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EFFECT OF NITRITE AND CITRIC ACID ON THE CHEMICAL COMPOSITION AND PH OF THE CANNED BEEF SAUSAGES

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ABSTRACT: The effects of nitrite and citric acid as preservatives on the chemical composition and pH of the canned beef sausage were investigated after three months storage at room temperature (35±5°c). Two experiments were conducted in this study, the first, was undertaken to determine the effect of nitrite as a preservative on the chemical composition and pH of the canned beef sausages retorted at 107.2°C (225°F) for 80 minutes, and at 115.5°C (240°F) for 40 minutes. The second experiment, which was based on the results of the first one, was conducted to determine the effects of the absence of nitrite on the canned beef sausage processed with meat treated by immersion in 1% citric acid before processing at (80 and 30°c) for one minute and drained, then the product retorted at 107.2°C for 80 minutes. The evaluation of percentages of the dry matter, ash, crude protein, fat and also pH were done monthly. The results in experiment 1 indicated that, percentages of the dry matter, ash and crude protein before and after canning of sausages were not significantly different (P>0.05). The fat (%) was significantly different among treatments (P<0.05) in the canned samples, and not in the raw samples. However, there was slight decrease in moisture content (increase in dry matter), ash, protein and fat percentages with increasing of storage period. The results in experiment 2 demonstrated that the dry matter, ash, crude protein and fat percentages were not significantly different (P>0.05) for the raw, cooked and canned sausages. Generally it was observed a decrease in moisture content (increases in dry matter content), ash%, crude protein fat (%) and pH value with increasing of storage period. Citric acid had no clear effect on chemical properties and pH value.

Keywords: Nitrite, Canned sausage, Citric acid.

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INTRODUCTION

New processing concepts such as the application of variable retort temperature have received attention from processing experts and promises to improve both the economy and quality of thermally processed foods (Awuah et al., 2007). In the past Sudanese preferred fresh meat to processed meat, but now the profitability and technological advances, and the change in the life style (the working women have a little time for food preparation), will probably affect the rate and ultimate extent to which meat is processed.

Thermal processing, specifically retort processing, has been used as a common preservation technique in food industry for shelf stable low acid foods. The United States Code of Federal Regulations defines commercial sterility as "The condition achieved by application of heat, chemical sterility, or other appropriate treatment that renders the equipment and containers free of viable microorganisms having public health significance, as well as microorganisms of non health significance, capable of reproducing in the food under normal non refrigerated conditions of storage and distribution (USFDA, 2009). In recent times, with the development of computing technology, programs are available to thermal process requirements, and also online monitoring and controlling of the thermal process (Fellows, 2009).

Meat products that can be stored at room temperature without the risk of microbial spoilage are considered to be shelf stable products. They include canned meats such as ham, tuna and chicken, jerky, dry sausages snack sticks, summer sausage and freeze dried meat. Because these products do not need cold temperatures for preservation, they are popular for camping, trips, hunting and fishing expeditions and other activities where refrigeration may not be available. In addition, they are convenient product to have on hand in your cupboard (Elizabeth, 1994). So in the Sudan the farmers in agricultural areas, the army in the military regions, people in the disaster areas, and regions of the displaced people, are in need of shelf stable and acceptable product that does not require refrigeration. Meat canning is a suitable method of preservation to solve these problems that meet the availability of safe foods in those areas.

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Today consumers all over the world especially in industrialized and developed countries increasingly demand minimally processed foods and food stuffs, which retain natural flavor, color, texture, nutritional characteristics, and contain fewer additives (e.g. preservatives) especially chemical additives (Ohlsson and Bengtsson, 2002). Accordingly to encourage the consumption of processed meat we must get rid of the use of chemical additives, as nitrite has been reported to be carcinogenic above and beyond its possible role in formation of nitrosamines (Person and Tauber, 1989). Qing-Lidong et al. (2007), indicated that no significant difference existed among the pH values and fat content of the cooked sausage with different sodium nitrite addition. The objectives of the study were, to investigate the use of many preservatives in canning in order to decrease the time and temperature required for commercial sterilization, to evaluate the necessity of using nitrite in canned sausages by examining its effect on chemical composition and pH of canned beef sausages, and also to develop a meat product that does not need freezing or refrigeration and accessible to people living in remote areas.

