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NUTRITION OF COWS AND UREA CONCENTRATION IN MILK

HRANIDBA KRAVA I KONCENTRACIJA UREJE U MLIJEKU

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SUMMARY

In summer, during pasture on three farms (A, B, C) in Slovenia in three summer seasons (1992, 1993, 1994), on each farm one season, the purveyance of cows with nutritive substances was evaluated. The protein energy ratio found in rations was connected with protein and urea concentration in milk. The coefficient P/U was also calculated from the protein and urea concentration in milk. On all three farms the increased urea concentration and small protein concentration in milk were found. Greater deviations were on farms B and C where also a great excess of proteins in rations was found. The investigation showed that urea and coefficient P/U in milk were proper and applicable indicators for evaluation of protein and energy level in rations.

Key words: cattle, cows, nutrition, milk, urea in milk.

INTRODUCTION

In herds with intensive milk production, particularly during first 10 to 12 weeks after calving, productional diseases were very frequently met. To prevent or at least to reduce the damage, which could consequently directly or indirectly resulting lower production, reproduction disturbances and metabolism diseases, the production and all disease occurrences in herd must be as best as possible controlled, and milk cow nutrition in short time intervals continually checked.

The relation between cow nutrition and milk composition from the point of view of increased economy is most important for the breeder. The nutrition represents a great deal of costs (45-60%) in the production price structure of milk, and milk composition determines today its purchase price.

The most valuable support to the breeder for carrying out successful diet are chemical analyses of teeds, which are regretfully for a majority of breeders a too great cost. The analysis results are often delayed and so the expected effects are not obtained.

Blood tests are organizationally and technically exacting and expensive for supply evaluation of milk cows. For that very reason the more modern researches for establishing metabolism disturbances are oriented to more accessible biological material such as milk, saliva, hair,

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urine and feces. Laboratory analyses are quicker and what is very important, cheaper.

Data on milk composition gain consequently an incresingly greater significance. Besides the daily milk yield and alredy recognized routine analyses for determination of fat and protein concentration for commercial and selection purposes. Data on concentration of urea, acetone B-hydroxibutyric acid, allantoin and somatic cell number are also important for the owner and an expert.

In numerous researches performed in the last 10 years it was established that the urea concentration in milk was an applicable indicator of purveyance of cows with proteins and energy, ration protein-energy balance, health and fertility of cows, milk quality and excessive nitrogen excretion into environment.By quotations from literature and data from our own investigations, we wish to illuminate the meaning of urea determination in milk of milk cows in pasture from the point of view of economic use of proteins and other nitrogenous substances.

LITERATURE

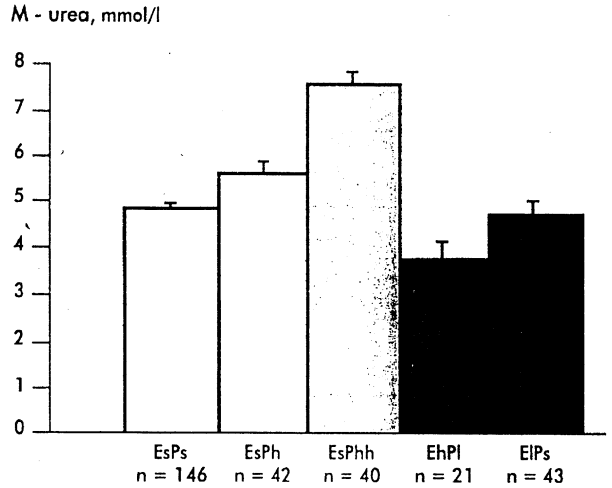
Kirchgessner et al. (1986) quote that urea concentration in milk in balanced rations ranged from 2,45 to 4,16 mmol/l resp. for cows yielding daily 20 kgs of milk from 2,66 to 3,98 mmol/l, which was then increased or reduced by 0,333 mmol for every 5 kgs of milk. Recent investigations of Carlsson and Pehrson (1994) recommend urea concentration in milk from 4,0 to 5,5 mmol/l to be still considered as normal if cows were fed with standard feed. In their investigations urea concentration in milk in a balanced diet oscillated from 4,66 to 4,92 mmol/l and 3,74 to 4,56 mmol/l and depended more or less upon ammonia concentration in the rumen. That was found with different systems of protein evaluation in ration. These findings showed that the upper normal reference value for urea concentration in milk was not yet clearly determined.

