WORLD RABBIT SCIENCE 1997, VOL. 5 (4), 161-165

FEEDING VALUE OF BREWER'S GRAINS FOR FATTENING RABBITS

MAERTENS L *, SALIFOU E. **

* Government Agricultural Research Centre Ghent, Research Station for Small Livestock Husbandry, Burg. Van Gansberghelaan, 92, 9820 MERELBEKE - Belgium

** B.P. 03-0411 COTONOU - Benin

ABSTRACT : Twenty-four, individually caged 5-week-old rabbits were used to determine the nutritive value of brewer's grains. Digestibility was determined using the substitution method with rabbits aged 45 to 50 d of age. Sun dried brewer's grains was included in a standard basal diet. The inclusion level, at the expense of all basal ingredients amounted to 30%. Both diets were pelleted. During the 6-weeks fattening trial rabbits showed a daily weight gain of 46.9g on the brewer's grains based diet. Daily weight gain tended to be higher on the basal diet due to the higher (P<0.05) feed intake. The digestibility of protein, ether extract, energy and ADF of brewer's grains was 75.5, 90.6, 39.5 and 17.5%, respectively. The digestible energy amounted to 10.06 MJ/kg DM.

RESUME : Vingt quatre lapereaux âgés de 5 semaines, logés individuellement, ont été utilisés pour déterminer la valeur nutritive de la drêche de brasserie séchée au soleil. La digestibilité a été déterminée par la méthode de substitution entre 45 et 50 jours d'âge. Le régime de base a été substitué à un taux de 30% par la drêche de brasserie. Ces 2 aliments ont été présentés sous forme granulée. Entre 5 et 11 semaines d âge, le gain moyen quotidien du lot drêche de brasserie a été de 46,9 g en moyenne. La vitesse de croissance tendait a être plus élevée dans le lot témoin à cause d'une consommation plus élevée (P<0,05). La digestibilité des protéines, de l'extrait hétéré, de l'énergie et de l'ADF de la drêche de brasserie était respectivement de 75,5; 90,6; 39,5 et 17,5%. L'énergie digestible calculée par différence était de 10,06 MJ/kg MS pour ce sous-produit de la bière.

INTRODUCTION

One of the advantage attributes of rabbits in comparison to other livestock (e.g. poultry, swine) is that they can be successfully raised on diets containing fibrous by-products (OWEN, 1981; CHEEKE, 1986). Therefore rabbits are in a favourable situation when a competition exists between humans and livestock for grains, starch and protein concentrates. This ability is of special significance in developing countries, where population and food shortage are greatest.

The major importance of fibre in rabbit diets is to regulate the transit time (GIDENNE, 1992). Due to its low digestibility, fibre is not considered as a real nutrient (MAERTENS and DE GROOTE, 1984; RAHARJO *et al.*, 1986; GARCIA *et al.*, 1996). Fibre requirements can easily be met in the tropics because forages and fibrous by-products are abundantly available. Protein concentrates, if not used by humans, are more efficient to produce poultry or swine meat (LUKEFAHR and CHEEKE, 1993). However, fibrous by-products containing a significant amount of protein are very suitable for rabbit feeding (CARABAÑO and FRAGA, 1992). In most cases they are considered as waste and available for a low price. Such a by-product which is available in Benin is brewer's grains (LEBAS *et al.*, 1996). Data about the feeding value of brewer's grains for rabbits are scarcely reported (FERNÁNDEZ-CARMONA *et al.*, 1996). This by-product of the beer industry is also available in Belgium, and was therefore chosen for an experiment during the stage of E. Salifou in Merelbeke,

The objective was to determine the digestibility and meanwhile the performances of fattening rabbits on a brewer's grains based diet.

MATERIAL AND METHODS

Animals and housing

Five-week-old rabbits belonging to the final cross between the dam and sire line, of the Institute's own selected strains (MAERTENS, 1992), were housed in a separate experimental rabbit house. In total 24 rabbits of both sexes were assigned randomly to dual purpose cages (fattening and digestibility). They were individually caged in the wire mesh cages (40 cm x 30 cm x 29 cm high). Cages were equipped with a nipple drinker and a 10 cm wide, outside placed feeder. During the digestibility trial, a perforated inox plate was introduced under the bottom of the cage for faeces collection. Water was always available ad libitum using nipple drinkers. Artificial ventilation was used to create optimal environmental conditions. During the experimental period (June-July, 1996), temperature oscillated between 14 and 23°C during the day and between 12 and 19°C during the night. In the windowless experimental house, 9 hours of light was provided per 24 hours period.

