EFFECT OF CORN PROCESSING AND LEVEL OF INCLUSION ON GROWTH OF MEAT RABBITS

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ABSTRACT

The effect of replacing wheat grain by extruded corn (Experiment 1) and two levels of inclusion (Experiment 2) in concentrates for rabbits on digestibility, productivity and meat quality were studied on F1 (New Zealand × California) rabbits of both sexes (32 per experiment) obtained from local suppliers. In experiment 1, young rabbits were raised from 35 d to slaughter (80 d). Animals were splited in two groups of 16 animals and fed with post-weaning and fattening iso-protein and iso-energy rations differing by the starch source (wheat or extruded corn grain). In experiment 2, animals were fed with the experimental rations: high (35%) and low (15%) inclusion of extruded corn grain from 40 d to slaughter (81 d). During the growing phase of experiment 1 no differences were found for nutrient digestibility, but the group receiving extruded corn grain promoted higher weight gains and final weight (P<0,05). No differences were observed in slaughter yield and slaughter wastes incidence (except for the higher empty stomach weight in extruded corn grain diet). Although, animals fed with the corn ration had a more pale meat. The hindleg of lighter rabbits fed with wheat rations had a trend to higher energy concentration and proportion of unsaturated fatty acids. Dry matter (P<0,05) and energy apparent digestibilities were higher in rabbits fed with high level extruded corn grain (Experiment 2). The high corn diet allowed higher weight gains (P<0,05) with lower conversion rate (P<0,01). With some differences in slaughter wastes, the high corn diet induced higher carcass weights (P<0,05), but with similar hindleg meat to bone ratio. *Longissimus dorsi* and hindleg were harder and more tender respectively for ration with higher corn inclusion. Meat of heavier rabbits, fed rations high in corn, had more energy content and were slightly fatter with a higher proportion of saturated fatty acids (P>0,05).

Key words: rabbits, extruded corn, productivity, meat quality.

INTRODUCTION

Starch to fibre ratio is of paramount importance among the dietary characteristics that influence growing rabbits productivity. Several authors have noted digestion problems associated to excessive starch consumption, particularly in diets after weaning, because of the incomplete enzymatic system development of the young rabbit (MAERTENS, 1992; BLAS *et al.,* 1994, DOJANÅ *et al.,* 1998). Because of the rabbit digestive physiology, a low dietary fibre to starch ratio, would bring about digestive disfunctions: altered caecal fermentation and intestinal motility (BELLIER and GIDENNE, 1996; BELENGUER *et al*., 2000; GIDENNE, 2003). This specific fibre need limits the chances of increasing the energy concentration and reduce the food conversion.

Worldwide, barley is the main grain used for rabbit diets followed by wheat and corn. It has been reported that maize nutritive value is lower than that of barley (VILLAMIDE and DE BLAS, 1991) and wheat (MARTENS and DE GROOTE, 1984; SEQUEIRA *et al*., 2000), probably due to corn lower starch digestibility. However, corn energy superiority over barley has also been reported (FERNÁNDEZ CARMONA *et al*., 1996). SEQUEIRA *et al*. (2000) found that extrusion increased energy value of corn and reduced that of wheat. Development of new grain processing technologies to increase digestibility would allow including a more digestible starch in post-weaning rabbit diets, avoiding the appearance of problems associated to caecum starch overload.

This work aims to assess the effect of substitution of wheat by extruded corn grain on the diet of rabbits at weaning and fattening phases. It is also expected to analyze the effect of processed corn level on the productivity, carcass and meat quality at slaughter.

MATERIAL AND METHODS

Rabbits were bred in individual cages, similar to those used in intensive breeding systems, in the School of Agronomy facilities. Cages were prepared to allow the determination of the *in vivo* digestibility and dietary nutritive value. Thirty-two F1 rabbits (NZ x California) of both sexes and weaned at 32 days of age were supplied by a typical Argentinean commercial farm.

Diets: In experiment 1, the study recorded two phases, post weaning (35-59d) and fattening (60-80d). During the post weaning phase, animals were fed ad *libitum,* one of the diets (Table 1), Wh1, control with 20% wheat grain and ExC1, with 20% of extruded corn grain. During the fattening phase animals were fed with diets similar to post weaning phase but added with 5 percent units of the respective cereal grains (Wh2 and ExC2), reducing consequently the proportion of lucerne. The experiment 2, was conducted during the growing phase from 40d of age until commercial slaughter age (81d). From the weaning to 39d of life animals consumed the same mother diet. During the experimental phase; each group was individually fed *ad libitum* one of two diets HexC, high level of extruded corn (35%) or LexC, low level of extruded corn (15%).