Oltner et al. (1981), Kirchgessner et al. (1986) found a high correlation between urea concentration in blood and milk. Refsdal (1984), Zadnik et al. (1983) furthermore found that an indicator of purveyance of cows proteins could also be an average stable milk sample from the basin.

Piatkowski et al. (1981). Oltner and Wiktorson (1983). Kirchgessner and Kreuzer (1985). Kirchgessner et al. (1985), Carlsson and Pehrson (1988) report on a correlation between purveyance of cows with proteins and/or energy and urea concentration in milk. They emphasized that urea concentration in milk was not an absolute indicator of anomalies in diet, but it only pointed out the relation between proteins and energy in ration. If there was an excess of proteins or a shortage of energy it was shown by data on protein concentration in milk. Dirksen (1994) illustrates the relation between protein and energy purveyance of milk cows and urea and protein concentration in milk with the following scheme:

Scheme: Urea and protein movement in milk depending on protein- energy purveyance of milk cows (Dirksen, 1994)
Shema:Kretanje ureje i bjelančevina u mlijeku ovisno o opskrbi mliječnih krava bjelančevinama-energijom

Milk Mlijeko		Ration Omjer
Urea Urea mmol/l	Protein Bjelančevine %	
n	n	balanced protein-energy ratio uravnotežen omjer bjelančevine-energija
↑	↓	energy deficiency nedostatak energije
↑	↑	excess proteins suvišak bjelančevina
↑↑	↓	energy deficiency and excess proteins nedostatak energije i suvišak bjelančevina
↑↑	↑	excess energy and excess proteins suvišak energije i suvišak bjelančevina



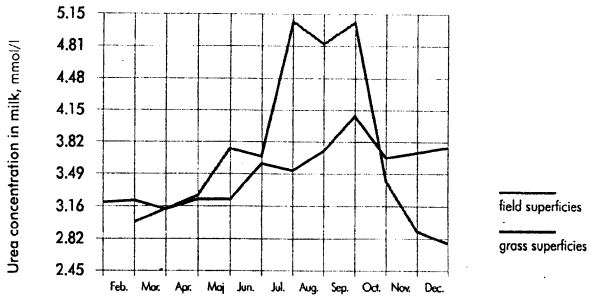
E = energy, P= protein, s= standard feeding, h= moderate, hh = heavy overfeedinf, I = underfeeding, n = number of samples.
E = energija, P = bjelančevine, S= standardno hranjenje, h = umjereno, hh = preobilno hranjenje, I = pothranjivanje, n = broj uzoraka.

Graph 1: Milk urea concentration (Carlsson and Pehrson, 1994)
Grafikon 1: Koncentracija ureje u mlijeku

Jilg (1992) reports that optimal protein-energy ratio (g crude proteins/MJ NEL) in ration for cows giving 15 kgs of milk per day was 21,1, and at production of 25 kgs of milk per day it was 22,6. A diagnosis of protein and/or energy supply of milk cows by urea and protein concentration in milk was alredy made by Kirchgessner (1986), and for Swedish evaluation system of ration balance of proteins and energy it was done by Carlsson and Pehrson (1994) as shown in Graph 1.

Represented scheme and graph are a fair warning for a breeder that reduced protein concentration and increased urea concentration in milk demand immediate ration analysis.

By numerous investigations Dirksen (1994) reports that increased urea concentration in blood and milk - above 4,995 mmol/l - during the first 12 weeks after calving influenced the fertility of cows. This was connected with metabolism disturbances caused by increased proteins consumed (> 17% in dry matter), consecutively shown by increased insemination index. Kirchgessner et al. (1993) report that proper crude protein concentration in balanced rations was between 13 and 17 %, While according to the NRC standards (1988) necessary crude protein concentration in dry matter of ration at daily production of 20kgs of milk was 15 %, and at 40 kgs of milk 17 %. Lotthamer (1982), Ropstadt and Refsdal (1987), Caroll et al, (1987 a, b) as well as Čadonič-Špelič et al. (1993, 1994) also reported that increased urea concentration in milk (above 7 mmol/l) could be in close negative connection with reproduction and health disturbances in milk cows.



