WORLD RABBIT SCIENCE 1999, VOL. 7 (4), 203-207.

THE USE OF SOYA BEAN HULLS IN RABBIT FEEDING : A REVIEW

DE BLAS J.C., CARABAÑO R., NICODEMUS N., GARCÍA J., MATEOS G.G.

Departamento de Producción Animal, Universidad Politécnica de Madrid, E.T.S. Ingenieros Agrónomos
28040 MADRID, Spain

ABSTRACT : Recent information about the nutritive value of soya bean hulls (SBH) for rabbits is reviewed in this paper. According to the results presented, DE content of SBH (1720 kcal/kg) is similar to that of alfalfa hay. Soya bean hulls can be included in fattening diets up to levels of 27% without negative effects on performance. However, higher levels of inclusion lead to an accumulation of digesta in the caecum that impairs feed intake and weight gain. The use of a combination of SBH with grape seed meal allows to include up to a 32.5% of SBH in the diet of lactating does without any impairment of performance.

RÉSUMÉ : Utilisation des coques de soja dans l'alimentation du lapin.
Cet article passe en revue les dernières informations sur la valeur nutritive pour le lapin, des coques de soja (SBH, enveloppe des graines de soja retirées avant l'extraction de l'huile). Les résultats présentés montrent un contenu en énergie digestible de 1720 kcal/kg, similaire à celui du foin de luzerne. Les coques de soja peuvent être incorporées dans l'aliment d'engraissement jusqu'à un taux de 27 % sans effet négatif sur les performances. Des taux d'incorporation plus élevés conduisent a une accumulation des digesta dans le caecum qui diminue la consommation et le gain de poids. L'utilisation combinée de SBH et de pépins de raisin permet d'inclure les coques de soja jusqu'à 32,5 % dans le régime des lapines allaitantes sans altérer les performances.

INTRODUCTION

Alfalfa hay, wheat middlings, beet pulp and sunflower meal are the main sources of fibre currently used in domestic diets for rabbits. There is a continuous search for new sources of fibre to reduce feed cost. In the last few years the demand of high-protein soya bean meal for poultry diets has increased and the availability of soya bean hulls for other uses has augmented. This has created an interest to study the potential of use of this raw material in diets for rabbits.

Soya bean hulls (SBH) is a fibre concentrated feedstuff, which can be used to meet a part of the high fibre requirements of rabbits (around one-third of NDF on as-fed basis, according to DE BLAS and MATEOS, 1998). However, it presents a number of chemical and physical characteristics which can affect digestion and feed intake with respect to the traditional sources of fibre used in rabbits as alfalfa hay or wheat straw.

The aim of this work was to review the information published about the nutritive value of SBH for rabbits, including the effects of its inclusion in the diet on performance of growing and lactating animals.

CHEMICAL COMPOSITION AND PHYSICAL PROPERTIES

Average chemical composition of SBH in Spanish samples (FEDNA, 1999; GARCÍA *et al.*, 1997 and 1999) is shown in Table 1. Around two-thirds of its dry matter content correspond to low-lignified cell wall constituents. Furthermore, SBH contains about 12% on dry matter of soluble pectins and oligosaccharides (raffinose, stachiose and verbascose), which are not included in the NDF residue (FEDNA, 1999). These constituents can not be hydrolysed by the animal digestive enzymes. Starch concentration is negligible, so that most of the DM content can be only digested through microbial fermentation. Crude protein content is significant (13.9% on dry matter) and quite variable (CV = 15.4%; FEDNA, 1999) depending on the amount of endosperm included with the hulls after the separation process.

Particle size distribution in the rabbit diets of SBH shows a proportion of fine particles (<0.315 mm) of 47%, which is lower than that obtained for alfalfa hay (71.3%) and similar to that of wheat straw (46.4%) (GARCÍA *et al.*, 1999). Proportion of large particles (>0.630 mm) was higher in SBH than in alfalfa hay (27.1 *vs* 12.9%) but lower than in wheat straw (32.5%). Other physical characteristics of SBH include a relatively high buffering and hydration capacity (GARCÍA *et al.*, 1999) and the presence of a palisade shaped parenchyma which makes microbial adherence difficult (GRENET and BARRY, 1987).

