JOURNAL OF THE SCIENTIFIC AGRICULTURAL SOCIETY OF FINLAND
Maataloustieteellinen Aikakauskirja
Vol. 53:307–313, 1981

Field peas as a protein source for high-production dairy cows on grass silage and hay based feeding

LIISA SYRJÄLÄ-QVIST, JOUKO SETÄLÄ and MIKKO TUORI

Department of Animal Husbandry, University of Helsinki, 00710 Helsinki 71

Abstract. Twenty-four dairy cows with high milk yields were used in an experiment in which peas and soybean meal were compared for feeding value, when given as protein sources in grass silage and hay based feeding. In their barley and outs based concentrate mixture three different groups recevied: 1) soybean meal 14 %, 2) soybean meal 7.5 % plus ground peas 15 % or 3) ground peas 35 %. The peas were almost equivalent as a protein source to the soybean meal. There were no significant differences between the soybean and pea groups in the intake and utilization of feeds, milk production and milk composition or liveweight changes of the animals. Thus, in silage and hay based feeding the proportion of peas in the concentrate mixture can be at least 35 % and the daily pea ration can amount to 3–4 kg without any harmful effects on milk production.

Introduction

In practical feeding the protein requirement of the dairy cow is covered up to a daily milk yield of 20 kg by a diet consisting of equal parts of grass silage and hay (SYRJÄLÄ 1981). At higher milk production levels protein concentrates are necessary, because of difficulties caused by the bulk of the diet. The crude protein fraction of silage is generally in a very soluble form, which decreases its utilization (SYRJÄLÄ 1977). Inportance thus attaches to the quality of the protein and energy supplements, and in this case soybean meal has proved to be a valuable source of protein (e.g. GORDON 1980), since its protein is not degrared as much or as rapidly in the rumen as the protein of silage (SETÄLÄ and SYRJÄLÄ-QVIST 1982).

In countries like Finland, where soya is an imported feed, it is desirable to find domestic alternatives to this supplement. One of these is field peas (*Pisum sativum and Pisum arvense*). The amounts of peas recommended earlier for dairy cows have been 1–2 kg per day (ANON. 1965, ERIKSSON et al. 1972), but supplements of 3–4 kg have also given promising results (UOTILA 1959, OLSSON and LINDELL 1975, PELLETIER and BOUCHARD 1975, THOMKE 1979). In those experiments, however, the milk production levels were generally less than 20 kg per day. The main purpose of this investigation was to study the value of peas when they replaced soybean meal as a protein source for high production cows on silage and hay based feeding.

Table 1. The men chemical composition and feeding value of the feeds[1]

	Hay	Grass silage[2]	Oats	Barley	Sugar-beet pulp	Soybean meal	Peas
Dry matter, %	87.9	26.5	89.6	89.2	88.7	87.2	86.2
% of DM							
Ash	6.1	8.9	3.1	2.8	13.8	6.4	3.2
Crude protein	9.6	15.8	13.8	13.0	15.0	51.6	27.1
Crude fat	1.9	5.8	5.4	2.4	0.9	1.2	1.2
Crude fibre	35.0	29.0	10.0	5.3	14.2	7.1	7.3
N-free extract	47.4	40.5	67.7	76.5	56.1	33.7	61.2
kg DM/f.u.	1.7	1.4	1.0	0.8	1.0	0.9	0.9
g DCP/f.u.	113	164	92	76	102	391	187

DM = dry matter
DCP = digestible crude protein
f.u. = feed unit = 0.7 kg Starch equivalent

[1] The feeding values were calculated by using the digestibility coefficients and value numbers presented by ANDERSEN and JUST (1979) and ANON. (1969).

[2] pH of silage 3.95, lactic acid 5.93 %, acetic acid 1.00 %, propionic acid 0.4 %, butyric acid 0.03 %, NH_3–N 0.09 % and water-soluble N 2.59 % of DM.

Experimental procedures

The experiment was performed with 24 dairy cows, 21 of which were Ayrshire and 3 of Friesian breed. The animals were brought into the experiment in three blocks. At the beginning of the experiment the average time that had elapsed from calving was 56 days. In the case of all the blocks the experiment lasted 14 weeks. The two first weeks formed a standardization period, when all the animals received the same feed, comsisting of hay, grass silage, grain concentrates, soybean meal and minerals. The feeding was adjusted to their nutrient requirements (BREIREM 1969). At the end of this period the cows were divided into 3 groups that were as similair as possible in respect of their fat-corrected milk (FCM) yields, days after calving, liveweights and breed. During the following two weeks the animals were changed to the experimental feeds. Feeding was still according to the nutrient requirements.

