UNIVERSITI PUTRA MALAYSIA

FATTY ACID PROFILE AND LIPID OXIDATION OF *LONGISSIMUS THORACIS* AND *BICEPS FEMORIS* MUSCLES IN GOATS

MADIHAH ISMAIL

FP 2015 186

FATTY ACID PROFILE AND LIPID OXIDATION OF *LONGISSIMUS THORACIS* AND *BICEPS FEMORIS* MUSCLES IN GOATS

MADIHAH BINTI ISMAIL

FACULTY OF AGRICULTURE
UNIVERSITI PUTRA MALAYSIA
SERDANG, SELANGOR DARUL EHSAN
2014/2015

FATTY ACID PROFILE AND LIPID OXIDATION OF *LONGISSIMUS THORACIS* AND *BICEPS FEMORIS* MUSCLES IN GOATS

BY

MADIHAH BINTI ISMAIL

162837

A project report submitted to
Faculty of Agriculture, Universiti Putra Malaysia
in fulfilment of the requirement of SHW 4999 (Final Year Project)
for the award of the degree of
Bachelor of Agriculture (Animal Science)

FACULTY OF AGRICULTURE
UNIVERSITI PUTRA MALAYSIA
SERDANG, SELANGOR DARUL EHSAN
2014/2015

CERTIFICATION

This project report entitled “Fatty Acid Profile and Lipid Oxidation of *Longissimus thoracis* and *Biceps femoris* Muscles in Goats” is prepared by Madihah binti Ismail and submitted to Faculty of Agriculture in fulfilment of the requirement of the course SHW 4999 (Final Year Project) for the award of the degree of Bachelor Agriculture (Animal Science).

Student’s name: Student’s signature

Madihah binti Ismail _____

162837

Certified by:

_____

Dr. Awis Qurni bin Sazili

Project Supervisor

Department of Animal Science

Faculty of Agriculture

Universiti Putra Malaysia

Serdang Selangor

Date : _____

ACKNOWLEDGEMENT

With the name of Allah, the Beneficent, the Merciful.

Sincere thanks and gratitude to God for being a faithful partner to me throughout the up and down of my life. I wish to express my deepest appreciation to my parents because without their support and instinctive love I could not become as what I am today.

Foremost, a special thanks to my beloved supervisor, Dr. Awis Qurni bin Sazili who has given me the opportunity to conduct this study and for the patience, encouragement and understanding he had given to complete this study.

I would like also to convey my warm thanks to Mr. Kazeem, Mr. Azad, Ms. Atikah, Ms. Aimi and all my fellow friends for providing many helpful suggestions throughout my studies. Last but not least, my special gratitude to all staff of Meat Science Laboratory in Department of Animal Science, which had generously provide me the precious knowledge and experience to work with ease and comfort that shall become valuable in the future.

Thank you very much.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ABBREVIATIONS

kg	kilogram
g	gram
ºC	degree celcius
ml	milli litre
min	minute
FAMEs	fatty acid methyl esters
GC	gas chromatography
SD	standard deviation
BF	*Biceps femoris*
LT	*Longissimus thoracis*
SFA	saturated fatty acids
UFA	unsaturated fatty acids
MUFA	monounsaturated fatty acids
PUFA	polyunsaturated fatty acids
PUFA : SFA	polyunsaturated : saturated fatty acid ratio

LIST OF FATTY ACIDS

Code	Common name
C14:0	Myristic
C14:1	Myristoleic
C15:0	Pentadecanoic
C16:0	Palmitic
C16:1	Palmitoleic
C18:0	Stearic
C18:1n-9	Oleic
C18:1, Trans-11	Transvaccenic
C18:2n-6	Linoleic
CLAC9T11	Clanine
CLAT10C12	Clatwelve
C18:3n-3	Linolenic
C20:4n-6	Arachidonic
C20:5n-3	Eicosapentanoic
C22:5n-3	Decosapentanoic
C22:6n-3	Decosahexanoic

Definitions of following terms as used in the thesis:

Oxidation : an energy releasing process. When carbohydrates, fat or protein are together with oxygen, it produce ATP in the mitochondria. The oxidation of fatty acids more specifically calls β-oxidation.