Table 1 : Average chemical composition and particle size distribution of soya bean hulls (% dry matter basis) (FEDNA, 1999; GARCIA *et al.*, 1999)

	No. samples	Average	CV
Dry matter	150	90.0	9.8
Ash	145	5.3	10.2
Crude fibre	120	36.7	11.1
Acid detergent fibre	104	48.6	10.5
Neutral detergent fibre	87	63.6	17.1
Acid detergent lignin	17	2.0	23.2
Acid detergent cutin	1	0.8	-
Sugars + oligossacharides	1	9.0	-
Crude protein	150	13.9	15.4
Ether extract	43	3.0	35.1
Gross energy (MJ/kg)	34	17.9	12.1
Particle size distribution in rabbit diets (%)			
< 0.315 mm	1	46.9	-
0.315-0.630 mm	1	26.0	-
0.630-1.25 mm	1	23.5	-
> 0.630 mm	1	3.6	-

DIGESTION EFFICIENCY

Because of the low degree of lignification of the cell wall, a high fibre digestibility of SBH might be expected. However, NDF digestibility determined both by the difference method (GARCÍA *et al.*, 1997) or by using semisynthetic diets (GARCÍA *et al.*, 1999) was around 30%. MAERTENS and DE GROOTE (1984) observed an even lower crude fibre digestibility (6 %) when using the difference method.

Most of the cell wall in SBH is composed of cellulose and hemicellulose which are slowly digested through microbial fermentation (DE SMET *et al.*, 1995; ESCALONA *et al.*, 1999). Ruminal digestion of SBH cell wall is almost complete after 72 h. However, caecal retention time of SBH in rabbits (14.1 h, GARCÍA *et al.*, 1999), limits efficiency of fibre digestion.

Digestibility of non starch polysaccharides (35%, GARCÍA *et al.*, 1999) is higher than that of NDF because of the high digestibility of pectins, a fraction that is not included in the NDF residue. This value is lower than that found in the same study for alfalfa hay (39%) and higher than that of NaOH-treated wheat straw (25%).

Protein digestibility of SBH was relatively low both in the study of MAERTENS and DE GROOTE (1984) and in that of GARCÍA *et al.* (1997) (54.4 and 30.0%, respectively) with respect to that of alfalfa hay (GARCÍA *et al.*, 1995). The same occurs in other non ruminant species and might be related to the high proportion of protein linked to fibre (43% of N-NDF on total N; GARCÍA *et al.*, 1997) or to an increase of endogenous losses of nitrogen through the hard faeces. However, protein digestibility might vary depending on the amount of kernel that remain attached to the hulls. In this sense, it should be expected a higher protein digestibility when protein content of SBH increase.

Both in the study of MAERTENS and DE GROOTE (1984) and in that of GARCÍA *et al.*, 1997, energy digestibility values (34.5 and 44.3%, respectively) were slightly higher than those observed for NDF digestibility. This might be a consequence of the high digestion efficiency of the pectic constituents (61%, GARCÍA *et al.*, 1999) and oligossacharides fractions.

Recent feeding standards (VILLAMIDE *et al.*, 1998) have assigned to this ingredient a DE concentration of 1.720 kcal/kg, which is similar to that of an alfalfa hay with a CP content of 15% (1.770 kcal/kg) and higher to that of wheat straw (650 kcal/kg), even when treated with sodium hydroxide (880 kcal/kg).

CAECAL FERMENTATION

Caecal traits of animals fed a semisynthetic diet based on SBH (GARCÍA *et al.*, 1999) are shown in Table 2. Data are compared with those obtained with diets based on traditional sources of fibre (alfalfa hay and wheat straw).

Weight of caecal contents, expressed as a proportion of live body weight, tended to be higher when using SBH than when using alfalfa hay or wheat straw. This observation does not agree with the proportion of fine particles (<0.315 mm) in each ingredient, which should favour the entrance and a longer mean retention time of the digesta in the caecum (BJÖRNHAG, 1972; GIDENNE, 1993; GARCÍA *et al.*, 1999). However, the slow rate of degradation of SBH might have compensated for this effect (ESCALONA *et al.*, 1999). The results agree with the shorter mean caecal retention time observed for alfalfa (6.9 h; GIDENNE *et al.*, 1990) than for SBH-based diets (14.1 h; GARCÍA *et al.*, 1999).

