NUTRITIONAL COMPOSITION AND PHYSICAL CHARACTERISTICS OF EDIBLE ANURAN MEAT (*Rana erythraea* and *Limnonectes blythii*)

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THIS DISSERTATION IS SUBMITTED IN PARTIAL FULLFILLMENT FOR BACHELOR DEGREE OF FOOD SCIENCE WITH HONORS IN FOOD TECHNOLOGY AND BIOPROCESS

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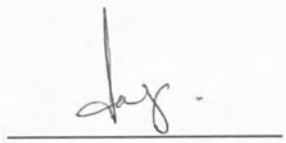

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ABSTRACT

The objectives of this study were to analyze the proximate composition, fatty acids and physical characteristic of *Rana erythraea* and *Limnonestes blythii*. Edible portion of both anurans were compared to chicken meat. In the proximate analysis, moisture, protein, fat and ash content for *R. erythraea* were 77.75 ± 1.68%, 16.60 ± 0.40%, 0.83 ± 0.09%, 3.38 ± 0.16% whereas *L. blythii* were 80.07 ± 0.77 fatty%, 17.29 ± 0.33%, 0.76 ± 0.12%, 0.83 ± 0.15%, respectively. For acids composition, *R. erythraea* has 25.48 ± 0.15%, 35.98 ± 2.44% and 38.54 ± 2.34% for SFA, MUFA and PUFA respectively; while for *L. blythii* is contains 39.62 ± 1.49%, 28.61 ± 2.64% and 31.77 ± 4.13% respectively. The main SFA were palmitic acid (C16:0) and Stearic acid (C18:0) while oleic acid (C18:1) and linoleic acid (C18:2) were the dominant MUFA and PUFA. PUFA: SFA ratio for both anurans were higher than 0.40. This ratio was recommended as a balanced fatty acids intake in a healthy diet. In the view of physical characteristic, cooking loss was higher in *L.blythii* (32.34 ± 1.28%) than *R. erythraea* (18.53 ± 0.98%). pH of both anurans (*R. erythraea* and *L.blythii*) was 6.58 ± 0.03 and 6.53 ± 0.03 respectively. The anurans are higher in moisture and protein content, while lower in fat content and higher in PUFA: SFA ratio than chicken meat. Besides, anurans' meats have lower cooking loss and higher pH than chicken meat. Therefore, the anurans' meat can be considered as lean meat and are excellent protein source. Beside, they are more tender and have high eating quality.

ABSTRAK

KANDUNGAN NUTRISI DAN SIFAT FIZIKAL DAGING ANURAN (Rana erythraea dan Limnonectes blythii)

Objektif kajian ini adalah untuk menganalisa komposisi proksimat, asid lemak dan sifat fizikal Rana erythraea dan Limnonectes blythii. Dua jenis anuran ini juga dibandingkan dengan daging ayam. Dalam analisis proksimat didapati kandungan kelembapan, protein, lemak dan abu dalam R..erythraae adalah 77.75 ± 1.68%, 16.60 ± 0.40%, 0.83 ± 0.09% dan 3.38 ± 0.16% masing-masing manakala untuk L. blythii adalah 80.07 ± 0.77%, 17.29 ± 0.33%, 0.76 ± 0.12% dan 0.83 ± 0.15%,masing-masing. Peratus bagi SFA, MUFA dan PUFA dalam R. erythraea adalah 25.48 ± 0.15%, 35.98 ± 2.44% dan 38.54 ± 2.34%. Untuk L. blythii pula, peratusnya adalah 39.62 ± 1.49%, 28.61 ± 2.64% dan 31.77 ± 4.13%. SFA yang utama ialah asid palmitik (C16:0) dan asid stearik (C18:0) manakala MUFA dan PUFA yang utama adalah asid oleik (C18:1) dan asid linolik (C18:2). Nisbah PUFA: SFA oleh kedua-dua spesies anuran adalah melebihi 0.40. Ini menunjukkan kedua-dua species ini mengandungi kandungan asid lemak yang seimbang bagi pemakanan yang sihat. Dari segi sifat fizikal, kehilangan kelembapan pemasakan, L.blythii (32.34 ± 1.28%) adalah lebih tinggi daripada R. erythraea (18.53 ± 0.98%). pH dalam kedua-dua anuran (R. erythraea and L. blythii) adalah 6.58 ± 0.03 and 6.53 ± 0.03 masing-masing. Secara keseluruhan, anuran mengandungi kandungan kelembapan dan protein yang lebih tinggi berbanding dengan daging ayam, pada masa yang sama anuran mengandungi kandungan lemak yang lebih rendah dan nisbah PUFA:SFA yang tinggi. Selain itu, kehilangan kelembapan pemasakan daging ayam adalah lebih tinggi daripada anuran. Oleh itu, daging anuran boleh digolongkan sebagai daging kandungan lemak rendah dan merupakan sumber protein yang sangat baik dan ia adalah lebih lembut dan mempunyai kualiti pemakanan yang lebih tinggi.

