



## The Effects of Nicin and Sodium Lactate on Some Quality Characteristics of Heat Treated Sausages

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**Abstract** – In this study it was researched that the effects of nisin and sodium lactate on some quality characteristics of Turkish style heat treated sausages. In the study control sample and 5 kinds of sausage groups were prepared by adding 100 ppm nicin, 250 ppm nicin, %1 sodium lactate, %2 sodium lactate, %2 sodium lactate + 250 ppm nicin into sausage dough. After sausage doughs were filled into natural casing, the samples were matured 12 hours at 4°C following heat treatment at 70°C. Thiobarbituric acid (TBA) values and colour values of samples were measured before heat treatment, after heat treatment and 15th, 30th and 60th days of the storage. At the end of the storage the highest L\* (brightness) values were detected in the control sample with the value of 45,43 and the sample which contained 2 % sodium lactate with the value of 44,17. In addition to this the highest a\* (redness) values were detected in the samples in which it was used 250 ppm nicin, 1 % sodium lactate and 2 % sodium lactate. TBA values of the samples were increased during storage and the highest value was detected with the value of 0,540 mg malonaldehyde/kg in control sample and the lowest value was determined with the value of 0,080 mg malonaldehyde/kg in the sample that contained 2 % sodium lactate + 250 ppm nicin. As a result it was detected that the antioxidant effect should be provide with the usage of 2 % sodium lactate + 250 ppm nicin in heat treated sausages.

**Keywords** – Sausage, Nisin, Sodium Lactate, Heat Treatment, Lipid Oxidation.

### I. INTRODUCTION

In recent years, depending on technology and changes in people's nutrition habits the trend has been started to the ready to eat foods. As a result of this situation the production of meat products and sausages have been scaling up [1]. In the course of production and storage of these products beside applying of processes for best preservation of physical, chemical and sensorial of these products, some additives are being used. On the other hand concerning in the implementations of these processes and usages of these additives, risks in terms of the consumers' health are being occurred as a result of manufacturers' improper applications. Some manufacturers have inadequate knowledge about these subjects.

Due to content of proteins which have high biologic values, meat and meat products have an indispensable place in people's nutrition. Especially highly containing vital amino acids which body could not synthesize and having rich mineral materials as Fe and Zn increase the importance of these products. At the same time meat and meat products take place in easily spoiling food so they have limited shelf life. For this purpose works on

lengthening of endurance period of these kind of products are still keeping importance [2].

In the preservation of meat and meat products preservative cultures (starter culture) as lactic acid bacterias or metabolites as bacteriocin which obtains from these cultures are being used. Bacteriocins are peptidyls which are being synthesized by some bacterias. The inhibition effects of these antimicrobial substances are generally on close species. Despite of having many varieties with different specialites usage of these substances frequently in food industry has been started with nicin [3]. Nicin are being synthesized by some *lactococcus lactis* bacterias. It is the only bacteriocin which is approved and legally accepted by World Health Organisation (WHO).

It is reported that nicin are effective on many gram (+) bacterias including *Lactococcus*, *bacillus*, *Mikrococcus*, *Staphylococcus aureus*, *Listeria monocytogenes* and *Clostridium botulinum* [4]. Beside this it was accepted and authorized to use in European Commission countries by Food And Drug Administration of Union Nations as a statue of 'GRAS' which means Generally Recognised as Safe [5]. Nicin are being safely used in mainly meat and milk products and canned food, beer and fish industry [6].

The importance of organic acids are higher in preservation of foods in the way of microbiological and biochemical properties. Also they have an important role to lengthen shelf life of foods. Lactic acid which is one of the major organic acid is being used for the features like preservation, pH regulation, flavour regulation and colour control [7].

Sodium lactate used in this study is the Sodium (Na) salt of lactic acid. Because of the liquid form of lactic acid some problems should be occurred especially in some dried foods. For this reason dry form of lactic acid in Calcium is preferred.

In the research that Paik *et al.* (2006) analysed the effects in storage of beef with Korean flavour showed that there was no significant changes in a\* and b\* during storage period. The values were close the initial values where they were 8,12 and 11,4 orderly. Moreover they reported that L\* values were firstly decreased in the samples which contained nisin at 4° C while there was no significant decrease at 25° C [4].

