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RESEARCH AND DEVELOPMENT MANAGEMENT

VITEN® CWS

Calves **Ref.: TNO 05/00**

NUTRITIONAL VALUE OF VITEN® AND VITEN® CWS IN VEAL CALVES (150 KG)

This study on the replacement of skim milk powder in calf milk for calves was conduct by T.N.O. – Wageningen – under the management of:

- **Jr. J.M.A.J. VERDONK**
- **Ing. G.M. BEELEN.**

Summary

This report deals with the results of an experiment to determine the nutritional value of VITEN® and VITEN® CWS in veal calves (150 kg body weight). In the experiment the apparent faecal nitrogen digestibility and the nitrogen retention of both products were determined.

The diets used in this experiment were a 57% skim milk powder (SMP) diet, a diet based on 7.5% VITEN® and 44% SMP, a diet based on 7.5% VITEN® CWS and 44% SMP and a diet based on 15% VITEN®CWS and 31% SMP.

Feed intake of all diets was good, no problems with health and appetite occurred.

Inclusion of VITEN® or VITEN® CWS in the diet caused stiffer faeces with darker colour and increased dry matter content compared to the calves fed the SMP diet. Inclusion of VITEN® in the diet at the level of 75 g/kg significantly ($p<0.05$) decreased faecal digestibility of the diet for dry matter and crude fat compared to the SMP diet and the VITEN® CWS (75g/kg) diet.

Inclusion of VITEN® CWS at level of 150 g/kg only decreased the apparent faecal diet digestibility of the carbohydrate fraction compared to VITEN® CWS 75g/kg diet and the SMP diet.

The average calculated apparent faecal crude protein digestibility of VITEN® and VITEN® CWS was approximately 92% and 95% respectively (SMP: 94%).

Inclusion of VITEN® and VITEN® CWS and the inclusion level of VITEN® CWS did not affect the N retention.

In conclusion:

-VITEN® at inclusion level of 7.5% can partly replace SMP in diets for calves if the fat digestibility can be improved to acceptable level.

-At an inclusion level of 75 g/kg VITEN® CWS had higher apparent faecal diet digestibility than VITEN. The enzymatic hydrolysis process successfully improved the faecal digestibility of vital gluten.

- Inclusion of 150 g/kg VITEN® CWS did not interfere with diet digestibility parameters.

- The low content of lysin might limit the possibility to use VITEN® CWS in diets for veal calves or requires the supplementation with crystalline lysin or other protein sources

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I. Introduction

Roquette Freres, Lestrem, France manufactures an extensive range of starches and derived products as well as proteins from wheat, maize and potatoes. Roquette is one of the main suppliers of starch products and vegetable protein products for the application in milk replacers.
Wheat proteins have been used for a number of years as a high quality feed ingredient and alternative for milk proteins. Roquette has developed a wheat gluten product, called VITEN® CWS. The production process includes controlled enzymatic modification and drying at low temperature. This process gives VITEN® CWS its characteristic composition, palatability, consistency and dipersibility required for the preparation of calf milk replacer.
This report deals with the results of an experiment run to determine the nutritional value of VITEN® CWS for veal calves. It has been tested and compared with protein from skimmed milk powder (SMP) and with vital (non modified) wheat gluten from Roquette called VITEN®.
In this experiment the faecal digestibility as well as the nitrogen retention of the diets was determined.
The control group (Group I) was fed a diet based on skim milk powder (SMP,
57%) as the sole protein source. The test groups received diets in which part of the SMP protein was replaced by protein from the test product. Group II and III received diets based on 7.5% VITEN® or 7.5% VITEN® CWS, respectively and 44.2% SMP. Group IV was fed a diet based on 15% VITEN® CWS and 31.3% SMP.
The experiment was conducted from 29 November until 17 December 1999 at facilities of ILOB in Wageningen, the Netherlands.

2. Materials And Methods

2.1 Experimental design

For the experiment in total 24 calves were used with an initial body weight of approximately 150 kg and a Hb content of approximately 5.1 mmo1/1. The calves were divided into 4 groups of 6 animals (including one spare animal) each with average body weight and Hb as equal as possible. Bach group was allocated randomly to one of the experimental diets.

