1. Preliminaries of the research

In countries which have well developed cattle breeding the lactating production of cows increased significantly in the last one and a half decade. The increase of milk production is observable in our country, similarly to the mentioned countries. This is supported by the fact that the lactating production of the controlled population increased by 3264 liter between 1975 and 1998 (table 1).

Table 1

Lactating production of controlled cattle population between 1975 and 1998

(Data of the Livestock Performance Testing LTD.)

Year	Number of standard lactations	Milk kg	Milk fat %	Milk protein %
1975	220200	3135	3,88	-
1980	278000	4138	3,75	-
1985	293000	4875	3,71	-
1990	288000	5534	3,66	3,24
1995	200000	5856	3,87	3,23
1998	202200	6399	3,73	3,36

The increase of milk production significantly increased the nutritive requirements of cows. First of all the energy and protein requirements of cows increased. Knowing the role that the microbial degradating and synthesis processes perform in the rumen to satisfy the nutrient supply of ruminants, it can be admitted that it is quite difficult to satisfy the energy and protein requirements of high lactating cows with traditional nutrition methods without damaging any of the processes of rumen fermentation.

For example, the continuously increasing energy requirement can not be satisfied only by the increase of dose of concentrate, because after an extent the structural efficiency of feeding ration degrades, which changes the character of rumen fermentation in an unfavourable way. Similarly, increasing only the protein content of feeding ration to satisfy the increasing protein requirement of cows is also difficult. Namely, after a limited protein content the further increase of intake damages the reproductive results (sperm index, percentage of fertility, number of days between two calving).

To satisfy the energy and protein requirements of high lactating cows is quite difficult mainly in the first third of the lactation when the dry matter intake of cows and the rhythm of increasing intake fall behind the rhythm of increasing milk production. The way of satisfying the energy and protein supply is to give animals the parts of nutrients in such a form where they do not degrade in the rumen, but degrade and absorbe in the postruminant part of the intestine. In this way, a part of nutrients can not be degraded by rumen microbes, which means that nutrients do not influence fermentation in the rumen.

All these can be realised by feeding cows with bypass feeds or protected products (protected from microbial degradation). The improvement of energy supply of cows can be realised by fats, but considering that a larger quantity of fats has an unfavourable effect to the rumen fermentation, fats can only be used effectively to improve energy supply of cows when these are fed in the form of bypass fat.

Protein overfeeding of high lactating cows and the decrease of reproductive results caused by this can be prevented or at least moderated by feeds the protein content of which has a low rumen degradability. Unfortunately, in Hungarian feedstuff there are only few feeds, which

contain a high protein level and the rumen degradability of which is lower than the average (70%). That is why there is an ambition to decrease the rumen degradability of protein content of feeds by chemical or physical methods and to make bypass protein or bypass fat product in this way.

In the future, in feeding of high and increasing lactating cows it will be determinant to make the rumen suitable for the reception and digestion of the increasing quantity of nutrients. This depends first of all on the fact that if we can control and influence the degradating and synthesis processes in the rumen. Feeding of bypass products offers a good possibility to maintain the normal rumen fermentation.

2. Own examinations

2.1. The objective of experiments

Nowadays it is a generally accepted opinion that a high level production of high lactating cows without metabolism disorder can be expected only if the requirement of all of the nutrients are satisfied and nothing damages the basic rules of the processes of rumen fermentation. That is why I planed to carry out the examination of two feed products, a bypass protein and a bypass fat product, from which it can have been expected that these would help to fulfil the protein requirement of cows and to improve their energy balance without disturbing the rumen fermentation. I planed to carry out the following examinations with these two products:

- During the examination of bypass protein concentrate obtained by chemical treatments from animal and plant

originated feeds, I would have liked to determine the followings:

*Is it possible to decrease the degradability of the protein originally having low rumen digestibility, such as blood meal, feather meal and maize glutein, with the treatment performed by glioxal or glutaraldehide?

* What is the dose of aldehide, the use of which can result that the largest quantity of postruminantly digestible protein get to the small intestine?

* What kind of effect does the protein feed treated with glioxal have to the rumen fermentation?

*What kind of result do we have replacing the RDP part, which is decreased by a treatment with aldehide with some kind of NPN?

* Is it possible to increase the milk production of cows by feeding bypass protein concentrate made by chemical treatment?

* Does the feeding of bypass protein concentrate influence the composition of milk and the quantity of nutrients produced by milk?