Maca *et al.* (1999) reported that sodium lactate had a colour protective effect when they used 3 % or 4 % sodium lactate in vacuum packaged beef meatballs. Also they reported that the samples which contained sodium lactate had darker and more red colour when they were compared with control samples. Researchers claimed that

pH should be influential in the conversion of myoglobin to metmyoglobin in cooked products[8].

Papadopoulos *et al.* (1991) had been added sodium lactate at the ratios of 1 %, 2 %, 3 % and 4 % into the vacuum packaged beef roasts. At the end of the study the subjective measurements showed that the red colour were getting more when 2 % sodium lactate was used. On the contrary yellow colour was getting lower depending on sodium lactate concentration increase [9].

In this study the effect of sodium lactate and nicin used in different rates were analysed on some quality characteristics of heat treated sausages.

## II. MATERIAL AND METHODS

### A. Sausage Production

The basic materials used in the study were grease and meat which obtained from arms and briskets of carcasses of cattles under 3 years old passed over rigor mortis. The beef was cooled before using where the grease was minced and frozen. The casing used in the study was air dried natural intestinal casing processed in Afyon.

For preparation of sausage dough 10 kg of meat (79,4 %) and 2 kg of grease were weighed. A homogeneous sausage dough was obtained mixing the weighed meat and grease with 180 gr cumin, 50 gr red hot pepper, 30 gr red sweet pepper, 50 gr black pepper, 5 gr pimento, 5 gr coriander, 100 gr garlic and 180 gr salt. The sausage dough that obtained was divided into 6 parts and this parts were prepared to be containing 100 ppm nicin, 250 ppm nicin, 1 % sodium lactate, 2 % sodium lactate, 2 % sodium lactate + 250 ppm nicin and non of them (control sample). Sausage production was carried out industrially in Afyon İpek Sausage Plant (Afyonkarahisar) as seciyede in Fig 1.

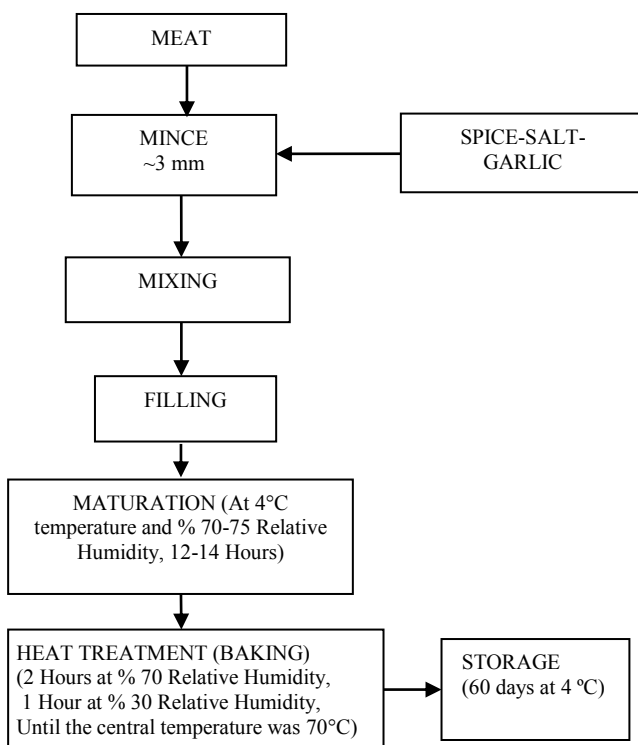


Fig. 1. Flow Chart of Sausage Production

### B. Humidity Amount Analysis

Analysis of humidity was determined by putting 10 gr of sample onto the hard-weighed drying caps and removing the humidity at 105 °C by AOAC [10].

### C. Colour Analysis

Colour analysis of the samples were done by colour measurement device. CIE L\* (brightness), a\* (redness) and b\* (yellowness) show colour values.

### D. TBA Analysis

In Thiobarbutiric Acid analysis (TBA); 10 gr of sample was homogenised by 97,5 ml of pure water at 50 °C and then took into the Kjeldahl baloon. The volume was completed to 100 ml adding 2,5 ml 4 N HCl solution (1:2 % 37 HCl : pure H<sub>2</sub>O) over it. Paraffin for avoiding foaming and boiling stones for facilitating boiling were putted into the solution and then binded to destillation unit. Distillation was continued until 50 ml of distilate was gathered. Then 5 ml of distilate was taken into the lid tube and added 5 ml of 0,02 M TBA reagent onto it. Also 5 ml of TBA reagent was added for blind trial, too. After shaking well the tubes they were putted into the boiling water bath and waited for 35 minutes. Then they were cooled in cold water for 10 minutes and absorbance values were read at 538 nm wavelength in spectrophotometer. Molanaldehyde values were calculated in the products multiplying read values by a factor of 7,8 [11,12].

