EFFECT OF ROSEMARY ESSENTIAL OIL ON THE QUALITY OF PORK BURGERS

Nieto G. [1,2,3], Skibsted L.H.[2], Andersen M.L.[2], Patarata L.[3] and Ros G.[1]

[1] University of Murcia/ Department of Food Technology and Science and Human Nutrition. Murcia, Spain.
[2] Food Chemistry/Department of Food Science, University of Copenhagen. Frederiksberg C, Denmark
[2]University of Trás-os-Montes and Alto Douro/ Centre of Studies in Animal and Veterinary Science (CECAV), Vila Real, Portugal.

Abstract— **The aim of this study was to determine the effect of rosemary essential oil (*EO*) on the quality of burgers manufactured without synthetic additives and stored under retail display conditions. For that 3 batches of pork burgers (minced to 5 mm and 2% salt) were prepared: the control group *C*, R_1 (0.05% *EO*), and R_2 (0.4% *EO*). The patties were packed with modified atmosphere (70%O_2: 20%CO_2: 10% N_2) and stored for a maximum of 9 days at 4ºC. Meat spoilage was determined by measuring colour, microbiological analysis (total viable, total psycrophiles and mould and yeast counts, log u.f.c/g), and sensory analysis was carried out evaluating visual and odour attributes (Rancid Odour and Meat Colour) through descriptive analysis with 10 trained panellists. Analysis was performed at 0, 3, 6 and 9 days. *L*, *a**, *b** values showed that *EO* (R_1 and R_2) increased colour stability. From day 3 of storage had higher *a** values (P<0.05), which implies less pigment oxidation and a better appearance. This was contrasted with the sensory analysis. Independently of the dosage used, a positive effect of rosemary was found on meat colour and rancid odour. Regarding the antimicrobial effect of *EO*, significant differences from *C* group and R_1-R_2, was observed in mesophiles and psycrophiles during all the storage. The use of *EO* of rosemary improves the quality of burgers due to the fact that this delays the oxidation of fat and colour and microbiological spoilage, improving the appearance of the meat.**

Keywords— **Rosemary, antioxidant, antimicrobial**

I. INTRODUCTION

Consumers increasingly demand healthier meat products, if possible free of chemical additives. The use of natural preservatives to increase the shelf life of meat products is a promising technology.

Therefore, there is a clear need for new methods of preserving food using natural additives and a very interesting option is the use of essential oils as antioxidant and antimicrobial additives, because they are rich sources of biologically active compounds.

Rosemary (*Rosmarinus officinalis* L.), is a common dense, evergreen, aromatic shrub grown in many parts of the world [1]. The fresh and dried leaves are frequently used in traditional Mediterranean cuisine as an additive. In addition, rosemary is the only spice commercially available for use as an antioxidant in Europe and the United States [2].

Rosemary contains antioxidant compounds, the most active being phenolic diterpenes such as carnosic acid, carnosol, rosmanol, epirosmanol, isorosmanol, methylcarnosate and rosmarinic acid [3]. The external addition of these compounds have been shown to help prevent lipid oxidation and associated colour loss as well as decrease microbial growth in red meat packaged in modified atmosphere packs [4, 5].

Therefore the aim of this study was to examine the influence of essential oil of rosemary, in the sensorial properties, microbiology and colour stability of pork burgers stored in modified atmosphere packs.

II. MATERIAL AND METHODS

3 batches of pork burgers (minced to 5 mm and 2% salt) were prepared: the control group *C*, R_1 (0. 05% *EO*), and R_2 (0. 4% *EO*). The patties were packed with modified atmosphere (70%O_2: 20%CO_2: 10% N_2) and stored for a maximum of 9 days at 4ºC. Burgers shelf life was determined by microbiological, sensory and physical-chemical meat spoilage indices. Analyses were made on days 0, 3, 6 and 9 under retail display conditions. The microbiological and physical-chemical analyses were made on raw samples. The samples used for microbiological analysis were blended using a masticator (IUL Instruments, GMBH, Königswinter, Germany) and diluted in peptone water (Oxoid Ltd. CM0087, Basingstoke, Hampshire, United Kingdom).

