ALTERNATIVE FODDER PROTEIN SOURCE FOR FEEDING DAIRY COWS

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Abstract

The average milk production for the control lot was 34.7 kg / day / cow ±1.36 kg standard deviation, and for the experimental lot 35.4 kg / day / cow ±1.04 kg standard deviation. It is found an extra quantity of 0.7 kg milk for the experimental lot in report to the control lot. The milk production standardized to 3.5% fat, was for the control lot 34.61 kg/ day / cow , ± 1.30 kg standard deviation, and for the experimental lot, 35.89 kg/ day / cow ± 1 kg standard deviation. We obtained an extra quantity of 1.280 kg milk. The forage consumption higher than the one necessary for the support functions determines an increase of the milk production corrected to 3.5% fat and of the forage efficiency from 1.29 to 1.93, corresponding to the increase with once to five times of the forage consumption.

Key words: **:** *forage, protein, peas, ration, dry substance .*

INTRODUCTION

Since January 2008, organic milk production should be based entirely on organically grown feed and, according to current European legislation, the majority of this feed should come from locally grown crops. These nutritional constraints are particularly difficult to meet by organic dairy farms located in the Alpine region, where there are no alternative agronomic solutions to fodder production from natural meadows and grazing (O'Brien 2017). Therefore, to meet the nutritional requirements of lactating cows, local forage must be supplemented with organic energy and protein sources purchased from the feed market. Maize and barley are the main sources of energy included in these diets, while most of the protein comes from soybeans and sunflowers. Nowadays, however, the use of soy products is endangered by the increasing risk of them being genetically modified (Comino2018)

The peas may replace the soybean meal when the non-degradable protein necessary is lower as it is in the second part of the lactation or at its end, but also in the commercial farms having a modest milk production (under 20 litres/day).

The energetic content of peas is similar to the one of maize and wheat. The starch content of peas varies between 41% and 54% of the dry substance(SU). Due to the slow degradation of the non-structural carbohydrates of peas, the fat percentage of milk is higher for the cows foddered with peas comparing to the ones foddered with soybean meals and cole.

For supporting the high performance levels of the milk cows, the forage rations should provide both the synthesis maximization of the microbial nutrients of the structural carbohydrates at the rumen level and the necessary bypass nutrients directly to the small intestine. The protean sources used in the forage concentrates for the milk cows are few, including here mainly the soybean meal, the sunflower meal and soya beans. Raw field peas have a lower protein content than soybeans, and pea protein has a higher rumen degradability compared to soybean meal (Osmane, 2017). From an energetic point of view, peas have a starch content of 44% based on DM (Tufarelli 2012, Cola 2021), which makes it an interesting ingredient for lactation diets based on meadow or pasture hay where additional sources are needed. of energy rich in easily fermentable carbohydrates in the rumen(Volpelli,2012).

The protean alternative sources are very necessary for partially or totally replacing soybean meal.

Peas may be considered as a forage source having a double role for its content of protein and energy. If we compare it to soya, the peas protein is richer in lysine, and if we combine it with maize, we may avoid the methionine deficit.

In the current global context, the new genomic technologies can represent the solution to the multiple challenges encountered by farmers in vegetable farms but also in livestock farms (Bonciu, 2023). On the other hand, there is a necessity to having alternative methods that can functioned in a friendly ecosystem such as organic farming (Bonciu, 2022 a, b).

Grass from grazing land (pasture) is an important source of feed for dairy cows in many parts of the world (Boye,Cola,2010). When managed correctly, pasture is a very nutritious feed, which allows dairy cows to produce milk rich in protein, vitamins, and minerals. Consumers usually consider pastoral farming as healthy, animal friendly, and an environmentally sustainable method of milk production The rising consumer interest in how foods such as milk are produced has led to the development of milk brands that only allow farmers feed their cows grass [e.g., Organic Valley's Grassmilk. These dairy products are in high demand in some nations and are sold at a market premium price in several supermarkets and convenience stores. Consumers' intuition regarding pasture-based farming is not necessarily based on scientific research, but several research studies support their opinion. For instance, regarding animal welfare, comparing cubicle-housed and pasturebased dairy cows over a full production cycle, showed that a pasture system improved cow welfare in terms of lameness. (D. O'Brien,1 B. Moran, and L. Shalloo, 2017.)

