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THE EFFECT OF INORGANIC AND ORGANIC FORM OF ZINC ON DIGESTIBILITY OF NUTRIENTS IN DAIRY COWS IN THREE STAGES OF REPRODUCTIVE CYCLE

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Abstract

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The aim of our experiment was to compare the effect of feeding inorganic and organic forms of zinc in premix on the coefficient of digestibility of nutrients in the feeding ration for cows in three stages of reproductive cycle – 14 d before calving and 30 and 60 d after calving. The experiment was carried out on 19 Holstein cows that were divided into two groups. A control group of nine cows designated as "Inorganic zinc form" (IZF) was fed a diet supplemented with mineral premix containing inorganic form of zinc (ZnO). An experimental group of ten cows designated as "Organic zinc form" (OZF) had zinc oxide replaced with zinc fixed to methionine (Khei-chelate Zn powder 15% by Kheiron). The experiment was divided into three periods - the first period lasted from 14th day before calving until 2nd day after calving, the second period lasted from 3rd day to 30th day after calving and the third period lasted from 31st day to 60th day after calving. Cows were fed the diet based on maize silage, lucerne haylage, sugar beet pulp silage, grass or lucerne hay and concentrate containing premix with either inorganic or organic zinc form. During the experiment samples of feeding ration and faeces were taken in 3 intervals, it si on 14th day before calving, on 30th day and on 60th day after calving to determine nutrients content. Digestibility of nutrients was calculated using indicator method (ash insoluble in 3 M HCl).
After feeding organic forms of zinc a tendency to higher digestibility of crude protein, fat, crude fiber, nitrogen-free extracts, ash and zinc was observed in cows regardless of stage of reproductive cycle. The digestibility of the zinc and fiber were the most increased. Digestibility of zinc in OZF on 14th day before calving was higher than in IZF ($P < 0.05$). Feeding of organic zinc forms had downward effect only on the digestibility of copper.

crude protein, crude fiber, fat, ash, copper

Biological functions of zinc in the organism are catalytic, structural and regulatory (COUSINS, 1996). Thanks to its stability and coordinated flexibility, zinc participates in a range of biological functions being in the form of protein, nucleic acid, carbohydrates or participating in the metabolism of lipids (VALLEE and FALCHUK, 1993). Zinc is contained as a basic trace element in nearly a hundred of specific enzymes (NRC, 2001) and according to KING and COUSINS (2006), zinc is contained in up to 300 enzymes. Zinc also serves as a structural ion, which is deposited and transferred in metallothioneine (COTTON *et al.*, 1999). Zinc is the second most abundant transit metal in organisms and the metal that appears in all enzyme classes (BROADLEY *et al.*, 2007). BRANDT *et al.* (2009) informs that zinc is often fixed to lateral chain of amino acids, e.g. aspartic and glutamic acids, cysteine and histidine. Zinc takes part in the metabolism of carbohydrates and is an insulin activator. It is indispensable in DNA replication and transcription and its deficiency results in the retarded growth and development and in other dysfunctions of the organism (KING and COUSINS, 2006).

The efficiency of trace elements depends among other things on the composition of diet. For example, the relation of zinc and blood-forming copper is considered to be antagonistic. Zinc and copper contend for absorption in the digestive tract. This means that the feeding ration with an excessive amount of one mineral element may result in the worse digestibility of another mineral element, which is its antagonist (JELÍNEK *et al.*, 2003).

The efficiency of various sources and forms of trace elements in feedstuff for individual animal species is limited too. Most efficient inorganic bonds are sulphates. JONGBLOED *et al.* (2002) claim for example that the efficiency of copper from $CuSO_4 \cdot 5H_2O$ and CuO is in ruminants 100% and 76%, respectively. According to JONGBLOED *et al.* (2002), the efficiency of zinc from the oxide bonding of ZnO is 98%, from organic bonding of zinc methionine is 100%, zinc lysine is 107% and zinc lysine + methionine is 105% compared to the sulphate bonding of $ZnSO_4$. According to HAHNA and BECRA (1993; cit. Close and Cole, 2003), it is possible to say generally, that the complex zinc-methionine, is about two times more available than zinc oxide. CAO *et al.* (2000) reported that the absorption of zinc-proteinate, zinc-amino acid chelate and zinc-polysaccharide were 83 to 139 percent of zinc sulfate (set at 100 %). Further, ŠIMEK *et al.* (2000) observed that addition of zinc-methionine had positive impact on increasing production and milk quality, fertility and health.

