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Nutrient digestibility and in situ degradability of alternatives to soybean meal protein sources for sheep

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ABSTRACT

An in situ degradability and three in vivo (by difference) digestibility trials were conducted. The feeds tested were, soybean meal (SBM; control), lupin seeds (LS), rapeseed meal (RSM), sunflower meal (SFM), faba bean seeds (FBS), vetch seeds (VS), pea seeds (PS), flax seeds (FS), and chickpea seeds (CS). Feeds were weighed into nylon bags for incubation in the rumen of three ruminally cannulated Chios breed rams for 0, 3, 6, 12, 24 and 48 h to measure DM and N degradability using a 3×9 incomplete Youden square design. Furthermore, three in vivo digestibility trials were conducted, by the use of a latin square (3×3 for the first trial and 4×4 for the second and the third trial) experimental design with castrated Chios rams, to estimate nutrient digestibility coefficients of these protein supplements. The results showed that RSM, PS and FS had similar N and dry matter (DM) digestibility compared to SBM. Even though PS had higher N degradability than SBM, the digestibility of N was similar for these two protein sources. The FS had the lowest effective protein degradability (EPD) compared to all other tested feeds, whilst VS, LS FBS and CS had higher EPD. This study reveals that RSM, PS and FS compared to SBM did not have adverse effect on DM and N digestibility. All tested seeds, but FS, have to be treated in purpose to reduce their N degradability, if they are to be used as main protein sources in highly productive diets for ruminants.

1. Introduction

The substitution of soybean meal (SBM) in livestock nutrition, by other protein sources, is a continuous challenge. This happens because the price and availability of imported SBM are affected by global trade and therefore created the need to check cheaper local alternatives as protein sources. Moreover, there is customer awareness about the usage of genetically modified (GM) SBM, even though there is no clear scientific evidence to causing health problems (Domingo and Bordonada, 2011). Former is the main reason that non-GM-SBM is double prized than GM-SBM. These parameters were recognized by international bodies such as European Union, which is about to undertake actions targeting self-adequacy via the support of cultivation and production of native produced protein supplements. With this option in mind, the eight most promising protein sources were selected to be compared to SBM in terms of digestibility of nutrients and N degradability. The protein sources included two meals (sunflower meal, SFM; and rape seed meal, RSM) and six untreated but ground seeds (lupin seed, LS; faba bean seed, FBS; vetch seed, VS; pea seed, PS; linseed or flaxseed, FS; and chickpea

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Table 1
Composition and nutritive value of the experimental diets.

Diet	First digestibility trial[a]				Second digestibility trial[b]					Third digestibility trial[c]				
	Basal	SBM	RSM	PS	Basal	SBM	FS	SFM	VS	Basal	SBM	LS	FBS	CS
Composition (%)														
Alfalfa hay	55.0	43.9	42.9	43.9	57.6	45.0	46.0	43.4	45.0	58.7	44.1	44.6	43.8	43.8
Corn grain	41.3	38.0	37.1	38.0	39.6	36.4	37.3	35.2	36.4	38.5	37.3	37.7	37.0	37.0
SBM		14.1				15.5					15.6			
PS				14.1										
RSM			16.2											
FS							13.5							
SFM								18.4						
VS									15.5					
LS												14.6		
FBS													16.2	
CS														16.2
Salt	0.9	1.0	1.0	1.0	0.7	0.8	0.8	0.7	0.8	0.7	0.8	0.8	0.8	0.8
$Ca(H_2PO_4)_2$	1.4	1.5	1.4	1.5	1.1	1.2	1.2	1.1	1.2	1.0	1.1	1.2	1.1	1.1
Premix	1.4	1.5	1.4	1.5	1.1	1.2	1.2	1.1	1.2	1.0	1.1	1.2	1.1	1.1
Sum	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Chemical analysis (g/kg DM)														
Organic matter	942	942	942	948	945	944	946	943	948	944	945	949	949	950
Crude protein	163	210	188	175	135	189	150	166	158	136	189	171	160	147
Ether extract	21	22	29	20	23	24	64	21	23	23	25	32	22	29
NDF	413	369	404	371	375	335	381	385	378	424	362	385	394	361
ADF	219	187	207	185	196	164	203	206	162	231	184	198	191	177
Nutritional value[d]														
M.E. (MJ/kg D.M.)	10.5	11.1	10.8	11.1	10.4	11.1	11.5	10.6	11.1	10.3	11.1	11.2	11.1	11.0
PDI (g/kg D.M.)	95.3	127.5	120.3	105.6	96.0	129.3	103.8	112.9	109.3	96.3	129.6	112.1	109.0	104.7

