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# THE UTILIZATION OF MILK DIETS WITH DIFFERENT FAT CONCENTRATIONS BY THE PRERUMINANT CALF 2. CHANGE IN BODY COMPOSITION BY MEANS OF NUTRITION *

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*OPSOMMING:* DIE BENUTTING VAN MELKDIËTE MET VERSKILLENDE VET-KONSENTRASIES DEUR DIE VOOR-HERKOUERKALF 2. VERANDERING IN LIGGAAMSAMESTELLING DEUR MIDDEL VAN VOEDING

Agt-en-twintig Friesbulkalwers is gebruik in 'n vergelykende slagproef om vas te stel wat in die invloed van die energie diëte (volmelk plus room) op die verandering in liggaamsamestelling van voorherkouer kalwers is. Totale liggaams-DM, -energie, -stikstof en -vet het toegeneem met 'n verhoging in energie inname. Hoogsbetekenisvolle regressie verwantskappe is gevind tussen log-lewende massa en die log van verskillende liggaamskomponente. Uit die resultate kan afgelei word dat die liggaamsamestelling van voorherkouer kalwers drasties verander is met voedingsbehandeling.

*SUMMARY*

Twenty eight Friesland bull calves were used in a comparative slaughter experiment to determine the influence of high energy diets (whole-milk and cream) on the body composition of preruminant calves. Results indicated an increase in total DM, energy, nitrogen and fat content with an increase in energy intake. Highly significant regression relationships were found between log live mass and the log of different body components. From the results it can be concluded that the body composition of preruminant calves was altered by nutrition.

The increasing demand for the production of greater quantities of high quality meat justifies research on factors governing change in body composition. The successful production of animal products is dependant on this type of knowledge (Robinson, 1971).

A precise knowledge of body composition is furthermore necessary to indicate the animal's potential and utilization efficiency of specific nutrients for human food production.

In an extensive review Reid, Bensadoun, Bull, Burton, Gleeson, Han, Joo, Johnson, McManus, Paladines, Stroud, Tyrrell, Van Niekerk & Wellington (1968) concluded that the body composition of pigs, cattle and sheep is relatively unaffected by nutrition. Elsley, McDonald & Fowler (1964) also found no significant nutritional effects on muscle and bone content of the fatfree carcass in lambs and pigs.

Burton & Reid (1969), found no differences in fat and protein content of wether carcasses due to feeding level. Ørskov (1970) on the other hand significantly altered body composition in lambs by changing the protein content of the diet from 10 to 20%. As most of the work on body composition has been carried out with sheep, there is a lack of comprehensive work on cattle, relating nutritional factors to body composition, specifically for the preruminant calf.

For comparative purposes it is important that interpretation of body composition data should be done on a common references base, for instance at a specific body mass and/or age. The purpose of this study was to determine whether different butterfat concentrations (and thus different energy concentrations) in milk diets for preruminant calves, had any influence on their chemical body composition when compared at a specific body mass and age. Body mass corrections were done by means of covariance analysis between experimental groups of calves, slaughtered at the same age.

## Procedure

This study was part of an experiment on the utilization of milk diets with different energy concentration by the preruminant calf. The experimental design and procedures were described in full elsewhere (Liebenberg & Van der Merwe, 1974).

Twenty eight calves, allotted randomly to four different groups (A, B, C & D) were used. The calves started their nutritional treatment at four days of age and were slaughtered on the morning of their 25th day of age.

### *Diets*

The four milk diets comprised a cow's whole milk control and three experimental diets prepared by adding different quantities of cream to whole milk. Energy was rationed on the basis of initial metabolic mass. Group A received 836 kJ GE/kg $W^{0,73}$ per day as whole milk, while to this basic allowance 334, 669 and 1 003 kJ GE/kg $W^{0,73}$ in the form of cream were added for Groups B, C and D respectively. Table 1 summarizes the eventual milk diets.

### *Slaughter technique and chemical analysis*

The calves were stunned by a captive bolt pistol. They were then suspended over a large plastic container to collect the blood after severing the jugular veins. The oesophagus was closed with a haemostat to prevent any loss of ingesta. The calves were skinned from the point of the nose to the hooves, while hanging in a closed room with high humidity. The hooves were removed by means of boiling water and the digestive tract removed and emptied. The skinned carcass was covered with a damp cloth to limit moisture losses.

