UNIVERSITI PUTRA MALAYSIA

SHELF LIFE AND QUALITY ATTRIBUTES OF FRESH BEEF INFUSED WITH ORGANIC ACIDS

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

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To my beloved parents Abd Elgadir and Fatima, who love me a lot,
to my wife Nedal the candle of my life,
to my bothers and sisters who bring the happiness to me

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement of the degree of Master of Science

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Chairman : Professor Jamilah Bakar, PhD

Faculty : Food Science and Technology

Fresh beef is a highly perishable food. It has a shelf life of one day at ambient temperature and a few days at refrigerated temperature. This study was conducted with the objective of extending the shelf life of fresh beef by infusing organic acids such as citric, tartaric, acetic and lactic acids, and combination of the organic acids with sodium chloride. Fresh beef (*longissmus dorsi*) purchased from the local market were sliced and were infused with citric, acetic, lactic and tartaric acids in concentration of 0.5%, 0.75% and 1%, and combination of 1.00% of citric and acetic acids with and without sodium chloride by placing samples in vacuum desiccators and pulling the vacuum to 29.5 in. Hg. for 20 min.,. All samples were packed in vacuum packs (22 (L) x 18 (w) cm. and stored

at 5°C for 28 days. pH, A_w, Total Plate Count (TPC), Thiobarbaturic acid values, Hunter colour values , instrumental texture, proximate composition were determined. The pH values of treated samples dropped from the initial pH of 5.30 (untreated) to 4. 20 - 4. 47 and upon storage, the pH values of all samples increased gradually. The TPC values were lower than 10^7 CFU/g on day 16, 20 and 28 in samples treated with 0.5%, 0.75% and 1.00% acids, respectively. The proximate composition of treated samples was affected by infusion process. The instrumental texture of fresh beef was harder upon treatment. The maximum shelf life of treated beef was 12 - 24 days for samples treated with 0.5% of all acids, 16 - 24 days for samples treated with 0.75% and 20 - 28 for samples treated with 1.00%. Citric acid in concentration of 1.00% gave the best effect which was followed by acetic acid.

In citric and acetic acids and citric and acetic acids with sodium chloride combinations, the later in the ratio of 2:1 was more effective in decreasing the initial pH of fresh beef immediately after infusion. Increasing concentration of NaCl in the infusion solution resulted in the smaller decrease in the pH values. The TPC value was observed in samples treated with 2:1 citric: acetic acids. The growth of *S.aureus* and *E.coli* O157:H7 were significantly ($P<0.05$) decreased by 0.85 $\log_{10}$ and 0.73 $\log_{10}$, respectively. The initial thiobarbituric acid value in untreated fresh beef was 0.735 mg MDA/kg which significantly ($p< 0.05$) decreased

in all treated samples. At the end of storage study, lowest TBA values were obtained in samples treated with 2:1 citric and acetic. The increase in the addition of NaCl caused a parallel increased in TBA values. For colour, Hunter 'b' and 'L' values increased with storage time while 'a' decreased significantly ($P<0.05$). The processed beef burger during chilled storage had a storage life of 8 days.

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Oleh

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Daging lembu segar adalah makanan yang sangat mudah rosak. Ia mempunyai jangka hayat selama sehari pada suhu persekitaran dan beberapa hari pada suhu dingin. Dengan itu, Kajian ini dijalankan dengan objektif untuk memanjangkan jangka hayat daging lembu segar dengan memasukkan asid organik seperti asid sitrik, tartarik, asetik, laktik, dan kombinasi asid – asid organik dengan sodium klorida (NaCl). Daging lembu segar pada bahagian (*longissmus dorsi*) telah dibeli dari pasar tempatan, dipotong dan dimasukkan dengan asid organik (sitrik, asetik, laktik dan tartaric) pada kepekatan 0.5%, 0.75% dan 1.00%, dan kombinasi 1.00% asid sitrik dan asetik dengan (1 hingga 3% NaCl dan tanpa NaCl. Ini dilakukan dengan meletakkan sampel – sampel ke dalam balang pengering vakum dan mengeluarkan gas 29.5 in. Hg. Selama

20 minit. Nilai pH sampel telah menurun dari pH asal 5.30 (tanpa rawatan) kepada 4.20 – 4.47 selapas rawatan; semasa penstoran, nilai pH pagi semua sampel yang meningkat secara perlahan – lahan. Nilai TPC bagi sampel – sampel yang telah dirawat dengan 0.5%, 0.75% dan 1.00% asid adalah kurang dari padah 10^7 CFU/g pada hari ke – 16, 20 dan 28. masing – masing telah menjadi komposisi terdekat bagi sampel telah dipengaruhi oleh rawatan memasukkan asid – asid, manakala tekstur daging lembu segar menjadi keras selapas rawatan. Jangka hayat bagi daging lembu yang telah dirawatan dengan 0.5% asid adalah di antara 12 – 24 hari, sampel yang dirawat dengan 0.75% asid mempunyai jangka hayat antara 16 – 24 hari dan jangka hayat antara 20 – 28 hari bagi bagi sampel yang dirawat dengan 1.00% asid. Kemasukan asid sitrik pada 1.00% telah memberikan keputusan yang terbaik di ikuti dengan asid sitrik.