## III. RESULTS AND DISCUSSION

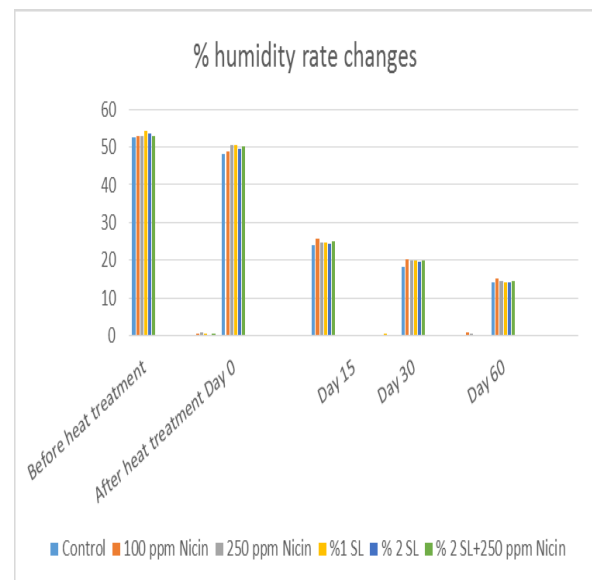


Fig. 2. % humidity amount changes depending on time for sausages in which different rates of nicin and sodium lactate added

The humidity amount of the samples were decreased between 14,01- 15,17 % rates on the last day of storage while they were 52,64- 54,17 % rates before heat treatment (Table 1.). Changes in rate of humidities in samples showed changes depending on time where they were independent of sample types. This results were varied between 24,09- 25,77 % rates on day 15, 18,35-

20,15 % rates on day 30. On day 60 they were decreased to 14,01- 15,17 values. These values were suitable for Turkish Standard (TS) 1070 in which it has to be maximum 40 % [13].

Table 1. % humidity rate changes in nicin and sodium lactate added sausages

	Control	100 ppm Nicin	250 ppm Nicin	%1 SL	% 2 SL	% 2 SL+ 250 ppm Nicin
<b>Before heat treatment</b>						
	52,64 ± 0,35	52,96 ± 0,55	52,78 ± 0,79	54,17 ± 0,49	53,61 ± 0,2	52,86 ± 0,45
<b>After heat treatment</b>						
<b>Day 0</b>	48,20 ± 0,035	49,00 ± 0,02	50,47 ± 0,402	50,58 ± 0,303	49,42 ± 0,29	50,32 ± 0,01
<b>Day 15</b>	24,09 ± 0,017	25,77 ± 0,012	24,54 ± 0,25	24,79 ± 0,43	24,43 ± 0,25	25,05 ± 0,008
<b>Day 30</b>	18,35 ± 0,325	20,15 ± 0,85	19,81 ± 0,43	19,96 ± 0,072	19,6 ± 0,40	19,80 ± 0,040
<b>Day 60</b>	14,24 ± 0,327	15,17 ± 0,012	14,47 ± 0,07	14,27 ± 0,033	14,01 ± 0,006	14,40 ± 0,02

L\* values of samples were increased to 49,36- 46,47 rates while they were varied between 40,28- 42,28 before heat treatment. On the last day of the storage L\* value was decreased to 40,75-45,43. (Figure 3 and Table 2.)

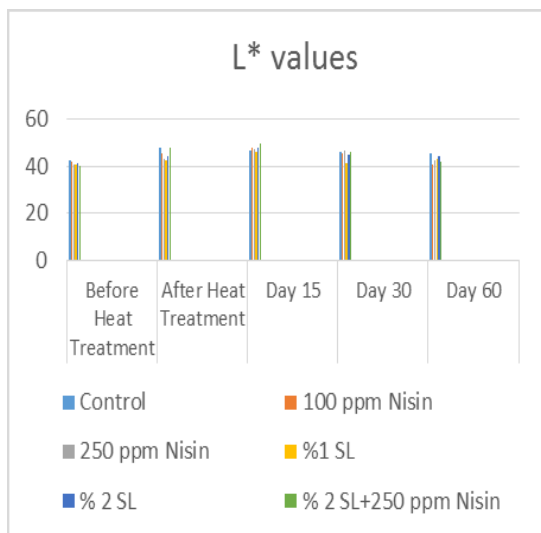


Fig. 3. Time depended changes in L\* (brightness) values in various rated nicin ve sodium lactate added sausage sample