Total VFA concentration in the caecum was higher for the SBH and alfalfa hay than for the wheat straw-based diets, which agrees with the differences observed for fibre digestibility. The lower energy available for growth of caecal microorganisms fed the wheat straw diet provides also an explanation for the higher caecal ammonia concentration observed with respect to the other diets. Molar proportions of VFA did not differ among treatments, except that of propionic acid which was slightly higher for SBH than for the other diets (Table 2).

Caecal pH was significantly lower for the SBH than for the alfalfa hay and wheat straw-based diets. This is a consequence of the differences observed in the caecal concentrations of VFA and ammonia, which are the main sources of H^+ and OH^- in the caecal contents. Furthermore, buffer capacity of SBH was lower than that of alfalfa hay according to JASAITIS *et al.* (1987) and GARCÍA *et al.* (1999). This variable quantifies the resistance of caecal contents to change its pH, so that it should be directly related to caecal pH.

The effect of source of fibre on N recycling through caecotrophy is shown in Table 2. Daily soft faeces DM

Table 2 : Effect of fibre source on caecal digestion traits and on excretion and chemical composition of soft faeces (GARCÍA *et al.*, 1999).

Item	Alfalfa hay	Soya bean hulls	NaOH-treated wheat straw	SEM[1]	P
Caecal contents wt (%BW)	4.01	4.81	3.84	0.28	0.056
Total VFA, mmol l^{-1} (%BW)	64.3[a]	64.4[a]	38.2[b]	2.23	0.001
Acetic acid (% BW)	75.4	73.3	75.3	1.00	NS[2]
Propionic acid (% BW)	7.3[a]	9.2[b]	7.8[a]	0.39	0.007
Butyric acid (% BW)	17.2	17.4	16.9	0.92	NS
NH_3-N, mmol l^{-1} (%BW)	9.6[a]	11.8[a]	18.0[b]	1.43	0.002
PH	5.83[b]	5.61[a]	6.28[c]	0.050	0.001
Soft faeces excretion, g DM d^{-1}	22.0[a]	21.4[ab]	15.9[b]	1.56	0.018
Total nitrogen recycled, g d^{-1}	1.00[a]	1.07[a]	0.57[b]	0.076	0.001
Microbial nitrogen recycled, g d^{-1}	0.66[a]	0.48[ab]	0.34[b]	0.060	0.003

[1]n=10. [2]NS= non significant (P>0.10). Mean comparisons were made using Scheffe test.

Table 3 : Effect of substitution of alfalfa hay and wheat straw for SBH on several digestion and performance traits in fattening rabbits (NICODEMUS *et al.*, 1999a).

	Diets				SEM[1]	Contrast[2]		
	A	B	C	D		1	2	3
Alfalfa hay	200	133	66	-				
Wheat straw	200	133	66	-				
Soya bean hulls	-	133	266	400				
Digestibility trial								
Feed intake, g DM d^{-1}	155	159	156	139	8.03	0.06	NS[3]	NS
Energy digestibility	0.550	0.563	0.547	0.575	0.007	0.01	NS	NS
Digestible energy content, MJ kg^{-1} DM	10.50	10.64	10.28	10.69	0.132	NS	NS	NS
NDF digestibility	0.209	0.246	0.229	0.271	0.012	0.004	NS	NS
Digestion trial								
Feed intake, g DM d^{-1}	160	172	174	134	9.6	0.07	NS	NS
Caecal weight, g kg^{-1} BW	16.0	18.2	16.4	19.9	0.9	0.009	NS	NS
Caecal content weight, g kg^{-1} BW	42.9	46.0	45.7	51.3	2.2	0.02	NS	NS
Caecal pH	5.99	5.97	5.92	5.80	0.05	0.009	NS	NS
Ammonia concentration, mmol N-NH3 l^{-1}	9.14	6.86	7.64	8.43	1.13	NS	NS	NS
Total VFA, mmol l^{-1}	59.6	65.4	70.8	72.6	4.86	NS	NS	NS
Whole fattening period performance trial								
Feed intake, g d^{-1}	122	123	123	110	1.81	0.001	NS	NS
Average daily gain, g	42.3	41.4	43.0	40.2	0.78	0.04	NS	NS
Mortality, %	7.50	10.0	7.50	17.5	5.53	NS	NS	NS

[1]n = 10 for digestion and digestibility traits and n=40 for performance traits. [2]1 = Diet D vs others; 2 = Diet C vs B, A; 3 = Diet B vs A.
[3]NS = non significant (P>0.10).

excretion, CP and microbial nitrogen recycled were higher for SBH and alfalfa hay than for wheat straw-based diets. These differences might again be related to the differences observed among diets in fibre digestibility, and then in daily microbial N synthesis, variables that were positively correlated (n = 30; r = 0.41; P = 0.023; GARCÍA, 1997).

