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# INFLUENCE OF RAW FIBER CONCENTRATE (VITACEL® 200) ON ZOOTECHNICAL PARAMETERS IN CALF NUTRITION

# UTJECAJ KONCENTRATA SIROVE VLAKNINE (VITACEL® 200) NA ZOOTEHNIČKE PARAMETRE U HRANIDBI TELADI

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SUMMARY

In modern calf rearing an early development from calf to ruminant plays an important role. A faster rumen development and therefore ability of the digestive tract to ferment roughage and concentrate feed contributes to beneficial growth performance, health and productivity. Some recent studies show that insoluble cellulose and lignin rich fiber in prestarter and starter diet have positive influence on early intestinal development in non-ruminant species. Objective of the trial was to investigate the influence of VITACEL® 200 raw fiber concentrate (74% crude fiber, 90 % NDF) given in milk/milk replacer on performance parameters of calves.

Trial was conducted on total 20 male Holstein calves divided in two groups (control and experimental) of 10 calves in group. Experiment started with 30 days of age and finished with 122 days of age. Both groups of calves received the same amount of the milk and milk replacer according to standard feeding regime until 80 days of age. In the milk and milk replacer experimental group of calves received raw fiber concentrate (Vitacel® 200, JRS Germany) at the dosage rate of 10 g/ L. Starter feed (18% crude protein), and alfalfa hay was fed *ad libitum*. Water was supplied trough automatic drinkers. Calves fed fiber concentrate in the liquid feed achieved 8, 69% higher final body weight (158, 9 kg vs. 146,2 kg) and 5,17% higher daily weight gain (1140g vs. 1084g, $p<0,05$). Concentrated feed intake per day was very similar in both groups but calves fed Vitacel® 200 during the liquid feeding phase utilized concentrated feed more efficiently compared to control calves (1.67 vs. 1,74). Level of glucose and pH value in the blood was higher in calves fed Vitacel® 200 ($p>0,05$). Earlier development of gastrointestinal tract in calves triggered by Vitacel® 200 enabled higher feed intake and better feed utilization.

Key words: raw fiber, zootechnical parameters, calf nutrition

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## INTRODUCTION

The stomach of ruminants is a complex structure, consisting of fore-stomachs (rumen, reticulum and omasum) and a true stomach (abomasums). In very young animals, calves, lambs and kids, rumen is not sufficiently developed. Most developed is abomasum accounting for about 60% of total volume of four-chambered complex stomach structure. Liquid feed directly enters abomasum via esophageal groove. During first 3 to 4 months of young ruminant animals lives, significant anatomical and physiological changes occur in development of digestive function specific for adult ruminants. In adult ruminants, rumen is the predominant compartment of complex stomach structure and accounts for almost 80% of its total volume. The following factors are important in promoting digestive function development: age, weaning time, dry feed intake, quality of dry feed as well as physical form and composition of carbohydrate fraction of such feed. (Stangassinger, 2007; Adamović et al. 2005; Stojanović et al. 2007). Development of fore-stomachs is greatly influenced by the presence of insoluble fiber, i.e. roughage feeds, and volatile fatty acids, i.e. fermentation products of soluble carbohydrate fraction. Even in older calves that are restricted to a liquid diet, fore-stomachs development and ruminal villi growth are slow. Raw fiber ("roughage") supplemented feed and concentrate in early feeding phase, preferably from the second week of age, promote beneficial changes in the digestive tract development. Effects of physico-chemical properties of fiber on rumen development have been extensively studied by many authors. Ratio of soluble (fermentable) to insoluble fiber plays a profound role in that development.

Corn, barley, sunflower meals, soy protein meal/cake and alfalfa and grass hay are most commonly used fiber sources in animal nutrition. In addition, there are new sources of fiber concentrate of high biological and functional value, available on the market. Recent studies have demonstrated that raw fiber concentrate (Vitacel® 200 commercial name of the product) fed at an early age **have a positive influence** on **intestinal development** (Sterr, 2002; Schedle et al, 2007), microbiological parameters (Steindl et al., 2007) and immune and health status in piglets (Schedle et al., 2006). First studies on calves have also demonstrated that raw fiber concentrate supplementation during **liquid feeding phase has a positive effect on the** number and length of ruminal villi and rumen wall thickness per $cm^2$ (Vikari and Dusel, 2008).

