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NARBON VETCH (*VICIA NARBONENSIS*) AS A POTENTIAL SUBSTITUTE OF SOYABEAN MEAL IN BROILER DIETS

K.M. Charalambous, P. Hadjigeorgiou and Chr. Papachristoforou

AGRICULTURAL RESEARCH INSTITUTE
MINISTRY OF AGRICULTURE, NATURAL RESOURCES AND THE ENVIRONMENT

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Dr A.P. Mavrogenis, Agricultural Research Institute, Nicosia, Cyprus.

NARBON VETCH (*VICIA NARBONENSIS*) AS A POTENTIAL SUBSTITUTE OF SOYABEAN MEAL IN BROILER DIETS

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ABSTRACT

An experiment was conducted to study the effect of feeding raw or autoclaved Narbon vetch (*Vicia narbonensis*) grain in partial substitution of soybean meal in broiler diets. Narbon vetch grain was used at the level of 10%, either raw (R) or autoclaved (T), in isonitrogenous starter (0-28 days) or grower (29-56 days) diets. At 4 weeks, half of the chicks raised on the R starter diet continued on the R grower diet (RR) and half were shifted to the T grower diet (RT). At the same time, half of the chicks raised on the T starter diet continued on the T grower diet (TT) and half were shifted to the R grower diet (TR). At 4 weeks of age, the cumulative weight gain (CWG) of chicks on raw vetch was significantly lower ($P<0.01$) than that of chicks on the control corn-soybean meal diet or on the autoclaved vetch diet. The CWG of chicks (from 29 to 49 or 29 to 56 days) on the raw vetch grower diet (groups RR and TR) was significantly ($P<0.01$) lower than that of chicks on the autoclaved vetch (groups TT and RT) and on the control (CC) grower diets. In accord with trends in CWG, cumulative feed consumption (CFC) from the start of the trial until 4,7 or 8 weeks of age, tended to be lower for chicks offered the raw vetch diets. Considering that no adverse effects were observed on the health of chicks that could be attributed to the use of raw or treated vetch, it can be concluded that Narbon vetch can be used in substituting part of soybean meal in broiler diets. Furthermore, autoclaving seems to be an effective method for denaturation of anti-growth factors in Narbon vetch. The use of Narbon vetch in broiler diets will depend on its price as raw feedstuff, the cost of autoclaving and the price of soybean meal.

ΠΕΡΙΛΗΨΗ

Η παρούσα εργασία έγινε για να δοκιμαστεί σε σιτηρέσια πάχυνσης ορνίθων κρεοπαραγωγής μερική αντικατάσταση της σόγιας από σπόρους Ναρβονικού βίκου οι οποίοι χρησιμοποιήθηκαν χωρίς επεξεργασία ή μετά από θέρμανση τους σε 120 ^{0}C υπό πίεση 17 bar για 30 λεπτά. Το ποσοστό αντικατάστασης της σόγιας με επεξεργασμένους ή μη σπόρους Ναρβονικού βίκου σε ισοπρωτεϊνικά σιτηρέσια έναρξης (0 μέχρι 28 μέρες) και ανάπτυξης (29 μέχρι 56 μέρες) ήταν 10%. Στις 28 μέρες, τα κοτόπουλα που μέχρι τότε έπαιρναν το σιτηρέσιο με τους επεξεργασμένους σπόρους (ομάδα Α) χωρίστηκαν σε δύο υποομάδες (με ίσο αριθμό στην κάθε μια) και τοποθετήθηκαν είτε σε σιτηρέσιο ανάπτυξης με επεξεργασμένους σπόρους (ΑΑ), είτε σε σιτηρέσιο με μη επεξεργασμένους σπόρους (ΑΒ). Με τον ίδιο τρόπο, η ομάδα που μέχρι τις 28 μέρες έπαιρνε σιτηρέσιο με μη επεξεργασμένους σπόρους (ομάδα Β) χωρίστηκε σε δύο υποομάδες και η μια τοποθετήθηκε σε σιτηρέσιο ανάπτυξης με μη επεξεργασμένους σπόρους (ΒΒ) ενώ η άλλη με επεξεργασμένους σπόρους (ΒΑ). Χρησιμοποιήθηκαν συνολικά 795 κοτόπουλα κρεοπαραγωγικής φυλής μιας ημέρας, με ίσο αριθμό των δύο φύλων. Μέχρι την ηλικία των 28 ημερών, η ανάπτυξη των κοτόπουλων της ομάδας Β ήταν σημαντικά πιο αργή εκείνων του μάρτυρα και της ομάδας Α. Από τις 29 μέχρι τις 49 ή τις 56 μέρες, η ανάπτυξη των κοτόπουλων στις ομάδες ΑΒ και ΒΒ (σιτηρέσιο με μη επεξεργασμένους σπόρους) υστερούσε σημαντικά εκείνης των κοτόπουλων του μάρτυρα και των ομάδων ΑΑ και ΒΑ (σιτηρέσιο με επεξεργασμένους σπόρους). Επι πλέον, υπήρξε τάση για μειωμένη συνολική πρόσληψη τροφής μέχρι τις 4, 7 ή 8 εβδομάδες στα κοτόπουλα που έπαιρναν σιτηρέσια με μη επεξεργασμένους σπόρους βίκου σε σύγκριση με τις υπόλοιπες ομάδες. Τα αποτελέσματα αυτά σε συνδυασμό με το γεγονός ότι η υγεία και θνησιμότητα των πτηνών δεν επηρεάσθηκαν από την πρόσληψη σπόρων Ναρβονικού βίκου, οδηγούν στο συμπέρασμα ότι οι σπόροι αυτού του ψυχανθούς μπορούν να αντικαταστήσουν μερικώς τη σόγια σε σιτηρέσια πάχυνσης. Η θερμική επεξεργασία των σπόρων Ναρβονικού βίκου φαίνεται να είναι αποτελε-