Feedstuff and diets

Fresh brewer's grains, a by-product of the beer industry, was obtained from a local brewery. After fermentation of germinated barley with beer yeast, the remaining solid fraction is called brewer's grains. The wet batch of this by-product used for the experiment contained only 19.1% DM and had to be dried before dietary incorporation. Air drying was used to simulate African conditions. The fresh feedstuff was spread outside on a concrete floor in a thin course. Three times a day, the feedstuff was turned to improve the drying process. During the night, the feedstuff was brought together and protected with a plastic cover. Because of the good climatic conditions (sunshine and 25-30°C), the feedstuff was sufficiently (> 90%) dry after 2 days.

Table 1 : Ingredient composition of the basal diet

Ingredients	%
Alfalfa meal	33.3
Wheat	12.0
Wheat middlings	30.0
Sunflower meal (29%)	5.0
Soybeans	7.0
Flax chaff	6.0
Molasses (cane)	4.0
Salt	0.05
Min.-Vit. Mix[1]	2.5
Methionine	0.05
Coccidiostat	0.1

[1] Provided by Trouw NV and contained (g kg^{-1}): Na, 60; Ca, 115; P, 45; I, 0.02; Co, 0.03; Se, 0.012; Cu, 0.3; Mn, 1.3; Zn, 2.3; Fe, 4.0; vitamin E, 0.68; vitamin K_3, 0.012; thiamin, 0.013; choline, 4.50; riboflavin, 0.11; panthothenic acid, 0.27; pyridoxine, 0.013; nicotinic acid, 0.54; vitamin B_{12}, 0.0006; vitamin A, 320.000 IU kg^{-1}; vitamin D_3, 70.000 IU kg^{-1}.

Dried brewer's grains was included in a standard basal diet (Table 1). The inclusion level, at the expense of all basal ingredients amounted to 30%. The basal diet and the experimental diet were pelleted (⌀3.2 mm). Temperature measured immediately after pelletization was always lower than 70°C.

Recordings

Rabbits were weighed and feed intake was determined after 3, 7, 10 and 14 days and thereafter on a weekly base. Recordings were executed on individual rabbits.

The digestibility trial was performed according to the European reference method (PEREZ *et al.*, 1995). A preliminary adaptation period of 10 days was carried out before the 4 days balance trial. The only difference with the mentioned method was that 6 replicates (rabbits) were used instead of the recommended 8 .

Rabbits were always fed *ad libitum*. Faecal output was collected daily, pooled individually in plastic boxes and stored at −18°C. After drying at 75°C for 48h and conditioning in the lab during 48h, total faeces was ground and collected in plastic tubes for further analysis.

Analytical procedures

Samples of feeds and faeces were analysed for dry matter (105°C until constant weight), ash (550°c for 5 h), nitrogen (Kjeldahl) and fat (Soxhlet petroleum ether extraction with a HCL–pre–treatment) and crude fibre following AOAC (1990) proscriptions. NDF and ADF were determined subsequently according to the procedure of VAN SOEST *et al.* (1991). An amylolytic treatment with a thermostable amylase was used prior to NDF extraction. Gross energy was measured with an adiabatic bomb calorimeter (IKA, C 400). All results were calculated on a dry weight basis.

Apparent whole-tract digestibility coefficients (DC) and the digestible energy (DE) content of diets were calculated from the respective dry matter intake and output, as well as their corresponding nutrient content. DC of brewer's grains was estimated by the substitution method using the difference principle.

Statistical analysis

Zootechnical performances, digestibility coefficients and DE content of diets were analysed statistically by a GLM procedure, using the SAS®/STAT version 6 (1990).

The standard error value of the nutritive value of brewer's grains estimated by difference was calculated according to the formula proposed by Villamide (1996) :

$$SE = 1/0.30\ [\ V(BGD)/n_{BGD} + (1-0.30)^2\ V(BD)/n_{BD}\ ]^{0.5}$$

where V(BGD) and V(BD) are the variances of the diet with 30% brewer's grains and of the basal diet, and n_{BGD} and n_{BD} the number of animals used for each diet, respectively.

