



UNIVERSITI PUTRA MALAYSIA

***EFFECTS OF FEEDING RAW AND TREATED MESKIT [*Prosopis juliflora*
(SW.) DC.] PODS TO OMANI SHEEP***

SAID SHANNAN ALI AL-KHALASI

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By

SAID SHANNAN ALI AL-KHALASI

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in
Fulfillment of the Requirements for the Degree of Doctor of Philosophy**

December 2017



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My dedication

To my mother, father, wife and sons



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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

EFFECTS OF FEEDING RAW AND TREATED MESKIT [*Prosopis juliflora* (SW.) DC.] PODS TO OMANI SHEEP

By

SAID SHANNAN ALI AL KHALASI

December 2017

Chair : Halimatun Bt Yaakub, PhD
Faculty : Agriculture

Inclusion of soaked or roasted Meskit pods at high level in concentrate diets for sheep to improve feed intake and reduce production cost has not been studied. The novelty of this study was to evaluate the effect of incorporating soaked or roasted Meskit pods at 50% level in formulated concentrates on digestibility, cost of production, performance, health status and carcass and meat quality of Omani sheep. A locally developed roasting machine was used to roast the Meskit pods at 150 °C for 30 minutes, and tap water was used in soaking the Meskit pods for 24 hours. Formulation of the Meskit pod concentrates was done using, 500 g/kg ground Meskit pods, 240 g/kg wheat bran, 200 g/kg barley, 50 g/kg dried sardine and 10 g/kg of salt. All feeds were evaluated using *in vitro* gas production method. Four groups of intact male Omani sheep at age of 10 months-old with an average of initial weights of 27.43 ± 2.47 kg were used in feeding trial. Each group comprising of six sheep was allocated to receive either 500g/day of commercial concentrate (Oman Feed Mills) or one of the formulated Meskit pods based concentrates; commercial concentrate (CC); roasted Meskit pods based concentrate (ROMPC); raw Meskit pods based concentrate (RMPC) or soaked Meskit pods based concentrate (SMPC). All sheep were allowed free access to Rhodes grass hay and water. Daily feed intakes and bi-weekly body weights were recorded for 84 days. Later, a total of 12 sheep (3 animals per diet) underwent a digestibility experiment comprising of 10 adaptation days and 10 days for sample collection. Blood samples were collected three times during the experimental period, day one, day 42nd and on the last day of the experiment (day 84). At the end of the experiment, the sheep were slaughtered to evaluate carcass and meat quality. The collected blood samples were analysed for hematological and serum biochemistry levels, liver and kidney samples for histopathology to determine the health status of the animals.

The outcome of the analysis revealed a higher CP in RMPC (14.69%) and had higher ADF and NDF in ROMPC (18.28% and 34.74%, respectively) in comparison to the rest of Meskit pods based concentrates. The RMPC indicated higher condensed tannin (2.18%) and saponin (4.12%) in comparison to other Meskit pods based concentrates whereas CC

revealed non-detectable tannin. *In vitro* gas production results showed that raw pods (0.087 ml/h) had the lowest gas production compared to treated Meskit pods. There were no signs of illness and microscopic results of kidney and livers samples of sheep did not show any abnormalities. There were no considerable variations of digestibility coefficients of all aspects, and rumen condition had no diets effect with an exception of increased acetic acid in ROMPC group. Roasting of Meskit pods significantly increased feed intake and body weight gain by sheep as compared to use of raw or soaked Meskit pods and were comparable to those fed CC. The carcass characteristics and meat quality indicated no significant differences with an exception that sheep fed with ROMPC and CC had increased carcass weights, and ROMPC fed animals had carcass with higher expressed juice. The use of ROMPC for sheep significantly maximized the profit of the feedlot operation. This study indicated that raw and treated Meskit pods could be used at level of 50% in concentrates for feeding Omani sheep without adverse impacts on health, digestibility, performance or carcass and meat quality and roasting the Meskit pods is highly recommended as a strategy to improve the feed intake and growth rate of Omani sheep and might be an alternative feed compared to the highly priced commercial concentrate.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

KESAN PEMAKANAN POD MESKIT [*Prosopis juliflora* (SW.) DC.] MENTAH DAN DIRAWAT PADA BIRI-BIRI OMANI