The ruminal degradability and the soluble fractions are higher for peas in report to soybean meal. Investigations are necessary in order to include peas as a protean source for the partial replacement of soybean meal in the milk cows' rations(Fathollahi,2018). The simplest measure of the forage efficiency is the report between the kilograms of milk accomplished per kilogram of dry substance consumed by the milk animal.

MATERIALS AND METHODS

The purpose of this research referred to the evaluation of the effect of the partial substitution of soybean meals and of grain maize, by peas, on the production, the milk production.

The experiment was developed in 2021 at S.C.FENOV and it contained 6 Holstein Friza cows, at the second lactation. Two forage rations were formulated, a control one and an experimental one, according to table no. 1

The animals were foddered by the control ration for two weeks, and then there were made groups of 3, based on the lactation days, the milk production and the corporal weight. The first group of cows had, at the beginning of the experimentations, 110 ± 29 lactation days, 27.4 ± 4.6 kg of milk per day with 3.35 ± 0.23% protein and a corporal weight of 665 ± 79 kg. The second group of cows had, at the beginning of the experimentations, 107 ± 49 lactation days, 28.1 ± 3.6 kg milk per day with 3.34 ± 0.20% protein and the corporal weight of 667 ± 65 kg. The first two forage weeks were for adaptation. In the next 6 weeks, the two groups of cows randomly received the control ration and the experimental ration (with 15% peas in S.U.

Table 1 Ingredients of the ration and chemical composition

Ingredientes	Ration (% of the dry substance)	
	Control	Experimental
Lucerne hay	27,0	27,0
Maize silo	25,0	25,0
Grain maize	19,0	11,5
Soybean meal (48 % PB)	7,4	1,6
Peas	-	15,0
Brewery mash	7,0	6,0
Grain barley	12,5	11,8
Vitamin-mineral premix	2,1	2,1
Composition		
Gross protein	15,6	15,2
Neutral detergent fibre	35,0	38,1

39.5% of the grain maize was replaced and also 78.4% of the soybean meal (in S.U.), of the control ration by 15% S.U. peas, in the experimental ration. The proportion of the other ingredients is almost similar for the two rations. The peas was grinded with a mill having hammers and a sieve of 2 mm. All the forage ingredients were mixed once a day, forming a "Total mixture ration" (R.t.a.), which was administrated ad lib twice a day (at 7am and at 5pm), with non-consumed leftovers contained between 5 and 10%. All the cows had access to water and to the salt blocks during the entire experimentation. We took daily individual samples of the volume forage, the total mixture ration and the non-consumed leftovers and every week, we took samples of the concentrates. The milk production was registered during the entire experimentation. The cows were milked "in a bottle" twice a day, at 6am and at 6pm. The samples were analysed in order to determine the fat and protein content. In this purpose the ECOMILK ULTRASONIC MILK ANALYSERS device was used.

The forage efficiency (EF) of the milk cows is a measure of converting the forage nutrients into milk. The simplest measure of the forage efficiency is the report between the achieved kilograms of milk and the consumed kilogram of dry substance. This report is an estimation of the efficiency by means of which the consumed energy ("input") appears as milk production ("output"). Whereas the "output" energy quantity known as milk varies depending on the fat content of the milk, for the measuring of the forage efficiency, we used the kilogram of milk corrected for the fat content. This is an adjustment to a standardized value (for example, to 3.5% or 4% fat). The analysis of the forage efficiency of the milk cows with rations including peas is made depending on the lactation stage, the forage digestibility and the fibre content of the ration.

RESULTS AND DISCUSSIONS

The genetic potential is usually expressed immediately after calving, as the cow is under the pressure of producing a very big quantity of milk. At this level, the cow has a limited capacity of ingesting the necessary quantity of forage, as there is a mobilization of the corporal fats for finding an energetic balance. A cow's ability to mobilize the corporal fats is correlated to the genetic potential (the cows having a very high genetic potential mobilize the corporal fat for a much longer lapse of time than the cows having a lower genetic potential). After calving, the cows may lose up to 0.7 kg per day of their corporal weight. This is why the experience was made with cows after 90-100 lactation days, and the use of peas in the cows' rations has a much better forage efficiency in this lapse of time.