Table 2. Time depended changes in L\*, a\* and b\* values in nicin ve sodium lactate added sausage samples

	Control	100 ppm Nicin	250 ppm Nicin	%1 SL	% 2 SL	% 2 SL+ 250 ppm Nicin
<b>Before Heat Treatment</b>						
<b>L*</b>	42,28 ±4,68	41,86 ±3,55	40,42 ±4,38	40,77 ±3,55	41,32 ±2,55	40,28 ±2,12
	5,51 ±0,96	7,60 ±0,85	7,52 ±2,35	7,70 ±2,31	7,38 ±0,95	7,46 ±1,25
	10,32 ±0,73	11,66 ±1,49	10,34 ±1,14	11,07 ±1,14	11,88 ±0,59	10,95 ±1,38
<b>After Heat Treatment</b>						
<b>Day 0</b>	L* 47,45 ±2,48	45,22 ±2,81	43,06 ±2,64	42,18 ±2,60	43,92 ±2,60	47,53 ±1,90
	a* 7,85 ±2,11	10,03 ±0,98	9,22 ±0,65	9,30 ±0,74	8,49 ±1,35	8,70 ±1,40
	b* 10,74 ±0,60	12,31 ±0,48	11,20 ±0,49	9,70 ±1,43	9,74 ±0,44	12,91 ±0,93
<b>Day 15</b>	L* 46,47 ±2,12	48,01 ±2,51	47,12 ±0,91	45,93 ±4,44	47,98 ±3,06	49,36 ±2,85
	a* 7,02 ±1,64	7,57 ±1,04	9,47 ±0,58	8,25 ±0,91	7,48 ±1,11	8,36 ±0,75
	b* 10,05 ±1,39	12,82 ±0,69	12,87 ±0,64	11,92 ±1,64	11,69 ±1,51	13,02 ±0,75
<b>Day 30</b>	L* 46,21 ±4,23	45,21 ±4,90	46,58 ±4,69	41,30 ±2,34	44,72 ±1,49	46,21 ±4,57
	a* 6,03 ±0,95	6,72 ±1,31	6,34 ±0,96	6,43 ±0,68	7,29 ±0,98	6,30 ±0,95
	b* 10,08 ±2,01	11,08 ±3,43	11,11 ±2,13	7,76 ±1,54	9,96 ±0,43	10,08 ±1,76
<b>Day 60</b>	L* 45,43 ±3,06	40,75 ±3,01	42,25 ±3,16	43,20 ±1,92	44,17 ±2,49	42,01 ±2,25
	a* 5,46 ±1,25	5,89 ±1,38	6,09 ±1,86	6,09 ±0,46	6,44 ±0,50	5,52 ±0,90
	b* 9,01 ±1,43	7,25 ±2,18	7,97 ±2,15	8,33 ±1,03	8,44 ±1,67	7,64 ±1,32

a\* (redness) values were decreased during storage while they were increased after heat treatment. The highest value was detected in 2 % sodium lactate containing sample after heat treatment on day 60 of storage. The least values for a\* were measured in control samples in all periods. (Figure 4. and Table 2.)

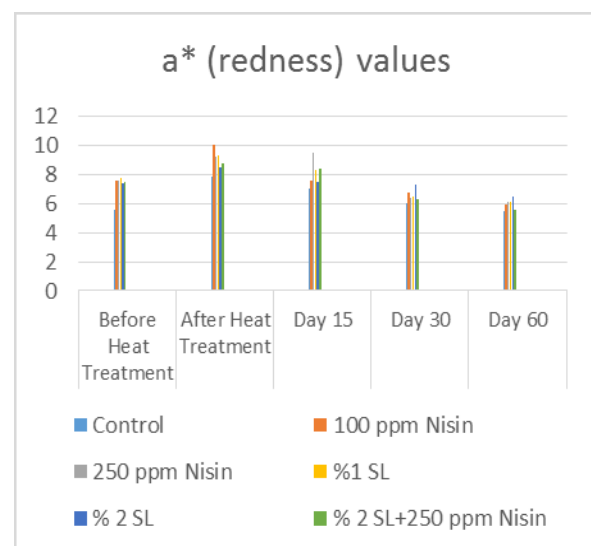


Fig. 4. Time depended changes in a\* (redness) values in various rated nicin ve sodium lactate added sausage samples

b\* (yellowness) values of samples were varied between 9,70-12,91 while they were varied between 10,32-11,88 before heat treatment. On the last day of storage it was detected that values were between 7,25-9,01. (Figure 5. and Table 2.)