- During the feeding of Ca-soap made by the by-product of seed oil industry, I would like to answer the following questions:

  * What kind of qualities (energy value, fatty acid composition and free fatty acid content) does the Ca-soap have that can be made by the cold filtered residue which is one of the largest quantity of by-products of the seed oil industry?

  * What is the stability of Ca-soap in the rumen like?

* What kind of effect does the Ca-soap have on the rumen fermentation?

*Is it possible to improve the energy balance of cows with the Ca-soap made by cold filtered residue, furthermore, and what kind of effect does it have on the milk production?

* Does the Ca-soap influence the fatty acid composition of milk fat and the dietary value of milk fat and butter?

2.2. Material and method

2.2.1. Methods used during the experiments on animals

2.2.1.1. Estimation of rumen degradability by 'in situ' method

The effects of aldehides, that were used to decrease the rumen degradability of protein, the bypass protein concentrate and the actual rumen degradability of bypass fat product were established by 'in situ' method.

We performed experiments on three Hungarian Pied x Holstein Friesian R_4 cows every time. Bags were made of plastic textile called Scrynel (Zürcher Beuteltuchfabrik AG. Schweiz), which had 40 micron pores. When we examined the effect of aldehides on the rumen degradability of protein, the incubation time was always 24 hours. At the time of establishing the actual protein and fat degradability, the incubation time were 0,2,4,8,12,24 and 48 hours. All of the feeds and products were examined in the case of each cow and in each incubation time in five repeats (5 bags for each cow at every repetition).

After the incubation we washed out the bags to remove the digested nutrients and the residue of the rumen fluid. We washed the bags in lukewarm water in the shaking–machine for 8x10 minutes. We changed the water for clean every time. The bags were dried at 60^oC in a

thermostat. The actual rumen degradability of bypass protein concentrate and bypass fat product were calculated with the method using Kristensen et al. (1982).

We wanted to conclude the effect of aldehides used for protein protection the bypass protein concentrate and bypass fat product on the rumen fermentation from the changes of the parameters of rumen fluid. We performed these experiments in the case of bypass protein concentrate on three rumen and duodenum fistulated Hungarian Pied x Holstein Friesian R_4 young bulls and in the case of bypass fat product on three rumen fistulated Hungarian Pied x Holstein Friesian R_4 cows using periodical method. The pre-feeding period took 10 days and it was followed by a four-day experimental period. On each day of the experimental period we took sample from the rumen fluid through the rumen fistula twice a day, before the morning feeding and 3 hours later, after the morning feeding. The samples were carried to the laboratory in a thermos bottle. It was needed to maintain the activity of rumen microbes, because we examined the activity of rumen fluid, too. We determined the following parameters from the samples of rumen fluid: pH, NH_3- and volatile fatty acid content and activity of rumen fluid.

2.2.1.2. Estimation of the quantity of microbial protein synthesised in the rumen

We examined the effect of the combination of bypass protein feeding and amide supplementation on the level of microbial protein synthesis in the case of three rumen and duodenum fistulated Hungarian Pied x Holstein Friesian R_4 bulls using periodical method. The pre-feeding periods took 10 days and they were followed by a four-day long experimental periods. On the first and fourth days of the experimental

periods, between 6 and 16 o'clock, we took samples from the duodenal chimus in every 2 hours. Concerning that the experimental animals did not have re-entrant, but T-fistula, therefore we had to use a marker to determine the quantity of chimus passing thorough the duodenum. Thus we added TiO_2 to the feeds of animals. TiO_2 is a good qualitied marker not only, because it passes through the intestine consistently and it is not absorbed in any parts of the intestine, but also its determination from the chimus or faces is a quite simple method(Brandt and Allam, 1987).

We determined the following parameters of the chimus samples: pH, dry matter, crude protein NH_3, DAPA (diaminopimeline acid) and TiO_2 content.

On the third day of the experimental period we took sample from the rumen fluid through the fistula. From this sample we obtained the microbial mass from which we established the crude protein content of the microbes as well as the DAPA content of the microbial protein. We took samples 3 hours after the morning feeding on each occassion.

2.2.1.3. Milk production experiments carried out on dairy farms

We performed four milk production experiments one in Szitamajor and one in Hegyfalu, both of them are dairy-farms of the Agricultural Share Company in Sárvár and one in Csémpuszta which is a dairy-farm of the Agricultural Share Company in Komárom. The purposes of these experiments were to establish the effect of the examined bypass protein concentrate and bypass fat product on the milk production of cows, composition of milk, quantity of nutrients produced by milk and fatty acid composition of milk fat.