Table 2 presents the S.U. consumption, the physical milk production, the milk production adjusted to 3.5% fat, the fat and protein percentage and the forage efficiency (EF) for the two lots of animals (the control one and the experimental one – including peas in a percentage of 15% of S.U. of the ration.

The dry substance consumption (S.U.)

The average of the dry substance consumption (S.U.) of the control lot was 23 kg ±
0.5 kg standard deviation (DS),and the one of the experimental lot, 23.15 kg ± 0.3 kg

standard deviation. The difference between the two values is 0.150 extra consumed kilograms for the experimental lot.

By including peas in the milk cows' ration, it is not found a refusal of the animals to consume the experimental ration. The peas ration is very well accepted, registering thus an easy tendency to increase the consumption (+0.150 kilograms in report to the control lot).

Table 2 The effect of including peas in the milk cows' ration regarding the consumption of S.U. and of the milk production and composition

Ingredients	Ration				Diferences (Experimental - Control)	
	Control		Experimental			
	$\bar{X}$	± DS	$\bar{X}$	± DS	± kg.	Statistical signification of the differences
SU consumotion kg/day	23,00	0,50	23,15	0,30	+0,15	Ns*
Milk production kg/day	34,70	1,36	35,40	1,04	+0,70	Ns*
Milk with 3,5% fat kg/day	34,61	1,30	35,89	1,00	+1,28	Increasing tendency
Milk fat %	3,49	±0,1	3,60	0,20	+0,11	Ns*
Milk protein %	3,21	±0,1	3,20	0,10	-0,01	Ns*

The total milk production

The average milk production of the control lot was 34.7 kg / day / cow ±1.36 kg standard deviation, and the one of the experimental lot was 35.4 kg / day / cow ± 1.04 kg standard deviation. It is found an extra quantity of 0.7 kg milk at the experimental milk in report to the control milk. Statistically, this difference is not significant.

The introduction of peas in the cows' ration had no significant influence on the milk production. However, there is an increasing tendency of the milk production with 0.7 kg/day and per cow. The milk production standardized at 3.5% fat was, for the control lot,

34.61 kg/ day / cow, ± 1.30 kg standard deviation, and for the experimental lot, 35.89 kg/ day / cow ± 1 kg standard deviation. 1.280 extra kg of milk were obtained. Statistically analysed, this difference is insignificant (p >0.05). Since the p value is under 0.1, we may state that the experimental peas ration included for foddering the cows has the increasing tendency of the milk production corrected to 3.5% fat percentage.

The fat quantity accomplished for the control lot was 1.211 kg (34.7 x 3.49%), and for the experimental lot, 1.274 kg (35.4 x3.6%), with an increase of 0.063 kg in report to the control lot.The protein quantity accomplished for the control lot was 1.114 kg (34.7x3.21%) and 1.137 kg (35.4 x 3.20%) for the experimental lot. This shows a similar profile of the amino acids of the two rations and in quantities approximately equal for absorption, at the small intestine level.

We should mention the fact that the energetic evaluation of the rations did not use adjusting factors (adjusting factors as a consequence of processing the cereals or all the

ingredients of the ration and adjusting factors of the forage consumption).

The cereal processing may improve the nutritive value due to the changes of the rates and of the digestions place. The physical processing (grinding, breaking, etc.), de usually does not lead to the change of the composition of the cereal nutrients, but it determines an increase of the starch digestibility It has been recently established for the report between the milk quantity corrected to fat and the S.U. quantity consumed by the milk animals to be used as the index of the forage efficiency Forage efficiency = the milk quantity corrected for fat / consumed S.U.

Most of the farms monitor the S.U. consumption, the milk production and the milk composition. In these conditions, we may calculate milk values corrected with 3.5% or 4% fat. The calculation formulas for milk corrected in fat were made with standardization means of the milk production based on the energetic equivalence necessary for the genetic analyses. The milk fat represents 50% or more of the energetic milk content, and the fat is the most variable content of milk, both regarding the race and between the races or across the lactation of a cow. The calculation formulas for the milk corrected in fat were made based on the milk combustion energy, namely: E (Mcal/kg) = 109.21 x milk quantity x (2.66 + % fat)

For the milk having a content of 4% fat:

E (Mcal/kg) = 109.21 x milk quantity x (2.66 + 4) = 109.21 x milk quantity x 6.66 = 727 Kcal/kg = 0.727 Mcal/kg.