σματική μέθοδος εξουδετέρωσης ουσιών που υπάρχουν σε σπόρους ψυχανθών και περιορίζουν το ρυθμό ανάπτυξης. Η χρήση του Ναρβονικού βίκου σε σιτηρέσια πάχυνσης ορνίθων κρεοπαραγωγής εξαρτάται από την τιμή του και το κόστος επεξεργασίας σε σύγκριση με την τιμή της σόγιας.

INTRODUCTION

Modern poultry production is exclusively based on corn-soybean meal diets supplemented with animal protein and/or synthetic aminoacids. In semi-arid areas, shortages of poultry feed ingredients have led nutritionists to investigate the possibility of using locally produced legume seeds in poultry rations. In this respect, much emphasis has been given to peas, broadbeans and vetch.

Narbon vetch (*Vicia narbonensis*) is a new promising species recently introduced in Cyprus from ICARDA, Syria. It is well known that most leguminous seeds contain antinutritional substances, mainly tannins or trypsin and chymotrypsin inhibitors, which interfere with digestive enzymes. Untreated vetch seeds have been found to be detrimental to monogastric animals, especially chickens. Harper and Arscott (1962) showed that inclusion of 30% of common vetch in diets resulted in 70% mortality of poults within 19 days, and 95.8% mortality of chicks within 12 days. In other studies, Arscott and Harper (1963, 1964) reported 100% mortality of chicks fed 30% common vetch seeds. However, Ocio *et al*. (1980), feeding a diet with 34% common vetch to young Lenghorn chicks for a period of 4 weeks, observed a reduction in growth rate but no mortality. Common vetch at the low rate of 10% (Ergum *et al*., 1990) or 15.6% (Castanon and Perez-Lanzac, 1990) in the ration significantly decreased feed intake and egg production. It is believed that ill effects are caused by certain heat-labile toxins, such as vicianin, b-cyano-alanine, vicine and convicine or their metabolites (Liener, 1980; Roy, 1981).

Various methods have been adopted for the denaturation of the various antinutritional factors contained in leguminous seeds. Water soaking followed by autoclaving or autoclaving alone alleviated the toxicity symptoms and reduced the mortality rate among poults and young broilers (Harper and Arscott, 1962). Fernandez-Figares *et al.* (1995) reported that autoclaving increased apparent digestibility of common vetch and bitter vetch seeds. Eason *et al* (1990), using male broiler-type chicks (1 to 21 days), found no significant differences in chick growth, feed consumption and feed conversion between diets containing Narbon vetch at the levels of 5 or 10% and soybean meal or meat and bone meal as protein sources.