MATERIALS AND METHODS

Experiment 1

Approximately 7 kg of lean meat (top side) cut were taken from beef animals of similar breed and age after 24 hours from slaughter at Meat Technology Department in Kuku Animal Production Research Centre and used in sausage preparation. The meat was ground through (0.64 cm diameter) plate of an electrical meat grinder. Synthetic cellulose casings were obtained from local market and round sanitary acid-resistance cans (6.83cm in diameter and 10.16cm in. height of nominal capacity 315 gm) were obtained from a local processing plan .

Sausage preparation

The ground meat (6 kg) was divided into two equal batches, one batch was formulated using the ingredients in Table 1 and 155 ppm sodium nitrite while the other was formulated using the same ingredients in Table 1 without addition of nitrite and considered as control. Each batch was chopped separately. The chopper was started after the minced meat was introduced. Salt, nitrite (in one batch), and half of the recommended ice water were added and uniformly dispersed. Then, the binder and seasoning were added together, with the remainder of the recommended ice water. The entire mass for each batch was chopped for about 5 minutes. The batter for each batch was then stuffed into cellulose casings of 22 mm in diameter and linked at length about 8 cm . The product was cooked for 15 minutes in boiling water followed by immediate cooling in ice water for 5 min. The sausages were peeled, packed in polyethylene bags and stored in refrigeration (4°C) over night. The product of each batch was divided into two treatments, in one treatment the canning was done by retorting at 107.2°C for80 minutes, and in the other treatment the canning was done by retorting at 115.5°C for 40 minutes and considered at 0 month storage. The other samples were awaiting chemical test at intervals of 1, 2, 3 months of storage.

Canning operation

The empty cans were spray washed with26.5°C water in accordance with federal meat inspection regulation (Pearson and Tauber, 1989). Each batch of the product was subdivided into two portions, one part to be canned, and retorted at 107.2° C for 80 min, and the other part to be canned and retorted at 115.5°C for 40 minutes. The cans were filled with sausages. Seven pieces (links) of sausage weighing about 160(g) were put in each can. Then the remaining space was filled with decontaminated boiling water. The cans were closed by double sealer machine (Mp 502120207/s) in the Canning Unit of the Food Research Centre, Shambat. Cans were placed into a vertical non-agitating retort. After retorting cans were water cooled by immersing in a cold water tank. Temperature of water was approximately (15°c). The wet cans were dried by heat which was permitted to accelerate evaporation (Pearson and Tauber, 1989).

Product storage

The cans were labeled and stored at room temperature Table(2) , 30gm of samples were taken randomly after 72 hours (incubation period)from canning for chemical analysis.

Table 1: Ingredients based on total mixed base

Ingredients	Percentage
Cold water (crushed ice)	12.20
Salt	2.40
Ground pepper	0.30
Sugar	0.30
Mustard powder	0.20
Skimmed milk powder	3.40

Experiment 2

Meat preparation: Meat samples were taken from beef animals of similar breed and age after 24 hours from slaughter at the Meat Technology Department in Kuku Animal Production Research Center.