FEEDING TRIALS

A) Effect of inclusion of SBH in the diet on digestion and performance of fattening rabbits

A study (NICODEMUS *et al.*, 1999a) has been conducted to measure the effect of a gradual substitution of a mixture 50:50 of alfalfa hay and wheat straw for SBH on several digestive and productive traits. Diets were designed to be isofibrous (around 430 g/kg NDF on DM) and to meet all the essential nutrient requirements for rabbits (DE BLAS and MATEOS, 1998). All the diets had a similar particle size distribution, as proportion of fine particles (<0.315 mm) varied from 71.3 to 67.1% among them. Diets differed in ADL concentration, which decreased from 59 to 33 g/kg DM with SBH inclusion level.

The results obtained in this work are shown in Table 3. Feed intake was measured independently in a digestibility, a digestion and a performance trials. In all cases feed intake tended to decrease at the highest level of inclusion of SBH (400 g/kg), but no differences among diets were found beyond this level. A parallel effect of type of diet on caecal contents weight was found, which agrees with observations made when using semisynthetic diets (Table 2). This effect might be explained by a slower rate of fermentation and/or the lower ADL concentration of SBH with respect to the mixture of alfalfa and wheat straw. GIDENNE and PEREZ (1994) have also observed an increase of caecal mean retention time for decreasing dietary lignin content. A negative relationship between caecal mean retention time and/or weight of caecal contents with feed intake has also been established by DE BLAS *et al.* (1999).

The accumulation of digesta in the caecum observed for the 400 g/kg of SBH diet led to a lower feed consumption and to a significant decrease (by 5%) in average daily gain in the fattening period with respect to the average of the other three diets. However, it also led to an improvement both of NDF and energy digestibilities (by 19 and 4%, respectively; P<0.01), so that feed efficiency (g gain . g^{-1} feed) increased (by 6%; P=0.03). Inclusion of 400 g/kg of SBH did not modify the dietary digestible energy content (Table 2).

B) Effect of inclusion of SBH in the diet on performance of rabbit does

The same diets used in the former experiment were fed to lactating does and young rabbits until weaning (see Table 4). Feed intake of does, milk production and litter weight at 21 d of age decreased linearly (P<0.02) with level of inclusion of SBH. However, neither intake nor growth of young rabbits were affected by treatments. Furthermore, feed efficiency (expressed as kg of young rabbits weaned per kg of total feed intake by rabbit does and young rabbits) was significantly higher (+8.7%; P = 0.02) for the highest level of inclusion of SBH than for the average of the other three diets.

A second lactation trial (NICODEMUS *et al.*, 1999b) was performed to elucidate if the previous results were related to the different lignin content of the diets. With this objective, four isofibrous (around 420 g/kg NDF on DM) and isolignified (70 g/kg ADL on DM) diets were formulated by

Table 4 : Effect of substitution of alfalfa hay and wheat straw for SBH on rabbit does and young rabbits performance. (NICODEMUS *et al.*, 1999a).

	Diets				SEM[1]	Contrast[2]		
	A	B	C	D		1	2	3
Alfalfa hay	200	133	66	-				
Wheat straw	200	133	66	-				
Soya bean hulls	-	133	266	400				
Feed intake of rabbits does, g d^{-1}	413	385	378	353	8.97	0.001	0.05	0.03
Milk production per lactation, kg	6.17	5.48	5.42	5.33	0.19	NS[3]	0.09	0.02
No. born alive per litter	9.54	10.3	9.00	10.0	0.47	NS	NS	NS
No. Weaned per litter	8.58	8.07	8.20	8.91	0.40	NS	NS	NS
Feed intake of litter from 21-30 days, g d^{-1}	152	148	146	141	10.7	NS	NS	NS
Average daily gain of young rabbits from 21-30 days, g	25.4	23.9	24.8	25.8	1.31	NS	NS	NS
Litter weight at 21 days of age, kg	3.11	2.86	2.82	2.80	0.09	NS	NS	0.07
Litter weight at weaning, kg	5.17	4.85	4.86	4.93	0.17	NS	NS	NS
Feed efficiency, kg weaned kg^{-1} feed	0.42	0.42	0.43	0.46	0.014	0.02	NS	NS