We set up the control and the experimental groups by the method of pairing cows. Selecting the pairs of cows we considered the following

points: the milk production in the last lactation, the number of lactations until now, the number of days after calving in the actual lactation and the milk production at the beginning of the experiment. We performed one of the experiments on pure of variety Holstein Friesian cows on the dairy-farm in Csémpuszta, while on the 2 dairy-farms of the Agricultural Share Company in Sárvár, on Hungarian Pied x Holstein Friesian cows. Selecting the cow pairs we did not consider it necessary to take the Holstein Friesian blood rate into account, because the Holstein Friesian gene rate was more than 90 percent in both populations of dairy-farms in Sárvár. In table 2 I summarised the development of parameters during the experiments, when selecting the cow pairs.

Based on the data of this table it can be established that we managed to form groups with similar parameters in each of the experiments, which is an important factor of reaching conclusions.

Table 2.

Trend of considered parameters during pairing cows in the farm milk production experiments

Parameter	1. experiment		2. experiment		3. experiment		4. experiment	
	control	experimental	control	experimental	control	experimental	control	experimental
group								
Number of cows in a group	25	25	30	30	18	18	25	25
Milk production in the last lactation, liter	8097	8166	7642	7662	7712	7757	8097	8132
Number of lactations till now	3,4	3,1	2,7	2,8	2,2	2,2	3,4	2,8
Milk production in a day at the beginning of the experiment, liter	36,61	36,73	29,2	29,5	30,19	29,67	36,61	35,75

In both dairy-farms of the Agricultural Share Company in Sárvár, a milking system connected with a computer operated, thus we were able to register and record the milk production of cows at each milking. On the dairy-farm in Csémpuszta we measured the milk production for each cow and at each milking with a Tru test instrument.

In each of the experiments, we measured the composition of milk for each cow twice a week. The examinations were performed by the Livestock Performance Testing LTD. Gödöllő with the System-5000 automatic machine (Foss Electric Koppenhaag). We established the fat, protein, sugar and carbamid content of the milk in each sample.

2.2.2. Chemical examinations used during the experiments

During the experiments we established the dry matter, crude protein, digestible crude protein, crude fat, crude fibre, crude ash, Ca and P contents of the experimental feeds using the methods described in the second volume (5.1., 6.1., 6.3.,7.1., 8.1., 10.1.,10.3. and 11.6. chapters) of the Hungarian Nutrition Codex (1990).

We determined the pH value of silage maize and rumen fluid with Radelkisz OP-211/1 electronical pH maesuring instrument, and the NH_3 content of the same samples with a NH_3-sensitive electrode (by Radelkisz OP 242-2 instrument).

We determined the volatile fatty acid content of silage maize and rumen fluid with Chrom-5 gas-cromatographe. The packing of the column was Supelco Carbopack B-DA resin (Supelco Inc., Bellefonte, PA.). We prepared the milk samples to establish the fatty acid content based on the method described by Husvéth et al. (1982) and Husvéth and Gaál (1988). We performed the examination by Chrom-5 gas-chromatographe. The packing was Supelco SP 2330 resin.

To establish the quantity of the microbial protein synthesised in the rumen we used DAPA (diaminopimeline acid), which can be found in the cell wall of rumen microorganisms, as a marker. We performed the examination with Amino-chrom-II amino acid analyser and the packing was Kemochrom-9 resin. We used the method described by Csapó et al (1991). for the examination. Important element of this is that we oxidise the methionine content of the sample with performic acid to become methionine-sulphone, in order to insure the good separation of DAPA. We performed the oxidation with performic acid based on the method described by Degussa (Degussa Analitik/Analysis 1986), the result of

which was that the DAPA appeared well measurably at the place of methionine between valine and isoleucine.

To determine the quantity of microbial protein synthesised in the rumen it is necessary to know the DAPA content of rumen microbial protein. Microbial protein is needed to it, which we obtained from the rumen fluid using the method described by Krawielitzki and Piatkowski (1977), which is based on differential centrifugalisetion. According to this method first we centrifuged the sample of rumen fluid, in which we prevented the reproduction of microbes by formalin (20 ml/l rumen fluid), at 3000 revolution/minute with which we removed the feed particles and protozoas from the rumen fluid. After that we obtained the rumen microbes from rumen fluid by centrifugalisetion with 16000 revolution per minute. We dried the microbial mass by liofilesition.