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Approximately 7 kgs of lean meat (top-side) cut were trimmed to a minimum amount of fat were used in sausage preparation in each replicate (three replicates were performed for each treatment). The lean meat was divided into two batches, one batch treated with citric acid and another batch treated with decontaminated water (free of contamination by water filtration). Each batch was divided into two parts. The first part was dipped in 1% (at 30ºC) citric acid for one minute and drained for one minute. The 2nd part was dipped in 1% citric acid at (80ºc) for one minute and drained for one minute. The third part was dipped in decontaminated water at 30ºC for one minute and drained for one minute. The fourth part was dipped in decontaminated water at 80ºC for one minute and drained for one minute. The meat was ground through 0.25 in/plate of electrical meat grinder. The same casings and cans as in experiment 1 were used. Four treatments were obtained: sausages processed with meat dipped in 1% citric acid at 30ºC for one minute and retorted at 107.2 ºC for 80 minutes, sausages processed with meat dipped in 1% citric acid at 80ºc and retorted at 107.2ºC for 80 minutes, sausages processed with meat dipped in decontaminated water at 30ºc for one minute and retorted at 107.2ºC for 80 minutes ,Sausages processed with meat dipped in decontaminated water at 80ºc for one minutes and retorted at 107.2Cº for 80 minutes.

Sausages preparation

Sausages were prepared following the previously mentioned procedures in experiment one. Random samples of raw (uncooked) and cooked sausages were taken for chemical analysis and pH measurement.

Sausages canning

All procedures of canning were performed as in experiment one except the retorting was done for all treatments at 107.2ºC for 80 minutes.

Product storage

The cans were labeled and stored for three months at room temperature Table 2 waiting chemical analysis and pH measurement every month. Each variable determination was replicated three times.

Proximate analysis

Three sausage links were taken randomly from each treatment of the pre-cooked and canned sausages and then a proximately 50 gm portion were taken from different places of each link, and mixed well to assure a representative sample for proximate analysis and pH measurement. .Moisture, crude protein, fat and ash content were determined accordingly to the A.O.A.C. (2002) methods.

Statistical Analysis

Statistical analysis was performed on all data of the various experiments using SPSS and was subjected to analysis of variance (ANOVA). Least significant difference (LSD) was used for mean separation (Gomez & Gomez, 1984).

Table 2: Average temperature and humidity of storage for the canned sausages

No. of experiment	Period of storage	Temperature C°	Humidity %
1	First month	35.30	32.25
	Second month	31.90	23.25
	Third month	30.50	21.30
2	First month	30.10	16.20
	Second month	30.90	14.80
	Third month	35.70	21.10

Table 3: Means and standard errors (S.E) for Dry matter%, Ash %, Crude Protein %, Fat% and pH of the raw sausage treatments*

Independent Variables	Treatment*		S.E
	Nitrite		
	with	Without	
Dry mater %	30.24 [a]	30.15 [a]	± 0.30
Ash %	2.17 [b]	2.28 [b]	± 0.04
Protein	20.28 [c]	19.58 [c]	± 0.23
Fat %	2.82 [d]	2.50 [d]	± 0.11
PH	6.97 [e]	6.92 [e]	± 0.03

a,b,c,d,e :Means in the same row bearing similar superscripts are not significantly different (P>0.05).

* Sausages canned using 107.2°C and 115.5°C processing temperatures with and without nitrite.

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RESULTS AND DISCUSSION

Experiment 1

Proximate composition: The results in (Table 3) showed that, addition of nitrite was not affected significantly (P>0.05) on the dry matter, ash, crude protein as well as fat content of the raw product (pre-canning) although there was a slight decrease in protein content of the sausages processed without nitrite. Qing- Lidong et al. (2007) in their study for determining the effect of sodium nitrite on the textural properties of cooked pork sausages during days at 0-21ºC storage which were prepared at four levels of sodium nitrite (0, 50, 100 and 150mg/kg), found significant differences in moisture and protein content between the control and nitrite added sausages (P<0.05), but not for fat contents among the different batches. As for fat content the results are agree with the previous study. The disagreement between the results of the previous study and these results concerning the dry matter, ash and crude protein, may be due to the difference in amount of nitrite used, that we use(155 p.p.m) in the processing ,also the difference in type of meat used ,that pork was other than beef . Qing-lidong et al., 2007 in their study of nitrite added sausages during cold storage, found that there was no significant difference in fat contents between the different batches and the control.

