

**INFLUENCE OF PACKAGING CONDITIONS ON THE CONTENT OF AMINO ACIDS
OF PICKLED VENISON**

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Abstract

The aim of the current research was to determine content of amino acids in different types of marinades pickled venison during storage. Beef as a control was analysed for comparison of obtained results. The meat pieces were pickled in two different types of marinades: mayonnaise and vinegar. The prepared meat samples were stored (marinated) at 4 ± 2 °C temperature for 48 ± 1 h. Marinated meat was placed in polypropylene trays, hermetically sealed with high barrier polymer film under modified atmosphere without and with iron based oxygen scavenger sachets; all samples were compared with packed pickled products in air ambiance. No significant differences were observed in amino acids content among the pickled venison and beef samples packaged in air ambiance and under modified atmosphere without/with oxygen scavenger during storage. Marinade type not significantly influence amino acids content changes in venison and beef meat samples.

Key words: pickled venison, modified atmospheres, oxygen scavengers

1. INTRODUCTION

Meat from animals raised under natural conditions has enjoyed a rise in popularity among consumer in recent years. The condition of “naturalness” is meat by venison, which at the same time is known for its very high nutritive value and specific, but highly desirable, sensory properties (Daszkiewicz et al., 2007).

Recent statistical updates indicate the significantly enhanced consumer interest in the venison meat, because of its high level of proteins, vitamins, mineral salts and lower, compared to meat of domestic slaughter animals, content of fat and cholesterol, as well as its lower level energetic value (Zochowska-Kujawska et al., 2009).

Currently, marination is widely used by consumers and producers to improve meat tenderness and juiciness (Ergezer and Gocke, 2011). The main aims of marinating have been considered to be tenderizing, flavoring and enhancing safety and shelf life of meat products due to inhibition of microbial growth (Bjorkroth, 2005). Marination is the process of soaking or injecting of meat with a solution containing ingredients such as vinegar, lemon juice, wine, soy sauce, brine, essential oils, salts, tenderizers, herbs, spices and organic acids to flavour and tenderize meat products (Kargiotou et al., 2011; Pathania et al., 2010). The functionality of most marinades are directly depend on of their ingredients. The most common and important ingredients of acidic marinades are organic acid solutions (acetic acid, lactic acid, citric acid, etc.), vinegars, wine or fruit juices (Burke and Monahan, 2003). Meat can be tenderized by the action of salt solutions or acids. Traditionally, meat is marinated in vinegar (acetic acid) or wine. The action of the acid is to break the muscle structure down, possibly by encouraging the action of collagenases and cathepsins, which work best at low pH. It also makes the myofibrils swell and hold water better, increasing tenderness and juiciness (Warriss, 2010). Marinades

are incorporated into meat by soaking texture and moisture retention; to enrich the meat flavour; to tenderize the fibers of muscle foods; and to preserve the products over a longer time (Alvarado and McKee, 2007).

Venison, as well as beef or poultry, is highly perishable product with a short shelf life. Packaging technology which modifies the atmospheric conditions of the package is popularly applied to extend the shelf-life of meat (Daszkiewicz et al., 2011). The basic process for modified atmosphere packaging (MAP) is to remove the air from the package and fill it with gas or gas mixture instead, and then seal hermetically (Gokoglu et al., 2011). The most appropriate gas composition for venison preservation is CO₂ 40 % + N₂ 60 % (Vergara et al., 2003). However, MAP technologies not always completely remove oxygen and oxygen penetrates through the packaging film. Using of oxygen scavengers can reduce oxygen level in a package (Brandon et al., 2009). Almost all oxygen scavenger sachets used commercially are based on the principle of iron oxidation. The sachets are made up of finely divided powdered iron, ferrous compounds and various catalysts, which under appropriate humidity conditions initiate the reaction, using up any residual oxygen to form non-toxic iron oxide (Brandon, 2009).

The aim of the current research was to determine changes in amino acids content of pickled venison during storage.