Lipid peroxidation : is a process of free radical. When lipid are oxidized without release energy, starting with a reactive species that abstract a hydrogen atom from the fatty acids

ABSTRACT

A scientific research on the relationship between obesity and their related diseases and diet has been emerged. One of the factors is overconsumption of the red meats such as pork and beef. In addition to the fat content of muscle and adipose depots, the fatty acid composition of lipids affects meat quality. Furthermore, relevant reports are difficult to use for comparisons, in that samples were collected from muscles and fat depots at various anatomical locations and experiments entailed different objectives, designs and methodologies. The general purpose of this study was to identify the fatty acid composition and oxidative stability within 7 days postmortem in *Longissimus thoracis* and *Biceps femoris* muscles in goats. In this study, a total of 8 Boer goats of 4-5 months old, having body weight of 30.54±0.47 kg were sourced from a commercial goat farm. After evisceration and dressing, the carcasses were split in two. The *Longissimus thoracis* and *Biceps femoris* muscles were taken from one side of the carcasses. The samples were divided into two parts, one for lipid oxidation and another one for fatty acid analysis. Samples for fatty acid analysis were snap frozen in liquid nitrogen and kept at -80ºC while lipid oxidation samples were placed in the refrigerator (4ºC) and the oxidative stability monitored for 0, 1, 4 and 7 day post-mortem. The major differences in fatty acid composition between the two muscles were that proportion of C18:2n-6 and C20:5n-3 was significantly higher in BF compared with LT. The proportion of C14:0 and C14:1 was numerically higher in LT muscle than the BF. Contrarily, the proportion of C20:4n-6 tended (p=0.07) to be higher in BF muscle compared with LT. There was no

significant difference between the muscles in the proportion of major fatty acids such as C16:0, C18:0 and C18:1n-9. However, the proportion of C18:1n-9 and CLA cis-12 *trans*-10 was numerically higher in LT than BF. The total n-6 fatty acids was significantly ($p<0.05$) higher in the BF than LT. The lipid stability of both muscles was shown in The TBARS values. The TBARS value of LT and BF did not differ on 0, 1, 4 and 7 day post-mortem. Regardless of muscle, TBARS value increased as post-mortem storage progressed. The TBARS value on day 0 and 1 was not significantly different but was different from those observed on days 4 and 7.

ABSTRAK

Satu penyelidikan saintifik ke atas hubungan antara obesiti dan penyakit yang berkaitan serta diet telah muncul. Salah satu faktor adalah pengambilan daging merah yang berlebihan seperti daging babi dan daging lembu. Selain kandungan lemak dan depot adipos otot, komposisi asid lemak lipid menjejaskan kualiti daging. Tambahan pula, laporan yang berkaitan adalah sukar untuk digunakan untuk perbandingan, dalam sampel yang dikumpulkan dari otot dan depot lemak di pelbagai lokasi anatomi dan eksperimen melibatkan objektif yang berbeza, reka bentuk dan metodologi. Tujuan umum kajian ini adalah untuk mengenal pasti komposisi asid lemak dan kestabilan oksidatif dalam tempoh 7 hari selepas penyembelihan bagi *Longissimus thoracis* dan *Biceps femoris* pada otot kambing. Dalam kajian ini, sebanyak 8 ekor kambing Boer berumur 4-5 bulan yang mempunyai berat badan 30.54 ± 0.47 kg diperoleh dari ladang kambing komersial digunakan. Selepas pembuangan organ dalaman dan kulit, karkas telah dibahagikan kepada dua. Otot *Longissimus thoracis* dan *Biceps femoris* telah diambil dari satu bahagian karkas. Sampel dibahagikan kepada dua bahagian, satu bahagian untuk melihat pengoksidaan lipid dan bahagian kedua untuk analisis asid lemak. Sampel untuk analisis asid lemak telah dibekukan dalam nitrogen cair dan disimpan di -80^{o}C manakala sampel pengoksidaan lipid telah diletakkan di dalam peti sejuk (4^{o}C) dan kestabilan oksidatif yang dipantau untuk 0, 1, 4 dan 7 hari penyembelihan. Perbezaan utama dalam komposisi asid lemak antara kedua-dua otot adalah bahawa sebahagian