The test period lasted 10 weeks. The basic feeds during this period were hay, grass silage, barley, oats, sugar-beat pulp and minerals (Table 1). The concentrate mixture of the different groups contained (Table 2):

Soybean meal 14 %, group 1
Soybean meal 7.5 % plus ground field peas 15 %, group 2
Ground field peas 35 %, group 3

These protein feeds were intended to supply 35–40 % of the protein needed by the animals for milk production. Fresh grass silage was given *ad libitum* and concentrate mixture at the rate of 0.3 feed unit per kg FCM. The concentrate allowences were corrected after a 2-kg decrease in milk production. The sampling, analyses, calculations and statistical treatments were as described by SYRJÄLÄ et al. (1978).

Table 2. The percentages of different feeds in the concentrate mixture.

	Groups		
	Soybean	Soybean-pea	Pea
Barley	21	12	10
Oats	40	45	34.5
Sugar-beet pulp	21	17	17
Soybean meal	14	7.5	–
Peas	–	15	35
Minerals	4	3.5	3.5

Results and discussion

Intake of feeds and nutrient supply

The average intake of feed varied slightly between the groups (Table 3, Fig. 1). It was lower in the soybean-pea group than in the other groups. The differences in the supply of energy and protein between the groups were not, however, statistically significant ($P > 0.05$). In all the groups the total net energy supply was near the corresponding feeding standard (BREIREM 1969). The protein supply exceeded the standards, however, being 115 % of the corresponding standard in the soybean group, 109 % in the soybean-pea group and 113 % in the pea group. The reason for the protein overfeeding lies mainly in the protein content of both silage and hay, which chanced to be unexpectedly high during the test period.

The average daily intakes of soybean meal and/or peas were: group 1, 1.1 kg soybean meal; group 2, 0.6 kg soybean meal and 1.1 kg peas; group 3, 2.8 kg peas. The maximum pea intake was 3.6 kg per day. In the different groups these protein feeds gave respectively, 31 %, 34 % and 38 % of the protein needed for milk production.

Production of cows

The milk production of the cows was at the same level in the different groups (Table 3, Fig. 2) and no statistically significant differences existed ($P > 0.05$). The average decrease in milk yield from the standardization period to the test period was about the same in the two groups receiving soybean, 3.4–3.5 kg FCM, but in the pea group it was a little greater, 5.1 kg FCM/day.

There were no significant differences in the fat and dry matter content of the milk between the groups ($P > 0.05$), but the protein content of the milk was significantly lower ($P < 0.01$) in the soybean-pea group than in the other groups, although the differences in the daily milk protein production were not significant ($P > 0.05$).

The reason for the lower milk protein content in the soybean-pea group than in the other groups is not clear. Perhaps the cows were suffering from an energy deficit, although this was not evident from the energy supply values. At least the cows in this group lost weight during test period, which was not found in the other groups

Table 3. The mean intake and milk yields in the different groups

	Standardization period Groups			Test period Groups		
	Soy-bean	Soybean-pea	Pea	Soy-bean	Soybean-pea	Pea
DM intake, kg/d						
Hay	1.65	1.57	1.34	4.15	3.89	4.02
Silage	7.19	7.23	7.36	6.00	5.83	5.97
Concentrate	7.71	7.36	7.75	7.16	6.75	7.06
Total	16.55	16.16	16.46	17.30	16.47	17.05
f.u. intake	14.11	13.71	14.09	14.13	13.49	14.08
DCP intake, g/d	1883	1826	1899	1968	1855	1908
Liveweight, kg	519	542	520	526	539	532
Liveweight change, kg/d				+0.20	+0.07	+0.13
FCM, kg/day	26.9	26.8	28.1	23.4	23.4	23.0
Milk fat %	4.77	4.58	4.70	4.74	4.59	4.64
" protein %	3.17	2.99	3.03	3.47	3.21	3.42
" DM %	13.41	12.99	13.12	13.63	13.15	13.49
Milk fat, g/day	1152	1127	1197	1000	983	970
" protein, g/day	763	732	772	729	683	722
" DM, g/day	3224	3198	3327	2876	2826	2835
Production, f.u./kg FCM	0.30	0.35	0.29	0.39	0.38	0.41
Production, DCP g/kg FCM	59	57	57	71	67	70