Oleh

SAID SHANNAN ALI AL KHALASI

Disember 2017

Pengerusi : Halimatun Bt Yaakub, PhD
Fakulti : Pertanian

Penggunaan pod Meskit yang direndam atau dipanggang pada tahap tinggi dalam diet untuk biri-biri bagi meningkatkan pengambilan makanan dan mengurangkan kos pengeluaran masih belum dikaji. Keberkesanan kajian ini adalah untuk menilai kesan menggabungkan pod meskit yang direndam atau dipanggang pada tahap 50% dalam formula yang dirumuskan pada pencernaan, kos pengeluaran, prestasi, status kesihatan, karkas dan kualiti daging biri-biri Oman. Mesin pemanggang tempatan yang direka telah digunakan untuk memanggang pod Meskit pada suhu 150 °C selama 30 minit, dan air paip digunakan untuk merendam pod Meskit selama 24 jam. Perumusan pod Meskit konsentrat dilakukan dengan menggunakan 500 g/kg pod Meskit kisar, 240 g/kg bran gandum, 200 g/kg barli, 50 g/kg sardin kering dan 10 g/kg garam. Semua makanan telah dinilai menggunakan kaedah penghasilan gas *in vitro*. Empat kumpulan biri-biri jantan Omani berumur 10 bulan dengan purata berat awal adalah 27.43 ± 2.47 kg digunakan dalam kajian pemakanan. Setiap kumpulan yang terdiri daripada enam biri-biri diperuntukkan untuk menerima sama ada 500g / hari konsentrat komersial (Oman Feed Mills) atau salah satu daripada konsentrat yang dirumuskan berasaskan pod Meskit; konsentrat komersil (CC); konsentrat yang berasaskan pod Meskit yang dipanggang (ROMPC); konsentrat berasaskan Meskit pod mentah (RMPC) atau konsentrat berasaskan Meskit pod yang direndam (SMPC). Semua biri-biri dibenarkan akses kepada rumput kering Rhodes dan air pada setiap masa. Pengambilan makanan setiap hari dan berat badan setiap dua minggu telah direkodkan selama 84 hari. Kemudian, sebanyak 12 biri (3 ekor haiwan setiap diet) menjalani kajian pencernaan yang terdiri daripada 10 hari adaptasi dan 10 hari pengumpulan sampel. Sampel darah telah diambil sebanyak tiga kali semasa tempoh kajian, pada hari pertama, hari 42 dan hari terakhir kajian (hari 84). Di akhir kajian, biri-biri telah disembelih untuk dinilai kualiti karkas dan daging. Sampel darah telah dianalisis untuk hematologi darah, tahap biokimia serum, dan sampel hati dan buah pinggang untuk histopatologi bagi menentukan status kesihatan haiwan.

Keputusan analisis mendedahkan CP yang lebih tinggi dalam RMPC (14.69%) dan mempunyai lebih tinggi ADF dan NDF dalam ROMPC (18.28% dan 34.74%, respectively) berbanding dengan konsentrat yang berasaskan pod Meskit yang lain. RMPC mempunyai kandungan tannin kondens (2.18%) dan saponin (4.12%) yang lebih tinggi berbanding dengan konsentrat yang berasaskan pod Meskit yang lain, walaubagaimanapun CC kandungan tanin yang tidak dapat dikesan. Keputusan pengeluaran gas *in vitro* menunjukkan bahawa RMPC (0.087 ml/hr) mempunyai pengeluaran gas terendah berbanding dengan pod Meskit terawat. Tidak ada tanda penyakit dan hasil keputusan mikroskopik sampel buah pinggang dan hati biri-biri tidak memperlihatkan sebarang keabnormalan. Tidak terdapat banyak variasi koefisien pencernaan dari semua aspek, dan keadaan rumen tidak menunjukkan kesan diet dengan pengecualian terdapat peningkatan asid asetik kumpulan ROMPC. Pemangangan pod Meskit meningkatkan pengambilan makanan dan meningkatkan berat badan biri-biri yang signifikan berbanding dengan pod Meskit yang mentah atau direndam dan setanding dengan biri-biri yang diberi makan CC. Ciri-ciri karkas dan kualiti daging tidak menunjukkan perbezaan yang signifikan ($p>0.05$) dengan pengecualian bahawa biri-biri yang diberi makan dengan ROMPC dan CC telah meningkatkan berat karkas, dan haiwan ROMPC yang diberi makanan mempunyai karkas berjus yang lebih tinggi. Penggunaan ROMPC untuk biri-biri dapat memaksimumkan keuntungan operasi feedlot yang signifikan. Kajian ini menunjukkan bahawa pod Meskit mentah dan terawat boleh digunakan pada tahap 50% dalam konsentrat untuk pemakanan biri-biri Omani tanpa memberi kesan buruk terhadap kesihatan, pencernaan, prestasi atau karkas dan kualiti daging dan pemangangan pod Meskit sangat disarankan sebagai strategi untuk memperbaiki pengambilan makanan dan kadar pertumbuhan biri-biri Omani dan mungkin menjadi makanan alternatif berbanding dengan konsentrat komersil yang tinggi harganya.