Considering the significance of early change from liquid to solid, dry feed for the development of fore-stomachs and taking into account the fact that digestive tract in a newborn calf is very similar to the stomach of monogastric animals, it is assumed that feeding of appropriate fiber concentrate in the milk or milk replacer stimulates anatomical and physiological changes in the development of digestive function and, consequently, promotes feed intake, feed efficiency and weight gain in calves.

Vitacel® 200 (JRS, Germany) is a raw fiber concentrate containing 74% of crude cellulose, that is, 89% NDF and 84% ADF. Due to a sophisticated manufacturing process, through extraction and fibrillation from wood, fine fibrillaton, i.e. particle structure is achieved, with intensive capillary network effect and surface activity. Average particle length is 200 μm.

The objective of the trial was to investigate the influence of raw fiber concentrate supplementation in milk/milk replacer on performance parameters of calves: body weight and gain, feed intake and utilization efficiency and selected blood parameters.

## MATERIALS AND METHODS

The trial was conducted on 20 male Holstein calves divided in to two groups (control and experimental) of 10 calves in group. The experiment started at 30 days of age and finished at 122 days of age. Both groups of calves received the same amount of milk and milk replacer according to the standard feeding regime, Table 1. Calves from the milk and milk replacer experimental group received raw fiber concentrate (Vitacel® 200, JRS Germany) from day 30 to day 80. Raw fiber concentrate was supplemented to milk replacer immediately before feeding at the dosage rate proposed by the manufacturer (10 g/ L milk/milk replacer).

Both groups were fed starter feed (18% crude protein), and alfalfa hay ad libitum from day 14 (Table 2). Water was supplied trough automatic drinkers. Chemical composition and energy value of offered feed is shown in Table 3.

**Table 1. Experimental feeding schedule**

**Tablica 1. Plan pokusnog hranjenja**

| Age, day<br>Dob, dana | Morning feeding - Jutarnje hranjenje | | Afternoon feeding - Poslijepodnevno hranjenje | |
|---|---|---|---|---|
| | Full-fat milk<br>Punomasno mlijeko | Milk replacer<br>Nadomjestak mlijeka | Full-fat milk<br>Punomasno mlijeko | Milk replacer<br>Nadomjestak mlijeka |
| 5-29 | 3.0 | - | 3.0 | - |
| 30-39 | 1.5 | 1.5 | 1.5 | 1.5 |
| 40-69 | - | 3.0 | - | 3.0 |
| 70-80 | - | 3.0 | - | - |

**Table 2. Composition of calf starter rations fed to both groups, %**

**Tablica 2. Sastav starter obroka teladi u obje skupine, %**

| | |
|---|---|
| Corn meal - Kukuruzno brašno | 34.30 |
| Barley meal - Ječmeno brašno | 10.00 |
| Full-fat soy grits - Punomasna sojina prekrupa | 22.50 |
| Sunflower meal - Suncokretovo brašno, 33% UP | 10.50 |
| Animal feed meal - Brašno za hranidbu životinja | 15.00 |
| Alfalafa meal - Brašno lucerne | 3.00 |
| Limestone - Vapno | 1.20 |
| Dicalcium phosphate - Dikalcijev fosfat | 0.40 |
| Salt - Sol | 0.60 |
| Vitamin and mineral premix - Premiks vitamina i minerala | 1.00 |
| Bentonite - Bentonit | 1.50 |
| Total - Ukupno | **100.00** |

**Table 3. Chemical composition of feeds**

**Tablica 3. Kemijski sastav obroka**

| Parameter - Parametar | Concentrated feed<br>Koncentrirana hrana | Milk replacer<br>Nadomjestak mlijeka | Alfalfa hay<br>Sijeno lucerne |
|---|---|---|---|
| Dry matter - Suha tvar | 88.87 | 96.12 | 87.46 |
| Ash - Pepeo | 5.13 | 10.70 | 10.14 |
| Fats - Masnoće | 5.36 | 16.11 | 1.35 |
| Cellulose - Celuloza | 7.72 | 2.73 | 18.80 |
| Protein - Bjelančevine | 18.33 | 20.74 | 18.55 |
| Calcium - Kalcij | 0.74 | 1.03 | 1.42 |
| Phosphor - Fosfor | 0.58 | 0.89 | 0.22 |
| NEL, MJ | 6.78 | 10.09 | 3.96 |

Blood samples were taken from jugular vein on day 120 approximately 2-3 hours after the morning feeding. Calf body weight was taken at the same time (2 hours after morning feeding) at the beginning and at the end of the trial.

