International Journal of Biological, Life and Agricultural Sciences
ISSN: 2415-6612
Vol:7, No:9, 2013

Evaluation of Packaging Conditions Influence on the Content of Amino Acids of Marinated Venison

Ilze Gramatina, Laima Silina, Tatjana Rakcejeva

Abstract**—**Venison is well known as a traditional meat type in Europe and it is lower in calories, cholesterol and fat content than common cuts of beef, pork or lamb. The aim of the current research was to determine content of amino acids (LVS ISO 13903:2005) in different types of marinades marinated venison during storage. Beef as a control was analyzed for comparison of obtained results. The meat (2x3x2cm) pieces were marinated in two different types of marinades: red wine and tomato sauce marinade. The prepared meat samples were stored (marinated) at 4±2ºC temperature for 48±1h. Marinated meat was placed in polypropylene trays, hermetically sealed with high barrier polymer film under modified atmosphere ($C0_2$ 40%+N_2 60%) without and with iron based oxygen scavenger sachets (Mitsubishi Gas Chemical Europe Ageless®), all samples were compared with packed marinated products in air ambiance. Results of current research show that changes of amino acids content in marinated venison mainly depend on packaging conditions.

Keywords**—**Marinated venison, modified atmospheres, oxygen absorber.

I. 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. 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 [1].

Currently, marinating is widely used by consumers and producers to improve meat tenderness and juiciness [2]. 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 [3]. Marinating 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 flavor and tenderize meat products [4], [5]. The functionality of most marinades is directly depending 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 [6]. 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 [7]. Marinades are incorporated into meat by soaking texture and moisture retention; to enrich the meat flavor; to tenderize the fibers of muscle foods; and to preserve the products over a longer time [8].

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 [9]. 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 [10]. The most appropriate gas composition for venison preservation is CO_2 40% + N_2 60% [11]. However, MAP technologies not always completely remove oxygen and oxygen penetrates through the packaging film. Using of oxygen scavenger can reduce oxygen level in a package. 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 [12].

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

II. Materials and Methods

The experiments were carried out at the Department of Food Technology, at Latvia University of Agriculture; at the Agency of the Latvia University of Agriculture (LLU) "Research institute of Biotechnology and Veterinary Medicine "Sigra"" in Year 2012.

A. Raw Materials

The meat of farmed red deer (*Cervus elaphus*) was obtained from a local farm 'Saulstari 1', located in Sigulda region, in Latvia; the beef of farmed cattle (*Colloquially cows*) from Ltd. 'Margret' located in Jekabpils region, in Latvia, was used for control. Wild breeding conditions of animals was very similar, without feeding with special forage. Animals were

Ilze Gramatina is with the Latvia University of Agriculture, Jelgava, LV-3001, Latvia (phone: +371 6 30 05673; fax: +371 6 30 22829; e-mail: ilzegramatina@inbox.lv).

Laima Silina and Tatjana Rakcejeva are with the Latvia University of Agriculture, Jelgava, LV-3001, Latvia (e-mail: imslaima@inbox.lv, tatjana.rakcejeva@llu.lv).

slaughtered at ~2 years of age.

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

1) tomato sauce marinade – tomato sauce, lemon, onion, parsley, sweet pepper, basil, black pepper, rosemary, salt;
2) red wine marinade – red wine, onion, vinegar, garlic, parsley, sweet pepper, basil, black pepper, rosemary, salt

B. Preparation of Samples

Marinating process of the samples included the following steps:

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

C. Packaging Materials

Marinated meat samples were placed in the polypropylene (PP) trays (210×148×35mm) and hermetically sealed with high barrier polymer film Multibarrier 60 (composition: APA/TIE/PA/EVOH/PA/TIE/PE/PE; with a thickness 60±2 μm) under modified atmosphere ($C0_2$ 40%+N_2 60%) without and with iron-based oxygen absorber sachets (Mitsubishi Gas Chemical Europe Ageless®).

