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Effects of sodium lactate and/or potassium lactate on the quality of beef frankfurter

(Kesan natrium laktat dan/atau kalium laktat terhadap kualiti frankfurter daging lembu)

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Key words: sodium lactate, potassium lactate, beef, frankfurter

Abstrak

Kesan natrium laktat dan/atau kalium laktat terhadap kualiti frankfurter daging lembu telah dikaji. Natrium laktat dan/atau kalium laktat dicampur ke dalam emulsi frankfurter daging lembu pada kepekatan 1%, 2% and 3% natrium laktat, 1% natrium laktat bersama 2.3% kalium laktat, 2% natrium laktat bersama 1.2% kalium laktat, dan hanya 3.4% kalium laktat. Frankfurter daging lembu yang dirumus tanpa natrium laktat, kalium laktat atau campuran natrium dan kalium laktat dilabel sebagai kawalan. Kestabilan emulsi dan hasil dari rumah asap tidak terjejas dengan penggunaan natrium laktat dan/atau kalium laktat. Penggunaan natrium laktat dan/atau kalium laktat tidak menjejaskan tekstur, kemasinan dan perisa. Berdasarkan skor bau terubah, mulai hari yang ke-21, sampel kawalan mempunyai bau yang tidak digemari berbanding dengan sampel lain. Pada masa ini juga, sampel kawalan mengeluarkan sedikit lendir cecair berbanding dengan sampel lain.

Abstract

The effects of sodium lactate and/or potassium lactate on the quality of beef frankfurter were evaluated. Sodium lactate and/or potassium lactate were incorporated into the beef frankfurter emulsion at concentrations of 1%, 2% and 3% sodium lactate, 1% sodium lactate with 2.3% potassium lactate, 2% sodium lactate with 1.2% potassium lactate, and only 3.4% potassium lactate. Frankfurter processed without the addition of sodium lactate, potassium lactate or combination of sodium lactate and potassium lactate served as control. Emulsion stability and smokehouse yield were not affected by the addition of sodium lactate and/or potassium lactate. The addition of sodium lactate and/or potassium lactate did not affect the texture, saltiness and off-flavour of the product. Based on off-odour scores, the control was detected to have objectionable off-odour sooner than the treated group, starting at day 21. During this time, the control showed a slightly cloudy purge appearance compared to the treated groups.

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Introduction

Today, with respect to food spoilage, the issue of food preservation has grown to be more complex as new food products are frequently being introduced that require longer shelf life and greater assurance of protection from microbial spoilage. Currently, consumers are concerned about their health and are demanding for higher food quality products. Furthermore, the consumers are concerned about food spoilage and are more aware of the danger from consuming contaminated food by microorganisms.

In the meat industry, two of the high risk products associated with *Listeria* are hotdogs and roast beef (Allen 1989). This organism can grow on a variety of processed meat products at refrigerated temperature (Glass and Doyle 1989). Thus, the long-held belief that refrigeration at 4–7 °C would prevent the growth of foodborne pathogens is clearly not valid. The industry can no longer rely entirely on refrigerated storage to be assured of pathogen control.

With technological advancement, several new and innovative products have been introduced where many displaying a longer shelf life. One such product is lactate salts (e.g. sodium lactate and potassium lactate). The USDA has approved sodium lactate as a flavour enhancer in meat products at the 2% level (3.33% of the liquid at 60% solids). It is also approved as an antimicrobial agent at up to 4.8% (8.0% of the liquid at 60% solids) (Anon. 1987). In support, the Food and Drug Administration (FDA) has affirmed that potassium lactate and sodium lactate are generally recognized as safe (GRAS) for use as direct human food ingredients. The use of meat product additives such as lactate salts (e.g. sodium, potassium, calcium or ammonium lactate), should be investigated as a possible safeguard against spoilage and pathogenic organisms. It is hoped that there is a synergistic effect of salt, nitrite and lactate salt in suppressing or inhibiting the survival of the organisms without significantly affecting the quality of the products.

Today, many meat processors are investigating ways to reduce the level of sodium chloride in meat products by substituting with other salts. This is due to the fact that a rise in blood pressure has been associated with the increased intake of sodium. It has been shown that potassium protects rats from the effects of high blood pressure induced by a high sodium chloride intake (Meneely and Battarbee 1976). Besides, sodium lactate can be used in frankfurter-type sausages as a replacement for sodium chloride (Igoe 1989). This study was undertaken to determine the quality of beef frankfurters treated with sodium or potassium lactate, or a combination of sodium and potassium lactate.