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LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
AOAC	Association of Official Analytical Chemists
FAME	Fatty Acid Methyl Ester
FID	Flame Ionization Detector
HDL	High-Density Lipoprotein
ISO	International Organization for Standardization
IUCN	The International Union for the Conservation of Nature and Natural Resources
LDL	Low-Density Lipoprotein
MUFA	Monounsaturated Fatty Acid
PUFA	Polyunsaturated Fatty Acid
SFA	Saturated Fatty Acid
SPSS	Statistical Package of Social Science
USDA	United States Department of Agriculture
WHC	Water Holding Capacity

LIST OF SYMBOLS

<	Less than
>	More than
±	Plus minus Sign
%	Percentage
α	Alpha
C	Carbon
°C	Degree Celsius
g	gram
L	Liter
min	minutes
mL	milliLiter
mm	milliMeter
N	Normality
µL	microLliter
µm	microMeter
ω	Omega
w/w	Weight by Weight

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CHAPTER 1

INTRODUCTION

Throughout the history, meat has always been an important dish on the dining table because of its appealing flavors, texture and its high nutritional value (Morrissey *et al.,* 1998). From nutritional prospective, meat is a valuable food. It not only provides energy, protein, long-chain fatty acids, but also vitamins such as B-vitamins, vitamin D, and minerals. For most people, meat makes a significant contribution to their nutrient intake (Robinson, 2001) and poultry is among the most popular food products world-wide. The consumers' demand is partly due to the desirable flavor of poultry products (Al-Najdawi & Abdullah, 2002).

However, in recent years the meat industry has been facing increasing scrutiny because of concerns such as those relating to saturated fat, cholesterol, heart disease, etc (Morrissey *et al.,* 1998). The increased health concerns have resulted in a shift away of high-fat, high-cholesterol products to low fat, low cholesterol products in human diet (Resurreccion, 2003). According to the study of Eichhorn *et al.* (1986), health professionals agree that persons who are susceptible to chronic atherosclerosis

should monitor their consumption of cholesterol, saturated fat and total calories.

Exotic meats such as edible anuran are an alternative to solve these worries. In marketing terms, exotic meats include anything which is not a supermarket staple (Westbrook, 2005). Anuran, horse, rabbit, deer, soft-shelled river turtle, big-tailed monkey, crocodile and snake are common consumed exotic meat. Anuran meat is not only appreciated for its exquisite flavour and texture but also as a source of protein with high biological value (Ramos *et al.*, 2004). According to Taithongchai (2005) edible anuran meat has been claimed as a healthy food which is high in calcium and low in cholesterol. This criterion is very beneficial to the health conscious society today.

In Thailand, canned frog meat has been introduced to the market by the people of Bo Talo (Taithongchai, 2005). Anuran legs are also extremely popular in Europe, Canada and the United States (Amphibiaweb, 2006). In the 1990's, Europe imported 6,000 metric tons of frog legs each year. Between 1981 and 1984, the United States imported more than 6.5 million pounds (3 million kg) of anuran meat per year. That is the equivalent of approximately 26 million anurans (Amphibiaweb, 2006).

In Borneo, anuran meat as part of the meal is common and popular especially among local people such as Kadazan-Dusuns, Ibans, and Bidayuhs. Local species of anuran mostly consumed are from *Rana leporina* group which include *R. ingeri, R. kuhlii, R. ibanorum and Fejervarya cancrivora* which is relatively larger in size and have

heavily muscled legs. *F. cancrivora* is the anurans of choice that served up in Chinese restaurants as "theen kai" or "paddy chicken" (Inger & Stuebing, 1997). *R. erythraea* has smaller size compared to the other species mentioned above, but yet is still consumed by local people (IUCN, 2004; Kueh, 2006). This species can be found at flooded rice field (Inger & Stuebing, 1997). Due to its habitat that is closer to human, it is easier for those who famous for its meat to obtain it.

Limnonectes blythii, also known as Malayan Giant Frog or Blyth's Giant Frog is widely found in south-east Asia including Peninsular Malaysia (IUCN, 2004). It lives in forest and along the banks of streams and often targeted due to high market demand. *L. blythii* has relatively larger size which is approximately 15 cm measuring from snout to vent (Inger, 1990). It is favored for its eating quality and thus is being nowadays (IUCN, 2004).

Demand for anuran meat as food in local or international market cannot be ignored. The total amount of domesticated frog was stated as high as 1,072,000 solely in Peninsular Malaysia in the year 2003 (Department of Veterinary Services, 2004b). Although it has high market demand, however, research on nutrient composition and physical characteristics of anuran meat are still limited and further study is required.