As a control sample in air ambiance packed marinated venison and beef was used.

Marinated meat samples were stored at 4±2°C.

D. Samples Analyzing System

All samples were analyzed after marinating and before packaging or in 0 day of storage. Stored time (days) of packaged marinated venison and beef samples depends from the microbiological parameters of meat. When the microbiological parameters exceeded permissible limit experiments were finished.

Venison samples marinated in tomato sauce marinade were analyzed after 7 days of storage in air ambiance and after 14 days of storage under modified atmosphere (MA) packaging without/with oxygen absorber.

Beef samples marinated in the same marinade were analyzed after 11 days of storage in air ambiance and under MA packaging without oxygen absorber, but after 14 days of storage under MA packaging with oxygen absorber. In red wine marinade marinated venison and beef samples were analyzed after 11 days of storage in air ambiance and after 14 days of storage under MA packaging without/with oxygen absorber.

D. Chemical Analysis

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

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

E. Statistical Analysis

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.

III. Results and Discussion

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 [13].

A. In Tomato Sauce Marinade Marinated Meat Amino Acids Content

Content of amino acids in chilled and marinated venison samples in tomato sauce marinade are given in Table I.

TABLE I
EFFECTS OF PACKAGING CONDITIONS ON THE AMINO ACIDS CONTENT OF VENISON MARINATED IN TOMATO SAUCE MARINADE G 100 G^{-1}

Amino acids	Chilled meat	After marinating	Packaging		
			A	B	C
			after 7 storage days	after 14 storages days	
Val*	**1.24**	**1.27**	**0.89**	**1.01**	**0.93**
Leu*	**2.51**	**0.79**	**1.30**	**1.54**	**1.36**
Ile*	**1.30**	**0.78**	**0.70**	**0.95**	**0.74**
Phe*	**1.23**	**1.69**	**0.69**	**0.94**	**0.73**
Lys*	**2.23**	**1.18**	**1.91**	**2.09**	**2.01**
Arg	0.79	0.67	1.26	1.42	1.33
His	0.91	1.48	0.71	0.81	0.74
Asp	1.28	0.71	1.43	1.70	1.50
Ser	0.65	2.78	0.69	0.81	0.72
Glu	3.57	0.80	2.69	3.28	2.84
Gly	0.99	0.88	0.81	0.95	0.85
Thr*	**0.97**	**1.10**	**0.89**	**1.03**	**0.93**
Ala	1.43	0.72	1.13	1.45	1.19
Pro	1.00	0.60	0.76	0.88	0.80
Tyr	0.99	0.49	0.58	0.73	0.61
Met*	**0.67**	**0.56**	**0.47**	**0.55**	**0.49**
Total:	21.75	16.47	16.88	20.13	17.76
Sum of essential amino acids	10.15	7.36	6.83	8.10	7.19

* essential amino acids. A=air ambiance; B= CO_2 40%+N_2 60% (without oxygen absorber); C= CO_2 40%+N_2 60% (with oxygen absorber).

During experiments it was determined, that the chilled venison has higher content of amino acids (21.75) comparing with chilled beef (19.24) it is by 12% higher, what is significantly ($p<0.05$). Similar results were obtained during analyzing of total content of essential amino acids. The higher

content of essential amino acids was found in chilled venison (10.15) comparing with chilled beef (8.26), what is significantly ($p<0.05$). It is necessary to mentioned, that the chemical composition of venison and beef depends from many factors, such as breeding, quality and amount, age, chemical composition of feed, meat storage condition, quality and others.