2. MATERIALS AND METHODS

The experiments were carried out at the Department of Food Technology, Latvia University of Agriculture, in 2012. The meat of farmed red deer (*Cervus elaphus*) was obtained from a local farm 'Saulstari 1', located in Sigulda region, Latvia; the beef of farmed cattle (*Colloquially cows*) from Ltd. 'Margret' located in Jekabpils region, Latvia, was used for control.

Two types of marinades were used for venison and beef pickling process:

- 1) a mayonnaise marinade – mayonnaise, onion, parsley, paprika, basil, black pepper, rosemary, salt;
- 2) a vinegar marinade – tomato sauce, mayonnaise, vinegar, lemon, onion, parsley, paprika, basil, black pepper, rosemary, salt.

Marinating process of the samples includes the following steps:

- 1) *Longissimus dorsi* muscle from venison and beef saddle cuts were manually divided by knife in 0.250±0.020 kg pieces;
- 2) 0.250±0.020 kg pieces of *Longissimus dorsi* muscle were divided into smaller pieces of the size 2×3×2 cm, and then marinades were added;
- 3) prepared samples were stand at 4±2 °C temperature in the refrigerator for 48±1 h;
- 4) marinated meat samples were packaged in plastic bags, labelled and stored in a freezer at -20±2 °C temperature for two weeks until analyses of amino acids.

Marinated meat samples were placed on the polypropylene (PP) trays (210×148×35 mm) and hermetically sealed with high barrier polymer film Multibarrier 60 (composition: APA/TIE/PA/EVOH/PA/TIE/PE/PE; thickness 60±2 µm) under modified atmosphere (CO₂ 40%+ N₂ 60%) without and with iron-based oxygen scavenger sachets (Mitsubishi Gas Chemical Europe Ageless®). As a control packaging in air ambience packed pickled venison and beef was used. Picked meat samples were stored at 4±2 °C.

All samples were analysed after pickling and before packaging or in 0 day of storage. Stored time (days) of packaged marinated venison and beef samples depends from the meat microbiological parameters.

When the microbiological parameters exceeded permissible limit experiments were finished. Venison samples pickled in mayonnaise marinade were analysed after 14 days of storage under modified atmosphere (MA) packaging and after 7 days of storage in air ambiance. Beef samples marinated in the same marinade were analysed after 18 days of storage under MA packaging without/with oxygen scavenger and in air ambiance. In vinegar marinade pickled venison and beef samples were analysed after 11 days of storage under MA packaging without/with oxygen scavenger and in air ambiance. Storage days were determined in previous experiments using microbiological tests.

For analyses, meat samples were homogenised using a household blender according to ISO 17604:2003 standard procedure.

Content of amino acids in prepared meat samples were detected by standard procedure LVS ISO 13903:2005.

The data was processed by analysis of variance (ANOVA: Single Factor, without replication) in order to determine the effect of packaging condition on each variable. The level of statistical significance was evaluated at $p < 0.05$. Statistical analyses were performed using *Excel* software packages.

3. RESULTS AND DISCUSSION

3.1. In mayonnaise marinade marinated meat amino acids content

The efficiency of amino acid utilization is best when all amino acids are at or slightly below, but not above, their need for protein accretion and maintenance. In addition, formulating diets that meet, but do not exceed, amino acid needs also results in less nitrogen excretion (**Corzo et al, 2005**).

Content of amino acids in fresh and pickled venison meat samples in mayonnaise marinade is given in Table 1.

Table 1. Effects of packaging conditions on the amino acids content of venison in mayonnaise marinade (g kg^{-1})

Amino acids	Fresh meat	After pickling	Packaging		
			A	B	C
			after 7 storage days	after 14 storages days	
Val*	1.235	1.031	1.173	1.113	1.085
Leu*	2.506	1.976	1.933	1.805	1.738
Ile*	1.304	1.072	1.069	1.017	0.985
Phe*	1.226	0.979	0.963	0.920	0.863
Lys*	2.232	1.726	1.866	1.735	1.663
Arg	0.789	0.730	1.475	1.201	1.057
His	0.912	0.672	0.777	0.693	0.652
Asp	1.276	0.946	1.178	1.095	1.011
Ser	0.647	0.483	0.611	0.559	0.534
Glu	3.566	2.647	3.064	2.782	2.696