Materials and methods

Formulation and processing

Meat blocks were divided into lean and fat sources which made up various ratios of lean to fat. These meat blocks were placed in cardboard boxes and then frozen at –16 °C. A day before manufacturing the frankfurters, the meat blocks were removed from the freezer and the lean and fat sources were fabricated separately to produce a 25 kg batch per treatment. The fabricated raw materials were then stored in a chiller at 2 °C for thawing. Once thawed, the lean and fat sources were coarse ground separately through a 0.5 inch plate using a Holly Matic grinder (Model GMG 150). The lean and fat sources were then mixed separately using a Leland "Double Mixer" Food Mixer (Model L 100 DA) for 1 min and representative samples for fat determination were obtained. Fat determination involves the Foss-let procedure (AOAC 1983). The coarse ground lean and fat sources were then frozen overnight and then thawed at 2 °C for 48 h before manufacturing the frankfurters.

Formulations were designated to yield 30% fat, while spices, prague powder, sodium erythorbate, salt, and sugar remained constant. Seven batches of frankfurters were prepared. The first batch contained no lactate and acted as a control group. The second, third and fourth batch were formulated to contain 1.0%, 2.0% and 3.0% sodium lactate, respectively, while the seventh batch contained 3.4% potassium lactate. The other two remaining batches were formulated by incorporating sodium lactate with potassium lactate in a ratio of 1:2.3 and 2:1.2 for the fifth and the sixth batch, respectively.

Standardized processing procedures were followed and the lean and fat sources were maintained at 0 °C. The lean source was chopped with ice water using a bowl chopper (RMF-Type RSV 35). Then, the fat source was added followed by other additives and all these ingredients were continuously chopped until an end-point temperature of 18.3 °C was reached. The blended material was transferred to a stuffer (VEMAG Robot 500) and stuffed into a 22 mm cellulose casing. The stuffed product was linked every 125 mm using an automatic linker (MF TY linker - model 90 ACL).

All batches were labelled and weighed separately before the product was smoked and cooked in a Vortron smokehouse (model # 500). The smoking and cooking cycle was as follows: 15 min at 54.4 °C, 30 min at 60 °C with smoke, 30 min at 76.7 °C until the internal temperature of the product was 68.3 °C. The frankfurters were steamed for 5 min, showered for 30 min, drained for 30 min, weighed and chilled at 1.7 °C for 24 h. After chilling the frankfurters were weighed again and the casings were then peeled. The product was then vacuum packaged in *Barrier Bag*.

Emulsion stability

Emulsion stability was performed by the test developed by Townsend et al. (1968). Three 34 g samples of raw emulsion from each treatment were placed into polycarbonate tubes (2.22 cm x 10.16 cm), capped and heated to 69 °C in a water bath. The separated material was collected in a graduated 15 mL centrifuge tubes and the volume of water and fat released in each tube was determined from the interface. Emulsion stability was expressed as the average volume of fat and water released per 34 g emulsion.

Chemical analysis and pH

The percentage of moisture by drying, fat by ether extraction and protein by Kjeldahl (AOAC 1983) were determined on all emulsion and final cooked products. The pH of the emulsion and the cooked products were monitored by adding 25 mL distilled water to 5 g of each tested material. For the final cooked products, the pH values were recorded at the first day of vacuum packaging of the frankfurters and thereafter at one week intervals. The pH measurements of the raw ingredients that is, lean and fat sources were also conducted. All the pH values were obtained using Corning pH meter (model 130).

Sensory evaluation

Preliminary selections of 10 panellists were conducted based on their ability to differentiate various levels of salt intensity. Texture (firmness), saltiness and off-flavour were evaluated using the hedonic scales method. Frankfurters were warmed by holding them in boiling water for 8 min. Then they are cut into portions of 2 cm each, after which the portions were placed in warm capped glass containers and presented to the panellists for evaluation. At each session, the samples were tasted in individual booths under coloured lights. Panellists were asked to cleanse their palate with apple juice warmed to room temperature between samples.

Retail evaluation

Six trained panellists were used to visually evaluate the differences among the frankfurters. Training was held prior to actual testing by showing the panellists the characteristic differences among the frankfurters purchased at a retail shop. Purge and off-odour were evaluated using the hedonic scale method. All evaluations were done during retail display under fluorescent natural light. A three-digit number was randomly assigned to each package to avoid bias judgement. The first evaluation was done on the day of vacuum packaging of the products and thereafter at every one week intervals.

