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ALTERNATIVE FEED INGREDIENTS AND THEIR EFFECT ON THE PRODUCTION OF GROWING RABBITS

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ABSTRACT

In order to develop new, more efficient diets for growing rabbits, the use of food processing by-products (apple pulp, brewer's yeast), less used vegetal materials (barley, carob pulp) and feed protein products (soya concentrate, milk-powder replacer) was tested with formulation of eight isonutritive diets and assessing their effect on the production. The 35-day-old Pannon white rabbits were weaned and caged singly (n=36/treatment) or in groups of three (n=54/treatment). Dietary ratio of raw materials used in the control diet (C) was reduced and substituted with 7.5% apple pulp (diet A), 2% brewer's yeast (diet Y), 5% barley (diet B), 4% carob pulp (diet CP), 2% hydrolized soya-protein concentrate (diet HS) and 2% or 4% milk-powder replacer (diet U2 or U4). The rabbits fed these diets until 63 days of age and a single finishing diet up to 77 days old. The 49–63 day growth rate of the C, A, CP and U4 rabbits was good and similar (41–44 g/day) and that of the A rabbits was 12–20% higher (P=0.010) than the Y, B, HS and U2 rabbits (44 vs 37–39 g/day). The 63-day body weight of rabbits fed C, A, CP, U2 and U4 diets did not differ (2036 g as average) and it was 3.8 % higher (P<0.05) than the rabbits fed Y, B and HS diets (1961 g, as average). The 35–77 day growth rate, feed intake and the 77-day final weight were similar but the U2 rabbits had poorer 35–77 day feed conversion (3.4 vs 3.2 in the other rabbits, P=0.022). The 35–77 day mortality was lower (P=0.05) for rabbits fed A diet (15 %) moderate in the CP, C, HS and U4 rabbits (from 21 to 29%) and higher in the U2, B and Y rabbits (from 31 to 35%). Both apple pulp and carob pulp are recommended as feed ingredient in weaning diets primarily because they promoted rabbits health.

Key words: Food processing by-product, Less used plant constituent, Feed protein product

INTRODUCTION

Food processing by-products, less used vegetal materials and feed protein products can be valuable ingredients in rabbits diet. Apple pulp can be an appetizer, source of energy, different fibre types and antioxidants (Bravo *et al*., 1992), thus it can reduce digestive disorders in weaning rabbits. Brewer's yeast is a high-digestible, amino acid rich protein source which contains also immunostimulants (Ferreira *et al*., 2010) but it is hardly studied in rabbit feeding. Barley is less used in Hungarian rabbit diets though it can substitute wheat in weaning diets as it contains more fibre and less protein. Carob pulp is rich in high-digestible carbohydrates, various fibre types and in strong antioxidants (Owen *et al*., 2003). It can be a good feed ingredient for the rabbit due to its similar dietary properties to the apple. The HS-500 hydrolized soya concentrate is a feed product in which the protein and antinutritive substances were hydrolized with enzyme. Its high protein (lysine, methionine) content is highly digestible and it has a low antinutritive content. It can play a role in the protein and amino acid supply of young rabbits. The UNILAC milk powder-replacer is a blend of soya-protein concentrate, milk-protein, whey-proteins and homogenized lipids and also contains protease enzymes and aromas. It supports feed intake and is a source of easily digestible protein, amino acid and energy.

This study tested the use of these by-products (apple pulp, brewer's yeast), less used raw materials (barley, carob pulp) and feed protein products (soya concentrate, milk-powder replacer) in isonutritive diets to help devise new, more efficient diets for growing rabbits.

MATERIALS AND METHODS

Dietary groups and animals

Eight growing diets were formulated to be isonutritive, in which the alternative ingredient (appe pulp, brewer's yeast, barley, carob pulp, HS-500 hydrolized soya concentrate, UNILAC milk-powder replacer) was used at 2–7.5% concentration (Table 1).

Table 1: Ingredients (%), chemical composition and calculated nutritive value of the diets