Gly	0.990	0.727	0.853	0.869	0.756
Thr*	0.971	0.668	0.764	0.804	0.759
Ala	1.426	1.003	1.083	0.976	0.911
Pro	1.002	0.831	0.893	0.879	0.791
Tyr	0.991	0.766	0.858	0.803	0.783
Met*	0.672	0.540	0.613	0.610	0.590
Total:	21.745	16.797	19.173	17.861	16.874
Sum of essential amino acids	10.146	7.992	8.381	8.004	7.683

* – essential amino acids. A = air ambience; B = CO₂ 40 % + N₂ 60 % (without oxygen scavenger); C = CO₂ 40 % + N₂ 60 % (with oxygen scavenger).

During experiments it was determined, that the fresh venison meat has higher content of amino acids (21.745) comparing with fresh beef meat (19.238) it is by 12%, what is significantly ($p=0,007$). Similar results were obtained during analysing of total content of essential amino acids. The higher content of essential amino acids was found in fresh venison meat (10.146) comparing with fresh beef meat (9.093), it is by 10% higher, what is significantly ($p=0.004$). It is necessary to mention, that the chemical composition of venison and beef meat mainly depend from many factors, such as breeding quality and amount, age, chemical composition of feed, meat storage condition and quality and others.

The total content of amino acids after venison pickling decrease significantly ($p=0.008$) by 23%. Acquired results mainly could be explained with albumen changes during pickling influencing by marinade composition. After pickling the content of essential amino acid decrease too; decreases are by 21%, what is significantly ($p=0.001$).

The results in table 1 shown that no significant differences ($p=0.785$) were found in amino acids content among under modified atmosphere (MA) without/with oxygen scavenger and in air ambience packaged pickled venison after 14 days storage. Essential amino acids content of in mayonnaise marinade pickled venison packaged under MA without/with oxygen scavenger and in air ambience not significantly different ($p=0.925$).

Acquired amino acid content of fresh and pickled beef samples in mayonnaise marinade is shown in Table 2.

The results in Table 1 and 2 indicate that the content of amino acids decreases after pickling in venison and beef samples, because protein content relents. The protein loss during storage could be explained by the fact that the marinated meat pH values increase due to decrease in soluble proteins.

During storage of pickled beef meat samples, no significant changes ($p>0.05$) were obtained in total amino acids and total essential amino acids content. In present research, no significant differences ($p>0.05$) were found among the amino acids and essential amino acids of pickled beef packaged in air ambience and under MA without/with oxygen scavenger after 18 days storage.

Table 2. Effects of packaging conditions on the amino acids content of beef in mayonnaise marinade (g kg^{-1})

Amino acids	Fresh meat	After pickling	Packaging		
			A	B	C
			after 18 storages days		
Val*	1.126	1.039	1.067	0.873	0.975
Leu*	1.902	1.713	1.714	1.604	1.786
Ile*	1.032	0.941	0.969	0.940	1.047
Phe*	0.928	0.868	0.820	0.806	0.884
Lys*	1.859	1.656	1.771	1.524	1.701
Arg	1.418	1.181	1.029	0.638	0.664
His	0.779	0.709	0.678	0.610	0.696
Asp	1.121	0.941	1.031	0.955	0.990
Ser	0.580	0.488	0.527	0.474	0.506
Glu	3.164	2.669	2.843	2.418	2.655
Gly	0.907	0.761	0.788	0.824	0.740
Thr*	0.857	0.655	0.654	0.593	0.620
Ala	1.274	1.001	0.963	0.890	0.990
Pro	0.902	0.840	0.841	0.836	0.821
Tyr	0.831	0.770	0.777	0.746	0.832
Met*	0.558	0.542	0.543	0.540	0.576
Total:	19.238	16.774	17.015	15.271	16.483
Sum of essential amino acids	9.093	8.184	8.315	7.626	8.421

* – essential amino acids. A = air ambience; B = CO₂ 40 % + N₂ 60 % (without oxygen scavenger); C = CO₂ 40 % + N₂ 60 % (with oxygen scavenger).