In vivo digestibility was evaluated with 10 rabbits for each diet at the beginning of the 2nd (growing) and 5th (fattening) wk of experiment 1 and at the beginning of the 3rd wk after the beginning of the experiment in experiment 2 (PEREZ *et al*., 1996). Rations and faeces analyses (individual dry matter and pool faeces ether extract, crude protein, ash, fiber fractions (NDF, ADF, ADL) and starch were performed according to A.O.A.C (1984) and VAN SOEST (1963).

The slaughter was carried out according to international recommendations (BLASCO and

OUHAYOUN, 1996). Caecum pH was determined *in situ* immediately after slaughter. Triplicate pH (Orion 230A) and colour (Minolta CR 300) measurements were made on muscles *Longissimus dorsi* and *Bíceps femoris*. Hardness was measured on 3 cooked samples (50', 80°C,1 cm^2 cylinders) using the Warner Bratzler accessory. Intramuscular fatty acids were extracted by FOLCH (1957) and was analyzed by gas chromatography (Shimadzu GC-14B). *Biceps femoris* muscle analyses were performed according to A.O.A.C (1984)

Data from both experiments were analysed according to a complete randomized design using PROC.GLM (SAS®, 1996). In experiment 1, independent analyses were carried out for each growing phase. For slaughter and meat quality traits slaughter weight was used as a covariable. Means were compared by Tukey test (P<0.05).

RESULTS AND DISCUSSION

In experiment 1, few unimportant diarrhea cases happened, hence animals were kept. Starch digestibility (Table 1) were similar for both treatments during the post weaning period and tended to increase for the extruded corn grain during fattening phase.

Table 1. Ingredients, chemical composition (%DM) & digestibility coefficients (%)

	Experiment 1 [(A)]				Experiment 2 [(A)]	
Age of animals	35-59d		60-80d		40-81d	
	Wh1	**ExC1**	**Wh2**	**ExC2**	**HexC**	**LexC**
Wheat	20,0		25,0			
Extruded corn		20,0		25,0	35,0	15,0
Dehydrated Lucerne 17%	37,0	37,0	32,0	32,0	32,0	35,0
Dry matter (%)	88,0	87,85	88,1	88,4	87,3	86,9
Crude protein (%DM)	19,3	20,1	18,1	20,4	18,2	19,0
ADF (%DM)	19,3	20,1	18,1	20,4	18,2	20,2
Starch (%DM)	20,1	18,9	23,4	22,2	28,9	25,8
Apparent digestibility (%)						
Dry matter	62,8	60,6	61,4	63,9	63,7[a]	60,3[b]
Crude protein	74,0	73,0	70,3	73,0	71,0	70,0
ADF	20,0	18,0	14,0	23,0	14,0	18,0
Starch	95,0	94,0	95,0	98,0	96,0	96,0

([A])experiment1= wheat bran: 25%; soya bean pellet(41%): 5%; sunflower pellet(29%):10%; experiment 2= wheat bran: 10 and 37%; soya bean pellet(41%): 8 and 6%; sunflower pellet(29%):12 and 4% for HexC and LecC respectively; common ingredients for all diets= vanilla flavour (0,03); Ca_2POH (0,6%); CO_3Ca(1,3%); ClNa (0,42); vitamin-mineral premix (0,15); DL methionine (0,10%); LysineHCl (0,15%); micotoxin absorvent (0,20%) and coccidiostatic (0,05%).

During the growing phase no differences were detected among digestibility for any nutrient. During the fattening period, group Wh had a lower DM, CP and FDA digestibilities than ExC, the opposite for the growing period (although non-significant in any period, P>0,05), but all diets had similar ED values. Enteric problems should be associated to the amount of starch in the young rabbits diet, rather than to the digestibility. In experiment 2, despite the wide difference of extruded corn inclusion in the diets, inclusion of wheat-bran resulted in only 3 percentage units of starch content. Despite the high PD/ED ratio, no cases of diarrhea were observed. Group HexC had higher dry matter digestibility (P<0,05) and only a trend for energy. As expected, no differences were showed for starch digestibilities.