Statistical analysis

The experimental design for retail evaluation and microbial analysis consisted of a repeated measures experiment utilizing multivariate analysis with the factors being experiment, days of storage and treatments. Specific orthogonal contrasts were conducted for comparisons of the treatment means within each day where appropriate. Others were analysed by univariate analysis and specific orthogonal contrasts were performed. Data collected from this study were analysed using PROC GLM found in Statistical Analysis System (SAS 1985). Significance was determined by the F-test and significant differences were accepted at the 5% level of probability.

Results and discussion

Emulsion stability was expressed as millilitres of fat and water released upon heating per 34 g of emulsion. No significant differences were observed in fat or water released due to the addition of sodium lactate and/or potassium lactate when compared to the control *(Table 1)*. Similarly, the release of fat or water from the product from all comparisons was significantly different *(Table 1)*. The addition of sodium lactate and/or potassium lactate did not significantly increase or decrease the smokehouse yield of the product after cooking or after chilling *(Table 1)*. Again, the addition of sodium lactate and/or potassium lactate did not significantly affect the moisture, fat and protein content of the product *(Table 2)*.

The mean values for different treatments of sodium lactate and/or potassium lactate and the P-values of the

Table 1. Mean values and P-values for F-test of specific orthogonal contrasts for emulsion stability and smokehouse yield of frankfurters processed with different amounts[a] of sodium lactate (NaLac) and/or potassium lactate (KLac)

	Emulsion stability (mL)[b]		Smokehouse yield (%)[c]	
	Fat	Water	After cooking	After chilling
Treatments	Means			
(1) Control	1.53 ± 0.46	6.22 ± 0.88	83.07 ± 0.04	81.37 ± 2.45
(2) 1% NaLac	1.54 ± 0.58	6.46 ± 0.91	82.90 ± 2.19	82.11 ± 2.98
(3) 2% NaLac	1.35 ± 0.80	6.16 ± 1.18	83.24 ± 2.10	82.74 ± 2.81
(4) 3% NaLac	1.99 ± 0.76	6.39 ± 0.86	82.23 ± 1.50	82.02 ± 1.80
(5) 1% NaLac + 2.3% KLac	1.87 ± 0.68	7.08 ± 0.79	82.86 ± 2.76	82.00 ± 3.98
(6) 2% NaLac + 1.2% KLac	1.53 ± 0.59	6.47 ± 1.04	82.39 ± 1.40	81.69 ± 2.39
(7) 3.4% KLac	2.03 ± 0.69	6.38 ± 1.22	82.81 ± 2.29	82.70 ± 2.45
Comparisons[d]	P-values			
1 vs 2,3,4,5,6,7	0.3806	0.3283	0.6412	0.1578
2 vs 3,4,5,6,7	0.3067	0.7149	0.7862	0.8243
3 vs 4,5,6,7	0.4961	0.8910	0.3816	0.2816
4,7 vs 5,6	0.2307	0.2404	0.8726	0.3247
4 vs 7	0.8988	0.9878	0.5377	0.3586

[a]Expressed as percentage of raw meat block weight
[b]Expressed as mean and standard error
[c]Expressed as mean and standard deviation
[d]Value significantly different if $p \leq 0.05$

Table 2. Mean values[a] and P-values for F-test of specific orthogonal contrasts for proximate composition of vacuum packaged beef frankfurters which were processed with different amounts[b] of sodium lactate (NaLac) and/or potassium lactate (KLac)

	Moisture (%)	Fat (%)	Protein (%)
Treatments	Means		
(1) Control	56.60 ± 0.31	25.45 ± 0.23	16.21 ± 0.12
(2) 1% NaLac	56.50 ± 1.15	25.12 ± 0.90	16.37 ± 0.31
(3) 2% NaLac	55.75 ± 0.31	25.87 ± 0.16	15.89 ± 0.35
(4) 3% NaLac	56.46 ± 0.28	25.33 ± 0.13	15.90 ± 0.26
(5) 1% NaLac + 2.3% KLac	55.14 ± 1.04	25.93 ± 0.59	16.00 ± 0.64
(6) 2% NaLac + 1.2% KLac	55.32 ± 0.92	25.97 ± 0.69	15.85 ± 0.57
(7) 3.4% Klac	55.31 ± 0.98	26.24 ± 0.91	15.65 ± 0.28
Comparisons[c]	P-values		
1 vs 2,3,4,5,6,7	0.2834	0.6774	0.4983
2 vs 3,4,5,6,7	0.2631	0.3077	0.2184
3 vs 4,5,6,7	0.8018	1.0000	0.9161
4,7 vs 5,6	0.3692	0.8002	0.6679
4 vs 7	0.2702	0.3365	0.6330

