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To cite this version:

Bas Rodenburg, Jan van Harn, Marinus Krimpen, Marko Ruis, Izak Vermeij, et al.. Comparison of three different diets for organic broilers: effects on performance and body condition. British Poultry Science, 2008, 49 (01), pp.74-80. 10.1080/00071660701823085 . hal-00545325

HAL Id: hal-00545325

https://hal.science/hal-00545325v1

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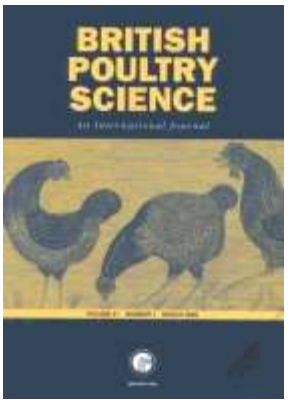

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Journal:	*British Poultry Science*
Manuscript ID:	CBPS-2007-085.R1
Manuscript Type:	Original Manuscript
Date Submitted by the Author:	27-Aug-2007
Complete List of Authors:	Rodenburg, Bas; Wageningen University, Animal Breeding and Genomics Centre van Harn, Jan; Wageningen University and Research Centre, Animal Sciences Group Krimpen, Marinus; Wageningen University and Research Centre, Animal Sciences Group Ruis, Marko; Wageningen University and Research Centre, Animal Sciences Group Vermeij, Izak; Wageningen University and Research Centre, Animal Sciences Group Spoolder, Hans; Wageningen University and Research Centre, Animal Sciences Group
Keywords:	Broilers, Diet, Free range, Welfare, Growth

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CBPS-2007-085
ed. MacLeod, November 2007

Comparison of three different diets for organic broilers: effects on performance and body condition

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RUNNING TITLE: **PERFORMANCE OF ORGANIC BROILERS**

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Accepted for publication 7th November 2007

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Abstract 1. The aim of this study was to assess the feasibility of 100% organic feed for organic broilers by comparing it with 80% organic feed (situation at the time of the experiment; 2004) and 95% organic feed (alternative).

2. Diets were optimised for nutritional value, allowing a maximum 10% increase in feed price when using 100% organic feedstuffs. This could only be achieved at the expense of the methionine content.

3. The birds were reared from zero to three weeks of age in a broiler house in three groups of 500 broilers each on either an 80, a 95, or a 100% organic starter diet. At three weeks of age, they were transferred to 15 pens with an outdoor run. Each treatment group of 500 birds was divided into 5 groups of 95 and given an 80, a 95, or a 100% organic finisher diet.

4. Broilers receiving 100% organic feed reached a lower body weight and grew more slowly than those receiving 95% organic feed, mainly because of a lower feed intake.

5. Broilers on 95 or 100% organic feed had a higher incidence of breast blisters than broilers receiving 80% organic feed.

6. The cost price for meat from broilers that received 80% organic feed was € 1.83 per kg live weight. The cost prices for broilers that received 95 and 100% organic feed were € 1.84 (+0.8%) and € 1.93 (+5.4%) per kg live weight respectively.

7. In conclusion, 95% organic feed led to a better performance than 100% organic feed in this study. Probably, the lower methionine content in the 100% organic feed negatively affected performance. The results for 95% organic feed were similar to 80% organic feed, except for a higher incidence of breast blisters.

INTRODUCTION

In organic animal husbandry, the feed must be produced from organic feedstuffs according to EU Council Directive 1804/1999. Until 2012, limited use of conventional feedstuffs is permitted, if there are too few organic feedstuffs available. After December 2011, all feed used in organic animal production should be produced from 100% organic feedstuffs. At present 85% organic feed is commonly used in

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organic broiler production. The transition from 85% to 100 % organic feed can cause problems in poultry. The supply of protein and amino acids (especially methionine) is the most common problem, because some feedstuffs are not available from organic origin and because organic feedstuffs generally have lower protein contents than conventional feedstuffs (Hovi and Sundrum, 2001; Zollitsch and Baumung, 2004). Furthermore, addition of synthetic methionine is not an option, as this is prohibited in organic farming (EU 1804/1999). It is possible to avoid shortage of methionine in 100% organic feed by addition of specific organic feedstuffs, such as organic sesame seed expeller. The problem is that these feedstuffs are not generally available and are relatively expensive. Rose *et al.* (2004) compared 100% organic diets with low and high methionine levels and found that laying hens fed on the high methionine diet performed better than hens given the low methionine diet. The higher ingredient costs of the high methionine diet, however, resulted in a 50% reduction of the margin of egg income over feed costs.

