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THE QUALITY DIFFERENCE BETWEEN FRANKFURTERS SEASONED WITH CONVENTIONAL AND ORGANIC SPICES

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Frankfurters seasoned with conventional and organic garlic or coriander were investigated for the differences in taste and odor intensities, instrumental color and oxidative stability during 35 days of cold storage. Garlic powder, both organic (0.78 mg MDA/kg) and conventional (0.71 mg MDA/kg), promoted lipid oxidation compared to control frankfurters without garlic (0.52 mg MDA/kg). Consumers assessed odor (6.68) and taste (6.18) intensities of frankfurters with organic garlic significantly higher compared to the odor (4.73) and taste (4.65) of the frankfurters with conventional garlic. Color of frankfurters with organic or conventional spices was also significantly different. At the 95% confidence level, at least 20% of the consumers could distinguish between the samples with organic and conventional garlic, and at least 14% of the consumers between the samples with organic and conventional coriander. For the first time it is suggested that seasoning with organic instead of conventionally produced spices might improve quality characteristics of meat products.

KEY WORDS: spices, sausages, sensory evaluation, lipid oxidation

INTRODUCTION

Edible spices serve many functions in food products. Their primary functions are to flavor food and provide aroma, texture, and color. Every spice or flavoring contains predominating chemical components that create these sensual qualities. The taste of a spice such as sweet, spicy, sour, or salty, is due to the presence of esters, phenols, acids, alcohols, chlorides, alkaloids, or sugars. The ratio of volatiles to non-volatiles varies among spices, causing flavor similarities and differences within a genus and even within a variety. They vary depending upon the species of spice, its source and environmental growing conditions (1). Quality considerations for organic spices are the most important,

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and they should be superior quality-wise in respect of inherent biochemical constituents (2).

The so-called 'secondary metabolites' make a major contribution to the specific odors, tastes and colors of (spice) plants (3). There is ample, but circumstantial, evidence that, on average, organic vegetables most likely contain more of these compounds than conventional ones (4). These findings make it only reasonable to assume that the application of organic spices in meat products would impact their color and taste significantly compared to the meat products made with conventional spices.

Garlic (*Allium sativum L.*) is one of the most commonly used ingredients as a flavor enhancer in meat products. Coriander (*Coriandrumsativum L.*) is sweet and aromatic (rose like) spice used in some smoked sausages. The flavor of frankfurters is typically due to black pepper, nutmeg, and possibly, to coriander and garlic (5). From a technological standpoint, the use of garlic and coriander and their derivatives in meat and meat products has been proposed by many authors due to their antioxidant activity (6-8).

Hence, the aim of the present study was to evaluate the possible differences in lipid oxidation, color and sensory properties of frankfurters made with organic and conventionally grown garlic and coriander.

EXPERIMENTAL

Frankfurter samples preparation

The raw materials: post-rigor pork (mixture of round and shoulder muscles) and fresh back fat were purchased from a major local retailer. The meat was trimmed of visible fat and connective tissue. Frankfurters were manufactured in a pilot meat processing plant of the Faculty of Agriculture, University of Belgrade. Five different batters, first without (control) and four with (single) spices, were produced all containing 50% of pork meat, 25% of back fat and 25 % of water (ice). This was performed in duplicate using meat batters of 4 kg. All batters were produced on the same day and in identical manner: refrigerated meat and fat were chopped to 8 mm particle size in a meat grinder (Laska 82H, Austria) and then mixed with ice, nitrite-salt (1.8%), polyphosphate (0.4%), soy protein isolate (1%), sodium erythorbate (0.04%) and sugar (0.5%) in a meat cutter (Müller EMS, Germany) until the temperature reached 7 °C. Finally, 3% of the single selected type of spice was added to the mixture and the comminution process was continued while ensuring that the maximum batter temperature did not exceed 12 °C. Four different spices used in our investigation were: garlic powder (*Allium sativum L.*) conventionally produced (GC) and from organic origin (GO); ground coriander (*Coriandrum sativum L.*) conventionally produced (CC) and from organic origin (CO). All spices were obtained from the same producer (Lay Gewürze, Queienfeld, Germany) declaring their accordance with organic Regulation (EC) No 834/2007 where appropriate.

After the emulsification, the prepared batter was stuffed into 24 mm diameter collagen casings, after which they were hanged, smoked and cooked for approximately 2 hours in a smoking/cooking chamber (Belje, Croatia), until the temperature in the central

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part of the sausages reached 72 °C/10 min. The cooked sausages were showered in cold water and stored at 4 ± 1 °C for a period of 35 days.