The aim of our experiment was to compare the effect of feeding inorganic and organic forms of zinc in premix on the coefficient of digestibility of nutrients in the feeding ration for cows in three stages of reproductive cycle – 14th day before calving and 30th and 60th day after calving.

I: *Composition of feeding rations [kg of fresh matter/cow/day] fed 14th day before calving, 30th day and 60th day after calving*

Components	14th day before calving		30th day after calving		60th day after calving	
	IZF	OZF	IZF	OZF	IZF	OZF
Maize silage	7.50	6.00	4.00	3.00	16.50	12.00
Sugar beet pulp silage	6.00	5.00	4.50	4.00	10.00	6.00
Lucerne haylage	3.00	6.00	5.00	12.50	5.00	17.00
Grass hay	1.00	0.50	-	0.65	1.00	-
Lucerne hay	-	-	2.00	-	2.00	-
Barley straw	1.00	0.50	1.00	-	1.50	0.50
Soybean meal	0.25	-	1.35	1.10	2.50	1.90
Maize meal	0.04	0.04	2.00	2.00	2.80	2.80
Wheat meal	0.04	0.04	2.00	2.00	2.80	2.80
Barley meal	0.02	0.02	1.00	1.00	1.40	1.40
Limestone	0.26	0.26	-	-	0.10	-
PO 9 [1]	0.10	0.10	0.05	0.05	0.05	0.05
Glycerol	0.25	0.30	0.20	0.20	-	-
Laktofeed	0.20	0.20	0.20	0.25	0.20	0.25
M 1 [2]	-	-	0.05	0.10		-
M 5 [3]	-	-	-	-	0.35	0.35
Monocalciun phosphate	0.06	0.06	-	-	-	-
Magnesium sulphate	0.05	0.05	-	-	-	-
Feeding salt	0.03	0.03	-	-	-	-
Berga fat	-	-	0.17	0.30	0.35	0.50
Sodium bicarbonate	-	-	0. 80	0.05	0.05	0.05
Premix [4]	0.80	0.80	0.87	0.87	0.87	0.87

[1] PO 9 contains (in kg) 1 g lysine, 1 g methionine, 1 g threonine, 78 g Ca, 44 g P, 109 g Mg, 1g K, 1 g S, 2 500 mg Cu, 6 200 mg Fe, 10 400 mg Zn, 10 100 mg Mn, 81 mg Co, 351 mg I, 35 mg Se, 750 000 IU vit. A, 150 000 IU vit D3, 10 000 mg vit. E, 10 mg niacinamide, 230 mg choline chloride, 9 mg BHT, 2 mg BHA and 18 mg etoxyquin

[2] M 1 contains (in kg): 50 g Ca, 90 g P, 90 g Na and 80 g Mg

[3] M 5 contains (in kg): 150 g Ca, 60 g P, 90 g Na and 80 g Mg

[4] Components and nutrients of premix for IZF and OZF are shown in Tab. III and IV

MATERIALS AND METHODS

The experiment included cows whose feeding ration, composed of roughage and concentrate feed, was supplemented with a premix of mineral substances with the inorganic or organic forms of zinc. The studied cows of Holstein breed originated from the stock of the agricultural farm Žabčice of Mendel University in Brno.