Productive parameters did not differ between treatments (experiment 1, Table 2). The ExC diet induced higher weight gains and final weight than wheat diet (P<0,10) during growing phase. There was a trend to higher growth rate and final weight (P>0,05) over the whole experiment. Feed consumption and feed conversion index were also not affected by cereal type. In the experiment 2, HexC had a higher weight gain during fattening phase (P<0,05) and over the whole period (P<0,10). Animals of HexC had olso higher final weight (P<0,10) and lower conversion index during all period (P<0,01).

Table 2. Performance from weaning to slaughter

	Wh	ExC	RMSE	P	HexC	LexC	RMSE	P
Initial weight g (g)	962±72	984±94	84		1039±74	1049±103	90	
Weight gain 35-59d (g/d)	31,2±6,2	34,5±3,8	5,1	0,07	39,4±6,2	35,0±4,9	5,6	
Weight gain 60-80d (g/d)	30,0±4,3	30,8±4,2	4,3		33,2±5,4	32,1±5,8	5,6	0,02
Total weight gain (g/d)	30,6±4,2	32,6±2,7	3,6		36,7±5,1	33,7±4,6	4,8	0,07
Total intake (g/d)	130±18	137±19	18,8		153±18	159±18	18,1	
Feed conversion(35-59d)	3,61±0,41	3,46±0,32	0,37		3,56±0,33	4,05±0,42	0,36	0,01
Feed conversion(60-80d)	4,98±0,65	5,12±0,79	0,72		5,23±0,49	5,81±0,76	0.64	0,01
Total feed conversion	4,25±0,29	4,25±0,43	0,37		4,18±0,29	4,75±0,46	0,38	0,01

RMSE= Root Mean Square Error

In experiment 1, no treatment effects were observed on carcass characteristics (Table 3). The weight of the gastrointestinal tract was not affected by diet type, although the rabbit empty stomach weight of ExC was superior to Wh group (P<0,05). Not statistically differences were found for empty and full (0,53%lw and 0,49%lw for ExC and Wh respectively) caecum weights, suggesting similar intestinal transit rates for both diets. Neither caecum pH differences were found, suggesting similar fermentation parameters. Although not significative differences, the rabbit carcass weights of ExC treatment were slightly heavier, concurrently with the live body weights, but Wh group had equal hindleg meat to bone ratio and a trend to higher fatness.

Final live weight of HexC animals slaughtered in Experiment 2 (Table 3) were higher than to those from LexC group, agreeing with the trend presented in Table 2. The higher corn grain ration induced higher cold and hot carcass weights (P<0,05) with significant differences for slaughter wastes (empty stomach, liver and kidney). Both treatments had similar fatness degree and meat to bone ratio.

Table 3. Diet effect on dressing percentage

	Wh	ExC	RMSE	P	HexC	LexC	RMSE	P
Slaughter LW (g)	2249±129	2367±159	144		2627±112	2413±224	181	0,05
Hot carcass weight (g)	1332±114	1400±100	108		1551±76	1413±112	97	0,05
Dressing percentage, %	59,2±2,0	59,1±1,2	1,70		59,0±1,7	58,6±1,5	1,51	
Caecum pH	7,1±0,4	6,9±0,5	0,46		7,00±0,2	7,04±0,2	0,23	
Gastrointestinal tract, %LW	17,1±2,4	16,0±1,3	1,93		15,8±0,8	16,3±1,1	0,93	
Empty caecum %LW	0,34±0,09	0,34±0,05	0,08		0,86±0,04	1,03±0,09	0,07	
Empty stomach, %LW	0,88±0,16	1,07±0,08	0,13	0,05	0,86±0,06	1,03±0,13	0,10	0,10[(c)]
Liver, %LW	5,23±1,06	5,87±1,34	1,20		8,11±1,26	6,92±0,80	1,04	0,05
Kidney, %LW	1,19±0,31	1,09±0,11	0,24		1,10±0,04	1,24±0,14	1,10	0,05
Cold carcass weight (CC, g)	1305±112	1375±98	106,6		1507±77	1392±113	98	0,05
Reference carcass weight (RC,g)[(A)]	1065±79	1132±101	86,7		1161±71	1082±79	75	0,06
Total carcass fat, %RC	6,06±1,69	5,41±2,10	1,88		6,91±1,10	6,45±1,19	1,15	
Hindleg meat/bone ratio[(B)]	4,94±0,61	4,83±0,14	0,044		5,73±1,42	5,62±0,56	1,05	

[(A)]RC=(CC-wastes)/CC;[(B)](hindleg weight – bone weight)/bone weight;[(c)]P<0,10 for diet and covariate. RMSE: Root Mean Square Error

Replacing wheat grain by extruded corn grain did not alter the meat quality (Tabla 4) except for a lower m.LD (P<0,05) and m.BF (P>0,05) colour saturation. Both treatments had similar values of tenderness for LD and BF muscle, being tender and with instrument readings inferior to 2,5 kg. In Experiment 2, diets didn't influence physical quality traits except m.LD from LexC treatment that had more luminosity (P<0,05). HexC diet was associated to harder LD (P<0,10) and higher tenderness of hindleg (P<0,05).

