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EFFECTS OF SUBSTITUTION OF SOYBEAN MEAL-ALFALFA-MAIZE BY A COMBINATION OF FIELD BEAN OR PEA WITH HARD WHEAT BRAN ON DIGESTION AND GROWTH PERFORMANCE IN RABBITS IN ALGERIA

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Abstract: The aim of the trial was to study the effects of replacement of a soybean meal-alfalfa-maize based diet by a mixture of field bean (g/kg as fed: 257 crude protein [CP], 139 neutral detergent fibre [NDF]) or pea (g/kg as fed: 203 CP, 122 NDF) combined with hard wheat bran (g/kg as fed: 140 CP, 396 NDF) and without supplementation of synthetic *DL*-methionine, on diet digestibility, growth and slaughter traits of growing rabbits. Three diets were formulated: a control diet mainly consisting of 15% of soybean meal, alfalfa and maize (SBM15 diet; g/kg as fed: 161 CP and 267 NDF) and 2 experimental diets based on 26% of field bean (FB26 diet; g/kg as fed: 167 CP and 250 NDF) or 30% of pea (P30 diet; g/kg as fed: 167 CP and 255 NDF) as main protein source, and completed with hard wheat bran (34 and 40%, respectively for FB26 and P30 diets) partly replacing alfalfa and maize. Diets were distributed *ad libitum* to 3 groups of 40 mixed-sex growing rabbits of Algerian white population, placed in collective cages (4 rabbits/cage) from weaning (28 d, mean weight: 614±112 g) until 77 d of age (slaughter). Faecal digestibility was measured between 42 and 46 d of age in 7 rabbits/group. Gross energy and crude protein digestibility coefficients were similar for SBM15 and FB26 diets (78.6 and 86.4%, respectively) and lower for P30 diet (75.1 and 83.6%, respectively; $P \leq 0.03$). Treatments had no effect ($P=0.12$) on mortality rate, which was on av. 9.2%. Treatments did not affect growth performance from 28 to 77 d of age (30.8 g/d) or feed intake (mean 94.6 g/d), but feed conversion ratio was higher for rabbits fed FB26 and P30 diets compared to those fed SBM15 diet (3.13 *vs.* 2.94; $P=0.006$). The dressing out percentages (mean 66.6%) and the muscle/bone ratio (6.8) were similar for the 3 groups of rabbits. In conclusion, the substitution of soybean meal-alfalfa-maize by a combination of field bean or pea with hard wheat bran, without methionine supplementation, does not seem to affect growth, nor the slaughter performances of the local growing rabbits. However, digestion of pea diet was reduced and feed efficiency of FB26 and P30 diets was impaired.

Key Words: digestibility, field bean, growth performance, pea, rabbit, slaughter traits.

INTRODUCTION

In the Algerian context, rabbit production is seriously affected by dependence on imports for the majority of feed ingredients, such as soybean meal, alfalfa and maize. Therefore, the development of rabbit breeding requires a search for local ingredients and the incorporation of grain legumes, such as field bean or pea, as alternative protein source, associated with hard wheat bran partly substituting alfalfa and maize in balanced pelleted diets, should help improve self-sufficiency in imported protein-rich feedstuffs.

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In Europe, the use of field bean and pea grains in rabbit feeding was reported in several studies (Colin and Lebas, 1976; Berchiche and Lebas, 1984; Seroux, 1984, 1988; Berchiche *et al.*, 1988, 1995a,b; Castellini *et al.*, 1991), while in Algeria, data on the use of these local raw materials in concentrate pelleted diets are scarcely reported for field bean (Berchiche *et al.*, 1999; Lounaouci *et al.*, 2008) and inexistent for pea. All studies cited indicated that rabbits can use field bean efficiently. For pea, some works (Seroux, 1984; Gutiérrez *et al.*, 2002) have shown a decrease in total tract apparent digestibility of dry matter and crude protein and a deterioration of feed efficiency when a mixture of cereal grains and soybean meal was substituted with pea. Moreover, those protein-rich legumes are characterised by a low content of sulphur amino acids and their use in rabbit feeds require a supplementation of synthetic *DL*-methionine (Colin, 1978; Berchiche and Lebas, 1984; Berchiche *et al.*, 1995a).