In organic broilers, problems of 100% organic feed may be reduced because a slow growing broiler, which has lower nutrient requirements than fast growing broilers, is used for organic production (Zollitsch and Baumung, 2004). On the other hand, imbalance of protein in the feed can lead to an increased water intake and wet manure (Walker and Gordon, 2001). Wet manure can cause other problems, such as a poor litter quality and a poor body condition (Weaver and Meijerhof, 1991). As organic broilers have an outdoor run, it may be that they can partly compensate for imbalances in the feed by foraging in the outdoor run, consuming vegetation, worms, and insects (Hermansen *et al.*, 2004). Alternatives for 100% organic feed could be 95% organic feed or 100% organic feed with synthetic amino acids (Lemme *et al.*, 2005; Moritz *et al.*, 2005).

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The aim of the present study was to compare three different diets for organic broilers: 80% organic feed (situation at the time of the experiment; 2004), 95% organic feed (alternative) and 100% organic feed. It was hypothesised that broilers that received 80% organic feed would have a better performance and a better body condition than broilers that received 100% organic feed (due to the lower methionine concentration), and that broilers receiving 95% organic feed would be intermediate. Also, broilers that received 100% organic feed were expected to compensate for possible deficiencies in the feed by increased use of the outdoor run.

MATERIALS AND METHODS

Feed

A total of 6 feed formulations were used: starter (0-3 weeks) and finisher (3-11 weeks) feeds, each with 80, 95, or 100% organic feedstuffs. The feed was produced by van Gorp-Teurlings BV, Waspik, The Netherlands. In 95 and 100% organic feeds, conventional sesame-seed expeller and toasted soybeans were removed, compared with the 80% organic feed (Table 1). Additionally, in 100% organic feed, conventional maize gluten meal and potato protein were removed, compared with the 80 and the 95 % organic feed. The 80% and 95% organic feeds were mainly supplemented with organic soya bean meal.

Tables 1 and 2 near here

The feed manufacturer was asked to produce 80, 95, and 100% organic diets from feedstuffs that are generally available and also to avoid feedstuffs or additives that would make the feed too costly, allowing a maximum 10% increase in feed price when using 100% organic feedstuffs. Within these restrictions, it proved impossible to keep the content of digestible methionine the same in all diets. Methionine concentration decreased as the amount of organic feedstuffs increased (Table 2).

Rearing

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Rearing of the broilers took place in June 2004. Three groups of 500 slow growing broilers (Hubbard JA 957) were housed in three compartments of a climate-controlled broiler house as d-old chicks. JA 957 chicks were used because this is the hybrid that is generally used for organic broiler production in The Netherlands. Each compartment measured 4.2 x 6.8 m with an available floor space of 28.1 m^2. Each compartment was fitted with 7 feeders (MiniMax, Roxell) and 45 nipple drinkers (Avron). The broilers were housed on softwood shavings and had *ad libitum* access to feed and water. One group received an 80%, one group a 95% and one group a 100% organic starter diet. During the first 2 d, continuous light was used. Thereafter, an 18L:6D lighting schedule was used.

Experimental design

The experiment was conducted in July and August 2004. At three weeks of age, the broilers were transferred to 15 pens with an outdoor run. Each pen measured 5.3 x 2.2 m with an available floor space of 11.4 m^2. The pens were all located next to each other. Each treatment group of 500 broilers was divided into 5 groups of 95 broilers, resulting in a total of 15 experimental groups. The remainder of the broilers were excluded from the experiment. The 15 pens that were used from 3-11 weeks of age had an open front that was covered only with windbreak netting. The broilers were housed on softwood shavings and had *ad libitum* access to feed and water. Five groups received an 80%, 5 groups a 95% and 5 groups a 100% organic finisher diet. For each group, treatment during the experimental period was the same as treatment during the rearing period (80%, 95% or 100% organic feed). The treatments were allocated to the pens at random. During the experimental period, no extra light was given (daylight only). Temperature and humidity in the pens were recorded continuously using the uMETOS, manufactured by Pessl, Germany. After one week

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of habituation to the new pens, the broilers had permanent 24 h access to the outdoor run (approximately 7 m^2 per bird). The windbreak netting was pulled up 50 cm to allow the broilers access to the outdoor run over the full width of the pen. The outdoor run consisted of a concrete part near the house (11.4 m^2 per group) and a large part with long grass and other vegetation (640 m^2 per group). In the pen, the broilers were kept at a stocking density of 8 birds/m^2. The broilers were slaughtered at 11 weeks of age.