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**Table 1**

*Dry matter, fat, protein (N x 6,38) gross energy and protein: energy ratios of the milk diets*

| Diet | | A | B | C | D |
|---|---|---|---|---|---|
| Diets as fed: | | | | | |
| Fat | (%) | 3,95 | 6,36 | 8,40 | 10,15 |
| Nitrogen | (%) | 0,53 | 0,51 | 0,51 | 0,50 |
| Gross energy | (kJ / g ) | 3,06 | 4,11 | 4,76 | 5,35 |
| Dry matter | (%) | 13,09 | 15,39 | 17,04 | 18,57 |
| Diets – dry matter | | | | | |
| Fat | (%) | 30,18 | 41,33 | 49,30 | 54,66 |
| Protein | (%) | 25,84 | 21,12 | 18,69 | 17,16 |
| Gross energy | (kJ / g ) | 23,40 | 26,70 | 27,91 | 28,79 |
| Protein: energy | (g : kJ ) | 1:90 | 1:126 | 1:149 | 1:168 |
| Protein energy as % of GE | (kJ / 100kJ) | 26,35 | 18,87 | 15,98 | 14,22 |

The skin-free body, empty digestive tract and blood were minced through a Wolfking mincer with two sets of screens, the smallest with 5 millimeter holes. The minced mass was thoroughly mixed by hand and minced four times successively. Two grab samples, respectively 200 and 1000g, were taken. The smaller sample was dried directly in an forced draught oven at 105°C for the determination of dry matter.

The 1000g sample was used for the determination of gross energy, nitrogen and ether extract after freeze drying. The freeze dried samples of the groups B, C & D had a relatively high fat content and had to be milled with dry ice as described by Hofmeyr, Kroon, Van Rensburg & Van der Merwe (1972).

The pelts were air dried after which a 200g sample was oven dried for DM determination. These dry skin samples were milled through a 2 millimeter screen. The hooves were oven dried at 105°C and then milled through a 1 millimeter screen. All the samples were analysed in triplicate for dry matter, nitrogen, energy and ether extract (Liebenberg, 1973).

**Results and discussion**

The means of total DM, nitrogen, fat and energy content of calves in the different groups are given in Table 2. It is clear that the body mass as well as the average total DM, energy, nitrogen and fat contents of the body increased

**Table 2**

*Average live mass (at slaughter), total DM, nitrogen, energy and fat for the experimental groups*

| Group | | A | B | C | D |
|---|---|---|---|---|---|
| Live mass | kg | 40,3 ± 3,4 | 42,9 ± 1,7 | 45,6 ± 5,8 | 47,1 ± 5,2 |
| DM | kg | 11,3 ± 0,1 | 13,3 ± 0,6 | 14,7 ± 2,2 | 16,1 ± 1,9 |
| Energy | MJ | 238,4 ± 21,0 | 303,9 ± 16,9 | 360,5 ± 58,5 | 409,5 ± 55,1 |
| Nitrogen | g | 1211 ± 120 | 1306 ± 79 | 1310 ± 203 | 1335 ± 153 |
| Fat | g | 1704 ± 149 | 3111 ± 302 | 4456 ± 756 | 5574 ± 939 |

with an increase in energy (fat) intake from Group A to Group D.

To express the influence of the experimental treatment on body composition, it was decided to compare the total mass of DM, energy, nitrogen and fat at the same live mass. These comparisons were made by covariance analyses between the log values of the different body components and the log of live mass. Preference for the use of log values is convincingly expressed by Tulloh (1964) and Hofmeyr, Roux & Olivier (1974).

Regression relationships between log live mass and the log of the different body components for the experimental groups are given in Tables 3, 4, 5 and 6.

With a single exception there were no significant differences between the slopes of the regression lines for the different groups. The exception was total body fat of Group A. For the covariance analysis of total body fat only Groups B, C and D were thus used. The "total body fat" results of Group A yielded negative correlation and regression coefficients, as may be deduced from Table 6. Due to the relatively small range in live mass and the small variation in body fat between the calves of Group A, the only logical explanation is that this phenomenon occurred by chance. Results of the covariance analyses are summarized in Table 7.

From Table 7 it is clear that the slopes of the regression lines for the different groups did not differ significantly. This justified the determination of adjusted means, (Snedecor, & Cochran, 1967) at a live mass of 43,7 kg (for total body DM, energy and nitrogen) and 45,0 kg (for total body fat), which represents the geometric mean of these experimental calves (vidé Tulloh, 1964).

Table 7 furthermore indicates that the means for total body DM, energy, nitrogen and fat differed highly significantly ($P < 0,01$) between the treatments. The adjusted means in anti-logarithmic form are given in Table 8. It is evident from Table 8 that an increase in butterfat contration of the diet led to an increase in body energy. DM and fat.