Dalam kajian kombinasi compuran asid sitrik dan asetik dengan dan tanpa NaCl telah digunakan. Campuran asid sitrik dan asetik pada nisbah 2:1 tanpa NaCl adalah lebih berkesan dalam menurunkan pH asal daging lembu segar sebaik selepas dirawat. Peningkatan kepekatan NaCl dalam larutan rawatan menyebabkan sedikit penurunan pada nilai pH. Nilai TPC yang terendah dapat diperhatikan dalam sampel yang telah dirawat dengan 2:1 asid sitrik: asetik. Pertumbuhan *S. aureus* dan *E. coli* O157:H7 telah menurun secara bermakna ($p < 0.05$) sebanyak 0.85 $\log_{10}$ dan 0.73 $\log_{10}$ bagi sampel – sampel yang telah dirawat. Nilai TBA asal bagi daging lembu segar tanpa rawatan adalah 0.735

mg MDA/ kg dan telah menurun secara bermakna ($p < 0.05$) dalam semua sampel yang telah dirawat. Pada penghujung kajian penstoran, nilai TBA yang terendah dapat diperolehi dalam sampel yang telah dirawat dengan 2:1 sitrik dan asetik. Peningkatan dalam nilai TBA. Bagi warna, nilai Hunter 'b' dan 'L' meningkat dengan masa perstoran manakala nilai Hunter 'a' menurun secara bermakna ($p < 0.05$). Burger daging lembu mempunyai jangka hayat penstoran selama 8 hari pada suhu 4° C.

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LIST OF ABBREVIATIONS

DFD	Dark Firm Dry meat
PSE	Pale Soft Exudative meat
Mb	myoglobin
MbO_2	oximyoglobin
MMb	met myoglobin
A_w	water attivity
ERH	Equilibrium Relative Humidity
ISO	International Organization for Standardization
EHEC	Enterohaemorrhagic Escherichia Coli
MAP	modified atmosphere packaging
VSP	vacuum skin packaging
AP	active packaging
VP	vacuum packaging
PE	polyethylene
PP	polypropylene
PS	polystyrene
ABS	acrylonitrile - butadiene – styrene
PC	poly carbonate
EVA	ethylene vinyl acetate
pK_a	Organic acid dissociation constant
FSIS	Food Safety and Inspection Service
USDA	United States Department of Agriculture

CFU/g	Colony forming unit per gram
CFU/ cm^2	Colony forming unit per squire centimeter
SPI	Soy protein isolate
TPC	Total Plate Count
TBA	Thiobarbituric acid

CHAPTER I

INTRODUCTION

Fresh beef is rich in vitamins and minerals and provides an important source of high quality protein. It has a short shelf life of one day or less at ambient temperature (15 – 30°C) and a few days at refrigerated temperature (0 – 10°C) due to microbial spoilage of both pathogenic and non - pathogenic (Dickson and Anderson, 1992) and/or lipid oxidation (Ahn et al., 1992; Shahidi; 1994b; and Morrissey et al., 1998). The maximum shelf life of fresh beef depends on several factors such as pH, water activity, microbial growth and temperature (Farber, 1991).

Many studies have been reported using organic acids to reduce organic spoilage microorganisms in beef such as spraying (Siragusa and Dickson, 1992 and Doores, 1993b), washing (Dorsa et al; 1997; and Cutter and Siragusa, 1994), and dipping (Miller et al., 1993). Food grade additives such as organic acids (citric, acetic, lactic and tartaric) and sodium chloride are reported to prolong the storage life of fresh beef. Organic acids are used as anti-microbial preservatives or acidulant in beef and its products due to their high solubility and low toxicity (Cassens, 1994). Citric acid was investigated for its inhibition effect on bacteria, yeast and molds and was shown to be more inhibitive and effective compared to lactic and citric acids (Sorrells,

1989). Anderson and Marshall (1990) concluded that a 3% concentration of acetic acid was most effective in sanitizing beef muscle inoculated with *Escherichia coli* and *Salmonella*. Spray washing of pork loin with 2% acetic acid before vacuum packaging followed by storage for 28 days at 4°C significantly lowered the aerobic, anaerobic and lactic acid bacteria counts (Anonymous, 1990). Lactic acid sprays have been effective in limiting microbial growth on meat carcasses under a variety of storage conditions at 4 – 55°C (Cutter and Siragusa, 1994). Tartaric acid acts synergistically with antioxidants to prevent rancidity and for miscellaneous and general purpose usage in accordance with good manufacturing practice (Doores, 1993a). However, organic acids have a negative effect on beef colour since they reduce the oxymyoglobin pigment (red colour) to metmyoglobin (brown undesirable colour). These studies were conducted to prolong the storage life of fresh beef.

Processing of beef products causes changes in texture and flavor and also adds variety to the diet. Processing also provides scope to mix the less desirable parts of the carcass with lean meat and in addition is a means of extending meat supplies by including other foodstuffs such as cereal in the product. Beef pattie is one of the examples. The quality attributes of pattie depends largely on the type and quality of lean meat and ingredients used.

Hence, the objectives of this study are (1) to determine the effects of the organic acids infusion on shelf life extension and physico - chemical