The following diets were tested:

Group SMP	: diet with 57% SMP as the sole protein source
Group VITEN® 75	: diet with 44% SMP and 7.5% VITEN®
Group VITEN®CWS 75	: diet with 44% SMP and 7.5% VITEN®CWS
Group VITEN®CWS 150	: diet with 31% SMP and 15% VITEN®CWS

In the test diets about 27% of the protein was derived from VITEN® and 27% and 49% from VITEN®CWS.

2.2 Animals, housing and management

For the experiment in total 24 calves were used. Up to one month before the start of this experiment the calves participated in a faecal digestibility experiment. In between the two experiments the calves were fed a commercial calf milk replacer diet containing 25% skim milk powder.
The average body weight of the calves was approximately 140 kg and the Hb content was approximately 5.1 mmol/l.

The calves were housed individually in a calf house (8 x 18 m inside measurements) with on each side of the feeding corridor (width 2 m) 22 wooden boxes with slatted floors (75 x 175 cm inside measurements, no bedding, no free water available).
The position of the calves was randomly determined, in such a way that there were twelve calves at each side of the feeding corridor.
At the start of the experimental period, mean body weight and blood hemoglobin content per treatment were similar.
Climate in the calf house was controlled by means of a system with central heating and mechanical ventilation. The inlet of fresh air was on both sides of the feeding corridor, while the outlet was by 2 fans in the ridge of the roof. Temperature and relative humidity were continuously registered with a thermohygrograph.
The calfhouse was illuminated by daylight (5.5/100 of the surface of the floor) and TL-lamps (48 TL-tubes of 36 Watt each), which were turned on during feeding and other experimental activities.

2.3 Test and control products

Test product in the experiment were VITEN® and VITEN® CWS supplied by Roquette, France. Skim milk powder (SMP) was used as the control product.
Other dietary sources were lactose, fat blend, premix, minerals and synthetic amino acids.
The analysed chemical composition of the test products is presented in Table 1.

Table 1. Analysed chemical composition (%) of the test products

Nutrient	VITEN	VITEN® CWS
Moisture	6.2	6.3
Crude protein (N * 6.25)	83.1	83.1
Crude fat	6.7	6.6
Ash	7.2	7.1
Calcium	0.86	0.84
Phosphorus	0.16	0.16
Sodium	0.37	0.36
Potassium	0.28	0.26
Iron (ppm)	60	55

2.4 Diets and feeding

During the month before the experiment the calves were fed a commercial milk replacer diet containing 25% skim milk powder (produced by Navobi). After allocating, the calves were changed gradually from this diet to the test diets by replacing every day 25% of the commercial diet.
The calves were bucket-fed, individually twice a day at 8.00 and 16.00 hrs.

The composition of the diets is given in Table 2 and 3.
The diets were balanced on calculated contents of ileal digestible lys, met+cys, thr, trp and ile using expected amino acid digestibility coefficients of SMP, VITEN® and VITEN® CWS.

Table 2. Composition (%) of the diets

Ingredient	Diet			
	SMP	VITEN 75	VITEN®CWS 75	VITEN®CWS 150
Skim milk powder	57.00	44.15	44.15	31.30
VITEN		7.50		
VITEN® CWS			7.50	15.00
Faf [1)]	20.00	20.00	20.00	20.00
Lactose	21.88	25.80	25.80	29.77
Premix [2)]	0.50	0.50	0.50	0.50
$CaCO_3$		0.20	0.20	0.40
$CaHPO_4.H_2O$		0.38	0.38	0.75
$NaHCO_3$	0.30	0.38	0.38	0.45
$Na_2HPO_4.H_2O$		0.13	0.13	0.25
$KHPO_4.H_2O$		0.13	0.13	0.25
$KHCO_3$		0.23	0.23	0.45
L-lys HCl		0.33	0.33	0.66
DL-meth	0.26	0.13	0.13	
L-threo	0.06	0.10	0.10	0.14
L-ileu		0.04	0.04	0.08

[1)] Composition: 34% tal1ow, 25% lard, 15% refined fish oil, 20% refined coconut oil, 3% native lecithin and 3% emulsifier