Hard wheat bran is abundantly available because Algerians are among the largest wheat consumers (205 kg/habitant year) in the world (Boudouma, 2009). The review of Lebas (2004) and previous works (Berchiche *et al.*, 2000; Lakabi *et al.*, 2008; Lounaouci *et al.*, 2011b) from our laboratory have demonstrated that this fibrous by-product can be used up to 40-50%. The study of Lounaouci *et al.* (2012) also showed that the incorporation of hard wheat bran up to a rate of 45%, in a growing rabbit's diet without soybean meal, did not impair growth and slaughter performances.

Due to limited literature reports on the use of hard wheat bran, faba bean and especially pea grains in diet formulation for growing rabbits in Algeria, the main objective of the current trial was to study how the replacement of soybean meal-alfalfa-maize by a mixture of field bean or pea with hard wheat bran and without supplementation in methionine affects the health, digestion, growth and slaughter performances of rabbits used in the Algerian context.

MATERIALS AND METHODS

The experiment was conducted during the months of May and June, in a rabbit breeding unit located near the University of Tizi-ouzou (Algeria). Animals were kept in a closed room with mean temperature and hygrometry ranging respectively from 19 to 23°C and from 68 to 78%. No artificial light schedule was applied.

Experimental diets

Three diets were formulated and pelleted (4 mm diameter, 9 mm length). The control diet (SBM15 diet) mainly consisted of 15% of soybean meal (as main source of protein), alfalfa (36%), maize (30%) and wheat bran (16%). Two other diets were prepared with total replacement of soybean meal protein by field bean (*Vicia faba*), incorporated at 26% (FB26 diet) or pea (*Pisum sativum*) incorporated at 30% (PS30 diet), without supplementation of synthetic *DL*-methionine. These 2 experimental diets were completed with hard wheat bran (34 and 40%, respectively for FB26 and P30 diets), included partly in place of dehydrated alfalfa and maize. It must be noted that soybean meal, field bean and pea accounts for around 39% of dietary protein and the combination of soybean meal-alfalfa in SBM15 diet and field bean or pea with hard wheat bran, in FB26 and P30 diets, provided nearly 71.6% of dietary protein. The chemical composition of the 3 protein sources studied is reported in Table 1. Diets were formulated to have a similar crude protein (16.5%) and fibre content (on av. 25.8% NDF; Table 2) and to cover the requirements for growth (Gidenne, 2000; Lebas, 2004). No antibiotics were added to the diets or in the water.

Table 1: Chemical composition of soybean meal, field bean, pea and hard wheat bran[1].

g/kg, as raw basis	Soybean meal	Field bean	Pea	Hard wheat bran
Dry matter	907	913	912	890
Ash	65	33	31	43
Crude protein (N×6.25)	439	257	203	140
Neutral detergent fibre (NDF)	124	139	122	396
Acid detergent fibre (ADF)	74	92	61	119
Acid detergent lignin (ADL)	4.1	8.0	3.2	34

[1]Samples from the material incorporated in the 3 experimental diets.

Table 2: Ingredient and chemical composition of the 3 experimental diets.

	Experimental diets		
	SBM15	FB26	P30
Ingredient (% as fed):			
Soybean meal	15.00	0	0
Field bean	0	26.00	0
Pea	0	0	30.00
Hard wheat bran	16.00	34.00	40.00
Dehydrated alfalfa	36.00	25.00	25.00
Maize	30.00	12.00	2.00
Wheat straw	2.00	2.00	2.00
Vitamin/mineral premix[1]	1.00	1.00	1.00
Chemical composition (g/kg, as raw basis):			
Dry matter	904	905	903
Ash	56	57	56
Crude protein (N×6.25)	161	167	167
Neutral detergent fibre (NDF)	267	250	255
Acid detergent fibre (ADF)	133	117	120
Acid detergent lignin (ADL)	36	27	28
Gross energy, (MJ/kg)	15.61	15.60	15.52
Calculated nutrient[2] (%):			
Sulphur amino-acids	0.53	0.45	0.46
Lysine	0.77	0.80	0.83
Tryptophan	0.19	0.17	0.18

SBM15: 15% of soybean meal, FB26: 26% of field bean, P30: 30% of pea.