Table 2 : Chemical composition (% of DM) of brewer's grains, basal diet and experimental diet (70% BD + 30% BG)

	Brewer's grains (BG)	Basal diet (BD)	70% BD + 30% BG
DM	93.3	90.1	91.0
OM	93.7	90.9	91.8
Ash	6.3	9.1	8.3
Crude protein	23.6	18.0	19.5
Lysine*	0.68	0.71	0.70
Methionine + cystine*	0.60	0.57	0.58
Threonine*	0.72	0.62	0.65
Ether extract (EE)	7.3	4.6	5.5
Crude fibre	16.2	16.1	16.2
NDF	62.4	38.5	46.3
ADF	19.7	19.6	19.7
GE (MJ/kg)	22.41	18.47	19.00

* calculated values

RESULTS

The batch brewer's grains used for the experiment contained 23.6% CP, 7.3% Cfat and 19.7% ADF (% on DM basis) (Table 2). The INRA tables (1989) and FERNÁNDEZ–CARMONA *et al.* (1996), mention a somewhat higher crude protein content for this by-product (27.7 and 28.9%, respectively).

Zootechnical performances

Although the number of rabbits was limited (12 individually caged rabbits/diet), some conclusions can be drawn concerning the use of sun dried brewer's grains in rabbit diets. The zootechnical performances are summarized in Table 3. On average, daily feed intake was 4.9% lower (P<0.05) on the brewer's grains diet. This was not due

Table 3: Zootechnical performances during the 6 weeks fattening period

	Basal diet	70% BD + 30% BG	SEM[1]	P value
Start weight (g)	942	957	18.2	>0.1
Finishing weight (g)	3018	2925	50.1	>0.1
Daily weight gain (g)				
0–14 d	53.9	51.1	1.7	>0.1
14–28 d	52.6	49.0	1.4	>0.1
28–42 d	41.9	40.6	1.1	>0.1
0–42 d	49.4	46.9	1.1	>0.1
Daily feed intake (g)				
0–14 d	131.6	124.3	3.1	>0.1
14–28 d	176.4	170.5	2.7	>0.1
28–42 d	194.2	182.8	2.6	0.03
0–42 d	167.4	159.2	2.2	0.04
Feed conversion				
0–14 d	2.45	2.48	0.07	>0.1
14–28 d	3.38	3.49	0.06	>0.1
28–42 d	4.68	4.55	0.11	>0.1
0–42 d	3.40	3.42	0.06	>0.1

[1] n=12

to palatability problems at the beginning of the experiment because the tendency to decreased feed intake was observed during the whole 6 weeks experimental period.

Daily weight gain was not significantly different (P>0.1) although in each period a small difference in favour of the basal diet was observed. This resulted in a lower, but not significant, weight at 11 weeks (2.925 g vs 3.018g for controls). As a consequence of the lower feed intake and gain in the experimental diet, feed conversion was nearly equal on both diets.

Digestibility

Digestibility coefficients of both diets are presented in Table 4. Organic matter, ash and gross energy digestibility were significantly (P<0.001) decreased in the diet with 30% brewer's grains. On the contrary, CP and NDF digestibility were higher (P<0.01) in the experimental diet whereas fat and ADF digestibility were unchanged. Based on the additivity principle, the calculated digestibility of brewer's grains is given in Table 5.

Table 4: Apparent digestibility of both diets (%)

	Basal diet	70% BD + 30% BG	SEM[1]	P value
DM	59.8	55.7	0.3	P<0.001
OM	60.3	56.6	0.3	P<0.001
Ash	55.2	46.4	0.5	P<0.001
Crude protein	71.8	73.8	0.4	P<0.01
EE	77.6	76.6	0.4	P>0.1
NDF	27.6	32.0	0.6	P<0.001
ADF	15.7	16.2	0.7	P>0.1
Gross energy	58.9	56.0	0.3	P<0.001
Dig. energy (MJ/kg) DM	10.88	10.64	0.1	P<0.001

[1] n=6

Less than 50% of the OM was digested (48.2%) in spite of the quite high digestibility of the protein fraction (75.5%) and the ether extract (90.6%). NDF and ADF digestibility were 39.5 and 17.5, respectively. A gross energy digestibility of 44.9 resulted in a digestible energy content of 10.06 MJ/kg DM.

