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QUALITY AND SENSORY ATTRIBUTES OF BURGER FORMULATED FROM FRESH BEEF CUTS (*LONGISSMUS DORSI*) INFUSED WITH CITRIC ACID

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ABSTRACT

Burger was formulated from fresh beef infused with citric acid (1.00%) and stored for 8 days at 4°C. pH, $A_{w,}$ TPC, TBA and sensory evaluation for color, flavor, odor, texture, and overall acceptability were conducted. The sensory evaluation was carried out using a 9 hedonic scale. A significant ($P < 0.05$) increased in pH value of the control burger was observed during storage. The pH value of the control sample was 5.6 which reached a value of 7.4 after 8 days of storage. Comparing to the control burger, citric acid treatment significantly ($P< 0.05$) decreased the pH value the burger, which was less than 6.5 at the end of storage period. A gradual increase in water activity value (A_w) was also observed during storage which was not statistically significant ($P>0.05$) on the overall. The burger formulated from citric acid treated beef had an initial microbial count of log 3.43 CFU/g and at the end of storage period it was log 4.2 CFU/g. The burger formulated from citric acid treated beef had an overall high sensory acceptability. Based on the properties evaluated, the burger is still acceptable up to day 8 of storage.

Key Words: Beef burger, citric acid, infusion, quality attributes

INTRODUCTION

Burger is a minced meat product. The minced meat is mixed with condiments and spices, shaped and then cooked by frying or baking (Gujral *et al*., 2002). The types of seasonings used vary depending on the taste requirement from mild to hot and spicy. Incipient spoilage of burger is accompanied by a rise in pH, because the increase in growth of spoilage microorganisms is affected by pH value. These microorganisms prefer pH values near neutral and incipient spoilage mean pH values of about 6.5 is possible.

During chilled storage of burger, growth of spoilage microorganisms which enhanced by an increase in $A_{w,}$ cause alternations in flavor, texture and disagreeable – smelling volatile compounds as a result of breaking down of complex organic components into simpler compounds. Lipid oxidation products and free radicals can also cause oxidation of oxymyoglobin to metmyoglobin indicating discolouration of meats (Lee *et al*., 1999).

The maximum shelf life of meat products depends on several factors such as pH, Aw, microbial growth and temperature (Marth, 1998). Several studies have been carried out to investigate the effects of organic acids in beef products in order to prolong the storage life (Glass *et al.*, 2002; Nunez de Gonzalez *et al.*, 2004; Stopforth *et al.*, 2004; Gill *et al.*, 2003 and Calicioglu, 2003). Using of treated beef in processing could also increased shelf life of products prepared from it. The aim of this paper was to investigate the quality and sensory attributes of burger formulated from fresh beef infused with citric acid at concentration of 0 - 1.00%.

MATERIALS AND METHODS

MATERIALS

Fresh beef (*longissmus dorsi*) was purchase from local market just after slaughtering and transported to the laboratory covered with crushed ice. The samples were prepared individually by slicing the meat parallel to the fibres direction to peaces measuring 0.5x15x10 cm – thickness x length x width with surface area of approximately 300 cm^2 and weighing about 200 g using filleting knife. Citric acid was purchase from Melon Food Ingredient Company, Malaysia. Citric solution was prepared in the concentration of 1.00% (w/v) by dissolving 10 g of citric acid salt in 1000 ml distilled water. The infusion process was carried out using vacuum pump (Model A3S, Tokyo, Japan) connected to glass desiccators (37 x 30 x 1.3 cm ; diameter x height x thickness). The prepared beef slices were put one by one individually in the desiccators and followed by pouring 400 mL of the prepared acid solution on each piece individually in the ratio of 1:2 w/v (1g meat: 2 mL solution) and vacuum was

pooled to 29.5 in Hg for 20 min. The control meat was treated with distilled water using the same procedure.