[1]Premix "Rabbit CMV at 1%" manufactured by Nutristar International. Mineral and vitamin composition (g/kg premix): Se, 0.08; Mg, 2.6; Mn, 2.0; Zn, 6.0; I, 0.08; Fe, 4.0; Cu, 1.10; S, 6.8; Co, 0.04; thiamin, 0.20; riboflavin, 0.20; calcium d-pantothenate, 0.8; pyridoxine, 0.10; biotin, 0.004; nicotinic acid, 2; choline chloride, 12; folic acid, 0.20; vitamin K3, 0.1; dl-α-tocopheryl acetate, 2.0; biotin, 0.004; folic acid, 0.2; cyanocobalamin, 0.002; vitamin A, 950000 IU; vitamin D3, 120000 IU.

[2]Levels calculated according to INRA (2004).

Animals and measurements

A total of 120 mixed-sex rabbits of Algerian white population (Lounaouci *et al.*, 2008; Zerrouki *et al.*, 2008), weaned at 28 d of age and weighing on av. 614±12 g, were randomly assigned to the 3 experimental groups (40 rabbits/diet, distributed into 10 cages of 4 rabbits), according to weaning weight and litter origin. Rabbits were bred into collective (4 rabbits/cage) flat deck cages (62×48×28 cm). The need to use the highest possible number of experimental rabbits and the limited number of cages available justified the collective housing system adopted in this trial. However, it must be underlined that the feeding hopper of each collective cage was divided into 4 compartments. Rabbits were fed *ad libitum* one of the 3 experimental diets, without transition from maternal diet, until the end of the experiment, at 77 d of age. Fresh water was always available.

During the 7 wk of the experiment, the body weight and feed consumption were registered weekly, while the mortality was checked daily, according to the guidelines for applied nutrition experiments in rabbits (Fernandez-Carmona *et al.*, 2005).

At the end of the experimental period (77 d), 10 rabbits were randomly chosen from each treatment (one per cage) and slaughtered (at 9:00 a.m.), without fasting, in controlled conditions. The weight of skin, full digestive tract, hot (weighed 15 min after the slaughter) and cold carcass, liver, perirenal fat and hindleg were recorded in accordance with Blasco and Ouyahoun (1996). The only differences were that carcasses were presented with heads not skinned and with the distal part of fore and hind legs with their skin, according to the local market tradition. Cold carcasses

(chilling +4°C for 24 h in a chilling chamber with air circulation) were presented with head (not skinned), thoracic content (heart, lungs), liver, kidneys and the distal part of legs with their skin. The incidence of this non-standard presentation is about 0.7-0.9 points, less than 1 point on the slaughter rate or on the total skin proportion, according to results published by Rochambeau *et al.* (1996). Dressing out percentage was calculated for the cold carcass presentation. The relative weight of perirenal fat was expressed as a percentage of the cold carcass. The muscle to bone ratio of the hind leg was also calculated, according to Ouhayoun *et al.* (1983).

The digestibility trial was conducted according to the European reference method (Perez *et al.*, 1995), using 21 additional growing rabbits (7/diet), weaned at 35 d of age and weighing on av. 708±120 g. The rabbits were placed into individual metabolism cages (56×38×28 cm) and after a 7 d adaptation period, the collection of hard faeces was carried out between 42 and 46 d of age and stored daily in polyethylene bags at –18°C until chemical analysis.

Chemical analyses

The chemical analyses were conducted at Toulouse INRA centre (UMR1289 Tandem), France.