Methods

Lipid oxidation (TBARS) measurement. Malondialdehyde (MDA), the compound used as an index of lipid peroxidation, was determined by a selective third-order derivative spectrophotometric method according to Botsoglou et al. (9), with slight modifications. In brief, 2 grams of samples with 10 ml of 5% aqueous solution of trichloroacetic acid (Merck, Darmstadt, Germany) and 5 ml of 0.8% butylated hydroxytoluene (Sigma Chemical Co, St. Louis, MO) in hexane, were briefly vortexed (CZ Classic, VelpScientifica, Italy) and then homogenized in an ultrasonic bathroom (ATM40-3LCD, Madrid, Spain) for 5 min before being centrifuged (Eppendorf Centrifuge 5804 R, Hamburg, Germany) at 3,000 rpm for 5 minutes. The top layer was discarded, and a 2.5-ml aliquot from the bottom layer was mixed with 1.5 ml of 0.8% aqueous 2-thiobarbituric acid (Sigma Chemical Co, St. Louis, MO) to be further incubated at 70 °C for 30 min in water bath (Memmert MB14, Germany). Following incubation, the mixture was cooled under tap water and submitted to conventional spectrophotometry (Shimadzu, Model UV-160A, Tokyo, Japan) in the range of 400-650 nm. The concentration of MDA in the analyzed samples was calculated as described by Botsoglou et al. (9). The results are expressed as mg MDA/kg frankfurter.

Color. Color of frankfurters was evaluated using a computer vision system (CVS) previously described by Girolami et al. (10) with a modifications explained below. A Sony Alpha DSLR-A200 digital camera featuring a 10.2 Megapixel CCD sensor was used for image acquisition. The camera was located vertically at a distance of 30 cm from the sample. The camera setting was the following: shutter speed 1/6 s, manual operation mode, aperture Av F/11.0, ISO velocity 100, flash off, focal distance 30 mm, lens DT-S18-70 mm f 3.5-5.6. Lighting was achieved with four fluorescent lamps (Philips Master Graphica TLD 965), with a color temperature of 6500 K and a color rendering index (Ra) close to 98%. Light diffusers covered each lamp. The camera was calibrated with a 24 color chart X-Rite Colorchecker; the CCD sensor was adjusted using the standard color rendition chart Colorchecker Passport (Michigan, USA).

The Colorchecker was photographed using the implemented CVS to obtain the input device RGB signals in the theoretical range of 0-255 (the RGB values are expressed as sRGB D65 and CIE Lab D50 2° observer). The camera was connected to a Toshiba Portege R830 PC equipped with a 22″ LG IPS LED external monitor. The monitor with an sRGB gamut (Standard RGB) was calibrated with X-Rite i1 Display Pro device by selecting white chromaticity at 6500 K (illuminant D65), gamma at 2.2 and white luminance at 140 cd/m^2, and the i1Profiler 1.5.6 software was used to create the ICC monitor profile. The Adobe Photoshop CC (64 bit) software was used for image analysis. The L*, a*, and b* values were measured on the digital image of the sample visualized on the monitor by pointing the cursor at the centre of the area (11x11 pixels) to be

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evaluated by clicking on it. The L*, a* and b* values from RGB images were measured from RAW photographs.

Total color difference (ΔE*) was calculated according to the formula:

$$\Delta E^* = \sqrt{(L_c^* - L_o^*)^2 + (a_o^* - a_c^*)^2 + (b_o^* - b_c^*)^2}$$

where the subscript (c) denotes the values for frankfurters with conventional and (o) denotes the values for frankfurters with organic spices.

Triangle test. Seventy-five consumers (38 male and 37 female) participated in all the triangle tests. For one participant, the odd product was the same for the two replications and the six triads (AAB, ABA, BAA, BBA, ABB and BAB) were counterbalanced over participants at each replication (11). The sausages were cooled to 21 °C, cut into quarters (length×diameter: 10×25 mm) and served to the consumers. The tests were carried in the meat laboratory under daily light. The degree of difference between the sample assessor choice and the others was expressed by circling one of the following descriptors which most closely describes the intensity of difference („0“ = none; „1“ - very slight; „2“ - slight; „3“ - moderate; „4“ - large; „5“ - extreme).