3.2. In vinegar marinade marinated meat amino acids content

The detected results of amino acids in fresh venison and pickled venison samples in vinegar marinade are shown in Table 3.

Table 3. Effects of packaging conditions on the amino acids content of venison in vinegar marinade (g kg⁻¹)

Amino acids	Fresh meat	After pickling	Packaging		
			A	B	C
			after 11 storage days		
Val*	1.235	1.166	1.026	0.979	1.036
Leu*	2.506	2.439	1.921	1.577	1.678
Ile*	1.304	1.285	1.084	0.911	0.943
Phe*	1.226	1.198	0.945	0.764	0.826
Lys*	2.232	1.959	1.840	1.706	1.698
Arg	0.789	0.657	0.692	1.068	1.051
His	0.912	0.767	0.624	0.636	0.601
Asp	1.276	1.159	1.031	1.017	1.000
Ser	0.647	0.591	0.498	0.500	0.506
Glu	3.566	3.059	2.725	2.611	2.671
Gly	0.990	0.792	0.785	0.727	0.958
Thr*	0.971	0.731	0.608	0.549	0.587
Ala	1.426	1.114	0.961	0.808	0.927
Pro	1.002	0.958	0.978	0.874	1.022
Tyr	0.991	0.904	0.800	0.720	0.717
Met*	0.672	0.629	0.535	0.477	0.493
Total:	21.745	19.408	17.053	15.924	16.714
Sum of essential amino acids	10.146	9.407	7.959	6.963	7.261

* – essential amino acids. A = air ambience; B = CO₂ 40 % + N₂ 60 % (without oxygen scavenger); C = CO₂ 40 % + N₂ 60 % (with oxygen scavenger).

Results indicate that packaging condition (air ambience and MA without/with oxygen scavenger) did not significantly ($p > 0.05$) influence the amino acids content changes in vinegar marinade pickled venison after storage.

Table 4. Effects of packaging conditions on the amino acids content of beef in vinegar marinade (g kg^{-1})

Amino acids	Fresh meat	After pickling	Packaging		
			A	B	C
			after 11 storage days		
Val*	1.126	1.070	1.079	1.211	1.104
Leu*	1.902	1.763	2.079	2.356	1.973
Ile*	1.032	1.002	1.221	1.316	1.135
Phe*	0.928	0.871	1.028	1.182	0.972
Lys*	1.859	1.660	1.754	1.968	1.750
Arg	1.418	1.217	0.627	0.665	0.843
His	0.779	0.680	0.676	0.795	0.736
Asp	1.121	1.148	1.072	1.324	1.102
Ser	0.580	0.576	0.547	0.675	0.566
Glu	3.164	2.890	3.048	3.705	2.996
Gly	0.907	0.761	0.785	0.986	0.773
Thr*	0.857	0.615	0.722	0.874	0.677
Ala	1.274	0.836	1.246	1.351	1.069
Pro	0.902	0.801	0.913	1.024	0.852
Tyr	0.831	0.735	0.869	1.012	0.826
Met*	0.558	0.539	0.604	0.702	0.596
Total:	19.238	17.164	18.270	21.146	17.970
Sum of essential amino acids	8.262	7.520	8.487	9.609	8.207

* – essential amino acids. A = air ambience; B = CO₂ 40 % + N₂ 60 % (without oxygen scavenger); C = CO₂ 40 % + N₂ 60 % (with oxygen scavenger).

The realised experiments did not indicate significant differences ($p > 0.05$) among the mean essential amino acids values of pickled venison packaged in air ambience and under MA without/with oxygen scavenger. During storage of in vinegar marinade pickled venison samples, content of amino acids and essential amino acids not significantly ($p > 0.05$) changed in all packages.

The results of amino acids in fresh beef and pickled beef samples in vinegar marinade are shown in Table 4.