Feed samples and faeces were prepared for chemical analysis according to the recommendations of Perez *et al.* (1995) and the chemical composition was analysed by ISO methods and considering the recommendations proposed by the EGRAN group (EGRAN, 2001): dry matter (ISO 6496:1999), crude ash (ISO 5984:2002), crude protein (N×6.25, Dumas method, ISO 16634-2:2009), gross energy (ISO 9831:1998) and fibre (NDF, acid detergent fibre [ADF] and acid detergent lignin [ADL]) according to Van Soest sequential method and using crucibles (Tecator apparatus) (AFNOR 1997, ISO 16472:2006 and ISO 13906:2008).

Statistical analyses

Data were analysed as a completely randomised design with the Statistical Analysis System (SAS, 1988) using the general linear model (GLM procedure). The variance analysis was performed with the diet as the sole source of variation. Since animals were housed in collective cages (4 rabbits/cage), the experimental unit was the cage (10 cages/diet) for feed intake and daily weight, according to Fernández-Carmona *et al.* (2005). It must be emphasised that mortality did not modify the average initial weight of rabbits (612 g for those alive at the end *vs.* 614 g for the 120 initial rabbits), nor the balance between the 3 treatments. Therefore, growth traits were calculated only for those rabbits alive at the end of the trial. When the treatment effect was significant ($P<0.05$), differences between means were determined using the Duncan test (SAS, 1988). Mortality rate was analysed using the CATMOD Procedure of SAS, considering the rabbit as experimental unit.

RESULTS AND DISCUSSION

Nutritional composition and digestibility of experimental diets

The average crude protein content was similar for the 3 diets (Table 2) and within the values recommended for growing rabbits (150 to 170 g/kg, as raw basis) (Lebas, 2004; Xiccato and Trocino, 2010). However, the substitution of soybean meal by field bean or pea, associated with a higher proportion of hard wheat bran (16 *vs.* 34 and 40%), increased the level of calculated dietary lysine for FB26 and PS30 (0.80 and 0.83 *vs.* 0.77%) and reduced the calculated dietary level of sulphur amino acids (SAA: 0.45 and 0.46 *vs.* 0.53%) compared to the control (SBM15) diet. These SAA levels were under the recommended values (0.54 to 0.60%) for growing rabbits (Carabaño *et al.*, 2009; De Blas and Mateos, 2010).

The fibre level of field bean and pea diets was slightly lower, in comparison to that of soybean meal diet, since in their formulation, a proportion of dehydrated alfalfa was replaced by hard wheat bran, which is less concentred in fibre (INRA, 2004). Globally, the fibre content of the 3 diets was below the requirements for growing rabbits (Gidenne, 2003; De Blas and Mateos, 2010), with a mean ADF level of 12.3%.

The substitution of field bean-wheat bran for soybean meal-alfalfa-maize did not induce a difference in dry matter, gross energy and crude protein digestibility coefficients. However, these coefficients were lower for the pea diet (on av. –4, –4 and –3.3 percentage units) compared to soybean meal and field bean diets ($P<0.05$; Table 3). The digestibility coefficient of crude protein of field bean diet was similar to that obtained by Lounaouci *et al.* (2008) with white population rabbits fed diets containing 30% of field bean (85.8 *vs.* 87.4% respectively). The significant ($P<0.03$) decrease in nitrogen digestibility of pea diet could be related to the effect of the compact structure of pea proteins (Gatel, 1994; Crevieu-Gabriel, 1999) and to the presence of antinutritive factors (Jezierny *et al.*, 2010), which is in agreement with the higher ileal protein concentration found by Gutiérrez *et al.* (2002) in weaned rabbits fed a pea based diet. The digestion of insoluble dietary fibre (NDF and ADF) of SBM15 diet was higher compared to FB26 and P30 diets ($P<0.001$). NDF digestibility was higher for FB26 than for P30 diet ($P<0.05$) but their ADF digestibility was similar (on av. 28.0%).

The P30 diet provided the same quantity ($P=0.14$) of digestible crude protein as the SBM15 and FB26 diets, despite its lower crude protein digestibility. However, the digestible energy content of pea diet was 5% lower ($P<0.001$) than that of SBM15 diet.