[2)] Premix: supplied per kg of diet:
20,000 IU vitamin A, 4,000 IU vitamin D_3, 50 mg vitamin E, 6 mg vitamin B_1, 10 mg vitamin B_2, 4 mg vitamin B_6, 25 ug vitamin B_{12}, 25 mg d-pantothenic acid, 40 mg niacin amide, 80 mg vitamin C, 4 mg vitamin K, 400 mg choline chloride, 100 mg ZnO, 0.65 mg KI, 0.5 mg $Na_2SeO_3.5H_2O$, 30 mg $CuSO_4.5H_2O$, 60 mg $MnSO_4.H_2O$, 10 mg $CoSO_4.7H_2O$, 1000 mg MgO, 1 mg folic acid, 0.5 mg biotin

Iron as was added (20 mg/kg) as iron sulfate; no antibiotic was added to the diets.

Table 3. Calculated and analysed () nutrient contents (%) of the diets

Nutrient	Diet							
	SMP		VITEN 75		VITEN®CWS 75		VITEN®CWS 150	
Crude protein (N * 6.25)	20.7	(20.2)	22.4	(22.8)	22.4	(22.7)	24.1	(25.3)
Crude fat	20.2	(19.9)	20.5	(19.7)	20.5	(19.7)	20.8	(19.5)
Ash	4.7	(4.7)	4.6	(4.7)	4.6	(4.6)	4.5	(4.6)
Carbohydrates	51.8		49.7		49.7		47.6	
Metabolizable Energy (kcal/kg)	4528		4555		4555		4581	
Calcium	0.74	(0.70)	0.74	(0.71)	0.74	(0.72)	0.73	(0.74)
Phosphorus	0.62	(0.58)	0.62	(0.57)	0.62	(0.59)	0.61	(0.60)
Sodium	0.30	(0.28)	0.30	(0.27)	0.30	(0.28)	0.29	(0.28)
Potassium	0.95	(0.90)	0.87	(0.82)	0.87	(0.82)	0.79	(0.73)
Chloride	0.62		0.56		0.56		0.49	
Base-excess (meq/100g)	20		20		20		19	
Lysine tot.	1.68		1.67		1.67		1.66	
Lysine dig.	1.59		1.59		1.59		1.59	
Methionine + cystine tot.	0.98		0.98		0.98		0.97	
Methionine + cystine dig.	0.90		0.90		0.90		0.90	
Threonine tot.	0.96		0.96		0.96		0.96	
Threonine dig.	0.83		0.83		0.83		0.82	
Isoleucine tot.	1.07		1.09		1.09		1.10	

2.5 Faecal digestibility study

In order to determine the apparent faecal digestibility of the diets, per calf feed intake and faeces production were conscientiously determined for a period of 5 consecutive days (5 x 24hrs).
Faeces were collected in plastic bags, which were attached to the calves through harnasses. These bags were attached in such a way that the faeces could be collected quantitatively and separately from the urine. Bags were emptied at least once daily after feeding. The collected faeces were weighed and stored at –20°C till the end of the collecting period. The faeces were then thawed, homogenised, sampled per animal and analysed according to standard methods.
From the contents of dry matter, ash, organic matter, crude protein, crude fat and carbohydrates in the diets, the contents of these components in faeces, feed intake per calf and quantity of faeces produced per calf, the digestibility coefficient (DC) of the components was calculated. Per diet per component the average digestibility coefficient and standard deviation were calculated. With the average digestibility coefficients of crude protein per diet and the content of this component in the diets and the test product, the average digestibility coefficient of crude protein of the test product was calculated, assuming that the digestibility of SMP in the test diets and the control diet was equal.