[1]n = 12. [2]1 = Diet D vs others; 2 = Diet C vs B, A; 3 = Diet B vs A. [3]NS = non significant (P>0.10).

Table 5 : Effect of inclusion of SBH in isofibrous and isolignified diets on rabbit does and young rabbits performance. (NICODEMUS *et al.*, 1999b).

Diets	A	B	C	D	SEM[1]	Contrast[2]		
Level of inclusion of SBH, g kg^{-1}	0	108	217	325		1	2	3
Feed intake of rabbits does, g d^{-1}	434	434	422	411	14.1	NS[3]	NS	NS
Milk production per lactation, kg	5.68	5.51	5.59	5.25	0.18	NS	NS	NS
Creep-feed intake of young rabbits 21-30 days, g d^{-1}	154	187	166	176	11.0	NS	NS	0.07
Average daily gain of young rabbits 21-30 days, g	22.3	27.0	23.9	26.0	1.21	NS	NS	0.02
Litter weight at 21 days of age, kg	3.03	2.98	2.87	2.86	0.09	NS	NS	NS
Litter size at weaning	8.64	8.66	8.30	8.14	0.45	NS	NS	NS
Litter weight at weaning, kg	4.89	5.19	4.88	5.01	0.14	NS	NS	NS
Feed efficiency, kg weaned kg^{-1} fed	0.375	0.404	0.388	0.408	0.012	NS	NS	NS

[1]n = 14. [2]1 = Diet D vs others; 2 = Diet C vs B, A; 3 = Diet B vs A. [3]NS = non significant (P>0.10).

gradual substitution of a mixture of alfalfa hay, sunflower hulls and wheat straw by a mixture 80:20 of SBH and grape seed meal. Proportion of SBH increased from 0 to 325 g/kg. Diets had a similar particle size (around 35% of particles larger than 0.315 mm).

Grape seed meal, as other grape byproducts, is characterized by a high lignin concentration. Its inclusion in the diet leads to an increase of rate of passage of feed throughout the gut and to a decrease of caecal contents weight (FRAGA *et al.*, 1991). Results presented in Table 5 show that in this trial, type of diet did not affect either feed intake, performance or efficiency of lactating does and young rabbits. Accordingly, it can be deduced the interest of combining the use of SBH with that of inexpensive highly lignified byproducts in diets for lactating does.

CONCLUSIONS

From the results presented in this review we conclude that:

i) SBH is not highly digestible in rabbits in spite of its low degree of lignification. Non starch polysaccharides digestibility (35%) and digestible energy content (1720 kcal/kg) are similar to those found for alfalfa hay.

ii) Soya bean hulls can be included in fattening diets up to levels of 27.0% without negative effects on performance. However, higher levels of inclusion lead to an accumulation of digesta in the caecum that impairs feed intake and weight gain. Lactating does fed with increasing levels of SBH show a slight and linear decrease of feed consumption and milk production.

iii) The use of a combination of grape seed meal and SBH (in a 20:80 proportion) allows to include up to a 32.5% of SBH in the diet of lactating does without any impairment of performance.

Received : June 9th, 1999
Accepted : November 3rd, 1999

REFERENCES

BJÖRNHAG G., 1972. Separation and delay of contents in the rabbit colon. *Swed. J. Agric. Res., 7, 105-114.*

DE BLAS J.C., MATEOS G.G., 1998. Feed formulation. *In: DE BLAS J.C., WISEMAN J. (ed). The Nutrition of the Rabbit, CABI Publ., Wallingford, UK, 241-253.*

DE BLAS J.C., GARCÍA J., CARABAÑO R., 1999. Role of fibre in rabbit diets: A review. *Ann. Zootech., **48**, 3-13.*