Total viable counts (T) (cfu/g) and total psychrotrophs (P) (cfu/g) were determined on PCA (Plate Count Agar) (Oxoid Ltd. CM0325, Basingstoke, Hampshire, United Kingdom) (ISO 4833:2003) incubating at 37ºC for 24 hours (T) and 4ºC for 7 days (P) in a ST 6120 culture incubator (Heraeus S.A., Boadilla, Madrid, Spain). Moulds and yeasts (M) were counted on RB (Rose-Bengal) (cfu/g) (Oxoid Ltd. CM0549, Basingstoke, Hampshire, United Kingdom) with chloramphenicol (Oxoid Ltd. SR0078E, Basingstoke, Hampshire, United Kingdom) and incubating at 25ºC for 5 days (ISO 7954:1987).

Colour was measured using a CR-200/08 Chroma Meter II (Minolta Ltd., Milton Keynes, United Kingdom) making six measurements per burger. Results were expressed as CIELab values: Lightness (L^*), redness (a^*) and yellowness (b^*).

Sensory analysis was carried out evaluating visual and odour attributes (Rancid Odour *-RO-* and Meat Colour *-MC-*), through descriptive analysis with 10 trained panellists and was carried out according to ISO 4121 (2003).

The statistical model was designed completely at random. Rosemary essential oil addition was considered the main treatment. The effects of *EO* addition was analysed by ANOVA (Scheffe means Test). The computer statistics program used was Statistix 8.0 for Windows (Analytical Software, New York, USA).

III. RESULTS AND DISCUSSION

Table 1 shows the results of L, a^*, b^* values. In all the samples, lightness (L^*) increased with storage time. It has been reported than an increase in L^* value may be related to an increase in metmyoglobin formation [6].

From day 3 of storage R_1 and R_2 had higher a^* values (P<0.05) and lower b* values (P<0.05), which implies less pigment oxidation and a better appearance, as has also been described by O'Grady et al. [7]. The results showed that rosemary essential oil (R_1 and R_2) increased colour stability. This was contrasted with the sensory analysis (Table 2). Independently of the dosage used, a positive effect of rosemary was found on meat colour and rancid odour from day 3 and 6 respectively.

This resulted in greater colour stability in R_1 and R_2 from day 3 onwards, could be as result of decreased myoglobin oxidation, due to the presence in R of antioxidant phenolic compounds which impart a more intense red colour and better appearance to the meat. According the results shown in this study, several authors have studied the effect of different antioxidants on the colour of meat and meat products [8] and have reported that pigment oxidation lowers a^* values.

Therefore, controlling autooxidation by using antioxidants like rosemary essential oil may reduce the extent of colour degradation in meat.

The higher concentrations of *EO* (R_2) did not improved the results.

Table 1. Average values and SD of L^*, a^* and b^* coordinates in burgers at 0, 3, 6 and 9 days under retail conditions.

		Day 0	*Day 3*	*Day 6*	*Day 9*
L	C	43.6 ± 0.48	56.7 ± 0.21^a	54.1 ± 1.22^a	59.2 ± 0.34^a
	R_1	53.1 ± 1.56	51.5 ± 1.22^b	49.6 ± 0.36^b	56.8 ± 0.16^b
	R_2	54.3 ± 0.83	55.7 ± 1.44^a	54.7 ± 0.47^a	59.2 ± 0.56^a
a^*	C	18.8 ± 0.48	17.2 ± 0.02^b	13.1 ± 0.50^b	12.5 ± 0.18^b
	R_1	17.6 ± 0.44	17.4 ± 0.30^b	15.5 ± 0.18^a	13.7 ± 0.09^a
	R_2	19.4 ± 0.27	19.8 ± 0.30^a	16.2 ± 0.16^a	14.2 ± 1.20^a
b^*	C	9.46 ± 0.20	10.8 ± 0.25^b	9.96 ± 0.19^a	13.9 ± 0.05^a
	R_1	6.64 ± 1.06	8.99 ± 0.46^c	8.67 ± 0.09^b	10.4 ± 0.23^b
	R_2	9.14 ± 0.09	12.7 ± 0.01^a	9.74 ± 1.16^a	9.26 ± 0.87^b

M ± SD: mean ± standard deviation. C: control; R_1: 0.05 EO; R_2, 0.4% EO. a, b, c: different letters within a same columns (different rosemary treatment) differ significantly ($P < 0.05$).

Regarding the microbiological analysis, table 3 shows the effects of *EOs* on total viable (T), total psychrotrophs (P) and mould and yeast (M) counts pork burgers. In general all the microorganisms studied increased with storage time. Statistically significant differences ($P < 0.05$) in T and P appeared between C and the two rosemary and oregano levels groups from day 3 of storage. In contrast, although highest counts of mould and yeasts were observed in the control group on day 3 and 6, these differences were not significant ($P<0.05$) between *C* and *EOs* samples.