2.6 N retention

The nitrogen retention (NR) was calculated as nitrogen intake (NI) diminished with faecal nitrogen (N_f and urinary nitrogen (N_u) excretion: $NR=NI-N_f-N_u$.
To accomplish this, per calf feed intake and amount of faeces and urine were conscientiously determined for a period of 5 consecutive days (5 x 24 hrs).
The urine was collected quantitatively in buckets by means of large funnels, which were attached under the slatted floors of the calf boxes. In order to prevent volatilization of ammonia, each day 50 ml H_2SO_4 (25% 1/1) was added to each bucket. The buckets were emptied each moming after feeding. The urine was weighed and homogenised. Per calf a subsample of 10% was taken and stored at 4°C For each calf, urine samples of 5 days were joined, homogenised, sampled and analysed on the content of nitrogen.
From the nitrogen contents in diets, urine and faeces, the feed intake and quantity of urine and faeces produced per calf, the nitrogen retention was calculated. Per diet the average nitrogen retention and standard deviation were calculated.

2.7 Observations and determinations

The following observations and determinations were performed :

- Apparent faecal digestibility of dry matter, ash, organic matter, nitrogen, crude fat and carbohydrates of the diets
- Apparent faecal digestibility of nitrogen of the test products VITEN® and VITEN® CWS
- Nitrogen retention of the diets
- Body weight and weight gain of the animals (enclosure 2)
- Hemoglobin content of the blood
- Health, drinking behavior and faeces quality
- pH, leucocytes, nitrite, protein, glucose, ketonbodies, urobilirubine, bilirubine and blood in urin (enclosure 3)

2.8 Statistical analysis

Faeca1 digestibi1ity coefficients, nitrogen retention and uti1ization were subjected to an one-way ana1ysis of variance (ANOV A), with diet as on1y source of variation.

A diet effect was considered as significant, if the probabi1ity P on having no effect was 1ess than 5% (P < 0.05). If a diet effect was observed, differences between two means were considered to be significant when these differences were 1arger than the Least Significant Difference (LSD) for P = 0.05.
LSD was ca1cu1ated as: t x RSE x $\sqrt{(}1/n_1 + l/n_2$,

With:

t = t-variab1e at 16 degrees of freedom ($t_{0.05}$ = 2.12)
RSE = residua1 standard error (= √ residua1 mean square)
n_i = samp1e size of group i.

3. Results

3.1 Course of the experiments

Health and appetite of the animals were good. No problems occurred with the change-over to the experimental diets. The feed intake for all diets was good, no calves in the VITEN® or VITEN® CWS group had feed refusal. The spare animal from the control group had once ± 1400 g feed refusal.
During the faeces collection period calves were fed based on live weight (approximately 1200 g powder mixed with 6800 g water per feeding).
One week after the change over, 3,3 and 1 animals in group VITEN® 75, VITEN® CWS 75 and VITEN® CWS 150 respectively had faeces which changed from normal consistency to stiffer consistency. Calves with VITEN® products in the milk also got faeces with more grey/brown colour compared to the animals fed skim milk powder.
Faeces composition and production figures can be seen in Enclosure 1.

3.2 Apparent faecal digestibility

The apparent faecal digestibility coefficients of the diets are given in tables 4a and 4b. The average calculated apparent faecal crude protein digestibility of VITEN® and VITEN® CWS was 92% and 95% respectively (table 4c). Inclusion of VITEN® in the diet at the level of 75 g/kg significantly ($p<0.05$) decreased the apparent faecal digestibility of dry matter, organic matter and crude fat. Inclusion of VITEN® CWS (75 g/kg or 150 g/kg) did not affect the faecal digestibility of the diets except for carbohydrate digestibility at the level of 150 g/kg.

Table 4a. Apparent faecal digestibility of the diets

Nutrient	Diet			
	SMP (n=5)	VITEN®75 (n=5)	VITEN®CWS 75 (n=5)	VITEN®CWS 150 (n=5)
Dry matter	$96.4^{a} \pm 0.8$	$94.3^{b} \pm 1.4$	$95.9^{a} \pm 0.7$	$95.4^{ab} \pm 1.4$
Ash	89.5 ± 2.7	86.7 ± 2.8	88.1 ± 2.2	85.1 ± 6.2
Organic matter	$96.7^{a} \pm 0.7$	$94.7^{b} \pm 1.4$	$96.3^{a} \pm 0.6$	$95.9^{ab} \pm 1.2$
Crude protein (N x 6.25)	93.6 ± 1.4	92.7 ± 1.9	93.9 ± 0.8	94.3 ± 1.6
Crude fat	$94.9^{a} \pm 2.0$	$89.7^{b} \pm 4.6$	$94.2^{a} \pm 1.3$	$94.1^{a} \pm 3.6$
Carbohydrates	$98.7^{a} \pm 0.3$	$97.9^{b} \pm 0.9$	$98.3^{ab} \pm 0.3$	$97.7^{b} \pm 0.2$