DE BLAS J.C., VILLAMIDE M.J., CARABAÑO R., 1989. Nutritive value of cereal by-products for rabbits. 1. Wheat straw. *J. Appl. Rabbit Res., **12**, 148-151.*

DE SMET J.L., BOEVER J.L., BRABANDER D.L., VANACKER J.M., BOUCQUE C.V., 1995. Investigation of dry matter degradation and acidotic effect of some feedstuffs by means of in sacco and in vitro incubations. *Anim. Feed Sci. Technol., **51**, 291-315.*

ESCALONA B., ROCHA R., GARCÍA J., CARABAÑO R., DE BLAS J.C., 1999. Characterization of in situ fibre digestion of several fibrous foods. *Anim. Sci., **68**, 217-221.*

FEDNA, 1999. Normas FEDNA para la formulación de piensos compuestos. De Blas C., García P. y Mateos G.G.(eds). *Fundación Española para el Desarrollo de la Nutrición Animal, Madrid.*

FRAGA M.J., PÉREZ P., CARABAÑO R., DE BLAS J.C., 1991. Effect of type of fiber on the rate of passage and on the contribution of soft faces to nutrient intake of finishing rabbits. *J. Anim. Sci., **69**, 1566-1574.*

GARCÍA J., 1997. Efecto de la fuente de fibra sobre la digestión en el conejo. *Ph. D. Thesis, Universidad Politécnica, Madrid.*

GARCÍA J., CARABAÑO R., DE BLAS J.C., 1999. Effect of fiber source on cell wall digestibility and rate of passage in rabbits. *J. Anim. Sci., 77, 898-905.*

GARCÍA J., PÉREZ L., ÁLVAREZ C., ROCHA R., RAMOS R., DE BLAS J.C., 1995. Prediction of the nutritive value of lucerne hay in diets for growing rabbits. *Anim. Feed Sci. Technol., **54**, 33-44.*

GARCÍA 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 Science, **4**, 205-209.*

GARCÍA J., VILLAMIDE M.J., DE BLAS J.C., 1997. Energy, protein and fibre digestibility of soya bean hulls for rabbits. *World Rabbit Science, **5**, 111-113.*

GIDENNE T., 1993. Measurement of the rate of passage in restricted-fed rabbits: Effect of dietary cell wall level on the transit of fiber particles of different sizes. *Anim. Feed Sci. Technol., **42**, 151-163.*

GIDENNE T., PEREZ J.M., 1994. Apports de lignines et alimentation du lapin en croissance. 1. Conséquences sur la digestion et le transit. *Ann. Zootech., **43**, 313-322.*

GIDENNE T., CARRÉ B., SEGURA M., LAPANOUSE A., GÓMEZ J., 1990. Fibre digestion and rate of passage in the rabbit: Effect of particle size and level of lucerne meal. *Anim. Feed Sci. Technol., **32**, 215-221.*

GRENET E., BARRY P., 1987. Etude microscopique de la digestion des parois végétales des téguments de soja et de colza dans le rumen. *Reprod. Nutr. Dévelop., **27**, 246-248.*

JASAITIS D.K., WOHLT J.E., EVANS J.L., 1987. Influence of feed ion content on buffering capacity of ruminant feedstuffs in vivo. *J. Dairy Sci., **70**, 1391-1403.*

MAERTENS L., DE GROOTE G., 1984. Digestibility and digestible energy content of a number of feedstuffs for rabbits. *In: Proc. II World Rabbit Congress, Rome, vol I, 244-251.*

NICODEMUS N., CARABAÑO R., GARCÍA J., MÉNDEZ J., DE BLAS J.C., 1999a. Performance response of lactating and growing rabbits to dietary lignin content. *Anim. Feed Sci. Technol., **80**, 43-54.*

NICODEMUS N., GARCÍA J., CARABAÑO R., DE BLAS J.C., 1999b. Efecto de la inclusión de cascarilla de soja en dietas isofibrosas e isolignificadas sobre la productividad de conejas en lactación. *I.T.E.A., **20**, 472-474.*

VILLAMIDE M.J., MAERTENS L., DE BLAS J.C., PEREZ J.M., 1998. Feed evaluation. *In: DE BLAS J.C., WISEMAN J. (ed). The Nutrition of the Rabbit, CABI Publ., Wallingford, UK, 89-101.*