UNIVERSITI PUTRA MALAYSIA

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

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FSTM 2005 4
SHELF LIFE AND QUALITY ATTRIBUTES OF FRESH BEEF INFUSED WITH ORGANIC ACIDS

By

MOHAMED ABD ELGADIR MOHAMED

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

March 2005
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
SHELF LIFE AND QUALITY ATTRIBUTES OF FRESH BEEF INFUSED WITH ORGANIC ACIDS

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March 2005

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), Thiobarbituric 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.
SHELF LIFE AND QUALITY ATTRIBUTES OF FRESH BEEF INFUSED WITH ORGANIC ACIDS

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 selepas rawatan; semasa pen storan, 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 selepas rawatan. Jangka hayat bagi daging lembu yang telah dirawat 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 campuran 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 4º C.
ACKNOWLEDGEMENT

First of all, praises and thanks for Almighty Allah who has given me all the best during all stages of my study. My acknowledgement goes to the following:

My supervisor Prof. Dr. Jamilah Bakar, really dear Prof., no words will be able to express my heartfelt gratitude for your kindly strong constant guidance, advice, invaluable discussion and new ideas through the period of this study.

My supervisory committee Prof. Dr. Yaakob Che Man and Prof. Dr. Russly Abdul Rahman for their advises and stimulating discussion especially during the presentation of my work.

All technicians in our faculty, En. Azman, Pn. Jamaliah; En. Abdul Halim; En. Zolkifli; Pn. Noorfaizan and Pn. Rozmawati (members of biochemistry lab.), for the continuously assistance and friendly relationship. My sincere gratitude also goes to En. Mohamed Soib in the engineering lab. for his unique effort with me in texture measurement and brotherhood relationship. Deepest gratitude to En. Zolkifli and Pn. Jamilah (Microbiology lab.) for their kind assistance. I wish to extend my appreciation to En. Razali Othman and Pn. Siti Shahrul Bariah (processing lab.) for their helpfulness during the processing of burger.
My wife for her love, encouragement, assistant and patience through the length of my study.
I certify that an Examination Committee met on 31st March 2005 to conduct the final examination of Mohamed Abd Elgadir Mohamed on his Master of Science thesis entitled “Shelf Life and Quality Attributes of Fresh Beef Infused with Organic Acids” in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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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.

MOHAMED ABD ELGADIR

Date: 18 JULY 2005
# TABLE OF CONTENT

DEDECATION ii  
ABSTRACT iii  
ABSTRAK vi  
ACKNOWLEDGEMENT ix  
APPROVAL SHEETS xi  
DECLARATION xiii  
TABLE OF CONTENT xiv  
LIST OF TABLES xvii  
LIST OF FIGURES xix  
LIST OF PLATES xxi  
LIST OF ABBREVIATIONS xxii

## CHAPTER

### I INTRODUCTION 1

### II LITERATURE REVIEW 4

**Nutritional and chemical composition of fresh beef** 4  
**Physico-chemical properties of beef** 5  
  **pH and Water activity** 5  
  **Colour** 5  
  **Texture** 8  
**Microbial characteristics of fresh beef** 10  
  **Spoilage microorganisms** 10  
  **Gram negative (oxidase positive) rod – shape** 12  
  **Bacteria** 12  
  **Coliform bacteria** 13  
  **Gram positive spore – forming bacteria** 14  
  **Lactic acid bacteria.** 14  
  **Pathogenic microorganisms** 15  
**Packaging and storage of chilled beef products** 16  
**Spoilage of fresh beef** 19  
  **Microbial** 19  
  **Lipid oxidation in beef and its products** 21  
  **Change in beef flavour during storage** 25  
  **The shelf life of fresh beef** 25  
**Organic acids as preservatives to prolong the shelf life of fresh beef** 27  
  **Citric acid** 28  
  **Acetic acid** 29  
  **Lactic acid** 30  
  **Tartaric acid** 30
Regulatory status of food grade organic acids 31
Effect of sodium chloride on fresh beef preservation 32
Beef burger processing 33
Storage stability of beef burger 34
Quality of beef burger 35
Sensory attributes of beef products 36

III  EFFECT OF ORGANIC ACIDS INFUSION ON SHELF LIFE EXTENSION AND PHYSICO-CHEMICAL PROPERTIES OF FRESH BEEF 38
Introduction 38
Materials and methods 41
Material 41
Methods 41
Preparation of organic acid 41
Preparation of peptone water 41
Preparation plates of Plate Count Agar 42
Infusion processing 42
Storage studies 42
Analysis 43
PH 43
Water activity 43
Total Plate Count 44
Colour 44
Texture 45
Proximate composition 46
Thiobarbituric acid value 46
Statistical Analysis 47
Results and discussions 47
PH 47
Water activity 48
Total Plate Count 51
Colour 52
Texture 58
Proximate composition 60
Thiobarbituric acid value 62