Consumer preference. Sixty consumers (24 male and 36 female, age ≤25) were invited to evaluate intensities of odor and taste of garlic and coriander in sausages. Samples were served in a sequential order, with a two-minute mandatory break between each sample. Participants rinsed their mouths with room temperature mineral water between samples to reduce potential carry-over effects (12). To evaluate taste and odor a 9-point intensity scale was used with two descriptive anchors, (1 = ‘‘very low intensity”) and (9 = ‘‘very high intensity”) in order to signify increasing sensation intensity (13). The data obtained from the 9-point scale were processed using t-test for sausages containing the same type of spice, garlic or coriander. The level of statistical significance was set at $\alpha = 0.05$ (95% confidence).

Statistical analysis. The data were analyzed using SPSS Statistics 17.0 (Chicago, Illinois, USA). A three-sample independent t-test was used to compare the pairs of means with P ≤0.05. When multiple effect comparison was made, factorial analysis of variance (ANOVA), and a post-hoc Tukey analysis of Honestly Significant Difference (HSD) were used. The data are presented as mean values of measurements along with standard deviations.

RESULTS AND DISCUSSION

TBARS measurements

The antioxidative activity of garlic aroma (sulphur) compounds (allicin, diallyl disulfide, and diallyltrisulfide) was previously confirmed (14). However, when it comes to the antioxidative activity of garlic powder in meat and meat products, limited data are available. Park et al. (15) examined the antioxidant effects of garlic powders (5%) in fresh pork belly and pork loin in the vacuum-packaged samples held at 8 °C for 28 days.

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The authors found that garlic powders were effective at reducing TBARS values in fresh pork belly, but no significant reduction was found in the pork loin treated with garlic powder.

Our results suggest that garlic powder, both conventional and organic, promoted lipid oxidation in frankfurters throughout the whole period of their shelf life. The MDA concentrations were significantly higher (P< 0.5) in samples with added garlic compared to control (Table 1). Significant difference in the lipid oxidation between the frankfurters with conventional and organic garlic could not be observed during the period of 35 days of cold storage. These results are in agreement with the findings of Mariutti et al. (16) suggesting that garlic presented no effect as antioxidant and accelerated lipid oxidation in chicken meat.

Table 1. Differences in lipid oxidation TBA-RS (mg MDA/kg) of frankfurters with conventional and organic spices during shelf life

	Time (days)				
Frankfurter	1 day	7 day	14 day	21 day	35 day
Control	$0.28^{a}_{(\pm 0.07)}$	$0.31^{a}_{(\pm 0.01)}$	$0.35^{a}_{(\pm 0.08)}$	$0.47^{a,e}_{(\pm 0.11)}$	$0.52^{a}_{(\pm 0.07)}$
Garlic conventional	$0.47^{b}_{(\pm 0.01)}$	$0.50^{c,d}_{(\pm 0.06)}$	$0.56^{c,d}_{(\pm 0.06)}$	$0.61^{c,d,e}_{(\pm 0.05)}$	$0.78^{b}_{(\pm 0.08)}$
Garlic organic	$0.59^{b}_{(\pm 0.01)}$	$0.62^{d}_{(\pm 0.06)}$	$0.65^{d}_{(\pm 0.07)}$	$0.68^{d}_{(\pm 0.05)}$	$0.71^{b}_{(\pm 0.01)}$
Coriander conventional	$0.31^{a}_{(\pm 0.12)}$	$0.32^{a,b}_{(\pm 0.12)}$	$0.39^{a,b}_{(\pm 0.09)}$	$0.42^{a,b}_{(\pm 0.06)}$	$0.47^{a}_{(\pm 0.01)}$
Coriander organic	$0.31^{a}_{(\pm 0.01)}$	$0.39^{a,b,c}_{(\pm 0.09)}$	$0.47^{a,b,c}_{(\pm 0.01)}$	$0.54^{a,b,c,d}_{(\pm 0.07)}$	$0.56^{a}_{(\pm 0.05)}$

Mean values of six replications ± standard deviation; Means within a same day lacking a common superscript letter are significantly different (*P*< 0.05).

Although it was previously reported that coriander significantly lowered MDA concentrations in different types of meat products (6, 17, 18) our experiments could not confirm its antioxidant activity in frankfurters. From the first until the last (35th) day of the cold storage, MDA concentrations in control and frankfurters with conventional or organic coriander were not significantly different (P > 0.5). During the same period, a significant difference in lipid oxidation between samples with conventional and organic coriander could not be observed (Table 1).