For standardizing the milk production to the milk energetic constant value whitt 4% fatt. It was decided to round off the values:

Concentrated milk 4% =0.4 x kg of milk +15 x kg of fat. In our case:

Concentrated milk with 4% fat = 0.4 x 34.7 +15 (34.7 x 3.5%) =32.03 kg of milk for the control lot.

Corrected milk with 4% fat = 0.4 x 35.4 + 15(35.4 x 3.6%) = 33.27 kg of milk for the experimental lot. In this case, the formula is:

Corrected milk with 3.5% fat = 0.4318 x kg of milk + 16.23 x kg of fat. In our case:

1) corrected milk with 3.5% fat =0.4318 x 34.7 + 16.23 (34.7 x 3.5%) = 14.98 + 19.63 =34.61 kg of milk for the control lot and,

2) corrected milk with 3.5% fat = 0.4318 x 35.4 + 16.23(35.4 x 3.6%) =15.28 = 20.61 = 35.89 kg of milk for the experimental lot.

The effect of the S.U. consumption of the forage efficiency

The milk cows that consume more will give more milk. As a result, both the consumption and the production increase, and so does the forage efficiency.

The reason of the improvement of the forage efficiency is that a bigger part of the forage consumption is used for the milk production and a smaller part is used for the supporting function. This is shown in figure 1, where the effects of the consumption on digestibility were not adjusted.

The forage consumption higher than the one necessary for the supporting functions determines an increase of the milk production corrected to 3.5% fat and of the forage efficiency from 1.29 to 1.93, corresponding to the increase with once to five times the forage consumption.

In this case, the digestibility decreases with almost 3 digestible units or 0.03 Mcal/kilogram. This is shown in table 3.

Table 3 The non-adjusted milk production and the one adjusted with a percentage of 3.5% fat and the forage efficiency as a response to the increase of the forage consumption from “once” to “5 times” of the supporting necessary (6 kg of the consumed S.U. with 1.66 Mcal/kg of S.U.)

A	Non-adjusted SU consumption	Consumed SU kg/day	6	12	18	24	30
		Multiple of the supporting necessary	1	1	3	4	5
		Milk net energy Mcal	10	20	30	40	50
		Milk net energy/kg SU	1.66	1.66	1.66	1.66	1.66
		Milk with 3.5% kg/day	0.0	14.5	29.0	43.5	58.0
		Forage efficiency	-	1.21	1.61	1.81	1.93
B	Adjusted SU consumptio n	Consumed S.U. kg/ day	6	12	18	24	30
		Multiple of the supporting necessary	2	1	3	4	5
		Milk net energy Mcal	10	19.50	28.80	37.68	46.2
		Milk net energy/kg SU	1.66	1.63	1.60	1.57	1.54
		Milk with 3.5% kg/day	-	13.1	25.4	35.8	45.4
		Forage efficiency kg Milk with 3.5% fat / S.U. consumption	-	1.09	1.41	1.49	1.51

We should mention the fact that the forage efficiency is very low, more than “4 times” the supporting necessary (1.49 in report to 1.52). This response shows the fact that a very high milk production does not determine a very high forage efficiency. For establishing certain standard values of the forage efficiency, we need several accomplishment of the lactation Figure 1 presents the effect of the number of the animal’s lactation and of the lactation days on the forage efficiency to a herd of Holstein cows having a production of 9,800 curves for the milk production, for the fat percentage and for the milk production corrected to 3.5% fat percentage.

