UNIVERSITI PUTRA MALAYSIA

EFFECTS OF MARINATING FACTORS ON THE QUALITY OF BEEF *SATAY*

CHEOK CHOON YOONG

EFFECTS OF MARINATING FACTORS ON THE QUALITY OF BEEF *SATAY*

By

CHEOK CHOON YOONG

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

May 2009

DEDICATED TO

my beloved father who passed away on 29 October 2008, for his love and encouragement. I am thankful and grateful for his sacrifices and determination to enable his children to get an education.

Deeply missed

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the Degree of Master of Science

EFFECTS OF MARINATING FACTORS ON THE QUALITY OF BEEF *SATAY*

By

CHEOK CHOON YOONG

May 2009

Chairman : Chin Nyuk Ling, PhD

Faculty : Engineering

A series of experiments were undertaken to investigate the effects of *satay* marinade on beef texture by measuring its physical changes in terms of weight gain, cooking loss and WBSF values. Experiment I was designed to find the main substances in *satay* marinade that alters the weight gain, cooking loss and WBSF values. Tenderloin beef muscle was selected and assigned into five treatments; i.e., control, brine solution, tamarind juice, tamarind juice plus salt and *satay* marinade for 30, 60, 90, 120, 150, and 180 minutes of marinating time. Experiment II was conducted to investigate the influence of muscles type, blade roast (BR), *biceps femoris* (BF) and *semitendinosus* (ST) on weight gain and cooking loss, and the *semitendinosus* muscle was used for further assessment of tenderness. All the beef muscles were assigned into treatments and marinating times as defined in experiment I. Experiment III was designed to find the better marinating temperature between 4 °C (in refrigerator) and 25 °C (room temperature) on weight gain for beef cuts in *satay* marinade.

Chuck tender beef cuts were assigned into two treatments of control and *satay* marinade in two different marinating temperatures of 4 °C and 25 °C for 1st, 2nd, 3rd, 4th, 5th and 6th hour of marinating times. The marinating time was extended to 7th, 9th, 12th and 24th hour for the 4°C in order to establish a relationship between weight gain and marinating time. Experiment IV was conducted to find the correlation between weight gain, cooking loss and WBSF values of tenderloin beef cuts marinated in *satay* marinade for 1, 2, 3, 4, 5, and 6 hours marinating time at 4°C.

Tenderloin beef cuts that were marinated in tamarind juice plus salt and *satay* marinade did not show significant difference ($P > 0.01$) in weight gain, cooking loss and WBSF which implied that tamarind juice plus salt were the main substances in *satay* marinade which attributed to changes in measured physical parameters. Although the tamarind juice provided the acidic condition to the marinades, it did not enhance meat water effectively due to the inductive effect of tartaric acid. Linear regression analysis found that the tenderness of tenderloin samples increases linearly ($P < 0.05$) with increasing weight gain, but it decreases linearly ($P < 0.05$) with increasing cooking loss, irrespective of treatments.

The weight gain of both BF and ST were found significantly higher ($P < 0.01$) than BR, but showed no significant difference ($P > 0.01$) between themselves in brine solution, tamarind juice plus salt and *satay* marinade treatments, which implied that BF and ST muscles from the same carcass have almost similar water binding ability. The beef chuck cuts marinated in *satay* marinade at 4 °C is more flavourable in meat water enhancing

compared to 25 °C ($P < 0.01$), but the influence of marinating temperature will only be significance for at least two hours of marinating time. A best fitted equation was established to express the relationship of weight gain of beef cuts marinated at 4 °C in response to marinating time up to 24th hour. Prediction from the equation found that the extended marinating time above six hours did not give any significant positive effect in water enhancing for beef chuck muscles marinated in *satay* marinade at 4 °C, and the weight gain rate was found at highest rate at the first two hours of marination, particularly at the beginning of 10 minutes.