daripada C18: 2n-6 dan C20: 5n-3 adalah lebih tinggi dalam otot BF berbanding LT. Peratusan C14:0 dan C14:1 adalah lebih tinggi nilainya dalam otot LT daripada BF. Sebaliknya, C20: 4n-6 cenderung ($p=0.07$) lebih tinggi dalam otot BF berbanding LT. Tidak terdapat perbezaan yang signifikasi di antara otot-otot di bahagian asid lemak utama seperti C16:0, C18:0 dan C18:1n-9. Walau bagaimanapun, nisbah C18:1n-9 dan CLA cis-12 *trans*-10 adalah lebih tinggi nilainya dalam LT berbanding BF. Jumlah asid lemak n-6 nyata ($p<0.05$) lebih tinggi dalam BF berbanding LT. Kestabilan lipid kedua-dua otot telah ditunjukkan dalam nilai TBARS. Nilai TBARS pada LT dan BF tidak berbeza pada 0, 1, 4 dan 7 hari penyembelihan. Nilai TBARS meningkat pada kedua-dua otot. Perbezaan nilai TBARS pada hari 0 dan 1 tidak ketara tetapi berbeza pada hari 4 dan 7 penyembelihan.

CHAPTER 1

INTRODUCTION

Goat meat or chevon is a popular food throughout the world, with greatest production and consumption in Asia and Africa (Devendra and Owen, 1983; Kirton, 1988). It has been classified as red meat, where it is leaner and contains less cholesterol and fat content. Chevon is the most important and preferable product of a goat where it said as healthiest red meat among the other meat such as lamb, mutton and poultry. Dietary saturated fat has been an important issue of health because of its relationship with the incident of atherosclerosis and heart attack. Its attributes are concordant with present day consumer demands for leaner and nutritious meat, and hence should be the basis for promoting the meat (Cassey and Simela, 2005).

In general, red meats like beef, pork and lamb have more cholesterol and saturated (bad) fat than chicken and fish. Saturated fat can raise our blood cholesterol and make heart disease worse. The unsaturated fats in fish, such as salmon, actually have health benefits. Omega-3 fatty acids may reduce the risk of cardiovascular disease. It has been documented that fatty acid profile varies with muscle (Wood *et al.,* 2008). In addition, muscle with different fatty acid compositions may vary in their level of oxidation (Decker *et al.,* 1998). It had been reported that there were variations in fatty acids composition in different muscles of goats (Park and Washington, 1993).

The fatty acid profile can be influenced by various factors like effects of animal species, muscle fibre type, and muscle fat content. Furthermore, fatty acid profile within the muscles affects meat quality. Physical and chemical properties of lipids affect eating and keeping qualities of meat. Meat flavour is influenced by fatty acid composition (Melton, 1990). Saturated fatty acids increase hardness of fat and being easily solidified upon cooling influence meat palatability. On the other hand, unsaturated fatty acids have potential in increasing the lipid oxidation which influences shelf life. Park *et al.* (1991) quantified moisture, total fat and cholesterol content in the liver, kidney, heart, *Longissimus dorsi* and *Biceps femoris* muscles of two goat breeds. Subsequently, Park and Washington (1993) quantified fatty acid in certain organ and muscles of Alpine and Nubian goats.

Little is known about the fatty acid composition of goat meat. In only a few investigations (Sauvant *et al.,* 1979; Nitsan *et al.,* 1987; Potchoiba *et al.,* 1990; Park and Washington, 1993; Johnson *et al*., 1995; Matsuoka *et al.,* 1997) has the fatty acid composition of lipids in some goat muscles been studied. Moreover, the fatty acid composition of some fat depots in goats is limited number of publication (Duncan *et al.,* 1976; Sauvant *et al.,* 1979; Bas *et al*., 1982, 1987, 1992, 1996; Casey and van Niekerk, 1985; Gaili and Ali, 1985; Muller *et al.,* 1985; Nitsan et al., 1987; Manfredini *et al.,* 1988; Potchoiba *et al.,* 1990; Zygoyiannis *et al.,* 1992; Rojas *et al.,* 1994; Hamminga *et al*., 1996).