In Table I the results shown that the total content of amino acids after marinating in venison decrease significantly ($p<0.05$) by 24.3%. Acquired results mainly could be explained with albumen changes during marinating influencing by marinade composition. After marinating the content of essential amino acids decrease to; decreases are by 27.5%, what is significantly ($p<0.05$). Results indicate that packaging condition (air ambiance and MA without/with oxygen absorber) did not significantly ($p>0.05$) influence the amino acids content changes in tomato sauce marinade marinated venison after storage. Essential amino acids content of in tomato sauce marinade marinated venison packaged under MA without/with oxygen absorber and in air ambiance not significantly different ($p>0.05$). Acquired amino acid content of chilled and marinated beef samples in tomato sauce marinade are shown in Table II.

TABLE II
EFFECTS OF PACKAGING CONDITIONS ON THE AMINO ACIDS CONTENT OF BEEF MARINATED IN TOMATO SAUCE MARINADE G 100 G^{-1}

Amino acids	Chilled meat	After marinating	Packaging		
			A	B	C
			after 11 storage days		after 14 storages days
Val*	**1.13**	**1.47**	**1.34**	**1.21**	**1.07**
Leu*	**1.90**	**0.86**	**0.83**	**0.75**	**1.64**
Ile*	**1.03**	**0.85**	**0.82**	**0.74**	**1.02**
Phe*	**0.93**	**2.16**	**0.85**	**2.01**	**1.00**
Lys*	**1.86**	**1.38**	**1.23**	**1.12**	**2.22**
Arg	1.42	0.81	0.70	0.64	1.52
His	0.78	1.56	1.48	1.34	0.86
Asp	1.12	0.76	0.70	0.63	1.81
Ser	0.58	3.10	2.84	2.57	0.86
Glu	3.16	0.92	0.82	0.74	3.50
Gly	0.91	0.97	0.90	0.81	1.01
Thr*	**0.86**	**1.27**	**1.26**	**1.14**	**1.10**
Ala	1.27	0.84	0.77	0.69	1.54
Pro	0.90	0.65	0.64	0.57	0.94
Tyr	0.83	0.49	0.48	0.43	0.78
Met*	**0.56**	**0.32**	**0.60**	**0.51**	**0.59**
Total:	19.24	18.40	16.22	15.89	21.45
Sum of essential amino acids	8.26	8.30	6.91	7.47	8.64

* essential amino acids. A=air ambiance; B= CO_2 40%+N_2 60% (without oxygen absorber); C= CO_2 40%+N_2 60% (with oxygen absorber).

The results in Tables I and II indicate that the content of total amino acids decreases after marinating in venison and beef samples, because protein content relent. The protein loss during storage could be explained by the fact that the marinated meat pH value increase due to decrease in soluble proteins. After marinating, the total amount of amino acids decreases by 4.4% ($p>0.05$), but amount of essential amino acids increase by 0.5% ($p>0.05$). After storage of marinated beef 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 marinated beef packaged in air ambiance and under MA without oxygen absorber after 11 days of storage. The same situation was established under MA with oxygen absorber after 14 storages days.

B. In Red Wine Marinade Marinated Meat Amino Acids Content

Amino acids amount changes of chilled and marinated venison in red wine marinade are given in Table III.

TABLE III
EFFECTS OF PACKAGING CONDITIONS ON THE AMINO ACIDS CONTENT OF VENISON MARINATED IN RED WINE MARINADE G 100 G^{-1}

Amino acids	Chilled meat	After marinating	Packaging		
			A	B	C
			after 11 storage days	after 14 storages days	
Val*	**1.24**	**1.05**	**1.05**	**1.37**	**1.44**
Leu*	**2.51**	**1.67**	**1.61**	**0.84**	**0.84**
Ile*	**1.30**	**0.98**	**1.00**	**0.83**	**0.83**
Phe*	**1.23**	**0.96**	**0.98**	**1.10**	**0.94**
Lys*	**2.23**	**2.46**	**2.18**	**1.26**	**1.34**
Arg	0.79	1.56	1.49	0.72	0.79
His	0.91	0.92	0.85	1.51	1.52
Asp	1.28	1.77	1.78	0.72	0.75
Ser	0.65	0.87	0.84	2.90	3.03
Glu	3.57	3.52	3.43	0.84	0.89
Gly	0.99	1.04	0.99	0.91	0.94
Thr*	**0.97**	**1.10**	**1.08**	**1.28**	**1.24**
Ala	1.43	1.44	1.51	0.78	0.82
Pro	1.00	0.96	0.92	0.65	0.64
Tyr	0.99	0.74	0.76	0.49	0.48
Met*	**0.67**	**0.56**	**0.58**	**0.49**	**0.55**
Total:	21.75	21.60	21.04	16.67	17.03
Sum of essential amino acids	10.15	8.78	8.48	7.17	7.17