The strong negative correlation between weight gain and WBSF ($P < 0.05$), and positive correlation between cooking loss and WBSF values ($P < 0.01$) found for tenderloin meat marinated in *satay* marinade highlighted the importance of water enhancement and cooking loss reduction in determining the tenderness of cooked tenderloin cuts. The local tenderloin beef and chuck tender block were recommended in preparation of *satay* based on data obtained. Marinating time of two hours at 4 °C is sufficient for beef cuts to equilibrate with *satay* marinade in order to have maximum water enhanced.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

FAKTA-FAKTA PEMERAPAN KE ATAS KUALITI SATE LEMBU

Oleh

CHEOK CHOON YOONG

Mei 2009

Pengerusi : Chin Nyuk Ling, PhD

Fakulti : Kejuruteraan

Empat eskperimen telah direkabentuk untuk tujuan mengkaji fakta-fakta pemerapan ke atas sate lembu, dan parameter yang diguna untuk mengkaji perubahan tekstur daging ialah peratus tambahan berat, peratus kehilangan berat dan daya memotong (Newton). Eksperimen I direkabentuk dengan tujuan mencari bahan utama yang terkandung dalam kuah sate yang menpengaruhi ketiga-tiga parameter tersebut. Daging *tenderloin* dipilih and direndam dalam kontrol, larutan garam, air asam, air asam campur garam dan kuah sate pada tempoh pemerapan dari 30 hingga 180 minit. Eksperimen II dilaksanakan atas tujuan mengkaji pengaruhan jenis daging, *blade roast* (BR), *biceps femoris* (BF) dan *semitendinosus* (ST) ke atas peratus tambahan berat dan peratus kehilangan berat, dan hanya *semitendinosus* sahaja yang digunakan dalam kajian daya memotong. Semua jenis daging direndam dalam kuah dan tempoh pemerapan masa yang seperti dalam eksperimen I. Eksperimen III direkabentuk untuk mengkaji pengaruh suhu pemerapan diantara 4 °C dan 25 °C ke atas perubahan peratus tambahan berat bagi daging rendam dalam kuah sate

pada jam pertama hingga keenam. Sample daging yang rendam pada 4 °C melanjutkan jangka masanya sehingga ke-24 jam supaya menperolehi hubungan antara peratus tambahan berat dengan meningkat masa pemerapan. Eksperimen 4 dijalankan untuk mencari kolerasi antara peratus tambahan berat, peratus kehilangan berat dan daya memotong bagi *tenderloin* yang rendam dalam kuah sate untuk 1, 2, 3, 4, 5 dan 6 jam pada 4 °C.

Daging *tenderloin* yang telah rendam dalam campuran air asam dan garam didapati tiada perbezaan ketara ($P > 0.01$) dengan kuah sate menunjukkan bahawa air asam dan garam ialah bahan utama terkandung dalam kuah sate yang mempengaruhi peratus tambahan berat, peratus kehilangan berat dan daya memotong. Walaupun air asam memberi keasidan kepada kuah, ia tidak memberi kesan positif ke atas peratus tambahan berat sebab kesan induktif yang terkandung dalamnya. Analisis *regression* menunjukkan bahawa daya memotong *tenderloin* daging menurun secara lurus dengan peratus tambahan berat ($P < 0.05$), tetapi ia meningkat dengan peratus kehilangan berat ($P < 0.05$), tanpa mempertimbangkan kuah pemerapan.

Peratus tambahan berat didapati dari kedua-dua BF dan ST adalah lebih tinggi ($P < 0.01$) berbanding dengan BR, tetapi tiada perbezaan ketara ($P > 0.01$) diantara mereka setelah rendaman dalam larutan garam, campuran air asam dan garam, dan kuah sate. Ini bermaksud BF dan ST diperolehi dari bahagian daging yang sama menpunyai keupayaan peyerapan air yang sama. Daging sample yang rendam dalam kuah sate pada 4 °C didapati

lebih berkesan dalam peningkatan peratus tambahan berat berbanding dengan 25 °C ($P < 0.01$), tetapi pengaruh suhu ke atas peratus tambahan berat hanya ketara pada tempoh pemerapan sekurang-kurangnya 2 jam.