METHODS

PREPARATION AND STORAGE OF BURGER

The treated meat (1 kg) was cut into small pieces and minced through a 4.5 mm plate. The ingredients (20g salt, 16g sugar, 10g garlic, 100g soy isolate protein, 30g fat and 6g black pepper were added (except fat) to the prepared minced in silent bowl cutter (Khin Shang Hoo Iron Works, Guu district, Kaohsiung, Taiwan) followed by mixing for 5 min. The fat was added after that and the ingredients were mixed for another 10 min until they homogenized. The homogenous mixture (approximately 80g) each was transferred to the burger shaper, pressed and a round-shaped burger was obtained. The processed burger was stored at 4^{o}C for 8 days. Data was collected every 2 days intervals.

pH MEASUREMENT

The material used in this test was the prepared burger. 10 g of sample was homogenized with 90 ml of distilled water (in the ratio of 1:9), using a Waring laboratory blender (Waring products Division Torrington, CT, USA.) for 1 min at low speed setting. The pH values of burger were obtained on first day (day 0) and every 2 days during storage period (8 days) at 4^{o}C. The analysis was conducted according to Dzudie *et al*., (2003). Digital pH meter (Tolledo320 pH meter, Mettler- Instrument, Shanghai, China) was used after standardizing it with two-buffer solutions; one in pH 7.0, and the other in pH 4.0. The pH of burger was obtained in the slurry with the direct insertion probe electrode of the pH meter.

WATER ACTIVITY MEASUREMENT

The prepared burger was used in this measurement. The water activity was measured on first day (day 0) and every 2 days during storage period (8 days). The burger was prepared by chopping it into fine pieces and then, the pieces were homogenized using glass rod. The instrument used in this measurement was Aqua Lab model 3TE, USA. It was switched on to warm for 30 min and the prepared sample was put carefully into the instrument drawer. Carefully the drawer was closed and the water activity of the samples was read out from the instrument directly in about 40s at temperature of 25^{o}C.

TOTAL PATE COUNT (TPC) ANALYSIS

The TPC was measured on first day (day 0) and every 2 days during the storage period of 8 days. Plate Counts Agar (Merck) which prepared by mixing 22.5 g in 100 mL distilled water followed by sterilizing in autoclave set at 120^{o}C for 15 min. The flask was cooled under stream of water to about 45^{o}C and the agar was then poured into sterilized 90 – mm plastic Petri dishes and then covered with their lids and left overnight. The Total plate counts of samples were conducted according to the procedure of Abdullah *et al*., (1994). Sample (10) from the burger was prepared by blending in 90 ml of sterile peptone water for 2 min using stomacher lab – blender 400 (Seward Laboratory, UAC, London, Britain). Aliquots (0.1 ml) of appropriate dilutions were then poured or surface – plated in duplicate. The plates were incubated for 3 days at 30^{o}C. The TPC counts were obtained from plates bearing 30 - 300 colonies and reported as the $\log_{10}$ of the numbers of colony forming units per g.

THIOBARBITURIC (TBA) ANALYSIS

In this measurement, solutions of 2.5 of 4N hydrochloric acid and 0.2883% of TBA solution in 90% in glacial acetic acid were prepared in the room temperature using distilled water. Stirring procedure was used in preparation. The TBA analysis was carried using the 2-thiobarbituric acid distillation method of Egan *et al*. (1981).

SENSORY EVALUATION EXPERIMENT

The round - shape prepared burger pieces were cooked on hot plate set at 170 -190^{o}C. Every piece was cut into four parts and provided to the sensory panelists. Sensory evaluations were conducted five times on day 0 and every 2 days during storage period (8 days). Sensory evaluation was performed by 30 panel members 25 - 40 year old from postgraduate students and staff of the faculty of food science & Technology, UPM, Malaysia. The students were asked to indicate how much they liked or disliked the processed burgers using hedonic scale (1= dislike extremely, 9 = like extremely) according to the attributes of color, flavor, odor, texture and overall acceptability. Scores were obtained and statistically analyzed.

STATISTICAL ANALYSIS

All the data of analysis were analyzed using analysis of variance (ANOVA) and Duncan's multiple range Test to determine the significance between the mean using a programmed Statistical Analysis package (SAS, 1992).

RESULTS AND DISCUSSION

pH MEASUREMENT

The pH values of the processed burger held under chilled condition are presented in table 1. Significant ($P<$ 0.05) increased in the pH of the control sample was observed during storage period. However, treated samples showed significant decrease in the pH till the 6th day of storage. Since the incipient spoilage of fresh meat was accompanied by a rise in its pH due to the increase in growth of spoilage microorganisms, Warris *et al*. (1989) have reported that incipient spoilage mean pH value of about 6.5 is possible. The spoilage microorganisms prefer pH values near neutral and the increase in pH might be due to the accumulation of metabolites by bacterial action in meat and determinations of proteins (Jay, 1996; McCarthey *et al*., 2001) over chilled storage. Based on this point of view, the pH of control sample in this study was almost 6.5 in the 4th day of storage and but the burger reached this value on the 8th day of the period and accordingly the burger gave value of 4 days longer. Thus, citric acid treatment delayed the rapid increase in the pH

and could also delay the growth of spoilage microorganisms.