As a consequence of the high digestibility coefficients of protein and energy content of the experimental feeds the digestible protein (DP) and digestible energy (DE) content of the experimental feeds was clearly above the recommended values for growing rabbit feeding (139-143 and 11.7-12.34 *vs.* 105-110 g DP/kg and 10.0-10.5 MJ DE/kg respectively) (Xiccato and Trocino, 2010). This may be attributed to the low fibre concentration (NDF: 25.8 *vs.* 31%), which would also account for the moderate level of feed intake (Table 4) of rabbits. The DP to DE ratio of field beans and pea diets was slightly higher than the recommended values (11.8 and 11.9 *vs.* 10.5-11.0 g DP/MJ DE; Xiccato and Trocino, 2010), but did not exceed the classic recommendations (11.5-12.0 g/MJ) for mixed diets (Lebas, 2004).

Health status, intake and growth of rabbits

During the entire experiment, the mortality (due to diarrhoea) occurred during the 1st and the 2nd experimental weeks and can probably be related both to the stress of weaning and the effect of the diet. Despite the fact that no significant effect of the diet on mortality rate was detectable ($P=0.14$), probably due to the number of rabbits used (10 cages of

Table 3: Effect of substitution of soybean meal-alfalfa-maize based diet by a combination of field bean or pea with hard wheat bran on faecal digestibility and nutritive value of experimental diets in growing rabbits between 42 and 46 d of age.

	Experimental diets			SEM	*P*-value
	SBM15	FB26	P30		
No. of rabbits	7	7	7		
Average daily feed intake (g/d)[1]	74.5	79.0	78.2	0.7	0.35
Digestibility coefficients (%):					
Dry matter	79.8[a]	78.2[a]	75.8[b]	0.6	0.004
Organic matter	79.2[a]	78.0[a]	75.6[b]	0.6	0.004
Crude protein	86.9[a]	85.8[a]	83.6[b]	0.5	0.03
Gross energy	79.1[a]	78.1[a]	75.1[b]	0.5	0.001
Neutral detergent fibre	50.5[a]	45.4[b]	39.3[c]	1.4	<0.001
Acid detergent fibre	39.6[a]	29.8[b]	26.1[b]	1.5	<0.001
Dietary nutritive value:					
Digestible protein (DP) (g/kg raw basis)[2]	139	143	139	0.82	0.14
Digestible energy (DE) (MJ/kg raw basis)[2]	12.3[a]	12.1[a]	11.7[b]	0.08	<0.001
Ratio DP/DE (g/MJ, raw basis)	11.34[a]	11.8[b]	11.94[b]	0.07	<0.001

SM15: 15% of soybean meal, FB26: 26% of field bean, P30: 30% of pea. SEM: standard error of the mean.

[1]Means corresponded to the value recorded from 7 rabbits/diet during the 42-46 d period of the digestibility trial.

[2]Calculated from digestibility coefficients obtained in the digestibility trial.

[a,b]Mean values in the same row with a different superscript differ at $P<0.05$.

Table 4: Effect of substitution of soybean meal-alfalfa-maize based diet, by a combination of field bean or pea with hard wheat bran, on growth rate, feed intake, feed conversion ratio and mortality of growing rabbit.

	Experimental diets			SEM	*P*-value
	SBM15	FB26	P30		
No. of rabbits[1]	39	36	34		
Post-weaning period (28-49 d):					
Body weight at 28 d (weaning) (g)	615	616	612	11	0.90
Body weight at 49 d (g)	1332	1317	1294	21	0.70
Daily weight gain (g/d)	34.1	33.4	32.1	0.7	0.38
Daily feed intake (g/d)	78.5	83.2	77.5	0.9	0.36
Feed conversion rate (g/g)	2.31	2.48	2.44	0.02	0.28
Finishing period (49-77 d):					
Body weight at 77 d (g)	2146	2125	2112	22	0.80
Daily weight gain (g/d)	29.1	28.4	29.1	0.4	0.92
Daily feed intake (g/d)	102	109	107	1	0.17
Feed conversion rate (g/g)	3.53	3.77	3.64	0.03	0.25
Whole fattening period (28-77 d):					
Daily weight gain (g/d)	31.2	30.8	30.4	0.3	0.56
Daily feed intake (g/d)	92.1	97.8	94.1	0.8	0.25
Feed conversion rate (g/g)	2.94[a]	3.17[b]	3.09[b]	0.02	0.006
Mortality rate[2] (%)	2.5 (1/40)	10.0 (4/40)	15.0 (6/40)	0.5	0.12