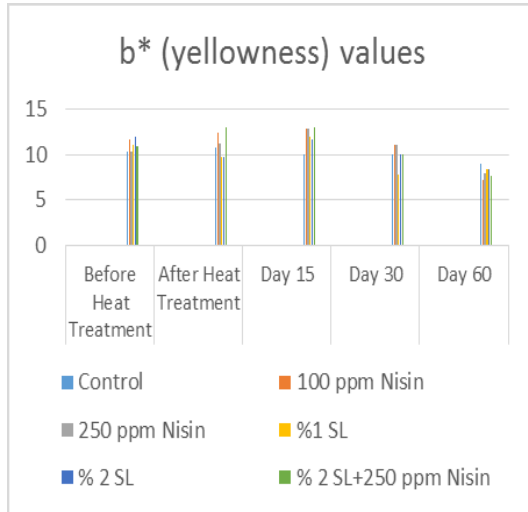


Fig. 5. Time depended changes in b\* (yellowness) values in various rated nicin ve sodium lactate added sausage samples

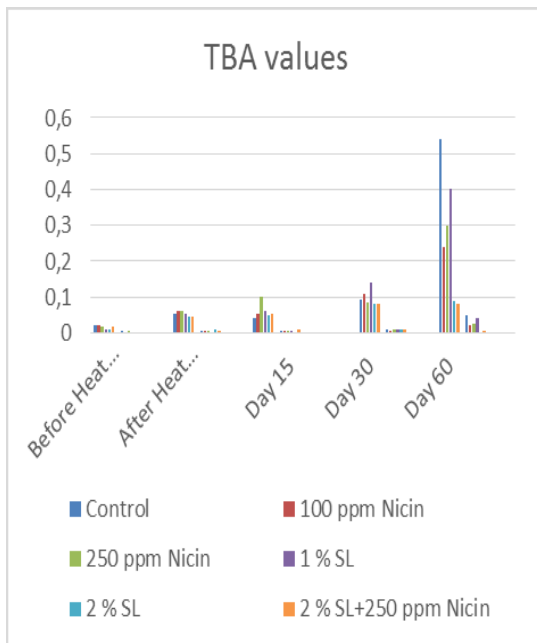


Fig. 6. Time depended changes in TBA (Thiobarbituric Acid) values in various rated nicin ve sodium lactate added sausage samples (mg malonaldehyde/kg)

TBA values were increased during storage. TBA values were detected at least in 2 % sodium lactate added samples on day 30 and day 60 of storage when the TBA values were highest. TBA values were increased highly after day 30 of storage. On day 60 of storage TBA values were detected as 0,5382; 0,2366; 0,2964; 0,3228; 0,0884 and 0,0770 mg malonaldehyde/kg orderly in control, 100 ppm

nicin, 250 ppm nicin, 1 % rated sodium lactate, 2 % rated sodium lactate and 2 % sodium lactate + 250 ppm nicin samples and the least TBA values were detected in 2 % sodium lactate added samples.

L\* values of samples were increased after heat treatment when they were decreased on day 60 of storage where the oxidation was at highest values. The cause of this reduction is thought to arise from because of oxidation cases during storage [14]. Similar to these results Ercoşkun (2006) reported that heat treatment increases L\* value and effect of heat treatment on L\* value is important ( $p < 0,01$ ). a\* values were reached to maximum level as L\* values after heat treatment following a decrease at the end of storage. However it was detected that decrease in a\* values were more that decrease in L\* values [15]. Lin and Lin (2002) reported that in the research where they tried to find effects of sodium lactate and trisodium phosphate on Chinese sausage, at the period of 12 weeks storage of samples dried with heat treatment there was no significant change in Hunter L\* values. In the same research they reported Hunter a\* and Hunter b\* values of samples were different in all samples nevertheless these differences were insignificant [16].