Color

Although, according to Mokrzycki and Tatol (19), even unexperienced observer can notice the difference in color when total color difference is $2 < \Delta E^* < 3.5$, it should be noted that when the difference is concentrated in one dimension, like it was the case with

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conventional and organic garlic samples in our study, this color difference is pronounced even more. Therefore, despite the fact that the values for lightness (L*) and yellowness (b*) were not significantly different between frankfurters with conventional and organic garlic (Table 2) and the point that total color difference was only slightly greater than 2 throughout the examined period of shelf life, we should conclude that there was a clear difference in color between the samples. From the first till the last day of cold storage, the frankfurters with organic garlic were significantly greener due to the repeatedly lower redness (a*) values compared to the samples with conventional garlic.

Table 2. Differences in color of frankfurters with conventional and organic spices during shelf life

		Time (days)				
Frankfurter	Color	1 day	7 day	14 day	21 day	35 day
Garlic conventional (GC)	L*	73.65^{a} (±1.13)	74.10^{a} (±0.97)	73.95^{a} (±1.14)	75.15^{a} (±0.74)	76.10^{a} (±1.11)
	a*	9.25^{a} (±0.79)	9.75^{a} (±0.64)	9.50^{a} (±0.55)	9.35^{a} (±0.98)	9.25^{a} (±0.59)
	b*	5.95^{a} (±0.89)	6.65^{a} (±0.67)	6.10^{a} (±0.85)	6.10^{a} (±0.55)	6.45^{a} (±0.87)
Garlic organic (GO)	L*	75.50^{b} (±1.54)	76.35^{b} (±1.26)	75.55^{b} (±0.72)	77.25^{b} (±0.72)	78.15^{b} (±1.13)
	a*	8.35^{b} (±0.99)	8.30^{b} (±0.47)	8.35^{b} (±0.95)	8.55^{b} (±0.35)	8.60^{b} (±0.59)
	b*	6.05^{a} (±0.60)	5.70^{a} (±0.97)	6.30^{a} (±0.57)	6.15^{a} (±0.43)	6.10^{a} (±0.87)
	$\Delta E^*_{(GC-GO)}$	2.06	2.84	1.98	2.24	2.17
Coriander conventional (CC)	L*	68.45^{c} (±0.76)	69.30^{c} (±1.41)	69.90^{c} (±0.97)	70.25^{c} (±0.65)	70.85^{c} (±1.46)
	a*	11.55^{c} (±0.76)	12.55^{c} (±0.89)	12.20^{c} (±0.65)	11.96^{c} (±0.85)	12.25^{c} (±1.02)
	b*	11.35^{C} (±1.75)	11.15^{c} (±1.08)	10.85^{c} (±0.99)	11.15^{c} (±1.19)	10.90^{c} (±1.07)
Coriander organic (CO)	L*	67.85^{c} (±1.95)	68.90^{c} (±0.76)	69.00^{c} (±0.85)	69.35^{c} (±0.97)	70.45^{c} (±1.46)
	a*	11.95^{c} (±1.23)	12.40^{c} (±1.27)	12.10^{c} (±0.55)	11.85^{c} (±0.75)	12.15^{c} (±0.98)
	b*	12.00^{c} (±2.31)	11.90^{c} (±2.80)	11.45^{c} (±0.95)	11.95^{c} (±1.05)	11.30^{c} (±1.26)
	$\Delta E^*_{(CC-CO)}$	0.97	0.86	1.08	1.20	0.58

Mean values of six replications ± standard deviation; Mean values within the same day denoted with the same small letter are not significantly different (P > 0.5).

On the other hand, the total color difference (ΔE*) between frankfurters with conventional and organic coriander was in the range of 0.58 - 1.20 during the 35 days of cold storage (Table 2), signifying that the observer could not notice the color difference

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between the samples, according to Mokrzycki and Tatol (19). This conclusion is supported by the fact that all color components measured in our study, lightness (L*), redness (a*) or yellowness (b*), did not exhibited significant differences between the samples with conventional and organic coriander throughout the examined period of shelf life.

Triangle test

The sensory analysis showed that the frankfurters with conventional and organic garlic can be distinguished as different (n = 75, nc = 42) at the level of α = 0.05. At the 95% confidence level, at least 20% of the consumers could distinguish between the samples. An average degree of difference for correct answers was 3.19 ±1.17, with no significant difference between the correct and incorrect answers (P ≥0.05).

The sensory analysis also indicated that the samples with organic and conventional coriander can be distinguished as different (n = 75, nc = 39) at the level of α = 0.05. At the 95% confidence level, at least 14% of the consumers could distinguish between the samples. An average degree of difference for correct answers was 2.15 ±1.20, with no significant difference between the correct and incorrect answers (P ≥0.05).