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I certify that a Thesis Examination Committee has met on (4 December 2017) to conduct the final examination of (SAID SHANNAN ALI AL KHALASI) on his thesis entitled "EFFECTS OF FEEDING RAW AND TREATED MESKIT [Prosopis juliflora (SW.) DC.] PODS TO OMANI SHEEP" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U. (A) 106] 15 March 1998. The Committee recommends that the student be awarded the Doctor of Philosophy.

Members of the Thesis Examination Committee were as follows:

Jothi Malar Panandam, PhD

Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Chairman)

Awis Qurni Sazili, PhD

Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Internal Examiner)

Liang Juan Boo, PhD

Research Fellow
Institute of Tropical Agriculture and Food Security
Universiti Putra Malaysia
(Internal Examiner)

Reza Valizadeh, PhD

Professor
Faculty of Agriculture
Ferdowsi University of Mashhad
Iran
(External Examiner)

NOR AINI AB. SHUKOR, PhD

Professor and Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 28 March 2018

This thesis was submitted to the Senate of Universiti Putra Malaysia and has accepted as fulfillment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

Halimatun Bt Yaakub, PhD

Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Chairman)

Abdul Razak Bin Alimon

Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Member)

Anjas Asmara @ Ab. Hadi Bin Samsudin

Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Member)

Osman Mahgoub Gaafar

Professor
College of Agricultural and Marine Sciences
Sultan Qaboos University
(Member)

ROBIAH BINTI YUNUS, PhD

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Signature: _____
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Committee: Dr. Halimatun Bt Yaakub

Signature: _____
Name of Member
of Supervisory
Committee: Prof. Abdul Razak Bin Alimon

Signature: _____
Name of Member
of Supervisory
Committee: Dr. Anjas Asmara Samsudin

Signature: _____
Name of Member
of Supervisory
Committee: Prof. Osman Mahgoub Gaafar

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LIST OF ABBREVIATIONS

| | |
|-------|---|
| ADF | Acid detergent fiber |
| ALB | Albumin |
| ALT | Alanin amino transeferase |
| ANF | Antinutritional factors |
| AST | Aspartate aminotransferase |
| AVS | Animal and Veterinary Science |
| BUN | Blood urea nitrogen |
| BWG | Body weight gain |
| Ca | Calcium |
| CAMS | Central Agricultural and Marine Science |
| CC | Commerical concentrate |
| CF | Crude fiber |
| CK | Creatine |
| CON | Concentrate |
| CP | Crude protien |
| CR-S | Creatinine |
| DCT | Distal convoluted tubule |
| DM | Dry matter |
| DMI | Dry matter intake |
| EBW | Empty body weight |
| EE | Ether extract |
| GE | Gross energy |
| GGT | Gamma-glutamyltransferase |
| GLU | Glucose |
| GP | Gas production |
| Gv | Gas volum |
| HCL | Sulphuric acid |
| IVOMD | In vitro organic matter digestibility |
| K | Potassium |
| KCL | Potassium chloride |
| LD | Longissimus dorsi |
| MAF | Ministry of Agriculture and Fisheries, Oman |
| MCH | Mean corpuscular hemoglobin |
| MCHC | Mean corpuscular hemoglobin concentration |
| MCV | Mean corpuscular voluml |
| ME | Metabolizable energy |
| Mg | Magnissum |
| NDF | Neutral detergent fiber |
| NEg | Net energy for gain |
| NFE | Nitrogen free extract |
| NS | Non significant |
| OMD | Organic matter digestibility |
| OMR | Omani rial currency |
| P | Phosphours |
| PCT | Proximal convoluted tubule |
| PO4 | Phosphours |
| RGH | Rhodes grass hay |
| ROMPC | Roasted Meskit pods concentrate |

| | |
|------|--------------------------------|
| SCFA | Short chain fatty acids |
| SEM | Standard error of means |
| SMPC | Soaked Meskit pods concentrate |
| Sp | Saponin |
| CT | Extractable condensed tanins |
| TG | Triglycerides |
| SP | Serum protein |
| TP | Total protein |
| VFA | Volatile fatty acids |