Table 3. Mean of TBA values in nicin and sodium lactate added sausage samples (mg malonaldehyde/kg)

	Control	100 ppm Nicin	250 ppm Nicin	1 % SL	2 % SL	2 % SL+250 ppm Nicin
<b>Before Heat Treatment</b>						
	0,023 ± 0,005	0,023 ± 0,001	0,016 ± 0,005	0,008 ± 0,002	0,008 ± 0,001	0,016 ± 0,001
<b>p</b>	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001
<b>Before Heat Treatment</b>						
<b>Day 0</b>	0,055 ± 0,005	0,062 ± 0,005	0,062 ± 0,005	0,055 ± 0,001	0,047 ± 0,008	0,047 ± 0,005
<b>p</b>	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001
<b>Day 15</b>	0,040 ± 0,005	0,055 ± 0,005	0,101 ± 0,005	0,062 ± 0,005	0,051 ± 0,001	0,053 ± 0,008
<b>p</b>	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001
<b>Day 30</b>	0,094 ± 0,009	0,109 ± 0,005	0,086 ± 0,009	0,140 ± 0,008	0,080 ± 0,008	0,080 ± 0,008
<b>p</b>	= 0,008	= 0,001	= 0,002	= 0,005	< 0,001	< 0,001
<b>Day 60</b>	0,540 ± 0,05	0,240 ± 0,02	0,300 ± 0,024	0,400 ± 0,04	0,090 ± 0,003	0,080 ± 0,007
<b>p</b>	= 0,042	= 0,006	= 0,01	= 0,02	= 0,001	= 0,001

A similar research made before showed that a\* values were higher than this study [15,17]. The cause of this situation should be thought that tends to nitrate usage and fermentation. Nitrate was converted to nitrite in fermentation and then red colour was increased by nitrite forming nitrosomyoglobin. Maca *et al.* (1999) reported

that in the samples which they used 3 % or 4 % sodium lactate in vacuum packaged beef meatballs sodium lactate had colour preservative effect and samples which contained sodium lactate had darker and more red according to control samples. Researchers claimed that pH should be efficient in conversion of myoglobin to metmyoglobin in cooked products [8]. Papadopoulos *et al.* (1991) had been added sodium lactate at the ratios of 1 %, 2 %, 3 % and 4 % into the vacuum packaged beef roasts. After this process they reported that a\* value is higher when sodium lactate was used at the concentration of 2 % where b\* value is lower depending on sodium lactate concentration increase. In this study a\* and b\* values showed a decrease in the sample used 2 % sodium lactate [9].

Öksüztepe *et al.* (2010) found significant differences in TBA values in meatballs made from Fresh Rainbow Trout. TBA values in samples were ranged between 0.87- 5.88 mg malonaldehyde/1000 g values where the initial values were around 0,62 value. These differences were explained with usage of different kinds of fishes and different processing technologies in preparing fish meatballs [19].

Lin and Lin (2002) reported that in Chinese sausages values were below 0,300 mg malonaldehyde/kg value in control samples where values were below 0,250 mg malonaldehyde/kg value in 3 % added sodium lactate samples. The cause of those values being higher than the values in this study is thought to arise from storage period of the researchers was 12 weeks [16]. Gök (2006) reported that in 60 day of storage TBA values in control samples were increased 4,4 times more than initial day of production and reached the maximum level [17]. Ercoşkun (2006) reported that TBA values of heat treated sausages were higher than traditionally produced sausages during storage and specified this result was arising from the heat treatment which increase oxidation in all free fatty acids [15].

During 60 day of storage increases in TBA values were between only 0,33-0,43 mg malonaldehyde/kg range in 2 % sodium lactate added while increases were nearly more than ten times in control samples according to first day. This effect is arising from the antioxidant property of sodium lactate that is more efficient when it used in rate of 2 %. On the contrary Shekarforoush *et al.* (2012) reported that TBAR values were decreased in nicin added and modified atmosphere packaged emulsion-type sausages. This result was thought to be originated from the antioxidant components and nitrite added to the samples and packaging with CO [18].

#### IV. CONCLUSION

It was observed that the best antioxidant effect of sodium lactate was detected when it was used at the rate of 2 %. Sodium lactate was not effective in preservation of colour while it was adequate in 60 days of storage with antioxidant effect of it. The colour healing process of product should be charming for consumers' admiration. For this purpose it requires working on spices.