IV  SYNERGISTIC EFFECTS OF ORGANIC ACIDS AND SODIUM CHLORIDE COMBINATION ON PHYSICO-CHEMICAL AND MICROBIAL QUALITY OF FRESH BEEF 64
Introduction 64
Material and methods 65
Materials 65
Analytical methods 65
pH measurement 65
Total Plate Count assessment 66
*Staphylococcus aureus* numeration 66
*E.coli* O157:H7 assessment 66
TBA measurement 67
Colour measurement 67
Statistical analysis 68
Results and discussions 68
pH measurement 68
Total Plate Count assessment 71
*S. aureus* and *E.coli* O157:H7 assessment 72
TBA measurement 76
Colour measurement 78
Conclusion 80

**V**

QUALITY ATTRIBUTES OF BURGER PROCESSED FROM CITRIC ACID TREATED BEEF 81

Introduction 81
Preparation of beef burger 82
Storage study 83
pH measurement of the burger 83
Water activity measurement of the burger 83
Total Plate Count analysis of the burger 84
TBA measurement of the burger 84
Sensory analysis 84
Statistical analysis 85
Results and discussions 85
pH measurement of the burger 85
Water activity measurement of the burger 86
Total Plate Count analysis of the burger 86
TBA measurement of the burger 88
Sensory analysis 89
Conclusion 91

**VI**

Conclusion and Recommendations 93

Bibliography 95
APPENDICES A 111
APPENDICES B 113
APPENDICES C 116
APPENDICES D 119
APPENDICES E 122
APPENDICES F 125
BIODATA OF THE AUTHOR 128
<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>pH of control and acids treated samples during storage at 5°C for 28 days</td>
<td>49</td>
</tr>
<tr>
<td>2</td>
<td>Water activity of control and acids treated samples during storage at 5°C for 28 days</td>
<td>50</td>
</tr>
<tr>
<td>3</td>
<td>TPC of control and acids treated samples during storage at 5°C for 28 days</td>
<td>54</td>
</tr>
<tr>
<td>4</td>
<td>Hunter ‘L’ ‘a’ and ‘b’ values for control and 0.5% acids treated samples during storage at 5°C for 28 days</td>
<td>55</td>
</tr>
<tr>
<td>5</td>
<td>Hunter ‘L’ ‘a’ and ‘b’ values for control and 0.75% acids treated samples during storage at 5°C for 28 days</td>
<td>56</td>
</tr>
<tr>
<td>6</td>
<td>Hunter ‘L’ ‘a’ and ‘b’ values for control and 1.00% acids treated samples during storage at 5°C for 28 days</td>
<td>57</td>
</tr>
<tr>
<td>7</td>
<td>Texture of control and 0.5% acids treated samples during storage at 5°C for 28 days</td>
<td>59</td>
</tr>
<tr>
<td>8</td>
<td>Proximate composition of control acids treated samples during storage at 5°C for 28 days</td>
<td>61</td>
</tr>
<tr>
<td>9</td>
<td>TBA values of control acids treated samples during storage at 5°C for 28 days</td>
<td>63</td>
</tr>
<tr>
<td>10</td>
<td>pH of control and acids combination treated samples during storage at 5°C for 28 days</td>
<td>70</td>
</tr>
<tr>
<td>11</td>
<td>Total Plate counts (TPC) of control and acids combination treated samples during storage at 5°C for 28 days</td>
<td>73</td>
</tr>
<tr>
<td>12</td>
<td><em>S. aureus</em> of control and acids combination treated samples during storage at 5°C for 28 days</td>
<td>74</td>
</tr>
<tr>
<td>No</td>
<td>Description</td>
<td>Page</td>
</tr>
<tr>
<td>----</td>
<td>-----------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>13</td>
<td><em>E. coli</em> O157: H7 of control and acids combination treated samples during storage at 5°C for 28 days</td>
<td>75</td>
</tr>
<tr>
<td>14</td>
<td>TBA values of control and acids combination treated samples during storage at 5°C for 28 days</td>
<td>77</td>
</tr>
<tr>
<td>15</td>
<td>Hunter colour 'a' values of control treated samples during storage at 5°C for 28 days</td>
<td>79</td>
</tr>
<tr>
<td>16</td>
<td>Values of analysis of burger during chilled storage (4°C) for 8 days</td>
<td>88</td>
</tr>
<tr>
<td>17</td>
<td>Sensory scores for burger chilled stored at 4°C for 8 days</td>
<td>91</td>
</tr>
</tbody>
</table>
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Reaction of lipase with fatty acids in meat.</td>
<td>23</td>
</tr>
<tr>
<td>2</td>
<td>pH of control and 0.5% acids treated samples of fresh beef during storage at 5°C for 28 days</td>
<td>113</td>
</tr>
<tr>
<td>3</td>
<td>pH of control and 0.75% acids treated samples of fresh beef during storage at 5°C for 28 days</td>
<td>114</td>
</tr>
<tr>
<td>4</td>
<td>pH of control and 1.00% acids treated samples of fresh beef during storage at 5°C for 28 days</td>
<td>115</td>
</tr>
<tr>
<td>5</td>
<td>Water activity of fresh beef (control) and 0.5% acids treated samples during storage at 5°C for 28 days</td>
<td>116</td>
</tr>
<tr>
<td>6</td>
<td>Water activity of fresh beef (control) and 0.75% acids treated samples during storage at 5°C for 28 days</td>
<td>117</td>
</tr>
<tr>
<td>7</td>
<td>Water activity of fresh beef (control) and 1.00% acids treated samples during storage at 5°C for 28 days</td>
<td>118</td>
</tr>
<tr>
<td>8</td>
<td>TPC of fresh beef (control) and 0.5% acids treated sample during storage at 5°C for 28 days</td>
<td>119</td>
</tr>
<tr>
<td>9</td>
<td>TPC of fresh beef (control) and 0.75% acids treated sample during storage at 5°C for 28 days</td>
<td>120</td>
</tr>
<tr>
<td>10</td>
<td>TPC of fresh beef (control) and 1.00% acids treated sample during storage at 5°C for 28 days</td>
<td>121</td>
</tr>
<tr>
<td>11</td>
<td>Hunter 'a' values for fresh beef (control) and 0.5% acids treated sample during storage at 5°C for 28 days</td>
<td>122</td>
</tr>
<tr>
<td>12</td>
<td>Hunter 'a' values for fresh beef (control) and 0.75% acids treated sample during storage at 5°C for 28 days</td>
<td>123</td>
</tr>
<tr>
<td>13</td>
<td>Hunter 'a' values for fresh beef (control) and 1.00% acids treated sample during storage at 5°C for 28 days</td>
<td>124</td>
</tr>
</tbody>
</table>
14 Texture of fresh beef (control) and 0.5% acids treated sample during storage at 5°C for 28 days