Graph 2: Curve of average urea concentration in milk in two milk populations: grass superficies in comparison with field superficies (Dirksen, 1994)
Grafikon 2: Krivulja prosječne koncentracije uree u mlijeku u dvije mliječne populacije: travnjaci u usporedbi s poljima

Through longer period, increased urea concentration in milk of milk cows or in milk from wider region could also be used as an indicator of possible environment pollution due to excessive excretion of nitrogen with excrements. Paulichs (1992) reports that urea in milk was a direct reflexion of nitrogen content in urine. If this finding is connected with pasture or grass silage, this is a warning for excessive fertilization of pasture-land, which has a harmful effect on environment (increased quantity of nitrogen in liguid manure, great concentration of nitrates in drinking water). Dirksen (1994) presents for the period February - December a highly increased curve of average urea concentration in milk for cow herd from grass region in comparison with the curve, where the feed for herd is produced on fields (Graph 2).

In Slovenia Pestevšek et al. (1990, 1991), Rajčevič et al. (1993 a, b, c), Rajčevič (1993). Zadnik et al (1994), Čadonič- Špelič et al. (1994) have already reported on connection between urea concentration in milk and purveyance of cows with proteins and energy. Investigations were perfomed on monthly individual milk samples or average samples of milk from the basin. Zadnik et al. (1994) also found by results of weekly urea and protein measurements in average samples of milk from the basin characteristic differences in urea concentration between different ways of breeding (tethered cows, free breeding) and between summer and winter rations. Čadonič-Špelič et al. (1994) calculated the coefficient of protein and urea concentration in milk and found that coefficient, which was smaller than 0,6 pointed out the protein excess in ration and was unfavourable for health of milk cows, while the coefficient values above 0,80 indicated a balanced ration. Rajčevič and Stekar (1994) found that urea in milk was a more reliable indicator of possible excessive quantity of nitrogen excreted with excrements into environment in unbalanced rations as by regression calculated quantity of excreted nitrogen depending upon consumed proteins (according to Kirchgessner, 1993).

MATERIALS AND METHODS

During three consecutive pasture seasons, in the years 1992, 1993 and 1994, on three farms (A, B, C), each year on one farm, nutrition of cows and milk composition were followed. On the farms concerned, in previous lactation, the following average milk production was achieved per year:

- farm A: 5740 kgs with 3,66 % of fat, status 200 cows

- farm B: 6392 kgs with 3,56 % of fat, status 215 cows

- farm C: 6756 kgs with 3,65 % of fat, status 405 cows

On farm A in 4 months (May, June, July, September) the research comprised 60 cows, 15 cows each month in postpartum period. Cows were of Friesian breed. On farms B and C, 17 and 15 cows in postpartum period were included in the research and were followed from June to September.

Feed rations were analyzed monthly. The DLG standards (1991) were considered for cows of body mass of 600 kgs. All laid down feeds, except pasture, were weighed daily. As pasture consumtpion for feed ration calculations was taken into consideration the evaluation of farm technical service as cows were on a whole-day pasture. The cows consumed on average per months:

- on form A: 40-45 kgs of pasture, 8-9 kgs of maize silage, 2,5 kgs of hay, 3 kgs of beet pulp and 2,5 kgs of feed mixture K12

- on farm B: 50-55 kgs of pasture, 2,5 kgs of hay, 5;22 and 11 kgs of grass silage (July August, September), 4-6 kgs of feed mixtures

- on farm C: 30-58 kgs of pasture, 1-3 kgs of hay, 10-15 kgs of maize silage, 12 kgs of grass silage (in September), 5-6 kgs of feed mixtures.

All used feeds were analyzed chemically.

The protein and urea concentration in milk was stated monthly. Urea was determined according to Erbersdobler et al. (1973).The data obtained for protein and fat were compared with data of regular monthly controls.The coefficient of protein and urea concentration in milk was calculated - P/UQ (Čadanič-Špelič et al.,1994), namely:

$$P/UQ = \frac{\text{protein, \%}}{\text{urea, mmol/l}} \times 6{,}006^{-1}$$

The analysis results were statistically evaluated with the analysis of variance, program package SPSS.

RESULTS

TAbles 1 to 6 show on average monthly consumed nutritive substances, protein-energy ratio in rations and protein share in dry matter in ration, namely tables 1 and 2 on the farm A in summer season 1992. tables 3 and 4 on the farm B in summer season 1993 and tables 5 and 6 on the farm C in summer season 1994.