Values as mean ± SD

^{ab} Means on the same 1ine without a common character in the superscript differ significantly ($P<0.05$)

Table 4b. Apparent faecal digestibility of diets with VITEN® 75 and VITEN® CWS 75

Nutrient	Diet		
	SMP (n=5)	VITEN®75 (n=5)	VITEN®CWS 75 (n=5)
Dry matter	$96.4^{a} \pm 0.8$	$94.3^{b} \pm 1.4$	$95.9^{a} \pm 0.7$
Ash	89.5 ± 2.7	86.7 ± 2.8	88.1 ± 2.2
Organic matter	$96.7^{a} \pm 0.7$	$94.7^{b} \pm 1.4$	$96.3^{a} \pm 0.6$
Crude protein (N x 6.25)	93.6 ± 1.4	92.7 ± 1.9	93.9 ± 0.8
Crude fat	$94.9^{a} \pm 2.0$	$89.7^{b} \pm 4.6$	$94.2^{a} \pm 1.3$
Carbohydrates	$98.7^{a} \pm 0.3$	$97.9^{b} \pm 0.9$	$98.3^{ab} \pm 0.3$

Values as mean ± SD

^{ab} Means on the same line without a common character in the superscript differ significantly ($P<0.05$) TNO report

Table 4c. Apparent faecal nitrogen digestibility (%) of the test products

Nutrient	Test product		
	SMP (n=5)	VITEN (n=5)	VITEN®CWS (n=5)
nitrogen	94	92	95

3.3 Nitrogen retention

Table 5. Shows the nitrogen retention of the calves.
N-retention was not affected by inclusion of VITEN® or VITEN® CWS in the diet.

Table 5. Nitrogen retention (g/day)

Criterion	Diet			
	SMP (n=5)	VITEN®75 (n=5)	VITEN®CWS 75 (n=5)	VlTEN® CWS 150 (n=5)
N-retention (g/dav)	41.7 ± 3.2	41.6 ± 4.0	41.0 ± 4.1	43.5 ± 3.2

Values as mean ± SD

3.4 Hemoglobin values

The hemoglobin content of the blood is given in table 6. At the start and at the end of the faecal digestibility experiment the Hb blood values were similar for all test groups.

Table 6. Hemoglobin content of the blood (Hb; mmol/1) and hematocrite (Ht; %) of the animals per experimental group

Criterion	Diet			
	SMP (n=5)	VITEN®75 (n=5)	VITEN®CWS 75 (n=5)	VITEN®CWS 150 (n=5)
Hb-content at allocation	5.0 ± 0.3	5.0 ± 0.3	5.3 ± 0.6	5.1 ± 0.4
Hb-content at the end of the experiment	5.1 ± 0.2	4.9 ± 0.2	5.1 ± 0.6	5.2 ± 0.6

Values as mean ± SD

4. Discussion

In general, the experiment proceeded well. Inclusion of VITEN® or VITEN® CWS in the diet caused darker (brown/grey) coloured, firmer faeces but health and appetite of the animals were good. No problems occurred with the change-over to the experimental diets.
The apparent faecal digestibility coefficients of the diets are given in Table 4a, 4b and 4c. The average calculated apparent faecal crude protein digestibility of VITEN® and VITEN® CWS was 92% and 95% respectively.
Inclusion of VITEN® in the diet at the level of 75 g/kg significantly ($p<0.05$) decreased the faecal digestibility of dry matter, organic matter and crude fat. Inclusion of VITEN® CWS at the level of 75 g/kg or 150 g/kg did not affect faecal digestibility of the diets except for carbohydrate digestibility.
Although ash digestibility was not decreased significantly this aspect needs to be further investigated.
Inclusion of VITEN® or VITEN® CWS in the diet and the inclusion level of VITEN® CWS did not affect the N retention (Table 5).