15 Texture of fresh beef (control) and 0.75% acids treated sample during storage at 5°C for 28 days

16 Texture of fresh beef (control) and 1.00% acids treated sample during storage at 5°C for 28 days
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DFD</td>
<td>Dark Firm Dry meat</td>
</tr>
<tr>
<td>PSE</td>
<td>Pale Soft Exudative meat</td>
</tr>
<tr>
<td>Mb</td>
<td>myoglobin</td>
</tr>
<tr>
<td>MbO₂</td>
<td>oxymyoglobin</td>
</tr>
<tr>
<td>MMb</td>
<td>met myoglobin</td>
</tr>
<tr>
<td>A_w</td>
<td>water activity</td>
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<tr>
<td>ERH</td>
<td>Equilibrium Relative Humidity</td>
</tr>
<tr>
<td>ISO</td>
<td>International Organization for Standardization</td>
</tr>
<tr>
<td>EHEC</td>
<td>Enterohaemorrhagic Escherichia Coli</td>
</tr>
<tr>
<td>MAP</td>
<td>modified atmosphere packaging</td>
</tr>
<tr>
<td>VSP</td>
<td>vacuum skin packaging</td>
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<td>AP</td>
<td>active packaging</td>
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<tr>
<td>VP</td>
<td>vacuum packaging</td>
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<tr>
<td>PE</td>
<td>polyethylene</td>
</tr>
<tr>
<td>PP</td>
<td>polypropylene</td>
</tr>
<tr>
<td>PS</td>
<td>polystyrene</td>
</tr>
<tr>
<td>ABS</td>
<td>acrylonitrile - butadiene – styrene</td>
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<tr>
<td>PC</td>
<td>poly carbonate</td>
</tr>
<tr>
<td>EVA</td>
<td>ethylene vinyl acetate</td>
</tr>
<tr>
<td>pKₐ</td>
<td>Organic acid dissociation constant</td>
</tr>
<tr>
<td>FSIS</td>
<td>Food Safety and Inspection Service</td>
</tr>
<tr>
<td>USDA</td>
<td>United States Department of Agriculture</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>CFU/g</td>
<td>Colony forming unit per gram</td>
</tr>
<tr>
<td>CFU/ cm²</td>
<td>Colony forming unit per square centimeter</td>
</tr>
<tr>
<td>SPI</td>
<td>Soy protein isolate</td>
</tr>
<tr>
<td>TPC</td>
<td>Total Plate Count</td>
</tr>
<tr>
<td>TBA</td>
<td>Thiobarbituric acid</td>
</tr>
</tbody>
</table>
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,
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