More consumers identified differences between the frankfurters with garlic than for frankfurters with coriander (42 compared to 39), and the overall intensity of difference was higher for "garlic" than for "coriander" samples (3.19 compared to 2.15).

Various factors that affect the chemical composition of garlic are involved in the production process and, therefore, could be a useful means to enhance the quality and the bioactive properties of the final product. Cultivation practices, particularly the fertilization schedule, are important, since they not only contribute to covering the crop requirements in nutrients, but also could beneficially influence the chemical composition and quality of the final product (20). Farming systems (intensive, conventional and organic farming) have been pointed out to influence not only plant growth and yield, but also the quality of the garlic, in terms of its chemical composition and quality features, such as allicin content (21). Perhaps, this can be an explanation for the observed differences in sensory perception between the organic and conventionally grown garlic used in our experiment.

Consumer preference

As can be seen from Table 3, the odor in organic spice is more intensive than the conventional one for both types of spices. This study confirmed that the sausages with organic garlic had statistically significantly higher odor intensity (6.68) compared to the sausages with conventional garlic (4.73), P <0.05. A similar situation was observed for the frankfurters with organic coriander, which received significantly higher (P <0.05) odor intensity scores (6.13) compared to the frankfurters with conventional coriander (4.73). Organic taste of garlic in sausages is more intensive (6.18) compared to the conventional one (4.65), with observed statistically significant difference (P <0.05). In contrast, the organic coriander had a less intensive, but not significantly different taste

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(5.50) compared to the sausages with conventional coriander (5.95, P >0.05). This can be explained by the previously published observations that the oil yield in the mature stage of ripening of coriander was slightly lower than for coriander under conventional agriculture (22, 23).

Table 3. Consumer preference of the frankfurters with conventional and organic spices

Sample	Odor[1,2,3]	Taste[1,2,3]
Garlic organic	6.68 ± 1.59[a]	6.18 ± 1.62[a]
Garlic conventional	4.73 ± 1.61[b]	4.65 ± 1.35[b]
Coriander organic	6.13 ± 1.68[c]	5.50 ± 1.95[c]
Coriander conventional	4.73 ± 2.18[d]	5.95 ± 1.95[c]

[1] *n* = 60;[2] The intensity scale ranking 1 = ‘‘very low intensity” and 9 = ‘‘very high intensity’;[3] Items denoted with the same small letter are not significantly different (P > 0.5).

CONCLUSIONS

This study reveals that garlic powder promotes lipid oxidation in frankfurters, while coriander powder does not exhibit this effect. The differences between conventional and organic spices in this matter could not be observed. On the other hand, when sensory attributes are concerned, it was clear that the frankfurters with conventional and organic spices can be distinguished as different by the consumers. Organic garlic contributed to more pronounced intensities of both odor and taste compared to conventional garlic, while for coriander the same was perceived by the consumers only for odor. It is also evident that there was a clear difference in color between the frankfurters with organic and conventional garlic. Based on the results of our study, it can be concluded that seasoning of frankfurters with organic spices can contribute to a significantly different sensory profile of this type of meat products.

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ИСПИТИВАЊЕ РАЗЛИКА УТИЦАЈА КОНВЕНЦИОНАЛНИХ И ОРГАНСКИХ ВРСТА ЗАЧИНА НА КВАЛИТЕТ ВИРШЛИ

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Виршле су зачињене конвенционалним и органским белим луком, односно коријандером и испитивана је разлика у њиховом укусу и мирису, боји и оксидативној стабилности током 35 дана чувања на хладном. Бели лук у праху, како органски (0,78 mg MDA/kg) тако и конвенционални (0,71 mg MDA/kg), промовисао је оксидацију липида у односу на контролне узорке виршли (0,52 mg MDA/kg). Потрошачи су оценили интензитете мириса (6,68) и укуса (6,18) виршли са органским белим луком као значајно израженије у односу на мирис (4,73) и укус (4,65) виршли са конвенционалним белим луком. Боја виршли произведених са органским, односно конвенционалним зачинима такође је била значајно различита. Са нивоом сигурности од 95%, барем 20% потрошача било је у стању да уочи разлике у боји између узорака са органским и конвенционалним белим луком, а најмање 14% потрошача уочило је разлике у боји између виршли са органским и конвенционалним коријандером. Резултати нашег истраживања сугеришу технолозима меса да би производња кобасица са органским уместо конвенционално узгајаним зачинима могла да доведе до побољшања њиховог квалитета.

Кључне речи: зачини, кобасице, сензорни квалитет, оксидација липида

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