DISCUSSION

The nutritive value of brewer's grains determined in our experiment is lower than those obtained by FERNÁNDEZ–CARMONA *et al.* (1996). They obtained a 37% higher DE content (13.8 vs 10.1 MJ in the present study) using the direct method for measuring the digestibility. Composition differences are partially responsible for the difference in feeding value; a 6% higher CP and a 3 % higher EE in the Spanish study. As mentioned by FERNÁNDEZ–CARMONA *et al.* (1996), the low daily feed intake level in their study (only 34 g DM/kg$^{0.75}$ compared to 91 g DM/kg$^{0.75}$ in our experiment) has an effect on the rate of digestive passage and consequently on the digestibility. A low feeding level or a feed restriction leads always to higher digestibility values (see review MAERTENS and LEBAS, 1989). This explains also the higher CP digestibility found by FERNÁNDEZ–CARMONA *et al.* (1996). Nevertheless, sun dried brewer's grains is a valuable by-product with an DE content comparable with e.g. a medium quality sunflower meal or wheat bran (VILLAMIDE *et al.*, 1991). The protein digestibility (75%) even exceeds barley (MAERTENS *et al.*, 1990 ; FERNÁNDEZ–CARMONA *et al.*, 1996).

An explication for the decreased feed intake, although moderate in the zootechnical experiment, and corresponding weight gain has probably to be searched in the composition of the experimental diet. Because brewer's grains replaced 30% of all the ingredients in the basal diet, the experimental diet was probably deficient for some nutrients. Vitamins and mineral supplementation was reduced with 30%. An amino acid deficiency, taking into account the high protein content of brewer's grains and its favourable digestibility, seems unlikely. The calculated dietary amino acid content was in the range of the actual recommendations. Moreover, under extensive conditions

Table 5: Digestibility of brewer's grains

	Mean	SEM[1]
DM	46.2	1.3
OM	48.2	1.4
Ash	16.7	1.8
Crude protein	75.5	1.6
EE	90.6	1.5
NDF	39.6	1.9
ADF	17.5	2.4
Gross energy	44.9	1.3
Dig. energy (MJ/kg DM)	10.06	0.3

[1] n=6

with moistened diets, BERCHICHE *et al.* (1996) obtained better results with a brewer's grains diet than with a horsebean based diet.

Nevertheless, rabbits showed a high average daily weight gain (>46 g/d) on both diets during the 6-weeks fattening period. Parts of it could be explained by the individual caging. In earlier experiments a difference in favour of individual caging versus group caging (4/cage) of 2.7g (6%) was observed (MAERTENS, 1986). However, recently FEKI *et al.* (1996) did not obtain higher gains when rabbits were caged individually.

In conclusion, sun dried brewer's grains is a valuable by-product because 1) of its energy and fibre content which is near to the dietary recommendations of rabbits and 2) the high quality protein content (dCP = 75%). Based on our results and those of LEBAS *et al.* (1996), using a brewer's grains diet in meal form, this by-product can be utilized at high levels in rabbit diets. However, further experiments are necessary using a larger number of rabbits than involved in this study.

ACKNOWLEDGEMENTS : The authors wish to acknowledge the Belgian Ministry for Development Cooperation, for the grant to E. Salifou. They are also grateful to Andre Vermeulen for his skilful technical assistance and to Raoul Lemmens for the good care of the rabbits.

Received : September 12th, 1997
Accepted : November 11th, 1997

REFERENCES

AOAC (1990) Official Methods of Analysis. *Association of Official Analytical Chemists* (15th Ed), Washington DC, USA, 1, 1230 pp.

BERCHICHE M., LEBAS F., LAKARI D., 1996. Utilization of home made diets. Effects on growth performance and slaughter yield of Algerian local rabbits. *6th World Rabbit Congress, Toulouse, Vol. 3, 309-313.*

CARABAÑO R., FRAGA M.J., 1992. The use of local feeds for rabbits. *Options Méditerranéennes, Série Séminaires, 17, 141-158.*

CHEEKE P.R., 1986. Potentials of rabbit production in tropical and subtropical agricultural systems. *J. Anim. Sci., 63, 1581-1586.*

FEKI S., BASELGA M., BLAS E., CERVERA C., GÓMEZ E.A., 1996. Comparison of growth and feed efficiency among rabbit lines selected for different objectives. *Liv. Prod. Sci., 45, 87-92.*

