

The effect of supplements containing different protein and energy sources and essential oils on the performance of pasture finished heifers

by
Michiel Nicolaas Engelbrecht

*Thesis presented in fulfilment of the requirements for the degree of
Masters of Science in Agriculture (Animal Sciences) in the Faculty of
AgriSciences at Stellenbosch University*



Supervisor: Prof CW Cruywagen
Co-supervisors: Prof LC Hoffman; Dr WH Hoffmann

September 2015

TABLE OF CONTENTS

Declaration	iv
Abstract	v
Uittreksel.....	vi
List of abbreviations.....	viii
List of tables	x
List of figures	xi
CHAPTER 1	1
GENERAL INTRODUCTION	1
1.1 Introduction	1
References.....	3
CHAPTER 2	5
LITERATURE REVIEW	5
2.1 Soil characteristics of the Southern Cape	5
2.2 Southern Cape grass legume pastures	5
2.2.1 Production potential	5
2.2.2 Pasture management	6
2.2.3 Botanical composition and morphology of grasses	7
2.2.4 Chemical composition of pasture.....	7
2.2.5 Reason for choosing grass legume mixtures	7
2.2.6 Measuring pasture intake	8
2.3 Nutrient requirements of beef cattle	9
2.3.1 The rumen environment.....	9
2.3.2 Energy requirement	10
2.3.3 Energy metabolism	12
2.3.4 Protein requirement	13
2.3.5 Protein metabolism	15
2.3.6 Fibre requirement.....	15
2.3.7 Mineral requirements	16
2.3.8 Growth and development rate of beef cattle.....	16
2.3.9 Bonsmara cattle in general	18
2.4 Supplementation	18
2.4.1 Beef cattle supplementation on pastures	18
2.4.2 Starch vs non-Starch supplementation.....	19
2.4.3 Monensin as feed additive	23
2.4.4 Essential oils as feed additives.....	25
2.4.5 South African beef classification system	28
2.5 Conclusion	30
References.....	31

CHAPTER 3	43
GENERAL MATERIALS AND METHODS.....	43
3.1 General information	43
3.2 Animals, experimental design and treatments.....	43
3.2.1 Vaccination and treatment of experimental animals.....	46
3.3 Pasture.....	46
3.3.1 Soil and fertilization.....	46
3.3.2 Irrigation management.....	48
3.3.3 Perennial grass-legume mixed pastures	49
3.3.4 Botanical composition	49
3.3.5 Grazing system and camp design	49
3.3.6 Pasture measurement	52
3.4 Supplementation	54
3.4.1 Feed formulation and level of supplementation.....	54
3.4.2 Premix formulation	56
3.5 Data collection	57
3.5.1 Concentrate and pasture sampling and analyses	57
3.5.2 Growth rate of heifers	58
3.5.3 Dressing percentages	58
3.6 Statistical analysis	58
References.....	58
CHAPTER 4.....	60
THE EFFECT OF SUPPLEMENTS CONTAINING DIFFERENT PROTEIN AND ENERGY SOURCES AND ESSENTIAL OILS ON THE PERFORMANCE OF PASTURE FINISHED HEIFERS.....	60
4.1 Abstract.....	60
4.2 Introduction	60
4.3 Materials and methods	61
4.4 Sample collection and analyses	62
4.5 Pasture composition and quality.....	63
4.6 Pasture yield	64
4.7 Pasture intake	66
4.8 Chemical composition of the starch and non-starch concentrates.....	66
4.9 Results and discussion of growth study	67
4.9.1 Interactions	68
4.9.2 Main effects: energy source and growth promoter	68
4.9.3 Dressing percentages of heifers.....	71
4.10 Conclusion	72
References.....	72
CHAPTER 5	75