Satu persamaan telah diperolehi menghubungkan diantara peratus tambahan berat dengan tempoh rendaman untuk daging yang direndam dalam kuah sate pada 4 °C sehingga ke-24 jam. Jangkaan dari persamaan didapati bahawa daging dalam pemerapan kuah sate tidak akan mengalami kesan positif yang ketara atas peratus tambahan berat bagi masa yang lebih panjang daripada 6 jam, dan kadar penyerapan didapati tertinggi pada 2 jam pertama pemerapan, khususnya pada masa 10 minit permulaan.

Korelasi negative yang kuah didapati diantara peratus tambahan berat dan WBSF ($P < 0.05$), dan korelasi positif diantara peratus kehilangan air dan WBSF ($P < 0.01$) bagi daging pemerapan dalam kuah sate menekankan kepentingan peningkatan peratus tambahan berat dan penurunan peratus kehilangan air dalam penentuan daya memotong daging masak. Berdasar kepada keputusan yang didapati dari eksperimen, daging jenis *tenderloin* dan *chuck tender block* adalah diperkenalkan dalam penyediaan sate. Masa pemerapan 2 jam pada 4 °C adalah cukup untuk daging mencapai peratus tambahan berat yang maximum.

ACKNOWLEDGEMENTS

I would like to express my sincere and deep gratitude to my Supervisor Dr. Chin Nyuk Ling (UPM), who provided valuable insights and comments to help and enhance the quality of my work. It is impossible for me to complete this research without her patient support technically and spiritually.

I would like to thank to members of the supervisory committees, Dr. Siti Mazlina Bt Mustapa Kamal (UPM) and Dr. Awis Qurni Bin Sazili (UPM), for their helpful advice and guidance during the course of this research.

I would like to thank to lab technicians, Mr. Raman Bin Morat, Mr. Kamarulzaman Bin Dahlin and Mr. Muhammad Badrushah Bin Bahat Uddin for their helps in experiments.

Finally, I dedicate this thesis to my beloved father.

I certify that a Thesis Examination Committee has met on 25 May 2009 to conduct the final examination of Cheok Choon Yoong on her thesis entitled "Effects of Marinating Factors on the Quality of Beef *Satay*" in accordance with 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 candidate be awarded the Master of Science.

Members of the Thesis Examination Committee were as follows:

Mohd Ali Hassan, PhD
Professor
Faculty of Biotechnology and Biomolecular Sciences
Universiti Putra Malaysia
(Chairman)

Thomas Chong Shean Yaw, PhD
Associate Professor
Faculty of Engineering
Universiti Putra Malaysia
(Internal Examiner)

Ling Tau Chuan, PhD
Associate Professor
Faculty of Engineering
Universiti Putra Malaysia
(Internal Examiner)

Ida Idayu Muhamad, PhD
Associate Professor
Faculty of Chemical and Natural Resources Engineering
University Teknologi Malaysia
Malaysia
(External Examiner)

_____
BUJANG KIM HUAT, PhD
Professor and Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 18 June 2009

This thesis submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee are as follows:

Chin Nyuk Ling, PhD
Lecturer
Food and Process Engineering
Faculty of Engineering
Universiti Putra Malaysia
(Chairman)

Siti Mazlina Bt Mustapa Kamal, PhD
Lecturer
Food and Process Engineering
Faculty of Engineering
Universiti Putra Malaysia
(Member)

Awis Qurni Bin Sazili, PhD
Lecturer
Department of Animal Science
Faculty of Agriculture
Universiti Putra Malaysia
(Member)

HASANAH MOHD. GHAZALI, PhD
Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 9 July 2009

DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

_____

CHEOK CHOON YOONG

Date: 4 June 2009

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ANOVA	Analysis of variance
a_w	water activity
BF	*biceps femoris*
BR	Blade roast
CL	cooking loss (%)
CT	connective tissue
CV	Variation coefficient
HP	hydroxylysylpyridinoline
k	weight gain rate constant (%)
K^+	potassium ion
KCl	pottasium chloride
Li^+	lithium ion
LiCl	lithium chloride
LL	*Longissimus lumborum*
M	molar
MPa	mega pascal
Na^+	sodium ion
NaCl	Sodium chloride
p*I*	isoelectric point
pK_a	log dissociation constant
PUFA	polyunsaturated fatty acid
r	coefficient of correlation
r'	weight gain rate (%/hr)
R^2	coefficient of determination
SEM	Scanning electron microscope

