UNIVERSITI TEKNOLOGI MARA

INVESTIGATING THE BIOMECHANICAL PROPERTIES OF FRESH GOAT SKIN, NATURAL DRIED SKIN AND LEATHER

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Thesis submitted in fulfillment
of the requirements for the degree of
Master of Science

Faculty of Mechanical Engineering

May 2015

AUTHOR'S DECLARATION

I declare that the work in this thesis/dissertation was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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ABSTRACT

Natural dried skin and leather which comes from fresh skin has been used for many applications in the automotive sector, furniture, clothes and other industries. However, the biomechanical properties of these materials have not been well established. Therefore, this study attempts to quantify and investigate the parameters of fresh goat skin (Category I), natural dried skin (Category II) and leather (Category III), which also include orthotropic analysis (longitudinal and transverse directions). Uniaxial tensile test (ASTM D2099-00) was conducted to obtain engineering stress-stretch data for all categories. Analytical and numerical approaches were also adapted to quantify the material parameters. Engineering stress-stretch curves for both approaches were fitted to the experiment data by adapting three hyperelastic materials models (i.e. neo-Hookean, Mooney-Rivlin and Ogden). Numerical approach adapting the Ogden model is likely the best hyperelastic material model in representing the parameters of fresh goat skin, natural dried skin and leather. For each category, the Ogden parameters (α and μ) range value were found from 15.154 to 18.344 and from 0.152 MPa to 0.277 MPa (Category I), from 0.675 to 5.652 and from 107.416 MPa to 1185.859 MPa (Category II) from 14.815 to 15.885 and from 1.827 MPa to 4.441 MPa (Category III) respectively. This study also found out that among fresh goat skin, natural dried skin and leather, natural dried skin was the stiffest skin of them all. As a conclusion, the biomechanical properties of fresh goat skin, natural dried skin and leather has been quantified, and thus proving that the objective of the study has been achieved successfully.

ACKNOWLEDGMENT

First and foremost, I would like to express my greatest appreciation and gratitude to my supervisor, Assoc. Prof. Dr. Jamaluddin Mahmud whose guidance, advice and support has enabled this thesis to be completed successfully. He is more than supervisor to me and it has been a wonderful and great experience working with him in such a lively environment.

I would like to thank all my teachers, present and past, for instilling the proper knowledge and attitude in me, which have enabled me to pursue this path.

It was a pleasure to work with my colleagues at the Postgraduate Room; and my friends at the Faculty of Mechanical Engineering. Their supports and ideas in many occasions have helped me to progress.

My thanks also conveyed to the Strength of Material Laboratory team who has provided an excellent technical support and high quality of service, which has contributed to the success of my experimental work.

I am grateful to Institute of Graduate Studies (IPSis) and Faculty of Mechanical Engineering, especially the staff whose help could not be forgotten since the first day I registered.

Not willing to miss anyone, I would like to express my gratitude to every single individual who has contributed directly or indirectly, towards completing my studies.

Finally, I honour the sacrifice of my beloved mother, Zaiton Jamaluddin and my beloved husband, Mohamad Faiz Abdul Rahim who has continuously without doubt provided me with ample moral support and consistently encouraged me to complete this thesis. Their love has given me the strength to complete this quest.

CHAPTER ONE
INTRODUCTION

1.1 OVERVIEW

As stated in history, humans have used leather in their daily life. Ancient Chinese people who have already used animal skin and hides to turn into clothes like coats, aprons, and shawls before 3000 B.C. [1]. In general, leather is another term for animal skin or hides which is used for material products such as garments, furniture, accessories and others. Leather more specifically can be defined as finished animal skin which consists of two different layers. The first layer is known as grain layers, which comprises entirely of hair follicles, and the second layer is known as corium which consists of mostly thick bundles of collagen fibres [2]. Another description which can define leather is that it is of collagen structure material [3].

Leather has been used in daily human life to fulfil their needs at individual, company and manufacturer level. It has been claimed by past research declares that every day, products made from natural leather are widely used in human life [4]. As an evidence, since 2009, the export of leather has increased 80% of value added leather products over the past decade, US$2 billion/year alone was made from India [5]. That is a large amount for export production. Famous brands such as Florsheim, Nunn Bush, Reebok, Stacy Adams, Gabor, Nike, Clarks, Salamander, Adidas, Ecco, Deichmann, Cole Hann, Elefanten, St Michaels and Wal Mart are global brands from India which use leather in their products [5]. In addition, leather is a significant economic source of by-product from the meat industry [6].

This review justifies the importance of new research to enhance the depth of knowledge already available pertaining to biomechanical properties of leather. Yet, before the stage of defining leather biomechanical properties, it is better to start the biomechanical properties determination beginning with fresh skin and natural dried skin itself. Thus, the current study is important as it could continuously support leather research to provide a significant knowledge in understanding the biomechanical properties of skin and leather.