle feeding programme of two feeds, one protein-rich-energy-poor (P+E-) and the other energy-rich-protein-poor (P-E+). The intake of each sequential feed is an essential key to reach an overall nutritional balance with sequential feeding. Therefore, for the present study, it was of interest to investigate the effect of sequential feeding on feed intake and consequences on growth performances of chickens (Exp. 1-2), and short- and long-term feed intake (Exp. 3). A control group (C) was fed with a standard diet, whereas for the sequential group (S) four cycles of 48h were used for sequential feeding of the two different diets E+P- and E-P+. Experiments 1 and 2 showed a significant decrease in growth with S (-6% for live weight at d28-30), due to low intake of feed and especially for E-P+. This effect was greater when the cycle started with E+P-. For experiment 3, feed intake kinetics indicated lasting under-consumption of E-P+: -9% after 1h of distribution, -1% the rest of the day, -2% at 24, 48 and 72h. In this situation, sequential feeding seemed to exacerbate how animals reacted by decreasing feed intake, which penalizes growth performance.

Keywords: sequential feeding, feed intake, growth performance, broiler chicken

Introduction

Sequential feeding is a feed distribution method which partly recreates more varied feeding conditions and at the same time enables chickens' natural feed intake tendencies to be managed and modulated (Gous and Du Preez, 1975; Rys and Koreleski, 1980). In addition, by adapting the feed formula, feed cost can be reduced. However, for an overall balanced diet in sequential feeding it is essential to control the intake of each feed. Field studies with Vedette chickens have shown that sequential feeding with two individually "unbalanced" feeds varying in their energy and protein concentrations and fed over 48-h cycles resulted in growth performance identical to that obtained with complete feed (Bouvarel et al, 2004). The feasibility of such sequential feeding requires verification in the extensively used Ross chickens.

Three experiments were carried out in cages and in pens to assess the impact on feed intake of sequential feeding over 48-h cycles, and its consequences on growth performance in PM3 male Ross chickens. The first experiment aimed to compare sequential to continuous feeding from D14 to D29 of animals reared in individual cages. The second enabled the results of the previous experiment to be completed using birds reared in pens. The third aimed to understand better chickens' short and long term reactions to being fed a protein-rich-energy-poor feed for three successive days.

Materials and methods

The starter feed used in the three experiments had the following nutritional characteristics: EM=2900 kcal/kg, CP=21% and total lysine =1.19%. All feeds were wheat, maize, soybean meal and rape-seed oil based in 2.5-mm diameter and 6-mm length pellets.

For the first two experiments, two conditions were compared: (C) a complete control feed fed continuously, and (S) two feeds sequentially fed over 48-h cycles: E+P- high energy and low protein, and E-P+ low energy and high protein (Table 1). The E+P- feed was the first in the sequence in the S_E batch and E-P+ was the first in the S_P batch.

The nutritional characteristics of the control and sequential feeds were identical - a feed reconstituted on the bases of 55% of E+P- and 45% of E-P+. The E-P+ feed had greater durability than the fat-rich E+P- feed. Feed change-over took place in the morning the moment the lights were switched on. The light period was 16h.

Experiment 1: 48 birds were reared in individual cages: 24 birds followed condition C, 12 S_E and12 S_P, from D14 to D30. Growth performances were measured: daily intake, weight gain and feed to gain ratio.

Experiment 2: This experiment was carried out in 24 pens of 82 birds. The birds were sequentially fed from D14 to D27, and started with E+P- (S_E) or E-P+ (S_P). From D14 daily feed intake was measured. Birds were weighed on D14 and D28.

Experiment 3: The two previous experiments showed that chickens following sequential feeding under-consumed, and in particular E-P+ feed. This third experiment thus aimed to investigate in more detail the intake kinetics of this feed. It was carried out in individual cages, for three successive series of 16, 96 and 96 chickens respectively, from 14 and 15 days old for series 1 and 2-3 respectively. Batches were constituted according to live weight two days before the feed change (T or E-P+) and the intake of the previous day. The feed intake was then measured 1, 24, 48 and 72h after the change of feed.

Statistical analysis: One-factor variance analyses (condition) and mean comparisons (Student's t test) were carried out using Statview software for experiments 1 and 2. For experiment 3, a two-factor covariance analysis (series and condition) was conducted with D1 intake as covariable.