Objectives

1. To carry out proximate analysis, and fatty acid determination on *Rana erythraea* and *Limnonectes blythii*.
2. To determine the physical characteristics of edible portion of *Rana erythraea* and *Limnonectes blythii*.
3. To make comparison between chicken meat with *Rana erythraea* and *Limnonectes blythii* on its nutritional composition and physical characteristics.

CHAPTER 2

LITERATURE REVIEW

2.1. Meat Industry

It is a fact that humans have been consuming meat for around 30,000 years (Lubbadeh *et al.*, 1999). In the history, the real issues about eating meat emerged after the introduction and growth of intensive livestock industry (De Boer *et al.*, 2006). Meat and meat products are essential components in the people's diets of developed countries. Meat comprises roughly 10–20% of energy intake in most people in meat consuming countries (Valsta *et al.*, 2005). Consumption from the meat, poultry, and fish group reached 241 pounds per capita at year 2000 in United States. Poultry increased more than fivefold—from 17 to 93 pounds per capita between 1909 and 2000 (USDA, 2004). Previous study by Resurreccion (2003) stated that consumption of red meat and poultry per capita has not changed significantly, but when examined separately, beef appears to be losing market share to chicken. The negative trend in beef per capita consumption coupled with the increase in capita consumption of chicken shows that US consumers do not perceive beef as being competitive with

chicken in terms of offering low fat and low cholesterol product lines (Resurreccion, 2003).

For the year 1999 through 2002, consumption from poultry meat had reached 781.970 million ton and even reached 854,000 million ton in 2003 in Malaysia (Department of Veterinary Services, 2005a). These increasing numbers had shown the large market demand of poultry meat in Malaysia.

There are some others domesticated animals consumed by Malaysian which included horse, deer, rabbit, frog (anuran) and others. Table 2.1 was shown the domesticated other animals in Peninsular Malaysia.

Table 2.1: Population of Domesticated Animals 2001-2003

	Horse (Total)	**Deer (Total)**	**Rabbit (Total)**	**Frog (Total)**	**Others (Total)**
Year					
2001	3,214	9,461	9,129	3,528,420	589,905
2002	3,387	9,230	7,181	861,500	183,631
2003	2,910	8,077	7,598	1,072,000	72,569

Source: Department of Veterinary Services, Malaysia

Statistics from Malaysia Department of Veterinary Services (2004a, 2005b) stated that the populations of edible anuran rose from 861,500 in 2002 to 1,072,000 in 2003 in Peninsular Malaysia.

2.1.1. Current Issues in Meat Industry and New Consumer Trend

There are several factors influencing the changes in consumer demand for meat. Some of the most important factors are: product characteristics (sensory and nutritional properties, safety, price, convenience, etc), consumer factors (changing preference, health concern, etc) and environment-related factors (psychological, health, family or educational aspects, general economic situation, climate, legislation, etc). These factors are usually closely linked to social, economic, political and geographical aspects (Guenther *et al.*, 2005; Jimenez-Colmenero *et al.*, 2001; Resurreccion, 2003).

Meat and meat products always been a high valued food (Lubbadeh *et al.*, 1999; Robinson, 2001) and are important source of proteins, vitamins and minerals, but they also contain fat, saturated fatty acids, cholesterol, salt, etc (Jimenez-Colmenero *et al.*, 2001). Thus, excessive consumption at the expense of a balance diet remains undesirable (Robinson, 2001).

In typical Western diets, low ratios of PUFA/SFA and high levels of cholesterol have been considered as one of the major the risk factors of cardiovascular diseases, which are among the most important causes of human mortality in developed countries (Alfaia *et al.*, 2006). The emerging public consensus that limiting dietary cholesterol contributes to good health has resulted in a series of new guidelines for food labeling which include specific requirements for cholesterol (Fletouris *et al.*, 1998).

An earlier report on Nutritional Aspects of Cardiovascular Disease recommended a reduction in saturates and total fat to energy intake. These include reducing the fat intake of meat and meat products by 50%, with no change in the amount of carcasses meat, but a switch to leaner meat (Robinson, 2001).

The patterns of meat consumption are changing. More and more people are eschewing meat and meat products in favour of a vegetarian or vegan diet (Robinson, 2001).

2.1.2. Consumer perception on meat quality

Quality characteristics of meat are influenced by muscle structure and chemical composition. Quality is product specific and is actually a measurement of acceptability by the consumer (Miller, 1994). The most important quality features in meat and meat products are sensory characteristic, health related and nutritional properties (Hoffman *et al.*, 2003; Muňoz, 1998; Resurreccion, 2003; Wood *et al.*, 1998). Among the quality assessment, tenderness is probably the most important to consumer (Wood *et al.*, 1998).

British consumers generally prefer opaque white fat on meat cut and a high lean: fat ratio (Maw *et al.*, 2003). In the study of four European countries: France, Germany, Spain and the UK, the most important product characteristic, which consumers base

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