Table 1. On average consumed nutritive substances (per cow/day), protein-energy ratio and crude protein share in dry matter of ration on farm A per groups (months) (n = 15)
Tablica 1: Prosječna potrošnja hranjivih tvari (po kravi/dan), odnos bjelančevine-energija i omjer sirovih bjelančevina u suhoj tvari obroka na gospodarstvu A po skupinama (mjesecima)(n = 15)

Group/ month Skupine/ mjesec	I.(May) Svibanj	II. (June) Lipanj	III. (July) Srpanj	IV. (September) Rujan
Dry matter kgs Suha tvar	18,49	17,35	17,15	17,03
Crude fibre g Sirova vlaknina	3910	3941	4175	3562
Crude protein g Sirove bjelančevine	3121	2526	2623	2732
NEL MJ	119,35	115,7	115,25	116,75
CP (g) SB (g)/NEL (MJ)	26,15	21,8	22,76	23,4
CP (g) SB (g) / DM ST (kg) %	16,87	14,5	15,29	16,04

In ration analysis a low excess of protein was found. The share of structural crude fibre in dry matter of ration was in groups resp. months 16,77 %, 18,04 % 19,62 % and 16,16 %. The protein- energy ratio, except in group I. within the limits quoted by Jilg (1992) for such production, was too wide in the group I. The share of crude proteins in dry matter of ration was within the limits quoted by literature.

The protein concentration in milk was small in all groups, the urea concentration in groups II. III and IV (June, July, September) greater (above 5 mmol/l) than represented by Dirksen (1994) for this period of the year. In these groups the urea concentration in serum was above the upper limit of reference values (6,64 mmol/l).

P/UQ was adjusted to the protein-energy ratio, except in group I.In our opinion small concentration of protein in milk was caused more by lactation stage than energy deficiency in ration.

Table 2: Average protein and urea concentration in milk and serum and coefficient of protein/urea in milk on farm A in the year 1992 in groups (n=15) and daily milk yield.
Tablica 2: Prosječna koncentracija bjelančevina i ureje u mlijeku i serumu i koeficijent bjelančevine /urea u mlijeku na gospodarstvu A godine 1992. u skupinama (n=15) i dnevna proizvodnja mlijeka.

		Group - Skupina		Month - Mjesec	
		I. (May) Svibanj	Group II. (June) Skupina II. Lipanj	Month III. (July) Mjesec III.Srpanj	IV. (September) Rujan
Protein in milk % Bjelančevine u mlijeku	$\bar{X}$	2,93	3,06	3,05	2,91
	SD	0,34	0,30	0,23	0,24
Urea in milk mmol/l ureja u mlijeku	$\bar{X}$	3,82	5,43	6,28	5,40
	SD	0,85	1,33	1,26	0,81
Urea in serum mmol/l Ureja u serumu	$\bar{X}$	5,24	7,07	7,38	9,20
	SD	1,10	1,37	1,23	1,88
P/UQ	$\bar{X}$	0,548	0,603	0,507	0,550
	SD	0,139	0,265	0,131	0,094
Daily milk yield kgs Dnevna proizvodnja mlijeka	X	29,76	28,45	29,98	27,50
	SD	3,55	3,62	3,34	3,43

Table 3: On average consumed nutritive substances per months (per cow/day), protein-energy ratio and crude protein share in dry matter of ration on farm B (n = 17).
Tablica 3: Prosječna potrošnja hranjivih tvari po mjesecima (po kravi/dan), omjer bjelančevine-energija i udio sirovih bjelančevina u suhoj tvari obroka na gospodarstvu B (n = 17).

Month Mjesec	June Lipanj	July Srpanj	August Kolovoz	September Rujan
Dry matter kgs Suha tvar	15,04	18,29	13,22	16,88
Crude fibre g Sirova vlaknina	3473	3388	2539	3265
Crude protein g Sirove bjelančevine	2097	3148	2187	3395
NEL MJ	105,45	120,44	87,32	111,42
CP (g) SB (g) / NEL (MJ)	19,88	26,14	25,05	30,50
CP (g) SB (g)/ DM (kg) ST (kg) %	13,94	17,22	16,54	20,11

The share of structural crude fibre in dry matter of ration was per months: 21,98 %, 17,62 % and 18,06 %. On farm B cows received deficient ration as regards energy and proteins in June and August. In July, in ration a great excess of protein was present and in September it was even bigger. The protein-energy ratio was, except in June, wide for such production. The crude protein share was over 17 % in July and September, and in these two months the urea concentration was also strongly increased (Table 4). P/UQ was in July and September a direct reflexion of excess proteins in ration.

Table 4: Average protein and urea concentration in milk and coefficient of protein/urea in milk on farm B (in the year 1993) per months (n = 17) and daily milk yield.
Tablica 4: Prosječna koncentracija bjelančevina i ureje u mlijeku i koeficijent bjelančevine/ureja u mlijeku na gospodarstvu B(godine 1993.) po mjesecima (n = 17) i dnevna proizvodnja mlijeka.