Animals

The experiment included two groups of cows: a control group of nine animals (3 heifers, 3 first parity cows and 3 multiparous cows) and an experimental group with ten animals (3 heifers, 4 first parity cows and 3 multiparous cows). The control group, which was fed a standard feeding ration and mineral premix with inorganic form of zinc (ZnO) was designated as IZF (Inorganic zinc form). "Inorganic zinc form" (IZF). The experimental group of ten cows designated as OZF (Organic zinc form) had zinc oxide replaced with zinc, which was fixed to methionine (Khei-chelate Zn powder 15% by Kheiron). Both groups of cows were housed in groups.

Feeding ration

The experiment was divided into three– the first period lasted from 14th day before calving until 2nd day after calving, the second period lasted from 3rd day to 30th day after calving and the third period lasted from 31st day to 60th day after calving. Prior experiment cows were assigned to respective diet 60th day before expected calving for adaptation.

The feeding rations were based on maize silage, lucerne haylage, sugar beet pulp silage and grass or lucerne hay (according to the parturition interval stage). A detailed list of feeding rations is presented in Tab. I and II.

Tab. III and IV show the components and nutritions of premix for cows with the inorganic (IZF) and organic zinc form (OZF) in the feeding rations.

II: *Nutrient content of feeding rations fed to IZF (Inorganic zinc form) and OZF (Organic zinc form) group of cows on 14th day before calving, on 30th day after calving and on 60th day after calving*

Nutrients	14th day before calving		30th day after calving		60th day after calving	
	IZF	OZF	IZF	OZF	IZF	OZF
NEL [1] [MJ/kg]	6.73	6.66	7.06	7.11	6.97	7.04
Crude protein [g/kg]	144.28	137.46	173.48	172.78	167.81	166.68
Crude fiber [g/kg]	160.46	171.19	155.56	160.13	150.82	160.39
NFE [2] [g/kg]	630.41	623.98	564.54	550.95	577.11	555.22
Starch [g/kg]	243.42	240.54	225.31	225.55	247.18	240.88
Fat [g/kg]	23.55	25.47	33.92	42.24	38.06	48.81
Sugars [g/kg]	1.14	1.10	0.65	0.60	0.57	0.38
ADF [3] [g/kg]	151.54	188.03	182.71	174.36	161.24	179.17
NDF [4] [g/kg]	262.6	296.83	268.1	256.96	279.9	272.26
Ash [g/kg]	41.3	41.9	72.5	73.9	66.2	68.9
Ca [g/kg]	15.51	16.91	9.46	10.06	9.12	8.76
P [g/kg]	4.63	4.37	4.42	4.33	4.35	4.18
Na [g/kg]	1.73	1.63	3.1	2.93	3.36	3.27
Mg [g/kg]	4.49	4.19	3.77	3.4	4.06	3.72
K [g/kg]	11.31	12.42	12.66	13.85	11.73	13.62
Ca : P	3.35	3.87	2.14	2.32	2.10	2.10
K : Na	6.55	7.62	4.08	4.73	3.49	4.16
Zn [mg/kg]	139.95	142.68	129.67	131.82	155.05	166.37
Cu [mg/kg]	33.99	34.64	30.6	30.84	35.18	37.29
I [mg/kg]	3.80	4.01	2.87	2.98	2.71	2.95
Se [mg/kg]	0.53	0.54	0.43	0.44	0.46	0.50
Vit. A [thous.IU/kg]	11.57	11.76	11.93	12.2	17.46	18.98
Vit. D [thous.IU/kg]	1.93	2.00	1.74	1.80	1.95	2.11
Vit. E [mg/kg]	99	105.64	65.26	68.26	41.92	45.33

[1] NEL (netto energy lactation)
[2] NFE (nitrogen free extract)
[3] ADF (acid detergent fiber)
[4] NDF (neutral detergent fiber)

III: *Components [%] of premix for IZF (Inorganic zinc form) and OZF (Organic zinc form) group of cows on 14th day before calving, on 30th day after calving and on 60th day after calving*