SM	*Semimembrannosus*
SSE	Errors sum of squares
SSR	regression sum of squares
SST	total sum of squares
ST	*Semitendinosus*
STPP	sodium tripolyphosphate
t	marinating time (hr)
TPA	Texture profile analysis
WB	Warner-Bratzler
WBC-F	Warner-Bratzler connective tissue force
WBM-F	Warner-Bratzler myofibrillar force
WBPSF	Warner-Bratzler peak shear force
WBSF	Warner-Bratzler shear force (N)
WG	weight gain (%)
WHC	water-holding capacity

CHAPTER 1

INTRODUCTION

1.1 Research Background

Satay is a popular food in Malaysia, especially during celebration of *Hari Raya Aidilfitri*. *Satay* is easily available from night markets or stalls at hawkers centre in Malaysia and can be bought at a price of about 50 to 60 cents (Malaysia ringgit) per skewer. *Satay* consists of three to four chunks or slices of meat, either chicken, mutton, beef, pork or fish, on bamboo skewers. The slices of meat are marinated in marinade prepared from ingredients of aniseed, white pepper, lemon grass, galangal, shallots, garlic, tamarind juice and of course the sugar and salt to taste (Dompok, 1999). Most recipes books recommended marinating of one to two hours before the meats are skewed together with a bamboo skewer. This research is particularly interested in the changes of meat texture within the recommended marinating time in *satay* preparation. Traditionally, these bamboo skewers are grilled or barbecued over charcoal fire and served with peanut sauce which is prepared from ingredients of small peanut, fresh red chilli puree, galangal, ginger, lemon grass, garlic, shallots, cinnamon stick and tamarind juice (Dompok, 1999). However in this research, sample meats are baked in a conventional closed door oven in a more controlled condition to minimize the variation.

The influence of pH and salt concentration on meat texture has been studied extensively for years (Aktaş *et al*., 2003; Baublits *et al*., 2006; Burke & Monahan,

2003; Gault, 1985; Hamm, 1975; Lemos *et al*., 1999; Mueller *et al*., 2006; Offer & Trinick, 1983; Oreskovich *et al*., 1992; Rao *et al*., 1989; Serdaroğlu *et al*., 2007; Xiong, 2005). However, the pH of marinade was mostly manipulated by acetic acid (Gault, 1985; Rao *et al*., 1989), lactic acid (Aktaş *et al*., 2003; Burke & Monahan, 2003), citric acid (Aktaş *et al*., 2003; Burke & Monahan, 2003; Serdaroğlu *et al*., 2007) and even citrus (Burke & Monahan, 2003) or grapefruit juice (Serdaroğlu *et al*., 2007). There is little information of tamarind juice on meat, even though it is very common substance used in most Asian culinary. The sour taste of tamarind is contributed by tartaric acid, consists of around 12% (Gunasena & Hughes, 2000). Tartaric acid consists of two carboxyl groups, which give two pKa values of 2.93 and 4.23 (Vollhardt & Schore, 2007). One of the carboxyl groups will be expected from the stabilisation of its anion by the electron-withdrawing inductive effect of the second carboxylic acid group in the molecule (Eğe, 2004). This inductive effect gets weaker as the distance between the second carboxylic acid group and the carboxylate ion resulting from the first ionization of the acid increases (Eğe, 2004). Most researchers (Aktaş *et al*., 2003; Serdaroğlu *et al*., 2007) explained the tenderizing effect of meat by organic acid using the electrostatic repulsion theory. The addition of acid below the isoelectric point of muscle protein results in the protonation of negatively charged carboxyl groups, which should lead to the breaking of some electrostatic bonds with adjacent protein chains (Gault, 1991; Hamm, 1975). The increase in the net positive charge is thought to result in repulsion between protein groups of similar charge, thereby creating space for immobilization of added water (Gault, 1991; Hamm, 1975). But in the case of dicarboxylic acid of tartaric acid, where the inductive effect occurred, the protonation of carboxyl groups of muscle protein is expectedly less (in this research). Hence, in