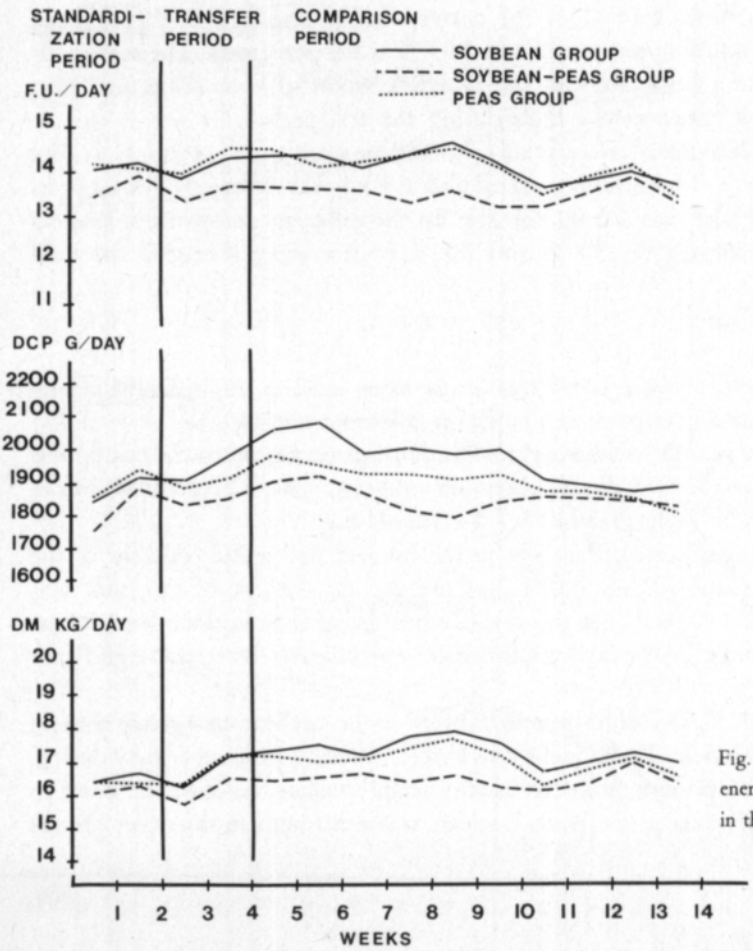

Fig. 1. The average intake of energy, protein and dry matter in the different groups.

Table 4. Haematological criteria and chemical constituents of the blood of the cows.

	Soybean group		Soybean-pea group		Pea group	
	Stand. period	Test period[1]	Stand. period	Test period[1]	Stand. period	Test period[1]
Hematocrit, %	32.2	32.3+0.6	31.8	31.9–0.9	31.2	30.2+1.9
Hb, g/1000 ml	112	113 +1.0	114	114 +1.0	109	109 +5.0
Plasma glucose, mg/100 ml	66.5	60.8+9.9	60.0	55.0+1.9	57.5	55.9–0.6
Plasma proteins, g/1000 ml	72	75 ±0	76	78 ±0	72	76 –3
Plasma urea N, mg/100 ml	10.1	17.1+1.8	8.9	15.6+2.0	9.4	15.3+0.6

[1] The change during the test period.