RESULTS

Experiment 1 (Table 2): For the two weeks of the experiment the total feed intake for the sequentially fed condition was 9% less than for the complete control feed ($P<0.01$). The intake of feeds E+P- and E-P+ represented 57% and 43% of the total intake respectively, corresponding closely to the 55% and 45% proportions used in the formula. The S_E batch tended to show an overall lower intake than S_P, but this was not significant with the 5% threshold chosen ($P=0.07$). The total intake of E+P- feed did not differ significantly from that of chickens fed complete feed, while for those receiving E-P+ feed there was a 22% decrease ($P<0.01$). For the first day of sequential feeding (D14), intake was not significantly different between conditions. Systematic under-consumption was then observed between E-P+ and control feeds fed over the same period. The mean weight of birds at the end of the experiment was 7% less with sequential feeding than for the control birds ($P<0.0001$), but the intake index was not significantly modified (+1.3%). The same linear relationship was observed between bird weight on D28 and their intake during the experimental period for the control and experimental batches ($R^2=0.90$, $P<0.001$).

Experiment 2 (Table 3): This second experiment carried out with birds reared in pens confirmed the results of the previous experiment. The total intake of sequentially fed feed was 6% less than that of the complete feed ($P<0.01$). The intake of the E+P- and E-P+ feeds represented on average 58% and 42% of the total intake respectively. The daily intake kinetics were very similar for the two experiments (Figure 1). The order in which the feeds were alternated had a significant effect on E+P- and E-P+ intake. When the E-P+ feed was distributed first in the cycle (S_P), the total intake did not significantly differ from that of the controls (-3%), whereas for the other condition (S_E), it was reduced by 9%. The respective intake of E-P+ feed was identical for the S_E and S_P conditions, and was much lower than that of the controls (-22%). On the other hand, the intake of E+P- was higher than that of the controls by 4% for S_E and by 16% for S_P. The mean bird weight at the end of the experiment for sequentially-fed birds was 6% lower than for controls and the intake index had decreased on average by 3.7% ($P<0.01$). The effects were greater for condition S_E. As for experiment 1, a linear relationship was observed between bird weight on D28 and their intake during the experimental period ($R^2=0.94$, $P<0.01$).

Experiment 3 (Figure 1): The chickens' short-term reaction was measured on the first day of feeding E-P+ and C feeds. The E-P+ feed was immediately and significantly under-consumed from the first hour of distribution compared to C, with significant series and covariable effects. This under-consumption reached -9% in the first hour and -1% for the rest of the day ($P<0.01$). The E-P+ feed was under-consumed for the three successive days of distribution (-2%), with overall significant series and covariable effects.

Discussion

The sequential feeding carried out in experiments 1 and 2 did not enable similar growth performance to that obtained with a complete balanced diet, even though the theoretical proportions of the two feeds were respected. This lack of weight gain was due only to the overall under-intake of feed, the birds' weight being linearly related to their feed intake.

In our experiments, the high-protein (low-energy) feed was consumed less than the control feed, whereas the high-energy (low-protein) feed was consumed in the same quantities during the first feeding cycles. Overall, chickens reared in cages or in pens showed the same responses in terms of intake. Chickens fed high-energy (low-protein) rather than high-protein (low-energy) on the first day of the cycle consumed less than those fed high-protein feed first.

The natural tendency of chickens to preferentially consume energy-rich (or protein-poor) feeds has already been observed. However, the 48-h sequential feeding cycles resulted in an overall intake similar to that obtained with complete feed for Cobb or Vedette chicken (Bouvarel et al., 2004).

Our results suggest there is an actual metabolic adjustment of intake because feeds were consumed in lesser quantities, and there was also an interaction between the physical appearance of the feed and the feeding pattern. The feed intake could alter at the metabolic level for the two energy and protein concentrations to avoid an energy deficit or a protein surplus, as observed by Bouvarel et al. (2004).

The study of intake kinetics indicates that the under-consumption of the high-protein (low-energy) feed was immediate and lasting with continuous feeding. This decrease was, however, less than that observed with sequential feeding, certainly due to a modulation linked to the feed composition. This immediate reaction suggests a sensorial reaction of chickens presented with feeds with different physical characteristics (Picard, 2002). In fact, the physical characteristics of the two feeds are affected by their chemical characteristics. The high-protein low-energy feed has a longer durability and pellet length (Table 1), and is certainly harder. Nir et al (1994) have shown that chickens consume smaller quantities of hard feed. The hardness and the longer pellet length combined could therefore reduce feed intake of Ross chicken, possibly showing greater sensitivity than Vedette.