[a]Expressed as mean and standard error
[b]Expressed as percentage of raw meat block weight
[c]Value significantly different if $p \leq 0.05$

Table 3. The mean pH values[a] and P-values for F-test of specific orthogonal contrasts of vacuum packaged beef frankfurters which were processed with different amounts[b] of sodium lactate (NaLac) and/or potassium lactate (KLac) stored at 1.7 °C

	Storage interval (days) at 1.7 °C					
	0	7	14	21	28	35
Treatments						
(1) Control	6.00 ± 0.10	6.04 ± 0.03	5.71 ± 0.29	5.63 ± 0.47	5.56 ± 0.39	5.44 ± 0.32
(2) 1% NaLac	5.91 ± 0.11	5.99 ± 0.02	5.94 ± 0.06	5.93 ± 0.11	5.87 ± 0.23	5.69 ± 0.40
(3) 2% NaLac	5.94 ± 0.09	5.97 ± 0.04	5.94 ± 0.04	5.91 ± 0.11	6.00 ± 0.03	5.89 ± 0.06
(4) 3% NaLac	5.85 ± 0.07	5.95 ± 0.05	5.93 ± 0.12	5.90 ± 0.03	5.82 ± 0.30	5.71 ± 0.23
(5) 1% NaLac + 2.3% KLac	5.88 ± 0.08	5.98 ± 0.02	5.94 ± 0.04	5.93 ± 0.06	5.90 ± 0.13	5.94 ± 0.06
(6) 2% NaLac + 1.2% KLac	5.90 ± 0.09	5.97 ± 0.02	5.92 ± 0.13	5.92 ± 0.07	5.99 ± 0.07	6.00 ± 0.03
(7) 3.4% KLac	5.86 ± 0.03	5.93 ± 0.05	5.90 ± 0.12	5.91 ± 0.11	5.96 ± 0.04	5.75 ± 0.24
Comparisons[c]						
1 vs 2,3,4,5,6,7	0.0020	0.0253	0.1008	0.1322	0.0766	0.0799
2 vs 3,4,5,6,7	0.3759	0.2743	0.9207	0.9500	0.7133	0.4224
3 vs 4,5,6,7	0.0215	0.7912	0.8906	0.9903	0.6753	0.8407
4,7 vs 5,6	0.1426	0.2311	0.8523	0.8824	0.7321	0.2062
4 vs 7	0.7724	0.6028	0.8281	0.9426	0.5433	0.8701

[a]Expressed as mean and standard deviation
[b]Expressed as percentage of raw meat block weight
[c]Value significantly different if $p \leq 0.05$

F-test for specific orthogonal contrast for pH are shown in *Table 3*. All the pH comparisons made among treated groups were not significant ($p \geq 0.05$) except on day zero between 2.0% sodium lactate and the sample group treated with 3.0% sodium lactate, 3.4% potassium lactate and combinations of sodium and potassium lactate. Throughout the entire sampling periods (day 0 to day 35), the pH ranged from 5.44 ± 0.32 to 6.04 ± 0.03.

It was reported that sodium lactate does not contribute any significant effect on the pH of meat and poultry products (Duxbury 1988). Debevere (1989) noted that pH remained unchanged after 6 weeks of storage at 6 °C for liver patties treated with 1.0% and 2.0% sodium lactate.

No differences were observed in all specific planned orthogonal contrasts between control and treated groups as well as among treated groups for texture, saltiness and off-flavour *(Table 4)*. The addition of 3.4% potassium lactate did not significantly affect the texture, saltiness and off-flavour of the product when compared with 3.0% sodium lactate. Therefore, addition of sodium lactate and/or potassium lactate used in this study did not affect the texture, saltiness or off-flavour characteristics of the product.

Duxbury (1990) obtained an improvement in sensory panel tenderness ratings for cooked beef roast injected with sodium lactate, which were also confirmed by physical measurement of shear forces. Besides that, the palatability attributes were improved by the addition of up to 1% sodium lactate, while no further effects were produced at higher levels of usage (Duxbury 1990).

