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Effect of added levels of citric acid on quality of fresh beef sausages

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Abstract

The study was conducted to evaluate the effect of adding citric acid to see its effect on the shelf life and quality of fresh beef sausage. Different levels (0% control, 0.1%, 0.2% and 0.3 %,) of citric acid were used. Forty eight kilograms of beef and 3.5 kg subcutaneous fat were divided into four groups with 6 replicates. Chemical composition, Cooking loss, water holding capacity, objective colour, PH, oxidative rancidity (TBA), total bacterial counts and sensory evaluation were determined. The results revealed that the moisture, protein, WHC, total microbial count and pH of fresh beef sausage decreased where as fat, ash, cooking loss and shrinkage increased insignificantly as citric acid levels increased. TBA value decreased with increasing the level of citric acid for all treatment Colour and sensory evaluation were not significantly affected. The maximum desired level of citric acid to be added to fresh sausages recipe is 0.2% which is acceptable to the consumer and demonstrated the most potent effect by extending the shelf-life.

Keywords: Citric Acid, Beef Sausage, Quality

Introduction

In recent years there has been an increased consumer demand for convenience or "case ready" meat and meat products requiring minimal home preparation (Stubbs et al., 2002). Meat is a perishable animal product; microbial spoilage of meat has always been of great concern to the food industry. Meat can be a source for food borne pathogenic microorganisms (Paulsen et al., 2006). Today, acidifier additives are used for flavouring, health benefits and other functions besides food preservation. Food acidulates can be used in most foods where acidity is desired or necessary for the keeping quality. Citric acid is the prominent general purpose acidulates. It is used widely in consumed food products, accounts more than 80% of general purpose acidulants used (Frederick, 1999) and inhibits bacteria such as salmonella and *E.Coli* when added to sodium chloride (Ransom et al., 2003).

The objective of this study was to improve the quality characteristics and extending the shelf life of fresh sausages by adding different levels of citric acid.

Materials and Methods

The meat was obtained from mature beef animals (3-4 years old Baggara bulls), purchased from Animal Production Research Centre (kuku). A total of 48 kg of fresh beef, 3.5 kg of subcutaneous beef fat and natural salted sheep casings were obtained. The samples were transported hygienically to the meat laboratories in the Department of Meat Production, Faculty of Animal Production, Shambat (Khartoum North), University of Khartoum. Then the samples were labelled, wrapped and kept in a refrigerator at 2℃ for overnight.

Four different levels of citric acid (0%, 0.1%, 0.2% and 0.3%) treatments were used. Sausages were prepared according to the recipe presented in table (1). Meat and fat for the treatment groups (0%,0.1%, 0.2% and 0.3 %.) were run separately through an electrical meat grinder (8mm and 6mm plate for meat and fat respectively). The other ingredients were weighed and thoroughly mixed by hand and the mixture was reground through a 5mm plate and finally stuffed into pre-soaked salted sheep casings. The stuffed casings were divided into links (units) by twisting; each sausage link was 10cm in length and stored in a freezer for -18℃ for analysis. Six replicates of each treatment were prepared.

Determination of total moisture, ash, protein and fat (ether extract) were performed according to AOAC (1990) methods.

PH was estimated as described by Okerman (1981) while thiobarbituric acid (TBA) was determined by the method of Hoyland and Taylor (1989). Water holding

capacity and cooking loss and shrinkage were conducted by the methods of Babiker and Lawrie (1983) and Nour (2003) respectively. Objective colour measurement and total bacterial counts were also done (Harrigan and MacConce, 1976). These products were also evaluated for sensory characteristics by a panel of students and teachers.

Table 1: Sausage Recipe

Ingredients	Percentage (%)
Lean beef	77
Beef fat S/c	10
Ice water	3
Skim milk	3
Bread crumbs	3
Salt	2
Spice	1.4
Sugar	0.5
Fresh garlic	0.1
Total	100

Statistical Analyses

Data were analyzed by analysis of variance and Duncan's multiple range tests using SPSS (version 10.05) computer program.