Conclusion

In the test situations, sequential feeding appeared to exacerbate the birds' reaction to the two feeds leading to an overall under-intake which penalized growth performance. Several factors could be responsible such as a greater sensitivity to feed appearance or metabolism adaptation difficulties.

References

BOUVAREL, I., B. BARRIER-GUILLOT, P. LARROUDÉ, B. BOUTTEN, C. LETERRIER, F. MERLET, M. VILARIÑO, L. ROFFIDAL, S. TESSERAUD, J. CASTAING, and M. PICARD M. (2004). Sequential feeding programs for broiler chickens: twenty-four- and forty-eight-hour cycles. *Poult Sci.* **83**(1):49-60.

GOUS, R.M., and J.J. DU PREEZ (1975). The sequential feeding of growing chickens. *Br. J. Nutr.* **34**, 113-118.

NIR, I., Y. TWINA, E. GROSSMAN, and Z. NITSAN (1994). Quantitative effects of pelleting on performance, gastrointestinal tract and behavior of meat-type chickens. *Br. Poult. Sc*i. **35**: 589-602.

PICARD, M., J.P. MELCION, D. BERTRAND, and J.M. FAURE (2002). Visual and tactile cues perceived by chickens. In: Poultry feedstuffs: supply, composition and nutritive value. Chap 15, pp 279-300. CAB International 2002. Eds J.M. McNab and K.N. Boorman.

RYS, R., and J. KORELESKI (1980). Effect of alternately fed diets with different protein level on the performance of broiler chickens. *Arch. Tierernahr.* **30**:133–139.

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Table 1 Physical and nutritional characteristics of feeds fed during the three experiments

	C			E+P-		E-P+		
	Exp1	**Exp2**	**Exp3**	**Exp1**	**Exp2**	**Exp1**	**Exp2**	**Exp3**
Nutritional characteristics (%)								
EM (kcal / kg)	3,080	3,000	3,000	3,270	3,250	2,855	2,700	2,800
Fat	5.8		5.8	6.8		2.9		
Crude protein	17.6	18.0	17.6	14.3	12.6	22.1	24.6	22.0
Total lysine	1.01	1.05	1.01	0.75	0.74	1.32	1.43	1.26
Physical characteristics								
Length (mm)	nm	nm	5.7±0.1	nm	nm	nm	nm	6.3±0.1
Durability (%)	87	63	86	82	49	92	91	92

Table 2 Feed intake and growth performances (n= 24 chickens per condition) – Experiment 1

Condition	**C**	**S[2]**	**P<**
Feed Intake D14-D29, g			
E+P-	832[1]	872	NS
E-P+	852a[1]	665b	***
Total	1,684a	1,537b	**
E+P- / Total, %	49b	57a	***
Body Weight in g			
D14	348	348	NS
D30	1,427a	1,321b	**
Feed to gain ratio D14-D30	1.561	1.581	NS

[1] Intake of C every other day; [2] No significant effect of feeding order of feeds

Table 3 feed intake and growth performances (n=8 pens per condition) – Experiment 2

Condition	**C**	**S_E**	**S_P**	**P<**
Feed Intake D14-D27 in g				
E+P-	746c	776b	862a	***
E-P+	757a	593b	594b	***
Total	1,503a	1,369b	1,456a	***
E-P+ / Total, %	50b	57a	59	***
Body Weight in g				
D14	413	417	415	NS
D28	1,428a	1,299c	1,377b	***
Feed to gain ratio D14-D28	1.483c	1.555a	1.521b	***

The means followed by letters show significant differences from the threshold α=5%

*** : P<0.001; ** : P<0.01; * : P<0.05 ; NS: Non-significant

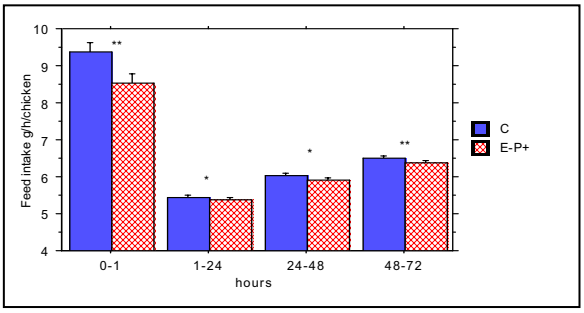

Figure 1. Changes in intake during the 72 hours following change of diet – Experiment 3

** : P<0.01; * : P<0.05; nm : no measured