SM15: 15% of soybean meal, FB26: 26% of field bean, P30: experimental diet with 30% of pea. SEM: standard error of the mean.
[1]Growth traits were calculated only for those rabbits alive at the end of the experiment.
[2]In brackets: No. of dead/No. of rabbits at the beginning of the trial.
[a,b]Mean values in the same row with a different superscript differ at $P<0.05$.

4 rabbits/cage per diet), the mortality seemed to have a tendency to be higher for rabbits from field bean (4/40) or pea (6/40) groups, compared to that recorded in SBM15 group (1/40) (Table 4). This result could likely be related to the higher deficiency in dietary fibre of FB26 and P30 diets, as pointed out by Gidenne (2003), probably reinforced by the change of the protein source at weaning. The rabbits were accustomed to eating, before weaning, a diet for rabbit does where the protein source was soybean meal and which was similar to SBM15 diet. The change to field bean and pea diet could probably impair ileal crude protein digestibility, leading to an increase of the protein flow to the caecum, which can lead to a higher mortality rate (De Blas *et al.*, 1981; Gutiérrez *et al.*, 2002, 2003; Chamorro *et al.*, 2007). Globally, the health status of rabbits was good, as only 11 rabbits died out of a total of 120 animals (no antibiotic treatment was applied during the trial).

Regardless of the experimental period considered, the complete replacement of soybean meal-alfalfa based diet by field bean or pea associated with hard wheat bran did not affect live weight, average daily gain or feed intake among the 3 groups of rabbits (Table 4). However, the feed conversion ratio, which was not affected by the treatment during the post weaning and finishing periods, was significantly (P= 0.006) impaired for the FB26 (+0.23 point) and PS30 (+0.15 point) groups compared to the control diet (FCR=3.17 and 3.09 *vs.* 2.94, respectively) when the whole fattening period (28 to 77 d of age) was considered.

It should be stressed that the average growth rate of the 3 groups of rabbits corresponded to a relative daily increase representing 0.85% of the adult weight (30.8 g for an adult weight of 3600 g, according to Zerrouki *et al.*, 2008). Also, the average live weight (2128 g) at slaughter (77 d) of the 3 groups of rabbits corresponded to a degree of maturity of 59.1%, which was broadly higher than that generally considered as optimum (55%) for selected European commercial lines of rabbits at 70-77 d (Lebas *et al.*, 2001). It must be also underlined that the experimental rabbits reached the recommended proportion of adult weight around 70 d (live weight of 1938 g on average, which corresponds to a degree of maturity of 53.8%). But because local market required heavier rabbits (equal to or higher than 2 kg), growth was prolonged until 77 d of age.

The effect of the field bean diet on the growth performance of rabbits in the present trial was similar to that reported by Lounaouci *et al.* (2008), using rabbits of the same population fed a diet based on 30% of field bean and supplied with synthetic *DL*-methionine. For the growth performance of rabbits in the pea group and as stated earlier in the introduction section, there was no Algerian experiment reported on the evaluation of pea in rabbit diet.

Globally, growth performance recorded in this trial reached a relatively good level if we consider the genetic potential of the rabbits of white population used (Lounaouci *et al.,* 2008 and 2011a,b; Benali *et al.*, 2011) and taking into account the fact that rabbits were caged collectively (4 rabbits/cage).