Osborne and Mendel (cited by Markley, 1951) were the first to observe the favourable effect of heated soybean protein on the growth of the rat. An effective method for the treatment of soybean and other leguminous seeds is wet toasting under pressure to avoid extremely high temperatures, which may render unavailable some aminoacids of the protein, such as lysine (Mailard reaction-browning effect). Evans and Bandemer (1967) studied the *in vitro* digestion of raw and heated soybean meals using various combinations of pepsin, trypsin and erepsin. Heat treatment (30 minutes at 100 to 120 ^{o}C) was found to increase trypsin digestion, the favourable effect being doubled by employing a preliminary pepsin digestion. Higher autoclaving temperatures decreased digestion by all enzymes and combinations used. Comparing the digestibility by the chick of the raw meal with that of the meal autoclaved for 30 minutes at 120 ^{o}C, the approximate coefficients were 77 and 90 for protein, 51 and 70 for organic sulfur, 35 and 57 for cystine sulphur and 78 and 94 for methionine sulphur, respectively. Everson *et al.* (cited by Markley, 1951) found that the protein efficiency ratio of soybean, determined on growing rats with diets containing 10% protein, increased from 0.48 to 1.70 by autoclaving for 15 minutes at 1.2 atm steam pressure. Everson and Heckert (cited by Markley, 1951) showed that the growth promoting value of protein of other legume seeds, including the Lima bean, the navy bean, the kidney bean and the pinto bean, was improved by heating, although in many cases the value of the heated products was still very low.

The objectives of the present work were to investigate in growing broiler chicks, 1) the possibility of using Narbon vetch grain as a protein source for partial substitution of soybean meal, and 2) to study the effect of autoclaving in improving the nutritional value of Narbon vetch grain.

MATERIALS AND METHODS

Seven hundred and ninety five straightrun day-old broiler chicks were allocated during the starter period (0 to 28 days of age) to the following treatments, after individual weighing and wingbanding.

(a) **Control (C)** **:** Three groups of 53 chicks each
(b) **Raw vetch (R)** **:** Three groups of 106 chicks each
(c) **Treated vetch (T)** **:** Three groups of 106 chicks each

The proportion of males to females within groups and treatments was circa 50%.

The groups on C were fed a control diet based on corn-soybean meal, those on R a diet containing 10% raw Narbon vetch grain, and those on T a diet containing 10% heat-treated (autoclaved) Narbon vetch grain. The inclusion of Narbon vetch was at the expence of soybean meal and corn (Table 1).

During the grower-finisher period (29 to 49/56 days), the three C groups continued on a control corn-soybean meal grower diet (CC), while half of the chicks from each replicate on R were shifted to a 10% autoclaved vetch grower diet (RT) and the rest continued on a 10% raw vetch grower diet (RR). Similarly, half of the chicks from each group on T were shifted to 10% raw vetch grower diet (TR), while the rest continued on a 10% autoclaved vetch grower diet (TT).

The need to keep experimental diets isonitrogenous, the limitations in the number of experimental pens, as well as the quantity of Narbon vetch available for this experiment, did not allow the use of Narbon vetch in more than one levels.

All three starter diets were prepared in mash form after a preliminary proximate analysis of the main feed ingredients, and were made isonitrogenous and of similar aminoacid (methionine-lysine) and mineral content. The same holds true for the 3 grower diets (Table 1). For the treated vetch diets, vetch seed was autoclaved at 120 ^{o}C and 17 bar pressure for 30 min. Aminoacid analysis

Table 1. Composition of experimental diets

	Starter diet (0-28 days)		Grower diet (28-56 days)	
Ingredient	Control	Vetch (R and T)	Control	Vetch (R and T)
Herringmeal-72	1.50	1.50	1.50	1.50
Meatmeal-60	2.50	2.50	2.50	2.50
Soybean meal-44	31.80	28.20	25.48	22.00
Yellow corn	61.45	55.34	67.65	61.13
Narbon vetch	-	10.00	-	10.00
Limestone	1.00	0.70	1.25	1.30
Dic. Phosphate	1.40	1.40	1.30	1.25
DL-Methionine	0.15	0.16	0.12	0.12
Sodium Chloride	0.20	0.20	0.20	0.20
Vit-Mineral premix*	0.35	0.35	0.35	0.35
Calculated Analysis				
Crude Protein (%)	21.80	21.80	19.50	19.50
Met. Energy Kcal/kg	2890	2796	2957	2850
Methionine (%)	0.50	0.50	0.44	0.44
M+C (%)	0.84	0.84	0.75	0.75
Lysine (%)	1.20	1.21	1.04	1.04
Ca (%)	1.05	0.91	1.10	1.10
P (%)	0.50	0.50	0.48	0.48
Linoleic acid (%)	1.30	1.17	1.39	1.25
Salt (%)	0.30	0.30	0.30	0.30

