A TECHNOLOGICAL STUDY ON THE LIPID PEROXIDATION IN GROUND MEAT AND PROLONGTION THE SHELF LIVE. CHEMICAL AND MICROBIOLOGICAL PROPERTIES

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Background

In the muscle hydroperoxides accumulate in lipids during refrigeration storage of ground meat at 0 - 4^{O}C (Dragoev and Danchev, 1997). After 5 days at these conditions their levels increase over admissible health recommendations. The secondary products of lipid peroxidation quickly accumulate when the light and oxygen are impact on the ground meat. As a result of this: the lipid oxidative stability considerably decreases, concentration of the haematin iron increases, polyunsaturated fatty acids (PUFA) reduce their levels, and the colour and appearance of the final product changes (Dragoev, 1999).
During the first month of storage of the frozen ground meat at -18ºC, the velocity of formation and development of hydroperoxides are comparatively low, but after that the primary derivatives of lipid peroxidation quickly transform in aldehydes and ketones (Dragoev et al., 1998). The lipid peroxidation processes extends at next boiling (Cheach and Ledward, 1996; Farouck et al., 1991; Raharjo et al., 1993) or cooking (Smith and Alfazar, 1995) of the meat.
In connection with indicated above the investigation of the antioxidative ability of some organic acids as lactic, acetic, and citric and their salts are with an indisputable interest.

Objectives

On the base of bibliography the purpose of this study is to determine the impact of pure sodium lactate parallel with a blend containing sodium acetate, citrate and L-ascorbate on the lipid peroxidation and microbiological status of ground meat.

Materials and methods

Prime and raw materials were purchased from the local market. The liquid sodium lactate type “Purasal S” (produced by “Purac”AG - Germany) was supplied by “Exelpack” Ltd – Sofia. The blend based on sodium acetate “Bombal” (produced by “Van Haas” Ltd - Germany) was furnished by “JVN” Ltd – Sofia.
The meat raw materials were cut on cutter machine type “Müller” (Germany). During the technological process 2 % salt, 3 % soy granulate, previously hydrated with 3 volumes water and the relevant preserving agents were added.
The following samples were prepared: **0** – control sample without preserving agents; **1** – experimental sample with addition of 1,2 % sodium lactate; **2** – experimental sample with addition of 2,0 % sodium lactate, and **3** – experimental sample with addition of 0,5 % blend (composition) containing sodium acetate, sodium citrate and sodium L-ascorbate. The ground meat – mix of beef and bacon = 3:1 w/w were divided in quarters. Each part was stored at two temperature regimes: standard at 0 - 4^{O}C, and irregular at 8 - 10^{O}C. The experiments were made on 0, 4 and 7 d. The samples on the 0 d were examined immediately after preparing the ground meat.
Peroxide value (POV). POV was determined using standard iodometric method, after extraction of total lipids following Bligh and Dyer recommendations (1959).
Thiobarbituric acid reactive substances (TBARS). TBARS were estimated by Schmedes and Hølmer method (1989) and presented as mg free malondialdehyde (MDA)/kg meat.
pH value. The pH was measured by pH-meter MS 2004 (Microsyst, Bulgaria), completed with combined temperature/pH-electrode Sensorex Combination Recorder 450 CD (pH Electrode Station, CA 90680, USA).
Microbiological status. The characterization of the microbiological status of the ground meat was made by determination of:

- *Total number of aerobic microorganisms* was established by cultural method (Boshkova, 2000), and presented as colony forming units per gram ground meat (cfu/g)
- *Coliforms number (CFN).* A definite quantity of ground meat was sowed on the special solid medium. On it coliforms develop typical colonies after cultivation at 37^{O}C. After examinations which conform the presence of coliforms the growing colonies in 1 g ground meat were counted. CFN was calculated by formula: CFN = N. 10 ^{n}, where CFN – the number of cfu coli forms/g; N – number of colonies at the respective dilution; 10^{n} – degree of dilution.
- *Determination of the coagulase positive staphylococcus strains.* Initially an enriched growth on the liquid medium was completed with aim to keep under the concomitant microorganisms. After that the samples for the second time were grown on the solid selective medium (Boshkova, 2000).

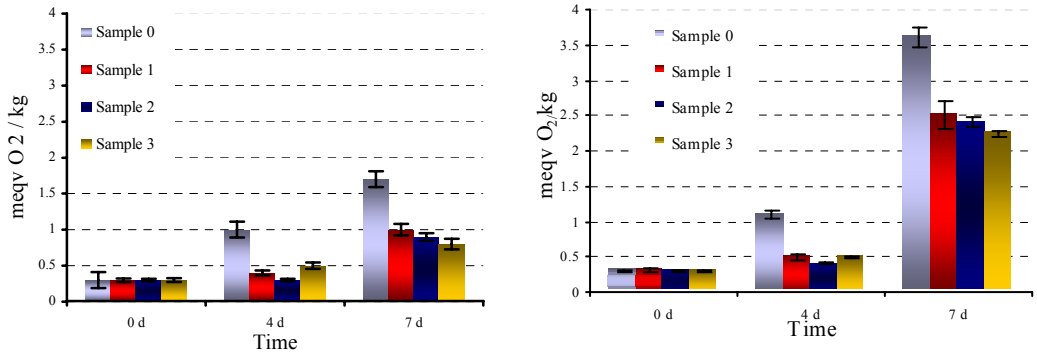
The results were processed statistically by standard methods using computer program Excel.