Table 3: Means and standard errors (S.E) for Dry matter%, Ash %, Crude Protein %, Fat% and pH of the raw sausage treatments*

Independent Variables	Treatment*		S.E
	Nitrite		
	with	Without	
Dry mater %	30.24 [a]	30.15 [a]	± 0.3
Ash %	2.17 [b]	2.28 [b]	± 0.04
Crude protein %	20.28 [c]	19.58 [c]	± 0.23
Fat %	2.82 [d]	2.50 [d]	± 0.11
pH	6.97 [e]	6.92 [e]	± 0.03

[abcde] Means in the same row bearing similar superscripts are not significantly different (P>0.05).

* Sausages canned using107.2 and 115.5 °C processing temperatures with and without nitrite.

The dry matter% as shown in Table 4 was increased with the increasing of storage period but the increase was not significant (P>0.05); also the increase in processing temperature caused slight increase in dry matter content. These findings are in agreement with Pearson and Tauber (1989) who reported that, cooking decrease the water content of raw meat, especially on the surface which intern lower the water activity and improves the peal ability of frankfurters and extended their shelf life. The results are also agreed with that reported by Garcia-Arias et al. (2004) and Garcia et al. (1994). As reported by Rasmussen and Morrissey (2007), who found that, percent moisture decreased significantly following the canning process. Leblanc and Leblanc (2007) mentioned that, assessed samples of vacuum canned frozen control lobster meat and meat retorted for 28, 35, 40 and 45min, respectively. Results showed a decrease in moisture content with sterilization.

Table 4: Means and standard error (S.E) for Dry matter % of the various canned sausage treatments*.

Storage (month)	Treatment *				S.E
	107.2 °C		115.5°C		
	Nitrite		Nitrite		
	Without	With	Without	With	
0	27.55[a]	29.08 [a]	28.55 [a]	28.15 [a]	± 0.16
1	30.06 [a]	29.51 [a]	29.49 [a]	30.00 [a]	

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2	30.43 [a]	30.79 [a]	30.29 [a]	31.24 [a]	
3	32.20 [a]	31.94 [a]	32.04 [a]	32.22 [a]	

[a]Means bearing similar superscripts are not significantly different (P>0.05).
* Sausages canned using 107.2°C and 115.5°C processing temperatures with and without nitrite.

The results in Table 5 explained that, there was a decrease in ash% with increasing of storage period irreversible to the action of nitrite which caused and increase in ash%. The results are in agreement with the findings of Slabyj and Carpenter (2006) who were analyzed blue muscles (mytilus edules), the raw and processed meats (fresh, frozen and canned) for proximate composition and mineral content. Initial steaming of blue muscles resulted increase in dry weight of meats but a decrease in carbohydrates and ash content.

Table 5: Means and standard error (S.E) for Ash % of the various canned sausage treatments*.

Storage (month)	Treatment *				S.E
	107.2°C		115.5°C		
	Nitrite		Nitrite		
	Without	With	Without	With	
0	2.30[a]	2.10[a]	2.22[a]	2.13 [a]	± 0.1
1	1.70[a]	1.90[a]	1.45[a]	1.85 [a]	
2	1.40[a]	1.60[a]	1.42[a]	1.80 [a]	
3	1.40[a]	1.60[a]	1.48[a]	1.70 [a]	

[a]Means bearing similar superscripts are not significantly different (P>0.05).
* Sausages canned using 107.2°C and 115.5°C processing temperatures with and without nitrite.