Observations

Performance (body weight gain, feed intake, feed conversion ratio and mortality), use of the outdoor run, litter quality, gait score, body condition, and slaughter data were recorded. To evaluate performance, all broilers were weighed at 0, 3, 7, and 11 weeks of age. Feed intake per group and mortality were recorded daily. To study the use of the outdoor run from 5 - 9 weeks of age, every Wednesday morning at 0830 h the number of broilers on the concrete part and on the grass of the outdoor run was counted. Litter samples were taken at 5, 7, 9, and 11 weeks of age from each pen to analyse the dry matter content of the litter, using a pooled sample from 5 locations in the pen. At 10 weeks of age, the gait of all broilers was assessed, using a group scoring method modified from the method described by Kestin *et al.* (1992). The gait score had a 6-point scale from 0 to 5, where 0 = no observable locomotory problems and 5 = unable to walk. In each pen, the percentage of broilers in each of the 6 gait score categories was recorded. At 10 weeks of age, the body condition of the broilers was recorded as well. The incidence and extent of breast smearing, breast irritations, scratches on the thighs, hockburns and footpad irritations were determined with a visual scoring method. The visual scoring method had a 4 point scale from 0 to 3, where 0 = no visual signs and 3 = severe visual abnormalities. At slaughter, the

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processing yields of 10 males and 10 females per pen were recorded. These broilers were randomly selected and processed at a commercial processing plant. According to a standard procedure, carcase yield, and yields of wings, breast meat, back and legs were determined. The carcase yield was calculated by dividing the carcase weight by the total body weight. The leg, wing, breast, and back yield were calculated by dividing their weight by the carcase weight. Finally, data of the experiment were used for an economic evaluation. Only significant differences and tendencies for differences in performance between treatments were taken into account for this evaluation. Other starting-points were taken from Vermeij (2004). Feed prices were supplied by the feed manufacturer.

Statistical analysis

Data were analysed in GenStat using analysis of variance, with the factor feed. Pen was the experimental unit. The Bonferroni test was used to test for significant differences between treatments in case of an overall effect of feed. Use of the outdoor run and dry matter content of the litter were analysed using repeated measures analysis of variance, to analyse the effect of age.

RESULTS

General

During the outdoor phase, temperature varied strongly between day and night; the lowest temperature recorded was 8°C and the highest temperature was 32°C. The mean temperature was 19°C. Air humidity was between 38 and 100% with a mean of 86%. During the outdoor phase (from 4 weeks of age) there was some mortality due to predators, especially birds of prey. The mortality due to predation was distributed equally over the treatments.

Performance

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At the end of the rearing period at three weeks of age, broilers that had received 95% organic feed were numerically heavier than broilers from the other two treatments (Table 3; not tested for significance due to limited number of groups during rearing). Over the entire growing period, broilers that received 100% organic feed reached a lower body weight ($F_{2,12} = 4.49$, $P < 0.05$) and grew more slowly ($F_{2,12} = 4.37$, $P < 0.05$) than broilers that received 95% organic feed. There were no differences in growth between broilers receiving 80 % organic feed and broilers from the other treatments. There also were no differences in mortality between the treatments. Feed intake was lower in pens with 100% organic feed than in pens with 80 and 95% organic feed ($F_{2,12} = 17.89$, $P < 0.001$). There was no difference in feed conversion, as calculated in practice (uncorrected for mortality). After correction for mortality, feed conversion tended to be better in pens that received 95% and 100% organic feed compared with pens that received 80% organic feed ($F_{2,12} = 2.89$, $P < 0.10$).

Table 3 and Figure near here

Use of the outdoor run

During observations of use of the outdoor run, a mean of 9% of all the broilers was observed on the concrete part of the outdoor run, near the house, and 7% of the broilers on the grass (Figure). The broilers were mainly observed in the part of the outdoor run located closest to the pens. There were no differences in use of the outdoor run between treatments. Use of the outdoor run increased with age ($F_{4,48} = 5.55$, $P < 0.01$).

Litter quality

Dry matter content of the litter was lower in pens that received 100% organic feed than in pens that received 95% or 80% organic feed at 7 weeks of age ($F_{2,12} = 38.70$, $P < 0.001$; Table 4). At 5, 9, and 11 weeks of age, there were no significant

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differences between the treatments. Dry matter content of the litter increased from 5 to 11 weeks of age ($F_{3,35} = 121.81$, $P < 0.001$).