1.1 Research Problems

Substantial information on fatty acid composition of various muscles in sheep, cattle and pork is available. However, information on variation in muscle fatty acid composition of goat meat is limited. In addition, there is dearth of information on how muscle fatty acid would affect oxidative stability of various muscles in goats.

1.2 Research Hypothesis

Different muscles have different fatty acids profile. The lipid oxidation is influenced by the fatty acid content within the muscle.

1.3 Significance of the Study

The current study would elucidate differences in fatty acid composition and oxidative stability of different muscles in goats.

1.4 Objectives

The general objective of this study was:

To identify the fatty acid composition and oxidative stability in *Longissimus thoracis* and *Biceps femoris* muscles in goats.

The specifics objectives of this study were:

1. To determine the effects of *Longissimus thoracis* and *Biceps femoris* muscles in goats on fatty acid composition.
2. To determine the effects of *Longissimus thoracis* and *Biceps femoris* muscles in goats on oxidative stability.

REFERENCES

Aghwan, Z. A., Alimon, A. R., Goh, Y. M., Nakyinsige, K. and Sazili, A. Q. (2014). Fatty acid profiles of *Supraspinatus, Longissimus lumborum* and *Semitendinosus* muscles and serum in Kacang goats supplemented with inorganic selenium and iodine. *Asian Australas. Journal Animal Science.* 27 : 543 – 550

Banskalievaa, V., Sahlub, T. and Goetschc, A. L. (2000). Fatty acid composition of goat muscles and fat depots: A review. *Small Ruminant Research.* 37 : 255-268

Beserra, F. J., Madrugab, M. S., Leite, A. M., Silva, E. M. C. and Maiaa, E. L. (2004). Effect of age at slaughter on chemical composition of meat from moxotó goats and their crosses. *Small Ruminant Research.* 55 : 177 – 181

Bonanome, A. and Grundy, S.M. (1988). Effect of dietary stearic acid on plasma cholesterol and lipoprotein levels. *New England Journal Medison*. 318 : 1244 –1247.

Dhanda, J. S., Taylor, D. G., Murray, P. J. and McCosker, J. E. (1999). The influence of goat genotype on the production of Capretto and Chevon carcasses. 4. Chemical composition of muscle and fatty acid profiles of adipose tissue. *Meat Science*. 52 : 375 – 379

Duncan, W. R. H. and Garton, G. A. (1967). The fatty acid composition and intramuscular structure of triglycerides derived from different sites in the body of the sheep. *Journal of the Science of Food and Agriculture*. 18 : 99 – 102.

Elmore, J. S., Mottram, D. S., Enser, M. and Wood, J. D. (1999). Effect of the polyunsaturated fatty acid composition of beef muscle on the profile of aroma volatiles. *Journal Agriculture Food Chemistry*. 47 : 1619 − 1625

Enser, M., Hallett, K., Hewitt, B., Fursey, G. A. J. and Wood, J. D. (1996). Fatty acid content and composition of English beef, lamb and pork at retail. *Meat Science*. 42 :443–456.

Enser, M., Hallett, K. G., Hewitt, B., Fursey, G. A. J. and Wood, J. D. (1996). Fatty acid content and composition of English beef, lamb and pork at retail. *Meat Science*. 42 :443–456.

Enser, M., Hallett, K., Hewitt, B., Fursey, G. A. J. and Wood, J. D. (1995). Fatty acid content and composition of English beef, lamb and pork at retail. *Meat Science*. 42 : 443 – 456

Enser, M., Hallett, K. G., Hewett, B., Fursey, G. A. J., Wood, J. D and Harrington, G. (1997). Fatty acid content and composition of UK beef and lamb muscle in relation to production system and implications for human nutrition. *Meat Science*. 49 : 329 – 341

Faustman, C., Sun, Q., Mancini, R. and Suman, S. P. (2010). Myoglobin and lipid oxidation interactions: Mechanistic bases and control. *Meat Science*. 86 : 86 – 94

Fernindez, J., Perez-harez J. A. and Fernindez-Lopez, J. A. (1996). Thiobarbituric acid test for monitoring lipid oxidation in meat. *Food Chemistry.* 59 : 345 – 353

Gaili, E. S. and Ali, E. A. (1985). Meat from Sudan Dessert sheep and goats. Part 2. Composition of the muscular and fatty tissues. *Meat Science*. 13 : 229 – 236.