* essential amino acids. A=air ambiance; B= CO_2 40%+N_2 60% (without oxygen absorber); C= CO_2 40%+N_2 60% (with oxygen absorber).

After marinating no significantly differences ($p>0.05$) were found in total amount of amino acids in venison, it is increased by 0.7% – from 21.75g $100g^{-1}$ to 21.60g $100g^{-1}$. But after marinating the amount of essential amino acids in venison decrease by 13.5% – from 10.15g $100g^{-1}$ to 8.78g $100g^{-1}$. During storage of in red wine marinade marinated venison samples, content of amino acids and essential amino acids decrease in all packages.

The detected results of amino acids in chilled and marinated beef samples in red wine marinade are shown in Table IV. After marinating the total amount of amino acids decreases in beef by 22.2%, but amount of essential amino acids by 23.0% ($p<0.05$). During storage the amount of total and essential amino acids in beef samples increase in all packages ($p<0.05$).

TABLE IV
EFFECTS OF PACKAGING CONDITIONS ON THE AMINO ACIDS CONTENT OF BEEF MARINATED IN RED WINE MARINADE G 100 G^{-1}

Amino acids	Chilled meat	After marinating	Packaging		
			A	B	C
			after 11 storage days	after 14 storages days	
Val*	**1.13**	**1.24**	**1.02**	**0.99**	**1.37**
Leu*	**1.90**	**0.76**	**1.56**	**1.51**	**0.85**
Ile*	**1.03**	**0.75**	**0.96**	**0.94**	**0.84**
Phe*	**0.93**	**0.80**	**0.95**	**0.92**	**2.02**
Lys*	**1.86**	**1.14**	**2.11**	**2.04**	**1.27**
Arg	1.42	0.65	1.44	1.39	0.72
His	0.78	1.36	0.82	0.80	1.52
Asp	1.12	0.65	1.72	1.67	0.72
Ser	0.58	2.63	0.82	0.79	2.92
Glu	3.16	0.76	3.31	3.22	0.84
Gly	0.91	0.83	0.96	0.93	0.92
Thr*	**0.86**	**1.16**	**1.04**	**1.01**	**1.29**
Ala	1.27	0.71	1.46	1.42	0.79
Pro	0.90	0.59	0.89	0.87	0.65
Tyr	0.83	0.44	0.74	0.72	0.49
Met*	**0.56**	**0.52**	**0.56**	**0.54**	**0.56**
Total:	19.24	14.96	20.35	19.74	17.76
Sum of essential amino acids	8.26	6.36	8.20	7.95	8.20

* essential amino acids. A=air ambiance; B= CO_2 40%+N_2 60% (without oxygen absorber); C= CO_2 40%+N_2 60% (with oxygen absorber).

After storage the current experiments did not indicate significant differences ($p>0.05$) among the mean amino acids value of marinated beef packaged in air ambiance and under MA without/with oxygen absorber.

The changes of results in Tables III and IV show that the content of detected parameters (amino acids) decreases after marinating in red wine marinade marinated venison and beef samples. Such changes could be explained by the decreasing of soluble proteins in marinated meat samples after pH value change.

IV. CONCLUSIONS

No significant differences ($p>0.05$) were observed in amino acids and essential amino acids content among the marinated venison and beef samples packaged in air ambiance and under modified atmosphere without/with oxygen scavenger.