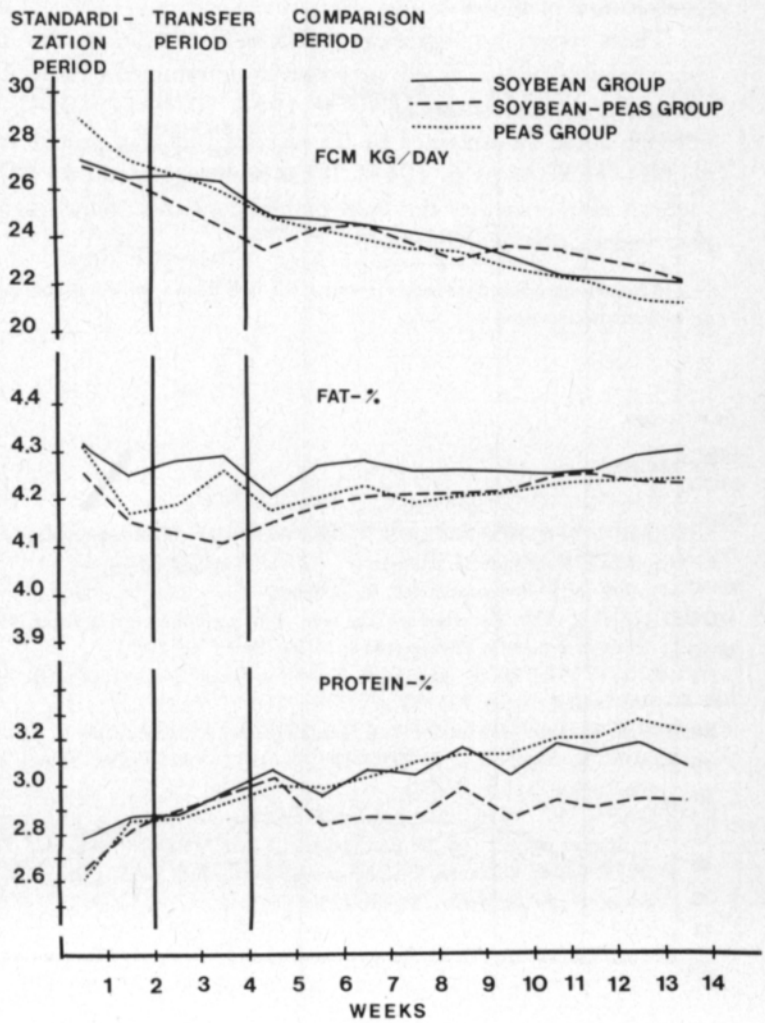

Fig. 2. Milk yield and composition in the different groups.

(Table 3). It has been shown that lack of energy can cause decrease in milk protein content (REID et al. 1966, KAUFMANN 1976, 1979, OLDHAM and SUTTON 1979).

Utilization of feeds

The feed unit and digestible crude protein consumption per kg of fat-corrected milk was used as a measure of feed utilization (Table 3). The f.u. and DCP needed for maintenance were substracted from the total supply. The maintenance values used were 4 f.u. per 500 kg liveweight and 75 g DCP/maintenance f.u. (BREIREM 1969). The energy requirements for a change in liveweight (Table 3) were taken as 2.2 f.u./kg liveweight decrease and 2.6 f.u./kg liveweight increase. No corrections were used in the protein calculations.

There were no significant differences between the groups in energy and protein utilization ($P > 0.05$). In the test period the consumption of production f.u. per kg FCM was near the corresponding requirement standard, as follows: soybean group 0.39, soybean-pea group 0.38 and pea group 0.41. The digestible crude protein consumed for milk production was higher than the standard by 18 % in the soybean group, by 11 % in the soybean-pea group and by 17 % in the pea group, the values being 71, 67 and 70 g DCP/kg FCM, respectively.

Compisition of blood

There were no significant differences between the three groups in the concentration of the blood constituents determined (Table 4). All the values fall within the normal ranges (RAUEN 1964, HEWETT 1974). The changes in urea-nitrogen could be explained by the increased level of protein feeding during the test period (PRESTON et al. 1965). It has been suggested by PAYNE et al. (1972) that soybean meal increases the level of blood glucose, which agrees with the increase observed in this experiment.

Acknowledgements. We wish to express our best thanks to Mr. Mikko Jylhä for technical assistance throughout the experiment.

References

ANDERSEN, P. & JUST, A. 1979. Tabeller over fodermidlers sammensetning. 56 p. Køpenhavn.

ANON. 1965. Handbuch der Futtermittel. 475 p. Hamburg.

— 1969. NJF. Fodermitteltabel. 40 p. Gjøvik.

GORDON F. J. 1980. The effect of silage type on the performance of lactating cows and the response to high levels of protein in the supplement. Anim. Prod. 30: 29–37.

HEWETT, C. 1974. On the causes and effects of variations in the blood profile of swedish daily cattle. Acta Vet. Scand., Supp. 50. 152 p.

BREIREM, K. 1969. Fôrnormer. K.K.Heje/Singsaas Lommealmanakk 1: 120. Oslo.

ERIKSSON, S., SANNE, S. & THOMKE, S. 1972. Fodermedlen. Sammansättning-Näringsvärde-Andvändbarhet. 251 p. Borås.

KAUFMANN, W. 1976. Zur Bedeutung der Energieversongung hochleistender Milchkühe für den Milcheiweissgehalt und die Fruchtbarkeit. Kieler Milchw. Forsch. Ber. 28: 347–357.

— 1979. Protein utilization. Feeding strategy for the high yielding dairy cow, Eds. Broster, W. H. and Swan, H, EAAP Publ. 25: 90–113.