## RESULTS AND DISCUSSION

Results related to age, trial duration, body weight and daily gain are given in Table 4. At the beginning of the trial calves from the control group were on average 7 days older, while at the end of the trial the age was the same, that is, 122 days. Calves fed fiber concentrate in the liquid feed achieved 8, 7% higher final body weight and significantly higher daily weight gain (1140g vs. 1084g, p<0,05). Concentrated feed intake was very similar in both groups (Table 5), but calves fed Vitacel® 200 during the liquid feeding phase utilized concentrated feed more efficiently compared to control calves (1.67 vs. 1,74). This result indicated that feed utilization efficiency was better by 4,02% in calves fed Vitacel® 200. Although anatomical and physiological changes in fore-stomachs were not studied, it can be assumed that earlier development of gastrointestinal tract in calves triggered by Vitacel® 200 enabled improved digestibility, better feed utilization and body weight. Vikari and Dusel (2008) showed that fiber concentrate supplementation during the liquid feeding phase had a positive effect on the number and length of ruminal villi and rumen wall thickness in calves. They also found that feeding fiber concentrate to calves in the liquid feed increased concentrate feed and silage dry matter and total energy intake. Furthermore, higher body weight and higher gain results reported by Vikari and Dusel (2008) are consistent with the results obtained in the current study. Other experiments have shown a positive effect of the application of insoluble cellulose rich fiber in prestarter diets for piglets on the growth of intestinal villi and increase of their absorption surface, resulting in improved weight gain and feed conversion rate (Markert i Backers, 2003). It can, therefore, be concluded that Vitacel®200 helped stimulate rumen function and development, and, consequently, better weight gain and feed intake utilization efficiency.

**Table 4. Calves body weight and gain**
**Tablica 4. Tjelesna težina i prirast teladi**

| Parameter - Parametar | Control group w/o Vitacel® Kontrolna skupina bez Vitacela® | Experimental group with Vitacel® Pokusna skupina s Vitacelom® |
|---|---|---|
| Initial age, days - Početna dob, dana | 37 | 30 |
| Final age, days - Završna dob, dana | 122 | 122 |
| Trial duration, days - Trajanje pokusa, dana | 85 | 92 |
| Initial body weight, kg - Početna tjelesna težina, kg | 54.05 | 53.70 |
| Final body weight, kg - Završna tjelesna težina, kg | 146.20 | 158.9 |
| Total weight gain, kg - Ukupni prirast težine, kg | 92.15 | 104.9 |
| Daily gain kg - Dnevni prirast, kg | 1.084 | 1.140* |

* Statistically significant (p< 0,05)

**Table 5. Feed intake and utilization efficiency**
**Tablica 5. Unos hrane i djelotvornost iskorištavanja**

| Parameter - Parametar | Control group w/o Vitacel® Kontrolna skupina bez Vitacela® | Experimental group with Vitacel® Pokusna skupina s Vitacelom® |
|---|---|---|
| Feed intake, kg/day - Unos hrane, kg/dan | 1.89 | 1.91 |
| Feed conversion per kg gain, kg Konverzija hrane po kg prirasta, kg | 1.74 | 1.67 |

Values obtained for feed intake and efficiency are similar to values reported by Adamović (1989) ; Adamović et al. (2007); Radivojević et al. (2003) and others for calves of similar genotype, age, diet formulation and weight gain achieved.