* All diets were supplemented with a mineral-vitamin premix (VTN CM1191) which supplied the following per kg of diet: Vit. A 15 000 I.U., Vit. D3 2800 I.U., Vit. E 40 I.U., Vit. B1 6 mg, Vit. B2 5 mg, Nicotinic acid 35 mg, Pantothenic acid 10 mg, Pyridoxine 1 mg, Folic acid 0.9 mg, B12 0.015 mg, Biotin 0.1 mg, choline-cl 250 mg, Zn 75 mg, Mn 85 mg, I 1 mg, Fe 60 mg, Se 0.1 mg, Co 0.5 mg, Cu 5 mg, BHT 6 mg. Starter diets were supplemented with coccidiostat (0.5 kg/t of finished feed).

Table 2. Proximate and aminoacid analysis of raw materials and experimental diets (dry matter basis)

Aminoacid	Narbon Vetch Autoclaved	Narbon Vetch Raw	Fish-meal	Meat meal	Starter diets C	Starter diets T	Starter diets R	Grower diets C	Grower diets T	Grower diets R
Aspartic	2.25	2.85	7.12	5.27	2.83	2.38	2.83	2.62	2.79	2.72
Serine	1.24	1.90	2.37	4.34	1.81	1.59	1.92	1.37	1.59	1.48
Glutamic	2.59	3.31	7.77	6.72	3.74	3.40	3.74	3.30	3.40	3.29
Glycine	2.03	1.69	5.72	5.69	2.83	2.04	2.15	2.16	2.73	2.27
Histidine	2.25	1.90	7.23	7.13	3.29	2.27	3.28	2.51	3.07	2.50
Arginine	0.34	0.46	8.85	5.38	0.34	0.45	0.45	0.34	0.45	0.34
Threonine	1.12	1.23	3.67	2.48	0.91	1.13	0.90	0.91	0.80	0.90
Alanine	0.56	0.54	2.70	2.58	0.91	1.02	0.68	0.57	0.68	0.68
Proline	0.68	0.96	4.96	4.03	1.59	1.81	1.36	1.48	1.25	1.14
Cystine	0.45	0.45	1.40	1.14	0.68	0.68	0.57	0.46	0.45	0.68
Tyrosine	1.24	1.06	3.13	2.69	1.36	1.13	1.36	1.25	1.36	1.32
Valine	1.80	1.79	4.85	3.83	1.59	1.59	1.59	1.48	1.59	1.48
Methionine	0.45	0.45	2.27	1.24	0.79	0.79	0.79	0.68	0.80	0.79
Lysine	1.58	2.13	6.25	3.41	1.25	1.47	1.70	1.82	1.36	1.25
Isoleucine	1.58	1.68	4.85	3.72	1.81	1.81	1.80	1.82	1.93	1.82
Leucine	2.14	2.13	5.61	4.86	2.83	4.08	2.83	2.85	2.95	4.08
Phenylalanine	1.58	1.57	4.85	3.72	2.26	2.04	2.26	1.82	1.93	1.93
Tryptophane	0.25	0.25	-	-	-	-	-	-	-	-
Proximate analysis										
Dry matter	88.80	89.20	92.70	89.70	88.20	88.20	87.30	87.80	88.00	88.10
CP	24.07	24.21	76.80	57.40	24.49	24.03	25.36	21.64	21.59	22.3
EE	2.03	1.23	8.73	15.50	3.74	3.63	3.28	3.76	3.30	3.52
Fiber	8.78	8.85	0.11	2.48	4.43	3.85	4.07	3.99	3.75	3.29
Ash	4.50	4.41	11.65	19.2	6.00	6.12	5.66	5.75	5.68	5.79
NFE	57.00	61.3	2.70	5.38	61.34	62.35	61.60	64.84	65.68	68.27
Ca	0.135	0.12	1.75	4.40	0.77	0.78	0.76	0.99	1.02	1.23
P	0.25	0.22	1.28	2.80	0.48	0.52	0.59	0.51	0.43	0.42
Na Cl	0.19	0.19	1.57	1.32	0.45	0.45	0.33	0.33	0.33	0.40

CP: crude protein, EE: ether extract, NFE: nitrogen free extract, Ca: calcium, P: phosphorus, NaCl:salt.

for both raw materials and experimental diets (Table 2) was carried out by Waters AccQ. Tag Aminoacid Analysis System (R.F. Bourgoine, 1993).