#### REFERENCES

- [1] Yıldırım Y., 1996, "Meat Industry", Uludağ University Faculty of Veterinary. Kozan Offset Press. Industry and Trade Ltd. Co. (4. Press), Ankara
- [2] Bingöl, E.B., Bostan, K., 2012. Usage of Lactates in Meat and Meat Products as a Food Additive. J. Fac. Vet. Med. İstanbul Univ. 38 (1), 79-88.
- [3] Rodriguez, J.M., Martinez, M.I., Horn, N., Dodd, H.M., 2002, "Heterologous production of bacteriocins by lactic acid bacteria". International Journal of Food Microbiology, 80, 101-116
- [4] Paik, H.D., Kim H.J., Nam, K.J., Kim, C.J., Lee, S.E., Lee, D.S., 2006, "Effect of nisin on the storage of sous vide processed Korean seasoned beef", Food Control 17 (2006) 994-1000
- [5] Bouttefroy, A., Mansour, M., Linder, M., Milliere, J.B., 2000, Inhibitory combination of nisin, sodium chlorid and pH on *L. monocytogenes* ATCC15313 in broth by an, experimental design approach. International Journal of Food Microbiology, 54, 109-115
- [6] Ettayabi, K., El Yamani, J., Rossi-Hassani, B.D., 2000, "Synergistic effect of nisin and thymol on antimicrobial activities in *L. monocytogenes* and *B. subtilis*". FEM Microbiology Letters, 183, 191-195
- [7] Wit, De, J.C., Rombouts, F.M., 1990, "Antimicrobial activity of sodium lactate". Food Microbiol. 7: 113- 120.
- [8] Maca, J.,V., Miller, R., K., Bigner, M., E., Lucia, L., M., Acuff, G.R., 1999, "Sodium lactate and temperature effects on shelf life vacuum packaged beef top rounds", Meat Science, 53, 23-29
- [9] Papadopoulos L.S., Miller, R.K., Acuff, G.R., Vanderzant, c., Cross, H.R., Effect of sodium lactate on microbial and chemical composition of cooked beef during storage. J. Food Sci. 1991, 56(2), 341-347.
- [10] Anonymous. 1990a. Method 926.08, 925.09. Association of Official Analytical Chemists. Official Methods of Analysis. 15th ed. AOAC, Arlington, USA.
- [11] Tarladgis, B. G., Watts, B. M., Younathan, M. T. and Dugan, L. R. 1960, "A distillation method for the quantitative determination of malonaldehyde in rancid foods", Journal of American Oil Chemistry Society, 37; 44-48.
- [12] Tarladgis, B. G., Pearson, A. M., and Dugan, L. L. 1964. "Chemistry of the 2-thiobarbituric acid test for determination of oxidative rancidity in foods II Formation of the TBA-malonaldehyde complex without acid-heat treatment. Journal of the Science of Food and Agriculture", 15; 602-607.
- [13] Anonymous, 1997a. "Turkish Soudjouk". TS.1070, Institution of Turkish Standards, Ankara.
- [14] Zanardi, E., Novelli, E., Ghiretti, G.P., Dorigoni, V. and Chizzolini, R. 1999, Colour stability and vitamin E content of fresh and processed pork. Food Chemistry 67; 163-171.
- [15] Ercoşkun, H., 2006, "Effects of Fermentation Times on Some Quality Characteristics of Production of Heat Treated Soudjouk", Ankara University Institution of Natural and Applied Sciences, Ankara
- [16] Lin, K. W., S.N., Lin, 2002, "Effects of sodium lactate and trisodium phosphate on the physicochemical properties and shelf life of low-fat Chinese-style sausage", Meat Science 60 (2002) 147-154
- [17] Gök, V., 2006, "Effects of Usage of Antioxidant on Some Quality Characteristics of Fermented Soudjouks", Ankara University, Institution of Natural and Applied Sciences, Ankara
- [18] Shekarforoush, S.S., Khajehali, E., Abdollah, H.K., Hoseinzadeh, Nazer., Hoseinzadeh, S., 2011. Effects of Nicin and Modified Atmosphere Packaging (MAP) on the Quality of Emulsion-Type Sausage. Journal of Food Quality 35 (2012) 119-126.
- [19] Öksüztepe, Ö., Emir, Çoban, Ö., Güran H.S., 2010. The Effect of Addition of Sodium Lactate in Fish Balls made from Fresh Rainbow Trout (*Oncorhynchus mykiss* W.). Kafkas Univ Vet Fak Derg 16 (Suppl-A): 65-72.