ECONOMICAL EVALUATION OF FINISHING EXPERIMENT; THE SOUTH AFRICAN APPLE INDUSTRY	75
5.1 Introduction	75
5.2 Economical terms used in a beef finishing systems	75
5.3 Methods and results of growth study	76
5.4 Costs and revenue summary of growth study	77
5.5 Overview of apple production in South Africa.....	78
5.6 Total apple production and projection in South Africa.....	79
5.7 Marketing distribution of the South African apple industry	80
5.8 Overview of the apple pulp industry in South Africa.....	81
5.9 Processing of dry apple pulp	82
5.10 Chemical composition of apple pulp for ruminant use.....	82
5.11 Advantages and disadvantages of dried apple pulp as feeding source	83
5.12 Investigation of expansion in the dried apple pulp market	83
5.13 Conclusion	84
References.....	84
CHAPTER 6	87
GENERAL CONCLUSION AND RECOMMENDATION.....	87
CHAPTER 7	89
CRITICAL EVALUATION.....	89
7.1 Pasture.....	89
7.2 Concentrate supplements.....	89

Declaration

By submitting this thesis/dissertation electronically, I declare that the entirety of the work contained therein is my own, original work, that I am the sole author thereof (save to the extent explicitly otherwise stated), that reproduction and publication thereof by Stellenbosch University will not infringe any third rights and that I have not previously in its entirety or in part submitted it for obtaining any qualifications.

Date: December 2015

Abstract

Title: The effect of supplements containing different protein and energy sources and essential oils on the performance of pasture finished heifers.

Name: M.N. Engelbrecht

Supervisor: Prof. C.W. Cruywagen¹

Co-Supervisors: Prof. L.C. Hoffman¹ and Dr. W.H. Hoffmann²

Institution: ¹Department of Animal Sciences and ²Department of Agricultural Economics, Stellenbosch University

Degree: MScAgric

Sixty Bonsmara heifers (328 ± 3.9 kg) on planted pastures were used to evaluate the effect of two energy sources and three growth promoters on body weight gain. Two supplementary feeds with dried apple pulp (A) or maize (M) as main energy source were formulated on an iso-nutrient base. One of three different growth promoters was included in each energy supplement: placebo (no growth promoter, designated as Treatments Ap and Mp), ionophore (monensin, designated as Treatments Am and Mm) and essential oil extract (from oregano, designated as Treatments Ao and Mo). A fixed amount of the supplements was offered to the six treatment groups in a growth/finishing study on cultivated grass-legume pastures.

Animals were stratified according to initial weight in ten blocks and treatments were assigned randomly to animals in each block. The 66 day growth study was conducted during spring (September to November, 2014) in the Western Cape Province of South Africa near Greyton. The cultivated pastures consisted of a perennial grass-legume mixture. A rotation grazing system was applied and animals were moved to new paddocks once a week. Based on falling plate meter readings, the heifers consumed a calculated mean amount of 4.48 ± 0.08 (SEM) kg DM/day over the entire experimental period. A fixed amount of 4 kg ("as is" basis) of the respective supplements were offered daily during the first 42 days, followed by 5 kg/day from 43 days until the end of the study (66 days). Animals were weighed bi-weekly and average daily gain (ADG) was calculated.

The mean ADG of the six treatment groups was 1.44 kg/day. No interactions occurred between the energy sources and growth promoters used in the concentrates and main effects were thus interpreted. The supplements that contained apple pulp as energy source resulted in a higher ($P < 0.02$) ADG (1.54 kg/day) than the maize containing supplements (1.33 kg/day). There were no differences between any of the growth promoters, with the placebo resulting in similar growth rates than monensin and oregano oil extract. Mean ADG values (kg/day) of the different growth promoter treatments were 1.44 (placebo), 1.49 (monensin) and 1.38 (oregano). All the heifers were slaughtered at the end of the trial. Carcass weight and dressing percentage did not differ between energy sources or growth promoters. The mean dressing percentage was 52.5%.

The mean income over feeding cost for the 66 day period of the three maize energy source treatments was R254.20/heifer, while that of the apple pulp treatments was R524.75/heifer. According to this study, concentrate supplements containing apple pulp as main energy source were economically more desirable than those containing maize as primary energy source.