WATER ACTIVITY MEASUREMENT

Water activity values of the control and treated burger which ranged between 0.955 and 0.986 is presented in Table 1. Kezban and Nuray (2003) noticed the water activity of frankfurter stored in refrigeration for 49 days was in the range of (0. 977 – 0.991). They found that this range was suitable for spoilage microbial growth. In general, an increase in water activity was observed over time during chilled storage period in this study which was statistically significant ($P< 0.05$) except in day 8 of storage which was not significantly different ($P>0.05$). The value of Aw of 0.975 was reported in day 4 of the storage in the control sample while the same value was reported after 4 days of the periods. The increase in Aw of patties might be due to its high moisture contents under storage condition (Biswas *et al*., 2003). Generally, all values were significantly (P<0.05) decreased as compared to the control. The decrease in moisture could due to increasing in the concentration of infused organic acid. The decrease in protein could be as a result of protein degradation with organic acids.

TOTAL PATE COUNT (TPC) ANALYSIS

The TPC values of burger were summarized in Table 2. At the end of chilled storage duration, the target burger had a low microbial count (log 4.24 CFU/g). Egbert *et al*. (1991) reported that during chilled storage of ground beef products, growth of spoilage microorganisms which was enhanced by an increase in Aw of the product could cause alternations in flovour, texture and odour as a result of break down of complex organic components into simpler compounds. Hygienic preparation of the patties could possibly play grate rule in decreasing growth of microorganisms (Jay, 1996). David *et al*. (2002) have noticed that microbial spoilage of fresh beef occurred and off- flavour became noticeable when total viable microbial count reach 10^7 CFU/g. The authors also found that when spoilage by microorganisms in this level presented, other factors such as lipid oxidation which lead to deterioration and off –odour and slime was also developed. In this study, the TPA of control sample was more than 10^7 CFU/g on day 6 of storage period. However, this level was less than the mentioned level by the end of storage period which confirm the great effect of the treatment in delaying the growth of the spoilage microorganisms and approved the success of the treatment. The microbial growth was significantly ($P< 0.05$) decreased at the end of the storage in the fresh burger from log 5.80 CFU/g to log 4.24 CFU/g.

THIOBARBITURIC (TBA) ANALYSIS

The TBA values of the fresh beef and the burger during chilled storage are shown in Table 2. A significant ($P<0.05$) in the values of the TBA was notices when the control and burger were compared. There was a significant increase ($P<0.05$) in (TBA) values of burger over the 8-day storage period. On first day (day 0), the initial TBA value of the target burger was 0.220 mgMA/kg and significantly increased during chilled storage reaching 0.736 mg MA/kg. Increase in rancidity parameters in flesh foods during chilled and frozen storage is well documented (Reddy *et al*., 1992, Lai *et al*., 1995 and Martin *et al*., 2000). The significant increase in TBA value in this study might be due to the higher fat level content in burger formulation and storage condition which enhanced oxidation of lipids (Warris, 2000).

Table 1: Values of analysis of the burger made with the fresh beef infused with 1.00% citric acid during chilled storage at 4oC for 8 days

	Days of storage	pH	A_W	TPC (log_{10} cfu/g)	TBA (mgMA/kg meat)
Control burger (without citric acids)	0	5.58 ± 0.01^{aD}	0.965 ± 0.001^{cC}	3.43 ± 0.01^{bD}	0.241 ± 0.01^{dE}
	2	5.96 ± 0.33^{aC}	0.975 ± 0.002^{cC}	3.71 ± 0.02^{bD}	0.398 ± 0.02^{bC}
	4	6.47 ± 0.15^{aB}	0.983 ± 0.004^{dB}	3.84 ± 0.05^{cC}	0.495 ± 0.03^{bB}
	6	7.19 ± 0.03^{aA}	0.986 ± 0.003^{cB}	5.58 ± 0.03^{bC}	0.654 ± 0.01^{dD}
	8	7.43 ± 0.04^{bA}	0.996 ± 0.002^{cA}	5.80 ± 0.05^{cA}	0.789 ± 0.02^{aA}
Burger sample (with 1.00% citric acid)	0	5.43 ± 0.03^{aD}	0.955 ± 0.001^{cD}	3.00 ± 0.03^{bD}	0.220 ± 0.01^{dE}
	2	5.56 ± 0.02^{aD}	0.964 ± 0.001^{cC}	3.67 ± 0.06^{bC}	0.395 ± 0.03^{dD}
	4	5.76 ± 0.03^{aC}	0.975 ± 0.002^{cB}	3.79 ± 0.02^{bC}	0.490 ± 0.08^{dC}
	6	6.18 ± 0.06^{aB}	0.981 ± 0.003^{cA}	4.00 ± 0.08^{bB}	0.612 ± 0.04^{dB}
	8	6.49 ± 0.04^{aA}	0.986 ± 0.003^{cA}	4.24 ± 0.11^{bA}	0.736 ± 0.02^{dA}