As shown in the results of protein% (Table 6) the addition of nitrite in canned sausage kept the protein% higher than the control (without nitrite). Generally the protein% was slightly decreased with increasing of storage period, but the difference was not significant among treatments (P>0.05). The increase in canning temperature (107.2-115.5ºC) was not affected the protein content for the different treatments. These results are in agreement with Qing-Lidong et al. (2007) who found significant differences in moisture and protein contents between the control and nitrite added sausage. The increase temperature of canning was slightly affected on the protein content. Aberle et al. (2001) stated that, when proteins of muscle are exposed to heat, they lose their native structure and undergo several changes in configuration which may be accompanied or followed by aggregation, or clumping, of protein molecules (coagulation), the presence of which indicates a loss in protein solubility. The net protein utilization of meat autoclaved in the laboratory in the presence of wheat flour and glucose was 70 compared with a value of 78 for the same meat autoclaved alone. Low net protein utilization value of the canned meat product is due both to the high content of connective tissue and the loss of available methionine on canning in the presence of the other food stuffs (Bender and Husaini, 1976).

Table 6: Means and standard error (S.E) for crude protein % of the various canned sausage treatments*.

Storage (month) Month	Treatment *				S.E
	107.2°C		115.5°C		
	Nitrite		Nitrite		
	Without	With	without	With	
0	18.75[a]	20.20[a]	18.80[a]	20.55[a]	± 0.03
1	18.47[a]	19.62 [a]	18.20[a]	19.55[a]	
2	17.77[a]	18.87[a]	17.70[a]	18.75[a]	
3	17.48[a]	17.0[a]	17.50[a]	17.90[a]	

[a] Means bearing similar superscripts are not significantly different (P>0.05).
*Sausages canned using 107.2°C and115.5°C processing temperatures with and without nitrite.

As for fat% there was a significant decrease in fat content with increasing of storage period (Table 7; P>0.05). The increase in processing temperature (115.5-117.2)ºC did not significantly affected on fat content. Addition of nitrite had no significant effect on fat% except for the two samples that processed with and without nitrite and canned at 115.5ºC. These results are disagree with the Quing-Lidong et al. (2007) who found no significant difference in fat between the control and nitrite added sausage (P<0.05). Rasmussen & Morrissey (2007) reported that, percent lipid decreased significantly after canning. This finding was in agreement with our results in the present study. Garcia-Arias et al., 2004 and Garcia Arias et al., 1994, found that the canning process


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has been reported to alter the proximate composition of albacore tuna resulting in a large increase in percent tepid which was not in agreement with our findings and this may be due the difference in the type of meat. During chopping the fat is coated with protein. Myosin in particular plays a very important role in completely covering the fat particles. Once the fat coated with myosin, of stable only for a period of hours, or all most about a day. Heating the emulsion, however, coagulates the protein and stabilizes the emulsion, so that the protein holds the fat in suspension for unlimited period of time (Pearson and Tauber, 1989).

Table 7: Means and standard error (S.E) for fat % of the various canned sausage treatments*.

Storage (month)	Treatment *				S.E
	107.2°C		115.5°C		
	Nitrite		Nitrite		
	Without	With	Without	With	
0	2.57b	2.92[a]	2.77[a]	2.77[a]	± 0.08
1	2.02[c]	2.28[d]	1.95[ce]	2.33[d]	
2	1.61[fgm]	1.69ghi	1.65[fhk]	1.83[ei]	
3	1.42[j]	1.5[gkj]	1.42[jl]	1.45[jm]	

[a,b,c,d,e] Means bearing different superscripts are significantly different (P<0.05).
* Sausages canned using 107.2°C and115.5°C processing temperatures with and without nitrite.