The chicks were placed in floored pens indoors and had free access to feed and water under continuous lighting. The trial took place in winter time and heat was supplied by small gas brooders, one for each pen. Individual chick liveweight was recorded on a weekly basis, while feed consumption was recorded weekly on a group basis.

Statistical analysis

Growth data were analysed using GLM procedures (SAS, 1989) that accounted for the effects of replication, treatment, sex and their two-way interactions. During the starter period (0 to 4 weeks), three treatments were considered (C, R and T), while during the grower period (5 to 7/8 weeks), the number of treatments considered was 5 (CC, RR, RT, TT and TR). Weekly and cumulative weekly feed consumption and feed conversion data were also analysed using GLM procedures that accounted for treatment effects.

Differences among means were tested using the Duncan's new multiple range test criterion.

RESULTS

Chick mortality. Eighteen chicks died during the starter period (5, 6 and 7 for the C, T and R groups, respectively), while in the grower (29 to 56 day) period, 44 more chicks died (9, 12, 8, 9, 6 for the CC, TT, RT, TR and RR groups, respectively). The post-mortem examination revealed that ascites was the death cause for 30 out of 62 chicks, six chicks died from suffocation, seven from *staphylococcal infection,* while 12 from other unidentified causes. Ascites was much more severe (16/27 chicks) in all treatment groups housed in building A, compared to those housed in building B.

Growth rate. Treatment, sex and replication were significant sources of variation for cumulative chick body weight gain (Tables 3 and 4) throughout the experimental period. The only significant interaction was between treatments and replications during the starter period.

As expected, males were significantly (P<0.01) heavier than females as early as eight days of age, the mean weight difference being 397 g by 49 days and 300 g by 56 days. The 4-week mean liveweight gain (Table 4) was significantly higher for C (1131 g) than for T (1114 g) and R (1052 g), the difference between T and R being also significant.

At seven weeks of age all chicks practically reached slaughter weight. As far as the 5 to 7 week mean weight gain is concerned, there was a significant advantage of chicks on treated vetch diets, i.e. RT (1704 g) and TT (1674 g), over the chicks on raw vetch diets, i.e. RR (1611 g) and TR (1567 g), while the control CC groups had an intermediate weight gain (1661 g). Differences between RT and CG may be explained by minor aminoacid differences in the respective diets.

The mean 5 to 8 week cumulative body weight gain was again higher for the TT (2217 g) and RT (2210 g) groups and not statistically different from the CC (2178 g) group; it was lower for the groups on the raw vetch diets RR (2132 g) and TR (2043 g). In summary, the groups on raw vetch grower diets gained significantly less weight than those on the control or on the treated vetch diets.

Feed consumption. Weekly and cumulative weekly figures for food consumption were

Table 3. Mean squares (MS) and tests of significance for cumulative liveweight gain in chicks

	0 to 4 weeks		5 to 7 weeks		5 to 8 weeks	
Source of Variation	df	MS	df	MS	df	MS
Replication	2	105110**	2	138594**	2	124208**
Treatment	2	512156**	4	406633**	4	686773**
Sex	1	3955958**	1	28762039**	1	54069758**
Treat x replication	4	30397*	8	36416	8	53092
Treat x sex	2	25023	4	9193	2	51754
Replication x sex	2	5487	2	22810	4	29739

* Significant at P<0.05; **significant at P<0.01.

Table 4. Treatment and sex effects on the cumulative liveweight gain of chicks

		0 to 4 weeks		5 to 7 weeks	5 to 8 weeks
Effect	Subclass	LWT Gain (g)	Subclass	LWT Gain (g)	LWT Gain (g)
Treatment	C	1131a	CC	1661b	2178a
	R	1052c	RR	1611c	2132b
			RT	1704a	2210a
	T	1114b	TT	1674ab	2217a
			TR	1567d	2043c
Sex					
	Males	1167a		1840a	2432a
	Females	1017b		1443b	1882b

Means within columns for treatment and sex effects followed by different letters are significantly different (P<0.05) using Duncan's New Multiple Range Test.

Table 5. Weekly feed consumption (FC) and cumulative weekly feed consumption (CFC) of chicks during the first three weeks of the experiment

	Week 1	Week 2		Week 3	
Treatment	FC	CF	CFC	CF	CFC
C	166ab	386a	552a	648ab	1200a
R	158b	365b	523b	627b	1150b
T	171a	388a	559a	658a	1217a

Figures within columns followed by different letters are significantly (P<0.05) different.

statistically different between treatments during the first 3 weeks of the experiment (Table 5). In all cases, chicks on the raw vetch diet consumed less food than those on the control and the autoclaved vetch diets. The same trend continued during the rest of the experimental period (weeks 4 to 8), but differences were not significant (Table 6).