For purge scores *(Table 5)*, no differences were observed between control and treated groups. However, after day 21 onwards, the control showed slightly cloudy purge appearance than the treated groups. Ordinarily, the free liquid (purge/exudate) associated with vacuum packaged products

Table 4. Sensory scores[a] and P-values for F-test of specific orthogonal contrasts of vacuum packaged beef frankfurters which were processed with different amounts[b] of sodium lactate (NaLac) and/or potassium lactate (KLac), stored at 1.7 °C and evaluated at 7-day intervals during retail display

	Texture[c]	Saltiness[d]	Off-flavour[e]
Treatments			
(1) Control	4.55 ± 0.37	5.80 ± 0.22	5.30 ± 0.23
(2) 1% NaLac	5.44 ± 0.29	5.56 ± 0.26	4.83 ± 0.35
(3) 2% NaLac	5.75 ± 0.22	5.70 ± 0.23	5.30 ± 0.16
(4) 3% NaLac	5.11 ± 0.33	5.28 ± 0.24	4.72 ± 0.32
(5) 1% NaLac + 2.3% KLac	5.95 ± 0.29	5.35 ± 0.30	5.10 ± 0.25
(6) 2% NaLac + 1.2% KLac	5.61 ± 0.24	5.78 ± 0.25	5.22 ± 0.23
(7) 3.4% KLac	5.30 ± 0.29	5.55 ± 0.23	5.25 ± 0.24
Comparisons[f]			
1 vs 2,3,4,5,6,7	0.1008	0.5166	0.3766
2 vs 3,4,5,6,7	0.9032	0.9484	0.3018
3 vs 4,5,6,7	0.6338	0.6231	0.3919
4,7 vs 5,6	0.2747	0.7850	0.5175
4 vs 7	0.7865	0.6678	0.1510

[a]Expressed as mean and standard error
[b]Expressed as percentage of raw meat block weight
[c]Based on a 8-point scale (8 = extremely firm; 1 = extremely soft)
[d]Based on a 8-point scale (8 = none; 1 = extremely salty)
[e]Based on a 6-point scale (6 = none detected; 1 = extremely strong)
[f]Value significantly different if $p \leq 0.05$

Table 5. Mean values[a] for purge scores[b] and P-value for F-test of specific orthogonal contrast of vacuum packaged beef frankfurters which were processed with different amounts[c] of sodium lactate (NaLac) and/or potassium lactate (KLac), stored at 1.7 °C and evaluated at 7-day intervals during retail display

	Storage interval (days) at 1.7 °C						
	0	7	14	21	28	35	42
Treatments							
(1) Control	8.0 ± 0.0	7.6 ± 0.2	7.6 ± 0.2	7.4 ± 0.2	6.8 ± 0.4	6.6 ± 0.4	6.2 ± 0.4
(2) 1% NaLac	8.0 ± 0.0	7.6 ± 0.2	7.7 ± 0.2	7.4 ± 0.2	7.6 ± 0.3	6.7 ± 0.3	6.8 ± 0.4
(3) 2% NaLac	8.0 ± 0.0	7.6 ± 0.2	7.6 ± 0.2	7.2 ± 0.2	7.3 ± 0.1	6.9 ± 0.3	6.8 ± 0.3
(4) 3% NaLac	8.0 ± 0.0	7.6 ± 0.2	7.6 ± 0.2	7.1 ± 0.1	7.0 ± 0.2	7.0 ± 0.3	7.0 ± 0.2
(5) 1% NaLac + 2.3% KLac	8.0 ± 0.0	7.4 ± 0.2	7.4 ± 0.2	7.0 ± 0.2	7.0 ± 0.0	7.4 ± 0.2	7.3 ± 0.2
(6) 2% NaLac + 1.2% KLac	8.0 ± 0.0	7.4 ± 0.2	7.4 ± 0.2	7.2 ± 0.3	7.6 ± 0.2	7.3 ± 0.2	7.7 ± 0.2
(7) 3.4% KLac	8.0 ± 0.0	7.5 ± 0.2	7.3 ± 0.2	7.2 ± 0.3	7.4 ± 0.2	7.6 ± 0.2	7.9 ± 0.1
Comparisons[d]							
1 vs 2,3,4,5,6,7	—	0.4483[e]	0.7657	0.4992	0.2364	0.5097	0.0996
2 vs 3,4,5,6,7	—	0.3743	0.4883	0.3765	0.3952	0.4934	0.3618
3 vs 4,5,6,7	—	0.2844	0.6169	0.8386	1.0000	0.5579	0.2723
4,7 vs 5,6	—	0.1659	0.8718	0.8554	0.8104	0.9883	0.9235
4 vs 7	—	0.4853	0.5016	0.6545	0.4095	0.5818	0.2498