Results and Discussion

As presented in table (2) increasing the added level of citric acid to 0.3% to fresh beef sausage has no significant effect (P>0.05) on its chemical composition content. The moisture content of fresh beef sausage decreased as the concentration of citric acid increased, because the acidity (lower pH) reduces the ability of sausage to bind water similar results were found by Carroll (2005) and Aktas et al. (2007). Al-Hajo (2008) reported that protein content was lower in poultry meat containing citric acid and salt. It also agrees with Desmond and Troy (2001) who found that samples treated with citric acid had low protein content when compared with control samples. The fat % increased insignificantly because citric acid prevents oxidation of fat. This result is in line with those obtained by Desmond and Troy (2001) who found that samples treated with citric acid had higher fat content when compared with control samples. Ash percentage showed increasing trend as citric acid level increased, because citric acid diffuses in sausage samples, and this agrees with the result obtained by Al-Hajo (2008) who stated that there was an increase in ash percentage in poultry meat containing citric acid and salt

Our results show that the overall means of pH of the fresh beef sausage samples were reduced significantly (P<0.05) with increasing the level of added citric acid and this could be attributed to its acidic nature (table 3). This result agreed with Hedrick et al. (1994), Sammel and Claus (2003, 2006) who reported that increased acidity will result in lower pH and thus a decrease in the ability of meat to bind water. Meltem et al. (2007) stated that with increasing citric acid concentration, there was a clear decrease in muscle pH.

In table 3, our results regarding thiobarbituric acid (TBA) showed that increasing the citric acid level resulted in a significant decrease (P<0.05) in value of fresh beef sausages because citric acid chelates oxygen and prevents formation of fatty free radicals, which react with or absorb oxygen in the autoxidation process, thus delaying oxidative rancidity in fresh beef sausage. This finding is in line with Shuming et al. (2009) who reported that lipid oxidation was inhibited in cooked beef blocks and ground muscle acidified with citric acid. It also agrees with the results of Madhavi et al. (1996) who stated that citric acid in combination with tocopherols and ascorbyl palmitate is effective in retarding oxidative rancidity in restructured beef patties. It did not differ with the result obtained by Macdonald et al. (2006) who stated that 1000 mg/kg of citric acid reduced TBA values of hams.

Water holding capacity (WHC) decreased with increasing citric acid levels but the decrease was not significant (P>0.05) as presented in table (3). The control (0 level) showed the highest WHC (0.47), where as 0.3 level showed the lowest WHC (0.69) this could be attributed to the decrease in pH which can cause the pH to approach the isoelectric point of myofibrillar proteins and affect the swelling of proteins that reduces the ability of meat to bind water. This result confirms the findings of Hedrick et al. (1994) and Desmond and Troy (2001) who stated that increase the acidity will lower the water holding capacity. This quality was reflected by other water parameters, cooking loss and shrinkage. Cooking loss and shrinkage percentages increased (P>0.05) with increasing citric acid as result of increased acidity (lower pH), which decreased the ability of meat to bind water. Hedrick et al., (1994) Nan et al. (1999), Kieffer et al. (2000) and Sammel and Claus (2003, 2006) obtained similar results. These findings disagree with Oreskovick et al. (1992) who reported that acid treatments decreased cooking loss of beef cores. These results indicated that addition of citric acid resulted in a decrease in WHC and increased cooking loss and shrinkage of fresh beef sausage.

The effects of adding different levels of citric acid on colour components of fresh beef sausage are shown in figure (1). The lightness (L) of fresh beef sausage increased by addition of citric acid because at lower pH and ionic strength, muscle proteins swell and light reflection alters and this results in lighter colour. Arganosa and Marriot (1989) and Kieffer et al. (2000) obtained the same result, they reported that samples

Table 2: Effect of adding different levels of citric acid on chemical composition of fresh beef sausage

Parameter (%)	Citric acid level (%)					
	0	0.1	0.2	0.3	SE	LS
Moisture	64.95	64.12	63.81	63.46	0.84	NS
Protein	18.72	18.70	18.56	18.55	0.24	NS
Fat	11.12	11.27	11.41	11.72	0.19	NS
Ash	1.57	1.58	1.59	1.64	0.08	NS

Table 3: Effect of adding different levels of citric acid on physical properties of fresh beef sausage