Nutritions	IZF	OZF
Monocalcium phosphate	4.5	4.5
Feeding salt	2.5	2.5
$NaHCO_3$ 27.3%	5.0	5.0
Hamag Kauster 82 [1]	2.7	2.7
Propionan Ca	1.3	1.3
$CuSO_4$ 25%	0.1	0.1
Bioplex Cu 10%	0.025	0.025
ZnO 76%	0.15	-
Khei-chelate Zn 15%	-	0.81
MnO	0.17	0.17
Optimin Mn 15%	0.05	0.05
$CoSO_4$ 22%	0.003	0.003
Optimin Co 2.5%	0.001	0.001
$Ca(IO_3)_2$	0.004	0.004
Selenite	0.012	0.012
Alkosel 0.2%	0.02	0.02
Vit A 1 000	0.012	0.012
Vit D_3 50%	0.004	0.004
Vit.E 45%	0.134	0.134
Antioxidant	0.012	0.012
Lacto-feed 70 [2]	30	30
Toxi-Tect [3]	1.5	1.5
Energizer RP 10 [4]	20	20

[1] Hamag Kauster 82 – active form of MgO, contains 85.6 %MgO, 5.9% CaO, 0.4% SiO_2, 7.5% Fe_2O_3 and 0.1% Al_2O_3.
[2] Lacto-feed 70 contains 70.0% lactose, 11.5% protein, 7.5% ash, 0.3% fat and 4.5 % moisure.
[3] Toxi-Tect had enzyme-inhibiting effect of mycotoxins.
[4] Energizer RP 10 was a rumen protected fat produced using the latest in fat processing technology from palm oil.

Each premix was incorporated into TMR (Total mixture ration) every day during the experiment. TMR were served twice a day and pushed over the manger several times a day. Refusals did not exceed 1% of daily portion of diet.

Sampling

The samples of feeding rations and faeces were taken from high-pregnant cows on day 14 before the expected calving and then on day 30 and 60 after calving. The samples of excrements were taken during the spontaneous defecation of animals or *per rectum*. Samples were transported to the laboratory of the Department of Animal Nutrition and Fodder Production of MENDELU where they were adequately modified for laboratory analyses (drying, grinding). In these laboratories, dry matter was analyzed according to ČSN 467092–42 by desiccation to constant weight at a temperature of 103 ± 2 °C and basic organic nutrients (crude protein, fat, crude fiber and ash) were determinate ascertained pursuant to the Decree No. 124/2001 Coll. and their later amendments and according to the Commission Regulation (EC) No. 152/2009 (POŠTULKA and DOLEŽAL, 2010). Crude protein was determined by FOSS 2300 Kjeltec Analyzer Unit (FOSS TECATOR company). Zinc and copper were analyzed at the Department of Agrochemistry, Soil Science, Microbiology and Plant Nutrition by using the method of nuclear absorption spectrometry also according the Commission Regulation (EC) No. 152/2009. Concentration of zinc and copper – feeding rations and faeces were determined on atomic absorption spectrometer with a continuous source of radiation with high resolution ContrAA 700 (Analytik Jena) – used wavelength were 213.857 nm for zinc, and 324.754 nm for copper.

Digestibility coefficients were estimated using the indicator method (ZEMAN *et al.*, 2006) with the naturally occurring ash insoluble in 3 M HCl (ŠÍMA, 2001). The statistic evaluation of differences between the digestibility coefficients of the studied groups of cows was made using the Scheffe´s test (SNEDECOR and COCHRAN, 1971).

RESULTS AND DISCUSSION

The average number of intake dry matter of IZF were ranged 13.1 kg/cow/day on 14th day before calving, 20.6 kg/cow/day on 30th day after calving and 20.9 kg/cow/day on 60th day after calving. The average number of intake dry matter of OZF were ranged 12.9 kg/cow/day on 14th day before calving, 20.3 kg/cow/day on 30th day after calving and 21.0 kg/cow/day on 60th day after calving.

Tab. V presents average intake of zinc from the roughage, concentrates and premix in cows fed inorganic or organic zinc form on 14th day before calving, 30th day after calving and 60th day after calving.