Experiment 2

Proximate composition: Raw and cooked sausages were analyzed for dry matter, ash, crude protein and fat percentage. The results as shown in Table 9 indicated that, there was no significant difference among treatments for all variables. However, raw sausages scored low values for dry matter (high moisture), crude protein, fat and ash content compared to the cooked sausages. Citric acid was not significantly affected on dry matter, crude protein, fat and ash content for the various sausage treatments compared to the control and this may be due to its low concentration (1%). These results are in agreement with Abrele et al., (2001) who were reported from the U.S. Department of agriculture Hand book the proximate composition and caloric content of separable lean of raw and cooked retail cuts of beef which indicate that (protein, fat and ash) percentage were increased in the cooked retail cuts while the moisture% decreased in comparison with the raw cuts. Also Pearson and Tauber (1989) explained that, cooking decrease the water content of raw meat and leads to denaturation and coagulation which involves change in the protein molecule. This may be due to unfolding of the protein or the loss of its characteristic conformation, which decreases its solubility. Chiou et al. (2004) reported that, in small abalone meats were heated at 80ºC and 98ºC for 0-120 min, the decrease in moisture and weight were relatively higher for cooking at 98ºC than at 80ºC.

Table 9: Means and standard errors (S.E) for Dry matter %, Ash %, Crude Protein %, Fat % and pH of the various sausage treatments*

Independent Variables	Treatment *				S.E
	Citric acid (1%)		Treated water		
	30°c	80°c	30°c	80 °c	
Dry matter (%)	25.69[a]	26.53[a]	25.61[a]	29.0[a]	± 0 .35
Raw sausages	26.69[a]	26.63[a]	30.22[a]	31.64[a]	
Cooked sausages					
Crude protein (%)	18.85[b]	19.1[b]	18.63[b]	18.83[b]	± 0.09
Raw sausages	19.47[b]	19.2[b]	20.28[b]	19.95[b]	
Cooked sausages					
Fat (%)	2.83[c]	3.12[c]	3.03[c]	3.18[c]	± 0.07
Raw sausages	3.22[c]	3.25[c]	3.13[c]	3.23[c]	
Cooked sausages					
Ash (%)	2.07[d]	2.37[d]	2.07[d]	2.37[d]	± 0.07
Raw sausages	2.12[d]	2.12[d]	2.28[d]	2.17[d]	
Cooked sausages					
pH	7.05[e]	6.98[e]	6.82[e]	6.78[e]	± 0.0 8
Raw sausages	6.88[e]	7.05[e]	6.8[e]	6.95[e]	
Cooked sausages					

[a, b, c, d, e] Means for each independent variable bearing similar superscripts are not significantly different (p>0.05).
* Raw meat was dipped in 1% citric acid at 30 °c and at 80° c (dipping and draining were performed for 1 minute in each treatment before processing).

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Raw meat was dipped in treated water at 30 °C and at 80 °C (dipping and draining were performed for 1 minute in each treatment before processing).

Means and standard error for dry matter% showed no significant difference among treatments (Table 10; P>0.05) although there was slight increasing in dry matter% age (decrease in moisture %) with increasing of storage period.

Table 10: Means and standard error (S.E) for dry matter % of the various sausage treatments*.

Storage (month)	Treatment *				S.E
	Citric acid (1%)		Treated water		
	30° C	80°C	30°C	80°C	
0	31.08 [a]	30.32 [a]	31.73 [a]	30.43 [a]	± 0.51
1	32.57 [a]	31.76 [a]	33.69 [a]	34.94 [a]	
2	34.6 [a]	33.43 [a]	34.44 [a]	33.04 [a]	
3	35.23 [a]	34.42 [a]	35.47 [a]	34.92 [a]	

[a] Means bearing similar superscripts are not significantly different (p > 0.05).
* Raw meat was dipped in 1% citric acid at 30 °C and at 80°C (dipping and draining were performed for 1 minute in each treatment before processing).
Raw meat was dipped in treated water at 30 °C and at 80°C (dipping and draining were performed for 1 minute in each treatment before processing).

As for crude protein the results in (Table 11) shows slight decrease in the protein content by increasing time of storage, but the difference was not significant. Citric acid and the difference of its temperature had no significant effect on the protein content. Bender and Husaini (1976) pointed that low net protein utilization value of the canned meat product is due both to the high content of connective tissue and the loss of available methionine on canning in the presence of the other food stuffs. Desrosier and Desrosier (1977) demonstrated that, denaturation of protein may be brought about by heat in the presence of moisture. When so denatured, the configuration of the nature protein molecules is lost and specific immunological properties which distinguish most proteins are diminished.