Parameters	Citric acid level (%)					
	0	0.1	0.2	0.3	SE	LS
PH	5.78	5.61	5.38	5.21	0.07	*
TBA (mg/ml)	0.09	0.09	0.08	0.08	0.12	*
Cooking losses (%)	21.42	23.14	23.74	23.84	1.7	NS
Shrinkage %	7.7	8.37	9.17	9.70	1.00	NS
WHC	0.47	0.58	0.60	0.69	0.07	NS

Table 4: Sensory evaluation of fresh beef sausage manufactured with different levels of citric acid

Parameters	Citric acid level (%)					
	0	0.1	0.2	0.3	SE	LS
Colour	6.38	6.28	5.89	5.65	0.10	NS
Flavour	6.17	6.11	5.94	5.92	0.14	NS
Juiciness	6.17	5.94	5.83	5.70	0.13	NS
Tenderness	6.17	6.17	5.78	5.53	0.15	NS
Overall acceptability	6.28	6.11	6.06	5.76	0.10	NS

containing citric acid had higher L values, rather than samples not containing citric acid. Alper et al. (2004) reported that the highest lightness was found in steaks marinated with citric acid solution. The redness (a) values of fresh beef sausage showed an increase by increasing citric acid levels, because citric acid prevents oxidation process. The yellowness (b) value increased in level of 0.1% compared to the control. Whereas the levels 0.2% and 0.3% showed decreased compared to the control. Similar results were obtained by Kieffer et al. (2000).

The effect of citric acid levels on sensory evaluation is presented in Table (4). The colour as evaluated by panellists showed a non significant decrease (P>0.05) with the increased level of citric acid, 0 level showed the highest colour score (6.38), while 0.3 level showed the lowest score (5.65).There was a slight non significant decrease (P>0.05) on the other components (flavour, juiciness, tenderness and overall acceptability) with increasing citric acid concentrations. The control (0%) showed the highest scores for flavour, Juiciness, tenderness and overall acceptability while the 0.3% level gave the lowest score for the same parameters studied. This is because acid treatment appeared to enhance the conversion of myoglobin to metmyoglobin, which has lower colour intensity. The flavour also decreased with increasing citric acid concentrations due to souring. Similar results were reported for samples of frankfurters (Lin et al., 2000). Juiciness, tenderness and overall acceptability show similar trend**.**

The effect of citric acid level on total bacterial count is presented in Figure (2). Citric Acid leads to insignificant decrease in total bacterial count. Total bacterial count in level (0%) was (3.99 log 10) it decreased to (3.87 log 10) in level (0.1%) and it was (3.81 log 10) and (3.75 log 10) in the levels (0.2%) and

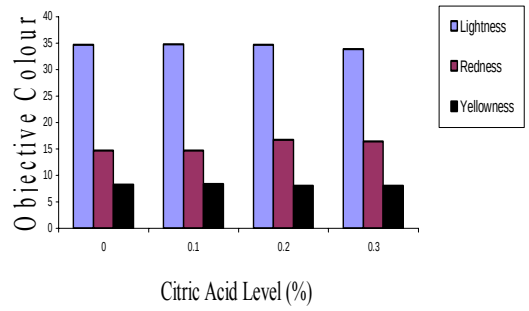

Figure 1: Effect of citric acid level on objective colour of fresh beef Sausage

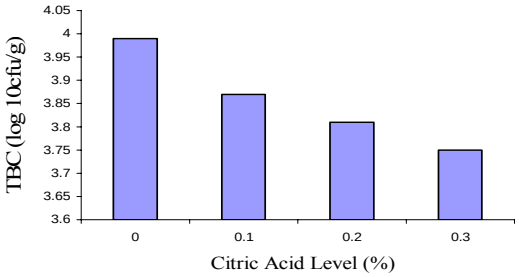

Figure 2: Effect of citric acid level on total bacterial count (log10 cfu/g) of fresh beef sausage; TBC: total bacterial count

(0.3%) respectively. This might be due to the increased acidity which limits microbial growth, because the lower pH disturbs the homeostasis of bacterial cells. These agreed with Mohamed et al. (2008) who stated that organic acids extend the shelf life of fresh by reducing the risk of bacterial contamination.

Conclusions and recommendations

It is concluded that citric acid provides antioxidant and antimicrobial benefits to fresh beef sausage and is recommended as an additive to extend the shelf-life of meat products at levels not more than 0.2% during storage at -18 C.

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