Crude proteins (CP), fats, crude fiber, ash, zinc and copper were established from the samples of feeding rations and faeces. Nitrogen-free extracts with individual digestibility coefficients were calculated. The digestibility coefficients of studied nutrients are presented as diagrams in Figs 1–5.

As compared with IZF, the digestibility of crude proteins in the respective studied intervals was higher in OZF by 9.5% on 14th day before calving; by 11.6% on 30th day after calving and by 4% on 60th day after calving; the values of fat digestibility were higher by 5.7% on 14th day before calving, by 4.8% on 30th day after calving and by 22.5% on 60th day after calving. Although OZF showed the increased digestibility of fat from the feeding ration, the value of 95% as claimed by NRC (2001) was not reached and the maximum value in our experiment was 86.0 ± 3.77%. The digestibility of crude fiber from the feeding ration in OZF cows was higher even by 23.7% on 14th day before calving, by 23.4% on 30th day after calving and by 20.6% on 60th day after calving while the digestibility of nitrogen-free extracts was higher by 8.2% on 14th day before calving, by 9.5% on 30th day after calving and by 3.8% on 60th day after calving

IV: *Nutrients of premix for IZF (Inorganic zinc form) and OZF (Organic zinc form) group of cows on 14th day before calving, on 30th day after calving and on 60th day after calving*

Nutrients	Premix	
	IZF	OZF
Calcium [g/kg]	13.96	13.94
Phosphorus [g/kg]	12.03	11.99
Natrium [g/kg]	23.47	23.47
Magnesium [g/kg]	14.35	14.33
Copper [mg/kg]	281.05	280.93
Iron [mg/kg]	1 192.82	1 192.07
Zinc [g/kg]	1 230.13	1 229.82
Manganese [mg/kg]	1 228.28	1 228.09
Cobalt [mg/kg]	6.94	6.94
Iodine [mg/kg]	26.06	26.06
Selenium [mg/kg]	4.00	4.00
Vitamin A [IU/kg]	120 000.00	120 000.00
Vitamin D_3 [IU/kg]	20 000.00	20 000.00
Vitamin E [mg/kg]	603.61	603.59
Biotin [mg/kg]	0.12	0.12
Niacinamide [mg/kg]	9.05	8.86
Pantothenan calcium [mg/kg]	4.72	4.62
Choline chloride [mg/kg]	907.59	889.29
Chloride [mg/kg]	14.70	14.70
NaCl [g/kg]	24.75	24.75
Butylhydroxytoluen [mg/kg]	12	12
Butylhydroxyanisol [mg/kg]	2.4	2.4
Etoxyquin [mg/kg]	24	24

V: *The intake of zinc [mg/cow/day] in cows fed inorganic (IZF) or organic zinc form (OZF) on 14th day before calving, 30th day after calving and 60th day after calving*

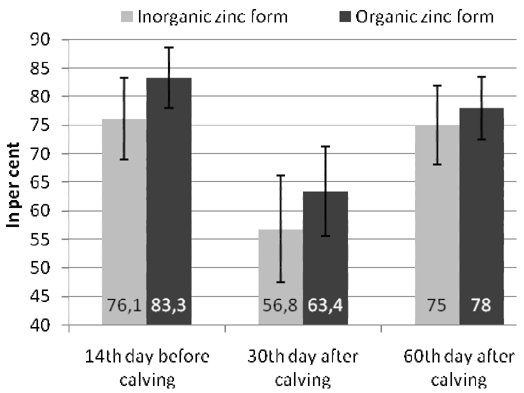
Period	Amount of zinc [mg/cow/day]	IZF	OZF
14th day before calving	**Total amount received**	**2 817**	**2 824**
	from roughage and concentrates	1 833	1 841
	from the ZnO premix	984	-
	from the premix of organic zinc	-	984
30th day after calving	**Total amount received**	**3 741**	**3 746**
	from roughage and concentrates	2 671	2 676
	from the ZnO premix	1 070	-
	from the premix of organic zinc	-	1 070
60th day after calving	**Total amount received**	**4 311**	**4 564**
	from roughage and concentrates	3 241	3 494
	from the ZnO premix	1 070	-
	from the premix of organic zinc	-	1 070

and that of ash by 7.5% on 14th day before calving, by 23.8% on 30th day after calving and by 6.1% on 60th day after calving.