	C control diet	A apple pulp	Y brewer's yeast	B barley	CP carob pulp	HS hydr. soya concentrate[1]	U2 milk-powder replacer[2]	U4 milk-powder replacer[2]
Dried apple pulp	4.5	7.5	4.5	4.5	4.5	4.5	4.5	4.5
Brewer's yeast	–	–	2.0	–	–	–	–	–
Barley	–	–	–	5.0	–	–	–	–
Carob pulp	–	–	–	–	4.0	–	–	–
Hydrolized soya conc.[1]	–	–	–	–	–	2.0	–	–
Milk-powder replacer[2]	–	–	–	–	–	–	2.0	4.0
Alfalfa meal	31	30	30	30	30	31	29	30
Wheat grain	12	12	12	10	12	12	12	12
Sugar beet pulp	12	9.0	13	10	10	12	12	13
Full fat soybean meal	9.2	8.2	9.5	9.2	9.7	9.5	9.0	8.5
Extr. sunflower meal	8.0	10	6.0	8.5	9.5	6.5	8.0	6.0
Wheat bran	8.0	8.0	7.0	5.5	3.0	6.0	7.0	4.5
Straw pellet	6.0	5.5	6.0	6.0	6.0	6.0	6.0	6.0
Whole corn meal	4.5	4.5	5.0	6.0	6.0	5.5	5.5	6.5
KNP-843 premix[3]	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
WAFOLIN-S pellet binder	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
BIOLIZIN (added lysine)	0.3	0.3	–	0.3	0.3	–	–	–
Dry matter, %	89.8	89.8	89.9	89.8	89.7	89.9	89.8	89.9
Digestible energy, MJ/kg	10.9	10.7	11.0	11.0	10.9	10.7	10.7	10.5
Crude protein, %	16.1	16.3	16.1	16.0	16.1	16.4	16.4	16.2
Ether extract, %	3.39	3.32	3.40	3.38	3.35	3.39	3.42	3.38
Crude fibre, %	16.3	16.2	16.2	16.2	16.2	16.2	16.1	16.2
NDF, %	34.0	33.2	33.7	33.5	33.2	33.6	33.5	33.3
ADF, %	21.3	21.2	21.1	21.0	21.6	21.2	21.0	21.0
ADL (lignin), %	4.01	4.16	3.90	3.96	3.94	3.92	3.92	3.86
Lysine, %	0.81	0.80	0.81	0.81	0.81	0.80	0.80	0.81
Methionine, %	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
Met+Cis, %	0.57	0.58	0.57	0.58	0.58	0.59	0.58	0.58

[1] HS-500® hydrolized soya (Bonafarm-Bábolna Feed Industry Ltd., Bábolna, Hungary): fine-ground and spray-dried soya concentrate (50% CP, 1.3% EE, 2% CF, 2.75% Lys and 0.77% Met) in which the protein and antinutritive substances were hydrolized with enzyme.

[2] UNILAC® milk-powder replacer (Bonafarm-Bábolna Feed Industry Ltd., Bábolna, Hungary): a blend of soya-protein (38% CP, 6% EE, 1.8% CF, 2.55% Lys and 0.55% Met), milk protein, whey protein and homogenized lipids and protease enzymes necessary for protein digestion.

[3] Supplemental medication: 50 mg/kg robenidine, 50 mg/kg tiamulin, 500 mg/kg oxytetracycline. Each diet contained 10000 NE/kg Vitamin A, 1000 NE/kg Vitamin D_3 and 60 mg/kg Vitamin E.

The 35-day-old Pannon white rabbits were weighed, ear-tagged, weaned and assigned to one of the eight dietary treatment to equalize body weight. The study was conducted with 288 rabbits housed individually (n=36/treatment) and 432 kept in groups of 3 rabbits (n=54/treatment) in all-wire cages

(61x30x28 cm, i.e. 1830 and 610 cm^2 individual area) at Gödöllő climatized experimental unit (20–23°C, 16L:8D). The rabbits were fed a single non-medicated finishing diet (11.5 MJ/kg DE, 17% CP, 4.5% EE, 15.5% CF) from 63 to 77 days of age. Feed and drinking water were provided *ad libitum*.

Body weight and feed intake were recorded fortnightly and weight gain and feed conversion rate were calculated with individual housing. Only body weight and mortality were measured at group housing.

Statistical analyses

The effects of the eight dietary treatments (C, A, Y, B, CP, HS, U2 and U4) and two housing systems (one or three rabbits/cage) on growth performance were assessed by two-way ANOVA. Contrasts were evaluated by Student's *t*-test. Mortality rate was subjected to Chi-squared tests with Yates correction. All analyses were performed with Statgraphics 6.0 (1992) statistical software.

RESULTS AND DISCUSSION

Feed intake was not affected by the diets (134 g/d as average). Total period feed conversion of the U2 rabbits was 6 % poorer (P=0.022) than that of the rabbits fed the other diets (3.2 as average, Table 2). The best productive performances were found with 7.5% apple pulp diet. The rabbits fed diet with higher apple pulp content (A) had similar performance to the C rabbits but their mortality was lower in the 49–63 day period (8 vs 20%, P=0.05). Gidenne and Bellier (2000) replaced starch (wheat) with hemicellulose (H: wheat bran) or hemicellulose+pectin (H+P: sugar beet pulp). Feed intake increased with the H and H+P diets but only the H+P diet improved the growth rate and caecal digestion. The caecal microbial fermentation and thus rabbit health can be aided if the diet contains digestible fibre of different vegetal origin (Jehl and Gidenne, 1996; Gidenne, 2003). The higher survival of the A rabbits could be supported by digestible fibre composition of a different origin and type of the A diet and by the high-digestible carbohydrate, acid and antioxidant content (Guo *et al*., 2003) of apple pulp. Alvarez *et al*. (2007) noted a reduced growth with 14% apple pulp but it was used in a higher ratio and to substitute for alfalfa hay and wheat straw.