Gait score

About 70% of all the broilers had no gait abnormalities. 25% of the broilers had a slightly trembling gait and 5% of the broilers had a trembling gait. There were no differences in gait score between treatments.

Tables 4 & 5 near here

Body condition

Broilers that received 95 or 100% organic feed had a higher incidence of breast blisters than broilers receiving 80% organic feed ($F_{2,12} = 3.95$, $P < 0.05$; Table 5). Furthermore, broilers that received 100% organic feed tended to have more footpad irritations than broilers that received 95% organic feed ($F_{2,12} = 3.26$, $P < 0.10$). There were no differences in breast smearing, breast irritations, and hock irritations between the treatments.

Processing yields

Broilers that received a 100% organic feed had a higher wing yield ($F_{2,12} = 4.39$, $P < 0.05$) and tended to have a higher leg yield ($F_{2,12} = 3.05$, $P < 0.10$) than broilers receiving 80 or 95% organic feed (Table 6). There were no significant differences in breast yield between treatments.

Tables 6 & 7 near here

Economic evaluation

Feed prices for 95% and 100% organic feed were 4.6% and 7.6% higher compared with 80% organic feed. The cost price for broilers that received an 80% organic feed was € 1.83 per kg live weight. The cost prices per kg live weight for broilers that received a 95% and 100% organic feed were € 1.84 (+0.8%) and € 1.93 (+5.4%) respectively.

DISCUSSION

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Broilers that received 100% organic feed reached a lower body weight and grew more slowly than broilers that received 95% organic feed. Possibly, the methionine level of the 100% organic feed was too low, resulting in an imbalance in amino acid profile. Moran (1994) also found that broilers on a low methionine diet grew slower than broilers from a control group, especially during the first six weeks of life. It may also be possible that the 100% organic feed used in the present study had a lower palatability than 80 and 95% organic feed, as the feed intake of broilers that received 100% organic feed was lower as well.

There were no differences in use of the outdoor run in this study and the use was lower than in other studies, with a mean of about 15%. For instance, Christensen *et al.* (2003) found a mean use of the outdoor run of about 35%. The lower use of the outdoor run may be caused by the type of housing (open front), but it may also be that counting once a week was too limited to get a good impression of use of the outdoor run. Nielsen *et al.* (2003) did find an effect of type of feed on use of the outdoor run in free range broilers. In their study broilers that received a moderate energy feed made more use of the outdoor run than broilers that received a low energy feed. Similarly, Moritz *et al.* (2005) showed that broilers that received lower methionine levels in their feed spent more time foraging, especially if their feed intake was restricted.

Broilers that received 95 or 100% organic feed had more breast blisters than broilers that received 80% organic feed. This difference could be caused by a poorer litter quality or by a lower activity of the broilers. In the pens that received 100% organic feed the dry matter content of the litter was indeed lower than in the pens that received 80% organic feed (significant only in week 7), but this was not the case in the pens that received 95% organic feed. Perhaps, broilers that received 95%

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organic feed were less active than broilers that received 80% organic feed, but activity was not recorded in this study. The wetter litter in the pens that received 100% organic feed may have been caused by an imbalance of the amino acid profile in the feed. This can lead to an increased water intake and wet manure (Walker and Gordon, 2001). Contrary to expectations, the dry matter content of the litter was lowest at 5 weeks of age and increased to the end of the growing period. This may be caused by the access to the outdoor run from 5 weeks of age and by weather influences. In comparison with other studies with slow growing broilers kept until 56 days of age (van Horne *et al.*, 2004), there was a higher incidence of gait abnormalities in this study, probably due to the longer growing period.

Feed prices for 95% and 100% organic feed were higher compared with 80% organic feed. The cost price for meat from broilers that received 95% organic feed was slightly higher than the cost price for meat from broilers that received 80% organic feed (+0.8%). For meat from broilers that received 100% organic feed, the cost price was 5.4% higher. The smaller increase in costs for the meat from broilers that received 95% organic feed was due to the fact that the improvements in feed conversion ratio and live weight compensated for the higher feed costs.

In conclusion, 95% organic feed led to a better performance than 100% organic feed in this study. Probably, the lower methionine content in the 100% organic feed negatively affected performance. The results for 95% organic feed were similar to 80% organic feed, except for a higher incidence of breast blisters.