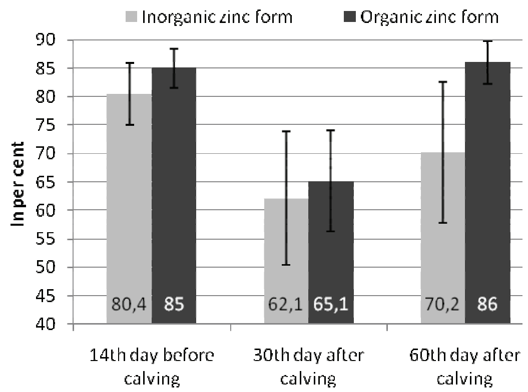
CASPER and MERTENS (2008) indicate the digestibility of crude proteins in lactating cows to be 63.4 ± 0.45% and WHEELER (1980) from 65.7% to 67.8%. Average coefficient of digestibility of crude proteins in IZF on day 30 after calving was 56.8 ± 9.34 and OZF had an average coefficient of digestibility of crude proteins similar as reported by CASPER and MERTENS (2008).

The digestibility coefficients of zinc and copper in the diets are shown in diagrams presented in Figs 6 and 7.

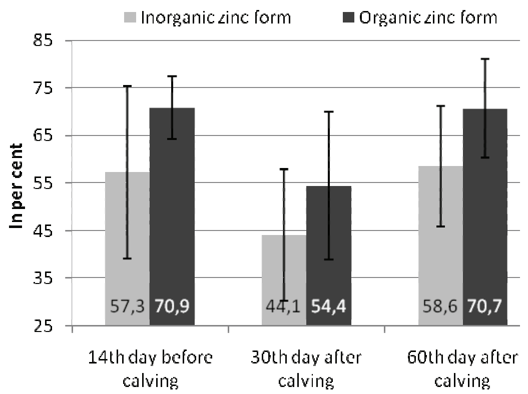
Fig. 6 presents zinc digestibility coefficients in the studied animals in relation to stage of reproductive



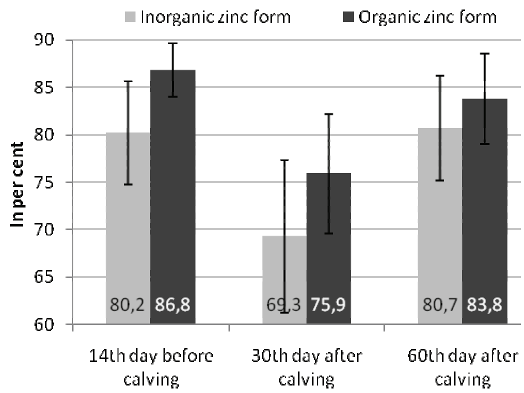
1: *Coefficient of digestibility of crude proteins [%] of IZF (Inorganic zinc form) and OZF (Organic zinc form) groups on 14th day before calving, on 30th and 60th day after calving*



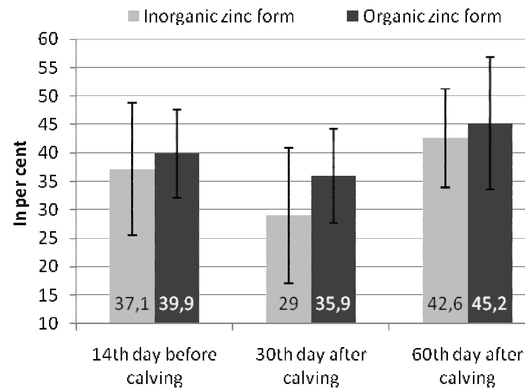
2: *Coefficient of digestibility of fats [%] of IZF (Inorganic zinc form) and OZF (Organic zinc form) groups on 14th day before calving, on 30th and 60th day after calving*