Feed conversion. Weekly and cumulative weekly feed conversion ratios were not statistically significant between treatments. For the starter and grower periods, the cumulative consumption and conversion figures are shown in Table 6.

DISCUSSION

Proximate analysis and aminoacid profile of Narbon vetch. Crude protein and fiber content of Narbon vetch grain (expressed on DM basis) were 24.1 to 24.2 and 8.78 to 8.85%, respectively as compared with 24.4 and 8.2% for common vetch reported by Castanon and Perez-Lanzac (1990). However, the ether extract content (1.23 to 2.03%) was appreciably higher than that of common vetch reported by the above researchers (0.8%).

The aminoacid profile of autoclaved narbon vetch showed increases of glycine and histidine and decreases in glutamine, serine, aspartic acid, proline and lysine content compared to the raw sample. The aminoacid picture of the Narbon vetch used, is similar for most aminoacids except for histidine, isoleucine, phenylalanine and valine, to that reported by Evans and Bandemer (1967) and Farran *et al* (1995) for two different varieties of common vetch.

Chick mortality

The high incidence of ascites syndrome is attributed to the accelerated growth rate of chicks, in combination with the cold weather that persisted during the early and middle period of the experiment. The effect of housing was prominent as mortality from ascites in building A was two times higher than that in building B.

Growth rate

The performance of chicks in terms of liveweight gain is considered satisfactory for all treatment groups. However, comparing the 4-week cumulative bodyweight gains, one can recognise (even as early as the 2nd week) that the chicks on the autoclaved vetch starter diet had significantly better growth than those on the raw vetch diet, while those on the control starter diet had significantly higher weight gains from those on both raw and treated vetch diets.

The advantage of the autoclaved vetch and control diets over the raw vetch diet continued during the grower (5 to 7 or 5 to 8 week) period. Moreover, the change over of diets containing the raw (R) or autoclaved (T) vetch during the starter period to autoclaved (RT) and raw vetch (TR) respectively, during the grower period, clearly demon-

Table 6. Cumulative Group Feed Consumption (Cons) and Feed Conversion (Conv) Ratios by Treatment

	0 to 4 weeks			0 to 7 weeks		0 to 8 weeks	
Treatment	Cons	Conv	Treat	Cons	Conv	Cons	Conv
C	2089	1.847	CC	6111	2.189	7767	2.348
R	1992	1.897	RR	5811	2.193	7744	2.350
			TR	5867	2.204	7425	2.366
T	2083	1.871	TT	6167	2.202	7804	2.334
			RT	6189	2.234	7879	2.405

strated the effect of raw vetch on growth depression.

The dietary supply of methionine and lysine seemed to be adequate in meeting the growth requirements of chicks, though, in the case of raw vetch, the observed growth depression demonstrated the necessity for the autoclaving treatment in order to alleviate the adverse effect.

Feed consumption

During the starter period, there was apparently a lower feed intake of chicks on raw vetch, particularly during the first 3 weeks. The changeover at 4 weeks of diets with the raw or autoclaved vetch (TR versus RT) indicated a trend towards lower feed consumption of chicks on raw vetch diets. This is consistent with the respective growth data showing that the possible cause of the lower 5 to 7 or 5 to 8 week cumulative weight gains of chicks on diets with the raw vetch was due to lower feed intake. This is in agreement with the results of Castanon and Perez-Lanzac (1990), who reported significant negative relationship between inclusion level (15 to 45%) of vetch and feed intake of white Leghorn hens. The present results are also in agreement with those of Farran *et al.* (1995), who reported that vetch at the level of 25% in the diets of laying hens was not detrimental to layers performance when autoclaved.

Feed conversion

Since this parameter is a function of feed consumption and weight gain and as the weight gain differences were most probably due to feed intake differences, it is rational that no differences were observed in cumulative feed conversion ratios.

Economic evaluation of Narbon vetch

With the present price of soybean meal (£145/t) and the subsidized price of yellow corn (£46/t), the corresponding usable price of Narbon vetch, as calculated from the data of chick weight gains and feed consumption, should be £80.3 to 80.7/t. This does not include the autoclaving cost.

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