[a]Expressed as mean and standard error
[b]Based on a 8-point scale (8 = none detected; 1 = extremely milky)
[c]Expressed as percentage of raw meat block weight
[d]Value significantly different if $p \leq 0.05$
[e]Not significantly different at $p \leq 0.05$

Table 6. Mean values[a] for off-odour scores[b] and P-value for F-test of specific orthogonal contrast of vacuum packaged beef frankfurters which were processed with different amounts[c] of sodium lactate (NaLac) and/or potassium lactate (KLac), stored at 1.7 °C and evaluated at 7-day intervals during retail display

	Storage interval (days) at 1.7 °C						
	0	7	14	21	28	35	42
Treatments							
(1) Control	7.9 ± 0.1	7.9 ± 0.1	7.7 ± 0.2	6.8 ± 0.6	5.8 ± 0.5	7.3 ± 0.3	5.8 ± 0.4
(2) 1% NaLac	8.0 ± 0.0	7.9 ± 0.1	7.7 ± 0.2	7.8 ± 0.2	7.5 ± 0.4	7.7 ± 0.2	7.1 ± 0.4
(3) 2% NaLac	7.8 ± 0.2	7.5 ± 0.3	7.7 ± 0.2	7.8 ± 0.2	7.7 ± 0.3	7.8 ± 0.1	7.7 ± 0.2
(4) 3% NaLac	7.7 ± 0.2	8.0 ± 0.0	8.0 ± 0.0	7.8 ± 0.2	7.8 ± 0.2	7.9 ± 0.1	7.9 ± 0.1
(5) 1% NaLac + 2.3% KLac	8.0 ± 0.0	7.8 ± 0.1	7.9 ± 0.1	7.8 ± 0.2	7.8 ± 0.2	7.7 ± 0.1	7.3 ± 0.3
(6) 2% NaLac + 1.2% KLac	8.0 ± 0.0	7.7 ± 0.2	7.6 ± 0.2	7.9 ± 0.1	7.8 ± 0.1	8.0 ± 0.0	7.5 ± 0.4
(7) 3.4% Klac	7.8 ± 0.2	7.9 ± 0.1	7.9 ± 0.1	7.3 ± 0.4	7.8 ± 0.1	7.9 ± 0.1	7.8 ± 0.1
Comparisons[d]							
1 vs 2,3,4,5,6,7	0.8194	0.3934	0.5880	0.0312	0.0006	0.0456	0.0153
2 vs 3,4,5,6,7	0.4037	0.3185	0.5237	0.7408	0.3949	0.5892	0.3464
3 vs 4,5,6,7	0.6540	0.0414	0.4388	0.8075	0.6603	0.7591	0.8940
4,7 vs 5,6	0.1294	0.1022	0.2627	0.3792	0.8875	0.8398	0.3870
4 vs 7	0.6369	0.6378	0.6774	0.3242	0.8416	0.9543	0.8883

[a]Expressed as mean and standard error
[b]Based on a 8-point scale (8 = none detected; 1 = extreme off-odour)
[c]Expressed as percentage of raw meat block weight
[d]Value significantly different if $p \leq 0.05$

is clear or straw coloured. But, when product contamination becomes severe, this liquid becomes milky in appearance (Aspelund 1984; Pearson and Tauber 1984). Extremely milky exudate contains higher total bacterial counts (Pearson and Tauber 1984). Significant changes ($p \leq 0.05$) in off-odour between the control and treated groups began to be recognized starting at the 21st day of sampling *(Table 6)* where the former had stronger off-odour.

Conclusion

There were no significant effects of sodium lactate and/or potassium lactate on the quality of beef frankfurter evaluated. Emulsion stability, smokehouse yield, texture, saltiness and off-flavour were not affected by the addition of sodium lactate and/or potassium lactate. Therefore, the levels of sodium and/or potassium lactate used in this study could be incorporated into beef frankfurter without having detrimental effects on the quality of the product.

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