Results and discussion

Peroxide value (POV). At temperature of storage 0 - 4ºC the accumulation of hydroperoxides in examined samples is restricted in comparison with the control sample 0. In sample 0 (without preserving agents) on the 4th day significant amounts of primary derivatives of lipid peroxidation were found. On the 7th day the POV levels are higher – around 1.5 meqv O_2/kg (Fig.1). The sample 3 – with 0.5 % blend based on the sodium acetate on the 4th day shows POV levels similar of those of samples 2 and 1 – with sodium lactate, but on the 7th day sample 3 contains the least amounts of hydroperoxides.

Figure1. Changes of peroxide value (POV) of ground meat during storage

at 0 - 4ºC at 8 - 10ºC

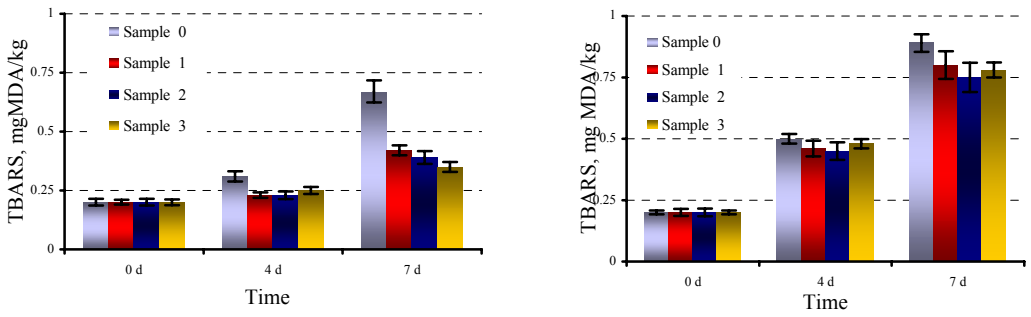


At temperature of storage 8 - 10ºC the situation is different (Fig.1). According POV the experimental samples – 1, 2 and 3 are good to the 4th day. On the 7th day the quality of every sample deteriorate. These results are confirmed by data for sensory analysis (Dragoev et al., 2004). The control sample 0 is the most unstable, while between lipid hydroperoxide levels of the experimental samples 1, 2 and 3 there are not statistically significant differences ($p > 0,05$) (Fig.1).

Thiobarbituric acid reactive substances (TBARS). At temperature of storage 8 - 10ºC the used additives do not prevent the development of deep lipid peroxidation process in ground meat (Fig. 2). The best restriction of TBARS development at 8 - 10ºC shows the addition of 2.0 % sodium lactate (sample 2).

Figure2. Changes of TBARS express as free MDA of ground meat during storage

at 0 - 4ºC at 8 - 10ºC



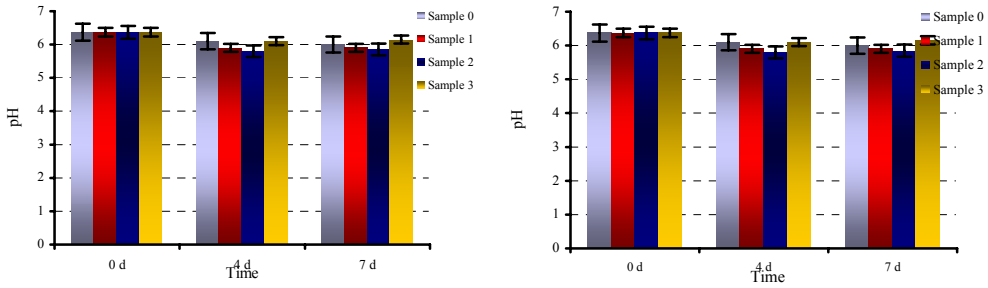
When the ground meat was stored at 0 - 4ºC TBARS slowly increases in comparison with temperatures 8 - 10ºC (Fig. 2). O the 7th day TBARS levels are least in sample 3 – with 0.5 % blend based on the sodium acetate. In the control sample 0 the TBARS is approximately two times higher than in three experimental samples.

