Copyright is owned by the Author of the thesis. Permission is given for a copy to be downloaded by an individual for the purpose of research and private study only. The thesis may not be reproduced elsewhere without the permission of the Author.
A STUDY OF ASPECTS OF THE UTILIZATION OF TALLOW BY YOUNG MILK-FED CALVES

A thesis submitted in partial fulfilment of the requirements for the Degree of Master of Agricultural Science at Massey University

by

KEITH BETTERIDGE

1973
ACKNOWLEDGEMENTS

Grateful acknowledgement is made of the valuable help and encouragement given throughout the course of this study by Dr C.W. Holmes and Mr A.W.F. Davey.

Sincere thanks are also extended to:

Mr R. Mitchell for the loan of five calves for this trial.

Mr E. Elley, Dairy Research Institute, for analysis of butter-milk powder samples.

Mr P. Vleig, Applied Biochemistry Division, D.S.I.R., for the loan of the homogenising machinery.

Miss E.M. Soulsby, Photographic Unit, D.S.I.R., for preparation of photographs and figures used in this thesis.

Mr V.J. Thomas, Applied Mathematics Division, D.S.I.R., for advice on statistical analysis.

T.V.L., Upper Hutt, for providing the calf mineral supplement.

Messrs G. Dukes, J. Raven, M. Baigent and L. Robertson of the Dairy Husbandry staff for technical assistance.

Members of the Massey University dairy farm staff for help with the animals and the making available of farm equipment.

My sister-in-law Mrs R. Betteridge for the many hours voluntarily spent typing this thesis.
TABLE OF CONTENTS

ABSTRACT

INTRODUCTION

CHAPTER I: REVIEW OF LITERATURE

CHAPTER II: MATERIALS AND METHODS

SECTION ONE - P.M.P. Experiment

2.1 Animals

2.2 General Outline of Experiment

2.3 Experimental Design

2.3.1 Preliminary and changeover periods

2.3.2 Experimental periods

2.4 Feeds and Feeding

2.4.1 Quality of feed

2.4.2 Level of feeding

2.4.3 Feed preparation

2.4.4 Feeding

2.5 Weighing

2.6 Calf Health

2.7 Calf Housing and Calorimetry

2.7.1 Operation of calorimeters

2.7.2 Tests applied to the calorimetric equipment

2.8 Collection of Faeces and Urine

2.9 Chemical Methods

2.9.1 Nitrogen determination

2.9.2 Lipid determination

2.9.3 Gross energy determination

2.10 Statistical Analysis

2.10.1 Analysis of energy and nitrogen balance data

2.10.2 Regression analysis

2.10.3 Covariance analysis

2.10.4 Faecal observations

2.10.5 Significance of differences

SECTION TWO - S.M.P. Experiment

CHAPTER III: RESULTS

SECTION ONE

3.1 Animals

3.1.1 General

3.1.2 Health

3.1.3 Liveweight
CHAPTER III (cont'd)

3.2 Derivation of the Exponent of Liveweight 39
3.3 Intake and Digestibility 41
3.3.1 Intake 41
3.3.2 Fat globule size 44
3.3.3 Digestibility 44
3.4 Nitrogen Balance 44
3.5 Energy Balance 48