SBM, soybean meal; LS, ground lupin seed; RSM, rapeseed meal; SFM, sunflower meal; FBS, ground faba bean seed; VS, ground vetch seed; PS, ground pea seed; FS, ground linseed; CS, ground chickpea seed.

[a] Basal ration was made of alfalfa hay (600 g/day) and ground corn grain (450 g/day). Rations were made of alfalfa hay (450 g/day), ground corn grain (390 g/day) and 145 g/day SBM (ration SBM), 170 g/day RSM (ration RSM) and 145 g/day PS (ration PS).

[b] Basal ration was made of alfalfa hay (800 g/day) and ground corn grain (550 g/day). Rations were made of alfalfa hay (580 g/day), ground corn grain (470 g/day) and 200 g/day SBM (ration SBM), 170 g/day FS (ration FS), 245 g/day SFM (ration SFM) and 200 g/day VS (ration VS).

[c] Basal ration was made of alfalfa hay (840 g/day) and ground corn grain (550 g/day). Rations were made of alfalfa hay (580 g/day), ground corn grain (490 g/day) and 205 g/day SBM (ration SBM), 190 g/day LS (ration LS), 215 g/day FBS (ration FBS) and 215 g/day CS (ration CS).

[d] M.E. and PDI values taken from INRA (1988).

seed, CS). All these feeds used to be cultivated extensively in past decades at European territory and wider Mediterranean area.

According to Richardson et al. (1981) SFM could replace SBM in rations of growing and fattening lambs. In spite, Eweedah et al. (1996) reported that dry matter (DM), organic matter (OM) and neutral detergent fibre (NDF) digestibility was lower with the SFM based diet.

The RSM is used extensively in ruminant rations having an excellent balance of amino acids, but it is not an effective source of amino acids because of its extensive N degradation in the rumen (Kendall et al., 1991). Previous works indicated that the effective ruminal degradability of the protein (EPD) of RSM ranged from 44.3% (Kendall et al., 1991) up to 74% (Moshtaghi-Nia and Ingalls, 1995).

The PS, LS and FBS, due to their high protein content, may be used in ruminant diets to balance other dietary ingredients low in protein (Dixon and Hosking, 1992). There has been renewed interest in these seeds because they can be grown in the European community (Aguilera et al., 1992). This makes them possible substitutes for imported protein sources such as SBM, although the protein content of these seeds is generally lower compared to SBM.

The VS is a multipurpose, cool season, annual legume grown for livestock feed, and soil fertility improvement in Mediterranean environments. The hay and grain could be used as sources of protein in ruminant rations (Gul et al., 2008).

The FS represents an attractive concentrate for inclusion in lactating dairy cow rations as a source of both energy and protein (Mustafa et al., 2003). As with other oilseeds, the high level of polyunsaturated fatty acids in FS can negatively affect ruminal fibre digestion (Palmquist and Jenkins, 1980).

The CS is one of the most important legume grains because it is a valuable source of protein, minerals and vitamins, which plays a very important role in human diets in many areas of the world. More than 70% of the world's chickpea production and consumption happens in India, but it is important in many other countries in Asia, Africa, Europe and the Americas (Singh, 1988). Although most of CS is produced for human consumption, it could be an alternative protein and energy source feedstuff.

The objectives of this study were to determine degradability parameters and total tract apparent digestibility of nutrients of eight protein sources in comparison with SBM, aiming to identify their possible strong and weak points

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