As it is mentioned in chapter 3.2.1.3., we added TiO_2 as a marker to the feed of animals to determine the quantity of chimus passing through the duodenum. Owen and Hanson (1992) state that TiO_2 as a marker has good result in the case of ruminants. We determined the TiO_2 content of chimus using the method of Brandt and Allam (1987). The animals were given 30 g TiO_2 at each feeding. In order to determine the quantity of chimus passing through the duodenum it is important that the animals get the all quantity of TiO_2, therefore we mixed the TiO_2 dose with the part of feed then before feeding we placed it into the rumen through the fistula.

Knowing the daily TiO_2 dose and the TiO_2 content of chimus we calculated the quantity of chimus passing through the duodenum with the following formula:

$$\text{Chimus passing through the duodenum (g/day)} = \frac{\text{TiO}_2 \text{ content of feed, (mg/day)}}{\text{TiO}_2 \text{ content of chimus, (mg/g)}}$$

We estimated the microbial activity of rumen fluid using the nitrite reduction test. We performed the examination with 3 nitrite concentrations (0,2; 0,5; 0,7 ml KNO_3 solutions). The used reagent was α-naftil-amine. We concluded the activity from the period the rumen microbes needed for the nitrite reduction. The disappearance of the red colour of KNO_3 reagent indicate the catabolism of nitrite (Horváth 1979).

We performed the statistical analysis with the help of the Statistica of Stat Soft Inc. Program.

3. New scientific results

The following new scientific results are achieved on the basis of the results of laboratory examinations, 'in vitro' and 'in situ' experiments, metabolisable experiments performed on rumen and duodenum fistulated animals and farm milk production experiments:

1. The rumen degradability of the protein of maize glutein and feather meal, which both contain low protein degrading in rumen, can be decreased further by a treatment with glioxal and glutaraldehide. The optimum dose of both glioxal and glutaraldehide in the case of maize glutein is 1 per cent of crude protein content, while in case of feather meal the greatest quantity of postruminantly digestible UDP can reach

the duodenum when we use 5 per cent glioxal and 3-5 per cent glutaralehide of the crude protein content for the treatment.

2. The examined two aldehides are not suitable for the treatment of blood meal because the postruminant digestibility of the protein of blood meal, due to the effect of treatment, decreases more than the degradability of protein in the rumen.
3. In intensive nutritional conditions, the rumen degradability of the protein content of the concentrate made of maize glutein, poultry blood meal and feather meal and measured by 'in situ' method can be decreased absolutely by 7 per cent and relatively by 27 per cent if the maize glutein and feather meal are treated with glutaraldehide and the poultry blood meal is treated with orthophosphorous acid.
4. The addition of vinasz to the protein concentrate made of maize glutein, poultry blood meal and feather meal increases the quantity of microbial protein synthesised in the rumen, because the glutamine acid content of vinasz has an important role in microbial amino acid synthesis.
5. The bypass protein concentrate made of maize glutein, poultry blood meal, feather meal and vinasz improve the metabolisable protein supply of cows and therefore it increases the milk production and the quantity of protein and fat produced by milk in the first third of lactation.
6. The Ca-soap, which can be made of the cold filtered residue of the seed oil industry, has good quality and good rumen stability. The production does not influence the fatty acid content of cold filtered residue.

7. This Ca-soap, which contains 60 percent crude fat, in a dose of 2,2 g Ca-soap for each live weight kg ^{0,75} dose (when the total fat content of feed is 5 per cent of the dry matter in the daily dose) does not influence the rumen fermentation. This is proved by the unchanged acetic acid and propionic acid production, the C_2/C_3 rate and the perfect microbial activity. However, a dose of 6,0 g Ca soap for each live weight kg^{0,75} has a minimal effect on the rumen fermentation, when the fat content of dry matter of feed dosage reaches 7.5 per cent which is already a significant quantity.
8. In the first third of lactation, the feeding of Ca-soap made of cold filtered residue in 730-875 g dose a day significantly increases the milk production of cows and the quantity of protein and fat produced by milk. The examined bypass fat product favourably influences the fatty acid composition of milk fat and thus the human dietary value of milk and butter made of this milk, because it significantly increases the proportion of biologically valuable unsaturated fatty acids in milk fat.

4. Scientific publications about the subject of dissertation

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2. Schmidt, J. – Sipőcz, P. – Cenkvári, É. – Sipőcz, J.: Use of protected protein in the feeding of dairy cows - 49th Annual Meeting of the European Association for Animal Production, Warsaw 24-27. August 1998. – Proc.61.

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PROTECTED PROTEIN AND PROTECTED FAT IN THE FEEDING OF DAIRY COWS

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