Month Mjesec		June Lipanj	July Srpanj	August Kolovoz	September Rujan
Protein % Bjelančevine	$\bar{X}$	3,11	2,99	2,86	3,41
	SD	0,31	0,17	0,18	0,18
Urea mmol/l	$\bar{X}$	6,19	8,20	6,39	10,48
	SD	0,93	1,14	0,89	1,41
P/UQ	$\bar{X}$	0,516	0,370	0,457	0,332
	SD	0,112	0,065	0,077	0,050
Daily milk yield kgs Dnevna proizvodnja mlijeka	$\bar{X}$	28,52	27,65	25,07	25,08
	SD	5,61	6,21	5,48	6,55

Table 5: On average consumed nutritive substances per months (per cow/day), protein-energy ratio and share of crude proteins in dry matter in ration on farm C
Tablica 5: Prosječna potrošnja hranjivih tvari po mjesecima (po kravi/dan) omjer bjelančevine-energija i udio sirovih bjelančevina u suhoj tvari obroka na gospodarstvu C

	June Lipanj	July Srpanj	August Kolovoz	September Rujan
Dry matter kgs Suha tvar	19,9	19,8	19,5	19,3
Crude fibre g Sirova vlaknina	3433	3578	3657	3622
Crude protein g Sirove bjelančevine	3507	3254	3026	3150
NEL MJ	139,5	134,9	130,1	132,2
CP (g) SB (g)/ NEL (MJ)	25,2	24,1	23,3	23,8
CP (g) SB (g)/ DM (kg) ST (kg) %	17,62	16,4	15,5	16,3

On farm C the excess proteins in rations were stated the whole time. The share of structural crude fibre in dry matter in ration was 17,25 % in June, 18,1 % in July, 18,8 % in August and 18,7 % in September.

Table 6: Protein and urea concentration in milk and coefficient of protein/urea in milk on farm C per months (n = 15) and daily milk yield
Tablica 6: Koncentracija bjelančevina i ureje u mlijeku i koeficijent bjelančevine/ureja u mlijeku na gospodarstvu C po mjesecima (n = 15) i dnevna proizvodnja mlijeka

		June Lipanj	July Srpanj	August Kolovoz	September Rujan
Protein % Bjelančevine	$\bar{X}$	2,96	2,94	3,02	3,33
	SD	0,25	0,20	0,20	0,22
Urea mmol/l	$\bar{X}$	7,32	7,27	5,61	6,57
	SD	1,51	0,92	0,80	1,25
P/UQ	$\bar{X}$	0,419	0,409	0,545	0,525
	SD	0,081	0,045	0,080	0,129
Daily milk yield kgs Dnevna proizvodnja mlijeka	$\bar{X}$	35,84	33,31	33,15	29,61
	SD	3,033	4,662	3,657	3,040

The coefficients of protein and urea in milk on farm C indicate a bigger excess of proteins in ration. The urea concentration in milk was bigger than quoted by Dirksen (1994) for summer period in pasture (to 5 mmol/l of milk) and it was, except in August, on the level (over 7 mmol/l) for which foreign and domestic expert (Čadonič-Špelič, 1994) point out the connection with reproduction and health disturbances.

CONCLUSIONS

1. The cows on farms, the subject of this research, were in summer period on pasture differently supplied with nutritive substances. In all three farms in rations smaller or a bigger excess of proteins was found on the farm B during 3 months there was also energy deficiency.

2. The average monthly protein concentration in milk was small on farms B and C, except in September.

3. The average urea concentration in milk was through the whole season on all three farms (except in May on form A) bigger than reference values for summer season from literature. The differences in urea concentration in milk between farms (seasons) were considerable and are supposed to result from rations.

4. The coefficients of protein and urea content in milk confirm stated excess proteins in rations.

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SAŽETAK

Ljeti, tijekom ispaše na tri gospodarstva /A, B, C,/ u Sloveniji, za vrijeme tri ljetna razdoblja /1992, 1993, 1994/, na svakom gospodarstvu jednog ljetnog razdoblja, procijenjena je opskrba krava hranjivim tvarima. Utvrđen omjer bjelančevine-energija u obrocima povezan je s bjelančevinama i koncentracijom ureje u mlijeku. Isto tako izračunao se koeficijent B/U iz bjelančevina i koncentracije ureje u mlijeku. Na sva tri gospodarstva utvrđena je povišena koncentracija ureje i mala koncentracija bjelančevina u mlijeku. Većih odstupanja bilo je na gospodarstvima B i C gdje je također utvrđen veći suvišak bjelančevina u obrocima. Ispitivanje je pokazalo da su ureja i B/U koeficijent u mlijeku mjerodavni pokazatelji za procjenu razine bjelančevina i energije u obrocima.