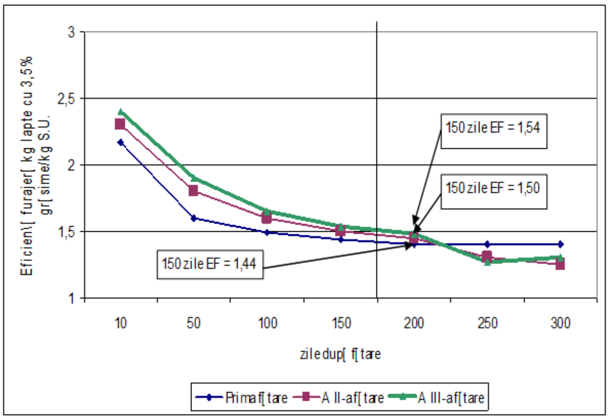

Figure 1. The effect of the number of the animal’s lactation on the forage efficiency

The S.U. consumption may be recalculated by using the NRC formulas (2001) across the recalculated lactation curve. The forage efficiency is calculated by using the presented formulas. The factor affecting the forage efficiency is the lactation stage. The forage efficiency decreases from about 2.25 at the beginning of the lactation to 1.30 at the end of the lactation. The forage efficiency is higher when animals pass from lactation I to lactation II or
III, due to the increase of the milk production.

Because of the fast decrease of EF at the same time with the increase of the S.U. consumption, the evaluation at the beginning of the lactation (under 60 days of lactation) has a reduced signification. A very high efficiency at the beginning of the lactation is a consequence of the use of the energy from the corporal tissues for supporting the milk production and it reflects a higher weight loss and a very reduced forage consumption.

Generally, the maximum S.U. consumption occurs at 100 days p.p., and EF decreases linearly until the end of the lactation. This allows the determination of the forage efficiency adjusted to the number of lactation days of a herd or group of cows.

It was established that the EF decrease after 100 days of lactation is about 0.1% daily. The conversion of a current EF to the EF at 150 days of lactation is made by decreasing the number 150 from the current number of days in lactation, correcting the EF with or without 0.1% daily.

Table 4 Shows the correction to 150 of the EF for 4 groups of cows

Group of cow	Days of lactation	Calculated Ef (milk 3,5 % SU consumption)	Days of lactation	Differences daysx0,1 %	Adjusting factor	EF adjusted to 150 days
1	125	1,47	- 25	- 0,025	0,975	1,433
2	150	1,44	0	0,	1	1,440
3	175	1,46	+ 25	+ 0,025	1,025	1,497
4	200	1,43	+ 50	+ 0,050	1,050	1,502

The forage-related factors may influence the EF. The actual management of theforage resources is the most important method for improving the use of forage. To 1.55 for the experimental lot, respectively with 0.05 units.This is explained by the fact that, by introducing peas into the ration, the fibres in the ration are better used. The peas starch has a slow degradability and there is no decrease of the ruminal pH. In conclusion, 15% of the dry substance of the peas included in the ration has led to the EF improvement with 0.05 units.

CONCLUSIONS

1.The peas produced at S.C.D.A. Șimnic is an acceptable source of nutrients and it may be included in the milk cows' ration, with minor restrictions.

2.The data of the achieved experimentations suggest that the inclusion of peas in a 15% percentage (of the S.U. of the ration) in the milk cows' ration has no significant impact of the forage consumption and on the milk production. However, it is found an increasing tendency of the S.U. consumption with 0.150 kg and an increase of the milk production corrected to 3.5% fat of 1.280 kg of milk (in report to the control ration including soybean meal).

3.Based on the results obtained in the achieved experimentations, peas may be successfully cultivated, accomplishing thus an alternative forage source for cattle.

4.We may replace a part of the soybean meals in the milk cows' ration, when the necessary non-degradable protein is smaller (in the second part of the lactation or in the commercial farms having a production under 20 kg of milk per cow).

5.Due to the variability of the compositional quality, the peas should be analysed in the laboratory before including it in the ration. It is necessary to determine the fibre content (fibre of acid detergent or fibre of neutral detergent) for estimating the net energy of milk, the total digestible nutrients and the relative value and quality of the forage.

6.The pulses for grains constitute a main protean vegetal source having a high digestive value for the animals' forage and for the humans' food.

7.Peas is a unique forage, it contains proteins and energy as starch and also some phenolic compounds having a strong antioxidant reaction, contributing to the improvement of the milk flavour.

8.The peas produced at S.C.FENOV has an average content of gross protein of 26% of dry substance. The analysed sort was Rodil.

9.The arginine, lysine, methionine, cystine, threonine and tryptophan amino acids from the peas protein are positively correlated to the gross protein percentage.

10.The total carbohydrates content was at Rodil peas 67.5% of the dry substance (S.U.) among which 20.3% structural ones and 47.2% non-structural ones.

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