ACKNOWLEDGEMENTS

The authors would like to thank Eveline Coenen for her help with the experimental work. We would also like to thank the employees of van Gorp Diervoeders BV, Waalwijk, The Netherlands, for their help with formulating and producing the feed

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and the animal care staff of experimental farm 'Het Spelderholt', Lelystad, The Netherlands, for taking good care of the broilers. This project was funded by the Dutch Ministry of Agriculture, Nature Conservation and Food Quality (LNV).

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Table 1. *Feed composition of 80%, 95% and 100% organic starter (0-4 weeks) and finisher feeds as g/kg of total*

	Starter diets (0-3 weeks)			Finisher diets (3-11 weeks)		
	80%	95%	100%	80%	95%	100%
Maize organic	200	200	200	130	190	150
Wheat organic	390	430	370	450	465	435
Sunflower organic	40	60	70	80	70	70
Pea organic	30			80	50	40
Rapeseed organic	30	40	50		20	20
Soya bean meal organic	70	160	240	25	100	220
Sesame organic		10	10		10	10
Soja oil organic	5	15	25	5	15	25
Premix, Minerals and Vitamins	30	30	30	30	30	30
Maize gluten	20	10		40	10	
Potato protein	50	40		25	40	
Soybeans toasted	55			110		
Sesame seed expeller	50			25		
Yeast	25					
Organic acid	5	5	5			

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Table 2. *Calculated feed composition of 80%, 95% and 100% organic starter (0-4 weeks) and finisher feeds*

	Unit	Starter diets (0-4 weeks)			Finisher diets (4-12 weeks)		
		80%	95%	100%	80%	95%	100%
CP	g/kg	220	207	205	194	185	197
Crude fat	g/kg	55	58	74	60	50	68
Crude fibre	g/kg	39	44	50	49	45	50
Crude ash	g/kg	61	60	63	59	57	61
ME broiler	MJ/kg	11.4	11.4	11.4	11.5	11.5	11.4
Lysine[1]	g/kg	10.7	10	9.8	8.85	8.8	9.4
Methionine[1]	g/kg	4.3	3.7	3.4	3.5	3.35	3.2
Methionine+Cysteïne[1]	g/kg	8.3	7.5	7.1	7.1	6.8	6.75
Threonine[1]	g/kg	8.9	8	7.5	7.3	7.2	7.1
Tryptophan[1]	g/kg	2.6	2.5	2.5	2.2	2.2	2.4
Calcium	g/kg	9.5	9.5	9.5	10	9.5	9.5
Phosphorus	g/kg	6.9	7	7.2	6.1	6.1	6.3
Available Phosphorus[2]	g/kg	3.7	3.7	3.7	3.1	3.1	3.1
Linoleic acid	g/kg	21	20	26	26.5	18	23.5

[1]Total amount.

[2]available phosphorus = total phosphorus – phytate phosphorus.

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Table 3. *Performance of broilers receiving 80%, 95% and 100% organic feed (0 – 11 weeks)*

	80%	95%	100%
Body weight 1 day (g)	42	42	41
Body weight 3 weeks (g)	493	561	499
Body weight 11 weeks (g)	3051[ab]	3094[a]	2970[b]
Growth (g/d)	41.2[ab]	41.8[a]	40.1[b]
Mortality (%)	3.3	3.5	2.9
Feed conversion	2.65[(a)]	2.59[(b)]	2.58[(b)]
Total feed intake (g)	7958[a]	7900[a]	7544[b]
Daily feed intake (g/day)	109.0[a]	108.2[a]	103.3[b]
Feed conversion (practice)	2.63	2.58	2.64

[ab]Values in a row not sharing a common superscript are significantly different ($P<0.05$).

[(a) (b)]Different superscripts between brackets indicate a tendency ($P<0.10$).

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Table 4. *Dry matter content (%) of the litter of broilers receiving 80%, 95% and 100% organic feed from 5 - 11 weeks of age*

Age (weeks)	80%	95%	100%
5	63	63	56
7	70[a]	73[a]	61[b]
9	72	76	73
11	77	79	77

[ab]Values in a row not sharing a common superscript are significantly different ($P<0.05$).