Ključne riječi: govedo, krave, hranidba, mlijeko, ureja u mlijeku.

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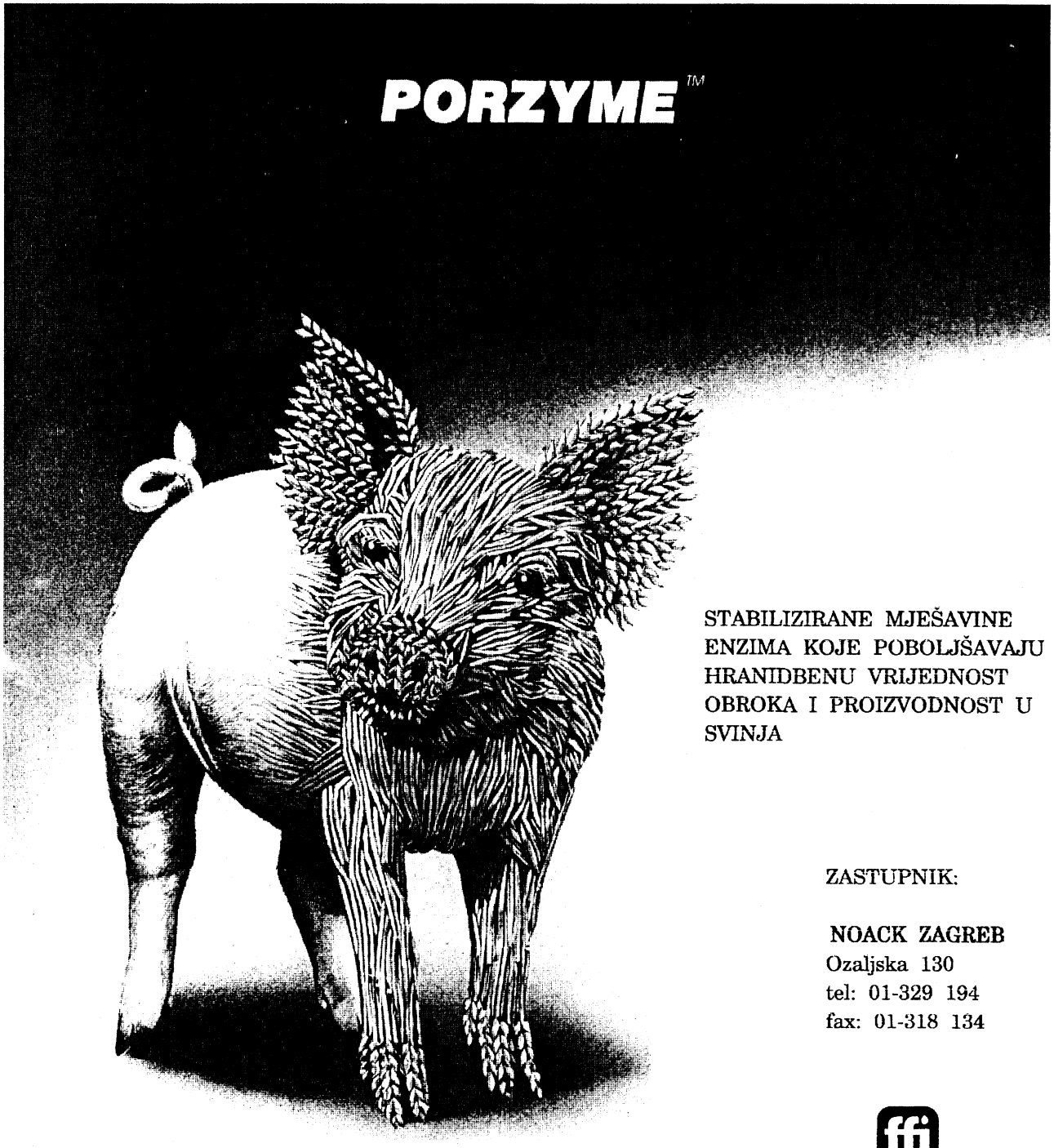

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