In conclusion:
-VITEN® at inclusion level of 7.5% can partly replace SMP in diets for calves if the fat digestibility can be improved to acceptable level.
-At an inclusion level of 75 g/kg VITEN® CWS had higher apparent faecal diet digestibility than VITEN®. The process of enzymatic hydrolysis successfully improved the digestibility of vital gluten.
-Inclusion of 150 g/kg VITEN® CWS did not interfere with diet digestibility parameters.
-To optimise the use of VITEN® CWS in diets for veal calves, supplementation of the diet with crystalline lysin or other protein sources rich in lysin is advised.

Dr. B.P.M. Janszen
Head
ID TNO Animal Nutrition

Ir. J.M.A.J. Verdonk
Author

Enclosure 1. Faeces production and composition

The faeces production and composition is given below

Faeces production (g/day) and composition of the faeces (%)

Nutrient	Diet			
	SMP (n=5)	VITEN 75 (n=5)	VITEN®CWS 75 (n=5)	VITEN®CWS 150 (n=5)
Dry matter	12.5 ± 1.8	16.9 ± 5.5	4.1 ± 1.9	16.3 ± 3.0
Ash	1.8 ± 0.3	2.0 ± 0.7	2.0 ± 0.3	2.5 ± 0.7
Crude protein (N x 6.25)	4.7 ± 0.5	5.1 ± 1.1	5.0 ± 0.7	5.4 ± 0.8
Crude fat	3.7 ± 1.3	6.8 ± 4.1	4.2 ± 0.8	4.5 ± 2.2
Carbohydrates (by difference)	2.3 ± 0.2	3.0 ± 0.6	2.9 ± 0.4	3.9 ± 0.6
Faeces production	676 ± 76	848 ± 382	685 ± 104	646 ± 99

Values as mean ± SD

Enclosure 2. Body weight and body weight gain

Body weight and body weight gain during the experimental period are given below. During the experiment animals were changed to the experimental diets and harnassed. This might have affected daily weight gain.
As a result, the figures for weight gain can only be considered as indicative values.

Body weight (kg) and weight gain (g/day) of the animals per experimental group (excluding the spare animals).

Criterion	Diet			
	SMP {n=5)	VITEN®75 (n=5)	VITEN®CWS 75 (n=5)	VITEN®CWS 150 (n=5)
Body weight at allocation	142.8 ± 4.7	141.1 ± 4.1	141.2 ± 3.9	141.2 ± 2.6
Body weight at start of test period	153.4 ± 5.3	151.2 ± 4.3	151.5 ± 3.8	151.1 ± 2.8
Body weight at end of the experiment	167.3 ± 6.3	162.5 ± 5.3	163.9 ± 4.8	163.4 ± 4.8
Weight gain pre test period	1178 ± 103	1116 ± 95	1147 ± 64	1107 ± 106
Weight gain test period	1538 ± 157	1262 ± 221	1382 ± 146	1369 ± 241
Weight gain total experimental period	1358 ± 125	1189 ± 113	1264 ± 61	1238 ± 162

Values as mean ± SD

Enclosure 3. Urin parameters

Leucocytes, pH, nitrite, protein, glucose, ketonbodies, urobilirubine, bilirubine and blood were determined in urin using a Comburg dipstick. The urin of all calves was collected in clean buckets at 11.00 h at the day of finishing the faeces collection. There were no clear differences between groups.

Urin samples of all animals were negative for leucocytes, nitrite, ketonbodies urobillirubin and billrubin. .
The average pH values were 6.8, 6.4 6.6 and 6.5 for group SMP, VITEN® 75, VITEN® CWS 75 and VITEN® CWS 150 respectively.
In group VITEN® CWS 150 two animals had protein (0.3 g/l) in the urin.
One, zero, two and three calves from group SMP, VITEN® 75, VITEN® CWS 75 and VITEN® CWS 150 respectively had blood in the urin.
Three, two, four and two calves from group SMP, VITEN® 75, VITEN® CWS 75 and VITEN® CWS 150 respectively had glucose (2.8 to 55 mmol/l) in the urin.