Slaughter performances

The substitution of soybean meal-alfalfa-maize based diet by a combination of field bean or pea with hard wheat bran and without supplementation in *DL*-methionine did not affect the carcass weight or characteristics. Consequently, the dressing out percentage of the 3 groups of rabbits was similar (Table 5). The average dressing out percentage of cold carcass (66.6%) recorded in the current trial was close (for the same carcass presentation) to the value (67.4%) reported by Lounaouci *et al.* (2008) with white population rabbits fed diet containing 30% of faba bean. However, in order to compare our results and those in the literature, the dressing out percentage, calculated after removing the lower extremities (–3.5%) from the cold carcass, was 63.1% on average, without any significant difference between treatments (P=0.25).

The proportion of liver was not affected by the protein source and the carcasses of the 3 groups of rabbits showed no excess adiposity. Perirenal fat, expressed as a percentage of cold carcass, was only 0.95% on av. (after adjustment, this proportion corresponds to 1.01%). This result supports the findings of previous studies showing significant

Table 5: Effect of substitution of soybean meal-alfalfa-maize based diet, by a combination of field bean or pea with hard wheat bran, on slaughter traits of the three groups of growing rabbits at 77 days of age.

	Experimental diets				
	SBM15	FB26	P30	SEM	*P*-value
No. of rabbits	10	10	10		
Measured:					
Slaughter weight (SW) (g)	2158	2154	2152	6	0.91
Skin (g)	205.5	204.7	206.4	2	0.92
Full digestive tract (g)	332.2	339.3	333.5	5	0.83
Hot carcass (HC) (g)	1526	1510	1509	8	0.18
Cold carcass (CC) (g)[1]	1447	1431	1430	6	0.17
Perirenal fat (g)	14.57	11.62	15.04	0.7	0.15
Liver (g)	77.5	72.9	67.3	2.34	0.21
Hindleg (g)	149.5	146.2	149.5	1.2	0.58
Calculated:					
Skin (% SW)	9.5	9.5	9.6	0.08	0.36
Full digestive tract (% SW)	15.4	15.8	15.5	0.2	0.45
Perirenal fat (% CC)	1.01	0.81	1.04	0.05	0.28
Liver (% CC)	5.35	5.10	4.70	0.16	0.20
Dressing out percentage (%)[2]	67.0	66.4	66.3	0.2	0.28
Muscle/Bone ratio	6.8	6.8	7.0	0.1	0.85

SM15: 15% of soybean meal, FB26: 26% of field bean, P30: 30% of pea. SEM: standard error of the mean.

[1] Cold carcass (24 h at +4°C) was presented with unskinned head, thoracic content (heart, lungs), liver, kidneys and the extremities with sleeves.

[2]Dressing out percentage for cold carcass.

[a,b]Mean values in the same row with a different superscript differ at P<0.05.

reduction in dissectible fat deposit when PD to DE ratio was above the optimum value of 10.5-11.0 g/MJ (Dalle Zotte, 2002; Hernández and Dalle Zotte, 2010), as was the case for our 3 experimental diets.

The muscle to bone ratio of the hind leg was similar for the 3 groups of rabbits and was also similar to that reported by Lounaouci *et al.* (2008) and those generally recorded with selected rabbits slaughtered at weight of 2400 g: 6.8 *vs.* 6.4 (Rochambeau *et al.* 1996). Moreover, the average muscle to bone ratio observed in the present trial was similar to that (6.6) recorded by Lounaouci *et al.* (2012) with rabbits of the same population fed diets with an average crude protein of 14.5%. This last observation might suggest the hypothesis that the low proportion of SAA (0.45-0.53 *vs.* 0.54-0.60%) (De Blas and Mateos, 2010) of experimental diets did not seem to be the single limiting factor for the growth of this rabbit population. Consequently, it became necessary to estimate, in further experiments, the specific protein and amino acid requirements for growth of the local rabbit population.

CONCLUSION

These results indicate that substitution of soybean meal-alfalfa-maize by an association of field bean or pea with hard wheat bran and without supplementation with synthetic *DL*-methionine, did not impair feed intake, growth or slaughter traits of rabbits belonging to a local Algerian population. However, digestion of pea diet was reduced and feed efficiency of field bean and pea diets was impaired. Further experiments including a higher number of rabbits are necessary to confirm the current mortality results and to study the specific aminoacid requirements of Algerian rabbits.

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