Table 2. Average values and SD of sensory attributes (Rancid Odour -*RO*- and Meat Colour –*MC*) in burgers at 0, 3, 6 and 9 days under retail conditions.

		Day 0	*Day 3*	*Day 6*	*Day 9*
RO	*C*	1.00 ± 0.00	1.00 ± 0.00	3.00 ± 0.25 [a]	4.00 ± 0.10 [a]
	R_1	1.00 ± 0.00	1.00 ± 0.00	1.00 ± 0.08 [b]	2.00 ± 0.05 [b]
	R_2	1.00 ± 0.00	1.00 ± 0.00	1.00 ± 0.00 [b]	1.00 ± 0.00 [b]
MC	*C*	7.00 ± 0.00	5.00 ± 0.31 [b]	4.00 ± 0.32 [b]	3.00 ± 0.10 [b]
	R_1	7.00 ± 0.00	7.00 ± 0.00 [a]	5.00 ± 0.15 [a]	4.00 ± 0.05 [a]
	R_2	7.00 ± 0.00	7.00 ± 0.00 [a]	6.10 ± 0.35 [a]	6.00 ± 0.25 [a]

M ± SD: mean ± standard deviation. *C*: control; R_1: 0.05 *EO*; R_2, 0.4% EO. a, b, c: different letters within a same columns (different rosemary treatment) differ significantly ($P < 0.05$).

The antimicrobial effect of rosemary has been widely demonstrated *in vitro* [12] and as a result of added directly to the meat and meat products, in beef meatballs [13]. By contrast, Ismail et al. [14] observed that external addition of rosemary decoctions had no effect on the microorganisms found in raw chicken.

The antimicrobial and antioxidant effect of rosemary essential oil are due to the phenolic compounds presents in the oil. Between the 39 components that were identified in the essential oil of rosemary, representing 89.5% of the total, the major constituents being, α-pinene (36.42%) camphor (15.05%), 1,8-cineole (12.02%) and camphene (11.08%), borneol (4%), β-pinene (3.67%), p-cymene (2.14%)and γ-terpinene (0.18%) [15].

These compounds are antimicrobial because interacting with the cell membrane of the microorganism, causing leakage of cellular components, changes in fatty acid and phospholipid constituents, impaired energy metabolism, altered nutrient uptake and electron transport, and changes in genetic material synthesis [16]. In addition, these polyphenolics act as antioxidants by means of a free radical scavenging mechanism and also through their known ability to chelate transition metals (inactivation of iron ions) [17].

Table 3 Average total viable count (*T*), total psycrophile count (*P*) and mould and yeast (*M*) (log ufc/g) in burgers at 0, 3, 6 and 9 days under retail conditions.

		Day 0	*Day 3*	*Day 6*	*Day 9*
T	*C*	4.37 ± 0.04	5.09 ± 0.04[a]	5.32 ± 0.02[a]	6.47 ± 0.04[a]
	R_1	4.14 ± 0.11	4.64 ± 0.04[b]	4.91 ± 0.01[b]	5.22 ± 0.02[b]
	R_2	4.17 ± 0.11	4.37 ± 0.06[c]	4.56 ± 0.06[c]	4.00 ± 0.08[c]
P	*C*	4.53 ± 0.05	5.62 ± 0.15[a]	6.32 ± 0.06[a]	6.49 ± 0.14[a]
	R_1	4.52 ± 0.01	5.17 ± 0.09[b]	5.72 ± 0.10[b]	6.01 ± 0.01[b]
	R_2	4.56 ± 0.03	5.22 ± 0.04[b]	5.60 ± 0.01[c]	5.90 ± 0.16[c]
M	*C*	3.44 ± 0.04	3.65 ± 0.04	4.06 ± 0.15	4.43 ± 0.17
	R_1	3.48 ± 0.10	3.39 ± 0.10	3.93 ± 0.10	4.65 ± 0.04
	R_2	3.44 ± 0.05	3.41 ± 0.01	3.84 ± 0.12	4.50 ± 0.18

M ± SD: mean ± standard deviation. *C*: control; R_1: 0.05 EO; R_2, 0.4% EO. a, b, c: different letters within a same columns (different rosemary treatment) differ significantly ($P < 0.05$).

IV. CONCLUSIONS

The use of essential oil of rosemary improves the quality of pork burgers due to the fact that this delays the oxidation of meat and colour and delay the microbiological spoilage, improving the appearance of the meat. As such this addition to the burgers is advantageous.

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