The conclusion can be done, that the type and quantity of added preserving agent do not conduct significant differences regarding to oxidative changes of ground meat. Every experimental sample - with 1.2 % sodium lactate (sample 1), with 2.0 % sodium lactate (sample 2) and with 0.5 % blend based on the sodium acetate (sample 3) suppress but can not prevent the development of lipid peroxidation in ground meat. The observed changes are in agreement with results of previous our studies (Dragoev and Danchev, 1997; Dragoev et al. 1998)

pH value. The pH of ground meat decreases in order of 5.8 – 6.1 at 0 – 4^{O}C and 5.1 – 5.4 at 8 – 10^{O}C (Fig. 3). Those results show that the extension of shelf-life of ground meat when the preserving agents are used is a result mainly of the enhanced acidity. It probably oppresses the growth of the putrefactive microorganisms.

Figure3. Changes of pH of ground meat during storage

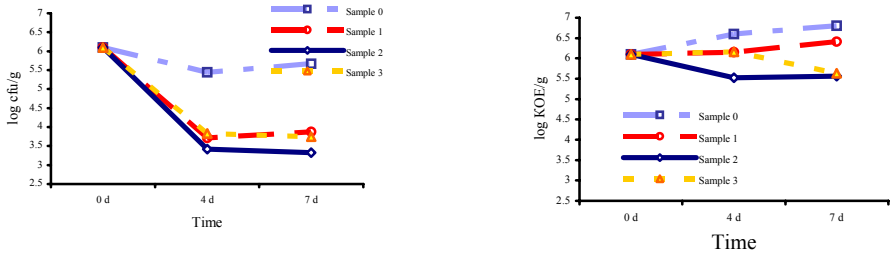
at 0 - 4ºC at 8 - 10ºC



At 8 - 10ºC both the sodium lactate and the blend based on sodium acetate (Fig.3) in practice do not decrease pH of ground meat (fig. 3). The decisive factors of this process are the temperature and initial microbial contamination. The samples with sodium lactate show a little lower pH on the 4th and 7th day of storage, which give them some advantage. Those results do not confirm the sensory properties of ground meat (Dragoev et al., 2004). The samples with sodium lactate - 1, and 2 do not have better flavor and aroma in comparison with control sample 0 and experimental sample 3 – with 0.5 % composition based on sodium acetate.

Figure4. Changes of total number of aerobic microorganisms of ground meat during storage

at 0 - 4ºC at 8 - 10ºC



Microbiological analysis. The results obtained show that the lactate affects significantly quickly on the total number of aerobic microorganisms in comparison with acetate blend, independently from temperature of storage. In spite of higher pH the samples with addition of 2.0 % sodium lactate have a smaller total count of microorganisms (Fig 4).

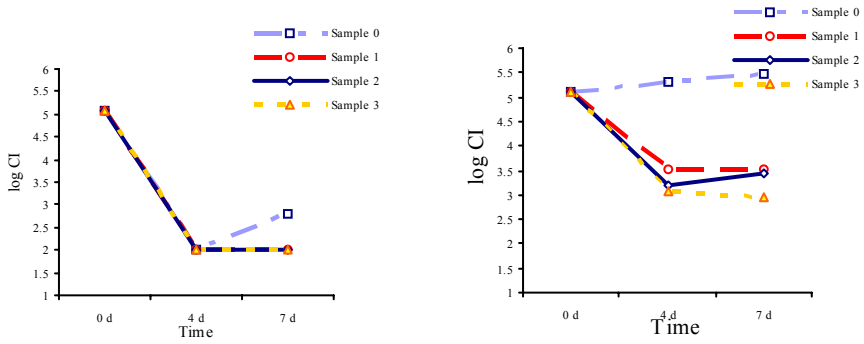
On the 7th day of storage at 0 - 4^{O}C the total number of aerobic micro organisms of ground meat is the best in sample 2 – with 2.0 % sodium lactate, followed from the sample 3 – with 0.5 % blend based on the sodium acetate, and sample 1 - with 1.2 % sodium lactate. On the 7th day of storage at 8 - 10^{O}C control sample 0 don't correspond to the norms for total number of aerobic microorganisms (cfu/g) (Fig. 4).

The tendency determined for the total number of aerobic microorganisms of the samples with preserving agents (Fig. 4) is the same for the CFN at the same conditions (Fig. 5). The control sample doesn't suit requirements for number of coli forms in 1 g meat.

At 0 - 4 ^{O}C the microbiological indices of samples are very good. Every sample, including the control one, correspond to the requirements of the total number of aerobic microorganisms and coliforms. At this temperature the experimental samples are distinguished with good microbiological status. The study implemented for the coagulase positive staphylococcus bacteria demonstrates the supremacy of sodium lactate over acetate composition.

Figure5. Changes of coliform number (CFN) of ground meat during storage

at 0 - 4ºC at 8 - 10ºC



Conclusions

The sodium lactate and the blend containing sodium acetate, sodium citrate, and sodium L-ascorbate can be successfully used as preserving agents with antioxidant action for prolongation of the shelf-life of ground meat at temperature of storage 0 - 4 ^{O}C. In those conditions the shelf-life maximum of ground meat is 7 d.

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