Geir K. Totland and Kryvi, H. (1991). Distribution patterns of muscles fibre types in major muscles of the bull (*Bos taurus*). *Anatomy and Embryology.* 184 : 441 – 450

Helge, J. W., Fraser, A. M., Kriketos, A. D., Jenkins, A. D., Calvert, G. D., Ayre, K. K. and Storlien L. H. (1999). Interrelationships between muscle fibre type, substrate oxidation and body fat. *International Journal of Obesity*. 23 : 986 – 991

Kannan, G., Kuakou, B. and Gelaye, S. (2001). Colour changes reflecting myoglobin and lipid oxidation in chevon cuts during refrigerated display. *Small Ruminant Research*. 42 : 67 – 75

Kemp, Y.D., Mahyuddin, M., Ely, J.D., and Woody, W.G. (1981). Effect of feeding systems, slaughter weight and sex on organoleptic properties and fatty acid composition of lambs. *Journal of Animal Science.* 51 : 321 – 330.

Ladikos, D. and Lougovois, V. (1989). Lipid oxidation in muscle foods: A Review. *Food Chemistry*. 35 : 295 – 314

Malekian, F., Khachaturyan, M., Gebrelul, S. and Henson, J. F. (2013). Composition and fatty acid profile of goat meat sausages with added rice bran. *International Journal of Food Science.* 2014 : 1 – 8

Mahgouba, O., Khanb, A. J., Al-Maqbalya, R. S., Al-Sabahib, J. N., Annamalaia, K. and Al-Sakrya, N. M. (2001). Fatty acid composition of muscle and fat tissues of *Omani Jebel Akhdar* goats of different sexes and weights. *Meat Science*. 61 : 381 – 387

Rhee, K.S. (1992). Fatty acids in meats and meat products, Fatty acids in foods and their health implications. *Meat Science*. 2 : 65-93

Rhee, K. S., Waldron, D. F., Ziprin, Y. A. and Rhee, K. C. (1999). Fatty acid composition of goat diets vs intramuscular fat. *Meat Science*. 54 : 313 – 318

Rhee, K. S., Ziprin, Y. A., Ordonez G. and Bohac C. E. (1988). Oxidation in pork muscles as affected by canola oil in the animal diet and muscle location. *Meat Science*. 23 : 201 – 210

Rhee, K. S., Ziprin, Y. A., Ordonez, G. and Bohac, C. E. (1988). Fatty acid profiles and lipid oxidation in beef steer muscles from different anatomical locations. *Meat Science*. 23 : 293 – 301

Sunagawa, K., Kishi, T., Nagai, A., Matsumura, Y., Nagamine, I. and Uechi S. (2014). Goat meat does not cause increased blood pressure. *Animal Science*. 27 : 101 – 114

Webb, E.C. and O'Neill, H. A. (2008). The animal fat paradox and meat quality. *Meat Science*. 80 : 28 – 36

Webb, E. C., Casey, N. H. and Simela, L. (2005). Goat meat quality. *Small Ruminant Research*. 60 : 153 – 166

Wood, J. D., Richardson, R. I., Nute, G. R., Fisher, A. V., Campo, M. M., Kasapidou, E., Sheard, P. R. and Enser. M. (2002). Effects of fatty acids on meat quality: a review. *Meat Science.* 66 : 21 – 32

Wood, J. D., Enser, M., Fisher, A. V., Nute, G. R., Sheard, R.I. Richardson, R. I.,Hughes, S. I. and Whittington, F. M. (2007). Fat deposition, fatty acid composition and meat quality: A review. *Meat Science*. 78 : 343 – 358

Wood, J. D. and Enser M. (1997). Factors influencing fatty acids in meat and the role of antioxidants in improving meat quality. *British Journal of Nutrition*. 78 : 49 – 60