FERNÁNDEZ-CARMONA J., CERVERA C., BLAS E., 1996. Prediction of the energy value of rabbit feeds varying widely in fibre content. *Anim. Feed Sci. Techn., 64, 61-75.*

GARCIA J., VILLAMIDE M.J., DE BLAS J.C., 1996. Energy, protein and fibre digestibility of sunflower hulls, olive leaves and NaOH-treated barley straw for rabbits. *World Rabbit Sci., 4, 205-210.*

GIDENNE T., 1992. Effect of fibre level, particle size and adaptation period on digestibility and rate of passage as measured at the ileum and in the faeces in the adult rabbit. *British Journal of Nutrition, 67, 133-146.*

INRA, 1989. Alimentation des animaux monogastriques: Porc, lapin, volailles. INRA, Paris, 2nd Edition.

LEBAS F., COUDERT P., KPODEKON M., DJAGO Y.A., AKOUTEY A., 1996. Rabbit breeding in tropical conditions, comparative study between a local strain and an European strain: 2 / utilisation of local concentrate or of imported pelleted feed in fattening rabbits. *6th World Rabbit Congress, Toulouse, Vol. 3, 381-387.*

LUKEFAHR S.D., CHEEKE P.R., 1993. Rabbit project planning strategies for developing countries. 2. Research applications. *World Review of Animal Production,* ***28(1)****, 74-82.*

MAERTENS L., 1986. Performance of growing rabbits in relation to housing management. *CEC-Seminar on "Rabbit production systems including welfare". Torino (Italy), 6-7 November 1986.* ***Report EUR n° 10983****, 83-92.*

MAERTENS L. 1992. Selection scheme, performance level and comparative test of two lines of meat rabbits. *Proc. 5th WRSA Congress, Oregon, July 25-30. In J. Appl. Rabbit Res., 15, 206-212.*

MAERTENS L., DE GROOTE G., 1984. Digestibility and digestible energy content of a number of feedstuffs for rabbits. *Proc. 3rd World Rabbit Congress, Rome, Vol. I, 224-252.*

MAERTENS L., LEBAS F., 1989. Mesure de la valeur énergétique des aliments et des matières premières chez le lapin. *Cuni-Sciences, 5 (2) : 35-46.*

MAERTENS L., JANSSEN W.M.M.A., STEENLAND E.M., WOLTERS D.F., BRANJE H. E. B., JAGER F., 1990. Tables de composition, de digestibilité et de valeur énergétique des matiéres premiéres pour lapins. *5èmes Journées de la Recherche Cunicole, Paris 12-13 Décembre, 1990. Ed. ITAVI, communication 57 (9p).*

PEREZ J.M., LEBAS F., GIDENNE T., MAERTENS L., XICCATO G., PARIGI BINI R., DALLE ZOTTE A., COSSU M.E., CARAZOLLO A., VILLAMIDE M.J., CARABAÑO R., FRAGA M.J., RAMOS M.A., CERVERA C., BLAS E., FERNANDEZ J., FALCAO E CUNHA L., BENGALA FREIRE

J., 1995. European reference method for *in vivo* determination of diet digestibility in rabbits. *World Rabbit Sci., 3, 41–43.*

OWEN J.E., 1981. Production de viande de lapin dans les pays en développement. *Revue Mondiale de Zootechnie, 39, 2–11.*

RAHARJO Y.C., CHEEKE P.R., PATTON N.M., SUPRIYATI K., 1986. Evaluation of tropical forages and by-product feeds for rabbit production. I. Nutrient digestibility and effect of heat treatment. *J. Appl. Rabbit Res., 9, 56–66.*

SAS/STAT, 1990. User's Guide, Version 6, Fourth ED. *SAS Institute Inc. Cary, NC, USA.*

VAN SOEST P.J., ROBERTSON J.B., LEWIS B.A., 1991. Methods for dietary fiber, neutral detergent fiber and nonstarch polysaccharides in relation to animal nutrition. *J. Dairy Sci., 74, 3583–3597.*

VILLAMIDE M.J., 1996. Methods of energy evaluation of feed ingredients for rabbits and their accuracy. *Anim. Feed Sci. Techn., 57, 211–223.*

VILLAMIDE M.J., FRAGA M.J., DE BLAS C., 1991. Effect of type of basal diet and rate of inclusion on the evaluation of protein concentrates with rabbits. *Anim. Prod., 52, 215–224.*