3: *Coefficient digestibility of crude fiber [%] of IZF (Inorganic zinc form) and OZF (Organic zinc form) groups on 14th day before calving, on 30th and 60th day after calving*



4: *Coefficient digestibility of nitrogen-free extracts [%] of IZF (Inorganic zinc form) and OZF (Organic zinc form) groups on 14th day before calving, on 30th and 60th day after calving*



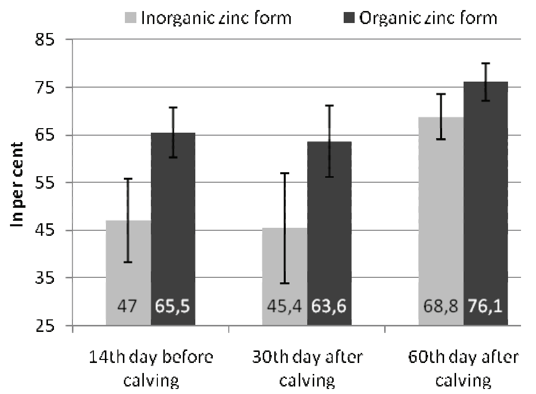
5: *Coefficient digestibility of ash [%] of IZF (Inorganic zinc form) and OZF (Organic zinc form) groups on 14th day before calving, on 30th and 60th day after calving*

cycle and illustrates the statistically significant difference ($P < 0.05$) between IZF and OZF on 14th day before calving.

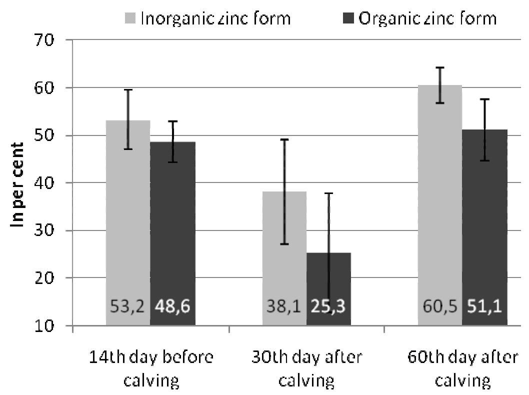
Apparent is a trend to decreased digestibility of nutrients after calving and a subsequent increase nearly up to pre-parturition values on day 60 after calving. This depression can be explained by increased intake of feeding ration on day 30 after calving with relatively small ability of rumen microflora to adapt to increases in dietary intake and milk production.

Our experimental results confirmed the antagonistic relation of zinc and copper (JELÍNEK *et al.*, 2003). While the OZF group of cows exhibited an increased digestibility of zinc, the digestibility of copper was opposite. During the monitoring of OZF, the amount of digested zinc increased by 39.4% on 14th day before calving, by 40.1% on 30th day after calving and by 10.6% on 60th day after calving as compared with IZF. The digestibility of copper in OZF was by 8.6% on 14th day before calving, by 33.6% on 30th day after calving and by 15.5% on 60th day after calving lower than in IZF.

The same trend of lower values on 30th day after calving than on 14th day before calving and on 60th day after calving as in the digestibility of crude proteins, fats, crude fiber, nitrogen-free extracts and ash was observed for copper (Fig. 7). Here, a fact needs to be taken into account that copper facilitates the absorption of iron and its deficiency can therefore result in anemia and similar symptoms (JELÍNEK *et al.*, 2003).



6: *Coefficient of digestibility of zinc [%] of IZF (Inorganic zinc form) and OZF (Organic zinc form) groups on 14th day before calving, on 30th and 60th day after calving*



7: *Coefficient digestibility of copper [%]of IZF (Inorganic zinc form) and OZF (Organic zinc form) groups on 14th day before calving, on 30th and 60th day after calving*

CONCLUSION

After feeding organic forms of zinc a tendency to higher digestibility of crude protein, fat, crude fiber, nitrogen-free extracts, ash and zinc was observed ($P > 0.05$) in cows regardless of stage of reproductive cycle. The digestibility of the zinc and fiber were the most increased. Digestibility of zinc in organic zinc form group (OZF) on 14th day before calving was higher than in inorganic zinc form group (IZF, $P < 0.05$). Feeding of organic zinc forms had downward effect only on the digestibility of copper.