^{a,b,c,d}Means with different lowercase superscripts within the row are significantly different ($p < 0.05$).
^{A,B,C,D,E}Means with different uppercase superscripts within the column are significantly different ($p < 0.05$).

SENSORY EVALUATION EXPERIMENT

Results of the sensory evaluation of color, flavor, odor and overall acceptability are shown in Table 2. Sensory scores for fresh beef were in the range of 6.93–8.20 in the first day (day 0) which decreased to 4.43 - 5.17 at the end of storage period (day 8), the differences between scores in day 0 and day 8 storage being significant ($P >0.05$). The effect of ingredients can't be ignored soya protein which used in processing of this burger was reported to be an important and widely used as non-meat protein in burger preparation due to its biological value, emulsification and stabilization properties, its high

ability to increase water- holding capacity and its unique ability to improve the texture of the final product (Macedo - Siva *et al*., 2001). On the other hand, the acceptability of beef burger has been correlated with its fat content. Earlier, Cross *et al*. (1980) showed that the burgers with 28% fat content were juicer than that containing 16 – 20% fat. However, Berry (1992) concluded that decreasing fat levels from 20 to 0% lowered the tenderness and juiciness. Beef burger product was acceptable (sensory scores more than 6.9) when stored up to 8 days. These results demonstrated that fresh beef treated with infusing citric acid in concentration of 1.00% was given acceptable scores (P<0.05) from 8 days of chilled storage. The scored values decreased gradually with the storage duration which indicated that, discoloration, loss of added ingredients, microorganism's degradation and lipid oxidation were present in the formulated burger during the chilled storage and gradually affected its quality characteristics (color, flavor, odor, texture and overall acceptability, respectively).

Table 2- Scores of sensory evaluation of control burger during chilled storage at 4oC for 8 days

Days of Storage	Sensory scores				
	Color	Flavor	Odor	Texture	Overall acceptability
0	7.73 ± 1.14^{abA}	7.41 ± 1.24^{cbA}	7.74 ± 1.21^{abA}	6.93 ± 1.51^{cA}	8.20 ± 0.89^{aA}
2	6.50 ± 1.31^{bB}	6.43 ± 1.38^{aA}	5.80 ± 1.52^{cBC}	5.43 ± 1.10^{cBC}	7.83 ± 0.70^{aA}
4	5.87 ± 1.41^{bBC}	5.03 ± 1.19^{cB}	4.83 ± 1.26^{cD}	5.13 ± 1.25^{cCD}	6.87 ± 0.78^{aA}
6	4.53 ± 1.38^{bC}	4.97 ± 1.16^{bcB}	4.30 ± 0.95^{bCD}	4.63 ± 0.72^{cD}	6.22 ± 1.00^{aB}
8	4.43 ± 1.14^{cC}	5.17 ± 0.93^{cB}	4.97 ± 0.85^{bB}	4.63 ± 0.69^{bB}	5.00 ± 0.99^{aB}

^{a,b,c}Means with different lowercase superscripts within the row are significantly different ($p < 0.05$).
^{A,B,C,D}Means with different uppercase superscripts within the column are significantly different ($p < 0.05$).

CONCLUSION

The results of the study showed that treating fresh beef with citric acid in concentration of 1.00% using infusion combined with vacuum technique is effective practice in keeping quality of fresh beef products during storage period and condition mentioned. The burger prepared using citric acid treatment during sensory evaluation according to the sensory attributes used gave high values. The results suggested that this procedure can be utilize successfully to prolong the shelf life of fresh beef and produce acceptable products.

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