SECTION TWO 54

CHAPTER IV: DISCUSSION 56

BIBLIOGRAPHY

APPENDICES: 1 Calculation of Heat Production from Raw Calorimetric Data.
2 Analysis of Chi-Square of the Classification of Faecal Consistency.
3 Analysis of Covariance of Liveweight Gains.
4 Analysis of Regression of log Heat Production on log Liveweight.
5 Analysis of Regression of Energy Retained on Metabolisable Energy Intake.
6 Analysis of Regression of Energy Retained on Gross Energy Intake.
<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Apparent digestibility of a fat plus a lecithin incorporated either by homogenisation or by melting and blending into skim milk diets fed to young dairy calves - after Warner, Locsli and Ley (1962).</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>Mean digestibility of ether extractable material in different diets - after Raven and Robinson (1964a).</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>Percentage Dry Matter of Bulked Oven-Dried Faeces Collected during the Five-Day Balance Periods.</td>
<td>34</td>
</tr>
<tr>
<td>4</td>
<td>Type of Drug Administered as Determined by Faecal Consistency and Slowness of Recovery of Calves to Normal Health.</td>
<td>35</td>
</tr>
<tr>
<td>5</td>
<td>Liveweight Data from Calves fed Buttermilk Powder.</td>
<td>38</td>
</tr>
<tr>
<td>6</td>
<td>Mean Daily Ration of B.M.P., Protein, Butterfat and Tallow/kg Liveweight, fed According to the Calf's Weight at the Beginning of each Period; Percentage of G.E. Intake Derived from Protein and from Fat, and Percentage of Total Dry Matter Intake as Fat.</td>
<td>41a</td>
</tr>
<tr>
<td>7</td>
<td>Mean Coefficients of the Percentage Apparent Digestibility of Crude Protein, Ether Extract, Dry Matter and Gross Energy.</td>
<td>42</td>
</tr>
<tr>
<td>8</td>
<td>Nitrogen Balance: Mean Data of Three Observations per Treatment (g/kg$^{0.75}$/day); Mean Percentage of Digested Nitrogen Retained; Nitrogen Retained/kcal M.E. Intake; and Ratio of Digested Nitrogen Retained/ kcal M.E. Intake.</td>
<td>45</td>
</tr>
<tr>
<td>9</td>
<td>Energy Balance: Mean Data of Three Observations/Treatment (kcals/kg$^{0.75}$/day); Mean Percentage of Apparently Digested and Apparently Metabolised Energy Retained.</td>
<td>49</td>
</tr>
<tr>
<td>Table</td>
<td>Description</td>
<td>Page</td>
</tr>
<tr>
<td>-------</td>
<td>-----------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>10</td>
<td>The Partition of Energy Retained into Protein and Fat Deposits (kcal/kg^{0.75}/day); the Ratio of Energy Retained as Fat : Energy Retained as Protein and the Percentage of Total Energy Retained as Protein.</td>
<td>51</td>
</tr>
<tr>
<td>11</td>
<td>Liveweights and Daily Liveweight Gains of Calved Fed Skim Milk Powder.</td>
<td>55</td>
</tr>
</tbody>
</table>
LIST OF FIGURES

Figure | Description                                                                 | Page
-------|-----------------------------------------------------------------------------|------
A      | Organisation of the experiment showing the average age of calves at the beginning and end of each period, and the number of calves used for the collection of liveweight and balance data. | 16b  
1      | Outline of the experiment showing the relative energy intakes, the source of energy and expected daily liveweight gains of the three groups of calves. | 18   
2      | The average growth curve of each of the 3 groups of calves.                  | 37   
3      | Logarithmic relationship between heat production and liveweight.            | 40   
4      | Mean daily nitrogen balance data (g/kg$^{0.75}$/day).                        | 46   
5      | Mean daily energy balance data (kcal/kg$^{0.75}$/day).                       | 50   
6      | Relationship between energy retained and metabolizable energy intake.        | 53   
<table>
<thead>
<tr>
<th>Plate</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Photomicrographs of Fat Globules in (A) Wholemilk and (B) Reconstituted B.M.P. plus Tallow.</td>
<td>43</td>
</tr>
</tbody>
</table>
1. Three groups of 4 Friesian bull calves were individually fed from 7 days of age on one of the following diets; (I) - Butter-milk powder (B.M.P.) to promote 0.45 kg liveweight gain (LWG)/day; (II) - B.M.P. to promote 0.67 kg LWG/day; (HT) - B.M.P. supplemented with beef tallow to promote 0.67 kg LWG/day. The diets, reconstituted to 15% dry matter (d.m.), were fed in direct proportion to the animal's liveweight at the beginning of each of the 3 consecutive 10-day experimental periods.

N.B. Skim milk powder (S.M.P.), initially used as the basal diet, was subsequently replaced by B.M.P. and the trial was restarted.

2. Daily faecal d.m. consistency was subjectively scored on a 0 - 5 scale. Quantitative measurements were made in conjunction with the faecal collections for the nitrogen balance.

3. Nitrogen balance data were collected from 3 of the 4 calves in each group during the last 5 days, and energy balance data during the last 2 days of each period.

4. The addition of 4% tallow (d.m. basis) significantly reduced the incidence of scours \((p < 0.01)\) in calves fed a basal diet of either S.M.P. or B.M.P.

5. Mean LWG's of calves on treatments L, H and HT were respectively 0.57, 0.73 and 0.62 kg/day; these differences were not statistically significant \((p > 0.1)\).

6. The calves on treatment H, although having the highest urinary nitrogen excretion \((p < 0.05)\), retained the most nitrogen \((g/kg^{0.75}/day)\) \((p < 0.05)\). The ratio of digested nitrogen retained : M.E. intake was highest for the calves fed the tallow supplement. This suggests that energy rather than protein is the factor most limiting protein deposition in calves fed solely on B.M.P.

7. During the second and third periods diets H and HT promoted a significantly greater retention of energy than did diet L \((p < 0.01)\). The percentage of energy retained as fat tended to be higher in calves on treatment H.

8. The maintenance energy requirement for a 50 kg calf was estimated to be 53.5 kcals D.E./kg liveweight. The efficiency of utilisation of M.E. for growth was found to be 78%.