Marinade type not significantly change ($p>0.05$) amino acids and essential amino acids amount in venison and beef samples.

Increasing of detected parameters after storage depends from condition of packaging materials

ACKNOWLEDGMENT

The work of the doctoral student L. Silina is supported by the ESF project No. 2009/0180/1DP/1.1.2.1.2./ 09/IPIA/VIAA/017.

This research and publication have been prepared also within the State Research Programme 'Sustainable use of local resources (earth, food, and transport) – new products and technologies (NatRes)' (2010.-2013.) Project No. 3. 'Sustainable use of local agricultural resources for development of high nutritive value food products (Food)'.

REFERENCES

[1] T. Daszkiewicz, P. Janiszewski., S. Wajda, "Quality characteristics of meta from wild red deer (*Cervus Elaphus* L.) hinds and stags", *Journal of Muscles Foods*, vol. 20, pp. 428 – 448, 2007.
[2] H. Ergezer, R. Gocke, "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, pp. 60 – 67, 2011.
[3] J. Bjorkroth, "Microbiological ecology of marinated meat products: a review", *Meat Science,* vol. 70, pp. 477 – 480, 2005.
[4] C. Kargiotou, E. Katsanidis, J. Rhoades, M. Kontominas, K. Koutsoumanis, "Efficacies of soy sauce and wine base marinades for controlling spoilage of raw beef", *International Journal of Food Microbiology*, vol. 28, pp. 158 – 163, 2011.
[5] A. Pathania, S.R. McKee, S.F. Bilgili, M. Singh, "Antimicrobial activity of commercial marinades against multiple strains of *Salmonella* spp.", *International Journal of Food Microbiology*, vol. 139, pp. 214 – 217, 2010.
[6] R.M. Burke, F.J. Monahan, "The tenderisation of shin beef using a citrus juice marinade", *Meat Science*, vol. 63, pp. 161 – 168, 2003.
[7] P.D. Warriss, "Meat Science: an introductory text – 2nd ed. Cambridge, Cambridge University Press, 2010.
[8] C. Alvarado, S. McKee**,** "Marination to Improve Functional Properties and Safety of Poultry Meat", *The Journal of Applied Poultry Research*, vol. 16, pp. 113 – 120, 2007.
[9] T. Daszkiewicz, J. Kondratowicz, M. Koba-Kowalczyk, "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, pp. 459 – 466, 2011.
[10] N. Gokoglu, P. Yerlikaya, H. Uran, O.K. Topuz, "Effects of Packaging Atmospheres on the Quality and Shelf Life of Beef Steaks", *Kafkas Universitesi Veteriner Fakultesi Dergisi*, vol. 17, no. 3, pp. 435 – 439, 2011.
[11] H. Vergara, L. Gallego, A. García, T. Landete-Casillejos, "Conservation of *Cervus elaphus* meat in modified atmospheres", *Meat Science*, vol. 65, pp. 779 – 783, 2003.
[12] K. Brandon, M. Beggan, P. Allen, F. Butler, "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*, vol. 44, pp. 188 – 196, 2009.
[13] A. Corzo, C.A. Fritts, M.T. Kidd, "Response of broiler chicks to essential and non-essential amino acid supplementation of low crude protein diets", *Animal Feed Science and Technology*, vol. 118:3-4, pp. 319 – 327, 2005.

I. Gramatina, Dr.sc.ing. was born in Bauska, Latvia at 1976. She has received her doctor's degree in Food Science at 2007, defending her thesis "Oat hydrolysates in food". The main scientific directions are: meat and meat products quality, development of new products and their quality evaluation. She has about 20 published scientific publications and participated in 11 different projects.

She is the leader researcher and at the Latvia University of Agriculture, Faculty of Food Technology, Department of Food Technology from 2007 until nowadays.