**Table 3**

*Values for a, b, $S_{yx}$, r and the C.V. for the relationship between log live mass and log total body DM*

| Group | a | b | r | $S_{yx}$ | C.V. |
|---|---|---|---|---|---|
| A | –1,376 | 1,028 | 0,956 | 0,030 | 1,24 |
| B | –1,626 | 1,121 | 0,960 | 0,017 | 0,66 |
| C | –1,780 | 1,171 | 0,977 | 0,043 | 1,61 |
| D | –1,313 | 1,062 | 0,975 | 0,030 | 1,08 |

**Table 4**

*Values for a, b, r, $S_{yx}$ and C.V. for the relationships between log live mass and log total body energy*

| Group | a | b | r | $S_{yx}$ | C.V. |
|---|---|---|---|---|---|
| A | 0,385 | 0,991 | 0,930 | 0,043 | 1,06 |
| B | –0,318 | 1,225 | 0,830 | 0,034 | 0,79 |
| C | –0,457 | 1,288 | 0,986 | 0,032 | 0,72 |
| D | 0,824 | 0,980 | 0,986 | 0,020 | 0,44 |

**Table 5**

*Values for a, b, r, $S_{yx}$ and C.V. for the relationships between log live mass and log total body nitrogen*

| Group | a | b | r | $S_{yx}$ | C.V. |
|---|---|---|---|---|---|
| A | 2,884 | 1,140 | 0,968 | 0,027 | 0,38 |
| B | 2,100 | 1,1350 | 0,851 | 0,035 | 0,49 |
| C | 2,477 | 1,232 | 0,978 | 0,038 | 0,53 |
| D | 3,247 | 1,025 | 0,985 | 0,021 | 0,29 |

**Table 6**

*Values for a, b, r, $S_{yx}$ and C.V. for the relationships between log live mass and total body fat*

| Group | a | b | r | $S_{yx}$ | C.V. |
|---|---|---|---|---|---|
| A | 8,789 | –0,366 | –0,352 | 0,090 | 1,21 |
| B | 3,207 | 1,286 | 0,508 | 0,092 | 1,14 |
| C | 3,378 | 1,316 | 0,960 | 0,056 | 0,67 |
| D | 3,598 | 1,303 | 0,773 | 0,128 | 1,49 |

**Table 7**

*Covariance, F-values for testing differences in body composition*

| Body components | F-values for differences in means (1) | F-values for the slopes of regressions (2) | Average regression coefficients (b) |
|---|---|---|---|
| DM | 39,89** | 0,353 | 1,10 |
| Energy | 69,53** | 0,540 | 1,19 |
| Nitrogen | 10,28** | 0,751 | 1,16 |
| Fat | 39,32** | 0,001 | 1,31 |

P 0,01 (1)** F3,23 = 4,76

P 0,01 (2)** F3,20 = 4,94

**Table 8**

*Adjusted means for total DM, energy and nitrogen at a live mass of 43,7 kg, and total body fat at a live mass of 45,0 kg*

| Group | | A | B | C | D |
|---|---|---|---|---|---|
| Total body DM | | | | | |
| At geometric mean | (kg) | 11,28 | 13,56 | 14,08 | 14,80 |
| As a % of A | | 100 | 120 | 125 | 131 |
| Total body energy | | | | | |
| At geometric mean | (MJ) | 263,46 | 310,30 | 343,73 | 373,22 |
| As a %of A | | 100 | 118 | 130 | 142 |
| Total body nitrogen | | | | | |
| At geometric mean | (g) | 1289,4 | 1323,2 | 1265,1 | 1253,0 |
| As a %of A | | 100 | 103 | 98 | 97 |
| Total body fat | | | | | |
| At geometric mean | (g) | | 2904,9 | 4390,2 | 5795,3 |
| As a % of B | | | 100 | 151 | 199 |

At a body mass of 43,7 kg, Group B had 20% more DM than Group A (Control) while Group C had 5% more than Group B and Group D, 6% more than Group C. Table 8 also shows that Group B had 18% more energy than Group A, while Group C had 12% more than Group B and Group D, in turn, 12% more than Group C.

Because of the exclusion of the fat results of Group A, Group B was taken as control in a body-fat comparison between the experimental groups. At a comparable body mass (45,0kg), Group C had 51% more fat than Group B and Group D 48% more than Group C.

The covariance analyses furthermore indicate that nitrogen content, when compared at a similar live mass (43,7kg) is significantly influenced by dietary treatment. However, from Table 8 it is evident that the treatment differences were small and probably of no practical significance. Meissner (personal communication) also found that the nitrogen content of lambs is relatively stable and that treatment differences show mainly in fat content.

The results show that an increase in dietary energy concentration by adding butterfat to whole milk, not only leads to a significant increase in growth rate but also to significant changes in the body composition of preruminant calves.

Although it would, in most instances, be entirely uneconomical to raise the energy concentration of calf diets by addition of butterfat to milk or milk substitute, the results do show that the very young calf can effectively utilize diets high in milk fat and that a widening of the protein:energy ratio from the 1:90 (g:kJ) in whole cow's milk to 1:150 may lead to a more efficient utilization of dietary protein. In this study butterfat was used solely for the reason that no facilities were available for the proper preparation before inclusion into a calf diet, of other, cheaper, fat sources.

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