OLDHAM, J. D. & SUTTON, J. D. 1979. Milk composition and the high yielding cow. Feeding strategy for the high yielding dairy cow, Eds. Broster, W. H. and Swan, H. EAAP Publ. 25: 114–147.
OLSSON, B. & LINDELL, L. 1975. Studier över utfording av ärter till mjölkkor. Lantbrukshögskolan, Inst. för husdjurens utfodring och vård 3: 1–15, Uppsala.
PAYWE, J. M., MANSTON, R. & DEW, S. 1972. The interpretation of metabolic profiles in relation to energy and protein intake. Nutr. Conf. Feed Manuf. 6. p. 55–89. Univ. Nottingham.
PELLETIER, G. & BOUCHARD, R. 1975. Evaluation of Faba beans and field peas as protein sources for lactating cows. Can. J. Animals Sci. 55: 474.
PRESTON, R. L., SCHWAKENBURG, D. D. & PFANDER, W. H. 1965. Protein utilization in ruminants I. Blood urea nitrogen as affected by protein intake. J. Nutr. 86: 281–287.
RAUEN, H. M. 1964. Biochemisches Taschenbuch II. 1984 p. Berlin.
REID, D. J. T., MOE, P. W. and TYRRELL, H. F. 1966. Energy and protein requirement of milk production. J. Dairy Sci. 49: 215–223.
SETÄLÄ, J. & SYRJÄLÄ-QVIST, L. 1982. (Unpubl.)
SYRJÄLÄ, L. 1977. Effect of fermentation level on the utilization of silage protein. Proc. XIII Int. Grassland Congr. Leipzig DDR, Eds. Wojahn, E. and Thöns H. p. 1465–1468.
– 1981. Significance of protein/energy relationships in the practical feeding of dairy cattle under the climatic conditions of Northern Europe. ECE symposium of new sources of protein in relation to energy supply for high production of milk and meat. Geneve.
– POUTIAINEN, E. & KOSKELA, V-H. 1978. Untreated and formaldehyde treated skimmilk powder as a protein supplement for dairy cows. J. Scient. Agric.Soc.Finl. 50: 155–165.
THOMKE, S. 1979. Ärter och åkerböna som foder. Akt. Sver. Lantbruksuinv. 271: 1–21. Uppsala.
UOTILA, I. 1959. Herne ja virna lypsylehmien rehuna. Maatal.tiet. Aikak. 31: 19–30.

Ms received November 26, 1981.

SELOSTUS

Herne korkeatuottoisen lypsylehmän valkuaisen lähteenä säilörehu- ja heinäruokinnalla.

Liisa Syrjälä-Qvist, Jouko Setälä ja Mikko Tuori.

Helsingin yliopiston kotieläintieteen laitos, 00710 Helsinki 71

Tutkimuksen tarkoituksena oli verrata hernettä soijarouheeseen runsastuottoisen lypsylehmän valkuaisen lähteenä. Koe tehtiin 24 lehmällä, joista muodostetut ryhmät saivat väkirehuseoksessaan 1) soijarouhetta 14 %, 2) soijarouhetta 7 % + hernettä 15 % tai 3) hernettä 35 %. Näillä valkuaisrehuilla pyrittiin täyttämään 35–40 % maidontuotannon valkuaistarpeesta. Perusrehuina olivat nurmisäilörehu, heinä ja ohra-kaura-melassileike-kivennäisseos.

Koe kesti yhteensä 14 viikkoa, mistä ajasta vertailukauden osuus oli 10 viikkoa. Ruokinta oli ravinnontarpeen mukainen ja yksilöllinen.

Herne osoittautui lähes soijan veroiseksi valkuaislähteeksi runsastuottoisilla lypsylehmillä. Keskimääräiset maitotuotokset vertailukaudella eri ryhmissä olivat 23.4 kg, 23,4 kg ja 23.0 kg 4-prosenttista maitoa. Rehun syönnissä ja hyväksikäytössä, maitomäärissä ja maidon koostumuksessa sekä elopainon muutoksissa ei ollut merkitseviä eroja ($P > 0{,}05$) soija- ja herneryhmien välillä. Hernettä voidaan näin ollen suositella käytettävän ainakin 35 % väkirehuseoksessa ja päivittäiset hernemäärät voivat haitatta nousta 3–4 kiloon säilörehua, heinää ja viljaa sisältävällä ruokinnalla.