Values for blood parameters (Table 6) were within optimum ranges, with no statistically significant difference between the treatments. However, deviations were reported in both control and experimental group in blood response to electrical and chemical stimulation and calcium to phosphorus concentration ratio. It is interesting to note that calcium/phosphorus ratio in both groups was below 1.2 (0.79 and 0.68, respectively). Based on the data available in this study, there is no satisfactory explanation for this result. However, some important factors influencing blood calcium and phosphorus absorption and concentration need to be mentioned. It is a well-known fact that calcium and phosphorus availability changes with age. Optimum absorption of these trace elements takes place in the earliest stage of life, and their availability decreases by more than 50% after six months of age. In addition to that, absorption rate, particularly in the case of calcium, is conditioned by the response of abomasal and intestinal content to electrical and chemical stimulation. Acid reaction has a positive effect, while alkali reaction, during which less available compounds are formed, has an inhibiting effect. Although we do not have data on the response of abomasal and intestinal content to electrical and chemical stimulation, blood pH levels in both control (7.49) and experimental group (7.54) are indicative of alkalosis, particularly in the control group due to less favorable calcium to phosphorus concentration ratio. Nevertheless, pH variations in digestive tract may greatly reduce calcium availability. For that the reason, in case of calcium deficiency special attention must be devoted to this microelement, regardless of its seemingly satisfactory presence in the diet (Timet, 1981). Yet another issue of concern is the fact that hyperphosphatemia has been reported in both treatment groups. It is known that vitamin D hydroxylation takes place at 25$^{th}$ carbon atom in the liver and at 1$^{st}$ carbon atom in kidneys. Contrary to 25-OH$D_3$ synthesis in the liver, synthesis of 1.25 $(OH)_2D_3$ in the kidneys is strictly controlled by ions and hormones. Since hyperphosphatemia (Šamanc et al., 1995) adversely affects hydroxylation process in kidneys, it is probably the cause of the relatively low hypercalcemia and calcium to phospohorus ratio in calves observed in this trial.

**Table 6. Results of blood analyses**
**Tablica 6. Rezultati analiza krvi**

| Parameter - Parametar | Control group w/o Vitacel® Kontrolna skupina bez Vitacela® | Experimental group with Vitacel® Pokusna skupina s Vitacelom® |
|---|---|---|
| Blood pH - pH krvi | 7.49 | 7.54 |
| Glucose - Glukoza, mmol/L | 4.36 | 4.56 |
| Ca, mmol/L | 2.24 | 2.21 |
| P, mmol/L | 2.83 | 3.24 |
| Fe, µmol/L | 29.84 | 29.14 |

## CONCLUSION

Supplementation of the raw fiber concentrate (Vitacel® 200) in milk replacer (10 g/L) from day 30 has been shown to be beneficial in improving weight gain, feed intake and feed utilization during the first 4 months of age and in preparing young calves for early weaning. Transition from milk and milk replacer to dry feed without compromising gastro-intestinal health of the calf is an important prerequisite for better health status and improved performance in later stages of life.

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## SAŽETAK


U suvremenom uzgoju teladi važnu ulogu ima rani razvoj teleta u preživača. Brži razvoj buraga i stoga sposobnost probavnog trakta da fermentira sirovo krmivo i koncentriranu hranu pridonosi korisnom, uspješnom rastu, zdravlju i proizvodnosti.Neki noviji radovi pokazuju da netopiva celuloza i vlakna bogata ligninom u predstarter i starter obrocima pozitivno djeluju na rani razvoj crijeva u nepreživača. Cilj polusa bio je istražiti utjecaj koncentrata sirovog vlakna Vitacel® 200 (74% sirovog vlakna, 90% NDF) dodanog mlijeku i nadomjestku mlijeka na rezultate uspješnosti teladi.

Pokus je proveden na 20 muške teladi pasmine Holstein podijeljene u dvije skupine (kontrolnu i pokusnu) od 10 teladi u skupini. Pokus je

započeo 30. dana starosti i završio sa 122 dana. Obje skupine teladi primale su jednaku količinu mlijeka i nadomjestka mlijeka prema standardnom režimu hranidbe do 80. dana. U mlijeku i nadomjestku mlijeka pokusna skupina teladi dobivala je koncentrat sirovog vlakna (Vitacel® 200, JRS Njemačka) u dozi od 19 g/l. Starter krmivo (18% sirovih bjelančevina) i sijeno lucerne davani su *ad libitum*.Voda je davana pomoću automatskih pojilica. Telad hranjena koncenratom vlakana u tekućoj hrani postigla je 8,69% višu završnu tjelesnu težinu (158,9 kg prema 146,2 kg) i 5,17% viši dnevni prirast tjelesne težine (1140g prema 1084g, $p<0,05$). Unos koncentrirane hrane po danu bio je sličan u obje skupine, ali telad hranjena Vitacelom® 200 u fazi tekućeg hranjenja iskorištavala je koncentriranu hranu djelotvornije u usporedbi s kontrolnom teladi (1,67 prema 1,74). Razina glukoze i pH vrijednosti u krvi bili su viši u teladi hranjene Vitacelom® 200 ($p>0,05$). Raniji razvoj gastrointestinalnog trakta potaknut Vitacelom® 200 omogućio je veći unos i bolje iskorištavanje hrane.

Ključne riječi: sirova vlaknina, zootehnički parametri, hranidba teladi