Uittreksel

Titel:	Die invloed van suplemente wat verskillende proteïen- en energiebronne, asook essensiële olies bevat, op die prestasie van vleisbeesverse wat op aangeplante weidings afgerond word.
Naam:	M.N. Engelbrecht
Studieleier:	Prof. C.W. Cruywagen ¹
Mede-studieleiers:	Prof. L.C. Hoffman ¹ en Dr. W.H. Hoffmann ²
Instansie:	¹ Departement Veekundige Wetenskappe en ² Departement Landbou-ekonomie, Universiteit van Stellenbosch
Graad:	MScAgric

Sestig Bonsmaraverse (328 ± 3.9 kg) op aangeplante weiding is gebruik om die invloed van twee energiebronne en drie groeibevorderaars op massatoename te ondersoek. Twee suplemente met gedroogde appelpulp (A) of mielies (M) as hoofenergiebron is op 'n isonutriëntbasis geformuleer. Een van drie groeibevorderaars is in elk van die energiesupplemente ingesluit: placebo (geen groeibevorderaar, aangedui as Behandelings Ap en Mp), 'n ionofoor (monensin, aangedui as Behandelings Am en Mm) en 'n essensiële olie-ekstrak (van oreganum, aangedui as Behandelings Ao en Mo). 'n Vasgestelde hoeveelheid van die suplemente is aan elk van die ses groepe in 'n groei/afrondingsproef op aangeplante weidings aangebied.

Diere is volgens aanvangsmassa in tien bloke gestratifiseer en behandelings is ewekansig aan diere in elke blok toegeken. Die 66-dae groeistudie is gedurende die lente (September tot November) in die Wes-Kaapprovinsie van Suid-Afrika naby Greyton uitgevoer. Die weidings het uit 'n meerjarige gras-klawermengsel bestaan. 'n Rotasiebeweidingsstelsel is gevolg en diere is weekliks na nuwe kampies verskuif. Volgens die lesings van 'n valplaatmeter het die verse 'n gemiddelde weidingsinname van 4.48 ± 0.08 (SEM) kg DM/dag getoon. 'n Vasgestelde hoeveelheid van 4 kg (lugdroë basis) van die onderskeie suplemente is daaglik gedurende die eerste 42 dae van die proef aangebied, gevolg deur 5 kg/dag vanaf 43 dae tot aan die einde van die proef (66 dae). Diere is tweewekliks geweeg en die gemiddelde daaglikse toename is (GDT) bereken.

Die gemiddelde GDT van die ses behandelingsgroepe was 1.44 kg/dag. Geen interaksies tussen die energiebronne en groeibevorderaars is waargeneem nie en hoofeffekte is gevolglik geïnterpreteer. Die suplemente wat appelpulp as energiebron bevat het, het tot 'n hoër ($P < 0.02$) GDT (1.54 kg/day) gelei as die mieliebevattende suplemente (1.33 kg/dag). Daar was geen verskille tussen enige van die groeibevorderaars nie met die placebo wat soortgelyke resultate as monensin en oreganum olie-ekstrak gelewer het. Gemiddelde GDT waardes (kg/dag) van die onderskeie groeibevorderaars was 1.44 (placebo), 1.49 (monensin) en 1.38 (oreganum). Al die verse is teen die einde van die proef geslag. Karkasmassa en uitslagpersentasie het nie tussen energiebronne of groeibevorderaars verskil nie. Die gemiddelde uitslagpersentasie was 52.5%.

Die gemiddelde wins bo voerkoste van die drie energiebronsupplemente was R254.20/vers, terwyl dié van appelpulpbehandelings R524.75/vers was. Volgens hierdie studie was die suplemente wat appelpulp as hoofenergiebron bevat het, meer winsgewend as dié wat mielies as hoofenergiebron bevat het.