In the present research significant differences ($p > 0.05$) were not found in amino acids values between fresh beef and in vinegar marinade pickled beef samples. After 11 days of storage the current experiment did not indicate significant differences ($p > 0.05$) among the mean amino acids values of marinated beef packaged in air ambience and under MA without/with oxygen scavenger.

Mean essential amino acids of beef packaged in air ambiance and under MA without/with oxygen scavenger not significantly different ($p>0.05$). No significant differences ($p>0.05$) were found in essential amino acids content in fresh beef and pickled beef samples during storage.

The changes of results in Table 3 and 4 shown that the content of detected parameters (amino acids) decreases after pickling in vinegar marinade marinated venison and beef samples. Such changes could be explained by the decreasing of soluble proteins in marinated meat samples after pH values change.

4. CONCLUSIONS

1. No significant differences ($p>0.05$) were observed in amino acids content among the pickled venison and beef samples packaged in air ambiance and under modified atmosphere without/with oxygen scavenger during storage
2. Marinade type not significantly influence ($p>0.05$) amino acids content changes in venison and beef meat samples.

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REFERENCES

- Alvarado C. and S. McKee (2007) Marination to Improve Functional Properties and Safety of Poultry Meat // The Journal of Applied Poultry Research, 16, p. 113 – 120.
- Bjorkroth J. (2005) Microbiological ecology of marinated meat products: a review // Meat Science, 70, p. 477 – 480.
- Brandon K., M. Beggan, P. Allen, F. Butler (2009) The performance of several oxygen scavengers in varying oxygen environments at refrigerated temperatures: implications for low-oxygen modified atmosphere packaging of meat // International Journal of Food Science and Technology, 44, p. 188 – 196.
- Burke R.M. and F.J. Monahan (2003) The tenderisation of shin beef using a citrus juice marinade // Meat Science, 63, p. 161 – 168.

Corzo A., C.A. Fritts, M.T. Kidd (2005) Response of broiler chicks to essential and non-essential amino acid supplementation of low crude protein diets // [Animal Feed Science and Technology](#), 118:3-4, p. 319 – 327.

Daszkiewicz T., J. Kondratowicz, M. Koba-Kowalczyk (2011) Changes in the quality of meat from roe deer (*Capreolus capreolus* L.) bucks during cold storage under vacuum and modified atmosphere // Polish Journal of Veterinary Sciences, Vol. 14, No. 3, p. 459 – 466.

Daszkiewicz T., P. Janiszewski., S. Wajda (2007) Quality characteristics of meta from wild red deer (*Cervus Elaphus* L.) hinds and stags // Journal of Muscles Foods, 20, p. 428 – 448.

Ergezer H., R. Gocke (2011) Comparison of Marinating with Two Different Types of Marinade on Some Quality and Sensory Characteristics of Turkey Breast Meat // Journal of Animal and Veterinary Advances, Vol 10, No. 1, p. 60 – 67.

Gokoglu N., P. Yerlikaya, H. Uran, O.K. Topuz (2011) Effects of Packaging Atmospheres on the Quality and Shelf Life of Beef Steaks // Kafkas Universitesi Veteriner Fakultesi Dergisi, Vol. 17, No. 3, p. 435 – 439.

Kargiotou C., E. Katsanidis, J. Rhoades, M. Kontominas, K. Koutsoumanis (2011) Efficacies of soy sauce and wine base marinades for controlling spoilage of raw beef // International Journal of Food Microbiology, 28, p. 158 – 163.

Pathania A., S.R. McKee, S.F. Bilgili, M. Singh (2010) Antimicrobial activity of commercial marinades against multiple strains of *Salmonella* spp. // International Journal of Food Microbiology, 139, p. 214 – 217.

Vergara H., L. Gallego, A. García, T. Landete-Casillejos (2003) Conservation of *Cervus elaphus* meat in modified atmospheres // Meat Science, 65, p. 779 – 783.

Warriss P.D. (2010) Meat Science: an introductory text – 2nd ed. Cambridge, Cambridge University Press, 234 p.