Table 4. Effect of diets on physical quality traits

	Wh	ExC	RMSE	P	HexC	LexC	RMSE	P
PH *Longissimus dorsi*	5,73±0,08	5,76±0,06	0,07		5,72±0,06	5,71±0,08	0,07	
PH *Bíceps femoris*	5,96±0,08	5,94±0,05	0,07		5,86±0,05	5,80±0,08	0,07	0,09
LD -L*	56,8±2,2	57,7±1,5	1,9		54,6±1,7	57,5±2,3	2,00	0,05
LD -C*	8,88±2,7	8,14±3,3	3,54	0,05	11,3±2,2	10,6±2,2	2,18	
BF -L*	53,9±2,0	48,8±7,2	6,4		53,7±2,6	52,9±2,8	2,7	
BF-C*	8,59±2,7	7,58±2,4	2,55		10,5±2,6	12,5±3,0	2,8	
WB LD	2,15±0,78	2,39±0,65	0,56		2,19±0,55	1,67±0,47	0,507	0,07
WB hindleg	1,40±0,31	1,45±0,46	0,56		1,25±0,24	1,74±0,45	0,39	0,05

RMSE= Root Mean Square Error

Muscle *Bíceps femoris* chemical composition(experiment 1, Table 5) also showed that replacement of wheat by corn grain and high corn inclusion rate do not alter the meat chemical composition. The lipid composition was not affected by treatments but inclusion of corn brought about an increase in the intramuscular fat saturation (P>0,05). In experiment 2, meat from heavier animals (HexC) was more energetic because of the higher level of fat content (P>0,05). The intramuscular lipid composition was similar with a slightly higher content of satured FA for HexC meat.

CONCLUSIONS

Results from experiment 1 indicated that substitution of wheat by extruded corn grain for post-weaning and fattening rabbit diets do not affect productivity, as well as carcass and meat quality. Both diets had similar digestibilities and the amount of starch reaching the caecum would be the cause of some enteric episodes during the growing phase. Consequently, inclusion of extruded corn grain into rabbit diet formulate would depend exclusively to the relative prices.

Results from experiment 2 support incorporation of extruded corn grain up to 35% in diets for rabbits from 40 d of life. The higher dietary digestibility induced lower indices of feed conversion, heavier animals at slaughter, and heavier carcasses with similar fatness degree with respect to the treatment with lower inclusion of corn grain. From a nutritional point of view, meat had higher energy content.

Table 5. Meat chemical (%) and Fatty acid composition (%AgTot) of the hindleg

	Wh	ExC	RMSE	P	HexC	LexC	RMSE	P
Water	59,7±3,3	62,7±4,1	3,65	0,05(A)	62,0±2,2	63,4±2,0	2,3	
Proteins	21,6±5,5	17,4±4,2	4,92		27,8±2,8	28,0±2,2	2,1	
Lipids(B)	14,4±5,1	15,0±3,6	4,48		6,2±2,6	4,5±1,6	2,2	
Ash	4,3±1,1	4,9±1,0	1,03		4,0±0,2	4,1±0,2	0,19	
EB kcal/kg(C)	2466±305	2277±319	312	0,05(A)	2101±212	1958±138	179	
Satured Fatty acids	54,5±6,4	57,6±6,3	12,9		56,2±4,0	54,2±9,0	7,6	
Monounsatured FA	34,2±5,2	32,2±7,2	6,4		37,5±2,2	37,4±2,0	2,1	
Poliunsatured FA	11,3±9,5	10,2±8,3	16,5		6,3±3,0	8,4±3,4	6,4	
AGI/AGS	0,86±0,2	0,77±0,5	0,98		0,79±0,2	0,92±0,4	0,36	

(A) P<0,05 for diet and covariate; (B) P<0,05 only for covariate (C) XICCATO (1989): EB (MJ/kg MS = EE x 36,3 + PB x 23,5). RMSE= Root Mean Square Error

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