Further, coefficients of digestibility of nutrients were greatly affected by calving. On day 30, both groups showed decreased digestibility of all studied nutrients (crude protein, fat, crude fiber, nitrogen-free extracts, ash, zinc and copper) whereas administration of organic form of zinc showed less distinctive negative impact on digestibility.

SUMMARY

The aim of this study was to compare the effect of inorganic (ZnO) and organic form of zinc (Zn-Met) in feeding rations of cows in three stages of reproductive cycle – on 14th day before calving, on 30th day after calving and 60th day after calving. on the coefficient of digestibility of nutrients

Our experiment was realized on the agricultural farm Žabčice of Mendel University in Brno. We used 19 cows of Holstein breed for our observation. These cows were at the same phase of their reproduction – on 14th day before calving. All 19 cows were fed the same roughage based on maize silage, lucerne haylage, sugar beet pulp silage and grass or lucerne hay and concentrate in their feeding ration. Cows were divided into 2 groups depending on the received premix. 9 cows ("Inorganic zinc form") were fed with zinc supplement of inorganic form (zinc oxide) in their premix and 10 cows ("Organic zinc form") were fed with organic form of zinc (Zn-Methionine).

We took samples of feed rations and faeces in 3 intervals – on 14th day before calving, on 30th day after calving and on 60th day after calving after the previous adaptation period. Samples of feeding ration and faeces were analyzed for crude proteins, fats, crude fiber, ash, zinc and copper content. Coefficients of digestibility were estimated using the indicator method (ZEMAN *et al.*, with the naturally occurring ash insoluble in 3 M HCl.

Digestibility of individual nutrients in OZF tended to be higher in comparison to IZF. Digestibility of crude proteins (CP) in OZF was 9.5% higher on 14th day before calving; about 11.6% higher on 30th day after calving and about 4% higher on 60th day after calving compared to IZF. Digestibility of fat in OZF was about 5.7% higher on 14th day before calving; about 4.8% higher on 30th day after calving and about 22.5% higher on 60th day than in IZF. Digestibility crude fiber of OZF were higher about 23.7% on 14th day before calving; about 23.4% on 30th day after calving and about 20.6% on 60th day after calving, digestibility nitrogen-free extracts were higher about 8.2% on 14th day before calving; about 9.5% on 30th day after calving and about 3.8% on 60th day after calving than IZF and digestibility ash of OZF were higher about 7.5% on 14th day before calving; about 23.8% on 30th day after calving and about 6.1% on 60th day after calving than IZF. Feeding of organic zinc forms had downward effect only on the digestibility of copper. Digestibility of copper in OZF were lower than in IZF by about 8.6% on 14th day before calving; about 33.6% on 30th day after calving and about 15.5% on 60th day after calving. The feeding organic forms of zinc had the greatest influence on digestibility of zinc. Zinc digestibilities in IZF were as follows: $47.0 \pm 8.76\%$ on 14th day before calving; $45.4 \pm 11.53\%$ on 30th day after calving and $68.8 \pm 4.77\%$ on 60th day after calving while zinc digestibility in OZF was $65.5 \pm 5.24\%$ on 14th

day before calving; 63.6 ± 7.50 % on 30th day after calving and 76.1 ± 3.96 % on 60th day after calving. Differences between digestibility of zinc were higher about 39.4 % on 14th day before calving, there was statistically significant differences ($P < 0.05$) between zinc digestibility of high-pregnant cows fed diet with organic and inorganic zinc, about 40.1 % on 30th day after calving and about 10.6 % on 60th day after calving.

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