Table 2: Effect of growing diets, uniform fattening feed (from d 63) and housing on the production

	Day	C	A	Y	B	CP	HS	U2	U4	SEM	Probability	
No. of rabbits		90	90	90	90	90	90	90	90		Diet	Housing[1]
Body weight g	35	895	874	894	885	879	882	902	887	3	0.481	0.311
	49	1415	1430	1387	1402	1419	1390	1435	1414	8	0.666	0.077
	63	2028[bc]	2067[c]	1970[ab]	1975[ab]	2042[bc]	1937[a]	2004[abc]	2041[bc]	11	0.032	0.083
	77	2620	2666	2619	2575	2635	2565	2616	2637	12	0.316	0.081
Weight gain g/d	35-49	37.7	38.6	36.0	36.7	37.9	35.9	39.2	37.6	0.5	0.724	0.095
	49-63	41.3[bcd]	44.2[d]	39.6[abc]	39.1[abc]	42.9[cd]	36.9[a]	38.3[ab]	42.7[cd]	0.5	0.010	0.105
	63-77	42.3	42.7	45.8	42.4	42.2	44.9	43.4	41.6	0.4	0.210	0.870
	35-77	41.3	42.4	41.3	40.2	41.7	40.0	41.2	41.7	0.3	0.316	0.081
Feed intake g/d	35-49	100	94	95	101	98	97	104	96	1	0.531	–
	49-63	140	141	139	135	136	125	145	135	2	0.286	–
	63-77	163	169	164	160	161	168	167	161	1	0.708	–
	35-77	136	136	134	132	133	127	141	133	1	0.231	–
Feed conversion ratio	35-49	2.87	3.04	2.66	2.03	2.54	2.92	2.70	3.92	0.20	0.476	–
	49-63	3.33	3.17	3.16	3.26	3.31	6.04	3.89	3.39	0.57	0.900	–
	63-77	3.86	4.00	3.86	3.91	4.15	3.62	4.07	4.34	0.08	0.497	–
	35-77	3.24[a]	3.21[a]	3.19[a]	3.26[a]	3.15[a]	3.22[a]	3.39[b]	3.17[a]	0.02	0.022	–
Mortality, %	35-77	25[abc]	15[a]	35[c]	35[c]	21[ab]	29[bc]	31[bc]	29[bc]	–	0.05	0.05

[1] Housing: 1 or 3 rabbits/cage (n=288 or 432, respectively)
Means in the same row with unlike superscripts differ.

The results with the 2% brewer's yeast and 5% barley diets (Y, B) were similar to the C diet. The growth and health promoting effect found in fishes due to the beta-glucans and MOS content of brewer's yeast (Ferreira *et al*., 2010) was not seen in the Y and B rabbits. Cobos *et al*. (1995) studied the dietary ratio of barley and sugar beet pulp and reported that barley can be replaced with beet pulp up to 15%.

Our good result with 4% carob pulp diet (CP), which can be linked to the high-digestible sugars, different fibre types and antioxidants confirms that a weaning diet could be improved by adding carob pulp because of its beneficial effect on digestion and health in agreement with Teillet *et al.* (2011).
The rabbits fed the C, A, CP and U4 diets had higher weight gain (P=0.010) from 49 to 63 d and body weight (P=0.032) at 63-day than the rabbits fed the 2% hydrolized soya concentrate diet (HS). Body weight of the U2 rabbits on diet with 2% UNILAC milk-powder replacer was not affected but their 49–63 day weight gain was lower than the A, CP and U4 rabbits. The diet with higher, 4% UNILAC addition (U4), resulted in a similar production to that found with 4% carob pulp diet (CP).

Chamorro *et al*. (2007) replaced the 33% lucerne hay content in two 18% protein diets partially (18% lucerne) or totally with soya-bean protein concentrate (4 or 7%), apple pulp (7 or 13%) and beet pulp (5 or 11%). The 25–56 day mortality was lower with higher dietary ratio of apple pulp and beet pulp. Gómez-Conde *et al*. (2007, 2009) studied the effect of neutral detergent soluble fibre (NDSF). The control diet contained 29% alfalfa and 2% beet pulp (103 g NDSF/kg DM). In the second diet half of the alfalfa was replaced with 15% beet pulp and 5% apple pulp (131 g NDSF/kg DM), while in the third diet with 15% oat hulls and 2% soya-bean concentrate (79 g NDSF/kg DM).The weight gain was unaffected but with increasing levels of NDSF the gut barrier function and feed conversion improved and the 25–60 day mortality decreased. These observations are in agreement with our results.

CONCLUSIONS

Both apple pulp and carob pulp can be useful ingredients in weaning diets. The different production with isonutritive diets confirms the importance of raw materials and their potential dietary interaction.

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