Table 11: Means and standard error (S.E) for crude protein % of the various sausage treatments*.

Storage (month)	Treatment *				S.E
	Citric acid (1%)		Treated water		
	30° c	80 °c	30° c	80 °c	
0	18.75 [a]	18.30 [a]	18.12 [a]	18.78 [a]	± 0.22
1	17.43 [a]	17.47 [a]	17.35 [a]	17.47 [a]	
2	17.10 [a]	16.90 [a]	16.75 [a]	16.78 [a]	
3	16.39 [a]	16.53 [a]	16.23 [a]	16.29 [a]	

[a] Means bearing similar superscripts are not significantly different (p > 0.05).
* Raw meant was dipped in 1% citric acid at 30 °C and at 80 °C (dipping and draining were performed for 1 minute in each treatment before processing).
Raw meant was dipped in treated water at 30 °C and at 80 °C (dipping and draining were performed for 1 minute in each treatment before processing).

There was no significant difference among treatments for fat% (Table 12; P>0.05). Nevertheless fat content was slightly decreased with increasing of storage period. Citric acid caused no change in the fat content as the increase in its temperature.

Table 12: Means and standard error for fat % of the various sausage treatments*.

Storage (month)	Treatment *				S.E
	Citric acid (1%)		Treated water		
	30° c	80 ° c	30° c	80 ° c	
0	2.35 [a]	2.97 [a]	2.97 [a]	3.2 [a]	± 0.11
1	2.35 [a]	2.32 [a]	2.50 [a]	2.43 [a]	
2	1.69 [a]	1.62 [a]	1.49 [a]	1.91 [a]	
3	1.46 [a]	1.39 [a]	1.34 [a]	1.44 [a]	

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A Means bearing similar superscripts are not significantly different (p > 0.05).
* Raw meat was dipped in 1% citric acid at 30 °C and at 80 °c (dipping and draining were performed for 1 minute in each treatment before processing).
Raw meat was dipped in treated water at 30 °C and at 80 °C (dipping and draining were performed for 1 minute in each treatment before processing).

As for ash there was no significant difference among treatments (Table 13; P>0.05), but we observed that, the ash content was decreased by increasing of storage period. Citric acid as the difference in its temperature had no significant effect on ash content. Slabyj and Carpenter (2006) claimed that blue mussels (mytilus edulis) have been frozen or canned, the raw and processed meats (fresh, frozen and canned) were analyzed for proximate composition and mineral content. Initial steaming of blue mussels resulted in significant increase in dry weight of meats but a decrease in carbohydrates and ash content.

Table 13: Means and standard error (S.E) for ash % of the various sausage treatments*.

Storage (month)	Treatment *				S.E
	Citric acid (1%)		Treated water		
	30 °c	80 °c	30 °c	80 °c	
0	2.38 a	2.58 a	2.38 a	2.45 a	± 0.19
1	1.68 a	1.72 a	1.62 a	2.22 a	
2	1.48 a	1.31 a	1.35	1.65 a	
3	1.35 a	1.17 a	1.20 a	1.21 a	

A Means bearing similar superscripts are not significantly different (p > 0.05).
* Raw meat was dipped in 1% citric acid at 30 °C and at 80 °C (dipping and draining were performed for 1 minute in each treatment before processing).
Raw meat was dipped in treated water at 30 °C and at 80 °C (dipping and draining were performed for 1 minute in each treatment before processing).

CONCLUSION

It would be concluded that, the canned beef sausages will be of good chemical properties if processed without added nitrite and retorted at 115.5°C for 80 minute at least for 3 months of storage at room temperature. So, we could get rid of nitrite which caused some problems in the meat industry.

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