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CHAPTER 1

INTRODUCTION

1.1 Study background

Livestock production is an important practice in Oman as it has been an essential component of Omani culture and economics for centuries. Animals in Oman are mostly raised under traditional systems based on grazing range plants plus some supplementation. The Sultanate of Oman has a total population of livestock (sheep, goats, cattle and camels) of 3,045,777 heads in 2013 according to the last agricultural statistical survey with 358,231 of them are sheep (MAF, 2013). Most sheep are found in Al-Batinah region, where they are kept for meat and milk. They are well adapted to harsh, semi-arid environment and have marked resistance to disease.

The shortage of fresh water in arid regions, such as Oman, is a major limiting factor to livestock production as it results in high costs of forage and other feedstuffs. A supply of protein and energy for animal production is needed. However, commercial concentrates are highly priced. Therefore, replacing commercial concentrate for Omani ruminant feeding would reduce feeding cost and increasing profitable revenue for livestock farmers.

Trees and shrubs have provided leaves, flowers, seeds, and tender twigs as an important source of wildlife and livestock feed. In many dry and semi-arid lands, this component is sometimes the only source of forage for these animals. Le Houérou (1984) studied that approximately one-third of the world's land surface is a natural grazing land and to varying degrees the shrub-tree component is a significant source of animal feed.

Browsing is important for animal feeding in arid regions such as Oman. The browsed materials consumed by livestock include leaves, fruits, seeds, pods, twigs, and sometimes bark. In Oman, various tree species with an abundance of browse such as *Acacia spp.*, *Prosopis spp.*, *Tamarind*, etc. are available. Meskit (*Prosopis juliflora*) tree may be a promising tree/shrub in the arid and semi-arid areas such as Oman, which are characterized by low rainfall (<100mm).

One of the problems encountered with feeding Meskit pods is the low level of feed intake by various livestock species. If fed in crude form, seeds will not be fully digested and subsequently released in feces. Also, the unpalatable taste of pods and high level of anti-nutritional compounds, such as tannin and saponin, contribute to the low feed intake. In Oman, sheep fed diet containing up to 20 % pods improved feed intake, feed conversion and body weight gain without adverse effect on carcass yield or quality. However, feed intake and body weight gain dropped sharply when pods were included at 30 % (Mahgoub et al., 2005a). Similarly Ravikala et al. (1995) cited lower growth rate in lambs fed on 30% Meskit pods diet. Physical treatment of pods through crushing or grinding would reduce the selection of other ingredients by the animals and increase the efficiency of digestion.

Processing of the pods to remove factors affecting palatability and anti-nutritional effects would help in improve feed intake by the animals. This may include washing with water to remove water soluble factors or roasting to improve the taste of the pods. It may also include grinding and pelleting with other ingredients. Several studies have shown the potential of using low level of Meskit pods as animal feed but incorporating of soaked or roasted Meskit pods at high proportions in diets to improve feed intake and reduce production cost has not been studied. In this way, the novelty of this study is to evaluate the effect of inclusion of soaked or roasted Meskit pods at 50% on feed intake, digestibility, performance, health , carcass and meat quality of Omani sheep.

1.2 General objective

The general objective of this study was to find alternative concentrate to be used as animal feed to reduce production cost and increase local farmer's revenue by investigating the effects of feeding raw and treated Meskit pods based concentrates compared to commercial concentrate on Omani sheep production and health.

1.3 Specific objectives

The aims of the current study were to:

- i) Determine the nutritive value of raw and treated Meskit pods as sheep feed.
- ii) Evaluate the *in vitro* gas production of raw and treated Meskit pods and *in vivo* digestibility of Omani sheep fed raw or treated Meskit pods based concentrates.
- iii) Evaluate the performance and cost benefit of Omani sheep fed on Meskit Pods based concentrates.
- iv) Investigate the health status of Omani sheep fed Meskit pods based concentrates.
- v) Evaluate the carcass and meat quality of sheep fed on Meskit pods based concentrates.

1.4 Hypothesis

The hypothesis of the current study was that there were no differences of feeding raw or treated Meskit pods based concentrates compared to commercial concentrate on performance, health status, carcass characteristics and meat quality of Omani sheep.

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