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Table 5. *Body condition of broilers receiving 80%, 95% and 100% organic feed at 10 weeks of age*

	80%	95%	100%
Breast smearing: none	1.5	1.5	3.0
slight	79.5	85.5	84.0
moderate	19.0	13.0	13.0
Breast irritations: none	60.5	74.5	72.0
slight	32.5	20.5	22.5
moderate	7.0	5.0	5.0
severe	0.0	0.0	0.5
Breast blisters: none	45.0[a]	24.5[b]	22.5[b]
slight	48.0[(a)]	64.5[(b)]	69.0[(b)]
moderate	7.0	11.0	8.5
Hock irritations: none	88.0	85.0	84.0
slight	12.0	14.0	15.0
moderate	0.0	1.0	1.0
Footpad irritations: none	97.0[(ab)]	99.5[(a)]	94.5[(b)]
slight	3.0	0.5	4.0
moderate	0.0	0.0	1.5

[ab]Values in a row not sharing a common superscript are significantly different ($P<0.05$).

[(a) (b)]Different superscripts between brackets indicate a tendency ($P<0.10$).

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Table 6. *Processing yields of broilers receiving 80%, 95% and 100% organic feed at 11 weeks of age*

	80%	95%	100%
Carcase (% of live weight)	68.7	70.0	69.0
Leg (% of carcase weight)	33.9[(a)]	33.8[(a)]	34.3[(b)]
Wing (% of carcase weight)	11.8[a]	11.7[a]	12.1[b]
Breast (% of carcase weight)	21.8	21.3	21.2
Back (% of carcase weight)	9.6	9.8	9.7

[ab]Values in a row not sharing a common superscript are significantly different ($P<0.05$).

[(a) (b)]Different superscripts between brackets indicate a tendency ($P<0.10$).

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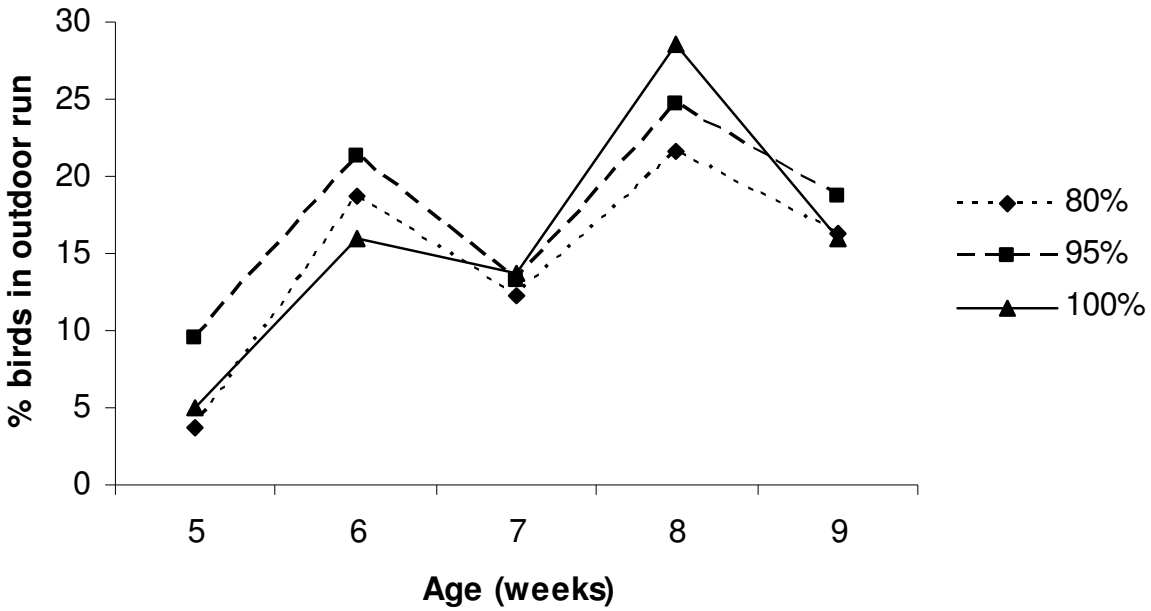
Table 7. *Economic results for broilers receiving 80%, 95% and 100% organic feed (€ per 1000 kg live weight)*

	80%	95%	100%
Day old chicken	169	167	174
Feed costs	973	1000	1049
Other variable costs	113	112	116
Housing costs	185	182	190
Labour costs	283	280	291
Other non-variable costs	96	95	99
Total costs	1828	1843	1927

For Peer Review Only

Figure. *Percentage of broilers observed in the outdoor run for groups receiving 80%, 95%, or 100% organic feed from 5 - 9 weeks of age.*



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